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Ph. D. Thesis
Soil Conservation in River Swat Watershed North West Frontier Province (NWFP) Pakistan

By
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(2004-2007)

Department of Environmental Sciences
University of Peshawar
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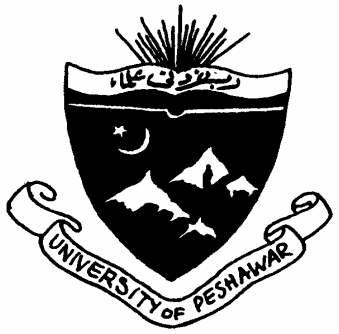

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Declaration

It is herein confirm that this thesis is original work completed by Mohammd Nafees, the author under the kind supervision of Dr. Hizbullah Khan and Dr. M. Rasul Jan. The primary data given in section E (Tables) is purely belonging to the author and not published in any national or international journal, neither presented in any conference. It is also not published on internet. All publishing stuffs are herein acknowledged in the form of references. The following papers are in progress/submitted to various journals.

S No	Title	Submitted to
1	Circulatory land tenure and its social and ecological impacts: A case study of Village Dheri Allahadand in Northern Pakistan	Submitted to Journal of Mountain Research and Development Switzerland
2	Study of Role of Collective Community Efforts (*Ashar*) in Minimizing Pesticides, Lower Swat, North Pakistan, Pakistan	Submitted to Journal of Mountain Research and Development Switzerland
3	Study of Pesticides uses, Its Environmental and Socio-economic Impacts in Swat Valley	Submitted to Journal of Mountain Research and Development Switzerland
4	Investigation of soil contamination in swat valley caused by Cadmium and Copper by using atomic absorption Spectrophotometer	In progress
5	Evaluation of Various Soil Extraction Methods for Heavy Metal (micro nutrients) in Selected Sample of Different Texture	In Progress
6	Study of Forest Fire in Swat Valley, causes, effects and prevention	In Progress
7	Investigation of Micronutrient Status in Swat Valley	In Progress
8	Status of Soil Texture and required associated Soil Conservation measure of River Swat Catchments Area, NWFP, Pakistan	Submitted to Sarhad Journal of Agriculture Agriculture University Peshawar
9	Environmental Impacts of Continuous Ban on Fishing in River Swat	Submitted to Journal of Law and Huminity, University of Peshawar
10	Study of land capability classes in Swat Valley	In Progress
11	Study of Soil Conservation in River Swat Watershed, North West Frontier Province, (NWFP), Pakistan	In Progress

SOIL CONSERVATION IN RIVER SWAT WATERSHED NWFP, PAKISTAN

By

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A thesis submitted in partial fulfillment of the requirements for the degree of

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Dedication

1. ***My sweet parents who always guide me in the right direction***
2. ***My wife and three kids Farukh Khan, Lala Rukh and Shah Rukh Khan***
3. ***My dear friend late Mohammad Ayaz Khan who spent few years in the department of Environmental Sciences as a faculty member.***

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List of Abbreviation

COTHM	College of Tourism and Hotel Management
DAP	Dia ammonium Phosphate
DDT	Di-chloro Di-phenyle tretra chloro ehthyleen
DTPA	Diethylene-Triamine-Pentaacetic acid
EC	European community
ECD	Electron Capture Detector
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPS	Environmental Protection Society
FAO	Food and Agriculture Organization
FAO	Food and Agriculture organization
FATA	Federal Administered Tribal Areas
FFS	Farmer Field School
GC	Gas chromatograph
GDP	Grass Domestic Product
GOP	Government of Pakistan
HCH	Hexa Chloro Hexan
IBRD	International Bank of Reconstruction and Development
IUCN	International Union for Conservation of Nature and Natural Resources
LPG	Liquid Petroleum Gas
MAC	Maximum acceptable concentration
mha	Million hectors
MRL	Maximum Residue Limits
MSL	Mean Sea Level
NCS	National Conservation Strategy
NM	Not mentioned
NRCS	Natural Resource Conservation Services
NWFP	North West Frontier Province
PATA	Provincially Administered Tribal Areas
PRA	Participatory Rural Appraisal
PTDC	Pakistan Tourism Development Corporation
SDA	Sarhad Development Authority
SDPI	Sustainable Development Policy Institute

SPCS	Sarhad Provencal Conservation Strategy
STC	Sarhad Tourism Corporation
TDS	Total Dissolved Solids
TIES	The International Eco-tourism Society
UNCED	United Nation Conference on Environmental and development
UNESCAP	United Nation Economic and Social Commission for Asia and the Pacific
US	United State
Vol.	Volume
WAPDA	Water and Power Development Authority
WHO	World Health organization
WWF	World Wide Fund for nature

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Mohammad Nafees

Abstract

River Swat watershed which is also known as Swat Valley is situated in the northern half of North West Frontier Province (NWFP), Pakistan. It is a combination of three districts, namely Malakand, Dir Lower and Swat was studied during 2004-07. These districts, especially Swat has got tremendous contribution in forestry, agriculture, horticulture and tourism. However, because of mismanagement, ignorance and lack of awareness, the quality of land resources is deteriorating day by day. Agricultural practices (over use of agro-chemicals), mining and tourisms are the various human activities, which affect soil quality in terms of habitat loss, deforestation, soil erosion and contamination.

In this study an attempt has been made to investigate different aspects of River Swat watershed with special reference to soil conservation. For this purpose literature and questionnaire surveys were conducted and were crosschecked with the results obtained in the laboratory. For laboratory analysis 212 soil-samples were collected from 100 villages. Theses samples were analyzed for soil texture, pH, conductivity and water-soluble contents. Out of 212 samples, 63 samples (30%) were analyzed for important anions and cations. Anions like Nitrate, sulfate, phosphate, and chloride while in cations calcium, iron, zinc, cadmium and molybdenum were determined. To evaluate the soil for contamination, selected samples (6% of the total) were analyzed for pesticides. For interview and questionnaire survey, 50 villages were selected. During the questionnaire survey, Participatory Rural Appraisal (PRA) techniques were also used. Soil erosion was estimated indirectly by analyzing river swat for suspended load. Three samples per month were collected from Chakadara, the end point of river Swat. Discharge data were colleted form Water and Power Development Authority (WAPDA), Pakistan.

The soil of the study area is almost sandy and sensitive to erosion. Among macronutrients only nitrogen was found a limiting factor while in micronutrients Molybdenum was found deficient. While cadmium a contaminant was also observed in some soil samples. Most of the area is mountainous and limited area is available for agriculture (15%). Because of population increase, demand for food has been increased, while 70% of the population is dependent on agriculture. To acquire maximum land for agriculture people are inclined toward encroachment of mountainous area. Over use of fertilizer and pesticides was observed in irrigated land, while in rain-fed areas,

under use of such agrochemicals was observed. As a result contamination of soil and food chain was observed. To increase agriculture production on sustainable basis, balance in the use of agro-chemicals is required.

Deforestation is one of the characteristic features of the area, which in combination with agriculture activities is increasing the hazard of soil erosion. To reduce soil erosion, agro forestry is needed to be encouraged. While at the same time mechanical measures are required to control soil erosion.

To avoid future burden on soil, aquaculture, tourism and mineral mining are identified as potential income generating activities. These organization are required to create inter departmental linkages, join hand with the local people of the area to overcome on soil related problems.

Chapter-I
Introduction

In this chapter an attempt has been made to give a general overview of soil, its importance, soil resources of Pakistan and NWFP, in comparison with that of study area. A brief summary of the whole thesis, objective of the study, methodology and major findings have been presented.

1.1 Background Information

Soil is an important resource directly available to human being for various uses specifically for agriculture is an important, which depend on the quality and quantity of soil. To increase agriculture production all societies are always concerned about the soil quality and its protection. Apart from agriculture it also provides a base for various ecosystems like grass land and wet land and has direct linkages with bio-diversity (William, 1991) and production of medicinal plants Hamayun, 2005).

Soil erosion and associated problems like decrease in soil fertility and productivity are serious agricultural problems of Pakistan in general and mountainous area in particular. There are substantial evidences of widespread environmental degradation through out the terrestrial ecosystem of Pakistan. The most important is erosion and sedimentation (Shafiq, et al 1997), contributed by deforestation and mechanized agriculture practices. Every year thousands of tone of soil is eroded and deposited in irrigation canal (Mumtaz, 2002), which badly affect soil quality. Another problem affecting soil quality is irregular use of agro-chemicals (Fertilizers and Pesticides). Agrochemicals not only affect soil quality but also ground and surface water quality (Waskom, 1994, Mount et al 1995, Karam et al 2000 and Hamayum et al 2003).

About sixty percent of Pakistan consists of mountains or deserts and only forty percent (33 mha) is available for cultivation (GOP, 1984). Only twenty five percent (19.8mha) is under cultivation (Manzoor, 2001). There are about 4.8 mha of forest land, which is not counted in the cultivated area (GOP, 2005).

Deforestation contributing to floods and soil erosion badly and as a result damages the limited area available for cultivation. In many instances such degradation is already far advanced and may be difficult if not impossible to arrest or even reverse, particularly with limited financial means. In Pakistan, visible ecological deterioration can broadly categorize into four groups i.e. Deforestation, Soil erosion & degradation, desertification and species extinction. (Sarfaraz, 2000)

In comparison with Pakistan total NWFP covers 13 percent (10.2 million ha) of the total country area. It has nearly 2 million ha cultivated land (about 20%) which is quite less than the total of Pakistan (27%). The majority of people (85 percent) live in rural areas, compared to 68 percent for the rest of Pakistan. Consequently, agriculture in the province employs 4 percent more labor force than the country average of 47 percent. Irrigated agriculture, which accounts for 51 percent of the cultivated area supports about 60 percent of the agricultural production. (World Bank, 2001) Similarly in terms of forest cover, NWFP appear a little lucky when compared with the rest of Pakistan. In NWFP forest cover ranges from 5 – 23% while that of Pakistan is 5% only. Grazing land is 23% while that of Pakistan is 6%. (Asif and Richard 2000).

The River Swat Watershed situated in the northern half of NWFP is presenting a rich and fragile view, because more than 75% area is mountainous (Map 2.2 &2.3). A limited portion of land (15%) is available for proper agriculture use (Yar et al, 1997), which is less than that of NWFP (20%). As the arable land is limited, people of the study area are struggling for encroachment, to acquire land at the cost of forest and grassland. This trend has a negative impact on the environment as well as it disturbs the socio-economic setup of the people (Sultan 2005). To over come soil related problems regular monitoring is required (Ashraf, 2005). The proposed study deals with two aspects, a) study of soil loss due to erosion and contamination, b) investigation of the present land use and possible re-allocation to avoid soil degradation.

1.2 Study Area

River Swat watershed is a combination of three districts, namely Malakand (upper Malakand), Dir Lower and Swat valley collectively form River Swat Watershed (Map 1.1, 1.2 and Chapter II,). These three districts are presenting a scenic view and is a source of tourist

attraction. The Study area is situated in the north of N.W.F.P, 34° 37' 08.12" to 35° 28'15. 21" North Latitude and 71°46'08. 67" to 72°35'34.59' East Longitude (as taken form Google Earth), and is enclosed by the sky-high mountains with an altitude 1280-2133 feet (390-650m) above Mean Sea Level (MSL). Total area of River Swat watershed is about 6288 Km^2 (Swat 5337 Km^2, Dir Lower: 475 Km^2 and Malakand 476 Km^2)[1] (GOP, 2002). The average annual rain fall is ranging between 450 and 1250 mm (Inam & Viaro 2002). The monsoon extending over June to September during which the area receive major portion of rainfall and causing the problem of soil erosion. According to Weather station Saidu Sharif, (1997 Report), the minimum and maximum temperature varies in the range of -0.5^0C to 39^0C (Rashid, et al 1999). The minimum average humidity was observed during the month of April (40%) and high value recorded in the month of July (85%). Climate in the southern part is subtropical while that in the northern part is Mediterranean. (Aslam et al, 1991). The soil texture is mainly sandy loam with a slope characteristics of 0-8percent in the plain area and goes up to 22percent in the mountainous area with the average soil thickness of 45cm (Rashid et al, 1999)(Chapter-VI).

1.3 Aim and Objective

In River Swat watershed more than 70% people are attached with agriculture, where arable soil in the study area is limited (15%) (Yar et al, 1997). On the other side, due to increasing population the soil resource is under pressure, causing soil degradation, leading to environmental problem. The aim of the study was to investigate the environmental setup and conservation with special emphasis on soil resource conservation which will address soil related challenges in a broader perspective.

1.3.1 General Objectives of the Proposed Study:

Pakistan had developed national and provincial level conservation strategies and now in the process of developing district level conservation strategies. In this regards efforts are continued. This study aim to help in investigating physical environment in relation to the preparation and implementation of district level environmental conservation strategies for the three districts of River Swat watershed and other on going soil related conservation activities by

[1] Total area of these three districts is 11232 Km^2 (Swat 8788 Km^2, Lower Dir 1683 $Km^2$and Malakand 952 Km^2). The area situated in River Swat Watershed is 9897 that include total of Swat, half of Malakand and 30% of Lower Dir.

individual, governmental and non-governmental organization and find out gap, where exist. Incorporation of these findings will strengthen future environmental conservation strategies.

1.3.2 Specific objectives:

i. **Analysis** of soil sample for texture, nutrients and contaminants, such as pesticides and to identify problem area(s) and its possible solution(s)

ii. **Identification** of areas sensitive to erosion and to find out suitable remedial measures

iii. **Exploration** of environmental conservation measures, already in practice, especially related to soil, indigenous in nature and to find out ways and means how to expand it further.

1.4 Methodology and Research Plan

Solution to complex environmental problems, especially soil, cannot be found within a single discipline. In this study an attempt has been made to merge three areas, including Chemistry, Society, and GIS & Remote Sensing. This study will be helpful for future researcher and decision makers. The proposed study includes an understanding of society, and natural processes. For successful implementation of the objectives, the following research plan was adopted (Chapter IV).

i. **Field Survey:** detail field survey was conducted to identify sites for soil sampling, questionnaire survey and Participatory Rural Appraisal (PRA).

ii. **Sampling:** Soil samples were collected from agriculture land situated in the watershed of River Swat. First soil types were identified for a representative sample will be collection.

iii. **Soil Analysis:** Collected soil sample were analyzed for physical and chemical parameters. Physical parameters include, texture, moistures, pH, and conductivity, while chemical parameters included macronutrients (Nitrate, Phosphate, Potassium), and micronutrients and pollutants like pesticides.

iv. **GIS and Remote Sensing have been** used for data analysis, visualization, presentation and also to create a base map and land capability map of the area.

v. **Questionnaire and PRA Surveys** were used to the selected area suitable for this purpose and which were identified during the field survey.

vi. **Data processing and Analysis:** The maps were prepared in IDRISI and Arc/View for visualization and presentation. For numerical data processing MS excel was used.

1.5 Main findings

Detail findings are given in chapter VII, important are listed as below

i. The physical parameters show that sand is the main characteristic of the soil in the study area and is very much sensitive to erosion.
ii. Deforestation is quite fast which is further boosting the erosion phenomenon. Of the total land 17% is forested. Looking into fragility and population pressures there must be forest on at least 40% area.
iii. In river swat watershed wind erosion is negligible, but the water erosion is about 1.8 tones per acre per year. Which is higher rate and needed to be arrested.
iv. In terms of macronutrients the soil appeared deficient. Because of sandy nature the soil cannot hold water-soluble nutrients. In this way large quantity of fertilizer is required, people are there with pooling agriculture field in plain area to arrest the nutrients. In most area people are also practicing crop rotation. But because of lack of awareness the practice is not scientific. However due to geology of the area, micro-nutrients are not a problem
v. Soil slope is another problem; most of the farmers have tried to reduce the slope. Some time the field boundaries are erected with stonewall. To make these wall stronger, grass are grown to give support. Still majority of the area is not fit for agriculture and it is required to be utilized for forestry, agro forestry or rangeland.
vi. Irregular mining is another activity, which is helping in accelerated erosion
vii. Activities like aquaculture, social and agro forestry and tourism are identified as potential activities to reduce pressure on soil resources and up-lift the socio economic status of the people on one hand and will bring environmental stability on the other hand.
viii. To achieve sustainable use of soil resources and make aqua culture tourism and miming effective, proper institutional arrangement will play an important role. For this purpose it is important to encourage local people, coordinate and consult them and strengthen and encourage and trust social institutions.

1.6 References

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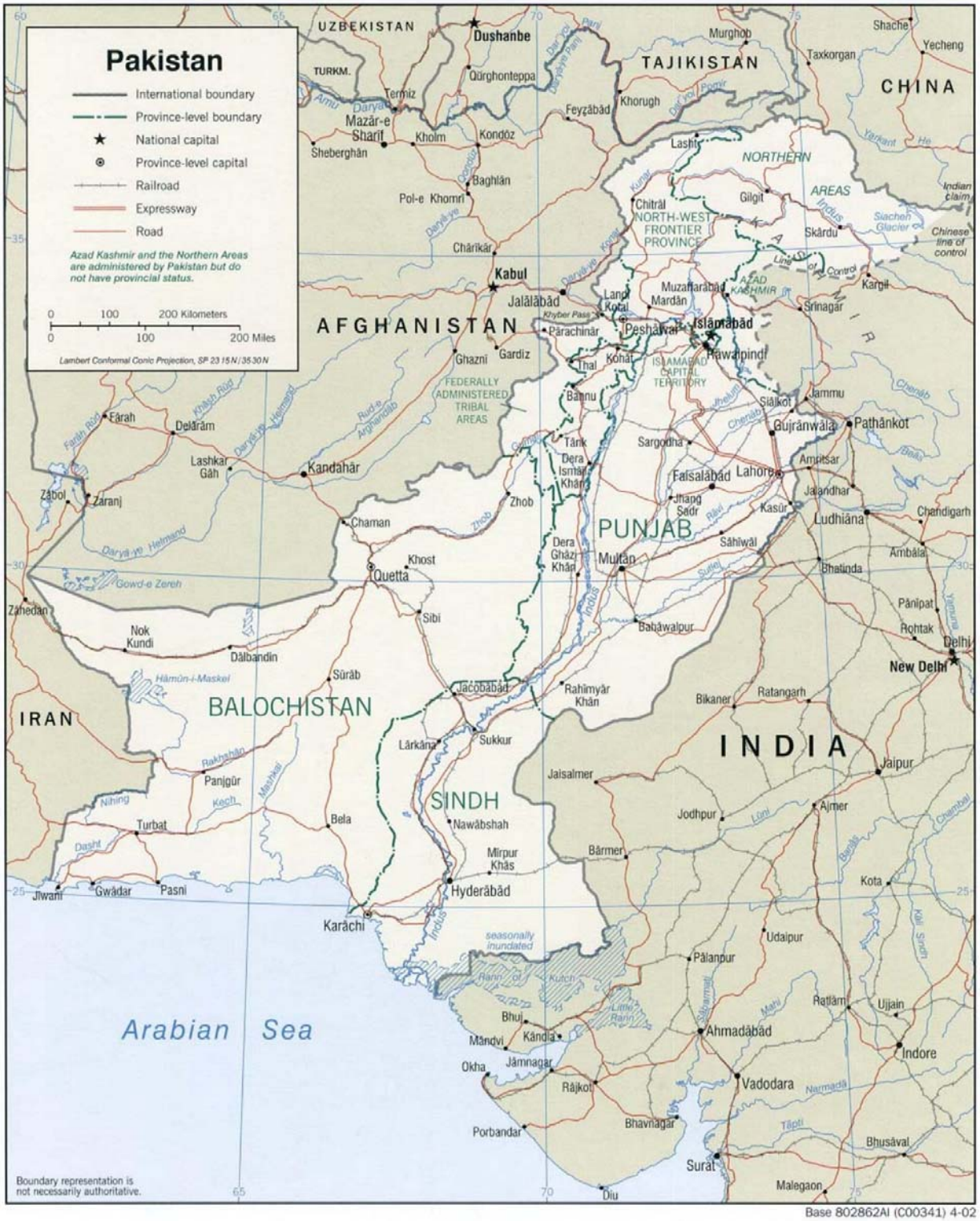
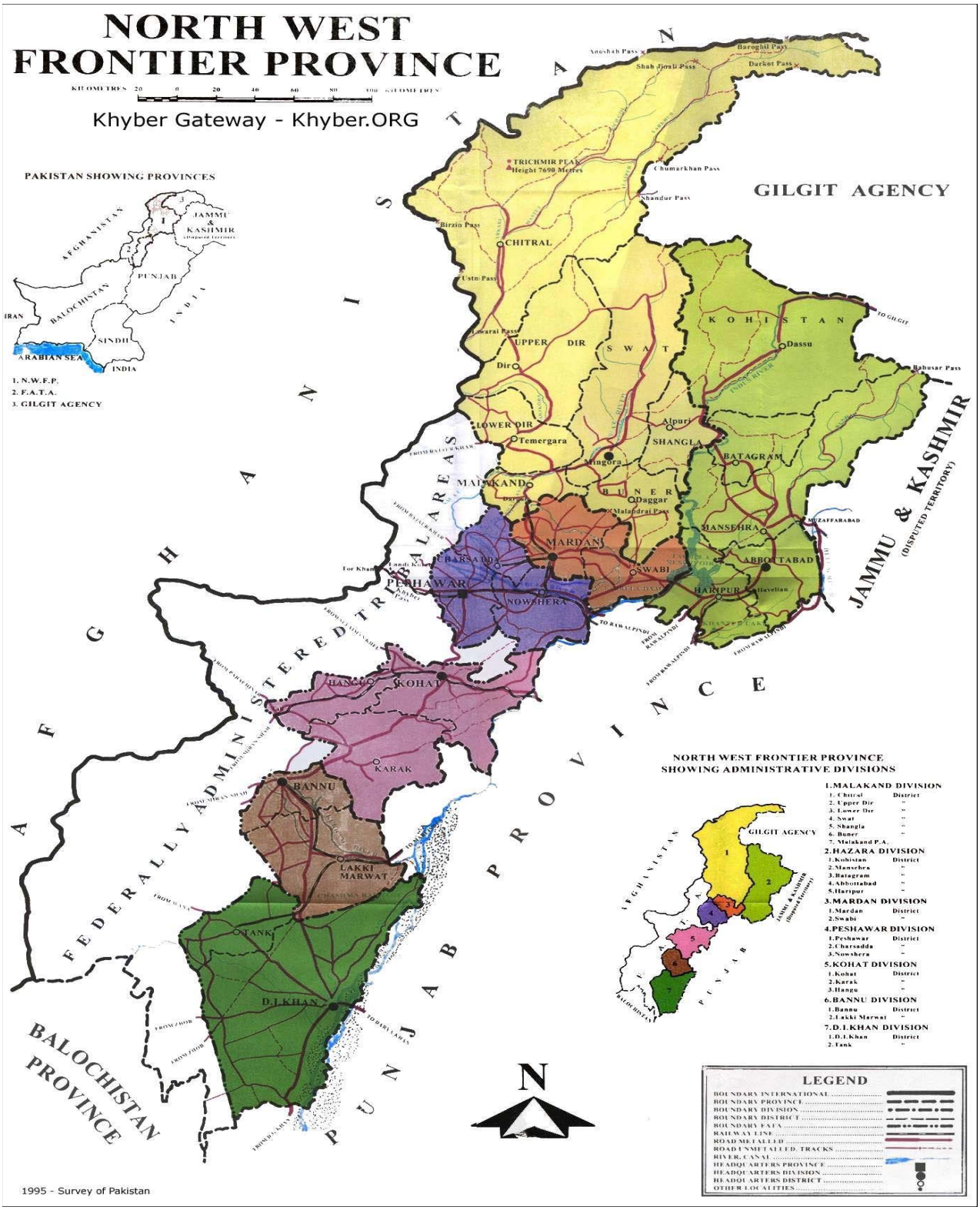
Map 1.1: - Pakistan Showing Study Area



Source: World map finder (http://www.worldmapfinder.com/En/Asia/Pakistan/)

Map 1.2: - NWFP Showing Study Area



CHAPTER-II

DESCRIPTION OF PROJECT AREA

In this chapter a detail of those aspects having direct or indirect relation to soil conservation has been given. Among these agriculture, mining, hydrology, forest etc. having direct impacts on soil resources, while tourism and Industries are activities having indirect impacts. Looking into the study area location an attempt has been made to discuss it with reference to NWFP. At the end of the chapter a brief profile of the three districts, making part of River swat Watershed has been given.

