The Economics of Land Degradation for the Agriculture Sector in Tajikistan

A SCOPING STUDY

UNDP-UNEP Poverty-Environment Initiative in Tajikistan | Dushanbe 2012

UNDP – UNEP Poverty-Environment Initiative in Tajikistan

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Final Report

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The Poverty-Environment Initiative (PEI) is a global joint United Nations Development Programme (UNDP) and United Nations Environment Programme (UNEP) initiative supporting country-level efforts to mainstream environmental management into national and sub-national planning and budgeting processes through creation of knowledge base, technical assistance and capacity development. To foster change in policy and operational framework in the Government and Non-Government Institutions, PEI focuses on mainstreaming Poverty-Environment (P-E) issues into national and sub-national plans, sectoral strategies, budgets, training programs and tools to facilitate sustainable economic decision-making.

The Economics of Land Degradation for the Agriculture Sector in Tajikistan – A Scoping Study

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Introduction

1.1 Background to study

Land degradation is a serious and growing global issue resulting in losses to Gross Domestic Product (GDP) and local livelihoods, food insecurity, climate change and biodiversity loss. Worldwide it is estimated to be responsible for a 3 to 5 % loss in the GDP in affected countries. Land degradation is a major factor contributing to low agricultural productivity, the incidence of which is felt most keenly by the poor, whose livelihood is often dependent on agriculture.

In 2002 the Global Environmental Facility (GEF) reported, "On about one-fourth of the world's agricultural land, soil degradation is widespread, and the pace of degradation has accelerated in the past 50 years". The area of land subject to desertification and land degradation is increasing each year driven by a number of factors including unsustainable land use, demographic changes and growing water scarcity. These pressures are exacerbated by climatic changes and drought. The problem does not just affect arid zones; within the European Union (EU), some 12 Member States have declared themselves affected by desertification and almost half of European soils are now poor in organic matter (EU website).

In September 2011 the European Commission, the German Government and the Secretariat of the UN Convention to Combat Desertification (UNCCD) launched the Economics of Land Degradation (ELD) Initiative. The ELD initiative will be a comprehensive assessment of land degradation that looks both at the costs of failing to prevent further land degradation and at the economic benefits of addressing it through sustainable land management policies. A study of the cost of land degradation in Tajikistan is therefore very timely.

Like many other countries in the developing world, land degradation is a substantial problem in Tajikistan. For example, an estimated 97% of Tajik farmland has been harmed by the poor irrigation services and salinization. The agriculture sector contributes around 18% of Tajikistan's GDP so declines in land quality impact the country's economy through reduce productivity and/or higher production costs. Furthermore, the costs associated with land degradation directly impact the livelihoods of the rural communities. While only 7% of the territory is considered to be suitable for economic land use, about two third of Tajikistan's population living in rural areas depend on agriculture for their livelihoods.

Although the extent of the problem is documented in Tajikistan's National Development Strategy (NDS) 2007–2015 and the recently adopted Poverty Reduction Strategy (PRS) 2010-2012 (so called PRS3), adopted in February 2010, there has been relatively little national scale analysis of the cost of land degradation to the national economy.

Efforts to implement sustainable land use are a national priority (Tajikistan Government 2006a, 2009b) and measures have been taken to encourage Sustainable Land Management (SLM) via policies documented in both the Tajikistan National Environmental Action Plan and the Poverty Reduction Strategy of Tajikistan 2010-2012 (Tajikistan Government 2006a, 2009). In October 1997, Tajikistan signed the UNCCD, however, the uptake of actions encouraged by the Convention has been slow and depend on a series of complex social, economic, political, ecological, and funding factors (Tajikistan Government 2006b).

Given the importance of the sustainable use of agricultural land in accelerating and sustaining pro-poor economic growth in Tajikistan, there is an imminent need to acquire a better understanding of the magnitude of land degradation (LD) and the benefits of Sustainable Land Management (SLM). Demonstrating the net economic benefits of SLM relative to current practices will support future evidence based policy making in Tajikistan related to sustainable land management for agriculture development.

1.2 Objective of study

As part of the broader United Nations Development Programme and United Nations Environment Programme (UNDP/UNEP) Poverty-Environment Initiative (PEI), Phase 1 Project, the overall objective of this study is to develop a framework to assess the impact of land degradation and the benefits of SLM. The framework sets out an approach that can be generally applied in Tajikistan to provide information on the costs of degradation, benefits of SLM practices, and trade-offs involved in policy choices that could guide decision-making, with the aim of supporting the mainstreaming of poverty and environment linkages into the national planning and budgeting processes.

The specific objectives of the study are:

- To conceptually develop a methodological framework for assessing the impact of land degradation, that can be applied to the different types of land degradation in Tajikistan focused on the agricultural sector;
- To develop a database for collating the data required to undertake an economic assessment of land degradation at the national, regional or district scale, and to populate this database with available information. This will provide an understanding of data availability and key data gaps.
- To *partially* apply the methodological framework to assess the cost of land degradation in six pilot districts.
- To recommend future activities to develop the evidence base on the economics of land degradation in Tajikistan.
- To prepare a PEI Policy Brief for Government decision-makers based on the findings of the study.

1.3 Approach

This study was undertaken within a three month period. Key stakeholders were consulted at the outset of the project on the objectives of the assignment, proposed approach, guidance on key issues associated with agriculture and land degradation, and the availability of relevant data. This consultation was performed both through bilateral meetings with concerned parties and a national consultation workshop held in Dushanbe 1 November 2011. A list of meetings held and attendees at the first national consultation workshop is provided in Annex 3.

Field visit were undertaken to six selected pilot studies – three in the North and three in the South of Tajikistan. The purpose of the field visits was to inform district authorities of the study, learn from them the key issues associated with agriculture and land degradation in their districts and to seek their support in the collation of data needed to undertake the economic assessment. The results for the pilot districts are presented in section 5 of this report. A database was prepared for the collation of relevant data at the national/regional level and at the district level.

A second national consultation was held in Dushanbe 14 December 2011, to present and discuss the findings and recommendations of the study.

The main limitations and challenges of this study have been:

- The limited timeframe (only 3 months) has constrained the data collection process and the level of detailed assessment that can be undertaken. Given the short timeframe and resources for the study the key outputs of the study are the identification of key land degradation and agricultural issues and the collation of available data to economically assess these issues thereby providing the basis for a more detailed follow up research studies, based on the methodology developed[1]. **This report should therefore be seen as a scoping study on the economics of land degradation in Tajikistan.**

- There is generally a lack of reliable statistical data and up-to-date land degradation data in Tajikistan, and data collation is not a straightforward process given that it is held by a range of institutions.

1.4 Outline of report

The rest of this report is organised as follows:

Section 2 provides background on land degradation in Tajikistan – the extent and type of land degradation and the main causes. This chapter also includes a high level summary of the key Government institutions responsible for managing land degradation.

Section 3 outlines Tajikistan's agricultural sector.

Section 4 presents preliminary estimates of the cost of land degradation to the economy at the national level. This estimate is based on the on–site cost of the lost agricultural production resulting from degraded land out of use.

Section 5 presents the findings of the pilot studies for the six districts.

Section 6 provides a qualitative discussion of the opportunities for Sustainable Land Management in Tajikistan.

Section 7 concludes and presents recommendations for improving the economic evidence on the cost of land degradation and the benefits of SLM.

Annexes 1 & 2 provide a comprehensive conceptual methodology and stepwise approach respectively for undertaking an economic assessment of land degradation. These annexes may be used to guide a more comprehensive assessment of the economics of land degradation in the future.

1 Inputs included 35 days from an International Consultant, and part time contributions from three local consultants.

2

Overview of land degradation in Tajikistan

2.1 Background

Tajikistan borders Uzbekistan, Kyrgyzstan in the north and west, Afghanistan to the south and China to the east. The western deserts and semi deserts of the Turan lowlands gradually translate into foothills. To the east, there are the huge mountain ranges of the Tibetan plateau, Gindukkush and Tian Shan. In the north lies the Ferghana valley and the Kuramin range, the west of the country is covered by low hills and irrigational plantations. The central region of the republic is occupied by the Kuhiston mountain ranges. To the west there is the Pamir – the most mountainous region in Tajikistan. The Western Pamir includes high mountain ranges separated by deep river valleys. The topology of the Eastern Pamir is ratter smooth, and due to severe climatic conditions only high-mountain desert prevails in the Eastern Pamir (HYDROMET, 2008).

2.2 Extent and types of land degradation

As stated in a recent World Bank publication (Wolfgramm *et al*, 2011), no public authority in Tajikistan regularly collects data on soil quality and land degradation. That study concludes that the current situation with regard to the extent and degree of degraded land in Tajikistan is unknown and that despite continued reports of massive land degradation there is no statistical evidence of significant abandonment of agricultural land (exacerbated by the fact that abandoned land is not properly reported in statistics and therefore available statistical evidence is not reliable). The lack of reliable data probably explains while soil degradation is not included as a component in the calculation of the vulnerability index for Tajikistan. This section provides available estimates on land degradation in Tajikistan.

Available estimates suggest that 82.3% of all land and 97.9% of agricultural land in Tajikistan suffers some level of erosion – of this 88.7% suffer high and medium level of erosion. According to the Tajik National Action Program (NAP) UNCCD in 1993, 68% of the country's agricultural lands are subject to erosion.

The United Nations Economic Commission for Europe (UNECE), 2004 estimated that erosion affect 60% of the irrigated land, while the PEI project document states that due to land degradation patterns, an estimated 97% of farmed lands in Tajikistan "have been harmed by poor irrigation services and salinization." Degradation from erosion caused by overgrazing is estimated to involve approximately 3 million hectares, or 85% of total pastureland area (Asian Development Bank, 2004). Government statistics indicate that since 1991, 4% of the land has been completely destroyed by land degradation from unsustainable agriculture practices (UNDP-UNEP 2010; Tajikistan Government 2009).

In order to get a general overview on the state of land degradation Wolgramm *et al*, (2011) undertook an assessment based on expert opinion. The results indicate that experts consider pastures and haymaking areas, but also natural forests most affected by degradation. **Haymaking** areas are often not exclusively used for haymaking, but also for open grazing, and thus heavy degradation is widespread. Heavy degradation is also observed along infrastructures, such as roads and water canals. An estimated 90% of **rainfed cropland** is believed to show signs of degradation, of which 40% is heavy degradation. Of the **irrigated cropland,** 22% of the area is estimated to show heavy degradation, 38% light to medium degradation, and 40% no degradation. Degradation in forest plantations is estimated to affect around 70% of the area. Agroforestry systems are considered the least degraded, with heavy degradation occurring on 22% of the area, light to moderate degradation on 30% of the area, and half of the area, 48% not showing any degradation.

Notwithstanding the issues regarding data, the available estimates suggest that erosion and soil degradation are important problems in Tajikistan, especially in light of the dependence of the economy and local livelihoods on the agricultural sector.

The erosive processes are especially active in the foothill regions where poorly cemented sandstones, loess like loams and similar rock predominate that lend themselves to washing out and wind erosion. The two main factors underlying the process of soils degradation in Tajikistan are **water erosion** and **gully erosion.** However, anthropogenic factors accentuate the erosive processes through intensive development of agriculture on slopes and unsustainable cultivation practices (Saigal, 2003).

The incidence and causes of soil degradation vary across the country, depending on natural features, climate and land use. In the south of motley low hills there are small sites of the unfixed sand and zones of strong degradation (e.g. in Karadum and Kumjalolkum). Above these zones there are semi-fixed sands and areas of weak and average degradation. Among the sandy massifs there are raised areas, which are strongly subjected to water erosion. In the limits of Yavan, Gozimalik, Vakhsh and other districts there are sites of different degrees of erosion, mainly caused by water. In the limits of irrigated zones, a wide variety of erosion processes are at work. On the slopes of the mountain ranges (Babatag, Aktau, Karatau), a number of sites face water erosion to varying degrees (Saigal, 2003). Table 1 shows the extent and intensity of land degradation by main areas of Tajikistan pre 2000.

Table 1. Distribution soil erosion

Administrative districts and provinces	Degree of erosion (%)					
	Non-eroded	Weekly eroded	Middle eroded	Strongly eroded	Very strongly eroded	Common area
Kurgantyube group of districts	3.2	18.8	51.8	18.0	8.2	96.8
Kulyab group of districts	2.0	14.0	43.0	26.4	14.6	98.0
Leninabad provinces[1]	2.8	4.5	58.6	22.0	12.1	97.2
Hissar group of districts	4.3	9.4	40.2	31.5	14.6	95.7
Garm group of districts	0.5	4.2	35.1	32.9	27.3	99.5
GBA0	–	4.2	32.8	37.8	25.4	100

Source: Tajikistan Country Situation paper (CSP) as reported in Saigal, 2003.
Notes: 1/ Leninabad province became Sughd region in 2000.

2.3 The main causes of land degradation

Agriculture land in Tajikistan is vulnerable to both natural factors causing land degradation (as discussed above) and a number of anthropogenic factors. The main anthropogenic causes of agricultural land degradation are summarised below.

In appropriate management practices

Tajikistan is a highly mountainous country. Three mountain ranges occupy 93% of the land, and approximately half of the country is at 3,000 m or higher (World

Bank, 2007). Almost all mountains in Tajikistan have smooth surfaces known as “dashts” and “pushta”. The country’s topography has a strong influence on the types of crops that can be grown and also determines which machinery is used, the method of soil irrigation and the productivity of the land. **Intensive agricultural activity on slopes inevitably results in erosion.** Soils are washed out, and the development of ravines decreases the area of arable soils. Slopes up to 250m are widely cultivated without the implementation of any anti-erosion measures.

In addition excessive use of **pesticides and fertilizers** has resulted in the contamination of soil and waterways.

Poor water management / irrigation practices

One of the most pressing environmental problems in agriculture is the poor water management practices (World Bank, 2007). According to the Soil Research Institute under the Ministry of Agriculture, 60 percent of the irrigated territory in 1996 suffered from water erosion. The PEI programme document states an estimated 97 % of farmed lands in Tajikistan “have been harmed by poor irrigation services and salinization’. Inefficient use of water is attributable to:

- deterioration of storage and irrigation infrastructure involving water leakage;
- weak on-farm water management. In-field water use efficiency is often only around 20 percent and is rarely greater than 40 percent (due to the incorrect quantity of water used and/or water is applied inappropriately). Often field losses are not counted since there is no monitoring of water distribution and losses at the lower end of the system;
- primary and secondary salinization due to wind and water erosion;
- water-intensive cropping patterns; and
- the absence of regulatory incentives and disincentives to promote water conservation. Water charges are not related to volumes used, and are only partially collected.

An estimated 94 % of water is used for agricultural purposes (HYDROMET 2008)[2] and crops are generally watered by surface irrigation. About one third of area under irrigation is dependent on pumping. Irrigation water is diverted from rivers by gravity, but in many cases is then lifted by large pumping stations into main canals; as a result the provision of irrigation water is energy intensive.

The main problems associated with irrigation on the supply side are: (a) low river levels; (b) silting up of the main and distributary canal sections thus reducing the useable discharge; (c) excessive seepage losses from canals through cracked or broken linings or where repairs have been carried out with poor supervision using

2 According to Wolfgramm et al (2011) irrigated farming comprises 84 per cent of water abstraction with lesser shares for the domestic drinking and agricultural water supply (8.5 per cent), industry (4.5 per cent) and fishery (3 per cent).

inferior materials; (d) lack of working cross regulators so that efficient water distribution is not possible, i.e. serving different areas with different water demands on rotation; and (e) power shortages (Saigal, 2003). Erosion-control measures on irrigated lands have reportedly been put on hold for want of funds.

On the demand side, water shortages can be created in the downstream areas of the system because of heavy withdrawals at the head through users taking more than their share. For example, the hilly parts of cotton fields suffer from under watering, while in the places where there are depressions, crops suffer from an oversupply in water (Saigal, 2003). Both negatively affect the productivity of cotton fields. Waterlogging causes secondary salinity.

It is estimated that poor management and under-performing drainage infrastructure have caused salinization on 16% of Tajikistan's irrigated lands. Salinization has negatively impacted soil fertility. The Ministry of Water Resources and Land Reclamation estimates that salinization reduces cotton production by 100,000 tons per year (World Bank, 2007).

Rising water tables are also of concern. It is estimated that groundwater levels of three meters or less from the surface characterize nearly 30 percent of all irrigated lands. Lands in Sughd region are in most advanced stages of land degradation due to combined problems of **salinization** and high water tables.

Overgrazing

All pasture lands of Tajikistan are subject to erosion—with 89% of the summer pastures and 97% of winter pastures suffering from medium to strong erosion as a result of over grazing.

Deforestation

One of the most powerful anthropogenic factors affecting land degradation and desertification is the cutting of **mountain forests, bushes and half-bushes** that provide important watershed protection services. Illegal harvesting of forests for fuel is of common, especially on the forest lands of collective and state farms, while reforestation, replanting and forest maintenance are weak or non-existent. Natural forest coverage in Tajikistan has experience a dramatic decrease in the last century falling from 25% to 2% (Kirchhoff and Fabian 2010 cited in Wolfgramm *et al,* 2011).

These pressures on the land are set to intensify due to population growth and climate change. Whilst the area of arable land has remained fairly constant at around 850,000 hectares since 1980, Tajikistan's population, especially the rural population, has grown rapidly. Between 1979 and 2009 Tajikistan's population grew at an annual rate of 2.2%, rising from 3.9 million to 7.5 million. Over this same period the rural population more than doubled from 2.6 million to 5.5 million – a growth rate of 2.6% per annum. The density of rural population per hectare of ***arable*** land (including fallow land) rose from 3.1 per hectare in 1980 to 6.3 per hectare in 2009. The stress of rural population on arable land resources in Tajikistan is similar to that in Kyrgyzstan, Turkmenistan, and Uzbekistan, but an order of magnitude higher than in Kazakhstan, Russia, and Ukraine. There is considerable variability in stress on land resources across the 4 administrative regions of Tajikistan: it rises from about 6 people/ha in the regions with larger areas of arable land (Khatlon and Sughd) to 10 people /ha in Region of Republican Subordination (RRS) and 16 people /ha in Gorno-Badakhshan Autonomous Province (GBAO), where the stock of arable land is the smallest (Wolfgramm *et al,* 2011)

As part of the Pilot Program for Climate Resilience (PPCR), Wolfgramm *et al* (2011) provides an assessment of the likely impact of **climate change** on the agricultural sector in Tajikistan and the options and opportunities for sustainable land management practices to adapt to climate change. It is expected that Tajikistan will continue to become warmer, especially in the winter, with prolonged dry periods and increased risk of glacier outbursts. Tajikistan, with the rest of Central Asia and the Trans-Caucasus, is especially vulnerable to drought for both geographic reasons (high interannual rainfall variability, dependence on snowmelt) and structural reasons (economies heavily dependent on agriculture, inadequate hydrometeorological monitoring, and poor water management planning).

Tajikistan's widespread land degradation will increase the sensitivity of the land to climate change impacts. While the implications of climate change for the agriculture sector and the role SLM can play in climate change adaptation are considered to be highly significant for Tajikistan, further elaboration is not provided here; further detail is provided in Wolfgramm *et al* (2011).

2.4 Institutional analysis

A summary of the roles and responsibilities of the key Government institutions responsible for managing land degradation in the Republic of Tajikistan is provided below.

The Department for Agro-Industrial Complex and Land Management under the Executive Office of the President of the Republic of Tajikistan is responsible for developing long-term and short-term programmes and strategies on the sustainable use of natural resources (lands, forests, pastures, watercourses, water reservoirs, etc.); submitting calculations of economic losses caused by land degradation, and developing legal and regulatory acts dealing with reduction of degradation levels.

The Ministry of Agriculture of Republic of Tajikistan is a public authority identifying and implementing a single public policy in agriculture.

Core competencies of the Ministry of Agriculture in terms of natural resources (land) management are as follows:

- Monitoring and controlling land use and protection, and issuing regulatory provisions for correcting violations of land legislation;
- Improving methods of land resources use management within the current legislation;
- Developing public investment programmes on land resource management, improvement, sustainable use and conservation, and implementing programmes developed;
- Representing the Government of Republic of Tajikistan in international organizations;
- Monitoring and controlling the proper use of financial and material resources aimed at the sustainable use of land resources;
- Developing agronomic methods for the sustainable use of land resources and increased in crop productivity;
- Performing other functions identified by the Government of Republic of Tajikistan in the field of land resource management and protection.

The Ministry of Land Reclamation and Water Resources of Republic of Tajikistan is a central executive authority for water resources and land reclamation with functions related to elaboration of a single public policy and legal and regulatory framework in the field of: irrigated land reclamation; operation and maintenance of waterworks; water resources formation, use and protection; construction; rural water supply and pasture watering; protection of territories against harmful effects of waters and water pollution; rehabilitation of facilities damaged due to emergencies, floods, mudflows and other disasters; performing bank protection works; implementation of an effective investment policy; and, optimization of the of public centralized capital investments and the funds of enterprises and organizations within the system.

The Ministry of Economic Development and Trade is responsible for calculating economic losses caused by land degradation (by types of degradation and current prices); identifying the size of losses within and beyond the area; preparing annual statements, and bringing information to the Government.

The Ministry of Finance's role is to indentify capital investments required to reduce degraded areas, rehabilitate forests and pastures and sources of financing (national budget, local budgets, donors, etc.).

The Committee for Environmental Protection is an authority competent to protect natural resources against their unsustainable use, and responsible for identifying human-induced impacts on natural resources, degradation of flora and fauna of Republic of Tajikistan; evaluating environmental impact, and developing measures and ways to reduce impacts on the environment.

The Committee for Emergency Situations and Civil Defence under the Government of Republic of Tajikistan is responsible for identifying the impact of potential natural disasters; preventing loss of soil, infrastructure and human lives in emergency situations; calculating losses caused by natural hazards/disasters (mudflows, landslides, rock falls, washing of soils and river banks, bridges and drive ways, destruction of dwellings, human losses, etc.).

The State Committee for Land Management, Mapping and Geodesy's functions relate to collecting information on areas exposed to various types of degradation; identifying reasons for land degradation, losses of agricultural lands, forests and pastures; preparing reports on the status of land resource use in oblasts and rayons, and publishing data received in relevant official compendia (or on its website).

The Centre for Strategic Studies under the President of Republic of Tajikistan is responsible for carrying out research-works in the agrarian sector; indentifying prospects of land problems development and ways of their solution; developing strategies of short-term forecasts related to degradation reduction by types of lands, and ways of reduction.

The State Committee for Statistics under the Government of Republic of Tajikistan is involved in collecting required information on natural resources degradation, losses caused by various types of degradation, and publishing a separate compendium on natural resources degradation levels at the national level and in breakdown by oblasts and rayons of Republic of Tajikistan.

The Tajik Academy of Agricultural Sciences is engaged in identifying falls in productivity and increased pressures on agricultural lands; livestock population growth and productivity; pasture productivity levels; assessing and evaluating various types of soil; identifying sustainable soil management methods and conservation and methods for increasing soil fertility; improving species composition of livestock (livestock productivity degradation), etc.

Roles and Functions of Local Governments at Oblast, Rayon and Jamoat Levels
Within their administrative boundaries, Khukumats of oblasts, cities/towns and rayons have the following responsibilities related to sustainable land use and protection against degradation:

- Organizing and performing land management activities; approving land management documentation related to works of regional significance to be performed; on lands assigned for their jurisdiction, maintaining the state land cadastre, and land monitoring;
- Undertaking measures to prevent land degradation;
- Finding resources within local budgets to reduce degraded areas;
- Taking the lead role in sustainable management of natural resources: agricultural lands, forest areas, pastures, water resources, watercourses, irrigation and drainage networks, etc.

Roles and functions of agricultural producers, including farmers
Farming enterprises and agricultural producers independently identify their structure and production practices. A farming enterprise and its members are obliged to:

- efficiently use land for its designated purpose; increase its fertility; perform a package of activities on land, forest, and water protection, and prevent environmental deterioration caused by their economic activities;
- timely make rent payments and pay other types of land use taxes;
- facilitate efficient and effective land use, and crop productivity increase;
- in the established order, compensate damage for land productivity decrease and other types of degradation caused due to the fault of a land user;
- respect rights of other land users.

Box 1 summarizes the different types of farming practices in Tajikistan.

Box 1. Farming practices in Tajikistan

Land in Tajikistan is owned by the state. The post Soviet era land reforms involve a reallocation of state-owned agricultural land to farmers and households through the granting of land use rights – not land privatization. Since 1992 agricultural land has been mostly reallocated from the Soviet-era collective and state farms to so-called dehkan (peasant) farms, which exist in three organizational forms: individual dehkan farms, family dehkan farms, and partnership (or "cooperative") dehkan farms. Dehkan farms coexist with household plots – the traditional smallholder "private" agriculture that continues from the Soviet era after substantial augmentation with "presidential lands" (allocated by presidential decrees in two waves in 1995 and 1997). Wolfgramm *et al* 2011

Collective farms *(kolhoz)* refer to the form of collective agriculture that was used in the USSR, but was dismantled through a series of laws and government resolutions throughout the 1990's (Lerman et al. 2009).

A *dehkan* farm *(khojagi dehkani)* is defined by the government as an "independent business entity based on the private labour of one person, members of one family or a group of individuals which is based on a plot of land and other assets belonging to its members" (Tajikistan Government 2009b). Dehkan farms replaced the soviet collective farms and in many cases are operating in the same capacity and managerial structures as former collective farms.

Production cooperatives are established and legal business partnerships made between *dehkan* farmers within a *dehkan* farm, where *dehkan* farmers receive a share of land and associated assets (Tajikistan Government 2009b).

Subsistence production on small household plots provides about half of a household's income. Each household owns approximately 0.8 ha of land and some livestock.

Source: Hannah and Orr 2011 and Wolfgramm et al, 2011

3

Overview of Tajikistan's agricultural sector

3.1 Background

In 2010 the total area of agricultural land was 3,746,000 hectares, with cultivated area comprising 859,500 hectares (22 %) of this total area (Statistics Committee). The vast majority of agricultural land is pasture. According to Wolfgramm et al, 2011 the area of arable land has remained fairly constant at around 850,000 hectares since 1980.[3]

Cultivable land is confined primarily to irrigated river valleys. There are only four well-defined valley systems in Tajikistan (Wolfgramm *et al* 2011).