North West Frontier Province (NWFP) as the name indicates is situated in northwestern part of Pakistan (Map-1.2). In the north it has a long boundary of 1100 Km with Afghanistan, in Southwest the Province of Balochistan, in the southeast the province of Punjab and in the north the territories of Gilgit, Kashmir and Jammu are situated (Map-1.3). Peshawar is its capital. NWFP covering 74521 km^2 excluding 27220 Km^2 of Federal Administered Tribal Area (FATA). In terms of geographic area it is the smallest of province i.e. (9.4%) of Pakistan (GOP, 1985) and ranks third in terms of population (12.18%) (GOP, 1998 and Zaid & Matthew, 2000) among the four provinces of Pakistan.

In NWFP two types of administration exist i.e. settled area (24 districts) and tribal areas. Tribal areas have further two sub categories i.e. provincially administered tribal area (PATA), which are four in number and federally administered tribal area (FATA) seven in number. These twenty four district and four PATAs are grouped in seven divisions (UNESCAP, 2002).

The Northern half of NWFP can be devided into five main valleys namely Chitral, Dir, Swat, Indus and Kaghan (Kunhar) (map. 1.2). Due to rainfall, especially during monsoon season, these valleys are comparatively green with natural vegetations. As monsoon cannot reach Chitral and is comparatively dry (Albert et al, 1994). River Swat watershed is a sub-watershed of Kabul River. It includes the three main districts i.e. Swat, Dir Lower and Malakand. River Swat watershed (for the sake of this study) start form Kalam where two river Utror and Ushou combine together (Map 2.1 and 2.2). From Kalam to Kamala the length of the entire stretch is about 154 Km (linear distance 120 km) as measured form Google earth facility (Map-2.3). Downstream Ckakdara, near

Kamala River Swat enter into Malakand Mountain range, where at Busaq, (5Km down stream of Kamala) Panjkora River join River Swat, which change the name of River Swat to Khyalay. In Charsada Area it Join Kabul River. This study covers an area from Kalam to Kamala. Where district swat, Malakand and Lower Dir make part of River Swat Water shed and was studied for soil conservation.

The various aspects including physio-graphy, soil, geology, hydrology, climate, forests and bio-diversity, which is directly or indirectly linked to Soil Conservation in terms of contribution and dependency are herein discussed.

2.1 Physio-graphy

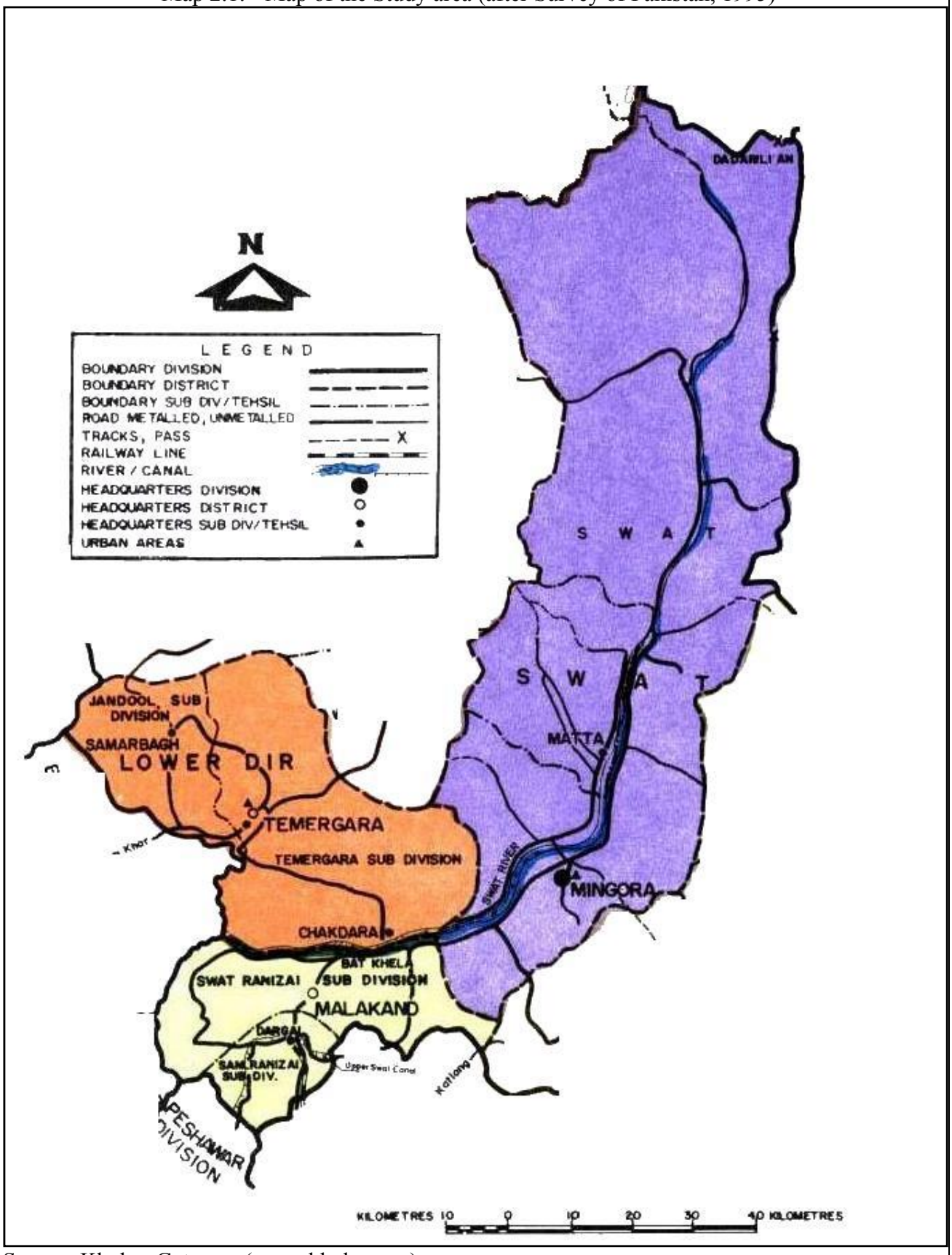
NWFP is the junction of three main mountain ranges namely Hamalya, Qara-Quram and Hindu-Kush (Rashid & Sadiq, 1990), and has got a rich diverse ecology. In the north it is characteriźed by mountains decorated with forest cover and snow. The western side is composed of rangeland and dry barren mountain of the tribal belt (FATA) and good apicultural land in the south and southeast. (UNESCAP, 2002). River Swat watershed is situated in the north side (Map 2.1, 2.2 & 2.3).

In terms of physiography River Swat is presenting comparatively diverse and complicated view. As measured from the Google Earth, the mean sea level at Totakan is 581 meter MSL (1909 feet). At Kalam its height reached to 2969 meter MSL (9744 feet). Falaksair is the highest peek (625 meter) in the study area. Emerging mountains covers both side of River Swat that gives a reasonable slope to the soil (Map 2.3).

2.2 Soils

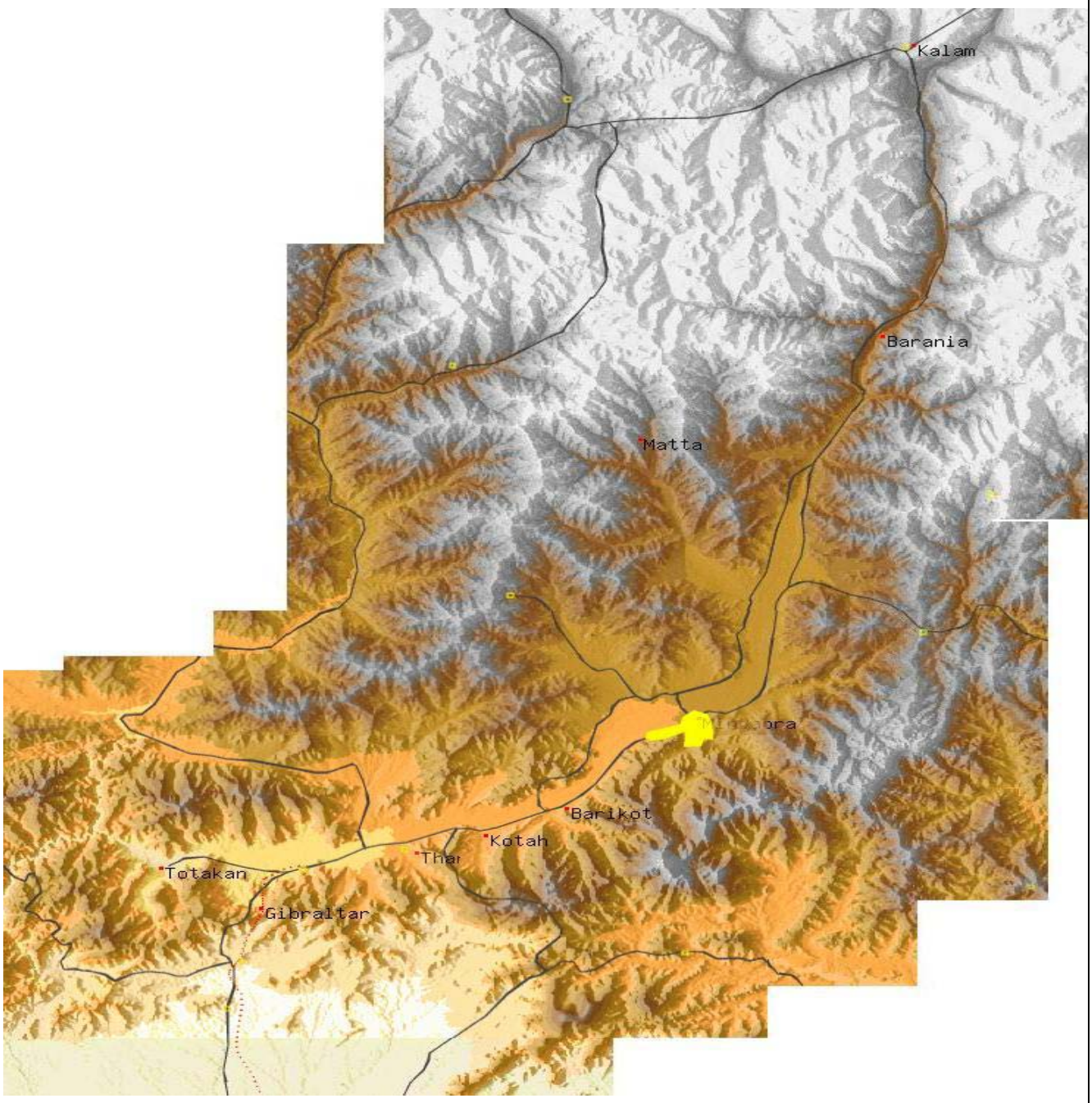
Soil provides base for agriculture and other human activities. It is the linking part between air and water that mediate various ecological cycles. Soil is also working as filter for underground water.

Map 2.1: - Map of the Study area (after Survey of Pakistan, 1995)



Source: Khyber Gateway (www.khyber.org)

Map. 2.2: Satellite Image of The Study Area



Source: Falling Rain Genomics, Inc. The worldwide index of cities and towns, 1996-2004**.**

Map 2.3 Satellite Image of the Project Area taken form Google Earth.

Soil Types

United State, Department of Agriculture (USDA) has divided world soil into 15 classes. Out of which six categories fall in Pakistan i.e rocky land, Inceptisols[1], Aridisols[2], Entisols[3], spodosole[4] and shifting sands (**Montgomery, 2003**).

River Swat watershed Rocky land, Inceptisols and Entisols categories of soil order are found. Rocky land is found in the upper Swat, and mountains surrounding the River Swat. Inceptisols are in found in the foothills of all mountains, where residual soil is accumulating as a result of weathering. Entisols category is found in middle Swat, Lower Dir and upper Malakand (**Map 2.4**).

From origin and physiographic point of view, Soil of Pakistan is broadly divided into six classes **(Karim, 1991)**.based on parent material (**Map 2.5**).

The soil of NWFP is divided into three broad categories: (a) alluvium soil which is transported and deposited by running water in valleys; (b) eolian or loess soil which is deposited by wind; and (c) residual soils of mountain slopes and fans (**UNESCAP, 2002**). The soil of the study area is classified as residual soils of mountain slopes, which occur in the upper Swart region and alluvial occupying the lower Swat region (including Matta, Dir Lower and Upper Malakand).

In upper Swat the area is mountainous with associated problems of steep slope and gully erosion, while the lower Swat plain area is there but water shortage is added to the above and are the main constraints in cultivation.

2.3 Geology

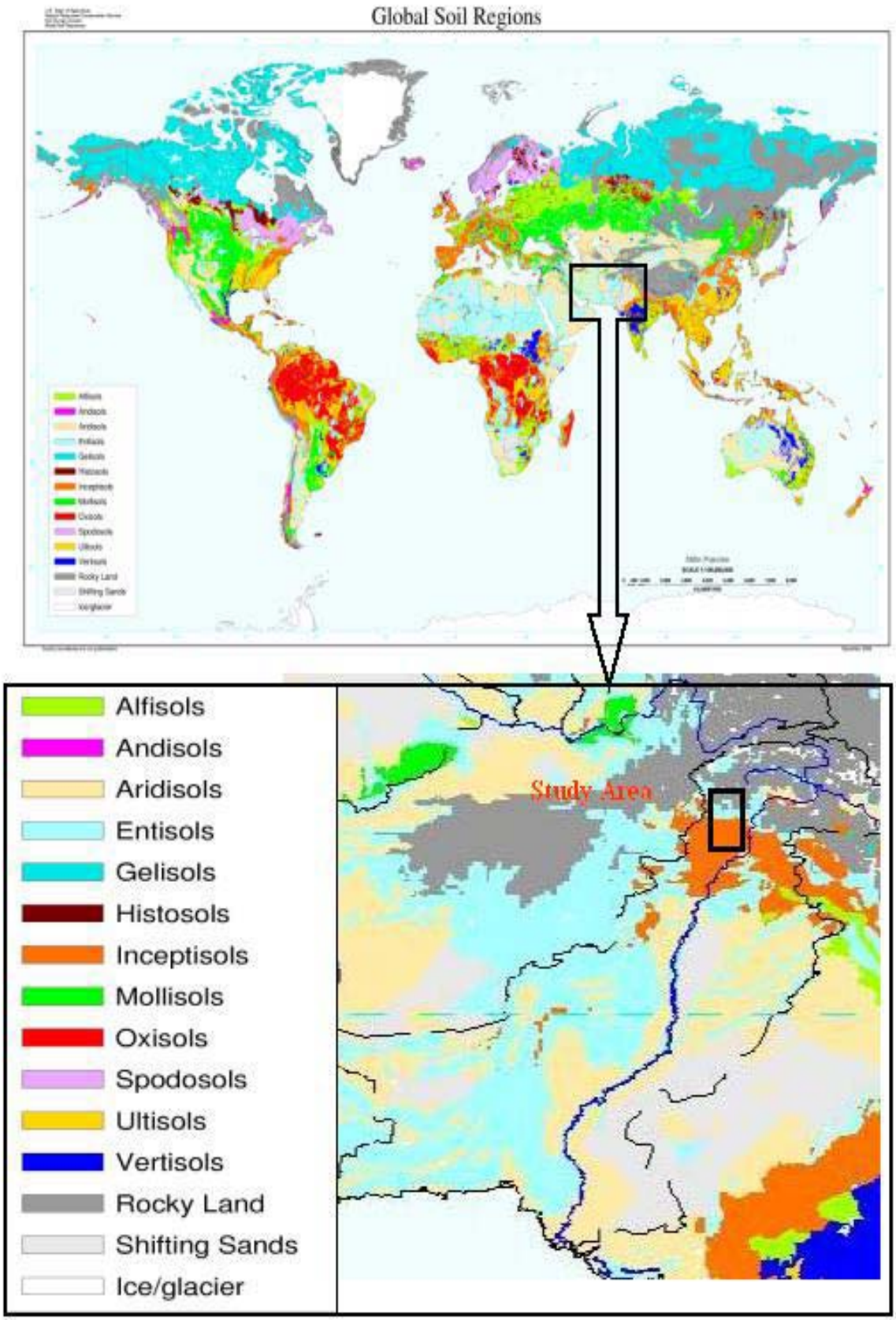
Geologically NWFP is divided into four major classes.

1. Paleozoic and Mesozoic era rocks of Northern Mountains.
2. The Mesozoic rocks of the southern and southwestern part of NWFP
3. The tertiary rocks of the central and southeastern part of NWFP
4. The upper tertiary and quaternary sediments

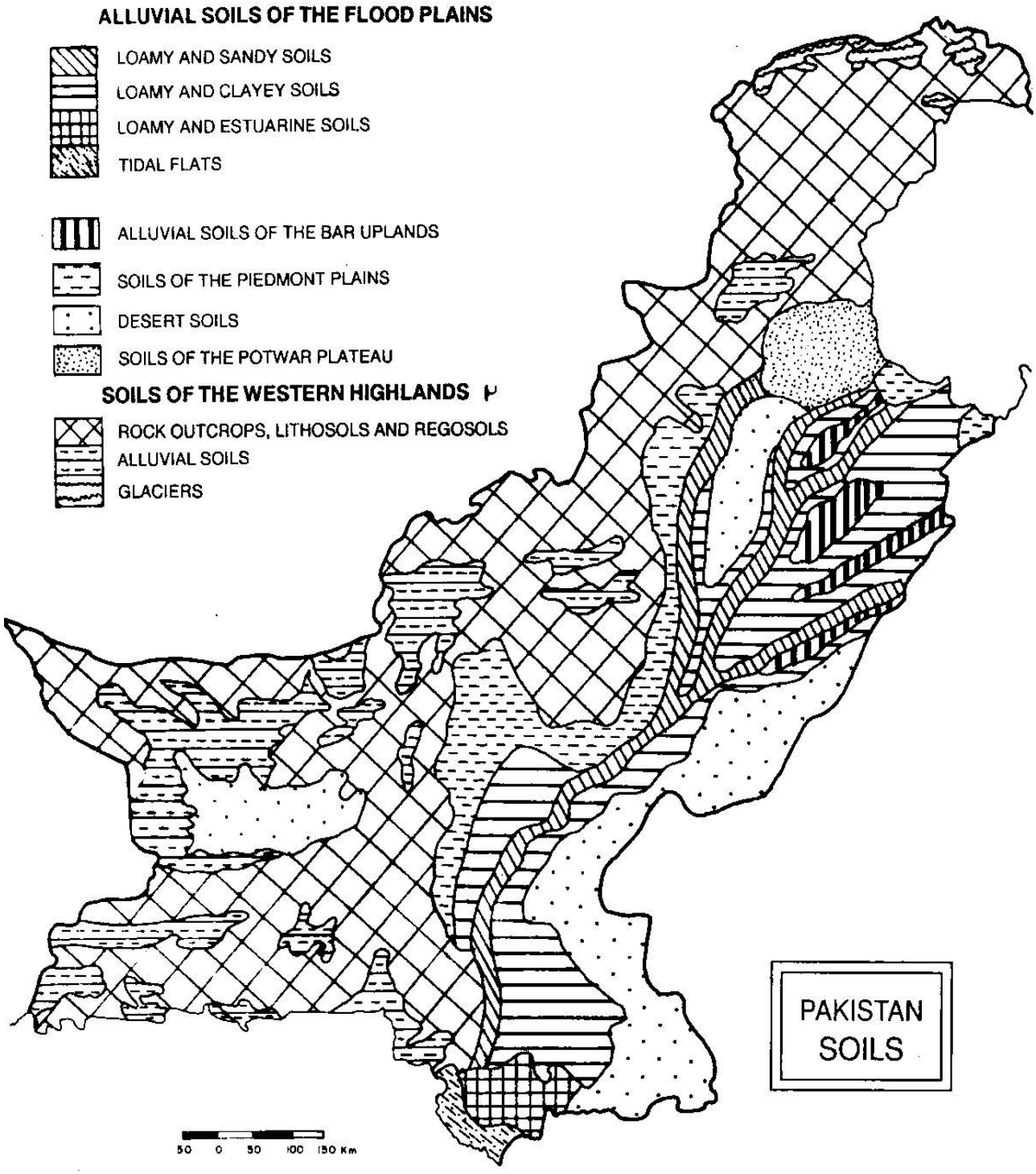
In river swat watershed the 1st category is found which are metamorphic and igneous. The broad classes are discussed as:

[1]Inceptisols is very young soils with weakly developed soil layers and not much leaching or mineral alteration.
[2] Soil of desert and semiarid regions and related saline or alkaline soils.
[3] Soils without layering, except perhaps a plowed layer
[4] Soils with a light, ashy gray A horizon and a B horizon containing organic matter and clay leached from the A horizon.