- the Ferghana Valley in the north of the country along the Syr Darya (this is the south-western part of the valley that stretches from Uzbekistan into Tajikistan);
- the broad Khatlon lowlands in the south-west, extending from Kulyab in the east to the border with Uzbekistan in the west;
- the Gissar Valley between Dushanbe and Tursunzade, just north of Khatlon;
- the narrow strip of the Zeravshan Valley extending east to west between Ferghana and Gissar valleys.

3 The HYDROMET (2008) states the total area of agricultural lands is 4,574,000 ha, or 32% of the total land area, with 739,000 ha of arable land.

Land resources show considerable variability across regions. GBAO is the least agricultural region, with negligible endowments of cultivable land while Sughd is the most agricultural region, with more cultivable land than Khatlon. RRP has 80% of its agricultural resources in pastures.

As a semi-arid country agricultural land use is largely dependent on irrigation. Arable agriculture in the water-abundant river valleys has benefited from the development of artificial irrigation networks. The irrigable area increased from 450,000 hectares in 1960 to 720,000 hectares in 2009, or 18% of all agricultural land. Of the total irrigated area, 580,000 hectares (80%) is irrigated arable land and 140,000 hectares (20%) is irrigated pastures. That is, irrigation covers nearly two-thirds of arable land and less than 5% of Tajikistan's pastures (Wolfgramm *et al* 2011). The share of irrigated agricultural land is just 3% in GBAO, 20%-30% in Khatlon and Sughd, and 10% in RRP (Table 2).

Table 2. Structure of different land use types across regions (percent of agricultural land)

	Agriculture		All land	Arable		Pastures	
	Rainfed	Irrigated		Rainfed	Irrigated	Rainfed	Irrigated
Tajikistan	81.8	18.2	100.0	6.9	14.7	74.9	3.5
GBAO	96.8	3.2	100.0	0.3	2.0	96.5	1.2
Sughd	71.4	28.6	100.0	8.5	20.8	62.9	7.8
Khatlon	78.9	21.1	100.0	7.7	18.6	71.3	2.5
RRP	89.1	10.9	100.0	7.4	8.9	81.6	2.1

Source: Wolfgramm et al 2011

3.2 Key agriculture sub-sectors[4]

Cotton: Cotton, along with aluminium, has traditional been the mainstay of the Tajik economy, however following a Government decision to reduce cotton growing area in favour of food production, the cotton producing area was reduced to 162,428 hectares in 2010, compared to 288,655 hectares in 2005. The area planted as orchards is increasing and fruits and horticultural products are becoming more important than cotton. Nonetheless cotton remains the principal cash crop accounting for 60 percent of agricultural output. The Tajik government provides financial assistance for cotton

4 This section draws heavily from ' Consolidated Document Agrarian Reform of the Republic of Tajikistan Primary Priorities August 2009 to December 2010'

farming. While cotton is one of Tajikistan's most valuable export commodity (contributing to about 20% of exports), cotton profitability is low. Cotton is also the primary source of income for 75% of poor households.

Cotton has been planted extensively in semiarid tracts using irrigation networks that have not been well maintained, resulting in soil damage from salinity and chemical fertilizers and the spread of toxic elements to downstream fields, endangering populations. Since independence, Tajikistan has stopped using toxic chemicals in agriculture and greatly reduced the amounts of mineral fertilizers applied. Due to lack of access to quality seed and appropriate technology, compared to most cotton producing countries cotton yield in Tajikistan is low, at 1.5 -1.6 ton/ha (the average yield in other developing countries is around 2 ton/ha). The absence of crop rotation in cotton fields has impacted soil fertility and in many areas, severe to medium soil degradation can be witnessed. However declines in productivity are also due to climatic factors (heavy rains, high water caused by mud flow, high air temperature accompanied by drought, strong winds and dust storms, frosts and extreme cold). Other challenges include poor water management; debts of restructured farms transferred to the newly formed dekhan farms; lack of knowledge among farmers and rural population on their rights and privileges, best practices, market economy and technical progress; shortage of necessary materials, micro-credits, property and resources to increased agricultural productivity; lack of information and advisory centres (HYDROMET, 2008). Processing technology is poor and access to markets limited, thus farmers end up selling their produces as raw material to middlemen. Incomplete land reform and interference by some local authorities in farm management continues to impede and obstruct investment by the farmers in the sector.

Cereals: Wheat is the second major crop in Tajikistan, after cotton, and the major staple food. Wheat makes up over 80% of the cereal yields, followed by maize, rice and small quantities of other cereals. However, due to absence of quality seeds, fertiliser, appropriate technologies and deteriorating irrigation infrastructure yields are low at around 3 ton/ha for wheat and 4 ton/ha for maize compared to average yields in other developing countries of around 6 ton/ha and 7 ton/ha respectively. Encouragingly research on pilot plots has shown that a two grain harvest per year is possible, which could potentially double cereal production.

Potato: Potato is the second major staple food in Tajikistan. The bulk of the potato crop is grown in mountainous areas both for consumption and for seed production; some potatoes are cultivated in the plain areas for consumption. According to some statistics there has been a drastic increase in potato production – over 600,000 tons in 2009, representing more than a 400% increase compared to 2005 production. However, production suffers from a lack of access to quality seed and fertiliser, access to appropriate technology, production, processing and marketing. The absence of rotation in potato farms not only reduces soil fertility and has led to spread of serious plant diseases, but it also reduces farmers' opportunity to make use of crop rotation to produce fodder for livestock.

Fruit and vegetable: In 2010, fruit production covered an area of 73,879 hectares, compared to 27,000 hectares in 2000. Similarly, vegetable production went up to 44,769 ha in 2010 compared to 30,029 hectares in 2000 (Statistics Committee). Viticulture and melon growing also increased significantly over the past five years, while citrus production decreased slightly. Most of the fruit and vegetable is produced by private households, presidential and similar and is largely consumed within Tajikistan, except for dry fruit for which there are export opportunities. Fruit and vegetable production has traditionally been very important in Tajikistan, however over the past 10 years barriers to development have included access to water, deteriorating infrastructure, market access and service delivery.

Fodder crops: During the Soviet era pastures, as a source of fodder, were only used as a last resort with the main sources being fodder grown on collective farms and Concentrate Feed imported from the other republics. Now, with the drastic reduction in local/national fodder production and the absence of imported concentrate feed, pastures are under pressure. Of the estimated 3 - 3.8 million ha of pasture land only around 3,500 ha are irrigated; the rest are rain-fed. With limited transport and infrastructure, most livestock herders cannot access the large summer pastures and have to rely on lower altitude pastures. Overgrazing is resulting in serious soil degradation that often causes serious land / mudslides and severe floods. Despite efforts by the government and international agencies to increase fodder production, there has been a steady decline in fodder production over the past 5-6 years. Farmers are growing maize instead of traditional fodder crops such as Lucerne and Alfalfa because in times of difficulties maize can also be consumed by households. Lucerne and Alfalfa would support the soil and increase fertility and subsequently productivity, therefore shot-term measures are being adopted at the cost of long term sustainable development of the sector. The country lacks a significant pasture rehabilitation and development programme.

Livestock: Since 2001 this sub-sector has experienced fast growth, with the number of livestock (cattle, goat and sheep, poultry and others) more than doubling by 2009. There are over 1 million head of cattle and around 3 million head of sheep and goats. While in absolute numbers small ruminants outnumber large cattle, sheep account for only 18% of the weighted-average headcount in cow equivalents (calculated with a weight of 10 head of sheep per 1 cow equivalent), while about 80% of the livestock herd is cattle (Hannah and Orr, 2011). Meat, milk, honey, egg, wool and other livestock products increased in general over the period 2001-2009 however, production per unit decreased drastically over this period. This was due to persistent diseases along with a lack of: access to proper feed; appropriate technologies; pure breeds; access to markets; and, knowledge on marketing strategies. Milk production, for instance, decreased from 5 litres per cow to 4 litres between 2005 and 2009.

Table 3 summarizes the key issues surrounding the main agricultural sub-sectors in Tajikistan.

Table 3. Overview of key agricultural sub-sectors

Agricultural sub-sector	Area (ha) or number of livestock, 2010[1]	Productivity / ha or per animal[2]	Issues
Cotton	162,428	1.5 – 1.8 ton /ha	Low productivity - average for mostly other developing countries in 2 tons/ha. Due to lack of access to quality seed and technology Severe to medium soil degradation (loss of soil fertility) due to absence of crop rotation
Cereals (wheat, maize, rice)	369,954	Wheat: 3 tons / ha Maize: 4 tons / ha	Productivity low due to absence of quality seeds, fertilizer, appropriate technologies & deteriorating irrigation infrastructure
Potato	31, 764	19,7-22,3 tons / ha	Lack of access to quality seed and fertiliser, access to appropriate technology, production, processing and marketing. Absence of rotation in potato farms reduces soil fertility and has led to spread of serious plant diseases. It also reduces farmers' opportunity to make use of crop rotation to produce fodder for livestock.
Fruits	27,171	2,8-3,5 tons / ha	Access to water, deteriorating infrastructure, access to market and service delivery
Vegetables	44,769	1 ton/ha	As above
Livestock	1,896,894 Cattle	Milk production 4 litres per cow in 2009	Productivity is low due to a lack of access to proper feed, appropriate technologies, absence of pure breeds, access to markets
	4,394,192 Goat & Sheep		As above
Pastures	3.8 million		Only 3,600 ha are irrigated, the rest are rain fed. Pastures in low altitudes are degraded. In some area pastures have been taken over by wheat growing and lack any significant pasture rehabilitation and development programme.. These degraded pastures are causing severe floods and mudslides in some areas during the rainy season. Reliance on lower level pastures, resulting in serious soil degradation that often causes serious landslides, floods and similar natural disasters

Source: 1/State statistics 2/Consolidated Document Agrarian Reform of the Republic of Tajikistan, Primary Priorities August 2009 to December 2010:

4

Preliminary macro assessment of the economic costs of land degradation

Annex 1 provides a conceptual framework for assessing the costs of land degradation and the benefits of SLM in Tajikistan. This is supported by a stepwise methodology for undertaken the assessment presented in Annex 2. The analysis presented in this section adopts aspects of this methodology to derive preliminary estimates of the cost of land degradation at the national, regional and district level, based on available data. Further research to refine these estimates is required.

In 2003 a study by the Asian Development Bank (ADB) concluded that there was no comprehensive study to estimate the economic costs of land degradation in the country (Saigal, 2003). The closest approximation is some evidence of decline in agricultural productivity provided in the Tajik National Action Program – United Nations Convention to Combat Desertification and Drought (NAP – UNCCD). This study therefore represents the first dedicated study on the economics of land degradation in Tajikistan.

4.1 The links between land degradation, agriculture and poverty

There is a close nexus between land degradation and poverty. Poor rural households in Tajikistan are highly dependent on natural resources for their livelihood and are most affected by environmental degradation, contamination of water sources and the outcome of natural disasters including droughts and floods. It is therefore important that policy makers involved in the PRSP process factor in the economic impact of land degradation in macro-economic and sectoral strategies (Saigal, 2003).

Land degradation is a key factor leading to low agricultural productivity and consequently low economic returns and reduced incomes for farmers. Furthermore, the poor returns from agriculture induce emigration of rural youth, which undermines economic growth in rural communities by depriving the agriculture sector of the energetic workforce required for sustainable development and management of land resources.

The significance of the agricultural sector in Tajikistan to the national economy, rural livelihoods and poverty alleviation is presented in Box 2. The productivity of the agriculture sector is underpinned by the quality of the land and its availability (quantity).

Box 2. Agriculture's contribution to the national economy and rural livelihoods and links with land degradation

Agriculture makes a significant contribution to the national economy: Tajikistan's economy relies primarily on the agricultural sector, a few large-scale industrial complexes, and hydropower. Major outputs and exports are cotton, aluminium, and hydroelectricity. The agricultural sector accounted for more than one-third of the overall economic growth between 1998 and 2004 (PEI brief), and it provided around 18% of GDP in 2010 (Statistic Committee). Furthermore 18% of export revenue is attributable to agriculture, with cotton being the key agricultural export crop (Statistics Committee).

Agriculture is country's main employer and the majority of the population depend on agriculture for their livelihood. The agricultural sector employs 1,471,000 people (60% of the workforce), and around 5.5 million people, 80% of the population, depend directly or indirectly on agriculture (Statistics Committee)[5].

Agriculture is the platform for improving local livelihoods and tackling poverty. Tajikistan's GDP per capita is the lowest among all Commonwealth of Independent States (CIS) countries (US$2,000 Purchasing Power Parity (PPP) in 2009 compared with US$18,000 for Russia, US$7,000 for Azerbaijan, and US$6,000 for Ukraine) (World Development Indicators, World Bank on line database). Rural poverty rates are still high with around 43% of the rural population living below US$2.15 per day (PPP), compared with 30% for the urban population ("Analysis of poverty in Tajikistan", TajStat, 2010). These poverty rates

5 It is estimated that one million Tajik citizens are working abroad – roughly 14% of the total population of 7 million. Remittances from abroad contribute to about 30-40% of the national GDP (IOM 2011).

based on the 2009 standard of living survey are lower than the corresponding rates recorded in 2003 and 2007, indicating an increase in poverty headcounts over time (Wolfgramm *et al* 2011). Undernourishment rates of 30% are also high relative to other regions (10% for all of Central Asia, 7% for Trans-Caucasia (Armenia, Georgia, Azerbaijan), and 16% for developing countries as a whole).

Given that agriculture is the main employer in rural areas, with 66% of the workforce engaged in agriculture, and the high rates of rural poverty improvements in agricultural performance are the primary bases for increasing the livelihoods of the rural population, addressing poverty and providing jobs and an affordable food supply. In a representative survey of 11,600 rural households conducted by TAJSTAT in November-December 2010, 20% identified agriculture as the only or main source of income, while another 75% reported that agriculture was a supplementary income source (TAJSTAT 2011).

Sustainable agriculture underpins food security. The provision of food security, specifically production of grain and potato crops is of strategic importance to the country. The yield in 2007 constituted more than 1 million tons of wheat and 500,000 tons of potato, which does not satisfy the country's needs (HYDROMET, 2008)

Gender. An estimated 14% of Tajikistan's workforce are working in Russia and neighbouring countries. Most of the rural population is therefore female and make up the majority of the labour force in agriculture sector, including seasonal employment. A sustainable and viable agriculture sector is therefore important to female workers and to the cohesion of rural communities.

Agricultural output depends on the quality and quantity of Tajikistan land and soils while land degradation imposes significant costs on the economy and hampers poverty reduction

4.2 The on-site and off-site costs of land degradation /soil erosion

An attempt has been made to establish the current cost of land degradation in Tajikistan. This analysis will then provide the bases for scenario analysis under which the Business As Usual scenario can be compared to a Sustainable Land Management scenario (see Annex 1). While this baseline analysis represents a static assessment, scenario analysis involves an analysis of trends in agricultural output, costs, and environmental impacts over a defined timeframe and is therefore able to make judgments on the sustainability of different land management practices.

The analysis is focused on the on-site and off-site impacts of land degradation associated with agricultural practices. It is acknowledged that land degradation is also caused by the activities of other sectors and by natural causes, this can impose costs on the agriculture and other sectors, however this broader analysis is not the focus of the analysis presented here[6].

The key on-site and off-site impacts of agriculture are summarized below and in Table 4.

- On site impacts of agriculture - impacts from land degradation occurring on agricultural land associated with poor management practices.
- Off-site impacts of agriculture - impacts on agriculture of land degradation occurring outside of agricultural land boundary under study. For example, overgrazing in the uplands can impact agriculture productivity in the valleys by increasing siltation of water reservoirs, which can reduce available irrigation water and thereby result in a reduced area under cultivation.

Table 4. Summary of on-site and off-site costs of land degradation

On site costs	Off-site costs
Losses of crop yield ■ Increased costs of remedial measures ■ Increased use of fertilisers to replace lost nutrients ■ Adoption of less erosive but more costly management practices ■ Repairs of damaged structures ■ Disruption to site operations Loss of soil carbon	Property damage ■ Run-off, sedimentation and nitrification ■ Deterioration of water quality ■ Sedimentation of hydropower reservoirs and irrigation reservoirs ■ Treatment costs of downstream users ■ Impact of flow modulation and frequency resulting in flood damage ■ Impacts on navigation ■ Health impacts related to reduced water quality ■ Deterioration of recreation and amenity values ■ Habitat degradation Dust nuisance Visual detraction

Source: adapted from Jones et al, 2008

The on-site and off-site costs of land degradation relating to arable land and pastures at the national scale are discussed below.

6 Impacts on land quality by non-agriculture sectors include the impacts of deforestation and infrastructure developments that cause land degradation. For example deforestation can affect water flow and lead to flooding, landslides and changes in water supply.

4.3 On-site costs

4.3.1 Arable land

Land Abandonment

As discussed in section 2, despite reports of widespread land degradation there is little statistical evidence of significant abandonment of agricultural land. Abandonment of farm land can be measured by the difference between the total stock of arable land (the potential for crop production) and the actual cropped area. According to official statistics the area of cultivable land (arable land and land under orchards and vineyards) has remained fairly constant at around 850,000 hectares since 1980 as shown in Table 5 (Wolfgramm *et al,* 2011). However, since abandoned land is not properly reported the complete picture is not known. The cropped (sown) area increased during the transition (especially after 1995) and since 2000 the ratio of sown to arable land has been around 100%, implying that virtually all available arable area is reported under crops (Table 5). Farm surveys also generally show that most of the land allocated to farms is cultivated, with very little land left unused. In the World Bank's 2009 CSRP baseline survey, the unused portion of land in surveyed farms was less than 1% (Wolfgramm *et al,* 2011).

The inconsistency between the reported statistical data and the opinion of experts that there are large areas of unused land therefore requires more in depth

Table 5. Utilization of arable land 1980-2009

Year	Total sown, '000ha	Arable land (incl fallow) 000 ha	Ratio of sown to arable, %
1980.	763.6	845	90
1985	802.8	859	93
1990	824.2	873.3	94
1995	758.0	865.1	88
1998	827.6	879.1	94
2000	864.3	881.7	98
2003	886.9	865.3	102
2006	900.2	897.7	100
2007	891.1	891.4	100
2008	888.9	889.0	100
2009	875.1	884.6	99

Source: Wolfgram et al, 2011

Table 6. Agricultural Land Out of Use 2005-2011

	Area out of use (ha)		Reason why land is out of use in 2010								
	Total	Irrigated Land	Salinization & over watering	Irrigation infrastructure damage	Mud slides	Lack of ameliorative activities	Repairing of water supply equipment	Water shortage	Drought	Inappropriate farming practices	
										Total	Irrigated land
District under Republic Subordination	2,044	241	0	10	0	0	0	103	1,194	738	128
Sughd Region	8,751	7,716	136	105	9	0	38	6,123	0	2,340	1,305
Khatlon Region	11,128	6,922	1,595	1,782	27	898	0	1,646	1,629	3,550	974
Badakhshon Region (GBAO)	0	0	0	0	0	0	0	0	0	0	0
Total in Republic 2011	**21,923**	**14,880**	**1,731**	**1,897**	**36**	**898**	**38**	**7,872**	**2,822**	**6,628**	**2,407**
Total 2009-10	19,290	15,297	2,114	3,245	148	880	166	6,426	na	6,311	2,518
Total 2007-8	14,272	12,209	1,280	1,914	32	704	0	7,526	n.a	2,816	753
Total 2005-6	6,256	5,220	480	39	601	0	0	4,653	n.a	483	0

Source: GOSKOMZEM (State Committee on Land Management of Tajikistan) evaluation. It may be that much of the arable land officially reported as sown or cropped is degraded and therefore produces below average yields. However, this is also not observed in harvest and crop yield statistics, which with the exception of cotton, do not reveal signs of under-productivity (Wolfgramm *et al*, 2011).

Statistical data is however available from the State Committee on Land Management of Tajikistan Table 6 on the area of land out of use due to, for example, salinization and overwatering and damage to irrigation infrastructure. The area of land out of use is seen to have increased from 6,256 ha in 2005/6 to 21,823 ha in 2011; a 250% increase in land loss / degradation. Around 68% of this degradation is occurring on irrigated lands highlighting concerns over water management and maintenance of irrigation infrastructure. Khatlon and Sughd regions are primarily affected, accounting for 50% and 40% of the total unused land respectively.

If it is assumed that this land could have been used to grow cotton or grain (cereals), the cost to economy in lost productivity is estimated at between US$185-208 million a year (Table 7). This is based on the following assumptions:

Cotton – average production per hectare of 20 centner (2,000kg) (Ministry of Agriculture) * market price per ton of 3,734 Somoni a ton * number of hectares lost (21,823ha) = Somoni 1,629,756,576 per year (US$ 307,399,221).

Cereals – average production per ha 30 centner (3,000 kg) (Ministry of Agriculture) * market price of 1,400 Somoni * number of hectares lost (21,823ha) = 916,574,000 Somoni or US$208,312,364.

These values are an over estimate of the value of lost production as the costs of production have not been deducted, that is they ate gross rather than net estimates.

Table 7. Value of production lost due to land out of use due to degradation

	Productivity tons per ha / year[1]	price per ton / Somoni, 2010 prices[2]	value per ha / year (Somoni)	ha unused	Value of lost production Somoni (year)	Value of lost production US$ (year)
Cotton	2	3,734	7,468	218,232	1,629,756,576	370,399,211
Grain	3	1,400	4200	218,232	916,574,400	208,312,364

Source: 1/ Source – Ministry of Agriculture; 2/ Source - Agency of the Statistical Committee under the President PT 2006-2011 and Operative Reports of Ministry of Agriculture. The price of cotton in 2009-2010 doubled encouraging production

Box 3 discusses the links between water management and land degradation in Tajikistan.

Box 3: Water Management and Land Degradation

The main cause of land degradation in the valleys (lowlands) is considered to be the uneconomic use of water. The climate in Tajikistan is warm and dry in summer and crop agriculture is heavily dependent on irrigation.

The irrigation and drainage infrastructure is based on large-scale systems built during the Soviet period 1930-1980. The area under irrigation increased from 450,000 hectares in 1960 to 700,000 hectares in 1990; and stabilised around 720,000 hectares. The system is complex, there are about 515 pumping stations; minor and major irrigation canals with a total length of 26,194 km; 8,320 km long various drainage line and facilities; 1,823 ameliorative and irrigation wells; 377 substations and 145.6 km of power transmission lines; 10 water reservoirs for irrigation and energy-supply purposes, and other auxiliary infrastructure.

While river water is abundant in Tajikistan it does not always reach the agricultural end-users due to the degraded irrigation infrastructure. About 60 percent of irrigated lands are served by gravity irrigation systems with hydro technical constructions built in the middle of the past century, 50% of which are now physically worn out. The technical condition of pumping stations' penstocks is of serious concern. They have been used for over 40 years and more than half of them are not working and need replacing.

The social and economic consequence of pump systems failing is extreme due to the high cost of repair and maintenance. The majority of irrigation systems are managed by farmers, who do not have the finances to maintain them; around 50% of drainage canals have not been cleaned for 20 year, resulting in groundwater degradation. While donor supported pilot studies have been successful, the benefits are temporary as after 5 years the canals need cleaning again. This highlights the need for long term funding and planning (annual maintenance budget). Prior to 1990 the government received US$250million a year to manage the system. Now they are allocated US$10million from the state budget, which is intended to be supplemented by fees for water management service amounting to 7 million Somoni (US$ 13 million), but in reality only half of this is collected. In addition it is estimated that around US$600million in capital investment is required to restore the irrigation system to its pre-1990s standard.

After payment for water supply was introduced in 1996 the reliability of water intake and water supply records has significantly decreased. So, while the total area of irrigated lands increased by 3.3% from 1996 to 2008, water users report water intake decrease by up to 30%. Furthermore, the overwhelming majority of farms (about 35,000 farms) do not have the means to keep water records, which causes difficulties in payment for water supply services. Out of 5,200 water delivery points (former collective and state owned farms), only 38 percent is nominally equipped with water metering devices (MLRWR).

There are 62,000 dekhan farmers (but unofficially there may be more than 100,000 water users) more than 50% can't manage water resources properly. It is common for people near pumps to take too much water leading to waterlogging, leaving people further away from the pumps with too little water leading to low crop productivity. **Water user associations** are being promoted as a means of improving water management. These associations will be responsible for the management and allocation of water.

Lost productivity

As well as areas being totally lost to production as a result of land degradation, reduce levels of output are likely on degraded lands that are still being cultivated.

For example, it is estimated that there are 100,000-120,000 ha of salinized soils spread between the North and South of the country (HYDROMET 2008). Due to the salinity of lands, the country is estimated to experience losses of 100 thousand tons in cotton yields and other agricultural products, reducing the quality of these products as well (HYDROMET, 2008). Under a changing climate, as temperatures rise and evaporation increases, prevention of degradation by salinization is becoming more difficult.

Table 8 shows the cultivated area and harvest for key agricultural crops for the period 2005-9 (Ministry of Agriculture). The data shows an increase in the productivity for the majority of crops over the period 2005-2009, including cotton, and the total area of land under cultivation increasing from 1,404.040 hectares to 1,433,467 hectares. It is not clear how to reconcile this evidence with the concerns over land degradation. It is possible that declines in land quality / soil fertility have been offset by the increased use of fertilizer and investments in land management. Further studies are therefore required to better understand the contribution of different factors to agricultural productivity.

Based on the crops seen to suffer a fall in productivity over the period – that is corn for seed, rice, other grains and tobacco, the value of lost production is estimated at **607million Somoni per year in 2009 (US$138 million)** as set out in Table 9.

This analysis assumes that the change in productivity is wholly attributed to the degree of land degradation, whereas in reality productivity is influenced by a number of factors including – management practices (including the use of fertilizers, types of seed used), climate and geography and labor effort.

Data on use of fertilizers is unavailable at the national level, and expenditure on fertilizers may have gone up to compensate for declining soil fertility.

Head of economic and strategic policy of Ministry of Agriculture: S. Mahmadiev

Table 8. Cultivated area and harvest for key agricultural crops 2005-10

Name of products	2005			2006			2007			2008			2009			2010	
	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Increase / decrease
Grains:	395,565	19,7	934,880	401,912	20,6	912,280	396,880	20,5	931,204	438,152	20,9	942,894	461,741	25,2	1,294,522	456,595	↑
Wheat	317,738	19,6	618,467	320,694	19,9	640,339	307,961	20,6	649,300	331,766	20,6	659,096	358,766	25,1	938,435	341,933	↑
Corn for seed	**9,984**	**40,5**	**155,813**	**10,137**	**37,7**	**138,885**	**11,383**	**40,1**	**130,075**	**14,516**	**38,4**	**136,428**	**14,411**	**37,8**	**142,515**	**12,590**	↓
Rice	**10,264**	**32,7**	**62,404**	**10,692**	**31,4**	**48,536**	**10,806**	**30,7**	**52,109**	**10,251**	**31,9**	**53,989**	**14,559**	**30,7**	**63,416**	**14,790**	↓
Barley	44,744	15,1	64,484	47,200	16,1	62,325	51,456	14,7	71,039	64,829	14,7	57,601	57,894	18,8	101,685	69,476	↑
Other grains	**12,835**	**26,3**	**33,712**	**13,189**	**16,8**	**22,195**	**15,274**	**18,8**	**28,681**	**16,790**	**16,3**	**35,780**	**16,111**	**14,8**	**48,471**	**17,815**	↓
Cotton	288,655	15,6	447,918	262,893	17,0	437,898	254,830	16,6	419,786	237,130	15,6	353,146	168,916	17,8	296,015	162,389	↑
fine-fibered	17,346	16,4	28,463	25,442	14,6	37,099	14,538	19,5	28,320	8,298	14,0	10,883	897	22,2	1,988	740	↑
Tobacco	**1,178**	**18,8**	**1,609**	**1,160**	**14,4**	**1,301**	**374**	**14,7**	**516**	**136**	**14,7**	**189**	**199**	**11,8**	**235**	**302**	↓
Sunflower for seed	1,794	10,0	2,121	2,029	12,3	4,012	2,310	13,5	3,490	2,236	14,0	3,274	3,771	13,2	5,254	3,805	↑
Flax	22,973	4,7	10,342	19,480	4,7	8,098	18,638	4,6	8,188	18,164	5,2	8,310	19,192	5,4	9,824	18,654	↑
Potatoes	27,483	196,2	555,126	27,935	198,5	573,687	29,752	218,4	662,093	28,676	226,9	679,774	29,838	223,1	690,853	31,463	↑

Name of products	2005			2006			2007			2008			2009			2010	
	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Increase / decrease
Vegetables	33,429	186,8	718,475	35,768	186,9	759,737	39,110	190,2	835,131	37,162	198,8	908,225	40,803	208,0	1,046,859	44,646	↑
Gardening	9,193	145,7	170,230	9,110	185,7	218,153	11,118	189,0	254,170	11,570	197,6	285,253	19,313	202,9	424,579	20,816	↑
Silage grasses	1,270	65,1	8,401	1,322	81,9	10,470	1,613	78,8	13,544	1,528	66,1	9,395	2,337	66,7	14,489	1,733	↑
Corn for green fodder and hay	16,679	122,1	339,723	18,366	I37,6	409,398	20,479	143,4	457,238	23,572	124,2	662,312	28,307	126,4	698,574	24,732	↑
Root crops, sweet	483	225,2	20,540	455	219,4	23,943	396	200,4	18,421	360	206,8	11,123	302	280,7	12,727	179	↑
One year grasses for fodder, green	45,458	14,4	61,742	62,361	12,5	53,509	55,794	16,0	67,409	29,953	19,6	44,706	36,448	20,9	74,708	25,432	↑
Multiflight grasses for hay	51,647	44,7	230,834	48,001	48,5	232,739	51,443	45,2	232,323	52,558	48,5	262,453	54,950	54,6	292,796	57,456	↑
Fruits	60,635	24,1	146,173	66,840	30,8	206,066	69,616	22,1	154,014	73,591	35,3	259,590	73,083	28,9	211,271		↑
Citruses	235	86,8	2,039	247	109,8	2,713	234	135,3	3,168	216	128,2	2,769	210	123,6	2,595		
Grape	31,452	28,8	90,654	31,745	33,1	105,224	32,838	35,6	116,930	31,944	36,9	117,897	31,419	44,1	138,665		
TOTAL	1,401,040		1,416,978			1,396,843			1,433,398			1,433,467					

Table 9. Cultivated area and harvest for key agricultural crops 2005-9

Name of products	2005			2009							
	Area, hectare	Productivity centner / ha	Production, ton	Area, hectare	Productivity, centner/ha	Production ton	Lost production / centner / ha relative to 2005	Lost production tons (= lost production * ha under production in 2009)	market price / ton[1]	lost value TJS / year	Lost value US$ / year
Corn for seed	9,984	40,5	155,813	14,411	37,8	1,42515	2.7	3,891	2,600	1,011,660	2,299,227
Rice	10,264	32,7	62,404	14,559	30,7	63,416	2	2,912	5,000	14,560,000	3,309,090
Other grains	12,835	26,3	33,712	16,111	14,8	4,8471	11.5	18,527	1,400	25,937,800	5,894,954
Tobacco	1,178	18,8	1,609	199	11,8	235	7	139,300	4,000	557,200,000	126,636,364
TOTAL										607,814,400	138,139,636

Notes: 1/ Price of corn based on market price of 1.5 – 1.8 TJS / kg in 2010 (lower bound range of 1.5 used); Price of rice based on market price of 4- 6 TJS / kg in 2009, central range of 5 TJS / kg used. Price of other grains based on xxx; price of tobacco based on market price of 4-10 TJS / kg in 2011 in Istaravshan (lower bound price of 4TJS.)

The cost of restoring degraded irrigated lands

Countrywide, the total area of lands with various salinity levels is 98,7000 ha, out of which 23,200 ha are moderately and highly saline and require special agro-technical and ameliorative approaches. The Programme developed by the Ministry of Land Reclamation and Water Resources (MLRWR)[7] for 2010-2014 envisages improving the condition of 49,000 ha of land in poor condition at a cost of over 34.3 million Somoni (US$7.8 million) (Table 10). This is to be financed through the state budget[8], payments for water supply services (20%) and other financing sources such as from private capital.

Table 10. Key Indicators of the MLRWR's Ameliorative Condition Improvement Programme for 2010-2014

Regions and oblasts	Total area of lands in poor condition before 01.01.2005 (ha)	Area of lands subject to ameliorative condition improvement (ha)	Total cost of works (TJS /'000)	Financing Sources		
				Water supply services (TJS /'000)	Central budget (TJS / '000)	Local budget (TJS / '000)
Kurgan-Tyube region	17,840	17,840	12,488	2,498	3,747	6,244
Kulyab region	4,340	4,340	3,038	607	911	1,519
Khatlon oblast	22,180	22,180	15,526	3,105	4,658	7,763
Sughd oblast	20,020	20,020	14,014	2,803	4,204	7,007
RRS	6,800	6,800	4,760	952	1,428	2,380
Total in the republic	49,000	49,000	34,300 (US$7,795)	6,860	10,290	17,150
Total in the republic, %	100	100	100	20	30	50

Source: MLRWR

Off site impacts

Cultivation and irrigation of lands over 0.03 degrees using existing irrigation technologies contribute to soil erosion and reductions in land productivity. An estimated 50-250 ton/ha of soil containing fertilizers are annually washed out[9] over

7 Plan for Improvement of Ameliorative Condition of Irrigated Lands of Republic of Tajikistan for 2010-2014, MLRWR, 2009
8 Budget of local (rayon) Khukumats: 50%; funds from the central budget: 30%.
9 Kamolidionov A. Mobile Irrigation Network to Irrigate Slope Lands in the Hissar Valley of Tajikistan, Moscow, MHMI, 1988

an area of 100,000 ha. While this data is from the late 1980s it is suggested that this estimate may still reflect the conditions today.

4.3.2 Pasture

Sustainable pasture management is key to addressing land degradation in Tajikistan, given that 97% of the country is mountainous, livestock numbers are increasing rapidly, and that most agricultural land is pasture rather than arable. The quality of livestock is poor as is the production of fodder crops. Pastures suffer from a lack of management, exacerbated by distortions in laws and regulations.

Based on data provided by the Ministry of Agriculture, the area of pasture was 3.8 million hectares in 2010, ***increasing*** by 48,501 hectares over the 5 year period[10] (Table 11).

Table 11. Area of pasture (hectares) 2005-2010

Type of pastures / year	2005	2006	2007	2008	2009	2010
Total	3,806,241	3,806,241	3,857,776	3,856,246	3,856,246	3,854,742
Irrigate	3,407	3,407	3,407	3,404	3,404	3,623
Dry	3,802,834	3,802,834	3,854,369	3,852,842	3,852,842	3,851,119

Source: Ministry of Agriculture: M. Mirzoev

Table 12 shows the area of pasture for each region (summer and winter) for the years 2005 and 2010. Khatlon and RRS have the largest share of total pasture at 31% and 28% respectively.

Of the total area of pasture (3,856 thousand hectare in 2008), 2,918 thousand hectares, around 76%, was allocated to agricultural (livestock) enterprises. Other areas of pasture are under the jurisdiction of the following departments.[11]

10 According to a recent World Bank study (Wolfgramm et al, 2011) between 1995 and 2009 pastures shrank by more than 400,000 hectares – a decrease of 12% from 3.4 million hectares to 3 million hectares. Cultivable land increased during the same period by 36,000 hectares – a positive change of 4%. Wolfgramm et al state that because of the huge difference in the area of pasture and cultivable land it is impossible to detect from country level data any possible conversion of one land use type into another. Since the decrease in pastures was accompanied by a commensurate decrease in total agricultural land (370,000 hectares – the balance between decrease in pastures and increase in cultivable land), Wolfgramm et al conclude that more than 10% of pastures was generally abandoned and withdrawn from agricultural use between 1995 and 2009. This may have been an outcome of increasing degradation (due to natural conditions) and exhaustion (due to overgrazing) of Tajikistan's pastures.

11 Plan of Pasture management, (Project 'Improvement of Food Safety in target rural areas of Tajikistan by increasing manufacture of cattle-breeding production and rehabilitation of pastures', OSRO/TAJ/605/EC), (Version №1) - Dushanbe – 2009.

Table 12. Distribution of pasture by regions (2000-2010)

2000					
Type of data	**National**	**Sughd**	**Khatlon**	**GBAO**	**RRS**
Area of pasture	3,681,906	761,372	1,157,860	767,737	994,937
2005					
	National	**Sughd**	**Khatlon**	**GBAO**	**RRS**
Area of pasture	3,797,566	795,685	1,220,446	757,427	1,024,088
Summer pasture	2,025,010	423,112	150,846	724,253	726,799
Winter pasture	685,274	110,385	563,071	1,864	9,954
2010					
National		**Sughd**	**Khatlon**	**GBAO**	**RRS**
Area of pasture	3,854,742	724,301	1,227,157	750,670	1,082,614
Summer pasture	2,020,933	403,361	151,997	7,16,919	748,656
Winter pasture	707,476	100,738	570,232	5,964	30,542

Source: Land Committee

- Forestry State Committee – 340,800 hectares
- Committee of Environment Protection, sanatorium– 181,100 hectares
- Ministry of Energy – 2,200 hectares
- State Reserve of Republic of Tajikistan- 428,000 hectares
- 10,700 hectares of these pastures are concentrated in the territory of neighboring states.

According to official statistics the animal headcount has increased sharply over the period 2005-2009 (Table 13). However, milk production has declined by 271 liters a cow per year over the period 2005-2009. The value of this lost production is estimated at US$96,122 per year. This assumes: lost milk production of 271 liters per cow per year * 951,000 cows = 257,721,000 liters = 265,452 metric tons * market price = 1590 Somoni per ton = 422,068,680 Somoni (US$95,924,700)

The increasing livestock density (animal headcount per hectare of pasture) is putting stress on pastures. However, the pressure on pastures varies across the country. Table 14 shows the variation of livestock density across regions: it is lowest in GBAO (26 standard head per 100 ha) and highest in Sughd (96 standard head per 100 ha) (Wolfgramm *et al* 2011).

Livestock is seen as an important source of food, income and stock of wealth for rural households; there is a ready cash market for live animals and milk is easily sold to dairies or directly to consumers. Livestock sales (the sale of live animals and milk sales) are estimated to represent 56 % of total sales revenue from household plots (Wolfgramm *et al* 2011). The animal headcount increased from 1.3 million

Table 13. Overview of Livestock Framing 2005-2009

	Years					
	2005	2006	2007	2008	2009	2009 on 2005, (+;-)
Livestock number, (thousand)						
Largely Horned livestock	1,371.9	1,422.6	1,702.5	1,799.5	1,829.9	458
Cow	710.8	756.6	864.2	932.8	951.5	231.7
Sheep and goats	3,053	3,162.1	3,798.4	4,146.7	4,200	1,147
Horse	75.4	76.1	78.5	77.0	75.7	0.3
All kinds of birds	2,451	2,580	3,280	3,683	3,938	1,4870
Yak	14.5	15.1	15.2	9.3	19.8	5.3
Beekeeping	64.8	81.7	118.6	137.5	140	75.2
Production						
Meat (thousand, ton)	53.8	111.7	118.9	129.8	134.4	80.6
Milk (thousand, ton)	553	544.7	583.6	601	629.7	76.7
Egg (mln. piece)	98.7	105.3	111.2	151	188.4	89.7
Wool (ton)	4,353	4,754	5,063	5,178	5,447	1,094
Honey (ton)	1,040	1,523.4	1,964.4	2,058.7	2,698.8	16,588
Productivity of livestock and birds						
Milk from 1 cow (liter) / year	1,597	1,492	1,388	1,365	1,326	-271
Egg from1 hen (piece)	123	122	118	146	159	36
Kittening						
Cattle (all,number)	27,190	27,167	27,067	26,908	26,781	-409
Sheep and goats (number)	276,191	278,100	285,239	279,510	280,598	4,407

Source: Ministry of Agriculture: M. Mirzoev

Table 14. Livestock density by oblast (standard head per 100 ha of pasture, 2009)					
	Large ruminants (head)	**Small ruminants (head)**	**Standard head ***	**Pasture (ha)****	**Density, standard head 100 ha**
Tajikistan	1,829,997	4,200,184	2,250,015	3,103,371	73
GBAO	101,646	305,108	132,157	510,228	26
Sughd	505,368	1,181,833	623,551	647,148	96
Khatlon	756,419	1,720,638	928,483	1,154,948	80
RRP	466,564	992,605	565,825	790,673	72

**Calculated assuming 10 head of small ruminants are equivalent to 1 head of large ruminants.*
***Estimated as the difference between agricultural land and arable land, as no data are available on pasture areas by oblast.*
Source: Agriculture in Tajikistan, TajStat, 2010 as presented in Wolfgramm et al 2011

cow equivalents in 1997-1998 to 2.1 million cow equivalents in 2007. Table 15 shows the average number of livestock per household in 2009.

Production of fodder crops

Milk yields in Tajikistan are the lowest among all CIS countries, which may be partly explained by the inadequate supply of animal feed. While the animal headcount has increased dramatically over the past decade, the relative area of fodder crops fell by 27.5 % (266,600 hectares) in 1991 to 14.5 % (130,300 hectares) in 2007 (Statistical data, Rural Economy of Tajikistan, 2005; Statistical data, Yearly, Dushanbe, 2008). This was due to a 28 % increase in the area of food grain and leguminous cultures. This has resulted in the increased use of both winter and spring-autumn pastures. According to Wolfgramm *et al* 2011 these changes are largely due to government policies that until recently imposed production targets for wheat and cotton and in effect discouraged or prohibited allocation of land for feed crops.

Table 15. Livestock in rural households 2009			
	Livestock headcount in rural hhs	**% of national headcount**	**Average per hh***
Cattle	1,676,300	92	2.2
Cows	909,700	96	1.2
Sheep and goats	3,456,900	82	4.6

** based on 757,608 rural hhs (Standard of Living Survey 2007, TAJSTAT and Unicef)*
Source: Agriculture in Tajikistan (TAJSTAT 2011)

4.4 Off-site costs

Land degradation can contribute to a number of off-site impacts such as flood damage as a result of increase surface runoff, health costs due to deterioration in water quality and loss of electrical power due to the sedimentation of hydro power dams.

It has not been possible to estimate the off-site costs of agricultural land degradation, however some qualitative, quantitative and monetary information pertaining to natural disasters in Tajikistan is provided below.

Tajikistan is joint first with Albania among the World Bank's Europe and Central (ECA) region in terms of the population affected by natural disasters and the extent of economic losses resulting from natural disasters (Table 16). Over 3,000 disaster risks are recorded per annum in Tajikistan. Landslides (classes 4-6) affect 36% of Tajikistan's area and 11% of its population; they cost Tajikistan more than 2,000 fatalities between 1980 and 2000 (Pusch, 2004 as cited in Wolfgramm *et al* 2011).

Table 16. Impact of natural disasters 1990-2008

	Affected population (per 1,000 person)	Rank	Economic losses (per US$1 million of GDP)	Rank
Tajikistan	25	2/28	135	1/28
Albania	65	1/28	25	3/28
Moldova	40	3/28	50	2/28
Macedonia	30	4/28	10	4/28

Source: World Bank, 2009.

The 2000–2001 regional drought was estimated to have cost Tajikistan 5% of its GDP (World Bank 2006). The potential economic loss from future natural disasters is estimated at upwards of 70% of GDP for Tajikistan (Pusch, 2004 as cited in Wolfgramm *et al* 2011). This estimate includes catastrophic events that are expected to occur on average once in every 200 years. Much of this potential loss of GDP is due to floods and mudslides (the rest is from earthquakes). Tajikistan is prone to landslides; there were an estimated 153 landslides between 1997 and 2005. The soft loess soils that cover many of the hill slope zones are prone to gully formation and mud slides following heavy rains, as experienced in Khuroson in May 2009 resulting in the loss of over 300 homes.

Degraded pastures contribute to landslides and flooding, but there are no studies attributing the part pasture degradation plays in these events. It is not possible to quantify therefore the contribution of pasture degradation to these off site costs. It is certain however that on-going land degradation will serve to intensify the magnitude of future disasters.

4.5 Summary of results

The total annual on-site costs of land degradation in Tajikistan are estimated to amount to 1,946 million Somoni (US$442 million) ***or 7.8% of GDP based on the Tajikistan's GDP for 2010 of 24,704 million (US$5,624 million) (Statistics Committee, Tajikistan)*** These values represent gross estimates, the cost of production have not been deducted. If the value of this foregone production was evenly distributed among rural households, this would result in a benefit of US$583 per household per year (based on an estimate of 757,608 rural households[12]). In addition an expenditure of US$7.8 million is planned to improved 49,000 hectares of degraded agricultural lands between 2010-2014 (US$159 per hectare) (Table 17). Further discussion on these findings is provided in Section 7.

Table 17. Summary of on-site and off-site costs of land degradation

On site costs	Gross value / year	Comment
Foregone productivity on unused (degraded) arable land	916,574,000 Somoni (US$208,312,364).	Based on cereals – average production per ha 30 centner (3,000 kg) (Ministry of Agriculture) * market price of 1,400 Somoni * number of hectares lost (21,823ha) = 916,574,000 Somoni or US$208,312,364
Lost productivity due to land degradation on arable land	607,814,400 Somoni (US$138,139,636)	Based on the 4 crops seen to suffer a fall in productivity over the period 2005-9 and market price
Lost productivity due to degradation of pastures	422,068,680 Somoni (US$95,924,700)	Based on lost milk production of 271 litres per cow per year * 951 cow = 257,721 litres = 266 metric tons * market price = 1,590 Somoni per ton
Increased costs of remedial measures ■ Increased use of fertilisers to replace lost nutrients ■ Adoption of less erosive but more costly management practices ■ Repairs of damaged structures ■ Disruption to site operations	34.3 million Somoni (US$7.8 million)	The Programme developed by the Ministry of Land Reclamation and Water Resources for 2010-2014 to improve the condition of 49,000 ha. The costs of other remedial measures, such as the increased use of fertilizer have not been estimated ad could be significant.

12 Standard of Living Survey TAJSTAT

On site costs	Gross value / year	Comment
Loss of soil carbon	Not estimated	This could be significant. The introduction of carbon credits for agricultural carbon could provide an incentive for SLM
Property damage Run-off, sedimentation and nitrification ■ Deterioration of water quality ■ Sedimentation of hydropower reservoirs and irrigation reservoirs ■ Treatment costs of downstream users ■ Impact of flow modulation and frequency resulting in flood damage ■ Impacts on navigation ■ Health impacts related to reduced water quality ■ Deterioration of recreation and amenity values ■ Habitat degradation Dust nuisance Visual detraction	Not estimated	The off-site costs such as flooding events and sedimentation of water reservoirs and hydro power dams could be significant. However, the bio-physical data is not available to be able to link agricultural land degradation, especially on pasture lands, with these impacts.

5

District pilot studies

5.1 Methodological overview of pilot study

As part of this study 3 districts in the North - Zafarabad, Ganchi and Istaravshan and 3 districts in the South – Qumsanguir, Jilikul and Kubadiyan were selected for pilot study. The pilot study was designed to provide a rapid assessment of the land degradation issues in the study districts, collate available data and carry out initial economic analysis based on the available data. The timeframe for the pilot study was 6 weeks.

Objectives

The objectives of the pilot study are to:

- Undertaken a qualitative characterization of the impact of land degradation on agriculture for each district.
- Collect and collate available data that can be used to inform an economic assessment of land degradation for each district
- Where possible undertaken an assessment of the cost of the different types of land degradation for each district.
- Identify key data gaps and priority areas for future research

Approach

- **Selection of pilot districts.** The districts were selected based on a consultation with key stakeholders and are considered to reflect the issues of land degradation in Tajikistan.

- **Design of database.** An excel data base was designed to collate key data and information needed to undertake the economic assessment of land degradation at the district level.
- **Site visits.** Site visits were undertaken of all districts to introduce the project to key stakeholders, gain an understanding of the main causes of land degradation in the district and request information.
- **Data collation.** The database was populated with the help of district experts.
- **Data Analysis.** The data received was analyzed and where possible high level estimates of the cost of land degradation were derived. Water management emerged as a key cause of land degradation in the pilot areas however the cost of other types of land degradation such as overgrazing of pasture were also estimated where possible. The economic analysis focused on the loss / change in productivity as a result of land becoming unavailable for cultivation due to degradation or a decline in land quality.

The results for each district are provided below, with a separate summary for the districts in the north and south.

5.2 Zafarabad

Zafarobod is located 106 km to the west of Khujand city, the capital of Sughd region.

Agriculture in general in the region involves long hours and the return on labor is low, especially for people hired to work on another person's land. According to Hannah and Orr (2011) a single mother of four children reported that she makes 120 Somoni (US$ 25) per month, and in some cases instead of receiving money from her employers, she is paid in oil and rice. It is not enough to maintain her household. Another land owner reported that he pays his workers 1,050 Somoni (US$ 220) per month. People working in the fields are surviving on the bare minimum and working on the land is not seen as a viable occupation (Hannah and Orr, 2011).

5.2.1 Arable land

The area under agriculture has increased over the period 2001-2010 from 23,060 to 27,744 hectares, an increase of 20 %. The main crop is cotton, and productivity has ranged between 1.2 tons per ha to 1.8 tons per ha (the average production in other countries is 2 tons per hectare). The area under cotton and wheat has fallen, while the area under fruit and corn has increased (Table 19). There are 292 registered dekhan farms in Zafarabad (Hannah and Orr 2011).

Hannah and Orr report that 80 % of respondents to their survey cited cotton as their primary crop. According to discussions with district authorities for this project, the recent increase in productivity is said to be the result of people working harder due to the high price of cotton and illustrates farmers' ability to allocate water and effort based on the market price of products. In general productivity seems to be increasing across crop types suggesting that the land is not affected by degradation.

There is no data available on soil fertility. However according to Hannah and Orr (2011), the use of **synthetic fertilizers** is common and many farmers cannot imagine producing a good harvest without synthetic fertilizers. The most popular synthetic fertilizers in use include selitra, amaphose, and carbamide. Field observations and discussions suggest an average usage of 200-300kg of a combination of synthetic fertilizers per year per hectare. For example, a farmer might use 100-150kg of selitra combined with 100-150kg of amaphose per hectare. Higher quality fertilizers (i.e. super selitra) are more expensive, and farmers therefore invest in the cheaper options (Hannah and Orr, 2011). These estimates are broadly consistent with the data provided on fertilizer use in Table 19. There is evidence of fertilizer use from 2003, which broadly remains constant over the period (Table 19). The use of fertilizers represents an increased cost for farmers and may be offsetting any declines in soil fertility that would have otherwise affected productivity. Further investigation is needed to determine if this is the case.

According to Table 19, all arable land is irrigated. Farmers primarily get water from shared canals (Hannah and Orr, 2011). Access to water is a particular concern, with only 33% of farmers claiming that they had enough to cultivate their crops (Hannah and Orr, 2011) and some land is reportedly not used due to the lack of water. In areas with limited or no irrigation access, people typically dig wells, some over 30 meters deep to access underground reservoirs. The use of salinized groundwater to irrigate crops is reportedly one of the main causes of land degradation.

The irrigation system is in general disrepair. Pump systems and drainage channels no longer work. Of the 668 km of drainage channels in the district, some 127 km are owned by farmers, who are unable to afford maintenance. However, according to District authorities 200 million m^3 of water was distributed in 2011, an increase of $60m^3$ on 2010 due to better water management.

Evidence from Uzbekistan suggests that an overuse of water and inefficient irrigation combined with extensive synthetic fertilizers and chemical pesticides contributes to soil salinization, which likely also the case in northern Tajikistan (Awan *et al* 2011, Stockle 2001 as cited in Hannah and Orr 2011).