Map 2.4. Soil Series of the study area



Map 2.5. Soil types of Pakistan



Source: Karim, 1991

2.3.1 Malakand Granite

Malakand granite is one of the will known granites of the north-western Himalayas (**Hamidullah et al , 1986**) fall in the Lower Part of the study area. The granite has intruded gneisses and metasediments of possible Cambrian and precambrain age (**Kempe 1983**). The Malakand Granite is an oval body which cover an area of 40 Km^2. the main areas includes Malakand proper, Jolagram, Dheri and Piran. It is mostly composed of quartz, plagioclase and alkali-feldspar (**Hamidullah, et al 1986**).

2.3.2 Malakand Gneisses

Malakand gneisses are genetically related to the Malakand granite (**Jabeen et al, 1985**). The Malakand gneisses are medium to coarse-grained rocks, grayish – white on fresh surface and gray to brownish on weathered ones. It mainly occurs in Amandara, Chakdara Area and the surrounding areas of Lower Dir (**Hamidullah et al , 1986**).

2.3.3. Meta-sediment

Member of the meta-sedimentary sequence are Schist, Chlorite-epidote schist, calcareous schist, garnet-mica schist, quartz-mica schist, graphitic schist and siliceous schist. Chlorite- epidote schist is exposed near the Malakand road tunnel. This is light gray to dark gray, and commonly contains calcite and quarts. The rock is fine to medium grained and is dominantly composed of amphibole, quartz, plagioclase and chlorite. Fine-grained tormaline of olive color occur in the surrounding of Malakand. Graphitic schist exposed south of the Malakand road tunnel varies in color from grayish black to black. The siliceous schist occurs near Rangmala Hospital. It is yellow in color and contains abundant quartz but micaeous minerals still import schistosity to the rock. Granitic quartzo- feld-spathic veins commonly intrude into siliceous schist (**Humayun, 1985**).

2.3.4 Upper Swat hornblendic group

This formation covers the entire Miandam area including Shin, Miandam proper and Pia valleys. It is also found in Charbagh and Shangla area. Its rocks range in composition form amphibole schist's and gneisses to diorites, quartz diorites and norite. The gneisses are composed predominantly of hornblends and plagioclase, but some also have sufficient quantities of epidote, iron ore, clinozoacite, and rutile and in some case muscovite. Many of these gneisses are of sedimentary origin. The diorites are composed of medium plagioclase and hornblende with minor

quantities of iron ore, biotite and other constituents. The norites are composed of andesine, labradite, otrhopyroxene, clinopyroxine, and iron ore hornblende (K**azmi, et al, 1984**).

2.3.5 Siliceous schists

Siliceous schists occur scatted in the Barikot and Marghuzar area. They are composed of quartz and muscovite and are generally brown in color. Some are rich in quartz. Abundant biotite is rare. Andalusite and epidote may occur occasionally. Beds of marble and amphibolite are frequently associated with this formation (Kazmi et al 1984 & Humayun, 1985).

2.3.6 Marble and calcareous schists

Occurring mostly in Marghuzar and Barikot area. Marble and calcareous schists are composed of bluish-gray marble. Kyanite also occurs in the formation, sometimes along with a lot of garnet associated with quartz veins. These rocks are over folded and faulted, exhibiting a very high apparent thickness (Kazmi et al 1984).

2.3.7 Phyllitic schists

Phyllitic schists occur in the Malam Jabba area and in parts of Marghuzar near Mingora. The rocks are dark-gray with micaceous sheen on their surface. But are true schists. They are predominantly composed of quartz and mica with minor quantities of iron ore and graphite. Some have garnets, which may be abundant in parts of lower Swat (Asif, 2000 and Asif & Richard, 2000).

2.3.8 Green schists

Green schists are found in the Manglaur area and over small areas near Maniar near Barikot. They are green in color but of variable composition comprising various combinations of epidote, albite, chlorite, feldspar, quartz, actinolite, talc and magnetite. They also have some marble beds associated with them. Near Mingora basic rocks and quartz veins intrude the calcareous members of these rocks. Gem quality emerald is found here (Martin et al, 1962 & Kazmi et al, 1984).

2.3.9 Swat granites and granitic gneisses

The Swat Granitic Gneisses are considered to be part of the Malakand Geanitic – gneiss (**Hamayun, 1985**) Scattered in patches over the Barikot and Marghuzar area, the Swat granites and granitic gneisses ranges form normal granites to gneissose granites and augen-gneisses (**FMC,**

1999). They are generally composed of potash feldspar, quartz, and minor mica and iron ore. Some of them also contain abundant plagioclase. The augen-gneisses are composed of large eyes of potash feldspar around which Ferro-magnesium minerals are twisted. Many of the granites contain epidotes, garnet, and zenoliths are common. The rocks are intrusive in the lower Swat Buner schists group and are an important feature of the geology of the region (**Jan, et al 1981**).

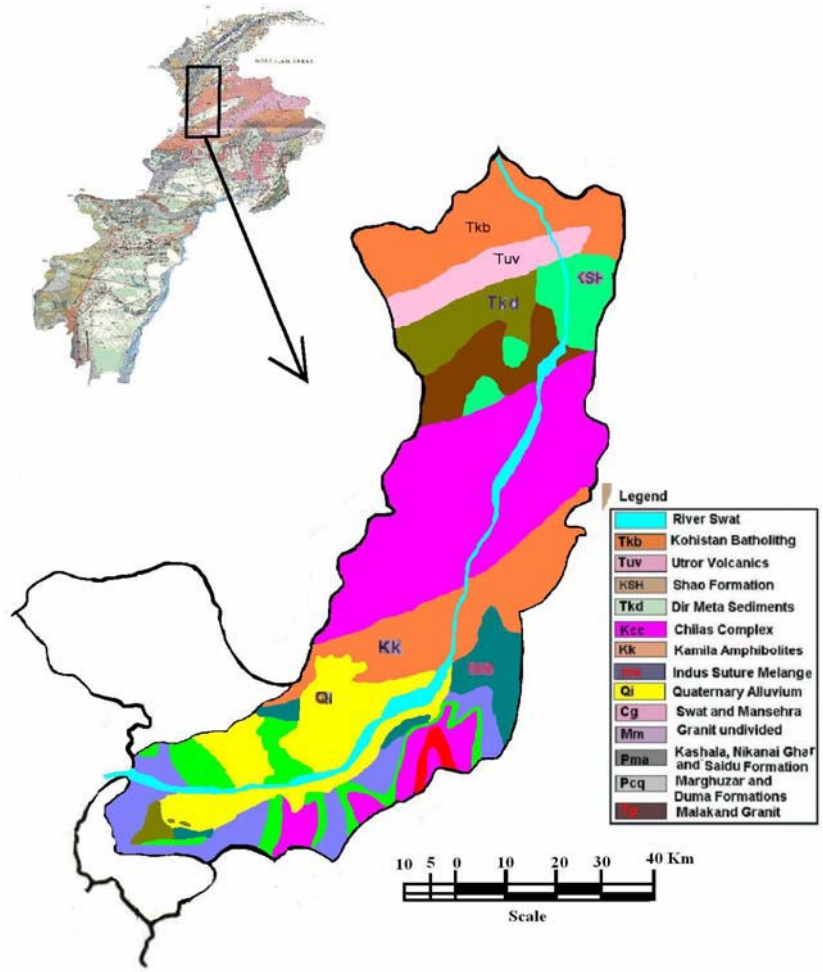
2.4 Hydrology

NWFP, especially the northern part is rich in water resources. Both, the surface and ground water are easily accessible and use for drinking, bathing, washing, irrigation re-creation, and power generation. River Swat is the major river in the study area, used for all the above mentioned purposes (IUCN, 1993). Other form of water bodies include springs lakes and streams. In the lower part of River Swat watershed (Malakand & Dir) ground water is used for drinking and irrigation (Nafees, 2004). Important lakes situated in upper Swat include Mahodand and Daral from which originate River Osho and River Daral respectively and are important tributaries of River Swat (UN**ESCAP, 2002**).

The average annual flow of River Swat during 2001-04 was ranging from 50.013 m^3/sec in the winter to 255.842 m^3/sec in the summer (WAPDA, 2004). River Swat is the most important tributary of the Kabul River. It rises in the region of Kalam (Swat), where its two principal sources, the Gabral and Ushu River, unite at approximately 2969 MSL above sea level (Google Earth, 2006). As observed in the field, from Kalam till Madayan the river is flowing in narrow stream surrounded by mountains. However, downstream from Madiyan the Swat valley become wider considerably. Since it is subject to the influence of both monsoon seasonal rainfall and summer snow melt, the river carries a tremendous amount of sediment during its flood peak. An indication of this can be gained from the average seasonal discharges of the Swat River at Kalam: average summer discharge 138.76 m^3/sec, average winter discharge 20.1575 m^3/sec (Data Source WAPDA, Lahore 2005).

Because of this heavy fluctuation it cause erosion and the water of River Swat appeared turbid in summer. This heavy erosion causes considerable deposition in the irrigation channel diverted from River Swat.

Map 2.6:- Geological Map of the Study Area



Source: Extracted from Geological Map of NWFP, Published by Geological Survey of Pakistan, 2006

Tkb (Kohistan Batholith): Granites, grano-diorites, quartz-diorites with dykes and sheets of hornblende gabbros and leucogranits.
Tuv (Utror volcanic): Andesite, rhyolite, dacite and tuffs interbedded with meta sediments in the Western Kohistan arc.
Ksh (Shao Formation): in the southern Kohistan near Kalam, consist slate, limestone, and quartzite sequence. Age cretaceous.
Tkd (Dir meta sediments): Sandstone, siltstone and turbidites with rare intercalated marine limestone containing late Paleocene faunas.
Kcc (Chilas Complex) Mafic-ultramafic stratiform plutonic complex, dominantly composed of gabbro-norite, pyroxine diorite-tonalite and olivine gabbro with minor ultramafic (Chromite-layered dunite, peridotite, pyroxenite, hornblendite) and anorthosite association. Age Cretaceous
Kk (Kamala Amphibolites) Upper amphibolite-facies and calc-alkline metabasilts intruded by subduction related gabbroic plutons, all strongly sheared. Trondhjemites, as partial melting products, common near contact with the Chilas complex. Common intrusions of diorites,, granodiorites and granites.
Ism (Indus Suture Melange): includes, shangla blue schist, Charbagh green schist, Mingora ophiolites, Nawagai melange and nawagai marble and Dargai ophiolotes. Chaotic assemblage of serpentinite, talc-schist, green schist, metabaslt and greenstone along the hanging wall of main mental trust.
Qi Quaternary Alluvium) unconsolidated deposit of gravel, sand, silt and clay.
Cg (Swat and Mansehra granite complexes undivided): mostly granite and leucogranite, siliceous gneiss ranging from finely foliated to coarse augen gneiss absolute age of Mansehra granite is 516+ 16 with mafic untrusions dated 284 to 262 Ma.
Mm (Kashala, Nikanai ghar and Saidu formation undeivided): Kashala formation which comprises cals. Garnet schist, schistose marble, marble and cqalcareous phyllite; Nakanai ghar formation sonsisting of calcite marble, dolomitc marble and minor phyllite; Saidu formation comprising graphitic phyllite and schistg with minor calcite marble. Age late to middle mesozoic.
Pma (Marghuzar and Duma formations undevided): comprises amphibolite hoenblende schyist, biotite schist, garnetiferous schist, schistose marble, phlogop[ite marble, dolomitix marble, tremolite marble and metapsammite. Age permian to late carbniferious.
Pcq (Tanawal and Manglaur formations undevided): In Peshawar basin and Hazara medium to coarse grained metaquarzite, subordinate garnet mica schist and quartizite of Manglaur formation.
Tg (Malakand Granite): in the Malakand pass area less deformed granitic rocks have been intuded in gneisses and schistose rocks. The granite contains albite, microcline, quartze, muscovite, epidote, calcite and garnte.

During the low-water period the River Swat from below Madiyan all the way down to Kalangi at 1,850 feet (a distance of 70 miles) exhibits all of the properties normally accorded to a braided stream. Spreading out on an average from one to three miles wide, the river flows in a network of ever-changing, branching and reuniting distributaries. The broad ravine flats formed by the Swat River in this section constitute the richest and most populous part of the district. It is also an area in which the most damaging floods occur (**EPS, 2002**).

River Swat is intersected by numerous ravines like nullahs and large 'Khwars', which bring down the drainage of the ranges immediately flanking the river over its entire course, relatively few maintain significant yearly flows. This is especially true in the southern stretches of the valley, which have catchment areas that do not involve regions high enough for permanent glaciations or even significant snowfalls. These tributaries are invariably choked with debris, usually as a result of floods resulting from warm season convectional showers. Their destructive power is considerable heightened by almost complete deforestation over the entire area. Immediately west of Kalangi, however, where the Swat river is joined by the relatively large drainage area that the Panjkira commands, the river conditions persists until it makes its final departure from the northern highlands and debouches on to the plains of the Peshawar Basin (locally known as Hastnagar) in the vicinity of Fort Abazai (**EPS, 2002**).

River Swat is a major source of Irrigation. Its entire stretch is used for irrigation not only by the inhabitants of the district Swat and Malakand but other district of NWFP, including Mardan, and Charsada till Malakand there is diverted canal system appeared in the form of contour irrigation called Wala in local language. The oldest canal was established in Pakistan in 1885 **[Dichter & Popkin, 1967]**, diverted from the left Bank of the Swat River at Munda Qila where the river first enters the Peshawar basin and irrigated the whole south-eastern area of Charsadda and middle tract of Mardan irrigating 54,200 hector **[Shahina, 2001**]. Downstream Chakdara, another canal, called Upper Swat Canal drained out from the left Bank in 1914 at Amandara Batkhaila, it enters Dargai through a 3400 meter long tunnel and it bifurcates into Abazai and Machai branches. The former commands 28,000 hector in the northwest of the Peshawar basin and the latter commands 84000 hector in the north and east [**Shahina, 2001**].

2.5 Forests

Forest cover directly affects both soil and water quality in terms of erosion and suspended load. North West Frontier Province, as compared to other provinces, has a rich bequest of forest (17%) **(Yar and Rafiq, 1997)**. In this way forests are the most important resource and revenue earner for NWFP. Most of the forests are natural and occur at high elevation on the fragile mountains on both sides of River Swat water system. It is generally over-exploited and under-managed, resulting in an adverse impact on the livelihood of the dependent population as well as threatening the wildlife in terms of habitat loss (**Iqbal, 2003**). The habitat loss is mainly attributed to deforestation and over grazing. According to forest department 1992-Master Plan, forest area of NWFP was 1.49 mhs (about 15%) while that of the study area was 21% of various categories (**Map-G.1–G.4**) **(Govt. of NWFP, 1995)**, which is under continuous pressure.

According to NWFP, Forest department, an estimated six percent (96754 hectares) of the total forest is termed as reserved forest and its ownership exist with government. The local community can not use it freely. In this type of forest only controlled grazing is allowed. In this way the negative impacts are minimized. Thirty percent of forest is called protected forest mostly occurred in the Malakand Division. This type of forest is owned by the government and managed by the Forest Department. There is no hard restriction on the local community regarding its use, and also receiving 60-80% share in the form of royalty in the revenue generated from the forest. The third catogery is called Guzara forest, mostly occurring in the Hazara Division, owned by a family or group of families. This is thirty three percent (549766 hectares) of the total forest. The forest department can regulate cutting under Hazara Forest Act-1936. remaining thirty one percent forest is termed as miscellaneous wooded area, which include afforested and reforested private or communal land (**Steimann, 2004**)

2.6 Species diversity

Water is indication of life and its varieties and good soil support it further. Species diversity is directly related to soil and water quality. Good soil quality will encourage not only terrestrial biota but also aquatic flora and fauna. The diversity of mammals, birds, fish, reptiles, amphibians, invertebrates and flora species in Pakistan, and NWFP in particular, is considered rich in bio-diversity. Roberts in 1977 prepared a detail list of mammals of Pakistan. According to him there are 158 species of mammals in Pakistan mostly in the Hamalayan moist and semi-moist temperate

forest (**Albert, 1994)**. According to another survey conducted by Roberts during 1991-92, reported 666 species of birds mostly belonging to the mountainous regions of Pakistan. Some of them were migratory such as bustard, starling, quail, waterfowl, falcon and dove visiting NWFP, **(UNESCAPE, 2002)**.

2.7 Land use

Total Area of NWFP is 10174100 hectares (considered round figure as 10.2 million hectares). Different sources giving different land use classification with different statistics. Ministry of environment and urban affair division dividing the total area of NWFP in to 6 classes i.e forest (17%), agriculture (15%) rangeland (48%), barren rock and gravel (1%) water bodies (0.5%) and urban (0.04%). While 18% is counted as unclassified **[GOP, 1996]**.

According to the statistic department 85% land area unavailable for cultivation and 15% is agriculture land. Cultivated land estimated by Bureau of land utilization department is 16% (1659225 hectare) and that of forest cover is 13.05% of the total NWFP (**Table 2.1**). In this way 84% area is not available for cultivation.

Table 2.1: Statistics about cultivated areas of NWFP, 1997-98 to 1999-2000 (In Hectares).

Item	1997-98	1998-99	1999-2000
Reported Area	5623129	5623129	5623129
Total Cultivated Area	1720295	1654608	1659225
Net Area Sown	1404967	1240343	1268083
Current Fallow	315328	303533	391142
Total Cropped Area	1924749	1844929	1763526
Area Sown More than Once	519782	496684	495443
Total Un-Cultivated Area	3902834	3968572	3963904
Culturable waste	900517	1044965	1033742
Forest Area	1315199	1328401	1327998
Not Available for cultivation	1687118	1595206	1602164

Source: - Directorate of Agriculture Statistics, NWFP., Peshawar (http://www.nwfpbos.sdnpk.org).

According to IUCN, 1995, 19% area is cultivated. Forest 17%, grazing land 18%, while unclassified is 17% (**Table 2.2**). For 1999, IUCN give cultivated land as 19%, forest cover 6-23% and grazing land 23% (**Table 2.3**). These statistics shows that limited area is available for

cultivation. While forest resources are also toward decline. There is an urgent need to improve cultivatable land and protect forest cover also. The watershed of River Swat is more fragile, because more than 80% area is mountainous (M**ap 2.2, and 2.3**), total cultivated land is 23.55% (**Table 2.5**). Most of the cultivated land is in mountainous area and need proper conservation measures.

Table - 2.2 North West Frontier Province (NWFP), Major Land Use

Category	**Land use Area Million hectares**	**%age Geographical Area**
Cultivable	1.92[1]	19
Culturable and not cultivated	0.04	-
Forest	1.72[2]	17
Grazing Land	1.78	18
Agriculture Un Productive	2.97	29
Unclassified and un-surveyed	1.74	17
Total	10.17	

Source: Adopted from SPCS 1996, p-10 Sources include A. Mian and M.Y.J Mirza 1993, Pakistan's soil resources, Pakistan National Conservation Strategy, sector paper 4. IUCN Pakistan, Karachi 1. Government of Pakistan, 1995. 2.Government of NWFP, 1995
(http://www.fadinap.org/ipns/workshop2001/pakistan.pdf)

Table-2.3 Basic Facts North West Frontier Province (NWFP)

Category	**NWFP**	**Pakistan**
Total Area (sq. km.)	74,521	803,940
Population (millions, 1998 est)	16.5	135.1
Literacy Rate	17%	36.4%
Population Growth (1996 est.)	3.2%	2.8%
Per Capita Income (1996 est.)	$200 US	$470 US
Pop. Living in Poverty (1996 est.)	20%	34%
Unemployment (1996 est.)	NA	16%
Refugees (millions, 1999 est.)	1.6 2	
Forest Cover	6-23%	5%
Grazing Land	23%	6%
Arable Land	19%	27%

Sources: The New York Times Almanac 1999; Sarhad Provincial Conservation Strategy 1997; Pakistan in the 21st Century: A Renewed Alliance 1997; Environmental Profile of NWF P, 1994; The Cambridge Factfinder 1993. (http://www.gechs.uci.edu/interlinkingcrises.pdf)

2.8 Agriculture

Agriculture activities are directly related to soil conservation. Healthy soil is needed for agriculture and if agriculture is not practiced properly, will adversely affect soil quality, leading to poor yield. Agriculture is the main driving force of Pakistan's economy generating about 25% of the grass domestic product (GSP) and providing employment to 50% people (**GOP, 2006**). Majority of the people of rural area of Pakistan in general and NWFP in particular are dependent on In NWFP in general and study area in particular, agriculture is the major source of economy and about seventy percent people of the rural area are attached with it (**Muddassir, 2000)**. The total arable land in River Swat watershed is 15% **(Yar and Rafiq, 1997),** which is quite low as compared with the total of NWFP (20%) and Pakistan (27%) (**Zaid and Matthew, 2000) Table 2.2.** In NWFP, during 10 years period (1975-76 to 1993-94) the cultivated land increased by six percent. Increase in yield was also observed which can not be attribute to increase in cultivated land but is mainly attribute to irrigation, improvement in seed quality and use of fertilizer and pesticides. Still there is room for improvement, because most of the area is rain fed (54% of the cultivated land) and affecting agriculture production, the difference of which varying between 25-80%. (**Govt. of NWFP & IUCN, 1996)**.