Farmers attempt to alleviate problems with soil salinization by washing out the land with water which washes off valuable top soil and may contribute to further degradation. The runoff produced is contaminated with phosphates and chemicals from the fertilizers and drains into shared water reservoirs, canals, or washed into neighboring lands. This can reduce the quality of drinking water and the opportunity of farmers using the nutrient-rich / overly salty reservoir water to pursue organic farming practices without water treatment (Hannah and Orr, 2011).

In Zafarobod, special reservoirs have been built along the border of Uzbekistan to store used water from the land. This water is then pumped back up to canals and re-used for watering crops. Though this system is efficiently recycling water, it carries the "washed out" nutrients that can then cause problems when the water is reused, altering soil chemistry in ways that contribute to land degradation (Hannah and Orr, 2011).

Chemical pesticides, are regularly used. Bio methods are also practiced including spiders and other useful insects, as well as sap from the trees and certain plants. The overuse of pesticides is contributing to poor quality soils or soil salinization, as well as contamination of common water resources. Farmers generally believe that pesticides are essential for producing a high yield. However, incidents of people passing away because they did not protect themselves with masks when applying fertilizers are reported (Hannah and Orr, 2011). The health impacts of improper use have been high.

Based on district level data, the area of the degraded lands in Zafarobod has decreased significantly from 3,644 hectares in 2000 to 385 hectares in 2010. This is considered to be due to investments by international organizations in the district's irrigation and drainage systems (Figure 1).

The Sate Land Committee on Land Management of Tajikistan estimates that 1,209 hectares of land were unused in Zafarabod in 2010. Based on the market prices of key crops (cotton, grain, fruit and vegetables), the loss productivity on this land is estimated to range from US$1,539,002 to US$443,263 a year (Table 18).

Figure 1. Degraded area, out of use, hectare

Table 18. Zafarabod - The value of lost productivity on unused lands.						
Product	**Area lost due to degradation, (hectares)[1]**	**Productivity 2011**	**Lost productivity due to degradation**	**price per ton[2]**	**Income lost**	**Income lost US$**
Cotton of mid fiber	1,209	1,500	1,813,500	3,734	6,771,609	1,539,002
Grain	1,209	1,680	2,031,120	1,400	2,843,568	646,265
Fruits	1,209	2,180	2,635,620	740	1,950,359	443,263
Vegetable	1,209	1,700	2,055,300	1,730	3,555,669	808,106

Source: 1/ The State Land Committee on Land Management of Tajikistan; 2/ Prices from the Agency of the Statistics Committee under the President RT (2006-2010) and Ministry of Agriculture

5.2.2 Pasture

The area of pasture has decreased from 783 ha in 2000 to 732 ha in 2010. It is assumed that 51 ha has been lost to overgrazing. The area of pasture is limited, representing only 2.5 % of total agricultural land in 2010 The number of sheep, cattle, and goats meanwhile has increased year on year. Sheep have increased by 30 % and cattle and goats by 10 % since 2003 (Table 20). The situation is therefore clearly *not* sustainable. Milk productivity per cow between 2003-2010 has remained fairly stable, suggesting that the growing pressure on pasture has not yet affected output.

5.3 Istaravshan

Istaravshan's economy is based on agriculture and industry (it hosts Tajikistan's largest mineral water factory, and also supports vegetable oil, brick making, garments, wine and fruit processing industries). The district's GDP has increased from 180,762,000 Somoni in 2010 to 315,832,000 in 2010, an increase of 74 %. Agriculture has consistently contributed to 70 % of GDP and therefore has underpinned the district's development and growth. The population of the district is around 250,000. There are 13,000 dekhan farms in the district (Hannah and Orr, 2011). The percentage of people employed in agricultural is 14 % - this is low compared to the national average and other districts in the region (Table 22).

Table 19. Zafarabod - arable land and crop types

	Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Area of land under agri-cultural production (ha)		23,060	23,366	24,601	24,503	24,526	24,490	26,146	25,832	24,237	27,744
Area of land under key crop types (ha) Note: this is all irrigated agriculture	cotton	12,312	14,481	15,934	16,468	16,503	15,834	16,071	14,188	11,403	11,920
	wheat	7,381	6,148	5,962	5,392	4,981	4,971	4,685	4,057	3,664	4,611
	maize	145	136	79	129	154	212	402	810	1,050	756
	rice	161	68	61	36	36	61	164	92	232	387
	fruits			312	269	258	269	268	245	319	511
	vegetables	128	129	176	248	353	398	629	414	473	631
Output (centner per ha) 1 centner = 100kg	cotton	15.7	20.3	17.6	18.1	18.6	19	15.5	12.2	15	15
	wheat	12.7	20.1	21.3	15.9	17.2	16	14.1	9.6	19.9	16.8
	maize	17.7	25.2	48.6	27.5	33.2	27.5	28.1	37.5	34.4	37.9
	rice	17.2	18.1	22.4	25.8	23.1	25.1	26.1	27.8	28.2	28.9
	fruits				0.3	0.4	6.1	1.5	21.9	22.5	21.8
	vegetables	101.4	111.8	116.8	123.4	125.6	126.2	146.5	130.8	150	170.1
Area suffering from different types of land degradation Note: areas of salinization are lost to production	overwatering	-	-	-	-	-	-	-	-	-	-
	salinization	3,644	1,351	1,215	1,120	878	656	438	495	473	385
	overgrazing	-	-	-	-	-	-	-	-	-	-
	cultivation on steep / marginal slopes	-	-	-	-	-	-	-	-	-	-

	Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Use of fertilizer (kg/ha)	Cotton			583	440	420	460	455	336	569	497
	Wheat			200	200	236	200	200	200	200	200
	maize			400	400	356	361	350	350	333	400
	Rice					694	700	700	700	500	500

Source: Zafarabod district

Table 20. Zafarabod - Grazing / Livestock

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Area of pasture, ha		783	771	771	771	771	732	732	732	732	732	732
No of livestock	sheep				1,518	1,631	2,006	2,008	2,013	2,015	2,016	2,018
	cattle				276	287	301	303	305	305	306	306
	goats				1,276	1,157	1,373	1,375	1,386	1,390	1,405	1,407
Productivity	litres of milk / cow				1,587	1,587	1,480	1,429	1,453	1,536	1,536	1,581
	livestock productivity / animal				n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a

Source: Zafarabod district

5.3.1 Arable land

The area of land under agricultural production has decreased by around 1 % from 24,300ha in 2000 to 23,976ha in 2010. However these figures do not align very well with the data provided for the area of land under key crop types in some years. For example, in 2000 only 34 % was under the key crop types, in 2005 it was 73 % and in 2010 – 93 %. It is not clear if arable land has been left out of production or whether other types of crops are being grown on this land. There has been a reduction in the area under cotton and a large increase in the area under wheat and vegetables over the period 2000-2010 (Table 23).

Productivity is increasing for most crops, so it would appear that land is not affected by degradation or these areas have introduced SLM to bring abandoned land back into production and /or increase productivity.

According to GOSKOMZEM (State Committee on Land Management of Tajikistan) 751 hectares of land is out of use in Istaravshan due to water shortage. The value of the lost production on this land is estimated to range from US$275,343 – US$955,989 per year, depending on the crop produced (Table 21).

Table 21. Istaravashan – The value of lost productivity on unused lands.

Product	Area lost due to degradation, (hectares)[1]	Productivity 2011 (kg)	Lost productivity due to degradation (kg)	Price per ton[2]	Income lost	Income lost US$
Cotton of mid fibre	751	1,500	1,126,500	3,734	4,206,351	955,989
Grain	751	1,680	1,261,680	1,400	1,766,352	401,443
Fruits	751	2,180	1,637,180	740	1,211,513	275,343

Source: 1/ The State Land Committee on Land Management of Tajikistan; 2/ Prices from Agency of the Statistics Committee under the President RT (2006-2011) and Ministry of Agriculture

5.3.2 Pasture

The total area under pasture has decreased by nearly 25 % from 33,400 hectares in 2000 to 25,260 hectares in 2010 (Table 24). Based on this decrease it is assumed that 8,140 hectares have been lost to overgrazing / degradation. The area of summer pasture has remained constant over the period and is estimated to be 4,497 hectares. While the area of available pasture has been falling, the number of sheep and goat has more than doubled over the period (an increase of 104 %), putting increasing pressure on pasture. In terms of productivity, the number of liters of milk per cow

Table 22. Istaravshan - Key Macro Indicators

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GDP, thousand Somoni		180,762	189,800	201,188	213,259	228,187	240,950	257,813	275,860	295,170	315,832
Contribution of agriculture in GDP, thousand Somoni		126,714	130,965	140,30	147,362	157,449	166,256	180,211	191,723	205,733	220,132
Total land area of district, hectare	68,746	68,746	68746	68746	68746	68746	68746	68746	68746	68746	68746
Population, thousand person	183.1	187.5	191.7	195.7	200.1	204.4	208.9	213.3	218.4	223.2	224.1
Number of population employed in agriculture, thousand person	10.5	10.6	10.7	10.9	17.9	21.2	23.3	24.9	26.9	27.2	32,2
% of population employed in agriculture, thousand person	5.7	5.6	5.6	5.5	8.9	10.4	11.2	11.8	12.3	12.8	14.4
Average income of population, Somoni per month	139.5	142.9	146.1	149.3	152.0	157.7	161.0	166.4	173.1	189	212
Average income of farmers, Somoni per month	3.7	37.4	45.2	49.0	46.1	48.3	50.1	50.0	51.7	52.0	60.0
Number of poor population, thousand person	5.8	5.9	6.1	6.0	6.4	6.4	7.0	7.1	7.9	7.9	8.9
Number of poor farmers, thousand person	3.7	3.9	3.9	4.1	4.1	4.4	4.5	4.8	5.0	5.0	5.3

Source: Department of Economy, Istaravshan district.

Table 23. Istaravshan - Arable Farming

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Area of land under agricultural production		24,300	24,300	24,250	24,200	24,160	24,100	24,050	24,053	24,938	24,324	23,976
Area of land under key crop types Note: land used for cotton, maize, fruits and vegetables is 100% irrigated	Cotton	350	360	340	300	311	285	308	380	430	164	121
	Wheat – total	6,150	4,642	9,332	13,303	13,240	14,825	13,156	15,413	10,371	18,787	19,618
	Wheat - irrigated	6,150	4,642	6,800	7,000	7,210	7,300	7,450	7,600	7,480	7,550	7,500
	MJaize	445	350	348	345	350	335	335	340	318	333	333
	Fruits	913	931	926	850	940	917	1221	125	1303	1743	1474
	vegetables	472	579	626	802	865	1289	1389	1834	1444	1272	1166
	TOTAL	8,333	6,862	11,572	15,600	15,706	17,651	16,409	18,092	13,866	22,299	22,412
Productivity per hectare	Cotton	15	14.8	13.9	15	16	11	10.5	16	15	18.1	19
	Wheat	5.8	6.8	13.6	13	10.8	12.6	11	13.9	11.9	16.7	16.1
	maize	28	30	40	36	40	30	35	35	35	40	41
	Fruits	34	8.5	15.4	1.4	9.8	1.94	20	2,9	43	3.0	17
	vegetables	133	124	142	142	158	177	176	183	175	239	260

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Current market price. Tajik Somoni per 1 kg (district market)	Cotton	1.20	1,20	1,20	1,30	1,30	1,40	1.40	1.50	1.50	1.60	2.80
	Wheat	0.50	0.60	0.75	0.80	1.0	1.0	1.10	1.10	1.20	1.30	1.50
	maize	0.80	0.80	1.0	1.0	1.0	1.10	1.20	1.20	1.30	1.50	1.80
	Rice	-	-	-	-	-	-	-	-	-	-	-
	Fruits	0.80	1.0	0.8	1.50	1.0	1.50	1.0	2.5	0.50	2.5	2.0
	vegetables	0.50	0,.0	0.50	0.30	0.40	0.50	0.60	0.60	0.70	0.80	1.0
Use of fertilizer (kg/ha)	cotton	4,0	4,5	4,5	4,5	5,0	5,0	5,0	6,0	5,5	5,0	6,0
	wheat	3	3	4	3,5	4	4	3,5	3,5	4	4	5
	maize	-	-	-	-	1,0	-	0,5	1	1	0,5	-
	fruits	2	3	3	4	4	4	1,8	2,5	3	2,5	3
	vegetables	5	5,5	4,5	4,0	4,0	4,0	3	3	3	4,5	5

Source: Department of Economy, Istaravshan district.

Table 24. Istaravshan - Grazing / Livestock

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Area of pasture, ha		33,400	33,340	33,280	33,200	33,150	33,040	32,950	32,926	32,861	25,199	25,160
No of livestock	Sheep & goats	3,239	8,493	8,795	8,876	8,888	7,015	6,554	6,584	6,600	6,600	6,610
	cattle	3,011	3,104	3,105	3,105	3,105	3,105	3,058	3,063	3,063	3,063	3,063
Productivity	litres of milk / cow per year	577	644	691	722	774	791	797	797	800	884	884
	livestock productivity / kg per animal	140	141	133	118	89	82	65	65	65	65	65
Current market price, TJS	Fodder, kg	0.60	0.50	0.30	0.30	0.40	0.40	0.60	0.70	0.80	1.0	0.50
	Milk, liter	0.50	0.50	0.50	0.50	0.50	0.70	0.70	1.0	1.3	1.4	1.5
	Meat, kg	8	8.5	9	10	11	12.5	14	15	20	23	23

Source: Department of Economy, Istaravshan district.

has increased year on year rising from 557 liters per cow / year in 2000 to 884 liters in 2010. This is the result of improved pedigrees and animal care. However livestock productivity meat has fallen from 140k to 65 kg. This lost productivity could be estimated at lost output per animal 75kg * number of animals * the market price. However, the number of animals sold for meat is unknown.

5.4 Ghonchi

Ghonchi district is located 400 km to the north of the capital city Dushanbe. It borders the district of Istaravshan to the east and the Kyrgyzstan to the west. It covers 111,800 hectares and is one of the largest trading cities of Tajikistan. The population grew by 25% over the period 2000-2010 to reach 143,640 (Table 26).

The GDP of Ghonchi district was 284,674 Somoni in 2010; a dramatic increase from 36,928 Somoni in 2000. Around 80% of the district's GDP in 2010 was derived from agriculture, and agriculture has consistently contributed between 80-97% to GDP over the period 2000-2010, indicating that the district's growth is underpinned by the agriculture sector (Table 26).

Agriculture accounts for 85% of employment in the district providing jobs for 114,913 people in 2010. However, Income from agriculture is consistently below average and a disproportionate number of the poor are in farming – 79% in 2010, ranging from 89%-79% over the period 2000-2010. It should be noted however that the number of poor people in the population in general and farmers decreased by around 65% over the decade 2000-2010 (Table 26).

5.4.1 Arable land

The area of land under agricultural production has increased from 32,621 hectares in 2000, to 41,289 hectares in 2010, a 26% increase over a decade (Table 27). This increase is the result of previously degraded areas being brought back into production. There are 552 registered dehkan farms in the district (Hannah and Orr, 2011).

The dominant crops in the district are wheat and maize, accounting for 75% of area under production in 2010. According to Hannah and Orr (2011) all farmers grow potatoes, however carrots, wheat and barley are also popular crops. Cotton was only produced between 2005 and 2007. The productivity of all crops has increased over the period, suggesting that output is not affected by land degradation. With the exception of 2008, productivity per hectare for wheat / maize has been between 10-13 centner per hectare (Table 27).

It is possible that fertilizer has been applied to offset declines in soil fertility, but further research is required to establish this. According to the data, the use of fertilizers virtually stopped in 2010, due to the high price of imported fertilizer, however this did not appear to have affected productivity.

All land, with the exception of areas used to produce wheat and maize is 100 % irrigated. Around 26 % of land used for wheat and maize is irrigated. Based on discussions with district officials, farmers divert water from nearby rivers or transport water from lakes and streams. Water shortage is an issue and some land suffers from salinization. In 2011 there have been water supply problems as the water reservoir is half full of silt. One water reservoir, should hold 26 million m^3, but now only holds 10-15 million m^3, which is not enough to irrigate the area. Of the 350 drainage channels, only 250 are in working order. Farmers can't afford to drill for groundwater and therefore while a lot of land is irrigated on paper in reality dry farming is practiced due to water shortages.

This concurs with the findings of Hannah and Orr (2011) who state that water irrigation systems in the region do not reach all cultivated lands, despite considerable efforts to develop irrigation systems in northern Tajikistan. Generally areas without access to irrigated water become unused, static and in some cases degraded. In Ghonchi only 41 % of farmers felt they had enough to cultivate their crops (compared to, 33 % in Zafarobod) access to water is therefore a particular concern for farmers. The most popular method to address limited access to water is to dig a well, and people have dug wells over 30 meters deep to access underground reservoirs. A well can cost up to US$ 13,000. Water User Associations (WUAs) have also been successful in monitoring the allocation of water resources to cultivated lands.

According to GOSKOMZEM (State Committee on Land Management of Tajikistan) 681 hectares of land is out of use in Ghonchi due to water shortage (173 hectares) and unsustainable framing activities (509 hectares). The value of the lost productivity on these unused lands is estimated to range from US$259,554 to US$5,033,209 per year, depending on crop type (Table 25).

Table 25. Value of lost productivity on unused lands in Ghonchi district

Product	Area lost due to degradation, (hectares) [1]	Productivity 2011 (kg)[2]	Lost productivity (kg)	price per ton (Somoni)[3]	Value of lost productivity Somoni	Value of lost productivity US$
Wheat / Maize	681	1,290	878,490	1,300	1,142,037	259,554
Fruits	681	2,400	1,634,400	1,100	1,797,840	408,600
Vegetable	681	27,100	18,455,100	1,200	22,146,120	5,033,209

Source: 1/ State Committee on Land Management of Tajikistan; 2/ Ministry of Agriculture. 3/ Table 27.

Table 26 – Ghonchi - Key macro data

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Source
GDP, thousand Tajik Somoni	35,926	41,574	66,045	78,596	81,923	91,494	141,539	176,920	293,716	281,022	284,675	agriculture, industry, trade
Contribution of agriculture in GDP, thousand Tajik Somoni (%)	34,329 (95%)	39,675 (88%)	63,949 (97%)	71,985 (91%)	73,800 (90%)	80,801 (88%)	126,500 (89%)	153,243 (86%)	258,093 (87%)	231,023 (82%)	228,099 (80%)	agriculture, industry, trade
Total district land area, hectare	111,800	111,800	111,800	111,800	111,800	111,800	111,800	111,800	111,800	111,800	111,800	district land department
Population,	115,000	117,520	120,369	122,735	125,866	129,366	132,219	135,441	138,196	140,859	143,641	Statistic department
Population growth	2,310	2,520	2,849	2,366	3,131	3,500	2,853	3,222	2,755	2,663	2,782	Statistic department
Employment in industry, thousand	620	620	620	616	616	78	68	91	86	61	85	Industry department
Employment in reconstruction, thousand	192	192	192	192	192	139	152	127	127	113	80	Industry department
Employment trade, thousand	164	164	164	164	164	162	288	152	134	130	122	Statistic department
Employment in social sphere,	5,058	5,063	5,098	50,122	5,179	5,201	4,955	4,827	4,901	4,944		District Social security department
Employment in agriculture,	70,265	67,104	64,157	75,850	66,457	86,805	95,727	95,080	112,353	113,955	114,913	Statistic department
in %	61.1	57.1	53.3	61.8	52.8	67.1	72.4	70.2	81.3	80.9	80.0	Statistic department
Average income of population, Tajik Somoni (TJS) per month	6.10	8.27	10.30	20.70	35.50	45.20	58.00	80.60	116.00	133.10	179.23	Salary rate
Average income of farmers, Tajik Somoni per month	4.12	5.68	7.20	14.60	26.20	34.30	35.90	44.80	76.10	66.40	133.50	Salary rate
Number of poor population, thousand person	63,904	63,477	63,009	62,712	61,825	61,825	62,721	61,997	20,250	20,250	23,850	District Social security department
Number of poor farmers, person (%)	54,310 (85%)	54,234 (85%)	54,108 (86%)	54,093 (86%)	54,095 (87%)	54,035 (87%)	54,012 (86%)	53,938 (87%)	18,102 (89%)	18,102 (89%)	19,009 (80%)	District Social security department

Source: Ghonchi District

Table 27. Ghonchi - Crop production

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Area of land under agricultural production, ha		32,621	31,538	27,403	36,610	39,205	40,877	39,049	38,083	40,740	41,352	41,289
Area of land under key crop types, ha Note: all crops areas are 100% irrigated except for wheat / maize	Cotton						808	555	558			
	Wheat, maize	23,542	23,550	20,389	26,779	28,838	28,776	26,919	27,144	19,929	30,622	31,978
	area irrigated	9.198	9.635	9.222	8.833	8.753	7.790	7.530	5.795	7.387	7.351	8.481.4
	Melon, watermelon, pumpkin	37	33	46	106	145	84	77	100	77	250	258
	Potatoes	2,545	2,472	2,611	2,778	2,685	2,799	3,014	3,667	3,390	3,572	3,241
	Fruits	1,588	1,241	1,504	1,661	1,614	2,528	2,781	2,530	1,724	1,944	1,744
	Vegetables	712	699	698	762	863	879	812	950	656	706	704
Output, centner (100 kg) per ha	Cotton						15.1	18.1	12.1			
	Wheat, maize	1.5	6.2	12.3	10.5	10.6	11.9	12.8	10.4	6.7	13.2	12.9
	Melon, watermelon, pumpkin	54.0	70.0	130.0	105.0	108.7	108.5	157.1	104.7	122.5	85.6	55.7
	Potatoes	94.0	113.0	119.0	163.0	165.5	188.2	186.4	280.2	334.8	274.7	302.8
	Fruits	21.0	24.6	17.6	7.7	10.1	11.6	21.6	2.1	82.3	20.7	24.1
	Vegetables	92.0	129.0	151.0	192.0	199.4	237.6	253.2	229.0	371.8	247.4	271.3

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Current market price, somoni per ton	Wheat, maize	0.40	0.45	0.45	0.50	0.50	0.60	0.80	1.0	1.6	1.0	1.3
	Melon, watermelon, pumpkin	0.40	0.40	0.40	0.45	0.45	0.50	0.60	0.90	2.0	0.5	1.1
	Potatoes	0.40	0.40	0.40	0.45	0.50	0.60	1.0	1.2	1.35	1.0	1.0
	Fruits	0.50	0.60	0.60	0.70	0.70	1.0	1.2	1.5	2.61	1.5	3.0
	Vegetables	0.40	0.40	0.40	0.45	0.50	0.60	0.75	1.0	1.37	0.50	1.2
Use of fertilizer (kg/ha)	Cotton						500	500	500			
	Wheat, maize	200	240	240	250	280	280	290	290	290	300	300
	Melon, watermelon, pumpkin	180	186	190	190	200	210	210	220	250	300	1.1
	Potatoes	150	180	190	190	200	270	280	280	290	290	1.0
	Vegetables	140	150	170	170	200	200	200	210	250	250	1.2
Price of fertilizer / kg, Tajik Somoni (TJS)		0.5	0.5	1.0	1.0	1.5	1.5	1.6	1.8	1.8	2.0	3.0

Source: Ghonchi District

Table 28. Ghonchi - Livestock and Grazing

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Source
Area of pasture, hectare (all summer pasture)		66,920	66,920	66,920	66,920	76,920	76,920	76,920	78,163	78,163	78,163	78,163	Statistic department
Area of pasture de-graded, hectare (%)		14,910 (22%)	15,000 (22%)	15,098 (23%)	15,200 (23%)	17,340 (22%)	18,000 (23%)	21,000 (27%)	22,100 (28%)	22,250 (28%)	22,600 (29%)	23,400 (30%)	Statistic department
No of livestock	sheep	44,801	35,132	41,851	47,743	51,147	54,188	63,622	69,382	77,446	94,243	94,214	Agriculture department
	cattle	12,500	12,580	12,728	12,986	13,000	13,150	8,748	8,732	17,133	18,769	18,860	Agriculture department
	goats	11,910	9,339	11,125	12,692	13,597	14,405	16,913	18,444	20,587	25,025	25,045	Agriculture department
Productivity	litres of milk / cow per year	977.6	569	645.3	890.5	900	766	370	366	391	994.5	989.3	Statistic department
	livestock pro-ductivity / kg/ animal per year	45.1	47.4	69.6	55.0	79.4	83.5	82.9	82.9	49.7	49.8	50.4	Statistic department
Market prices, TJS	fodder / kg	1.2	1.2	1.2	1.25	1.25	1.25	1.25	1.5	1.8	2	2.2	Statistic department.
	milk / litre	0.50	0.50	0.50	0.50	0.70	0.80	1.00	1.00	1.00	1.50	1.50	Statistic department
	meat / kg	8.0	8.0	8.5	9.0	9.0	10.0	11.0	13.0	15.0	19.0	23.0	Statistic department

Source: Ghonchi District

5.4.2 Pasture

The area of pasture has increased from 66,920 ha in 2000 to 78,163 ha in 2010 (a 17% increase). However, there is a steady increasing trend in the area of degraded pasture, with degraded areas rising from 22% in 2000 to 30% in 2010. This increase in pasture degradation is coupled with a dramatic increase in the number of livestock. Sheep and goats have more than doubled in the past 10 years increasing from 44,801 to 94,214 and 11,910 to 25,045 animals respectively. Cattle have increased by 50%. This increase in livestock numbers is putting pressure on pasture. It is reported that sometimes animals dig for roots to eat and people are resorting to using their plots of land as pasture. However, there does not appear to be a fall in productivity over the past decade (Table 28).

5.5 Summary of results of pilot studies - North

Table 29 summarises the results of the pilot studies in the North of Tajikistan. In terms of the area of arable land, this has increase quite dramatically in Zafarabod and Ghonchi and remained fairly stable in Istaravshan. In all districts crop productivity has increased, suggesting that arable areas are not affected by land degradation / loss in soil fertility. However, a deeper understanding of farming practices and costs is needed to fully understand the net benefits of farming – including levels of soil fertility, expenditure on fertilizers, investments in irrigation systems, labour inputs and adoption of SLM practices.

Based on the area of land unused in the districts, the total lost productivity across the three districts is estimated at US$1,307,262 based on the area being used for cereal production.

There is an alarming increasing trend in livestock numbers and available pasture has decreased in 2 of the districts studied. However, this does not seem to have affected milk productivity per cow. Meat productivity has fallen in Istaravshan.

Table 29. Pilot studies - Summary of Findings

	Zafarabod	Istaravshan	Ghonchi
Arable land			
% increase / decrease in area of arable land 2000-2010	↑ 20% ↓ 1.3%	↑ 26%	Productivity of key crops 2000-2010
↑	↑	↑	Value of lost
productivity on unused land / year			

	Zafarabod	Istaravshan	Ghonchi
Pasture			
Area of pasture 2000 -2010	↓ 6.5%	↓ 25%	↑ 17%
Number of livestock 2000-2010	↑ Sheep 30% Cattle/goats 10%	↑ Sheep 104% Cattle/goats 1.7%	↑ Sheep 100% Cattle/goats 50%
Milk productivity 2000-2010	*stable*	↑	↑
Meat productivity 2000-2010	n.a	↓	↑

5.6 Qumsanguir District

Qumsanguir district is located in the south of the Republic of Tajikistan. It borders Jilikul district in the west, J. Rumi district in the north, Pyanj district in the east, and Afghanistan in the south. It is 55km from the oblast centre – Kurgan-Tyube and 160km from the capital – Dushanbe. The population is 111,000 (2010), and the district covers an area is 97,000 hectares.

The district is basically agrarian, and produces for example, raw cotton, onion, lemons and gourds. In 2011 87 percent of the population was engaged in agriculture. Over the period 2000 to 2010, average per-capita income has increased dramatically from 7.94 Somoni per month to around 150 Somoni per month. However, for people engaged in agriculture per-capita income in 2011 was only 92 Somoni per month (Table 30).

5.6.1 Arable land

Cotton is the principal crop produced by the district, however the area under cotton production has fallen steadily over the past decade from 10,180 ha in 2000 to 7,116 hectares in 2010 (Table 31). Raw cotton yield has ranged between 1.1 and 1.7 t/ha. Low cotton yield is considered to be due to the sowing of low-grade seeds, inadequate use of organic-mineral fertilizers, deteriorating soil fertility, and the lack of irrigation water at crucial stages in the growth cycle.

The area of arable land under cereals and horticultural crops has increased over the decade 2000-2010. For example, the area under fruit crops increased by 138 ha, and areas under vegetable crops increased by 628ha. A strong increase in yield for these crops is also observed (Table 31).

Table 30. Qumsanguir District. Macroeconomic & Socio-Economic Data

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Share of agriculture in GDP (thousand Tajik Somoni)	37,039	45,917	42,691	63,369	67,861	63,909	66,581	153,849	145,016	185,581	208,089
% of total exports attributable to agriculture						3.8	4.2	4.8	4.7	5.4	8.7
Tax revenues from agriculture, Somoni						110,200	151,300	160,800	278,600	303,500	480,100
Number of population	86,100	87,700	89,800	92,000	94,500	96,800	99,300	101,900	105,400	107,100	111,000
Number of people engaged in agriculture						77,440	81,420	84,580	91,670	93,180	96,790
% of rural population engaged in agriculture						80	82	83	87	87	95
Average income (minimum), Somoni/month	7.94	16.1	19.4	25.88	40.7	43.55	57.62	70.75	100.22	119.56	149.33
Average income of farmers (minimum & maximum) /month	6.65	13.1	16.8	25.9	31.9	34.4	37.7	45.3	67.3	67	92.2

Source: Economy Department of Qumsanguir district.

Table 31. Qumsanguir District. Crop Production

Type of data / Year		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Land areas under key crops, ha	Cotton	10,180	10,393	11,000	11,604	11,425	11,425	10,750	10,138	9,200	7,116
	Wheat				4,524	3,464	3,365	3,530	3,334	3,385	4,197
	Maize				103	145	153	191	238	341	329
	Rice				8		70	100	102	108	236
	Fruits	589	581	485	643	599	669	635	635	630	727
	Vegetables	369	492	506	606	824	823	863	864	877	997
Output, dt/ha	Cotton	13.1	15.9	17.2	16.5	14.6	11	11.9	16.2	11.3	14.9
	Wheat				33.4	34.9	32.6	28.5	28.6	31	32
	Maize				37.4	47.4	51.6	47.8	37.3	37	39
	Rice						30	25.6	26	30	31
	Fruits	23	74.1	32.1	25.8	92	97.7	92.2	93.8	95	120.6
	Vegetables	88.4	121.9	55.9	172.6	162.1	155.1	159	159.1	166	174

Source: Department for Agriculture of Qumsanguir District.

Table 32. Qumsanguir District. Livestock

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
No of livestock	Sheep	11,500	13,300	13,600	15,900	15,600	17,200	20,300	27,000	28,100	26,900	30,500
	Cattle	6,200	2,400	2,500	5,600	5,700	5,700	5,800	6,800	7,300	7,400	7,500
	Goats	5,700	6,600	6,700	7,500	7,800	8,600	10,200	13,100	13,600	14,700	14,800
Productivity	Litres of milk / cow	1,108	1,443	1,280	1,254	1,333	1,340	1,414	1,462	1,471	1,484	1,492
Market prices, Somoni	Milk / litre									1.5	1.5	2
	Meat / kg									17	20	25

Source: Department for Agriculture of Qumsanguir district.

5.6.2 Pasture

The livestock population has increased year on year over the period 2000-2010. For example, the sheep and goat population has nearly tripled (Table 32). The high goat population is seen as a treat to forest tree species. According to official statistics milk yield per cow has increased by 134% over the period 2000-2010, suggesting that pasture degradation has not yet affcetd productivity. The district grows fodder crops to feed their livestock. In order to meet the growing demand for livestock feed more areas should be allocated for fodder crops, and fodder crops such as Lucerne, Maize, and Sudan grass should be included in cotton crop rotation. trees.

5.7 Jilikul District

Jilikul district is an administrative unit of Khatlon oblast in the South of Tajikistan. The district was established on October 16, 1929 as a part of Kurgan-Tyube oblast of the Tajik SSR. The district is located in the valley of the Vakhsh River, a tributary of the Pyanj River, 94 km away from Kurgan-Tyube town in the south-west. The distance to Dushanbe city is 198 km. It borders Rudaki and Khuroson districts in the north and north-east, Rumi district in the east, Kubadiyan district of Khatlon oblast of Tajikistan in the west, and Kalai-Zal district of Kunduz province of Afghanistan in the south. The area of Jilikul district is 122,600 hectares, and the population is 92,100 (2010).

5.7.1 Arable land

Cotton is a key crop, however, over the period 2006-2010 the area under cotton production decreased 2-fold, and in 2010 cotton was sown on the area of only about 5 thousand hectares (Table 33). For these years, raw cotton yield has ranged between 1.2 and 1.8 t/ha, which is considered to be much lower than the crop capacity. The increase in cotton yields in 2010 to 1.8 t/ha is considered to be due to the increase in fertilizers use to 350 kg/ha despite the high price of fertilizers.

A decrease in cultivation area is also observed for other key crops: wheat and maize, while the area under horticultural crops and rice has increased slightly (Table 33).

According to the data provided by the Department for Agriculture under the Executive Authority of Jilikul district, the total area of irrigable arable land is 8,936 ha[13]. However, in 2009, some lands of Garauti Jamoat (1,475.54 ha), Nuri Vakhsh Jamoat (335.53 ha), and Dekhkonobod Jamoat (47.12 ha), that is a total area of 1,853.19 ha, were not sown due to the lack of irrigation water.

13 R.Khakulov. Assessment of Alternative Water Supply Methods for the Garauti Irrigation Scheme Project: Interim Report

Table 33. Jilikul District, Crop Production

		2006	2007	2008	2009	2010
Land areas under key crops, ha	Cotton	9,760	9,760	8,860	5,110	4,842
	Wheat	2,607	1,705	1,902	2,659	2,584
	Maize	165	150	270	227	123
	Rice	100	150	243	620	360
	Fruits	48	48	48	42	51
	Vegetables	150	165	122	223	224
Output, dt (100 kg)/ha	Cotton	13.1	13.1	13.2	11.9	18.2
	Wheat	20.8	32.3	25.8	28.2	28.4
	Maize	30.1	34.3	30.4	29.7	39.1
	Rice	26.1	24.5	24.6	30.6	35.30
	Fruits	29.2	30	39	35.8	38.4
	Vegetables	131.9	133.4	182.6	125	125
Area of irrigated lands, ha	Cotton	9,760	9,760	8,860	5,110	4,842
	Wheat, maize	2,607	1,705	1,902	2,659	2,584
	Maize	165	150	270	227	123
	Rice	26.1	24.5	24.6	30.6	35.3
	Fruits	29.2	30	39	35.8	38.4
	Vegetables	131.9	133.4	182.6	125	125
Use of fertilizers (kg/ha)	Cotton	220	210	230	200	350
	Wheat	150	180	155	158	160
	Maize	170	155	160	200	220
	Fruits	100	100	110	105	115
	Vegetables	300	315	210	200	210
Price of fertilizers / kg, Tajik Somoni (TJS)		1.2	1.5	1.8	1.9	2.2

Source: Department for Agriculture of Jilikul district

According to the data by the Land Committee of Jilikul district, 1,500 ha of land are degraded due to salinization and 60ha were uncultivated due to land degradation in 2010.

According to the data of the Water Management Department of Jilikul district, the length of the district's drainage system is 50.2 km, out which 5.2 km are in bad condition and not used. Also, in 2010 out of 82 pumps, 5 were out of service.

5.7.2 Pasture

Jilikul district has a just over 45,000 hectares of winter pastures. Over the past 5 years, the area of pasture area decreased by 24 ha, and the livestock population has also decreased by 91,000 animals (Table 34). There are 44-46 animals per hectare of pasture. An increase in milk yield by 110% and meat production by 139% is observed over the period 2005-9.

Table 34. Jilikul District, Grazing and Livestock

		2005	2006	2007	2008	2009	2010
Pasture areas, ha		45,156	45,156	45,156	45,156	45,139	45,132
Winter pastures, ha		45,156	45,156	45,156	45,156	45,139	45,132
No of livestock, thousand	Sheep		1,604	1,605	1,631	1,632	1,666
	Cattle		498	498	325	327	345
Productivity	Litres of milk / cow		1,142	1,216	1,286	1,293	1,260
	Livestock productivity, t		1,540	1,685	1,859	1,990	2,138
Market prices, TJS	Milk / litre		0.5-0.6	0.8-0.9	1-1.2	1.5-1.6	1.5-1.8
	Meat / kg		4-6	6-9	12-14	15-17	17-20

Source: 1/ Land Department; 2/ Department for Agriculture of Jilikul district

5.8 Kubadiyan District

Kubadiyan district is an administrative unit of Khatlon oblast in the South of Tajikistan[14]. The district was established on October 27, 1939 as a part of Stalinabad

14 The district is also referred to as Kabodiyansky district.

oblast of the Tajik SSR, and in 1930-1970 its name was Mikoyanabadsky district – in honour of A.I. Mikoyan. Starting from January 7, 1944, it was a part of Kurgan-Tyube oblast. The district centre is Kubadiyan. The district is located in the valley of the Kafirnigan River, a tributary of the Pyanj River, 94 km away from Kurgan-Tyube town in the south-west and 198 km from Dushanbe city. It borders Rudaki district in the north, Jilikul district in the east, Shakhrituz district of Khatlon oblast of Tajikistan in the west, and Kalai-Zal district of Kunduz province of Afghanistan in the south. The area of Kubadiyan district is 183,440 hectares, and the population is 145,800 (2009).

5.8.1 Arable land

The area under crop production decreased by 14% over the decade 2000 to 2010, to 16,000 hectares (Table 35). The area under cotton production decreased by 2,500 ha, and the area under cereals by 500 hectares form 2000 to 2010. Raw cotton yield ranged between 1.5 and 2.3 t/ha. The highest yield of 2.3 t/ha was achieved in 2004, which had favorable climate conditions for cotton growing. Over the decade 2000-2010 the area under vegetable production increased 1.48-fold, while yield increased almost 3-fold. This suggests that there are good opportunities for growing vegetables in the district.

5.8.2 Pasture

There has been a sharp increase in the livestock population; in 2010, the sheep population increased 2.26-fold, and cow population 1.87-fold relative to 2000 (Table 36). By 2010, the total livestock population in the district constituted over 117,500 animals. Milk productivity increased from 670 to 1,038 liters per cow, an increase of 155%. Meat production also increased by over 3,000 tons reaching 4,272 tons in 2010.

5.9 Summary of pilot studies results - south

According to the data of the State Committee for Land Management, Mapping and Geodesy, 1,753-3,559 ha of arable lands for the three study districts in the South were not used for agriculture in the period of 2005-2011. In 2010, 5,095 ha of irrigated arable lands were excluded from agriculture production. This was due to a variety of reasons including – salinization and over watering, water infrastructure damage, mud slides, water shortages and unsustainable farming practices.

Taking into account areas of unused arable lands in the three districts in 2009 (Kubadiyan – 1,223 ha, Qumsanguir – 1,323 ha, and Jilikul – 1,013 ha), yields of key crops and unit prices in 2009, the approximate lost revenue caused by land

Table 35. Kubadiyan district. Crop production

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Land areas under agricultural production, ha		18,589	18,589	19,447	19,467	20,081	18,951	18,145	18,161	17,511	17,283	16,001
Land areas under key crops, ha	Cotton	8,380	10,005	10,134	11,050	11,369	11,455	10,450	10,190	9,705	7,865	5,862
	Wheat, maize, rice	5,695	5,856	6,189	5,561	5,095	4,117	4,080	3,934	4,368	4,887	5,257
	Vegetables	968	939	1,030	606	1,069	1,029	1,025	1,027	1,039	1,179	1,433
Output, dt (100 kg)/ ha	Cotton	16.1	15.4	22	23	23.5	19.1	19.3	21.1	18.5	18	20
	Vegetables	85.1	80.4	80.1	103.1	150.1	157.9	176.3	213.0	263.3	263.5	251.1

Source: Department for Agriculture of Kubadiyan district

Table 36. Kubadiyan district. Livestock

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
No of livestock	Sheep	35,131	32,536	31,511	31,868	44,465	47,399	49,835	69,451	73,907	76,119	79,320
	Cattle	20,572	20,083	19,022	22,937	26,404	26,535	26,838	33,971	34,221	34,664	38,435
Productivity	Litres of milk / cow	670	759	793	1,005	1,018	1,115	1,151	1,017	1,020	1,047	1,038
	Livestock productivity, t	1,189	590	751	1,621.0	2,041	2,744	2,884	2,956	3,364	3,752	4,272

Source: Department for Agriculture of Kubadiyan district degradation are estimated in Jilikul, as an example, at TJS 4,538-5,927 thousand for cereals and cotton respectively. If the land was used to cultivate vegetables the net losses would be much higher. Based on average expenditures of farmers net loss is estimated at 1,635 – 3,019 thousand Somoni for cotton and cereals respectively, or 1,614 Somoni (US$366) per hectare for cotton, and 2,989 Somoni (US$677) per hectare for cereals (Table 37).

Table 37. Pilot Districts in South of Tajikistan - Value of lost production on unused land. Somoni ('000) / year

Indicators	Districts	Cotton	Cereals	Vegetables
Lost revenues	Kubadiyan	6,560	5,479	16,386
	Qumsanguir	7,097	5,927	17,726
	Jilikul	5,434	4,538	13,572
Expenditures, total	Kubadiyan	4,586	1,835	6,247
	Qumsanguir	4,961	1,985	6,758
	Jilikul	3,799	1,520	5,174
Net profit	Kubadiyan	1,974	3,645	10,139
	Qumsanguir	2,135	3,943	10,968
	Jilikul	1,635	3,019	8,398

Table 38 provides an overview of the results of the pilot studies in the South. The area of arable lands under cotton has decreased quite dramatically in each of the three districts. In all the districts, crop productivity has increased, suggesting that arable areas are not affected by land degradation/loss in soil fertility. However, a deeper understanding of farming practices and costs is needed to fully understand the net benefits of farming, including levels of soil fertility, expenditures on fertilizers, investment in irrigation, labour inputs and adoption of SLM practices.

Based on the area of land unused in the districts, the total lost productivity across the three districts is estimated at TJS 15,944,000 (US$3,623,000), based on the area being used for cereal production.

There is an alarming increasing trend in livestock population for two of the districts studied. However, in all the studied districts milk yield per cow and meat production have increased.

Table 38. Pilot Districts in South Tajikistan. Summary of Findings

	Qumsanguir	Jilikul	Kubadiyan
Arable land			
Land areas under the principal crop – cotton, 2000-2010	↓ 30%	↓ almost 2-fold	↓ 14%
Key crops yield, 2000-2010	↑	↑	↑
Cost of lost productivity on unused land / year	TJS 5,927,000	TJS 4,538,000	TJS 5,479,000.
Livestock			
Number of livestock, 2000-2010	↑ Sheep: 2.65-fold Goats: 2.6-fold Cattle: 1.2-fold	↓ By 91 thsd. of animals	↑ Sheep: 2.26-fold Cattle: 1.87-fold
Milk production, 2000-2010	↑ 134%	↑ 110%	↑ 155%
Meat production, 2000-2010	n.a	↑ 139%	↑ Over 3,000. tons

6

Sustainable land management – qualitative assessment

6.1 Background

The World Overview of Conservation Approaches and Technologies (WOCAT) program states that SLM systems aim to "use land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions" (WOCAT 2010).

Sustainable Land Management (SLM) is a standard answer to preventing further degradation, mitigating existing erosion and degradation hazards and promoting development and poverty alleviation.

It has not been possible within the timeframe of this study to undertake an economic assessment of SLM at the national scale or at the pilot districts. This section however, provides an overview of current activities in SLM in Tajikistan and a qualitative assessment of likely SLM options.

6.2 On-going initiatives in SLM

There are number of on-going and past initiatives in SLM in Tajikistan, this section provides a few examples.

Wolfgramm *et al* 2011 provide an overview of implementation zones and SLM practices in Tajikistan, which could form the bases of an economic assessment of SLM. Furthermore the global WOCAT database contains 55 technologies addressing SLM practices for grazing land in semi-arid areas. The Central Asian Countries Initiative for Land Management (CACILM) plans to document additional case studies from Central Asia. New approaches in pasture management have been developed in Kyrgyzstan after a new pasture law has come into effect in 2010, and will be documented within the CACILM knowledge management efforts. Taking into account these experiences will be especially valuable for Tajikistan. (Wolfgramm *et al* 2011)

Hannah and Orr, 2011, undertook an assessment of mechanism that facilitate (or inhibit) the adoption of SLM practices in northern Tajikistan. A multi-scale, case study-based approach was applied to four districts in Sughd Oblast: Babojon Gafurov, Ghonchi, Mastchoh, and Zafarobod. Combined quantitative (surveys) and qualitative (semi-structured interviews and field observations) methods were used to capture the perspectives of 177 stakeholders on the following themes: local agricultural practices, land ownership policy, the ecological capacity of the land to support populations, and the interactions among stakeholders in agriculture development..

Soil Science Research Institute (Academy of Science) / International Atomic Energy Agency IAEA TC project TAD5002 (Assessment of Soil Erosion and Sedimentation for Land Use, 2005-2008) Two small agricultural catchments were selected for estimating soil erosion rates by using fallout radionuclides (^{137}Cs) as tracers to obtain quantitative estimates of soil erosion and deposition in agricultural landscapes and preparing soil erosion maps under contrasted agroecological and geomorphological conditions. The results show that the use of Fallout Radionuclides (FRNs) is an efficient option for the assessment of soil erosion and evaluation of soil and water conservation technologies and approaches in Tajik agro-ecosystems. The collected data will be used for upscaling and preparing the Soil Erosion Map of the Central Part of Tajikistan.

Strip cropping, mulching, gabion construction, gully rehabilitation, plantation of shrubs and trees, wind break poplar plantation, pasture rotation approaches and technologies have been shown to decrease the soil erosion rate from **150 t/ha to 8-15 t/ha/ year** in Tajikistan. By employing appropriate soil management practices with the use of FRN, a considerable amount of nutrients such as nitrogen, phosphorus, sulphur and potassium was retained in farm land for crop production, instead of being lost in the wind or water runoff to streams and rivers.

The **High Pamir and Pamir-Alai Mountains (PALM) funded by the Global Environment Fund (GEF)** is an integrated transboundary initiative of the governments of Kyrgyzstan and Tajikistan. The project aims to: (I) address the link between poverty, vulnerability and land degradation through the promotion of sustainable land management practices that contribute to improving the livelihoods and economic well-being of the inhabitants of the High Pamir and Pamir-Alai Mountains; and, (ii) to mitigate the causes and negative impacts of land degradation on the structure and functional integrity of the ecosystems of the High Pamir and Pamir-Alai Mountains through mainstreaming sustainable land management tools and practices from household, community, local government, national and regional levels. This project is executed by the Committee on Environment Protection in Tajikistan and the National Center for Mountain Regions Development in Kyrgyzstan.

The Government has begun to address land degradation from improper irrigation, overgrazing and crop cultivation on marginal lands. **A Land Use Concept,** prepared by the State Committee for Land Management, approved by the government in 2004 focuses on land use improvements, erosion prevention techniques, and expansion of rainfed lands, but little concrete progress has been made. In 2002, Tajikistan adopted **a cotton development program** covering irrigation infrastructure improvement, crop rotation, and integrated pest management, but its implementation remains inadequate (World Bank, 2007).

The World Bank Farm Privatization and Rural Infrastructure Rehabilitation Project and the Community Agriculture and Watershed Management Project, have begun to rehabilitate Tajikistan's irrigation infrastructure and establish water user associations. The latter project is attempting to introduce sustainable crop and livestock systems in fragile upland watershed areas. Despite donor support and stated government commitment, few farmers have agricultural education or access to advisory services.

A recently published paper shows that farmers in Kyrgyzstan, positively assessed their initial decision to convert to organic cotton growing (Bachmann 2011). Cotton yields on organic farms were found to be 10 % lower, while input costs per unit were 42 % lower. Due to lower input costs as well as organic and fair trade price premiums, the average gross margin from organic cotton was 27 % higher. Additional positive effects of organic cotton growing are uncontaminated seeds for oil production and animal feed, improved soil health and improved human health conditions. These benefits seem to offset the higher workload required for organic cotton farming. (Wolfgramm et al, 2011).

Box 4 summarises the priority needs of the agriculture sector as assessed by a World Bank study in 2007.

Box 4: Priority Needs of the Agriculture Sector (World Bank, 2007)

- Implement a rational water pricing system that reflects true irrigation costs—particularly for more costly pumped systems—coupled with policies that encourage less water-intensive crops and reduce irrigation water use. Continue investing in modernizing irrigation and drainage systems, inter alia, to minimize salt mobilization.
- Promote intensification of cotton production to raise yields and farm incomes, while reducing water use and salinization and promoting integrated pest management.
- Build land management capacity, for example, through watershed approaches that stress environmental, economic, and social objectives—so that farmers and herders will adopt soil and water conservation techniques, and better livestock management methods.
- Make systematic efforts to increase public awareness of environmental impacts, improve monitoring and information access, and strengthen governmental institutions and NGOs.
- Establish an extension service system to provide farmers with information on agricultural technology, sustainable practices, and business planning.
- Continue reforestation efforts, with special attention to improving forest health and combat illegal logging, including the provision of alternative energy sources.

6.3 Sustainable land management options[15]

The following SLM practices have been identified for Tajikistan. These practices provide a menu of options that could be selected to best match the land degradation problem being faced in a certain agro-ecological area.

Amelioration (land improvement)

In order to reduce the use of irrigation water in areas with insufficient irrigation and to reduce the cost of production, crop rotation using cultures requiring less water and the creation of gardens of fruit and fast-growing shade tree species (to be used for food, building material and fire wood) is recommended.

1) Less hydrophilic cultures include:
   - grain – sorghum, millet, barley, wheat;
   - oil-bearing plants – Sesame (which can be 2-5 times more profitable per m^3 of used water compared to corn and a cotton, sunflower and flax olive).
   - Bean – Chickpea (which can be 3-7 times more profitable per m^3 of water) and peanut
   - Melon, watermelon, pumpkin.

15 This section is based on the expert opinion of Rakhmon Shukuroz

2) Planting of profitable fruit crops using row-spacing to ensure a steady harvest (on irrigated land or the land with pump irrigation):
   - Almonds
   - Pistachios
   - Wild cherry
   - Hawthorn, dogrose, sucker, sea-buckthorn berries, etc.

Watering technology

Suggested actions include: the use of a plastic film to retain humidity; improved watering practices (drip irrigation, watering on deep furrows/trenches); planting of tree species along water canals; planting alfalfa and Lucerne; and, the balanced use of organic minerals fertilizers.

Salinization

Planting of tree species such as quince, sucker and willow.

Decrease level of ground waters (prevention of bogs)

Restoration of the canal-drainage system is required. Planting of Californian poplar, which serves a bio drainage function and is a fast-growing wood breed. This wood can also be used for heating and cooking.

The washing out of soil

To prevent the washing out of valuable fertile layers of soil it is recommended to adhere to scientifically well-founded norms of watering on furrows. The length of irrigation furrows should be regulated according to the features of the irrigated site. Night watering is recommended. Prevention of further soil degradation should be the priority using organic-mineral fertilizers, and short crop rotations with the obligatory inclusion of bean cultures within the rotation pattern (lucerne, clover, chickpea, string beans and etc.) should be introduced.

Shoreline strengthening

Planting of shade and tree species such as poplar, willow and sucker in order to strengthen shorelines, shade canals, and provide construction material and fire wood.