There is change in land use and agriculture land is continuously converting into residential and commercial usage such as road and other infrastructure development. For example in Peshawar valley in 20 years period (1965- 1985) the agriculture land reduced by 12.4%. (**Khan 1996)**. The same trend can be seen in River Swat Watershed also. In rural areas on the other hand this trend is toward increase. More and more land has been included in the category of agriculture land at the cost of reducing grass land, forest etc and tend to create environmental problem.

Although the may not be that relevant to the study area but establishment of industrial units and Industrial estates on productive farmland is also contributing toward the decreasing trend in agricultural production. Because of ill planning and lack of treatment technology, it will eventually lead to a food deficit on one side and environmental pollution on the other. Therefore, there is an urgent need of land use planning in NWFP; especially in the mountainous regions such is Swat Malakand and Dir, and proper implementation of related legislation.

2.9 Tourism

Greenery and scenic beauty with availability of clean water are always inspiration for tourists, which is an important growing industry of Pakistan (**Jagdish, 2002**). Tourists are always there with money but with out food. They need accommodation, and other basic facilities as well as food. Apart from food in Swat area where temperatures remains low, they need fire wood also. Hence on one side there are associated economic benefits, while on the other side there are expected environmental problems (**Erik, 1978**). This is why tourist activities need special attention.

Tourism, compared to industrialization, has more potential to reduce pressure on soil resources in River Swat watershed and will be helpful in soil conservation. But unfortunately it is not exploited effectively. Besides, the beneficiaries are not people of Swat valley. In this way no single contribution is there to safeguard soil, but have negative impact in terms of fuel wood consumption, solid waste dumping and water pollution.

2.10 Mining

Mining is another potential activity, which can help indirectly in soil conservation in terms of providing jobs opportunities and reduce pressure on agricultural activities. However, it has not been exploited properly. Mining was given importance in late sixties (1970) and exploration activities were accelerated. The responsible organization was Directorate of industries and mineral Development. In early eighties this responsibility was assigned to Sarhad Development Authority (SDA). Until 1996 forty three minerals deposits were explored. Still it is argued that mineral resources are not exploited properly (GOP, 1996). Besides, it has got negative environmental impact directly/indirectly affecting soil and water quality, especially during mine exploration. If proper remedial measures were not considered then the water quality may alter in the project vicinity, causing negative effects on soil in terms of erosion and also aquatic flora and fauna. In this regards special attention must be given to occupational health and safety, on time environmental Impact Assessment and site reclamation and mining waste management along with exploration and mining.

All these activities directly/indirectly affect soil and water quality, especially during mining exploration. If proper remedial measures were not considered then the water quality may alter in the project vicinity, causing negative affect on soil in terms of erosion and also aquatic flora and fauna.

2.11 Profile of the three district situated in River Swat watershed

River Swat watershed, as mentioned earlier is a collection of three main district namely, Malakand, Swat and Lower Dir. It is the place where three big mountain ranges, namely the Himalaya, Hindukush and Karakurum meets. Major portion of the watershed is mountainous, some highest peaks of which are covered with permanent snow cover. The mountain ranges run north and south. The following is a brief description of each district:

2.11.1 District Swat

When Pakistan came into being, Swat was its state and a district in 1969. Mingora is the district capital and is the centre of trade and commerce. During Budhism period Swat was called Odyana meaning garden. Swat is full of beautiful sceneries, fountains and rivers because of which its is famous for tourism and is called Switzerland of Pakistan (**Govt of NWFP, 2006**).

The total area of district Swat is 5337 Km2 (533700 hector) with a population density of 236 people per Km^2 (Table 2.6). According to district census report 2005, estimated population for the year 2004-05 was 1577000 with population density of 295/Km^2. Agriculture is the main source of income. Total Cultivable land is 98720 hectors. About 99% of the population of Swat is attached with agriculture (**Amanullah, 2005**). Except Kalam, the remaining people of Swat are enjoying two crop growing seasons, Spring Harvest and autumn season. In Kalam there is one growing season. Which is in summer and growing winter crops and is famous for off-season vegetables including peas, potato, cabbage and turnip. While crops of the remaing Swat includes, Wheat, Rice, Maiz, Pulses and vegetables.

The summer season is short and moderate. It is warm in the lower valley, but cool and refreshing in the upper northern part. The hottest month is June with mean maximum and minimum temperature of 33^{o}C and 16 ^{o}C respectively. The coldest month is January when the mean maximum and minimum temperature are 11 ^{o}C and 2 ^{o}C respectively. The winter season is long and extends form November to march. Rains and snow occur during this season. The temperature falls below freezing point. The amount of rainfalls received during the winter season is greater than during the summer season. The highest rainfall recorded during the month of March is about 242 mm (Table 2.4).

Table 2.4- Metrological Data of District Swat (2004 & 2005)

Metrological data of 2004					Metrological data of 2005		
S:No	Months	Rain fall (mm)	Temperature Cº		Rain fall (mm)	Temperature Cº	
			Min	Max		Min	Max
1	January	108	1.29	13.16	115	0.68	12.23
2	February	79	2.14	17.45	216	0.21	9.21
3	March	11	8.94	24.90	134	7.0	18.77
4	April	83	11.97	26.87	79	8.83	24.46
5	May	48	14.81	31.39	89	12.52	26.87
6	June	67	18.23	32.23	11	18	34.9
7	July	168	18.71	32.65	147	20.32	31.19
8	August	96	18.71	31.48	91	18.71	31.38
9	September	47	15.63	30.96	66	16.5	31.2
10	October	171	8.74	23.71	41	9.29	6.97
11	November	14	4.37	22.03	33	2.27	18.8
12	December	67	2.65	17.06	-----	-----	-------
Source: Agriculture Research Station Mingora Swat, 2005							

2.9.2 Malakand

During creation of Pakistan Malakand was part of FATA. After 1970 it got the status of PATA. Because of strategic position it had histoeical importance because of having ways going northern areas. Life style of Malakand is similar to Qabailee (FATA) (Govt of NWFP, Official http://www.nwfp.gov.pk/).

Total area of Malakand District is 952 Km^2 with a population density of 475 peoples per Km^2 (Table 2.6). According to district census report, estimated population for year 2004-05 was 567000 with a population density of 596/Km. Agriculture is the major source of income. In 1999-2000 agriculture department surveyed a total of 52134 hector land (54.78% of the total area). Total cultivable land is 45681 hectors (47.98% of the total) (**Table 2.5**). District Malakand is divided into two sub-divisions, Sama Ranizai and Swat Ranizai. Swat Ranizai (also called upper Malakand or Lower Swat) is contributing to River Swat watershed (**Map 2.1**). The Sama Ranizai is plain area, while the Swat Ranizai is mountainous. Most of the cultivated land is situated in the Sama Ranizai area. According to our estimate about 30% of the Swat Ranizai is cultivable. Most of the area is rain-fed. Rainfalls mostly occur in December to March and July to September. This is why wheat crop is visible on most of the rain-fed area on regular bases. Other major crops include maize, rice and vegetable cultivated on irrigated land.

Lower Dir

When Pakistan came into being, district Dir was called as state of Pakistan. Later on, as a result of Bajaur-Dir operation it came under the administration of Malakand Agency. After 1970 Dir become district of Pakistan. Dir-Lower is laying parallel of Swat and upper Malakand. (**Official web page of Govt. of NWFP, 2006)**. The lower Dir is devided into two administrative units, Tamargara and Adenzai Tehsil. Among these Adenzai Tehsil contributing to River Swat watershed.

The climate of Dir is cold. The northern most part, which is mostly mountainous receive snow fall in winter. The summer is not very hot and is good for tourist. The average rainfall is 1415 mm (Pakistan Meteorological Department 2005) and temperature is ranging between -0.86^{o}C to 32.52°C. Total Population of lower Dir is 717649 with a high growth rate of 3.42% and population density of 453/Km^2 (**Table 2.6).**

Agriculture and forest stuff are the two main income sources. Important crops are maize, wheat, rice, tomato, potato and onion. This area is also famous for fruits, including malta, Peers, almond and walnut. Due to hilly area it is full of natural resources. Because of lack of fresh water resources, more than 90% area is rain-fed. The part, which is situated along river Swat, is partly irrigated. Some areas in the mountains are also irrigated.

Table 2.5: District Wise land utilization statistics in the three districts of River Swat Watershed1999-2000 (hectare)

		Malakand	Swat	Dir (Lower)
Total Area		95200	533700	158300
Reported Area		52134	506528	142138 (23.5%)
Cultivated Area	Total	45681	95281	44432
	Net Sown	36249	78582	37614
	current Fallow	9432	16699	6818
Cropped Area	Total	57880	17211	53522
	Area sown more than once	21631	98629	15908
Un Cultivated Area	Total	6453	411247	
	Culturable Waste	1035	80569	745
	Forest	4622	135427	91480
	Not Available for cultivation	7196	195251	5481
Source:- Director Agriculture Statistics, NWFP, Peshawar				

Table 2.6: Population statistics in the three districts of River Swat Watershed1999-2000

District	Area (Km^2)	Population		%age Change in 1998 over 1981	Population Density (pop/ $Km^{2)}$		Growth Rate 1981-98
		1981	1998		1981	1998	
N.W.F.P	74522	11062319	17737591	60	148	238	2.82
Malakand Division	29872	2466767	4262700	73	83	143	3.27
Malakand Agency	952	257797	452291	75	271	475	3.36
Lower Dir	1583	404844	717649	77	256	453	3.42
Swat	5337	715938	1257602	76	134 *	236	3.37
Source: - North West Frontier Province Census report 1998, Population Census Organization, Government of Pakistan, Islamabad (http://www.nwfpbos.sdnpk.org/nwfpds/2000/4.htm).							

Concluding Remarks

Compared to NWFP, major portion of the study area is brought under cultivation. Visual interpretation of satellite images (Maps 2.2 and 2.3), are clearly showing sensitivity of the area toward degradation. Comparing demographic aspects, the study area has got high rate of population growth and population density. On the other hand other economic activities like industries, mining, tourism etc. are slow or negligible. Incase, if somewhere these activities are there, they are not managed properly and instead of reducing pressure they are increasing pressure on soil resources. Forest resources, by comparing with international standard of 25%, less forest resources are available which are under pressure and are toward decline. To enhance agriculture production, farmers are using pesticides, which is another threat not only for soil and human being but also for bio-diversity. The soil of the study area itself is also sensitive, because of sandy texture.

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Chapter III
LITERATURE REVIEW

River Swat watershed is an important area of North West Frontier Province and is gifted with scenic beauty die to its mountains and forest, abundance of water and mineral deposits. It has been explored by various researchers from different angles. To clear the picture and scope of this study and related methodology, it is necessary to survey the literature for the already existing relevant information on the findings and research works of various scientists in the field of soil protection related to River Swat watershed. As soil is a complex natural resource and has many aspects, therefore, the literature survey is divided into various sub-heading i.e. Geology, agriculture, hydrology and water quality, legislation and institution, forest and tourism etc.

3.1 Geology

- **Hamidullah et al, 1986**, studied geology of Malakand (Upper part of Malakand, called Swat Ranizai) fall in the tail of River Swat. According to them Malakand granite includes a series of low grad meta-sediments and granitic gneisses. It appears to be calc-alkaline in character. The chemical features and age relationship also indicate that the Malakand granite is not genetically related to the alkaline igneous complex of Peshawar plain. Three types of gneisses have been distinguished: a) siliceous gneisses b) Silica – rich granitic gneiss and c) normal granite gneiss. Among these only the normal granitic gneiss seems to be genetically related to the Malakand granite.
- The meta-sediments indicate several episodes of regional metamorphism ranging from lower green – schist facies to upper green schist facies environments.
- **Irshad et al, 1992**, studied Chakdara area fall in Lower Dir district. According to their study the mountain of wuch, Kotegram are amphiblite, while that situated west of Chakdara *Khwar* is granite and gnesiss. Near Kat-kala Kandow, which is the end point of River Swat Watershed is Phyllite. On the east of Kat-kala Kandow is green schist, Kohistan Thrus Passing through these Area. The main mineral assemblage, include Calcite, Quartze, plagioclase, K-Feldspar, Garnet and Magnesite.
- **Arif 1996**, studied magnisite-rich rocks including magnisite, talc, Quarta, fuchite, toumaline and chlirite. According to him these rocks contain trace to accessory amount of disseminated grains as well as small nodulare segregations of chrome spinal. The spinal displays unusually high Cr ($Cr^{+}Al$) and Low Mg ($Mg^{+}Fe$) ratios. A detail investigation revealed that the present chemical characteristics of the chrome spinal are probably the result of modification related to the formation of the host rocks by a low grade metamorphism in the presence of CO_2 bearing fluid.

- **Arif and Moon, 1996**, studied ultramafic rocks, especially chromitites, of ophiolite complex with the objective that it may contain platinum group element concentration of economic significance. The Pt and Pd were found negligible (<2ppb each) in two samples, while the concentration in two Chromitite sample found 126 – and 10 ppb and 15 ppm Au.
- **Arif et al, 1996** Studies the genesis of emeralds and their host rocks. Emerald deposits in Swat, northwestern Pakistan, occurring in talc-magnesite and quartz magnisite assemblages, have been investigated through stable isotope studies. This study shows that Swat emerald has two origins, metamorphic and magmatic.
- **Asim, 1999,** studied geology of Shamozai area fall with in River Swat watershed. Their study area was in the Main Mantle Thrust. For this purpose field investigations and thin section study was conducted. The main rock identifies as granitic gneisses, minor calcareous schists and phyllites. It was found out that Alkali feldspar and quarts are found in abundance, which is important form soil point of view.
- **Asif, 2000,** studied chrome spinal from the Swat Valley with the objective to find out reason for the development of this particular rock. According to him the studied chrome spinal grains are high Chromites containing anomalously high amount of Zinc and Manganese. They thus appear to represent a solid solution among three end-member spinal compositions: Mg, Al, Fe^{+3}, bearing Chromite ($FeCr_2O_4$) Gahite ($ZnAl_2O_4$) and Galaxite ($MnAl_2O_4$) formed as a result of metamorphism.. Other rocks, which are important from soil point of views are, occurrence of Schist, (Green schist, Blue Schist, Carbonate Schist, Chlorite Schist, Grafitic Schist, Mica Schist), granite, Gneiss. The soil formed around River Swat was termed as Alluvium.
- **Kfayatullah et all, 2001**, studies environmental impacts of chromites mining in Malakand area. Where biogeochemical distribution of enzyme-bound metals in the plants and soil of the chromites-rich mineralized area of Malakand Agency and the non-mineralized area of Mardan (N.W.F.P, Pakistan) was studied in regard to mineral prospecting and environmental pollution. Samples of lower plants accompanied with their associated soil samples were collected and analyzed for copper, lead, zinc, nickel, chromium and cobalt. Considering the plant-soil chemical relationship, there is a weak correlation of Cu, Ni, Cr and Co relative to Pb and Zn. Among the five plant species, *Verbascum thapsus* has the greatest capability to accumulate Cr(VI) and Ni in its tissues by scavenging through the soil in which it is grown. This anomalous concentration of Cr and Ni in *Verbascum thapsus* can be used for mineral prospecting; however, it can be a major environmental threat with regard to the health of the inhabitants of the area. Therefore, it was concluded that *Verbascum thapsus* could be an environmental threat for the living organisms of the Malakand area in proximity to the mineralized area.
- **Irshad et al, 2003** studied the tectonic evidences of the Indian Plate. The study revealed that the Indian plate in northern Pakistan contains a good record of granitic rocks ranging from Late Archean to Quaternary. They classified those granitic rocks in seven broad categories also found in the study area.

- **Jehan, 2004**, conducted a detail study in Malakand and Mohmand Agency to investigate problems related to asbestos and talk mining. It was observed that mining in these areas are not environment friendly and due to unscientific mining practices bulk of rocks goes into waste. The unaware people are highly exposed to huge amount of asbestos and silica containing dust. Based on the findings of this study detailed recommendations are formulated for the sustainable utilization of minerals and mineral rocks not only to avoid wastage of these minerals but also to save the environment and inhabitants of the area.

3.2 Agriculture

- **Noor, 1989** studied the rangeland management in Pakistan and northern area, where alpine pastures were also studied in the upper mountains regions including Dir and Swat. The alpine floral species ae very sensitive while slop and temperature are the limiting factor in forage production. Therefore, continuous grazing in summer can make it more susceptible to erosion, which ultimately has negative impacts on soil quality. Therefore, controlled grazing was recommended.
- **Sulaman, et al, 1995**, studied development of a rainwater harvesting system for increasing soil moisture in arid rangeland of Pakistan. Their study shows that soil moisture can be significantly increased with micro catchments that have 4 to 5 m long water catchments aprons and 7 to 15% slope gradients. Increases in soil moisture were found in both the late summer and the late winter season when the highest precipitation is received. There are some year-to-year differences depending on how much precipitation was received each year. Rill erosion on the aprons increased with apron length and gradient.
- **Gillett, 1996** studied the possible utilization of agriculture land to avoid the use of Opium in district Dir. He pointed out that major area of Dir is still forested: deodar and other conifers are dominant at the higher altitudes, and deciduous species including oak, wild olive and walnut proliferate lower down. Increasing population pressure and the insatiable demand for firewood locally and for timber throughout Pakistan has reduced tree cover drastically. Much cleared forest has become seriously degraded through uncontrolled grazing and conversion to arable. Unfortunately, unless new farmland is laboriously terraced and irrigated the thin soils soon erode and lose fertility. Even as rough pasture such steep slopes are of little value, since high rates of evapo-transpiration and un-shaded capped soils inhibit the maintenance of grass and shrub cover.
- **Nusser, 2000**, studied the land-use system in northern mountainous region of NWFP, Pakistan. Fast growth rate of population was considered the major threat to natural resources and land use changes. The possibility to use photograph in land use change, taken during 1934-37 was also explored.
- **Ayub et al, 2001,** studied the possibility of introducing modern exotic lentil variety in the rain fed area of Mingora, Swat. With the idea to increase production of pulses. Because Pakistan generate 85% of Pulses requirement while 14% is imported. They obtained twenty-five different varieties from four different countries. Fertilizer were applied @ 12 kg N, 30 kg PO (a bag of DAP)/acre during soil preparation before sowing. Agronomic practices viz hoeing, weeding, thinning and plant protection

measures were adopted. Theses varieties were found low in terms of maturity, flowering and seed yield. The research is still continued to identify the right species for NWFP in general and Malakand division in particular.

- **Umar et al 2002** studied response of rice to Zinc fertilizer in calcareous soil of Daira Ismaial Khan. Where a comparison was made with soil of River Swat Watershed. In total 45 soil samples were collected from Dir, Swat and Malakand were analyzed. Out of which 45% appear deficient or marginal ranges. The response of rice variety IRRI-6 (Oryza Sativa L) to various levels of Zinc was studied in a pot culture experiment. There was increase in growth with increasing amount of Zinc. After analyzing the plant it was found that 10 Kg/he was found the best dose.
- **Bakhtyar et all 2003** conducted study to assess the impact of Project for Horticultural promotion's (PHP) extension and training materials on end user in the five districts of Malakand Division. The project was executed by Agricultural Research Station, North, Mingora (ARSNM). For this purpose two hundred randomly selected respondents were interviewed through a pre-designed questionnaire to see the effectiveness of project extension materials in disseminating information amongst the farming community and the role of project in solving horticultural problems in the target area. The extension materials were found very useful for the farmers. But some of the respondents complained the poor distribution of extension materials, lack of practical demonstration of extension materials and limited number of field days. The study shows that the project was useful in nurseries establishment and seed production of modern technology and management practices. This study seems important in future guidance, especially social research.
- **World Bank, 2003** studied water productivity of Pakistan in drought situation by using satellite imageries of 1km resolution. According to their findings water productivity values for wheat in 2001-02 (dry year) were higher due to increased solar radiation, which boosts crop growth when good quality groundwater is sufficiently available. During this 17-year period, yield increases were also due to improvements in farming practices and seed quality. In an average rainfall year, the water productivity for wheat in Pakistan (0.76 kg/m^3) is 24% less than the global average (~1.0 kg/m^3) and, therefore, can be classified as "moderately acceptable". It was concluded that Pakistan under-utilizing its potential resources, resulting in unnecessarily low yields per hectare and per unit of water consumed. Satellite remote sensing techniques can provide vital, periodic, and unbiased information on water productivity across vast areas. It will also facilitate establishment of adequate land and water use databases, which in turn will facilitate good agricultural practices.
- **Shah et al, 2003,** worked on importance of crop residue and fertilizer effects on nitrogen fixation in NWFP, Pakistan. According to their study, improved management of nitrogen (N) in low N soil is critical for increased land productivity and economic sustainability. They report results of a rain-fed rotation experiment, conducted in the Northwest Frontier Province (NWFP**),** Pakistan**,** during 1995–1999 to evaluate effects of residue retention and fertilizer N on N_2 fixation inputs and yields of a mungbean

(*Vigna radiata*)–wheat (*Triticum aestivum*) sequence, and a lentil (*Lens culinaris*)–summer cereal sequence. Mungbean and sorghum (*Sorghum bicolor*) or maize (*Zea mays*) was grown in the summers and lentil and wheat in the winters. They concluded that crop residue increase the rate of nitrogen fixation and in increase crop productivity.