Pasture

Pasture improvement should be carried out on sites with grass cover even if they are in a depression or where the lay of land doesn't warrant spending on root improvement. Pasture improvement on these areas requires the following actions:

- Cleaning of stones;
- Removal of hummocks / knolls;
- Removal of bushes;
- Weed management;
- Planting of grasses;
- Use of fertilizers.

Scientific studies on pastures (autumn-winter-spring) recommend the following fodder plants: Barley bulbous, Meadow grass bulbous, Saxaul black, sown Lucerne dark blue, Espartset, sown Espartset. Possible grasses for pastures and haymaking are: Espartset, sown, Lucerne dark blue, sown Espartset, pilotweed and orchard grass.

Infrastructural needs and improvements of pastures include the construction of borders (weirs) in order to better plan and manage the placing of livestock, access roads and watering sites.

Forest

Forest restoration and reforestation to restore/maintain forest microclimate and the water conservation functions of forests and to protect against climate change. Maintenance of forests, appropriate use of fertilizers and the introduction of fire-prevention actions is also recommended.

Siltation of water reservoir

In order to prevent the washout of soils and the sedimentation of reservoirs soil protection is required. Cultivation of different fish breeds in water reservoirs to reduce eutrophication and increase fish productivity.

Increasing of livestock

Pasture rotation needs to be introduced in order to regulate the use of pastures. Forage production and the area under forage crops needs to increase and to by-products of processing enterprises such as oil cake, treacle, bone flour should be used fodder for animals.

7

Conclusions and Recommendations

In order to address the problems of land degradation in Tajikistan there is a need for coherent policies and measures. This study aimed to provide a clearer understanding of the full costs of land degradation in order to raise awareness of the issue and thereby promote the development of effective mitigation strategies.

Given that this is the first study of the economics of land degradation in Tajikistan, important achievements of the study have been awareness raising of the range of impacts and costs associated with land degradation, the development of an approach that could be used to undertake a comprehensive assessment of the net benefits of SLM, the identification of data requirements and key data gaps, capacity building, and the demonstration of how the methodology developed can be used as part of a scoping study.

A methodology has been developed to compare the net benefits of the Business as Usual Scenario (BAU) with those of a SLM scenario (see Annexes 1 & 2). Current agricultural practices have hidden costs, both on and off site, and research is required to demonstrate where the high hidden costs justify a movement to SLM. Based on a broader concept of cost and benefits, SLM approaches can often be self sustaining – for example funds saved from water treatment or sediment removal could be used to prevent soil loss and sedimentation. Such analysis, as well as informing policy makers, will also aid decisions by the private sector by setting out the economic argument for investment in sustainable land management practices.

7.1 Key findings

This study has demonstrated that the economy in Tajikistan and the livelihoods of rural communities is underpinned by the agriculture sector. Therefore the quality of agricultural land in Tajikistan is of paramount concern. Currently the agriculture sector contributes 18% of Tajikistan's GDP and employs 60% of the workforce.

The role of agriculture as the engine for growth is illustrated through the pilot studies – for example in Istaravshan agriculture has consistently contributed to 70% of GDP over the period 2000-2010 and is therefore the bases of the district's development and growth; GDP of the district has grown by 74%. Similarly in Ghonchi district agriculture has consistently contributed between 80-97% to GDP over the period 2000-2010, fueling the districts impressive growth in GDP.

No public authority in Tajikistan regularly collects data on soil quality and land degradation. Wolfgramm *et al* 2011 conclude that the current situation with regard to the extent and degree of degraded land in Tajikistan is unknown. Notwithstanding the issues regarding data, the available estimates suggest that erosion and soil degradation are important problems in Tajikistan, especially in light of the dependence of the economy and local livelihoods on the agricultural sector.

At the **national level** it has only been possible to estimate the on-site costs of land degradation associated with lost crop productivity and declines in milk production. The on-site cost of land degradation is estimated at **US$442 million per year – *7.8% of GDP based on the Tajikistan's GDP for 2010 of 24,704 million.*** In addition US$7.8 million is estimated to be needed to restore 49,000 ha of degraded land over a four year period. If the value of this foregone production was evenly distributed among rural households, this would result in a benefit of US$583 per household per year (based on an estimate of 757,608 rural households[16]). **Additional research is required to refine these estimates and include the off-site costs of land degradation.**

While this initial estimate of the cost of land degradation to the economy may be considered an overestimate given that it is a gross, rather than a net value (that is the costs of production have not been deducted), there are a number of reasons why it may in fact be an underestimate. These reasons include:

(i) Many crops in Tajikistan demonstrate **low average production levels** relative to international standards, this may be partly due to land degradation and so losses in production across all crop types (including those that have shown an increase in recent years) relative to potential sustainable levels may be relevant;

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(ii) Farmers may be undertaking **additional expenditures** on fertiliser to offset declines in soil fertility. These additional expenditures reflect part of the total cost attributable to land degradation.

(iii) Importantly no estimates have been made of the **off-site costs** of agricultural land degradation – these include the contribution of degraded pastures to floods and landslides which have imposed significant costs to land, property and human life over the past decade and are set to increase, and the cost of siltation of reservoirs used for irrigation and electricity production. These off-site costs could be significantly greater than the on-site losses associated with foregone productivity. For example a study has estimated that the costs of future disasters could be as high as 70% of Tajikistan's GDP; a proportion of this cost would be attributable to the contribution of land degradation (especially of pastures) to flood and mudslide events.

At the **district level** land degradation does not appear to have affected productivity on existing arable land as output per crop has increased over the period 2000-2010. For two of the districts studied the area under arable production has also increased, suggesting that degraded lands have been rehabilitated. However, there are still an estimated 2,643 ha of arable land out of use in the North and 5,095 hectares in the South due to unsustainable farming activities, salinization and over watering, water shortages and mud slides. This foregone agricultural productivity as a result of this land being out of use is valued at nearly **US$5 million** for the six districts combined (US$638 per hectare per year).

For the districts studied a clear picture emerges regarding the growing pressure on pasture. Again, this pressure does not yet appear to have resulted in a loss in productivity, with the exception of a decline in meat production in Istaravshan.

There are many factors contributing to crop and livestock productivity in addition to land quality, such as the use of fertilizers, technologies and management practices adopted, labour effort and natural conditions. More in-depth study is therefore required to understand the contributing factors to the increases in productivity evident from the available data.

Underpinning an economic analysis of land degradation at any scale is **quantitative or physical data** on the extent and rates of soil erosion, under various agro-ecological conditions and land use systems. Key physical data appears to be lacking in Tajikistan. **Estimates of soil loss (t/ha/ year for different parts of the country) and how this translates into changes into productivity were not found. Also missing is data on soil fertility such as the average loss of nutrients per ha (Nitrogen, Phosphorus, Potassium).** Information of the carbon sequestration rates of different soils and under different management practices could be used to estimate the carbon sequestration value of agricultural soils in Tajikistan. There is also insufficient understanding of the bio-physical impacts of soil erosion and sedimentation. For example, the proportion of flood damage costs that can be directly attributed to soil erosion is not known. The carrying capacity of different types of pasture is also required.

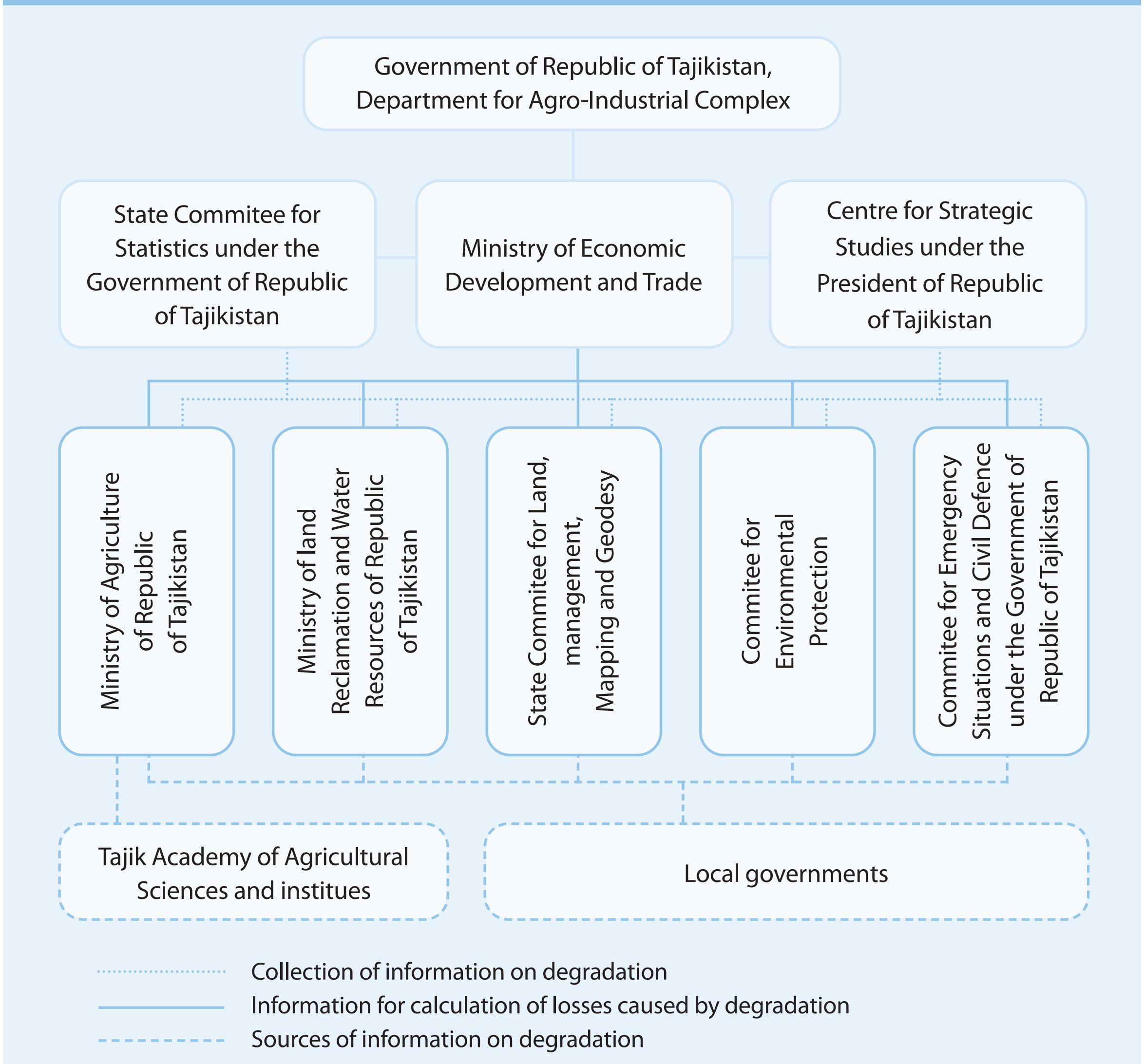
7.2 Recommendations

Key recommendations for further developing the work on the economics of land degradation in Tajikistan are presented below. The recommendations are grouped into short-term and medium – longer term actions.

Short term recommendations

Improved data management. At present data on land degradation and agriculture is held by a number of Government Institutions making it difficult to collate and to derive an overall picture of the land degradation problem. It is recommended that data and information on land degradation is more co-ordinated within Government. A possible information data management structure is provided in Figure 2.

Figure 2. Proposed scheme of information collection and its submission to the Government of Republic of Tajikistan to inform decisions on land management



Source: Rakhmon Shukurov.

Generation of key physical data. Economic analysis of environmental impacts is dependent on good physical data. The lack of physical data in Tajikistan currently restricts the economic analysis. Missing information includes: the rate of soil loss across the country and factors contributing to this soil loss; the relationship between soil loss and crop productivity; soil fertility levels and predictions of how crop productivity will fall based on soil fertility levels (and how losses in soil fertility may be compensated for through increased use of fertilizers). Economic valuation depends on good physical data and models that quantify how changes in agricultural land (quality and quantity) impact economic endpoints such as crop productivity, human health and property.

Determining marginal benefits. This study has estimated the current aggregate cost of land degradation at the national and district level, based on foregone production. Such information is important to demonstrate the range and scale of costs to policy makers and practitioners. However of greater use to policy makers is an understanding of the marginal benefits of moving from the current situation to an alternative, which reduces land degradation. This involves comparing the net benefits of current practices with the net benefits of an alternative. In order to carry out marginal assessments data is required on the net benefits of alternative SLM practices and the costs of production under different scenarios.

Assessment of the economic benefits of SLM. This study only provided a qualitative assessment of available SLM practices. Assessment of the economic benefits of SLM practices currently practiced across the country is recommended. This information can be stored in a database. This will enable the costs and benefits of SLM to be compared with current practices. The database can be supplemented appropriate SLM practices that have been successfully implemented in the region. This could build on the work undertaken for the Pilot Program for Climate Resilience, which has started an inventory of SLM practices in Tajikistan.

Data on the costs of production. This study did analyse data on the costs of production due to time constraints, but such data is required to derive the net benefits of alternative land use practices. There also appears to be limited data on the cost of removing sedimentation and addressing flood damages, which is needed to estimated the offsite impacts of land degradation.

Farm surveys. At the pilot site specific scale farm surveys could be undertaken to derive detailed data on the costs and income of farmers (monetary and non-monetary) and derive a better understanding of the profitability of current and future land use practices and implications of farmers' livelihoods

Analysis for agro-ecologic regions / types of land degradation. It is recommended that further site specific pilot studies are undertaken to build up the evidence of the costs of specific types of land degradation across representative areas of the country. This could be based on an assessment of the impacts of land degradation and how this could be mitigated through SLM across different agro-ecologic regions (zones). Pilot studies could be undertaken for each agro-ecological zone, which could then be extrapolated to similar agro-ecologic zones across the country. The CACILM – Central Asian Countries Initiative for Land Management has reportedly identified 6 different agro-ecology regions based on crops, seasonality and climate, which could be used as a basis for determining the agro-ecologic groupings. Such an approach would help to prioritise interventions. The first step would be to determine the susceptibility of each zone to erosion, deposition, or flooding based on factors such as slope, underlying geology, and vegetative cover. A second stage would be to map the values (ecosystem services) at risk from erosion. This could be a function of the annualised value of current production, plus the value of any infrastructure at risk from damage from erosion effects. A third stage would be to identify the current erosion prevention and containment activities of both public agencies and private bodies (Jones *et al* 2008).

Pasture as priority issue. A priority subject for future analysis is considered to be the affect of degraded pastures on the agricultural sector and the economy in general. This is due to the fact that the majority of agricultural land in Tajikistan is under pasture, the livestock population is growing rapidly, and continued pasture degradation is likely to be an important contributing factor in potential future disasters such as floods and landslides.

Inter-disciplinary teams. Future research on the economics of land degradation in Tajikistan should be undertaken by an inter-disciplinary team, including soil scientists, agricultural specialist, and economists.

Medium term

More detailed economic analysis. The production function approach could be adopted to isolate the contribution of land / soil quality to productivity levels (see Annex 2). It cannot be assumed that all the losses in productivity are due to land degradation or that gains in productivity reflect sustainable land practices. Factors contributing to productivity include management practices, used of fertilizers, labour effort and natural conditions.

It would also be possible to use Computable General Equilibrium (CGE) models to estimate the impact of changes in agricultural yields on GDP growth, such as the model developed by the International Food Policy Research Institute (IFPRI). This model was extended by Benin *et al* (2008) in Malawi to investigate how changes in agricultural productivity affect poverty by linking the CGE projections to household survey income data. This is a longer term research project, given the data requirements of the model and the capacity building required to undertake such an exercise. Such an approach offers an alternative assessment to that set out in Annexes 1 & 2.

Value chain analysis. The economic analysis of the benefits of transitioning to SLM would best be supported by a value-chain approach, which sets out where to find seeds, how to commercialize the different products, access to markets, local, national and international markets that may affect prices, and the key legal and institutional requirements.

Inclusion of other sectors. This study has focussed on agricultural land degradation, however other sectors contribute to land degradation such as forestry and infrastructure. An analysis of the on-site and off-site costs of land degradation associated with other sectors and potential mitigation measures is required to provide a complete picture of the implications of land degradation in Tajikistan.

8

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9

Annex 1: Conceptual Framework

9.1 Introduction

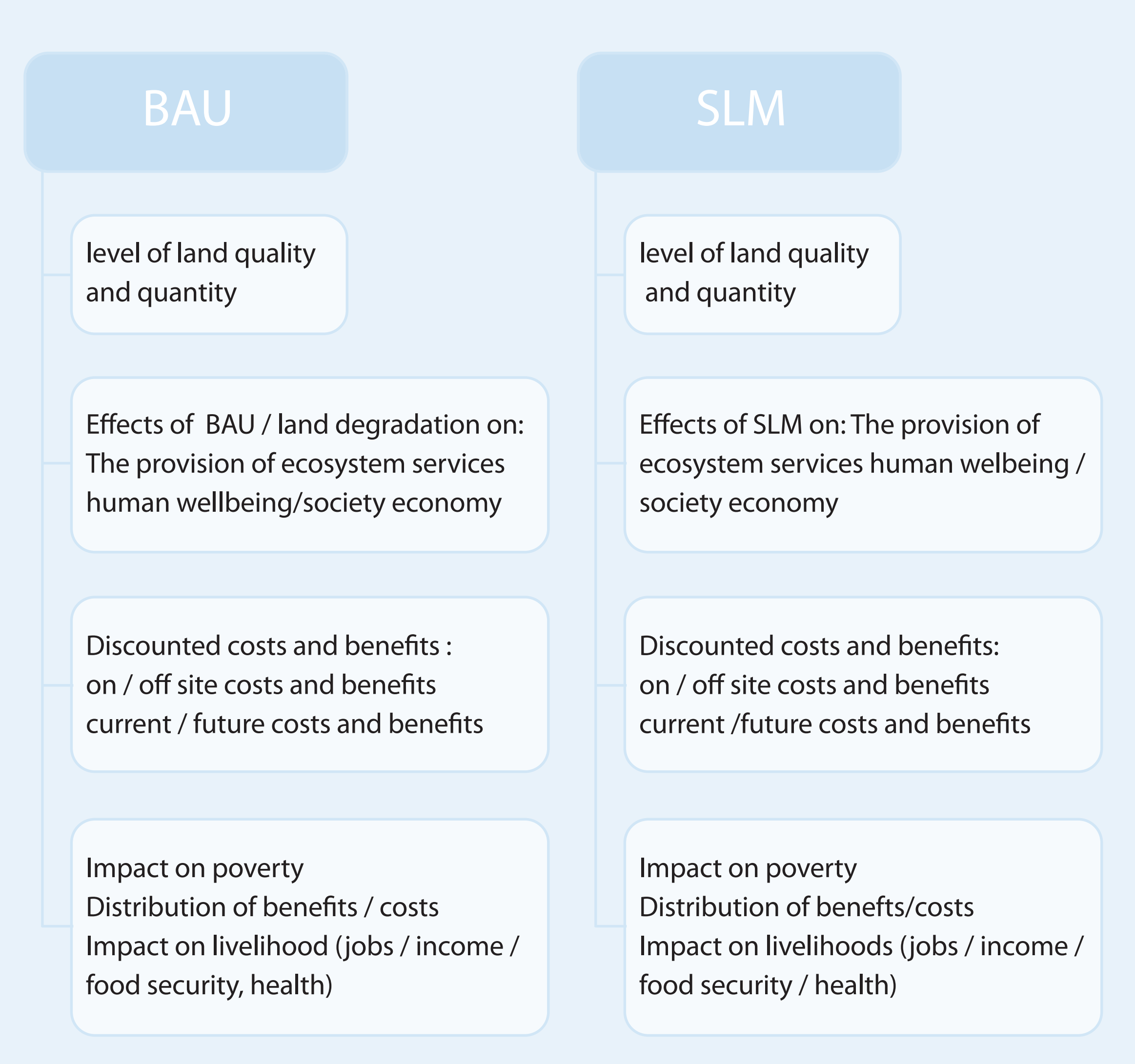
The conceptual framework presented here is focused on demonstrating the economic costs of agricultural land degradation and the benefits of sustainable land management in Tajikistan. The framework is based on a comparison of the costs and benefits of agricultural land use under a business as usual scenario (where it is assumed that land degradation is occurring) with those of an alternative sustainable land management scenario. Cost Benefit Analysis (CBA) is recommended to compare alternative agricultural land use options in order to identify the economically optimal land use.

Importantly the methodology is concerned with identifying and monetizing where possible the environmental and social impacts of land degradation / SLM both on-site and off-site the farm, now and over-time. On-site effects are those directly felt by the land and properties where the erosion takes place. Off site effects are those impacting process and activities off-site, largely due to sedimentation and deposition. These off site effects can include damage to infrastructure and increasing sedimentation of waterways, and less tangible effects such as impacts on landscape and amenity or biodiversity[17].

17 Direct and indirect effects may also be identified. Indirect effects are those affecting entities as a consequence of a direct effect felt elsewhere (secondary effects), such as a processing plant that suffers reduced value added from changes in supply from primary producers. Indirect costs are often difficult to account for due to lack of data. They can also include intangible costs such as loss of farmer motivation and confidence.

An overview of the conceptual framework is provided in Figure A1.

Figure A1. Conceptual framework for assessing the costs of land degradation and the benefits of SLM



Key features of the methodology

- The methodology is grounded in the **Ecosystem Services Approach** (2005). This means that the methodology considers the broad range of benefits provided by agricultural land and natural ecosystems, including provisioning, regulating and cultural services. The various benefits provided by agricultural land are referred to as 'ecosystem services' and they may include for example the production of food crops, the regulation of water flows, and the provision of opportunities for recreation and nature conservation. Land degradation is defined as 'The reduction in the capacity of the land to provide ecosystem goods and services and to assure its functions over a period of time for the beneficiaries' (Land Degradation Assessment in Drylands – FAO, 2009).

- The methodology is designed to compare current land use (BAU) under which land degradation is occurring with a SLM alternative. Different agricultural land uses have positive and negative impacts, both short-term and long-term, on agricultural productivity, society and ecosystem services. Costs and benefits occurring both on-site and off-site should be considered. In theory all impacts (positive and negative) can be assigned value to estimate the importance of the economic benefits and costs to agriculture and society (Bann, 2010). A common framework for assessing such issues is Cost Benefit Analysis (CBA) of alternative scenarios or options. CBA is recommended in combination with established valuation techniques for establishing non-market values, depending on data available.
- **Importance of temporal aspects.** The analysis is not static, but considers the costs and benefits of BAU / SLM over time, to ensure that the long term viability of the agricultural system is not been sacrificed to short term gains that damage or destroy key environmental services underpinning productive and sustainable agricultural practices.
- The methodology can be applied at **different scales** (local, regional, national) to assess the benefits and costs of SLM.
- The methodology recommends the reporting of **key macro indicators** to aid decision on land management and to highlight the incidence of different land management practices and their impact on local livelihoods and poverty alleviation. These include: the contribution of agriculture to GDP at the national / regional level; employment; the population dependent on agriculture; and, the incidence of poverty. The methodology also recommends that key quantitative information is presented where it is not possible to provide monetary evidence, e.g., annual soil loss, dependence on irrigation.

Land degradation is a serious problem in Tajikistan. The methodology seeks to help decision making on SLM by:

- Revealing the economic costs and benefits of different types of land management. For instance, the economic costs and benefits of short-term exploitation for maize on pasture land can be compared with those of sustainable management practices involving Lucerne and Alfalfa, which would support the soil and increase fertility and subsequently productivity. In this way it can also show the trade-offs in land management, i.e., the economic benefits lost and gained, and the stakeholders benefiting and losing from different policy alternatives.
- Demonstrating the interests of different groups of stakeholders in land and ecosystem management, thereby providing a basis for conflict resolution and integrated, participatory planning of resource management.
- Providing the basis for setting up Payment for Ecosystem Services (PES) type of schemes, which are innovative mechanisms for allocating funds from the beneficiaries of ecosystem services to the providers of these services. Such schemes are yet to be introduced in Tajikistan, but could become important in the future.

9.2 The ecosystem services approach

The ecosystem services approach (ESA) explicitly recognizes that ecosystems and the biological diversity contained within them contribute to the individual and social wellbeing of humans. Importantly, it recognizes that this contribution extends beyond the provision of 'goods' such agricultural crops to services which support life by regulating essential processes such as carbon sequestration and the control of erosion and sediments. The ESA therefore provides a framework for considering whole ecosystems in decision making and for valuing the services they provide to ensure that we can maintain a healthy and resilient natural environment.

Ecosystem services - the processes whereby ecosystems render benefits to people are increasingly becoming the principal means for communicating the impact of ecological change in terms of human benefits.

The ecosystem services provided by agricultural ecosystems can be grouped under four main categories as commonly defined by the ESA:

- **Provisioning services:** agricultural ecosystems provide food, fodder and genetic resources.
- **Regulating services:** refers to processes such as climate regulation, modification of flow processes (e.g. flood control) and the regulation of pests and pathogens.
- **Cultural services** relate to the non-material benefits obtained from agricultural land, for example, through tourism and educational and spiritual experiences.
- **Supporting services:** these are necessary for the production of all other ecosystem services (e.g. soil formation, nutrient cycling). They differ from the other services in that their impacts on people are either indirect (via provisioning, regulating or cultural services) or occur over a very long time.

Table A1 provides a list (typology) of the potential services provided by agricultural land organized using an ESA. This typology can be used to identify the key on-site benefits of the area under study. These ES may be impacted by land degradation and/or benefit from the introduction on SLM. It is important to note that the valuation is focused on the 'final services' or 'benefit' realized by society from the services agricultural land, not the services and functions that contribute to those outcomes, in order to avoided double counting. Thus, supporting services are not valued independently as they provide intermediate benefits which contribute to the provision of a range of final benefits. For this reason the typology presented in Table A1 links each ecosystem service to its final benefit or outcome that can be valued in economic terms.

Land degradation reduces the capacity of the land to provide ecosystem goods and services and ensure their function for future beneficiaries (MA 2005).

Table A1. Typology of Ecosystem Services provided by Agricultural Ecosystems		
Ecosystem Service category	**Service**	**Benefit / outcome**
Provisioning Services	Food	Food
	Fodder	Fodder (Including grass from pastures)
	Fuel	Fuel (e.g. wood and dung)
	Biochemical and medicinal resources	Biochemical and medicinal resources
	Genetic resources	Genetic resources
	Ornamental resources	Ornamental resources
Regulating Services	Sink for atmospheric carbon dioxide	Carbon capture
	Hydrological services / flood risk regulation	Protection of property, agricultural land, human lives
	Protection against storms	Protection of property, agricultural land, human lives
	Control of erosion and sediments	Maintenance of soil fertility
	Regulation of pest and pathogens	Natural pest control service
Cultural Services	Cultural, spiritual, religious,	Cultural, spiritual, religious
	Scientific and educational information	Scientific and educational information
	Tourism and recreation	Tourism and recreation

Cross cutting benefits

While often very important, **health benefits** are not presented as an ecosystem service as they are considered to be cross-cutting and are typically secondary benefits resulting from a number of primary benefits. They are associated with a range of services including – food provision, flood risk regulation. The benefits to human health in terms of reduced risk to life or days of illness can be used to monetize these impacts where a relationship between the quality of the service and human health impact can be quantified.

Similarly **biodiversity value** can be captured through the provisioning, regulating and cultural services set out in Table A1, as biodiversity underpins the provision of these services.

9.3 The links between ecosystem services and agriculture productivity

A distinction can be made between the ES provided *to* agriculture and the ES provided *by* agricultural ecosystems. Agricultural production depends on being provided with ES such as water supply, microclimates, soil fertility, natural pest control, and pollination. The quality and quantity of these ES in turn depends on management of ecosystems *off-site*, that is outside of the field / farm. For example, pollination of many crops depends on there being sufficient suitable habitat in landscapes surrounding the cropland to maintain viable pollinator populations. Many crops depend on streams or rivers for water provision; whether or not these streams retain adequate flow depends, in part, on proper management of the upper catchments of the watershed.

Agriculture in turn provides ES, particularly provisioning services such as food but also cultural and regulating services. Many factors influence what ES a given agricultural system provides, including what is being produced, how the land is prepared, how it is managed, and where the system is located. For example it may be possible to enhance the provision of carbon sequestration through enhanced management practices. Where the ES provided by agriculture are also inputs to the production process, they can increase profits or attract additional sources of revenue, such as payments for watershed protection.

Therefore the flow of agricultural ecosystem services depends on how agro ecosystems are managed ***on-site*** and on the diversity, composition, and functioning of the surrounding landscape on which they depend, that is the management of ***off-site*** ecosystems (Zhang *et al.* 2007). Agriculture therefore is reliant on strong policies and practices across a number of key sectors such as industry, forestry and water management.

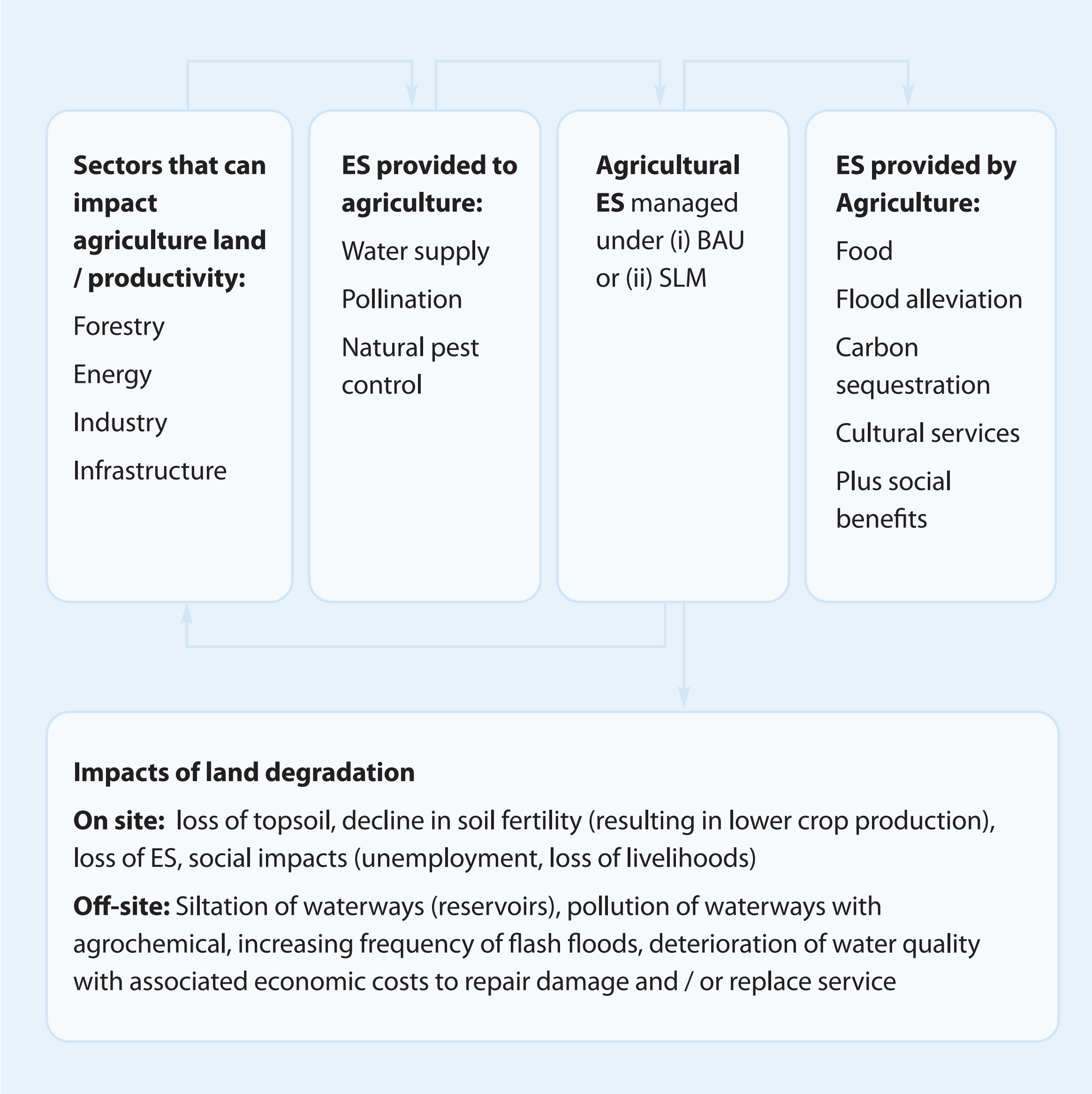
Poor management at on-site and off-site can cause negative externalities that in the long run reduce productivity, increase costs, and impact society-like diffuse pollution of waterways, over-abstraction of water, soil erosion, and climate change. Some ES can be substituted by man-made inputs (e.g., fertilizer, flood mitigation works). In other cases no replacement is possible, making these ES not just inputs, but irreplaceable 'life support' facilities for agricultural activity (Bann, 2010).

The linkages between ES and agricultural production are presented in Figure A2, highlighting that many sectors can impact on the quality and quality of agricultural land.

The following sections describe the ES provided to and by agriculture, and how management of agricultural lands and surrounding landscapes can affect them[18].

18 This section is based on Bann, 2010

Figure A2. Interactions between on-site and off-site management practices, the provision of ES and agricultural productivity and land degradation



9.3.1.1 Provisioning

The key provisioning services associated with agricultural ecosystems is food. Agriculture also uses natural inputs such as freshwater, nutrients, and genetic resources.

Water supply is affected by farm management decisions on abstraction and irrigation practices, agrochemical use, soil conservation, and disposal of wastes. Negative feedback loops from agricultural water is common. Crops and livestock depend on reliable sources of sufficiently clean water. In turn, ground and surface waters are influenced by agriculture as to both the quality and quantity of water available for agriculture, other human uses and for ecosystems downstream.

Nutrient and energy availability. Agriculture is highly dependent on those natural processes that make nutritious pasturage available to grazers and browsers, and sunlight and nutrients to crop plants. Such ES are taken for granted until circumstances restrict them, as for instance when dust storms or agricultural smog shade the sun, coat leaves, and disrupt metabolism.

Genetic resources. Agriculture is heavily reliant on genetic diversity, the raw material for natural and artificial selection. It is vital to productivity maintenance; many crops could not retain commercial status without regular genetic input from wild relatives (de Groot et al., 2002). Genetic diversity at the crop level can also enhance biomass output per land unit by better utilization of nutrients and reduced losses to pests and diseases (Zhang et al., 2007). Low genetic diversity makes crops susceptible to epidemics and catastrophic losses (Zhang et al. 2007). Genetic resources provided both by and to agriculture thus serve to ameliorate risk as well as to increase production.

Tajikistan is regarded to be a key center for genetic diversity and local populations depend on natural resources for food (fruits and berries of wild tree species, productive pastures, medicinal plants) (HYDROMET, 2008). An on-going GEF project – Sustaining Agrobiodiversity in the face of climate change, implemented by the National Biodiversity and Biosafety Centre, is aiming to embed globally significant agrobiodiversity conservation and adaptation into national, local and rural development practices in Tajikistan. The diverse climatic, geological and natural environmental conditions in Tajikistan have led to a very rich biodiversity, best indicated by almost 9,800 recorded plant species. Tajikistan is a centre of origin for many species important to agriculture, and the country's agro-biodiversity is outstanding. Many of the landraces and their wild relatives potentially house resistance and tolerance to pests, diseases, and to abiotic stresses. As such they constitute a valuable source of genetic material for future germplasm enhancement programs around the world. Tajikistan's agricultural biodiversity is not only of importance to the livelihoods of rural communities, to the local economy, and to local long term food security, but also to global food security in the light to future challenges of global climate change.

9.3.1.2 Regulating Services

Regulating services are among the most diverse ES provided to agriculture. Agricultural landscapes are affected by and contribute to the population dynamics of pollinators, pests, pathogens and wildlife, as well as by fluctuations in soil loss, water quality and supply, greenhouse gas emissions, and carbon sequestration. Some examples:

Flood regulation is an ES provided to and by agriculture. Intact ecosystems are critical elements in natural flood control, slowing the accumulation of waters in rivers, protecting banks and natural levees, slowing and channeling currents, buffering storm surges along coasts, and more. Agricultural land can similarly alleviate flooding by storing waters, increasing infiltration and slowing overland flow, or conversely, worsen it. Poor management of agricultural lands and supporting landscapes (such as upland areas and wetlands) can contribute to flooding of farms and other areas downstream. Soil compaction and vegetation removal increase down-slope flow rates and can add to local flooding, sedimentation, and downstream risk.

Climate regulation, both local and global, is another ES. Favorable microclimates—temperature, precipitation and wind regimes—confer advantages to farms. Stability of suitable local climates relies in part on atmospheric regulation that is influenced by the functioning of agricultural ecosystems and their supporting landscapes. Agriculture is vulnerable to climate change, be it local or global; yet farming practices contribute to greenhouse gases: about one third of worldwide CO_2 emissions and the largest part of methane (from livestock and flood rice) and nitrous oxides (primarily from fertilizers). Conversion of forest for agriculture is a major source of CO_2 release. Agriculture can also be an important carbon sink, storing it both above and below ground. In addition, farming practices can offer options to adapt to climate change.

Soil carbon capture or sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic materials. It is being heralded as one of the key ways to offset emissions that cause climate change. Markets are being established to trade credits earned through soil-based sequestration of carbon. One of the proponents of this is the World Bank. There is however a debate around the extent to which soil carbon markets and reduce GHG and also whether in reality they will benefit smallholder farmers. (actionaid, 2011).

Storm protection depends on vegetative structure, topography, and length and width of the vegetation belt. Ecosystems may act as windbreaks preventing wind erosion and limiting losses of crops and infrastructure from storms. This may be measured by analyzing impacts of past storms or by modelling erosion processes.

Disease, pest, and waste control: Ecosystems may contribute to the control of certain pests and pathogens by harbouring populations of species that control such pests. Bacteria, fungi, and arthropods have roles in both the damage caused by some and the vital pest and disease control services supplied by others. They decompose wastes, thus recycling nutrients and reducing exposure to pests and disease—providing ES of significant economic value to the livestock industry, among others (Zang *et al* 2007). Natural control of pests is carried out by generalist and specialist predators and parasitoids, including birds, bats, spiders, beetles, bugs, mantids, flies, and wasps, as well as microorganisms (Zang *et al* 2007). This ES in the short term suppresses damage and improves yield, while contributing to long term ecological equilibria that prevent pest and disease organisms from reaching plague status (Zhang *et al* 2007). The conservation of natural enemies of crop pests underpins Integrated Pest Management, providing self-renewing pest control that is easily disrupted during agricultural intensification (African Pollinator Initiative Secretariat, 2003).

9.3.1.3 Supporting Services

Supporting services are those necessary to produce other ecosystem services, such as primary production, liberation of oxygen, and soil formation (MA, 2005). Supporting services provided to agriculture include soil structure and fertility, pollination, nutrient cycling, and primary production.

Soil structure and fertility: Soil is formed through disintegration of rock, accretion of organic matter, and release of minerals. It usually is a slow process; natural soils may be generated at a rate of only a few centimeters per century. After erosion, soil regeneration from bedrock can take 100 to 400 years (Pimentel and Wilson, 1997). Given that time scale, soil may be seen as a non-renewable resource in many situations.

Ecosystem services derived from soil formation relate to the maintenance of crop productivity on cultivated lands and the integrity and functioning of natural ecosystems (de Groot *et al.*, 2002). Soil structure and fertility play a large role in determining where different kinds of farming take place and the quantity and quality of agricultural output (Zhang *et al.*, 2007). Soils are increasingly recognized as a multi-functional resource that provides additional ES such as drinking water purification, biodiversity provision, a CO_2 sink; and cultural services (Montarella, 2008).

Soils are extremely diverse, with properties can vary abruptly or change slowly over extensive gradients. The effects of soil degradation, through erosion, nutrient depletion, pollution, compaction, loss of biodiversity, etc.—impact not only on-site fertility and crop yields, but also off-site aspects like silting of infrastructure, CO_2 release, food and water contamination, and increased risk of flooding and landslides (Montarella, 2008). Soil degradation is exacerbated by unsustainable agricultural practices and varies greatly with soil type, technology, and rainfall.

Pollination is perhaps the best known ES performed by insects (Losey and Vaughan, 2006). Production of 75% of the world's most important crops and 35% of its food depends on animal pollination (Klein et al., 2007). Bees are the best known, but birds, bats, butterflies, beetles, flies and other insects are also important. Wild pollinators may nest in fields (e.g., ground nesting bees), or fly from nesting sites in nearby habitats to pollinate crops (Ricketts, 2004). Pollination from natural vectors improves productivity and in some cases the quality of the product. Insect pollinators are essential for many fruit and vegetable crops; demand for pollinators grows as agricultural productivity increases. Development of larger fields and simplified landscapes for agriculture risks removing pollinator habitats (African

Pollinator Initiative Secretariat, 2003). Conserving wild pollinators in habitats adjacent to agriculture improves both the level and stability of pollination, raising yields and income (Klein *et al.*, 2003).

Nutrient cycling. Life on earth depends on the continuous cycling of 30 to 40 of the 90 chemical elements that occur in nature. Many aspects of natural ecosystems facilitate nutrient cycling at local and global scales. For example, soil organisms decompose organic matter, releasing nutrients to plant growth, to ground water, and to the atmosphere. Migration of insects, birds, fish and mammals helps move nutrients among ecosystems. Ecosystem services derived from nutrient cycling are related to soil maintenance and to regulation of gases, climate, and water (de Groot *et al.,* 2002). Biological nitrogen fixation - through fixation of atmospheric nitrogen, leguminous plans can enhance soil fertility. Their impact can be measured in terms of soil organic matter.

9.3.1.4 Cultural Services

Cultural services are nonmaterial benefits people obtain from natural and agricultural ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (MEA, 2005). They both influence agriculture and help shape the socio-economic environment for it. Commonly found values include appreciation for open space, rural views, and the cultural heritage of rural lifestyles, recreational hunting and tourism. These ES are largely unvalued in the market economy (Swinton *et al.,* 2007) but can be highly esteemed by individuals—who may be moved to defend biodiversity or consume certified products.

9.4 Temporal considerations

It is important to consider the temporal impacts of different agricultural land uses and their impacts on land degradation. A possible scenario is for BAU profits to exceed those of SLM in the short run. However, land degradation will slowly lead to decreasing net revenues and over the medium to long term SLM will be the economically superior option. In the extreme BAU could lead to complete resource collapse and high economic costs to society. Even if BAU profits remain positive, it could be that the discounted net profits from SLM exceed those of BAU.

SLM net revenues may be negative in the first years, as sunk investment costs take a toll on private revenues, and/or crops take time to reach maturity. Government policies can either target the sunk costs (e.g. technical assistance) or promote a larger planning horizon (e.g. by providing cheap access to credit) to facilitate the uptake of SLM (Bovarnick *et al,* 2010).

10

Annex 2: Step wise Methodology

10.1 Overview of methodology

The methodology is based on six key steps as presented in Figure A3. The methodology presented involves a comprehensive assessment of the costs of soil degradation and the benefits of SLM. However, in reality a partial analysis of the land degradation may only be possible initially due to data and time restrictions[19].

Step 1 provides background on the study area and the context for the economic assessment. This step involves building up an understanding of the agricultural land area under study (its physical characteristics and the type of land degradation it faces under current management regimes) and an identification of sustainable land use management options.

Step 2 defines the scope of the assessment. Under Step 2 the key ecosystem services at the site such as – key crops grown and carbon sequestration benefits are identified through a qualitative assessment along with the key off-site impacts associated with BAU and SLM. The scope of the assessment is based on the significance of the service / off site impact, data and resources available for the assessment.

19 Additional references sources include Hein 2006, Jones et al 2008 and Yaron et al 2011

Step 3 quantifies in bio-physical terms the impact of BAU and SLM both in terms of the impact on the ecosystem services provided by agriculture and the off-site impacts. This is an important step underpinning the valuation of the impacts.

Step 4 values those ecosystem services and off-site impacts identified in Step 2 and 3 as being significant and possible to value given available data and resources.

Step 5 analyses the valuation undertaken in Step 4. For example: unit values need to be aggregated based on the appropriate population, or by the number of hectares, benefiting from the land use to derive total values; sensitivity analysis is required to highlight to decisions makers the confidence that may be attached to the values; and, discounting of annual values and one off costs over an appropriate timeframe is undertaken to derive net present values (NPV). A distributional analysis is recommended. This is used to draw out who wins from current and potential land use options use and who loses (taking into account both on-site and off-site costs and benefits). This information can be used to develop mechanisms to compensate those who lose from a particular land use or allocation.

Step 6 involves a discussion of the institutional barriers to achieving the optimal economic land use identified.

10.2 Step 1: Defining the issue and context for the economic assessment

Step 1a: Define the physical characteristics of the study area

The first step is to define the physical characteristics of the agricultural ecosystem e.g. its area, soil type, hydrology. This can be collated from existing studies, maps and statistics on the site and / or through discussions with land managers / scientists familiar with the site.

The geographical (spatial) scale of the assessment is a key consideration and should be clearly specified. The scale of the study can either be an ecologically defined system such as an agricultural plot or watershed / catchment. Or an institutionally define system, such as a municipality, region or country. The area can be relatively homogeneous, including only one main ecosystem type (e.g., semi-arid rangeland), or it can be hetrogeneous (comprising a mix of agricultural and semi-natural lands). If the area comprises different systems these systems are likely to supply different services and the assessment will be more complex.

Step 1b: Define the type/s of land degradation facing the study area

The economic value of agricultural land is related to what that land can be used for, its availability and its quality. Land value therefore varies from location to location, with degraded land being of less economic value than un-degraded land. In order

Figure A3. Key Steps in the economic assessment of the costs of land degradation & the benefits of SLM

Step 1: Characterize the land area and determine the context for the assessment	1a. Develop a conceptual understanding of the physical characteristics of the area to be studied e.g. its size, soil type, typography, hydrology 1b. Define the issues. That is, what are the main uses of the agricultural land / study site and threats (type of land degradation), who is being affected and how. 1c. Define the BAU and SLM scenarios to be analyzed.
Step 2: Define the scope of the economic assessment	2a. Select ecosystem services for valuation Undertake qualitative assessment of ecosystem services Determine data availability (scientific / quantitative) Determine which ecosystem services are to be valued.
Step 3: Quantification of impacts	3 Quantify (in bio physical terms) the impacts of BAU and SLM, taking into consideration both on-site and off-site impacts
Step 4: Undertake valuation of ecosystem services	Derive monetary estimates of the ecosystem services under BAU and SLM using an appropriate valuation approach
Step 5: Analysis of valuation evidence	CBA (from an economic and financial perspective). Aggregation, discounting, sensitivity analysis and distributional analysis
Step 6: Understanding the institutional requirements	Specify the institutional barriers to achieving the optional economic land use

to assess the cost of land degradation and the benefits of SLM for agricultural land in Tajikistan it is first necessary to understand the issues the study area faces. This provides the context for the economic assessment.

While a holistic overview of the services provided by agricultural ecosystems is a core part of the methodology, a focus is on understanding the costs of different types of land degradation and the benefits of alleviating / avoiding land degradation through the adoption of SLM. Types of land degradation include:

- Soil erosion caused by water. In areas of sloping land this can be severe causing permanent loss of the land's productive capacity
- Soil loss caused by wind
- Soil fertility loss due to the lowering of soil organic matter and loss of nutrients due to, for example, the incorrect use of fertilizer
- Waterlogging, or the lowering in land productivity through the rise in groundwater close to or above the soil surface. This is caused by incorrect irrigation management.
- Salinisation, or soil degradation caused by increase of salt in the soil, caused by incorrect irrigation management. It reduces crop yield and in severe cases causes complete abandonment of agriculture.
- Lowering of the groundwater table, caused by over-extraction of groundwater
- Rangeland degradation
- Acid sulphate formation
- Soil pollution
- Soil destruction through mining and quarrying
- Urban encroachment onto agricultural land

Factors causing land degradation can be categorised into three groups: (i) natural factors; (ii) direct anthropogenic factors; and, (iii) underlying causes (socio-economic structures, which give rise to direct factors) (Table A2). This methodology is focussed on quantifying and monetizing where possible the impact of anthropogenic factors contributing to land degradation on human welfare.

Table A2. Factors contributing to land degradation

Natural factors	Direct anthropogenic factors	Underlying causes
Heavy rains Steep slopes Arid climates (contribute to salinisation and lowering of the water table)	Overcutting of vegetation Deforestation Overgrazing Inappropriate use of fertilizers Non-adoption of soil conservation practices Mismanagement of canal irrigation Overpumping of groundwater	Inappropriate land tenure Land shortage Population growth Poverty

Key questions to consider are:

- *How is the land currently used?* What crops are currently grown and what management practices are in place.
- What are the current institutional arrangements (e.g., land tenure)?
- *What type of land degradation is evident and what are the underlying causes / pressures of land degradation?*
- *Where and when will change happen?* Effects may be evident at local, regional and/or national scales in the short term or longer;
- *Who will the change affect and how?* The benefits of an area may accrue to stakeholders at different scales – local farmers, regional traders, national investors or the global community. The assessment could cover all stakeholders or focus on a specific group, e.g., impact of SLM on local food security, or the national cost of land degradation.

These questions can be addressed through a review of the available literature, a site visit and interviews with stakeholders.

Table A3 provides an overview of the uses of agricultural ecosystems in Tajikistan and the pressures that they face

The assessment could focus on one type of land degradation within the study area, or consider all the different types of land degradation. This decision should be based on the priority pressures identified at the study site and available resources to undertake the assessment.

Table A3. Key pressures facing agricultural land in Tajikistan

Direct pressure	Description	Policy driver / underlying pressure	Sector responsible
Intensive development of agriculture on steep slopes	This is resulting in soil erosion as the soils are washed out and the growth of ravines tends to decrease the area of arable land.	Lack of agricultural land / population pressure / low productivity resulting in a vicious cycle	Agriculture
Poor irrigation practices Under / over watering of cotton fields	The hilly parts of cotton fields suffer from under watering, while in those places where there are depressions, crops suffer from an oversupply of water. Both negatively affect the productivity of cotton fields	Lack of qualified farm technicians due to labour migration	Agriculture
Overuse of pastures	All pasture lands of Tajikistan are subject to erosion—with 89% of the summer pastures and 97% of winter pastures suffering from medium to high erosion.	Lack of transport / infrastructure to reach summer pastures increases pressure on low level pastures Preference to grow food crops given crop shortages and concerns over food insecurity	Agriculture - livestock

Direct pressure	Description	Policy driver / underlying pressure	Sector responsible
Felling of mountain forests, bushes and half-bushes	The illegal and unplanned cutting of forests for fuel is of wide scale, especially on the forest lands of collective and state farms, while reforestation, replanting and others amelioration measures are weak or non-existent.	Household fuel demand The use of wood as a building material.	Households

Step 1c: Define the baseline and the SLM option to be analysed

The BAU and SLM scenarios are broadly defined below based on Bann 2010. They would need to be tailored to a site / regional / agro-ecological area specific assessment as appropriate.

Business As Usual (BAU) or the baseline refers to agricultural practices across Tajikistan (national assessment) a given region or are currently practice at a given site that contribute to land degradation. Broadly speaking these systems share a focus on attaining near-term financial results based on on-farm costs and processes. Decision making does not take into account externalized on site costs, the value of ES that underpin production processes, or the effects of off-site impacts (like siltation of waterways due to soil degradation). While such systems can realize good profits in the short run, they impose costs on society (externalities) and in the longer term their productivity is likely to be undermined by depletion of or damage to the ES they depend on.

Business As Usual does not consider the relations among production decisions, environment, and broader social goals. BAU practices can be sub-optimal because they overuse natural resources, cause unnecessary pollution or waste, do not maintain their resource base, nor align with broader social and cultural objectives. BAU systems thus tend to have a high environmental impact and low sustainability, but are often attractive for their earnings levels, at least initially.