- **Shah, et al 2004** worked on improvement of Nitrogen fixation in NWFP, Pakistan. According to the study NWFP has got diverse agro-climatic conditions, which is helpful to grow different types of cereals, fruits, vegetables and a number of legumes. Legumes have long been considered important in sustaining yields of cropping systems. They are grown annually on about 139,000 ha of the total 1.90 million ha cultivated land in this province. The average yield of these crops is very low than their potential production, which in most cases is due to the absence of effective nodules on the roots of these crops. It was concluded from the on-farm trials that artificial seed inoculation of pea, chickpea, lentil, mung bean, soybean and berseem crops is necessary before sowing as their native Rhizobia. A starter dose of N @ 20-30 kg ha^{-1} and an appropriate amount of P @ 50-100 kg P_2O_5 ha^{-1} must be applied at sowing time to these crops in order to stimulate early growth of plants, root development and other growth factors. Incorporation of mung bean crop residue increased the yield of succeeding wheat crop considerably in a rainfed rotation experiment conducted in Malakand Division during 1995-99. Moreover, incorporation of crop residue also significantly improved the N_2 fixation by mung bean from 74 to 112 kg ha-1.
- **Ashraf, et al 2005,** conducted study at a Livestock Farm in an arid region of Pakistan, to determine the uptake of mineral nutrients from the food of buffaloes. Samples of feed, water, forage, soil as well as blood, milk, urine, and faeces of the animals were collected and analysed for K+, Ca^{2+}, and Fe^{2+} during summer and winter. The results showed that the concentrations of K^+ and Ca^{2+} in plants were low, whereas that of Fe^{2+} was high. In animals, K^+ was not found in the milk in significant amounts, rather it was excreted in the urine. The calcium taken in by the animals was used for the synthesis of milk, as a result of which low Ca^{2+} concentrations were detected in urine. Mineral nutrient concentrations (K^+ and Ca^{2+}) in forage plants and water were lower than the optimum requirement of the animals, as a result of which blood plasma contained lower amounts of minerals (K^+ and Fe^{2+}) than that of the normal animals or critical limits. From the findings of the present study, it can be concluded that the buffaloes raised at the livestock farm had a severe deficiency of mineral nutrients, particularly K^+ in lactating and Fe^{2+} in both lactating and non-lactating animals. Feed supplements, that can overcome these deficiencies, should be used for the optimum growth, milk production and resistance to diseases.
- **Rashid et al, 2006,** studied the possibilities of earlier germination by seed priming (soaking seeds in water prior to sowing). For this purpose two type of experiment were conducted, on-station and on-farm in several environments, including saline, saline–sodic and normal (non-saline, non-sodic). In general, priming was found to increase yields of both grain and straw (an important product in NWFP agriculture). Grain yield increases due to priming were up to 53%. Priming was also advantageous on saline–sodic than on saline soils, possibly as a result of the water content of the soil. It was concluded

that "on-farm" priming of barley could be recommended to farmers in NWFP and in similar environments in other parts of the world who produce barley both for grain and for fodder.

3.3 Residual Pesticides

- **Al-assiuty and Khalin 1996,** studied the effect Atraxin herbicid on Entomobrya musatica (Collembola). Field and laboratory toxicity tests were carried out, to evaluate the effects of atrazine on population abundance, distribution pattern, and duration of *Entomobrya musatica* (Collembola). In field experiments atrazine treatments at different doses. It is concluded that the atrazine treatment of 4.0 kg ha^{-1} has an adverse effect on the abundance and the development of the test species.
- **Minelli and Ribeiro, 1996** conducted study among the worker involved in malaria eradication program in Barazil in comparison with unexposed worker. For extraction n-hexane:acetone with a ration of 9:1 was used through alumina column chromatography, and analysis using gas-liquid chromatography with electron capture detection. The DDT level was found ranging from 1.6 to 62.9 ug/l in exposed worker while in the unexposed the level was ranging from 1.1 to 2.5. Similarly HCH was also found in the exposed worker and the level was quite high form that of unexposed worker. This indicates that these compounds are slowly excreted by the body, and also clearly indicates the bioaccumulation of these pesticides in the human body.
- **Karam, et al, 2000,** studied eight insecticides namely Dichlorvos Mevinphos Dimethoate Methyl parathion Fenitrothion Chlorpyriphos Endosulfan and Profenphos in ground water collected from four different areas of NWFP, Pakistan, which are also used in River Swat watershed. Residual insecticides were observed in ground water. For extraction dichloromethane was used, which was evaluated on GC equipped with Electron Captured Detector (ECD). The observed concentration was compared with maximum acceptable concentration (MAC) suggested by the European community (EC). In three out of eight site the values were above these MACs.
- **Saqib et al, 2002,** investigated six pesticides for residual concentration including Cypermethrin, Methamedophos, Monocrotophos, Cyfluthrin, Dialdrin and Methyl Parathian in three different Mango varieties collected from Multan. For extraction a mixture of cyclo-hexane and ethyle acetate of 1:1 ratio was used. The extracts were evaluated on GC fitted with ECD. All samples appeared positive for the mentioned pesticides but within the permissible limits of FAO & WHO. Looking into the bio-accumulative effect a regular monitoring was suggested with the objective to avoid contamination of food cycle.
- **Humauun et al, 2003** studied effect of weedicides and Hand weedings on the yield of onion Swat-1 (Alliam cepa L), which is also cultivated in Swat area. Field experiment was conducted at Agriculture Research Station Serai Naurang, Bannu to find out the effect of two weedicides i.e Ronstar @ of 3 Kg/ha and Stomp 330-E @ 4 Lit/Ha along with hand weeding, i.e 2 and 4 times, keeping the required intervals

in onion crop. The combined effect of weedicides and hand weeding was productive. It was calculated that to increase yield and reduce weedicides use hand weeding was recommended.

- **Rasul M.J. et al 2003** analysed residual pesticide in water and soil samples collected form Peshawar, Charsada and Swat District. They analyzed five pesticides namely, Dichlorovos, Isoproturon, Diazinon, Methidathion and Cypermethrin. Dichloromathan was used as extracting agent and was analysed on GC-ECD with capillary column. The samples collected from Swat area the concentration of Dichlorovos was in the range of 13 to 2452 ppm, Isoproturon 42 to 144ppm, Diazinon 28-283 ppm, Methidathion116 to 235 ppm and Cypermethrin was in one sample of 88 ppm.
- **Walker and Rautin, 2003** studied the degradation rate of Isoproturon (Herbicides). It was observed that the residual concentration came down to about 50% in seven days time.
- **Ilyas, et al, 2006**, assess the behavour of persistant pesticides in sandy loamy in Punjab, Pakistan. the va\rious critera considered include moistures, temperature and microbial activities. Endosulfan and cyalothrin were showed persistence in sandy loam soil up to a depth of 10 cm.
- **Sarfaraz et al, 2006,** study the role of fungi in degradation of Endosulfan, a widely used pesticides in Swat valley. This study indicates that the isolated strains carried efficient enzyme systems required for bioremediation of endosulfan-contaminated soil and water environments.

3.4 Institutional Strengthening

- **Mehdi 1997,** studied the importance of Geographic Information System for forest inventories and monitoring. For which institutional strengthening is of prime concern. According to him, the present practice of GIS activities are very much limited and a few organization making use of this. There is a need to expand it further. For which proper funding and training is required. To make map production efficient and cost effective he suggested installation of GIS facilities at the department of Soil Survey of Pakistan. The achievement of sustainable development and implementation of Pakistan national Conservation Strategy (PNCS) depend on the availability and sharing of reliable information. Therefore, he oppose the stick policy of Government of Pakistan and emphasis in inter institutional cooperation and involvement of academia.
- **Qasim and Tariq, 1998,** studied Barani area of NWFP with special reference to institutional strengthening. They identify five different problems. Among these accelerated degradation of forest and range land were alarming one which were attributed to population increase and irregular grazing. For effective remedial measures three elements were identified that is community participation, proper utilization of supporting organization, especially the NGOs and proper cooperation and coordination among concerned organization and community.
- **Ghaffar et al, 2002,** agriculture development with the idea how to make it sustainable by considering population increase, culture and social institutions. The main focus was on policies, process and institutions. According to them, in developing countries like Pakistan agriculture has the ability to up lift

the concept of lift the concept of sustainable development. The various project completed in the River Swat Watershed were reviewed. Theses project include PATA Project, Malakand Social Forestry Project, Malakand Fruit and Vegetable Development Project, Kalam Integrated Development Project etc. appear successful to some extent, mainly because of involvement of local people and respecting the social institutions.

- **Geiser, 2004**, studied a social institution *rivaj* in the North-West Frontier Province (NWFP) of Pakistan in relation to forest protection. He identified two types of rules i.e. formal (acts, ordinance and rules) and informal (traditional *pukhtoon* rules) in the form of *rivaj* (customs). The informal regulations are practiced under the supervision of *jirga*. The *rivaj* although varies in time and space is respected by the people and comparatively strong. A huge gape between formal and informal regulation was observed and the present institutional set up cannot solve the problem of defloration.
- **Shaheen and Kruseman, 2004**, was with an attempt to answer the question of increasing poverty and relation to institutional arrangement and resource degradation. In NWFP there are people who are dependent on natural resources. Any policy appear failed will increase poverty further. In NWFP various property rights exist. Which is supported by two types of institutions the de-fecto and de-jure. These are different from each other. The de-jure supporting a poor to utilized natural resources as li8velhood, while de-fecto opposing but can not stop him. On the other side the stack holder are given a set of limited property rights, which causing conflict with the governmental organization. But there exist no such mechanism of conflict resolution, which is acceptable to both parties, the government and the community. To handle the increasing trend of poverty, these gaps must be addressed properly.
- **Sultan, 2004**, studied historical aspects of Swat Forest Resources starting from 16th century. This was the period when Yusufzai tribes appear in Swat area. In 1947 when Pakistan came in being, Swat was a state and in 1969 it was made part of Pakistan. Until 1969 the people of Swat governed the forest resources and later on when it become part of Pakistan was taken by the government of Pakistan in 1970. Soon the government of NWFP brought this under its own authority and declared the forest of Swat area protected forest. But it was not protected properly. This failure is attributed to inefficient given in the hands of Pakistan. and week implantation of rules and regulation and ill management in forest department.
- **Moor, 2004** studied rights in the context of Customary and Statutory Law. There is old strong collection of traditional law in Northern parts of NWFP respected by all people. Collective responsibility or sharing of responsibility is the main characteristic, under which natural resource and land resource are shared among families and tribes. This collective responsibility is strengthening by customary regulatory institution. To improve the natural resource conservation, these should be utilized properly. For this he recommended to make these traditional rules part of the statutory law through the process of consultation.
- **Samad,** 2003, Studied Institutionalization of Environmental Impact Assessment (EIA) in NWFP, Pakistan. According to him EIA procedure has been injected in the already existing planning process and

all developmental activities initiated by government are asking for EIA. But due to institutional weaknesses it is still in the initial stages. For its proper implementation apart form legislative measures a colossal support form bureaucracy and politician is required.

- **Lubna 2001**, analyze the institutional arrangement for protection of forest in NWFP, Pakistan and addressed mountain ecosystem specifically. She identifies the role of institutions as: Institutions perform a coordinating function in the society and to reduce uncertainty by giving a stable structure to human interaction. For forest protection some one has to adopt some rules regulation, which can be facilitated with proper institutions. The main problem in NWFP identified as of ownership and rights of an individual in a community and identification of his/her role in forest protection. Second suggestion was about public participation in natural resource management, third point relates to accountability system of forest official.
- **Riaz, 2002**, study the role and importance of judiciary in achieving sustainable development. For this he reviewed various available national and international laws and found it appropriate. For its effective implementation strong institutional set up was suggested.
- **Steimann, 2004**, worked on the concept of decentralization and role of state and local people in forestry sector in NWFP. According to them 40% of Pakistan's forest occur in the NWFP Province. The hypothesis set for research was "On local level, a big gap exists between de-jure and de-facto forestry. Therefore, the ongoing reform process cannot be called a true decentralization yet". To verify the hypothesis two districts were selected namely Swat where protected forest is there and district Hazara where Guzara forest exist. Semi structure interview and questionnaires were used as data collection tools. As 60% of countries worldwide have decentralized some aspect of natural resource management, and was suggested for Swat and Hazara forest sector. Eight types of stakholder were identified as: Residents, Gujars (nomads), Provincial Government / Forest Department (FD), Federal Government, Timber contractors, 'Timber Mafia', Non-governmental Organizations (NGOs) and International Donor Agencies. It was found that the forest department is working in individually while it is required to absorb local government as well as attract the confidence of local people. Strongly suggest a regular communication link between forest department and local people.
- **Jahangir, 2004-05** studied forest of NWFP as sustainable livelihood and its institutional aspects. The study was conducted in three villages of Kohistan region by selecting two villages in the Western Himalayas in Kohistan District and one village in the Hindukush mountains in Swat District of North-West Frontier Province (NWFP), Pakistan. The empirical analysis shows that local people protect forest resources with the view to producing forest goods, which are important for livelihood resources. Local collective action is highly effective in excluding outsiders but at the same time unable to fully protect the forests from overexploitation by individuals within the community. The underlying causes of the unsustainable use of forest are the longstanding conflict over the ownership of the coniferous forest between state and local communities, and non-involvement of locals by state in forest management. The

study proposes co-management of natural coniferous forests as village commons. To this end it proposes that local government structures should mediate between locals and the Forest Department concerning forest management.

3.5 Forest

- **Rauf 1993** analyzed forest degradation in the communal lands in the northern Pakistan and found it under pressure. If the present exploitation continues, remaining ***guzara*** forest will disappear. He suggested two measures, a) contractual arrangement or 2) institutional reform. Under contractual arrangements one option is long term leasing, if not outright purchase, of guzara lands by the government. In either case, it seems appropriate to entrust the management of these forest to the forest department of the respective province, thereby abolishing for all practical purposes. For institutional reform, besides the *panchayat* (decision body of local elders) system and the cooperative societies, the existing elected local government bodies are an attractive alternative.
- **Sanaullah and Mukhtar, 2002**, undertaken study to obtained information about nomadic grazing over time. Since the merger of the Swat State in Pakistan (1969) many social and political changes and developments have affected the use and management of natural vegetation from hillsides, landownership and distribution of user and owner rights. A tremendous decrease has been noticed mainly contributed to lack of winter grazing areas due to afforestation, increase of agricultural land, privatization of hillsides and closure of trekking routes. The number of animals per family has decreased (48% decrease in sheep/goats) as well as the number of families rearing livestock. The total number of animals depending upon winter grazing in these areas has decreased with more than *50%* according to the informants. Comparing the field data with data derived from the Livestock Census (1976-1986) it can be concluded that the same trends are observed. According to the trends derived from the census the goat/sheep population is reducing with 4.9 and 1.1% respectively. This gives a reduction of 36% over 10 years. In Buner livestock comprises mostly goats as the vegetation is more shrubby as compared to Swat. About 25% of the total number of ajar families has been reported to have sold all animals and found an alternative job in agriculture or daily labor in cities.
- **Geiser, 2000,** studied forest resources of NWFP. According to him forest is the major source of livelihood in NWFP. In this process of forest uses include various types of people such as local individual, contractors, politician. They are using forest resources, as source of income in un-sustainable way, while forest department is trying to make is sustainable through institutional regulation. The "formal plan" prepared for this purpose is not matching the actual practice in the mountanioi9s area. It was suggested to review the forest formal plan and make it compatible with local situation.
- **Willem and Marie, 2002**, investigated planning and management aspects of forest in NWFP. According to them the forest department has changed its traditional way of handling forest resources and had encouraged public participation. For this purpose a representative community organization have been

established. As a result of this communities also helping to give their input in land use planning. This trend appeared quit effective and has strengthened the planning and management aspects of forest conservation. Still more efforts are required to extend this approach to all villages in the mountainous area and strengthen forest department further.

- **Iqbal 2003,** studied deforestation in NWFP in comparison with other province and of Pakistan. Where different reasons for deforestation and some suggested measures for efficient aforestation has been given. A comparison of Pakistan forest is also given with other countries, like Angola, Kenya, Nigeria, South Africa, Egypt, Bangladesh, China, India, Indonesia, Malaysia, France and UK has been give. The lowest forest is in Egypt (0.1%) and Pakistan is 2nd to Egypt (3.1%). The highest forest cover is in Republic of Congo and Malaysia (59.6 and 58.7%) respectively. Comparing NWFP with other province of the country has high score of 31.8%, while Sindh has 24.4%, 8.7% and Punjab 8.7%. The forest of NWFP is classified as State/Reserved Forest (6%), Protected Forest (30%), Private forest (33%), Plantations trees and farmlands (31%). The major threats to NWFP forest are un-scientific harvesting and smuggling. Which has got negative impacts on soil quality and negatively affecting dams and reservoir.
- **Shahbaz and Tanvir**, **2004** studied forest use pattern and importance of public participation in forestation activities. In Swat majority of the people using forest for fuel wood, timber needs and as a livelihood. Because of which the forest cover is toward decline. The organization like forest department and women organization were less trusted, while village development committee (VCD) Union Council and Jirga (an informal council of local elders) were trusted more. To decrease burden on forest resource he suggested alternative means of fuel and maximum utilization of *Jirga* and Union Council.
- **Sultan, 2005,** studied detail historical prospective of Swat valley. According to him commercial utilization of timber was started around 1850s. In 1897-98 appeared as a regular business. In 1922 efforts were started to make forest as state property. In 1926 the forest of Swat valley was considered as state property liable to the payment of 10% of the sale proceeds to the respective landowners or former. Large scale cutting was started after 1969 when Swat stat was merged with Pakistan and the forest was declared as stat property. The royalty was increased varying between 20 to 80%. This was the period when timber mafia appeared in the area and uncontrolled deforestation started. There exist a huge gap between social institution and government institution that need harmonization. For this the forest department is required to adopt participatory approach.
- **Nasreen, 2005,** studied diseases caused by the Ganderma spp. On perennial crops in Pakistan. The various tree species affected in Pakistan are Pinus, Dalbargia, Artocarpus, Morus, Cedrus, Melia, Qurcus,m Populus and other trees in Pakistan Causing stem, butt and root rot diseases. A research institution to manage the disease of perennial crops in general and of trees yielding edible oil in particular such as coconut and oil palm needs to be established in Pakistan. Besides for NWFP the various reasons of deforestation were also studied. Among these fungus disease, Afghan Refugees and water run off from melting glaciers were considered the main threat to forest and soil. Research and

regular monitoring was suggested. Therefore a research station was recommended to combat spread of diseases and pest of forest trees.

- **Hamayun et al, 2005** conducted ethnobotinacal study in two region of Swat district. The study was aimed to investigate ethnobotanical profile, conservation status and plant diversity of Utror and Gabral, situated near Kalam. These valleys are located in the northwestern part of District Swat. The area is gifted with diverse and unique flora, as it is adjacent to the confluence point of Himalayas, Hindu Kush and Karakorum. The people are mostly poor, illiterate and depend upon plant resources for their domestic needs. The inhabitants of Utror and Gabral utilize 181 plant species for more than 42 domestic needs. These include 148 spp. of Dicotyledons (54 families), 14 spp. of Monocotyledons (5 families), 8 spp. of Gymnosperms (3 families), 3 spp. of Pteridophytes (2 families), 7 spp. of Fungi and 1 spp. of Algae (1 family each). Most of the plants are used for multiple purposes. Some plants are also sold in the local markets, thus providing an additional source of income. To make the use sustainable he suggested utilization of local knowledge.
- **Hamayun, 2005**, carried detail ethnobotanical survey of Swat Kohistan (upper Swat). He identified twenty eight species belonging to fifteen different families that were used by the local for different purposes. Among these the use of plant as a source of fuel wood appeared a major threat to forest resources. He suggested alternate fuel resources such as LPG cylinder and fuel-efficient stove. To insure the use of these facilities and importance of bio-diversity public consultation and awareness was suggested.
- **Jahangir 2005**, studied forest resource in Kohistan and Swat Districts. Deforestation, soil degradation, loss of biodiversity and unsustainable livelihoods were identified as major problems. The study was conducted in three villages of Kohistan region by selecting two villages in the Western Himalayas in Kohistan District and one village in the Hindukush mountains in Swat District of North-West Frontier Province (NWFP), Pakistan. The available livelihood assets of the local indi9vidual were analyzed with an attempt to find out ways and means to divert dependency on forest resources and protect it. He also explored the working behaviors and efficiency of the forest department. And local indigenous organization. For batter forest protection involvement of local community was emphasized.
- **Zubair and Garforth, 2006** studied forest situation in the southern part of NWFP, Pakistan. they pointed out the alarming situation of deforestation and farm forestry was identified as a suitable solution. For this the forest department is required to consult farmer community and educate them about the associated benefits farm forestry. In this way pressure on natural forest will decrease.
- **Tanvir et al, 2006,** studied deforestation rate and various factor contributing to deforestation. Questionnaire survey was conducted in Mansehra and Swat area. Four villages were selected form each district. A total of 50 families were selected randomly for questionnaire survey and 400 people were interviewed. According to them total forest cover is 4.5 million heaters. Most of the country's forest resources are found in NWFP (40%) 15% in Northern Areas and 6.5% in Azad Kashmir. It was find out

that Pakistan has the highest rate of deforestation. The forest, even it present is of divers in nature. In NWFP, factors responsible for deforestation are illegal cutting, the intensive use of forest wood for household need (cooking and heating), and ineffective forest management strategies by the forest department. Policy guidelines (implementation) are suggested for improving the effectiveness of forest extension services.