Sustainable Land Management (SLM) refers to agricultural practices that leverage natural processes to produce long lasting returns at attractive levels through addressing land degradation. This implies a movement from BAU practices towards others that are economically efficient over the long term, internalizing the negative impacts of production on the natural resource base and on society. SLM approaches mitigate negative environmental externalities or avoid them altogether.

The basic SLM approach is to move from high to low impact production schemes, diversify farming systems, and rationalize the agricultural landscape. Among the options are soil and water conservation practices, use of polycultures and multicropping regimes, organic growing, and adoption of low-till or no-till production, integrated pest management, and agroforestry systems. Low impact management focuses on better use of ES, with more efficient, carefully targeted use of agrochemicals, minimizing pesticide use, and reducing runoff, erosion and discharge of pollutants into streams. Such changes will often provide economic benefits by reducing the cost of inputs. Organization and empowerment of communities or producers associations is often used to support the process of change, since isolated efforts provide few opportunities for synergy, economies of scale, and sharing knowledge—they are prone to failure. The broad effects of SLM practices are to maintain and strengthen ES.

The SLM options identified for Tajikistan will be informed by the pressures and drivers identified in step 1b.

Table A4 illustrates the environmental impacts associated with BAU for some key commodities and potential management practices to mitigate those effects in a transition toward SLM.

Table A4. BAU impacts versus SLM practices

Commodity	BAU - major environment impact	SEM – potential management practices
Cotton	■ On-site: - Monoculture cotton reduces the fertility of the soil; - Loss of biodiversity - Salinisation due to inappropriate water use - Use a large number of chemical fertilizers and pesticides; ■ Off-site: - Water pollution	■ Use of improved varieties ■ Introduction of water saving technologies (in areas of pumped irrigation) ■ Reduced use of fertilizers and chemicals ■ Pilot studies suggest that replacing cotton with oilseeds, cereals and fodder production enhances the quality of the soil (corn and wheat can be highly profitable, while Lucerne will enhance fodder production and allow long term soil fertility. ■ Sun flower, soya, rapeseed and alfalfa offer a combination of oil and fodder source, enhance soil quality especially when used as part of double cropping mechanism, by adding organic matter to the soil.
Livestock	■ On-site - Low productivity of the breeds; - Degraded pastures - Forest loss ■ Off-site - Sedimentation of waterways and land	■ Improvement of infrastructure in remote pastures ■ Improved rotation of pasture ■ Planting forage crops, especially legumes ■ The introduction of crop rotations with forage crops ■ Improved animal breeds ■ Development of service extension services

At least two options should be defined. This would be the baseline (BAU), and a SLM, however other possible options are outlined in Table A5.

Table A5 - Defining the options to be compared

Option	Description
Option 1: Business as usual	BAU represents the value of the agricultural ES over time assuming that no new actions are taken at the site and land degradation continues.
Option 2: Sustainable Land Management	This option defines the measures needed to reduce key pressures causing land degradation and thereby threatening the sustainability of agricultural productivity and demonstrates the net benefit of these measures,
Option 3: Variation on option 2	In some cases it may be possible / necessary to compare the baseline to more than one option. This for example could involve looking at different uses for the site, or different degrees of management and/or restrictions on use and comparing the net benefits of each option.
Option 4: Deterioration of agricultural ecosystem services, relative to BAU	This option demonstrates how BAU situation may worsen as a result of continued or increasing pressures on the agricultural resource or the potential adoption of unsustainable management practices and uses.

10.3 Step 2: Defining the scope of the economic assessment

Step 2a: Select ecosystem services for valuation based on a qualitative assessment of the services provided by the agricultural ecosystem and an understanding of available data and resources to undertake the assessment.

Identification of ecosystem services

Monetization of agricultural ecosystem service under a BAU or SLM scenario initially requires a qualitative description and quantitative measures of that service in its current use (the baseline). Table A6 provides a check list of the possible benefits provided ***by*** agricultural ecosystems. The provision of these benefits will change under different agricultural land use practices.

In order to gain an overview of the services provided at the study site/area under BAU a qualitative assessment of the ecosystem services it provides and their significance can be undertaken, where:

Table A6. Qualitative analysis of Ecosystem Services provided by Agricultural Ecosystems and the expected temporal impact on BAU and SLM (including off-site impacts)

Ecosystem Service category	Service (Benefit / outcome)	Significance under the baseline[1]	Impact BAU scenario[2]	Impact SLM scenario[2]
Provisioning Services	Food	++		
	Fodder			
	Fuel			
	Biochemical and medicinal resources			
	Genetic resources			
	Ornamental resources			
Regulating Services	Sink for atmospheric carbon dioxide (carbon capture)			
	Hydrological services (regulation of timing and volume of river flow)		Consider on & off site impacts	Consider on & off site impacts
	Flood risk regulation (protection of property, agricultural land, human lives)		Consider on & off site impacts	Consider on & off site impacts
	Protection against storms		Consider on & off site impacts	Consider on & off site impacts
	Control of erosion and sediments		Consider on & off site impacts	Consider on & off site impacts
	Regulation of pest and pathogens			
Cultural Services	Cultural, spiritual, religious,			
	Scientific and educational information			
	Tourism and recreation			

1/ Code: ++ means that the service is important; + means that the service is provided; - means that the service is not relevant; and, ? means that there is uncertainty surrounding the provision of a service. 2/ Code: +: constant positive effect; +/-: initial positive effect but returns start to decline due to resource degradation; 0 no /neglible effect; -: negative effect; - - significant negative effect

- \+ + means that the service is important;
- \+ means that the service is provided;
- \- means that the service is not relevant; and,
- ? means that there is uncertainty surrounding the provision of a service.

Step 2 also involves a qualitative assessment of the impact of BAU and SLM on the ES provided by the site ***over time.*** It gives an overview of which ecosystem services will be positively or negatively affected by each option and which will remain unchanged. The BAU scenario is a continuation of the baseline through an agreed timeframe used to compare the costs and benefits of BAU and SLM scenarios. That is the baseline analysis is static and provides a snap shot of current use and impacts, while the BAU projects output and impacts over the project timeframe. The analysis should start therefore with understanding the baseline.

The qualitative assessment should also consider the off-site impacts of BAU and how these could be reduced under SLM (e.g., water pollution, sedimentation of rivers).

10.4 Step 3: Quantify (in bio physical terms) the baseline and impacts of SLM

This step requires that the SLM option is defined in some detail, and assumptions are made on how the ecosystem services will improve or decline under each option over a given time frame. This information could be built up based on expert opinion or through a steering group or focus group. Table A7 provides a template for recording quantitative data / indicators for the BAU and SLM.

10.5 Step 4: Undertake Valuation of Land use options Ecosystem Services

The valuation of the cost of land degradation / benefits of SLM involves linking the bio-physical impact data provided in Step 3 with economic data. Question of interest may include

- What is the economic cost of soil nutrient depletion? To answer this question we need to know the relationship between soil nutrient levels and crop yield. The fall in crop yield association with a given soil nutrient depletion levels can then be estimated using market prices. Economic costs could also be estimated based on the cost of replacing the lost soil nutrients (through additional fertilizer).
- What is the economic cost of erosion? Soil erosion can lead to reduced fallow periods and loss of vegetation cover it can also result in the siltation of downstream waterbodies reducing, for example, the lifetime of the reservoirs with associated economic costs. Economic costs could also be estimated based on the cost of land reclamation and restoration. Sedimentation impacts can also

Table A7 - for undertaking quantitative assessment of options of the impact of each scenario on ecosystem services

Ecosystem service		Impact of BAU and SLM Options		
		Units	Quantity (BAU)	Quantity (SLM)
Provisioning	Food, fodder, fuel, biochemical and medicinal resource, genetic resources, ornamental resources	Amount of product harvested / year (e.g. x tons of cotton); inputs required for harvesting (e.g., time, equipment, land, fertilizers, pesticides, seeds)		
Regulating	Sink for atmospheric carbon	Carbon content and exchange of the above and below ground biomass and soil organic matter		
	Hydrological services / flood risk regulation (regulation of the timing and volume of river flows)	Impact of vegetation on water flows, as a function of the topology, peak flows, vegetation cover, absorbing capacity of the soil, infiltration rates etc		
	Protection against storms	Storm protection depends on vegetative structure, topography, and length and width of the vegetation belt. This may be measured by analyzing impacts of past storms or by modelling erosion processes.		
	Control of erosion and sediments	Vegetative ground cover, rainfall erosivity and soil erodibiity (slope characteristics, texture, organic matter contents etc) impacts on dams / waterways		
	Regulation of pests and pathogens	Impact may be measured by comparing crop yields or health impacts in areas with and without such control		
Cultural	Cultural, spiritual, religious	Amount of people benefitting from services. Type of benefits obtained (e.g. use or non-use)		
	Scientific and educational information			
	Tourism and recreation			

be based on damage costs related to flooding, drinking water treatment facilities, water storage, navigation and water conveyance facility dredging and maintenance. Costs include infrastructure damage costs to reservoirs, channels and sediment clean up by local government and road and rail operators and direct expenditure costs on soil conservation measures

- What is the benefit of sustainable irrigation systems? This can be estimated based on the value US$ per year generated by irrigated and non-irrigated agriculture, plus any external costs avoided. Economic costs could also be estimated based on the cost of land reclamation and restoration.
- What are the health costs of wind erosion? This could be estimated through an understanding of health impacts such as the relationship between dust and asthma. This impact could be valued based on medical expenditures or work days lost.

The main categories of valuation approaches are as follows:

Market price approaches: Consider *use values* associated with agricultural products that are bought and sold in actual markets.

Productivity approaches: Productivity approaches look at the way in which changes in the quantity or quality of land affects the production of other marketed outputs or income flows (e.g., agricultural crops or hydropower). The *use value* is inferred by changes in production that result from changes in an input to production (e.g. soil quantity or quality). Often detailed physical data is required. For example to estimate the extent to which downstream hydropower and irrigation schemes depend on upper catchment protection services it would be necessary to relate catchment deforestation to a particular rate of soil erosion, consequent siltation of a hydropower dam and reduced power outputs. To be able to specify these kinds of relationships typically involves consultation with experts, and potentially situation-specific laboratory or field research, controlled experiments, detailed modelling and statistical regression.

Revealed preference methods: Estimate the *use value* of non-market goods and services by observing behaviour related to market goods and services that can be linked to the agricultural ecosystem in some way. For example the travel cost method may be used to estimate the cost (both money and time) incurred in undertaking agricultural related or agricultural-affected recreation and tourism activities.

Stated preference methods: These survey based approaches create hypothetical markets to determine the value of non-market goods and services. Individuals are typically asked what they would be willing to pay or accept for a specified change in the provision of a service Stated preference techniques are the only approaches that can estimate all the various components of Total Economic Value (TEV) - direct and indirect use value and non-use value.

Broadly speaking market price and productivity approaches are ordinarily applied to value *market goods and services,* while revealed preference and stated preference approaches are applied to value *non-market goods and services.* However, there can be overlaps between methods and often combinations of methods are required to inform decision-making.
In addition to the valuation evidence, the assessment should also collect information and data that is likely to be important to decision making. This includes the number of jobs associated with a given agricultural practice, the importance of agricultural ecosystems to local livelihoods and the role agricultural ecosystems play in maintaining the health of local communities.

Table A8 outlines the impacts of different types of land degradation and approaches and data requirements that may be applied to monetize these impacts. Valuation of the off-site effects of soil erosion is likely to be harder than on-site effects due to the difficulty of specifying the impact of soil erosion and sedimentation on water quality, ecological diversity, flood severity and the associated damage.

Market pricing approaches and benefits transfer are considered to be most applicable for the initial study of land degradation and its effects on agricultural productivity in Tajikistan and are discussed below.

Market price approaches

Market price approaches include the use of market prices to value traded ecosystem services and also the so called cost based approaches (e.g. change in productivity approach, replacement cost, market prices, opportunity cost).

The use of market prices for agricultural ecosystem services that are traded reflect a lower bound estimate of its value, as they do not capture the consumer surplus element of value. They are therefore only proxies of welfare value. However, such estimates are still very informative and relatively straight forward to derive. They can be used to capture direct and indirect use values, but not non-use values. `

Cost based approaches take the cost of replacing a service or averting a damaging impact as a proxy for the value of the benefits provided by a given agricultural land use. Values that may be derived from these approaches do not represent true valuations as the assessment only considers whether the non-market good is of greater value than the opportunity cost (Bateman, 1999). They suffer from the same complications as market prices and risk under-valuation of non-market goods; the price reflects the cost of obtaining a good, not the actual benefit derived from its 'consumption'.

The values derived from cost based approaches such as the replacement cost, cost of alternatives, mitigation costs and cost of illness are a benchmark set by the market. However, market prices can over-estimate the true opportunity cost of an

Table A8: Overview of the impacts of different types of land degradation and approaches to their monetization

Type of land degradation	High level physical impact	Specific impacts	Possible monetary approaches	Data requirements
Overgrazing	Soil erosion	On site: ■ Reduced fodder available leading to lower milk / livestock productivity ■ Loss of land available for grazing ■ Reduced carbon sequestration	■ Cost of substitute fodder ■ Present and future Δ in milk production × market price ■ Present and future Δ in meat production × market price ■ Δ in carbon sequestration function × market price of carbon	■ Time series data on loss of soil cover on pastures ■ Relationship between soil cover and fodder available ■ Time series data on the change in milk / milk production ■ Time series data on the number of livestock / ha ■ Market price fodder / milk / meat products (over past 10 years)
	Sedimen-tation	Off site: ■ Siltation of reservoirs resulting in loss energy output ■ Changes in runoff leading to flooding / landslides ■ Reductions in water quality and ecological diversity	■ Loss of energy output as a result of the reduce life time of reservoir × market price of energy ■ Impact of flooding on property damage / loss of agricultural land / human life estimated based on replacement cost/ market prices/ Value of life assessments	■ Area of reservoir capacity loss as a result of siltation ■ Lost power capacity over lifetime of reservoir ■ Market price of energy / kWh ■ Change in runoff as a result of erosion ■ Probable incidence of flooding / landslide as a result of increase in run off ■ Replacement cost / damage cost avoided of likely damage
Poor water manage-ment / inad-equate drainage in-frastructure	Salinization and water logging which affect soil fertility and land available for agriculture	On site: ■ Reduced productivity due to reduce soil fertility ■ Reduced productivity due to loss of area available for agricultural production	■ Δ in productivity × market price of affected crop ■ Cost of replacing loss nutrients to maintain soil fertility	■ Area of land affected by salinization and water logging ■ Scientific evidence of change in fertility levels ■ Lost production /year ■ Market price of key crops

Type of land degradation	High level physical impact	Specific impacts	Possible monetary approaches	Data requirements
		Off site: ■ Siltation of reservoirs resulting in loss energy output and water supply ■ Low flow rivers resulting in impacts on biodiversity and water available for agriculture	■ Loss of energy output as a result of the reduce life time of reservoir × market price of energy ■ Loss of water supply × Δ in productivity × market price of affected crops	■ Change in runoff as a result of erosion ■ Probable incidence of flooding / landslide as a result of increase in run off ■ Replacement cost / damage cost avoided of likely damage ■ Change in river flow / incidence of low flow ■ Impacts of low flows on water supply, biodiversity etc
Intensive agriculture on steep slopes / marginal lands	Soil erosion	On site: ■ Reduced productivity due to reduce soil fertility ■ Loss of area available for agricultural production	■ Δ in productivity × market price of affected crop ■ Cost of replacing loss nutrients to maintain soil fertility Time series data on soil fertility levels	■ Time series data productivity per ha for key crops ■ Market price of key crops ■ Area lost to agriculture as a result of soil erosion ■ Market prices of replacing soil nutrients lost
		Off-site: ■ Siltation of reservoirs resulting in loss energy output and water supply	■ Loss of energy output as a result of the reduce life time of reservoir × market price of energy ■ Loss of water available for irrigation × Δ in productivity × market price of affected crops	■ Change in runoff as a result of erosion ■ Probable incidence of flooding / landslide as a result of increase in run off ■ Replacement cost / damage cost avoided of likely damage

Note: Water resources generate about 95% of all electricity produced in the country (World Bank, 2007). If the reservoirs and dams needed for large-scale power generation were to collapse, this could cause catastrophic flooding.

action due to distorted market structures which reflect political objectives rather than competitive relationships. Highly intervened markets, such as agriculture, imply a certain degree of complexity in the link between market prices and underlying costs, suggesting that it may be difficult to assess the value of non-market goods in this manner.

Replacement cost methods can be used to estimate the cost of restoring productivity of degraded land to their pre-erosion level. For example, what would be the cost of chemical replacements to replenish nutrients lost to erosion? This requires information on soil nutrient concentrations and the prices of chemical fertilizers. For land degradation on eroded slopes replacements costs can include the cost of stabilization works, reseeding and restoring soil fertility, and could also include lost production if stock that would have grazed the eroded site need to be excluded during the restoration period (Jones *et al*, 2008)

Value Transfer

Value transfer (also called benefits transfer) involves the application of values from an existing study (often called the 'study site') to a new study (often referred to as the 'policy site') where conditions are similar and a similar policy context is being investigated.

Value transfer is a practical means of demonstrating the monetary value of ecosystem services. It is cheap and quick relative to primary research, but there are a number of factors which influence the reliability of the transfer exercise. They are particularly useful for estimating regulating services, where site specific bio-physical data may be missing.

The quality of the original study is obviously a key consideration for value transfer applications. In order to minimize errors / uncertainty, the primary research study should be based on adequate data and a theoretically sound approach. The degree of similarity between the study site and the policy site is also a major factor. Value transfer will be more reliable if the policy site is located within the same region / country as the study site, and displays similar site characteristic (e.g. size, services and availability of and distance to substitutes). Other factors affecting the reliability of the value transfer exercise include: the reference condition[20] (i.e., how closely the baseline at the study site matches the baseline at the policy site); the proposed change in the provision of the service (i.e., the magnitude of the change and whether the valuation is of a change in the quantity or the quality of an attribute); and the range/ scale of the commodity being valued (e.g., one site or many sites valued and physical area).

20 Valuation responses are non-linear, therefore interpolating values for similar percentage changes occurring at different points on the response curve may lead to significant error.

The same benefits realized in different geographical areas may have different values due to the differences in socioeconomic characteristics of the relevant population and their cultural preferences. It is important then to understand the population size and density of the study site and to what extent the relevant socio-economic variables for the study site match the policy site. It is also possible that two sets of the population with similar socio-economic profiles within Tajikistan could have quite different tastes and preferences, which would influence their values for goods and services.

Overview of costs and benefits

Table A9 summarizes the types of benefits and costs that should be included in the analysis. Benefits include the key ecosystem services provided by the study area monetized where possible and a quantitative description of the key social benefits associated with a land use (e.g., jobs related to agricultural land use). The costs associated with agricultural land use options also need to be identified in order to derive the net benefit of each option. Operating costs include: labor, seeds, fertilizers, pesticides etc. Offsite environmental costs include water pollution and the sedimentation of waterbodies.

Table A9. Key Categories of Costs and Benefits

Benefits	Costs
Key ecosystems services – food, carbon sequestration	On-site financial costs – labour, seeds, fertilizers, pesticides
Social benefits – jobs, health (quantified)	Off-site environmental costs – water pollution, sedimentation of water bodies

10.6 Step 5: Analysis of Valuation Evidence

Step 5 focuses on the analysis required to complete the economic assessment: the unit values derived from the valuation exercise need to be aggregated to derive total values and in order to be input into a cost benefit analysis; sensitivity analysis is undertaken in order to draw out uncertainties around the monetary evidence; streams of benefits (and costs) over time need to be discounted to derive present values; and, **distributional analysis** is recommended to draw out the key beneficiaries and cost bearers associated with current practices and alternative management options. **Emphasis should be placed on how different agricultural practices contribute to poverty alleviation.** Distributional weights might also be considered for the cost benefit analysis.

10.7 Step 6: Understanding the institutional requirements

Under step 6 the institutional context is specified and the barriers to the adoption of the optimal economic scenario identified discussed.

Tackling land degradation and developing a sustainable agriculture sector will depend on a range of preconditions (Consolidated document for agrarian report, 2010). These include:

- A long-term land-use right. Developing orchards and vineyards will take years to come into production and begin to pay off, so farmers will not plant them unless they are sure of keeping the land for a lengthy period.
- Tax concessions will be necessary to promote long-term investment during the first years of change.
- Extensive support in rehabilitation and development of rural infrastructure (roads, utilities, irrigation facilities, market facilities, processing, energy, etc)
- Access to long-term and affordable credit and grants, and interest-rate subsidies will attract farmers to undertake new initiatives.
- Groups with marginal incomes may require subsidies for the initial years to manage the change process effectively and economically.
- Changing cropping patterns and diversifying agriculture sector will require extensive capacity-building of farmers so that they can understand the potential benefits, accept and implement the change.
- Scientific analysis of alternative crops determined by market conditions, based on gross margin analysis.
- Viable market regulations and information system based on demand and supply and improved access to markets and marketing
- Regulation of exports and imports
- Market regulation and tariff policy
- Quality control, grading, standardisation and certification
- Building trust between suppliers and consumers

Annex 3: Stakeholders consulted

List of counterparts met during PEI tour for Economic study on land degradation

1.	Sodik Khusainov	Ministry of Economic Development and Trade, Head of Department of management of real economic sectors
2.	Tojinisso Nasirova	Ministry of agriculture, Head of scientific researches department
3.	Mahmadtoir Zokirov	State Committee for Land Management and Geodesy, Chairman
4.	Aziz Nazarov	Committee on environment protection, Head of international relations department
5.	Kadamov Muboraksho	Committee on environment protection, Head of the department on State control of the water resources
6.	Maskaev Abdukodir	Committee on environment protection, Head of the department of land resources and waste management
7.	Kodir Aliev	Ministry of land reclamation and water resources, Head of division
8.	Olimjon Bobokalonov	Center for strategic research under the president of RT, Deputy of Director
9.	Saodat Sohibnazarova	Center for strategic research under the president of RT, Head of department
10.	Khurshed Kasimov	State agency on statistics, Head of Agriculture data division
11.	Prof. Khukmatullo Akhmadov	Academy of Agricultural sciences of RT, Chairman

12.	Bobojon Yatimov	World bank, Agriculture Development Project, Manager
13.	Sukhrob Khoshmukhamedov	UNDP, ARR Programme
14.	Gulbakhor Nematova	UNDP, CP Manager
15.	Mirzokhaidar Isoev	UNDP, "Energy and Environment" programme
16.	Firuz Ibrogimov	UNDP, Central Asian Countries Initiative for Land Management, Manager
17.	Normahmad Navruzov	Hukumat of Zafarabad district, Deputy of Chairman
18.	Khorkashev	Hukumat of Zafarabad district, Head of Agriculture Department
19.	Furqatjon Umurov	Hukumat of Zafarabad district, Head of District Land Committee
20.	Ravshan Sherquziev	Hukumat of Zafarabad district, Head of Water Management Department
21.	Abdushukur Ma'murov	Hukumat of Zafarabad district, Head of Cocoon Department
22.	Isoqjon Zokirov	Representative from TV of Sughd oblast
23.	Fiyz Sultonov	Hukumat of Istaravshan district, Deputy of Chairman
24.	Khosiyat Fozilova	Hukumat of Istaravshan district, Head of Department of Economy
25.	Firuza Solieva	Hukumat of Ghonchi district, Head of Department of Economy
26.	Habiba Atovulloeva	Hukumat of Ghonchi district, Main Specialist of Department of Economy
27.	Adiba Imomova	Hukumat of Ghonchi district, Specialist of Department of Tax
28.	Olim Shukurov	Hukumat of Ghonchi district, Head of Department of Ecology
29.	Abdurazzoq Rakhimov	Hukumat of Ghonchi district, Head of District Land Committee
30.	Zarif Uyldoshev	Hukumat of Ghonchi district, Head of Department of Water Management
31.	Abdumalik Hojiev	Hukumat of Ghonchi district, Head of Department of Agriculture
32.	Khursed Sa'dulloev	Hukumat of Ghonchi district, Head of Department of Road
33.	Tour Nazarov	Hukumat of Ghonchi district, Head of Department on Statistics
34.	Murod Nurmuhammedov	Hukumat of Qumsanger district, Deputy of Head of Department of Economy
35.	Nuriddin Sattorov	Hukumat of Jilikul district, Head of Department of Economy
36.	Muminkhuja Davlatov	Hukumat of Qabodiyon district, Head of District Land Committee
37.	Sijovuddin Isroilov	Ministry of Agriculture, Deputy Minister
38.	Ahmadov Mahmudovich	Tajik Academy of Agricultural Sciences, President

List of participants of the PEI Economic study workshop on land degradation 1 November 2011

1.	Sulkhiya Sodikova	Committee on environment protection under the government of RT, Deputy head of department
2.	Halim Ibragimov	Committee on environment protection under the government of RT, Main specialist
3.	Akram Kakhorov	State committee for land management and geodesy, Director GUP "Markaz-zamin"
4.	Egamberdi Kholmurodov	State committee for land management and geodesy, Head of department of public land registration
5.	Nematullo Safarov	UNDP, Agro-biodiversity national center, Project Manager
6.	Tatyana Novikova	UNDP, Agro-biodiversity national center, Deputy Project Manager
7.	Prof. Abdulkhamid Kayomov	Academy of sciences of RT, Climate change Expert
8.	Farzona Mukhitdinova	World bank, Agriculture Development Project Assistant
9.	Nargiz Usmanova	UNDP, Programme associate
10.	Yusuf Kurbonkhojaev	UNDP, CP, Senior local governance advisor
11.	Manuchehr Rakhmonov	UNDP, CP, Senior economic development advisor
12.	Camille Bann	UNEP-UNDP, PEI International consultant
13.	Rakhmon Shukurov	UNEP- UNDP, PEI National consultant
14.	Dilorom Rakhmatova	UNEP- UNDP, PEI National consultant
15.	Lutfullo Boziev	UNEP- UNDP, PEI National consultant
16.	Zulfira Pulatova	UNEP- UNDP, PEI National Project Manager
17.	Bahrom Abdoulhakov	UNDP, RGP&PEI Assistant

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