3.6 Water quality

- **Canadian Company 1952-54** conducted an aerial survey for the preparation of Canadian Colombo Plan Survey. In which the Kabul River watershed was photographed to prepare detail water utilization Plan for Indus Basin. The aerial photos were also interpreted for sediment load carried out by different rivers. In this it was found that the water of Swat River was quite clear, while that of the Panjkora and Kabul River appeared silty, which show comparative state of erosion among the three rivers.
- **Ali 1991-93** studied and assessed water quality of Swat River for nine (9) parameters including Temperature, pH, Conductivity, Dissolved Oxygen, Dissolved Solids, Suspended Solids, Alkalinity, Chloride, Nitrate. In the light of this study the river Swat was considered environmentally safe except Suspended Solids. Which was associated with heavy deforestation activities in the river Swat watershed. For which aforestation and reforestation were recommended. Besides, as heavy erosion was also observed along the bank, for which embankment was recommended.
- **Iftikhar and Samina 1992** studied the environmental impacts of tourists on Bahrain valley (Swat). They studied various phisco-chemical parameters including pH, conductivity, Dissolved Solid, Suspended Solids, Chloride, Sulfate and Nitrates. As per their study the results were within the permissible limits. But there were some problems that could be associated with tourist, such as plastic bags, milk packs, oil and grease and detergent, which appears occasionally in summer. In this way the ever increase in tourism may cause heavy impacts in the form of solid waste dumping.
- **Ghulam and Nafees 1992** studied Adazai River for various parameters including pH, Temperature, Conductivity, Dissolved Solids, Suspended Solids, Chloride, Nitrate and BOD and were compared it with water quality standard for drinking. In the light of this study the Adazi River was found safe for drinking except suspended solids. Which was associated with soil erosion and deforestation along the riverbanks. It was also observed that River Swat (Called Khialay in Charsada area) is comparatively clean and has got positive impacts on Adazai River (main branch of kabul River) in terms of dilution. Other problems includes over fishing and uneven use of agro-chemicals. For which proper embankment, aforestation and reforestation were recommended.
- **Khalid, 1992** studied water situation of Pakistan till 1987. According to them irrigation canal is important for agriculture especially for winter crop. He worked on its historical prospects which were traced back to 1351AD in the era of Feroz Shah Tughluq. Akbar improved this further in 1568AD. After that in 1633AD Shah Jehan upgrades canal system and extend it further to various area of Punjab. During

the ear of British India Head works were installed and flow was regularized. In this way at the time of independence average canal withdrawal was 64 million-acre feet. This figure was increase to 102.82 MAF in 1986-87. In which the share of NWFP was 5.65 MAF. The various problems, identified as irregular water flow, Excessive water loss, lack of drainage facilities, limited control capability, poor operation and maintenance of the system, and siltation. To achieve sustainable water use, control of losses, regular maintenance of tubewells, over come on sedimentation. Besides to improve water quality the industrial and municipals effluents must be monitored and install proper treatment facilities, where required.

- **Pervez 1993** studied Kabul River for flood plains vegetation in Dauba-Daudzai area (Area from Warsak dam to Jaba (Akbarpura). He classified the branches of Kabul River on the basis of Pollutants they carry, as a) Clear water (Adezai which also receive River Swat) b) Contaminated water (Naguman) and Highly polluted water (Shalam). Shalam River was found polluted most because of municipal effluents and effluents from Khazana Sugar Mills and Tothi tanneries.
- He also found that the flood plains of Duaba-Daudzai were in lush-green tree forests, grasslands and some parts were pastures. As a whole the vegetation is much disturbed. Duranl and seasonal activity, over grazing and fire bring about major changes in vegetation setup and soil structure, which has negative impacts on agriculture and Kabul river for which grazing and forestry management practices were recommended.
- **Jehanzeb 1993-94** studied River Swat for 12 parameters (Dissolved Oxygen, BOD, pH, Conductivity, Total Suspended Solids, Total Dissolved Solids, Nitrate, Sulfide, Alkalinity, Chloride, Phosphate and COD. All parameters except Suspended Solid, BOD and COD were within permissible level. For which measures like aforestation, proper embankment were recommended. As the people along the river using it for drinking purpose, therefore, the Government should initiate water supply scheme and huge public awareness programs to save River Swat.
- **Iqbal 1993-94** studied Mingora *Khwar* and its impacts on River Swat. He studied the *Khwar* for 17 different parameters (Temperature, pH, Conductivity, Total Solids(TS), Total Dissolved Solids(TDS), Total Suspended Solids(TDS), Chloride, Hardness, Alkalinity, Nitrite, Nitrate, Sulfate, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Lead (Pb), Chromium (Cr), and Zinc (Zn). Among these Total Solids (TS), Alkalinity, Chlorides, BOD and Sulfate were found increasing in the receiving Swat River while there was decrease in Dissolved Oxygen. This increase was associated with the dumping of solid waste and dead animals, sewage and un-aware public. The *Khwar* is in use for drinking, bathing and washing while it is not fit for drinking at least. Therefore, proper cleaning and monitoring program was recommended.
- **IUCN and Department of Environmental Planning and Management University of Peshawar, 1994** worked on "Pollution and The Kabul River". They analyzed the water for different parameters. Their findings revealed that River Kabul carries high-suspended solid loads ranging from 10-800 mg/L under

low flow conditions and 340-1,310 mg/L under high flow conditions. The Kabul River water is also high in Alkalinity, Conductivity values, Sulphide and Magnesium, Calcium and heavy organic pollution. Of the metals analyzed Chromium concentrations were of most concern.

- **Amjad 1996** analyzed 10 rivers of NWFP for suspended load quantitatively and qualitatively. In Kabul River system Chitral and Bara river were found turbid most with 1112 ppm and 1152 ppm respectively followed by Kabul (684 ppm) Punjkora (443 ppm) Swat (57 ppm). Other parameters that were studied include pH, TDS, Conductivity, Sodium, Potassium, Lithium, Sulfate and Phosphate, which were found within the permissible level of drinking. The problem of Suspended Solids was associated with barren and steep mountain slopes upstream and aforestation, reforestation and other watershed management practices were recommended.
- **Rehman et al. 1997** studied eight important rivers of North West Frontier Province (NWFP) including Kabul River, Swat River, Chitral River and Punjkora River to analyze the available surface water resource potential. It was found that the amount of Total Suspended Solids (TSS) being very high in most of the rivers and have resulted in rapid silting and subsequent loss in the storage capacity of the existing reservoirs. Kabul River was found the largest tributary of the Indus river in NWFP while Bara River was the smallest river in terms of discharge and sediment load. Chitral River was called the most significant river in the study area (NWFP) in terms of its annual sediment yield. It yields the highest sediment load per square Kilometer of the drainage basin (1842 tKm^2a^{-1}) indicates a very high denudation rate in the Chitral Valley. The Swat River was found with the lowest sediment load in the region.
- **Shaheen and Shabnam 1999-2000** studied the WWF activities with focus on fish conservation and awareness project of Malakand River network. It was found that the fresh water network of Malakand has a tremendous biological, economical and social value for the residents of Malakand division. Aquatic fauna is rapidly deteriorating both in quality and numbers. Which were associated with population increase and lack of awareness. People on one side adding domestic and commercial effluent to river swat and on the other side practicing illegal ways of fishing. Besides, deforestation is there in the watershed, which increased sediment load in river swat having negative impact on aquatic fauna. In this way aforestation, awareness and proper legislation were recommended.
- **Shahina 2001** studied surface and subsurface water of Peshawar Basin for various cations and anions; include Calcium, Magnesium, Potassium, Sodium, Bicarbonate, Sulfate and Chloride. The water was also analyzed for Oxygen Isotopes and trace elements, such as Iron, Manganese, Chromium, Nickel, Copper, Cobalt, Lead and Cadmium. These parameters were studied and were found within the permissible limits recommended by various international Agencies for drinking, domestic and Agricultural uses. The surface water of Akbarpura in its vicinity (Near Kabul River) was found unsuitable for domestic uses. The Oxygen Isotopic data for the underground water system of Peshawar Basin indicated that the aquifers in the Peshawar Basin were recharged both by rainwater and water from

the Kabul and Swat rivers. In this respect the Kabul River remain dominant over the Swat River. This also indicated that the shallow waters in the basin were more contaminated than deep water. The problems were associated with urbanization and industrialization in and around the major cities of NWFP. Therefore, pre-treatment, legislation, awareness and regular monitoring were recommended.

- **Ijaz et.al 2000-01** studied the relation of sediment load with catchment area and annual runoff volume of Kabul River basin in Afghanistan. Rivers that were analyzed include the Kabul, Loghar, Gurband and Punjshir rivers. The river was found turbid for which watershed management was recommended, with the emphasis on aforestation and reforestation activities to reduce the sediment load.
- **Amjad 2002** evaluated surface water resources and sediment load in Indus Swat Kohistan north Pakistan. Where Swat River was also studied in detail. The Swat River was contributed by Gabral River by 43% followed by Ushu River 34%, Daral Khwar 11% and Batal Khwar by 12%. The sediment contributed by the swat river to the Kabul River is mostly dependent on Punjkora River that joins it before it falls in the Kabul River. It was concluded that Swat River stand to be the noble most river in the region regarding sediment load. In this study a rational had been established between sediment load and catchments area, discharge and suspension of rivers. While to over come the problem of Suspended Solids reforestation was recommended in the catchments area.
- **Environmental Protection Society (EPS), 2002** Swat conducted a detail study and cover various ecological aspects of River Swat watershed. They Swat area into four ecological zones, as 1) Lower Swat (600-900 m) extending from Boosaq in the south to Nagova Spur in the north, represented by the, "Sub-humid Tropical Region". 2) Central Swat (900 – 1400 m), extending from Nagova Spur up to Madyan in the north, represented by the, "Sub Humid Sub-Tropical Region". 3) Upper Swat, altitudinal ranges generally exceeding 1200m in the side valleys and 1400m across the River Swat, represented by the, "Moist Temperate Region" and 3) Swat Kohistan (1500-6000m) extending from Shagram to the high mountain Hindu Kush ranges in the north, represented mostly by the, " Sub humid to Dry Temperate Region".
- For Agriculture seven agroecological zones were recognized for the catchment on the basis of the agricultural landuse, cropping pattern and the geo-climatic conditions. The zones along with their altitudinal ranges and landuse pattern as 1) Sub tropical with altitude 600-1000M, 2) Humid Temperate with altitude1000-1500M, 3) Cool temperate with altitude1500-1900M, 4) Cold temperate with altitude1900-2300M, 5) Sub-alpine with altitude 2300-3600M 6) Alpine with altitude3600-4600M, and 7) Cold Desert with altitude4600-6000M.
- While River Swat was divided into four zones as 1) Deep water zone, Shallow Water zone, Marsh zone and flood plain zone.
- The direct and indirect role of man as an ecological factor in affecting the River Swat and its tributaries with special reference to water pollution, habitat loss, illegal fishing, depletion of recharge sources and biodiversity degradation is also elaborated. Fish fauna of the area is represented by 19 species, which are

exposed to excessive fishing, dynamiting, poisoning and electrocution. Birds were divided into 24 resident and 27 migratory species. Both the faunal and floral, biodiversity is under ecological stress in the catchment; particularly the wild mammals, birds and a number of plant species. An appendix of 235 plant species belonging to 85 families, their local and scientific names along with their economic uses, were studied. To safeguard the River Swat watershed they recommended social mobilization, environmental Awareness, wise management and conservation of natural resources, pollution control, population control and massive plantation.

- **Pakistan Council of Research in Water Resources (PCRWR), GOP, 2002**, conducted a comprehensive study for water quality in Major Cities of Pakistan. Where three cities of NWFP (Mingora, Mardan and Peshawar) were also monitored. The various parameters studied include Conductivity, pH, Turbidity, TDS, Alkalinity, Carbonate, Bicarbonate, Calcium, Hardness, Chloride, Fluoride, Nitrate (N), Phosphate, Sulfate, Arsenic, Chromium, , Iron, Magnesium, Potassium, Sodium, , Total Coliform. The water quality of Mingora was found within the permissible limits.But some parameters, such as Nitrates and Coliform were found toward increase, and need attention.
- **Nafees 2004** studied Kabul River and its tributaries in NWFP, Pakistan. According to him River Swat was comparatively clean when compared with Adzai, Naguman and Shalam. The only problem observed was suspended load, which was because of heavy deforestation and irregular mining.

3.7 Tourism

- **Haroon, 1999**, studied tourism in Mountains areas of Pakistan. He highlighted the importance of tourism in rising living standard and achievement of sustainable development. As tourism poses negative impacts on environment, therefore it is required to work on the concept of ecotourism and address economic, environment and cultural values of the area.
- **Zulfiqar , 2002,** analyzed increasing trend in tourism. In comparison with 1997 an increase of fourteen percent was observed in 1998. The study reveled that the trend of increase and decrease remained un-even and emphasis on strategies to make it sustainable. Seven countries were identified including UK, India, USA, Japan, Germany, Canada and Saudi Arab form where Pakistan receiving about seventy five percent tourist. As tourism is among the top tem in the list of income generating activities and need proper attention to make it a regulate source of foreign exchange.
- **Haroon, 2002**, worked on the concept of ecotourism and its application in Pakistan and supported the definition given by Divid Barkin in 1996. To work under this definition, involvement of local community comes on top priority. Therefore to encourage tourism a comprehensive strategy is required to incorporate different required facilities, suitable accommodation, job security and respect cultural values.
- **Nadir 2002**, studied Abbotabad District to formulate eco-tourism program in the light of Pakistan National Conservation Strategy (PNCS) and NWFP Sarhad Provincial Conservation Strategy (NWFP-

SPCS). Where five places were identified for tourism attraction, including Abbotabad town, Thandiani, Nathiagali, Dongagali and Ayobia. These places are already in use for tourism, especially in summer season. Where per year the number of tourist ranging from 19000 to 7100. The number of foreigners was found toward declined while that of Pakistani National is toward increase. Various negative environmental impacts identified as, Pollution because of biodegradable and non-biodegradable waste, un-controlled development, deforestation and erosion and wildlife disturbance. Jin their recommendation includes, preparing eco-tourism policy, comprehensive code of practices, legislations, training and awareness.

- **Haroon, and Niazi, 2002,** working on Ecotourism, presented a picture of Pakistan in South Asian prospective. According to them Pakistan has got a good number of mountains, painted with greenery. These were never used for proper tourism. Degradation in the form of soil erosion and deforestation attributed to population pressure increasing poverty and over grazing are continued, which have negative impacts on bio-diversity. To control these degradations, proper planned tourism is required.
- **Gurung, 2002** worked on Hamalaya range. He studied various aspects of this range, such as cultural, demographic and ecology and to identify role and importance of national parks and protected areas. As a case study Annapurna, Nepal national park was discussed in detail, where conservation measures started in 1986 and presenting itself as a good model. He suggested that this type of model need replication in other parts of Hamalya. He emphasized on public participation in conservation and other developmental activities. These national parks and protected areas can be use to attract tourist as well as protect the ecology.
- **Stephan, 2002,** studied Northern part, especially Chitral area for eco-tourism. According to him eco-tourism as a set of activities than to define it as a separate industry. It is very important and beneficial also to view Ecotourism programming in Mountain areas as a social development initiative, in the new tradition, with a wide variety of oft-assumed but often over looked additional and important values. As the mountain area of NWFP, Pakistan has got various natural gifts, such as glaciers, Mountain peeks, lacks and streams, which attracts tourist. It can be used as an alternative livelihood for the people in the mountain area where job opportunities are limited. The various problems identified as 1) Over grazing, 2) Lack of accessibility, 3) Lack of research to find out the pasture condition, 4) Watering points and lack of palatable species, 5) Lack of awareness in local communities for conservation and sustainable use of pastures, 6) Lack of management skill in local communities. In this way the following are required to encourage eco-tourism in the mountain areas of NWFP, Pakistan: **a**) New methods for community co-management of governance of the Conservancies, **b**) New methods for transparency, accountability and quality control of eco-tourism, **c**) Basic training in small

enterprise management, **d**) Basic training in organizational development, **e**) Basic training in guiding and interpretation, **f**) Improvement of PTDC construction standards, **g**) Appropriate facilities location sitting, **h**) Basic Infrastructure (e.g. hot water) needs, **i**)Tourism sanitation standards training, **j**) Environmental Impact assessment

3.8 Analytical Methods

- **Soltanpour, 1991** worked on nutrients availability and elemental toxicity by using DTPA (diethylene triamine penta acetic acid) extraction method. He suggested this method for calcereous soil usually has high pH values. Later on Florida State University worked on this method. It was concluded that this extraction method appeared suitable for phosphate test and can not be use for calcium and magnesium.
- **Mount, et al, 1995,** worked on method to assess the effect of chemical on arid and semi arid ecosystem and evaluate method for soil analysis. He tried DTPA extraction method to investigate micro nutrients including Iron Manganese, Zinc and copper in soil samples. He also considered it suitable for nickel and cadmium in polluted soil only. In both case a prior calibration of the method was suggested.
- **Szakova et al, 2000,** worked on the extraction efficiency of various extraction methods and compared aqua rigia, acetic acid, nitric acid and DTPA. These methods were tested to analyzed Arsenic, Cadmium, and Zinc. Among these methods acetic acid and DTPA appeared efficient for cadmium. The method of DTPA appeared less efficient for Zinc and Arsenic.
- **Tokalioglu et al 2003,** worked on application of a three stage sequential extraction procedure for the determination of extractable heavy metals (Cadmium, Cobalt, Chromium, Copper, Iron, Manganese, Nickel, Lead and Zinc in highway soils. This procedure provides measurements of extractable metals from media such as acetic acid (0.11 mol L1), hydroxylammonium chloride (0.1 mol L1) and hydrogen peroxide (8.8 mol L1) plus ammonium acetate (1 mol L1), which are exchangeable, reducible and oxidizable metals, respectively. The detection limits of the elements investigated were in the range 0.01- to 0.72-µg/ml for the different extraction stages. This study illustrates the importance of considering metal speciation when assessing the mobility of potentially toxic elements in industrially (especially from traffic) contaminated land.
- **Gavlak et al, 2003** evaluate the DTPA (diethylene triamine pent aaceticacid). This method was found good for Zinc, Copper, Manganese and Iron. When the concentration is above 0.1 mg/kg and is also good for monitoring of nickel, lead and cadmium.
- **Sastre et al 2004**, Applied Sorption and extraction tests to predict the dynamics of the interaction of trace elements in agricultural soils contaminated by a mine tailing accident. Composite soil samples were collected form sandy loam and clay textured soil with three month and 21 months interval after the accident. Four single extractions (0.01 and 1mol l $CaCl_2$; 0.05 mol l EDTA; 0.43 mol l CH COOH) were applied to soil and sludge samples. Results from extraction tests indicated that changes of the trace

element interaction over time depended on the soil pH and on the source of contamination. The CH COOH was recommended as the best test among those studied here to derive conclusions about dynamics pattern because it provided significant desorption yields in most scenarios. Acidic soils with sludge contamination represented the scenarios with the highest risk, while calcareous soils better attenuated contamination. In a longer time scale, the depletion of calcareous components needs to be controlled.

- **Gryschko et al 2004**, evaluated the use of 1M NH_4NO_3 for extraction of micronutrients from soil and was compared with 1M KNO_3 solution. It was recommended that one molar nitric acid is comparatively good, especially to analyze readily plant available trace contents like Cadmium, Zinc, Nickel, Copper and Cobalt.
- **Katrina and David, 2004,** conducted a study to evaluate the applicapability of Mehlech-3 extractent as universal soil extractent. According to them the results for Mehlich Ca, Mg, K and Na were highly correlated with both the ammonium chloride and bicarbonate-K procedure. The Mehlich trace elements, Cu, Zn, Mn and Fe, were also well correlated when compared to DTPA-Cu, Zn, Mn and Fe results, however the Mehlich extractant was 30-50% more efficient in extracting these elements. The Mehlich results for S and B were also well correlated with the KCl-S and hot water tests respectively. The Mehlich No. 3 results for phosphorus were well correlated with the Colwell-P results. The Mehlich No. 3 method however, is not suitable for soils or composts treated with rock phosphate. The levels of arsenic, selenium and lead in soil were below the detection limits, using the Mehlich test. The test can however detect low levels of these elements in compost. Further work is required to correlate these levels with bioavailability.
- **Ishaq, 2004,** studied lower Swat region and analyzed 50 soil samples for texture and major macronutrients. For soil texture he used dry sieve method. While for macronutrients (NO_3, PO_4 and K) Olsen method was followed for extraction. This study was helpful in identification of sample sites in the lower region of River Swat watershed.
- **Amanullah 2004** studied Matta Tahsil for soil fertility. He collected 50 samples macronutrients and texture by following dry sieve method. His study area is mountainous and idnetificaiton of sample point is always difficult. As he used GPS and facilitated this procedure.
- **Ijaz 2004,** studied Tahsil Babuzai, district Swat. In total 50 samples were collected and were tested for texture, pH, E.Cond K, NO_3 and PO_4. This area is the middle part of Swat District situated along River Swat and was found susceptible to erosion. Majority of samples were found deficient in NO_3 and PO_4.
- **Fouzia and Najma, 2005** studied upper Malakand, fall in River Swat watershed. They collected 10 samples and analyzed it for micronutrients. On three samples they tried five methods of extraction namely Aqua Rigia, DTPA, NH_4NO_3 and Mehlich-3. Out of these Mehlich-3 was considered as best and remaining seven samples were extracted by this method.

- **Eva et al, 2005**, studied risks of soil contamination in area where waste materials were used, as fertilizers in neighboring areas of A Coruña (northwest Spain). The study sites were characterized as medium textured soils, with a range of pHs, soil organic content, and cation exchange capacity. The objective of this work was to compare two extraction methods (DTPA and Mehlich-3) to determine micronutrient contents in soils with and without compost additions. DTPA and Mehlich-3 extractions were carried out, and then analyses for Iron, Manganese, Copper, Zinc, Nickel, Chromium, Lead, and Cadmium contents were performed by ICP-AES. Overall, DTPA was less efficient than Mehlich-3 for Fe and Mn extraction. Lead, Ni, and Cd were extracted more effectively by DTPA than by Mehlich-3. In general, the efficiency of the extractants was related to compost addition, a trend that was most apparent for Zn and Cu. Levels of trace metals extracted by DTPA and Mehlich-3 from soils without compost addition were already highly variable, because of traditional farmyard manure and slurry fertilization. Diagnostic criteria for allowable loading limits of heavy metals during compost application should take into account direct measurements of background levels and relevant soil properties such as soil acidity.

3.9 Remarks

The literature survey presented in this chapter describes the state of soil in River Swat watershed. Geology related last study conducted in 2004. All geology related study always covered a small pocket of River Swat watershed. The geological aspects were cleared with the help of geological maps published by geological survey of Pakistan, 2006 (**Chapter II**).

In the field of Agriculture a lot of research work has been done and were collected to the maximum. Recent most study appeared in 2005. No doubt, uses of agrochemicals have been increased, which on one hand helps in increasing production, on the other hand causing environmental problem. Therefore, it is required to have a look on the negative aspects of this activity.

Water related literature survey describes the state of pollution in river Swat. Last study conducted in 2004 was on surface hydrology and sediment load. In remaining study all the time a segment of river Swat water had been studied. It was IUCN and department of environmental Sciences; university of Peshawar conducted a comprehensive study of River Kabul and its tributaries including River Swat in 1994. Nafees conducted this type of study in 2004. Which give a clear comparison of River Swat with other rivers of NWFP.

Tourism related literature shows that it is an important economic activity of our country. River Swat watershed presenting an ideal environment for tourism. But it has got negative impacts on the environment. On the other hand it is a required activity not only to uplift the socio-economic condition of the people, but also to reduce pressure on soil resources. Forest related studied show a regular decrease in forest resources, which is a big threat not only to the people and bio-diversity but also to soil resources. Deforestation accelerates erosion and was a study to identify suitable remedial measures.

For soil analysis a series of methods are available. Direct selection of a method was a problem. Therefore, to identify particular method suitable for the study area, literature survey was conducted. Looking to our resources best possible and suitable most method was adopted for a particular analysis.

Institutional arrangement and social code of conduct always playing an important role in natural resource management. What are the shortcomings was reviewed. In this way a guidelines were identified.

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Chapter IV

Methodology

4.1 Introduction

After literature review, the present study was designed to evaluate the soil resources of River Swat watershed and various conservation measures with the objective to identify ways and means, helpful to uplift the socio-economic conditions of the people of the area. Soil study has got various aspects, varies geographically as well as temporally along the entire stretch of River Swat. These include climate and anthropogenic interference with the river system. This chapter describes the procedures followed for the study of all various possible aspects like agriculture and other socio economic activities identified in River Swat System. The study was divided into fieldwork and laboratory work. Fieldwork comprise socio-economic survey and to identify sample site for Laboratory analysis. The farmer was to analyze the situation along the river's bank and the later was to analyze various physical and chemical characteristics of soil. In support of laboratory work, detail questionnaire survey was carried out and various related institutions were visited and interviewed.

For investigating the soil quality its possible impacts on agriculture, human being and other biological life, 212 soil sample were collected from 100 different villages (**Table 4.1, Map. 4.1**) and analyzed for different physical and chemical parameters.

4.2 Social and Participatory Rural Appraisal (PRA) Survey

During sample collection, farmers were consulted to get information about the particular use of soil for some specific crops etc. For this purpose a questionnaire scheduled was prepared and was filled from the farmer (**Section H, Annexure-A**).

To identify uses of soil and evaluate pressure on soil resources, survey was conducted in 50 selected villages (**Map 4.3**). The method and techniques used include, questionnaire and interview schedule, library survey, historical survey and PRA Techniques.

PRA survey was conducted among the people of different age groups and profession. That includes farmer actually working in the field, old age people who are no more involved in agriculture but remained in touch with agriculture activities for a long time and college going students. Various techniques used include Matrix, Time Line, Transit Walk, and Seasonal calendar (**Bishnu, 2003 & Ababa, 1999**). The results are presented in table E.11.

During the study various concerned department were also visited, that include Soil Conservation Department, Forest Department, Agriculture Department, WAPDA, Fisheries Department, and Offices of District Council/Union Council. The various NGOs visited include Hujra Swat, IUCN, Swat, WWF Swat and EPS Swat. The idea behind these meeting was to come across various activities of both governmental and NGOs related to environmental protection and resource conservation, particularly soil resources. For this purpose semi-structured interview technique was used. Various shops dealing with agrochemicals (Fertilizer and Pesticides) were visited and the owners were interviewed to know about the status of fertilizer and insecticides uses. Information collected from these interviews were used to cross check the information collected from the farmers in the field.

4.3 Sample Size Statistics

During sample collection, questionnaires were filled from the owner of the land at the sample site. After the analysis of 212 questionnaires, 50 villages were short listed (**Map 4.2**) and questionnaire survey was conducted in these villages, which is 24% of the sample collected for Laboratory analysis. .

The criteria for number of respondents selected was aimed to cover at least 10-15% of the households. Besides, to identify respondents, selective method purposive Sampling **(Zari, 1987)** was used. In this way those farmers were selected having experience of a types of soil, such as *Shoulgar* (irrigated), *Jewardara* (semi-irrigated) and *Daman* (rain-fed). The selected respondents were 25% of the total work force of the area (**Table-E-10**). River Swat covers 12% of the area in upper Swat (mountains), 53% middle Swat (wet area) and 36% in the lower swat (dry plain). The sample size was kept round about in this respective share.

4.4 Soil Sampling

4.4.1 Identification of Sample points

Prior to sample collection the whole area, from Kalam to Totakan was visited twice. During these visits major land types and sampling points were selected. The criteria adopted for site selection was, that sample should cover maximum area, must be accessible and representative (**Map 4.1, Table 4.1**).

4.4.2 Collection and storage

A systematic composite soil samples from top up to 30 cm depth were collected from selected field before sowing of crop (**William, 1998**). For this purpose the months of June and July 2005 (summer season), and November, December 2005 (winter season) were selected. As Kalam area is not accessible in winter and hence was sampled in summer only. In the remaining area an attempt was made to sample half of an area in summer and half in winter.

In each agriculture field, four points were selected for sample collection. These samples were then mixed in a plastic basket. For detail Physico-chemical analysis a representative portion (2-3 Kg) was packed in plastic bag. Generally soil in River Swat watershed is divided into three categories, *Shoulgar*, *Jewardara* and *Daman*[1]. In this way from each selected village three samples were collected separately. Each sample, after collection was properly labeled along with name of the village, and longitude and latitudes. Samples were dried at room temperature and were stored in Plastic bottles (**Vandre, 2001**). Detail of sample is given in table 4.1 and shown on the map (**Map. 4.1 & 4.2**). For each site an introductory proforma was filled in the field (**Annexure -A**)

In total 100 villages were selected for sampling. For initial tests 212 samples were collected and were tested for pH, Electrical conductivity, total water-soluble dissolved contents, and texture. Out of 212 collected samples, 63 samples (representing 27 villages) were short listed for determination of major and minor cations and anions. The cations studied include, Na, K, Ca, Fe, Cu, Mo, Zn, Ni, and Cd, while anions includes, NO_3, SO_4, Cl, CO_3, HCO_3 and PO_4.

4.4.3 Sample Size Statistics

For a representative sample an attempt was made to select the most accessible site and to cover almost all type of soil. In total there are about 200 villages out of which 100 were selected for initial tests. In this way 50% of the villages were covered. The total number of samples collected (212) covers an area of about 1000 Km^2 which is one sixth of the total River Swat Watershed (6604 Km^2) and 75% of the agriculture land. Looking into the proportional aspects, 12% come in mountainous area and 52% in the Midde Swat (30% & 22% North and south Bank

[1] Shoulgar is irrigated land where water is available through out the year and the farmer has got option to grow maize crop or rice, jewardara is also irrigated land but water availability is limited and maize crop is possible only along with wheat crop. While Daman is rain fed area and only wheat crop is possible.

of River Swat respectively). This is in comparison with their promotional area contributing to River Swat Watershed (**Map-2.1**).

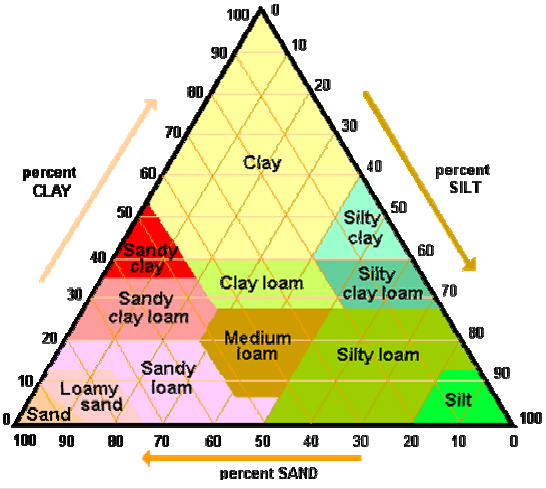
All the collected samples were analyzed for texture, pH, Conductivity and Water Soluble contents. For detail analysis, 63 samples were short listed, which is 30% of the whole lot (212) and 27% of the selected villages (100). The areas covered by these samples are 475 Km^2, which is 10% of the agriculture land. Proportionate composition come out as 15% in upper Swat, 50% in middle Swat and 35% in the lower Swat (Upper Mallakand and Lower Dir) (**Map2.2**).

4.5 Physical Parameters

4.5.1 Soil Texture

Soil texture was tested in the field by feel method (**Plaster, 1992**), which was latter on conformed in the laboratory. For clay and silt wet method (pipit gravimetric method) and for sand dry sieve method was followed (**Rowell, 1994 and Kettler *et al,* 2001**). Different sand particles were with the help of automatic electric sieve shaker. Four sieves of different mesh size were used, includes 2mm (very coarse) 1mm (coarse) 0.5mm (medium coarse), 0.25mm (fine), mesh sizes were used.

Fig: - 4.1. Soil Texture classification Triangle



For classification, the procedure adopted by United States Department of Agriculture was used as a reference (**Table 4.2**). (**Brady, 1984 and Saxton, 1986**). Before shaking the sample was grind gently and was dried in oven at 50 ^oC overnight and was placed in a dessicator to cool. Sample was placed on the upper sieve and the shaker was run for two hours at various vibration modes. After shaking, different soil fraction were collected from different sieves, weighed and the percentage contents were calculated. The soil texture class was identified with the help of using soil texture triangle (**Fig-4.1**).

4.5.2 Soil bulk density

A cylindrical steel core cutter, 75 mm long and 75 mm internal diameter with wall thickness approximately 3 mm, was used for sample collection. The core was inserted in soil

through a hammer. To avoid moisture loss the soil filled core was wrapped in plastic and was brought to the laboratory. The core was weighed and was placed in oven at 105°C for 24 hours. Cooled to room temperature in desiccator and was weighed again. After calculating the internal volume, bulk density was calculated as below (**NRC, 2005**).

Bulk Density (g/cm^3) = Mass of Dry Soil (g)/Volume of Core (cm^3)

4.5.3 Moisture Contents

Oven dry method (section 4.7 bulk Density) was used for calculation of moisture contents in soil. The moisture content (%) was calculated from the sample weight before and after drying it in oven at 105°C for 24 hours and was found out along with bulk density by applying the following formula. (**NRCS, 2005**)

$$\text{Moisture contents} = \frac{\text{Wet waight - Dry waight}}{\text{Dry Weigth}} \text{ x } 100$$

4.5.4 Soil Slope

Soil slope was measured in 35 villages for 76 samples. Two types of techniques were used for slope estimation i.e. field observation and Google Earth facility. In field observation a particular field was measured along the direction of water flow and an average slope was calculated. For mountainous agriculture land Global Positioning System (GPS) **Magellan color trak, Made in USA** was also used. In the second method the Google Earth facilities were utilized for slope calculation. GPS data (height from the Sea level) taken in the field was compared with that of Google Earth. For distance measurement, measuring tool menu of the Google Earth was used.

4.5.5 Electrical Conductivity and Dissolve Contents

Electrical conductivity and dissolved contents were measured with the help of portable conductivity meter; model Jenway-470, Japan in the field as well as in the laboratory. In both cases 1:1 soil-water suspension was prepared (**Rayment, et al 1992**). In the field soil sample was weighed through spring balance while water was measured in calibrated plastic cylinder. The

mixture was shacked mechanically. In the laboratory 1:1 soil water suspension was prepared by weighing soil sample using electronic balance.

50-gram air dried sample was taken and 50 ml de-ionized distilled water was added to it and was shacked at 15 rpm with the help of shaker for one hour. Conductivity meter was calibrated according to the manufactures instruction using KCl reference solution. Electrical conductivity of 0.01 M KCl reference solution and sample was measured at the same temperature. Before each reading the meter was rinsed three to four times with de-ionized water.

4.5.6 Soil pH

Soil pH was also measured in the field as well as in the laboratory using pH meter model Jenway-350, Japan. A suspension of 1:1 soil: water was prepared (**Cong, 2005**) by adding 50 g air-dry soil (<2 mm) into a beaker with 50 ml de-ionized water. The suspension was shaken mechanically shake for 1 hour at 15 rpm.

pH meter calibrated according to manufacturer's instructions using the buffer at pH 4.00-6.00 and 9.00 – 10.00 buffer depending on the expected values for the soils. pH value was obtained when the equilibrium was reached while stirring with a mechanical stirrer **(Rayment, et al 1992)**.

4.6 Chemical Parameters

4.6.1 Soil Organics

The organic matter was measure indirectly by measuring oxidizable organic carbon by Walkely-Black method (**Schulte, 1995**). 10ml of potassium di-chromate (0.167M) along with 20ml concentrated sulfuric acid (96%) were added to a 2gms air dried soil sample. The solution was withhold for thirty minutes and diluted to 150ml by adding de-ionized distilled water. To avoid the interference of Fe^{+3} the solution was treated with treated with 10 ml of H_3PO_4 (85%) and 0.2gms of sodium fluoride. This was titrated with against ferrous ammonium sulfate (0.5M) in the presence of ferrion indicator. For accuracy blank was run every time. The following equation was used for calculation of organic carbon.

$$\%C = \frac{(B\text{-}S) \times M \text{ of } Fe^{2+} \times 12 \times 100}{g \text{ of soil} \times 4000}$$

Where B= ml of FAS solution used to titrate blank
S= ml of FAS solution to titrate sample
12/4000 = milli equivalent weight in grams

The following equation was used to convert total organic carbon to organic matter.

$$\% \textit{ Organic Matter} = \frac{\% \text{ total C x } 1.72}{0.58}$$

4.6.2 Anions

4.6.2.1 Nitrate

Nitrate was determined in 63 selected samples. As nitrogen is the difficult parameter to analyze and interpret, due to the reason that major portion of soil nitrogen may be present in the soil organic matter (OM). Availability of organic N is dependent on OM breakdown, which is difficult to estimate (**Walworth, 2002**). Because of this, different methods are in use. As the Soil in the River Swat watershed is poor in organic matter, therefore, in-organic nitrogen was determined using the following procedure (**Bremner, 1965 and Hernan et al, 2000**)

The extraction of nitrates was carried out on moist soil for most soil tests, as air-drying may result in large changes to the extraction of nitrate concentrations (**Hernan et al 2000**). Nitrate was extracted with 0.01 M $CuSO_4$ containing Ag_2SO_4. A clear soil extract was obtained by using $CuSO_4$, $Ca(OH)_2$ and $MgCO_3$. Chloride interference was prevented by the use of Ag_2SO_4. Nitrate was determined colorimetrically by the nitrophenoldisulfonic yellow color method. The absorbance was measured at 450 nm using Hitachi-U-1100, spectrometer Japan.

4.6.2.2 Phosphate

Phosphate was extracted with Bray No 1 method. The extractant used was mixture of Ammonium Fluoride A.R. (NH_4F, 22.2 g) and 5 ml concentrated HCl, diluted to 2L solution. The extracted phosphorus was measured on spectrophotometer based on the reaction with ammonium molybdate and development of the 'Molybdenum Blue' colour. The absorbance was measured at 882 nm (**Menage, 1973**) using spectrophotometer model Hitachi-1100, Japan.

4.6.2.3 Chloride (Extraction)

For chloride extraction 0.01M solution of calcium nitrate was used. To a 12gms air dried sample 25gms of activated carbon in the presence of 30ml calcium nitrate and was stirred for about 30 minutes. The extract was filtered and analyzed titramatically by using argantometric method and titrated against standard silver nitrate solution (0.0147N) (**Gelderman et al, 1998**).

4.6.2.4 Sulfate

For sulfate Tubidimetric method was used. Soil sample was extracted with acidified 0.5 M Ammonium acetate (39 g of Ammonium acetate in one L of 0.25 M Acetic Acid). Turbidity was produce by adding Barium Chloride ($BaCl_2$) and was measured on spectrophotometer at 420 nm (**Robinder et al, 1995**). The concentration was evaluated by comparing with that of the standard prepared from Potassium Sulfate (K_2SO_4)

4.6.3 Major Cations (Heavy metals and Micronutrients)

Heavy metals were determined in 63 samples using Mehlich-3 methods (**1984**) as described below. While for 10 sample of different texture five different methods were tried, with the objective to find out correlation between different methods and soil texture and suggest best possible method for the soil analysis in the project area.

4.6.3.1 Extraction with Mehlich-3

Mehlich-3 is a solution of five different chemical with a particular ratio (0.2N CH_3COOH + 0.25N $NH4NO_3$ + 0.015N NH_4F + 0.013N HNO_3 + 0.001M EDTA).

To a 2 grams soil, 20 ml of Mehloch-3 solution was added and was agitated for five minutes at 25-39^oC temperatures. The sample was filtered through a watman-42 filter paper. The sample after extraction was analyzed for selected metals ions using atomic absorption spectrophotometers (Perkin Elmer Model Aanalyst700 USA made (**Mylavarapu and Kennelley, 2002**).

4.6.3.2 Extraction with Ammonium Acetate

In this method 1M Ammonium acetate solution was used as extractant. To 5 grams sieved sample, 125 ml of 1M Ammonium acetate solution was added and extracted as per standard procedure (**Slingsby, 2005**).

4.6.3.3 Extraction with Aqua Regia

3 g of the sample was weighed into a 250 ml reaction vessel, moisturized by a small amount of de-ionized water and mixed with 21 ml of concentrated HCl and 7 ml of concentrated HNO_3. After a 16 hours equilibration at 20 °C (mostly over night) the samples were heated for 2 hours under reflux. The mixture was cooled down and the reflux was rinsed using diluted HNO_3.

The sample was filtered in a 100 ml volumetric flask. The flask was filled up to 100ml mark with dilute $HNO_3$and kept until measurement (**Szakova, et al 2000**).

4.6.3.4 Extraction with Diethylene-Triamine-Pentaacetic acid (DTPA)

The DTPA (0.005M) extraction solution was prepared by dissolving 1.967 grams of DTPA in 14.92 grams of Tri Ethanol Amine (TEA) in one liter distilled water to which 1.469 grams of $CaCl_2$.$2H_2O$ (0.01M) was added. The pH was adjusted to 7.3 ± 0.05 by using 1.0 N HCl.
10 grams air-dried sample was taken in 120 ml vessel to which 20 ml DTPA extracting solution was added. Agitated for 2 hours with the help of mechanical shaker, filtered and analyzed using atomic absorption method (**Gavlak et al, 2003**).

4.7 Analysis For Organochlorine Pesticides and PCBs In Soil

Pesticides were determined in 10 different soil samples using the following procedure. Twenty five gram soil sample was extracted with acetone followed by hexane, by allowing soaking one hour in each with intermittent shaking. The combined extract was centrifuged and decanted into a separatory funnel containing sufficient water to facilitate partitioning of residues into hexane portion. The hexane mixture was washed twice with water and concentrated to appropriate volume and was passed through a 1.6g Florisil mini-column topped with 1.6g sodium sulfate. Residues were eluted from the column in two elution fractions. Fraction I consists of 12 ml hexane followed by 12 ml of 1% methanol in hexane, and Fraction II consists of an additional 24 ml of 1% methanol in hexane. For additional cleaning to separate PCBs from other organochlorines in Fraction I, further purification on a Silicic acid column was carried out (**Anon, 2005 and Craig, 1998**). Pesticide residue was quantified by using capillary column using GC-ECD on Shimadzu, model GC-14A, Japan (**Rasul et al 2000**)

4.8 River Swat Suspended load

Soil erosion was estimated indirectly and water samples of River Swat were analyzed for suspended load. For this purpose Chakdara bridge was end point of River Swat was selected. Three samples per month were taken for one year. For this purpose flow data of Chakdara was taken form WAPDA, Lahore office.

4.9 Remote Sensing and GIS

For remote sensing, satellite images (**Map-G.1**) were acquired form Forest Management Center, Peshawar (FMC), Falling Rain Genomics (**Map-2.2**) and Google earth (**Map-2.3**) web sits. The data was utilized for visual interpretation for vegetation, slope detection, topography and preparation of maps. Apart from this, ground photography was also used to get first hand information. For positioning GPS was used. The data from GPS was later on compared with toposheet received from survey of Pakistan and the facilities offered by Google earth.

Forest data was acquired from Forest department, Peshawar in Arc/View format, which was presented as such. For other parameter such as thematic maps for sample sites and various soil quality parameters, IDRISI was used. For which the satellite image of JPG format received form Falling Rain Genomics web site was used as base image.

As the images were in parts for which IP-Photo+ was used to prepare a mosaic of the study area.

4.10 Preparation of Land capability map

Satellite Images (Landsat-TM) having 30 meters spatial resolution (**Map. G.1**), along with field survey was used for the preparation of land capability map for which help was taken from published toposheets (1985) of survey of Pakistan. Satellite Images (Landsat-TM) having 30 meters spatial resolution (Fig.1) was used as a base image to identify boundary line of Swat Valley, differentiate mountainous and plain area by visual interpretation (**Lee, *et al* 2001**). For field coordinate identification GPS (Magellan colourTRAK, USA Made) was used. The geo-referenced image was crosschecked with that of Google Earth Facility. The satellite image was geo-referenced in ILWIS 3.2. Land capability map was developed in Arc/View 3.1 version by using menu “event Theme” and was exported as joint photographic exerts group (JPEG also written as JPG) format. Three criteria were used i.e. i) slope, ii) texture, and iii) moisture and availability of water for irrigation. Interview and Participatory Rural Appraisal (PRA) techniques were utilized to evaluate suitability of an area for agro forestry and also to evaluate the land capability map. Data from farmer (892 in number) was collected with the help of interview and group meetings, mostly using PRA techniques. Departments like Agriculture extension program and Forest Department were visited and the concerned staff members were interviewed.

4.11 Data Analysis and Report Writing

For tabular data analysis Microsoft excel was used, while for report writing Microsoft word and Acrobat-5 was used. For arrangement of Picture and presentation Microsoft PowerPoint was used.

Table 4.2 Sample sits with Lat long (DMS), Altitude (M) and approximate Population

S No	Village	Lat (DMS	Long (DMS)	Altitude (Feet)	Date of Sampling	
					2005	2006
1	Kalam	35° 28' 59.62N	72° 35' 58.33E	6460	15-Jun	16-Jun
2	Pashmal	35° 25' 59.04N	72° 35' 59.22E	6421	15-Jun	16-Jun
3	Asharopatai	35° 25' 04.74N	72° 36' 31.34E	6080	15-Jun	16-Jun
4	Laikot	35° 24' 14.55N	72° 36' 15.26E	6017	16-Jun	16-Jun
5	Asrit	35° 21' 44.67N	72° 35' 59.93E	5978	16-Jun	16-Jun
6	Mankial	35° 19' 01.22N	72° 36' 08.34E	5433	16-Jun	16-Jun
7	Kedam	35° 15' 19.84N	72° 35' 24.93E	5099	16-Jun	17-Jun
8	Bahrain	35° 12' 29.35N	72° 32' 59.76E	5771	16-Jun	17-Jun
9	Satal	35° 11' 05.63N	72° 30' 55.24E	5296	16-Jun	1-Jun
10	Madyan	35° 08' 45.83N	72° 31' 54.76E	5328	17-Jun	17-Jun
11	Jare	35° 05' 54.95N	72° 30' 04.67E	4173	17-Jun	18-Jun
12	Fatepur	35° 04' 10.21N	72° 29' 09.86E	4065	17-Jun	18-Jun
13	Darmai	35° 04' 54.63N	72° 26' 39.63E	4570	18-Jun	18-Jun
14	Sakhra	35° 04' 40.55N	72° 24' 45.52E	4800	18-Jun	18-Jun
15	Bagh Dheri	35° 02' 54.88N	72° 26' 49.53E	4731	18-Jun	18-Jun
16	Asharai	35° 01' 11.16N	72° 27' 40.64E	3753	19-Jun	19-Jun
17	Dursh Khela	35° 04' 41.33N	72° 26' 55.82E	3822	19-Jun	19-Jun
18	Sambat	34° 55' 59.45N	72° 25' 60.43E	3429	20-Jun	20-Jun
19	Shokhdara	34° 51' 57.55N	72° 25' 01.54E	3199	20-Jun	20-Jun
20	Wainai	34° 58' 11.35N	72° 20' 59.66E	4039	21-Jun	21-Jun
21	Chuprial	34° 58' 59.55N	72° 21' 58.27E	4147	21-Jun	21-Jun
22	Changialai	35° 01' 48.94N	72° 20' 24.85E	4223	21-Jun	21-Jun
23	Gwalarai	35° 03' 14.22N	72° 19' 15.26E	4567	22-Jun	22-Jun
24	Roringar	35° 04' 24.68N	72° 19' 19.52E	5391	22-Jun	22-Jun
25	Fazal Banad	35° 04' 11.57N	72° 16' 19.75E	5506	2-Jul	3-Jul
26	Sarkarai	34° 58' 29.27N	72° 15' 01.77E	4912	3-Jul	3-Jul
27	Kalagai	34° 55' 44.25N	72° 22' 45.22E	3586	3-Jul	3-Jul
28	Shairpalam	34° 53' 59.36N	72° 25' 01.68E	3350	4-Jul	3-Jul
29	Shakar Dara	34° 51' 01.93N	72° 24' 01.25E	3235	4-Jul	4-Jul
30	Ningulai	34° 51' 01.22N	72° 25' 01.17E	3199	5-Jul	4-Jul
31	Bara & Kuza Bandai	34° 49' 01.66N	72° 22' 59.32E	3120	5-Jul	5-Jul

Table 4.2 Continue

S No	Village	Lat (DMS	Long (DMS)	Altitude (Feet)	Date of Sampling	
					2005	2006
32	Sigram	34° 52' 01.38N	72° 20' 59.53E	3819	5-Jul	5-Jul
33	Kanju	34° 47' 59.74N	72° 19' 59.62E	2858	5-Jul	5-Jul
34	Kala	34° 50' 01.83N	72° 16' 29.78E	3396	5-Jul	6-Jul
35	Deolai	34° 52' 01.76N	72° 15' 00.32E	3458	8-Jul	6-Jul
36	Tal	34° 55' 00.55N	72° 13' 01.63E	4219	8-Jul	7-Jul
37	Tutano Banda	34° 50' 01.54N	72° 13' 59.46E	3491	8-Jul	7-Jul
38	Sarsanai	34° 49' 00.67N	72° 16' 59.44E	3058	17-Dec	20-Dec
39	Gul Jaba	34° 47' 58.92N	72° 17' 30.33E	2871	17-Dec	20-Dec
40	Kabbal	34° 46' 59.44N	72° 16' 59.62E	2736	17-Dec	20-Dec
41	Kotlai	34° 47' 15.33N	72° 14' 09.86E	3537	17-Dec	20-Dec
42	Surgalai	34° 45' 29.46N	72° 13' 10.34E	3320	17-Dec	20-Dec
43	Parrai	34° 42' 20.42N	72° 13' 49.86E	2585	17-Dec	20-Dec
44	Nagwa	34° 41' 49.57N	72° 12' 09.74E	2523	17-Dec	20-Dec
45	Dedawar	34° 40' 54.79N	72° 10' 11.86E	2464	17-Dec	20-Dec
46	Tirang	34° 40' 49.82N	72° 8' 34.75E	2438	17-Dec	20-Dec
47	Chongai	34° 40' 31.47N	72° 7' 19.55E	2421	17-Dec	20-Dec
48	Sarai	35° 03' 54.44N	72° 30' 49.76E	5059	26-Jul	28-Jul
49	Miandam	35° 03' 05.12N	72° 33' 39.84E	6152	26-Jul	28-Jul
50	Shin	35° 01' 34.44N	72° 28' 29.54E	4177	26-Jul	28-Jul
51	Kotanai	34° 58' 44.52N	72° 27' 29.71E	3747	26-Jul	28-Jul
52	Chalyar	34° 56' 01.83N	72° 29' 01.74E	3717	26-Jul	28-Jul
53	Khwazakhela	34° 55' 59.56N	72° 28' 01.43E	3658	26-Jul	28-Jul
54	Gulibagh	34° 51' 01.89N	72° 25' 59.77E	3330	20-Dec	21-Dec
55	Dakorak	34° 50' 01.97N	72° 25' 59.81E	3242	20-Dec	21-Dec
56	Charbagh	34° 49' 59.83N	72° 25' 58.93E	3209	20-Dec	21-Dec
57	Tilgram	34° 49' 31.44N	72° 29' 30.52E	3425	20-Dec	21-Dec
58	Manglaur	34° 47' 59.67N	72° 26' 01.78E	3527	26-Jul	29-Jul
59	Dangram	34° 45' 15.23N	72° 24' 29.86E	3452	26-Jul	29-Jul
60	Sangota	34° 46' 59.92N	72° 24' 01.84E	3714	26-Jul	29-Jul
61	Takhtaband	34° 46' 59.65N	72° 18' 01.54E	2894	26-Jul	29-Jul
62	Jambil	34° 43' 15.44N	72° 26' 01.86E	4446	26-Jul	29-Jul
63	Bologram	34° 45' 01.96N	72° 18' 01.89E	2864	26-Jul	29-Jul
64	Gogdara	34° 44' 01.91N	72° 16' 59.87E	2733	18-Dec	23-Dec
65	Pajigram	34° 42' 58.93N	72° 15' 01.76E	2631	18-Dec	23-Dec
66	Ghaligai	34° 42' 01.34N	72° 16' 01.45E	2730	18-Dec	23-Dec
67	Manyar	34° 43' 01.26N	72° 16' 00.75E	2776	18-Dec	23-Dec
68	Barikot	34° 40' 58.76N	72° 13' 59.56E	3035	19-Dec	23-Dec

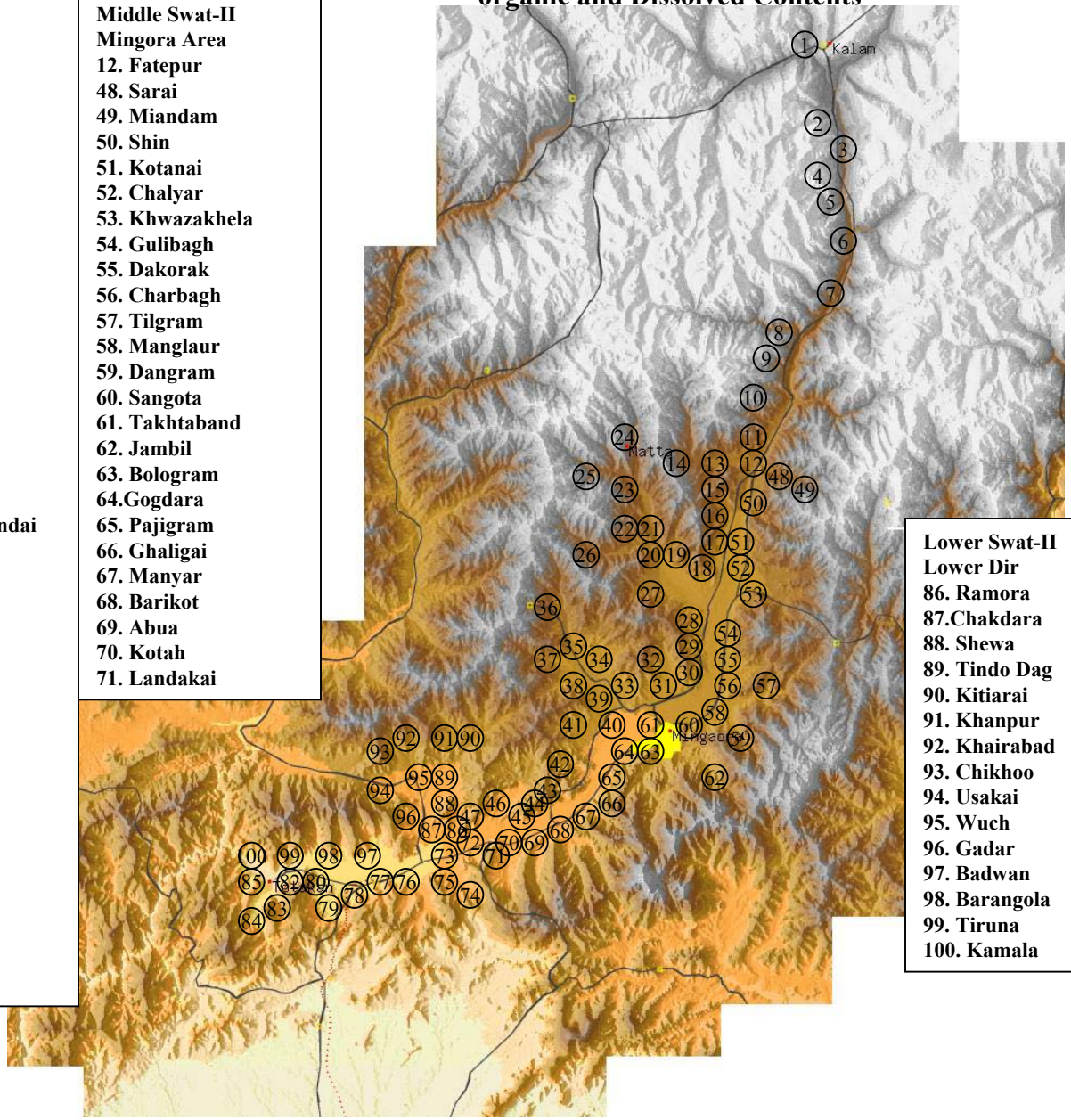
Table 4.2 Continue

S No	Village	Lat (DMS	Long (DMS)	Altitude (Feet)	Date of Sampling	
					2005	2006
69	Abua	34° 39' 41.11N	72° 11' 15.23E	2828	19-Dec	23-Dec
70	Kotah	34° 39' 11.17N	72° 09' 09.94E	2444	19-Dec	23-Dec
71	Landakai	34° 39' 40.34N	72° 08' 41.22E	2421	19-Dec	23-Dec
72	Haibatgram	34° 39' 09.93N	72° 05' 10.14E	2480	24-Jun	23-Jun
73	Thana	34° 37' 59.44N	72° 04' 58.93E	2379	24-Jun	23-Jun
74	Nal	34° 36' 11.45N	72° 06' 41.15E	2730	24-Jun	23-Jun
75	Gunyar	34° 36' 21.13N	72° 03' 39.46E	2864	24-Jun	23-Jun
76	Allahadan	34° 37' 01.24N	72° 01' 58.67E	2346	24-Jun	23-Jun
77	Batkhala	34° 37' 31.63N	71° 58' 17.55E	2339	24-Jun	23-Jun
78	Piran	34° 35' 53.67N	71° 56' 21.15E	2533	21-Dec	27-Dec
79	Rangmala	34° 34' 46.76N	71° 55' 12.67E	2120	21-Dec	27-Dec
80	Jolagram	34° 37' 01.55N	71° 53' 43.28E	2093	21-Dec	27-Dec
81	Matkani	34° 37' 25.78N	71° 51' 01.77E	2015	21-Dec	27-Dec
82	Totakan	34° 37' 04.56N	71° 49' 30.66E	2028	21-Dec	27-Dec
83	Bagh Raji	34° 36' 23.14N	71° 49' 36.78E	2126	21-Dec	27-Dec
84	Makhband	34° 33' 15.35N	71° 49' 40.52E	2152	21-Dec	27-Dec
85	Kalangai	34° 37' 52.44N	71° 48' 03.77E	1923	21-Dec	27-Dec
86	Ramora	34° 39' 01.88N	72° 02' 59.56E	2339	17-Jul	17-Jul
87	Chakdara	34° 38' 59.73N	72° 01' 59.45E	2412	17-Jul	17-Jul
88	Shewa	34° 43' 01.45N	72° 04' 01.33E	2648	17-Jul	17-Jul
89	Tindo Dag	34° 41' 52.75N	72° 02' 58.78E	2454	17-Jul	17-Jul
90	Kitiarai	34° 44' 54.26N	72° 04' 59.22E	2930	17-Jul	17-Jul
91	Khanpur	34° 46' 21.57N	72° 03' 40.76E	3730	17-Jul	17-Jul
92	Khairabad	34° 45' 54.76N	71° 59' 41.29E	3845	17-Jul	17-Jul
93	Chikhoo	34° 44' 01.88N	71° 58' 06.78E	2858	17-Jul	17-Jul
94	Usakai	34° 42' 42.61N	71° 58' 22.45E	2769	22-Dec	28-Dec
95	Wuch	34° 43' 58.44N	72° 01' 01.46E	2720	22-Dec	28-Dec
96	Gadar	34° 40' 59.66N	72° 01' 39.63E	2421	22-Dec	28-Dec
97	Badwan	34° 38' 47.83N	71° 57' 21.57E	2179	22-Dec	28-Dec
98	Mian Barangola	34° 38' 23.76N	71° 55' 31.74E	2142	22-Dec	28-Dec
99	Tiruna	34° 38' 30.73N	71° 51' 24.15E	1910	22-Dec	28-Dec
100	Kamala	34° 38' 06.87N	71° 49' 14.25E	1814	22-Dec	28-Dec

Table 4.2: Size limits (diameter in millimeters) of soil separate in the USDA soil textural classification system.

Name of soil separate	Diameter limits (mm)
Very coarse sand*	2.00 - 1.00
Coarse sand	1.00 - 0.50
Medium sand	0.50 - 0.25
Fine sand	0.25 - 0.10
Very fine sand	0.10 - 0.05
Silt	0.05 - 0.002
Clay	less than 0.002
Source: Soil Survey Division Staff, U.S. Department of Agriculture, 1993	

Map 4.1 Showing Sample Sites Analyzed for Texture, pH, E. Conductivity, B. Density, Soil organic and Dissolved Contents



Middle Swat I
Matta Area
13. Darmai
14. Sakhra
15. Bagh Dheri
16 Asharai
17 Dursh Khela
18. Sambat
19. Shokhdara
20. Wainai
21.Chuprial
22. Changialai
23. Gwalarai
24. Roringar
25. Fazal Banad
26. Sarkarai
27. Kalagai
28. Shairpalam
29. Shakar Dara
30. Ningulai
31. Bara & Kuza Bandai
32. Sigram
Kabbal Area
33. Kanju
34. Kala
35 Dealai
36. Tal
37 Tutano Banda
38. Sarsanai
39. Gul Jaba
40. Kabbal
41. Kotlai
Shamozoo Area
42. Surgalai
43. Parrai
44. Nagwa
45. Dedawar
46. Tirang
47. Chongai

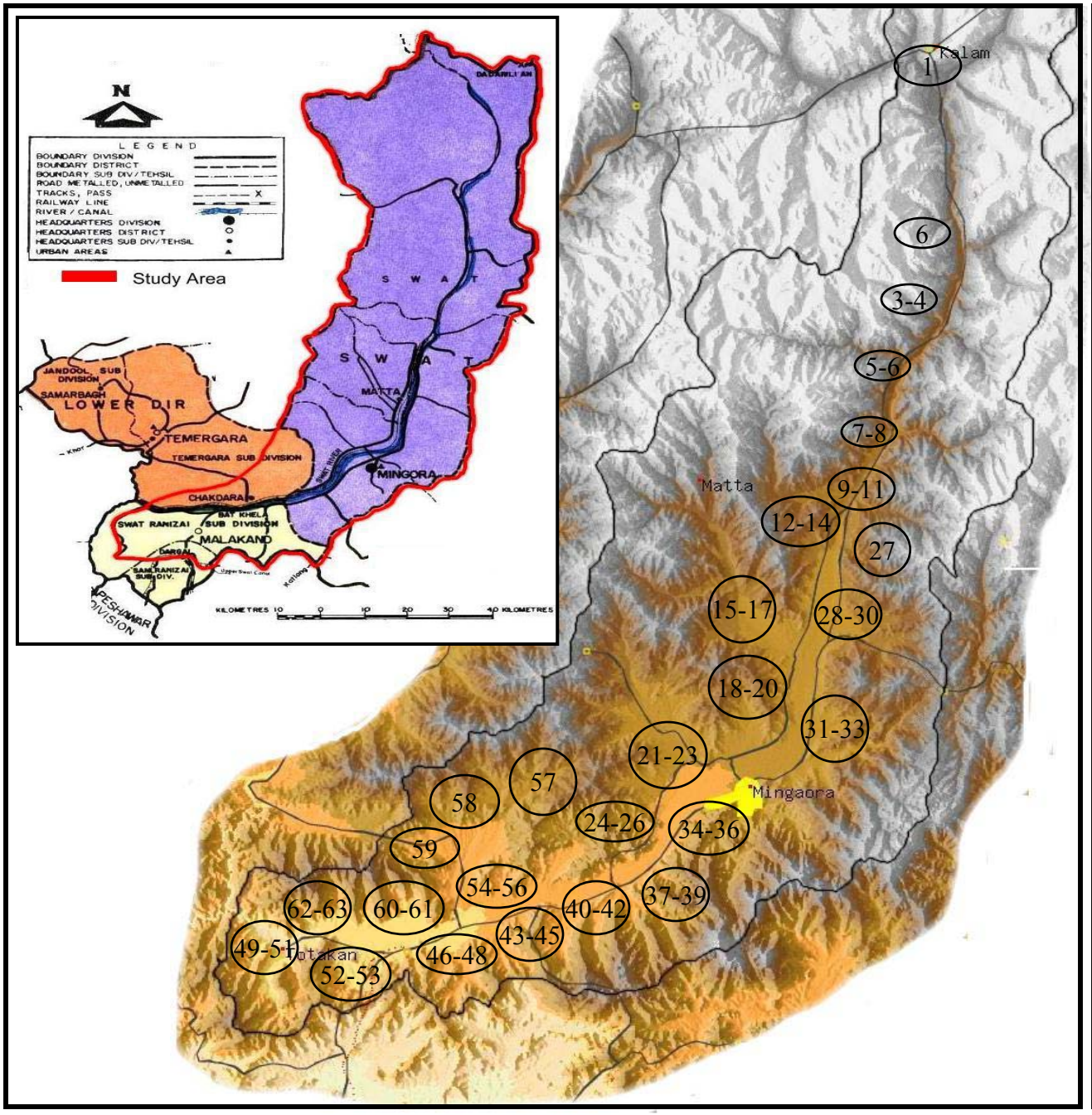
Middle Swat-II
Mingora Area
12. Fatepur
48. Sarai
49. Miandam
50. Shin
51. Kotanai
52. Chalyar
53. Khwazakhela
54. Gulibagh
55. Dakorak
56. Charbagh
57. Tilgram
58. Manglaur
59. Dangram
60. Sangota
61. Takhtaband
62. Jambil
63. Bologram
64.Gogdara
65. Pajigram
66. Ghaligai
67. Manyar
68. Barikot
69. Abua
70. Kotah
71. Landakai

Upper Swat Area
1.Kalam
2. Pashmal
3. Asharopatai
4. Laikot
5. Asrit
6. Mankial
7. Kedam
8. Bahrain
9. Satal
10. Madyan
11. Jare
12 Fatepur

Lower Swat-I
Upper Malakand
72. Haibatgram
73.Thana
74.Nal
75. Gunyar
76. Allahadan
77. Batkhala
78. Piran
79. Rangmala
80. Jolagram
81. Matkani
82. Totakan
83. Bagh Raji
84. Makhband
85. Kalangai

Lower Swat-II
Lower Dir
86. Ramora
87.Chakdara
88. Shewa
89. Tindo Dag
90. Kitiarai
91. Khanpur
92. Khairabad
93. Chikhoo
94. Usakai
95. Wuch
96. Gadar
97. Badwan
98. Barangola
99. Tiruna
100. Kamala

Map 4.2:- Showing Project Area and Sample Points Analysis for Major Anions and Catrions



Upper Swat Area

1 .	Kalam
2.	Mankial
3-4	Bahrain
5-6	Satal
7-8	Madyan
9-11	Fatepur

Middle Swat I
Matta Area

12-14	Bagh Dheri
15-17	Shokhdara
18-20	Shairpalam
21-23	Kabbal
24-26	Dedawar

Middle Swat-II
Mingora Area

9-11	Fatepur
27	Miandam
28-30	Khwazakhela
31-33	Manglaur
34-36	Ghaligai
37-39	Barikot
40-42	Kotah

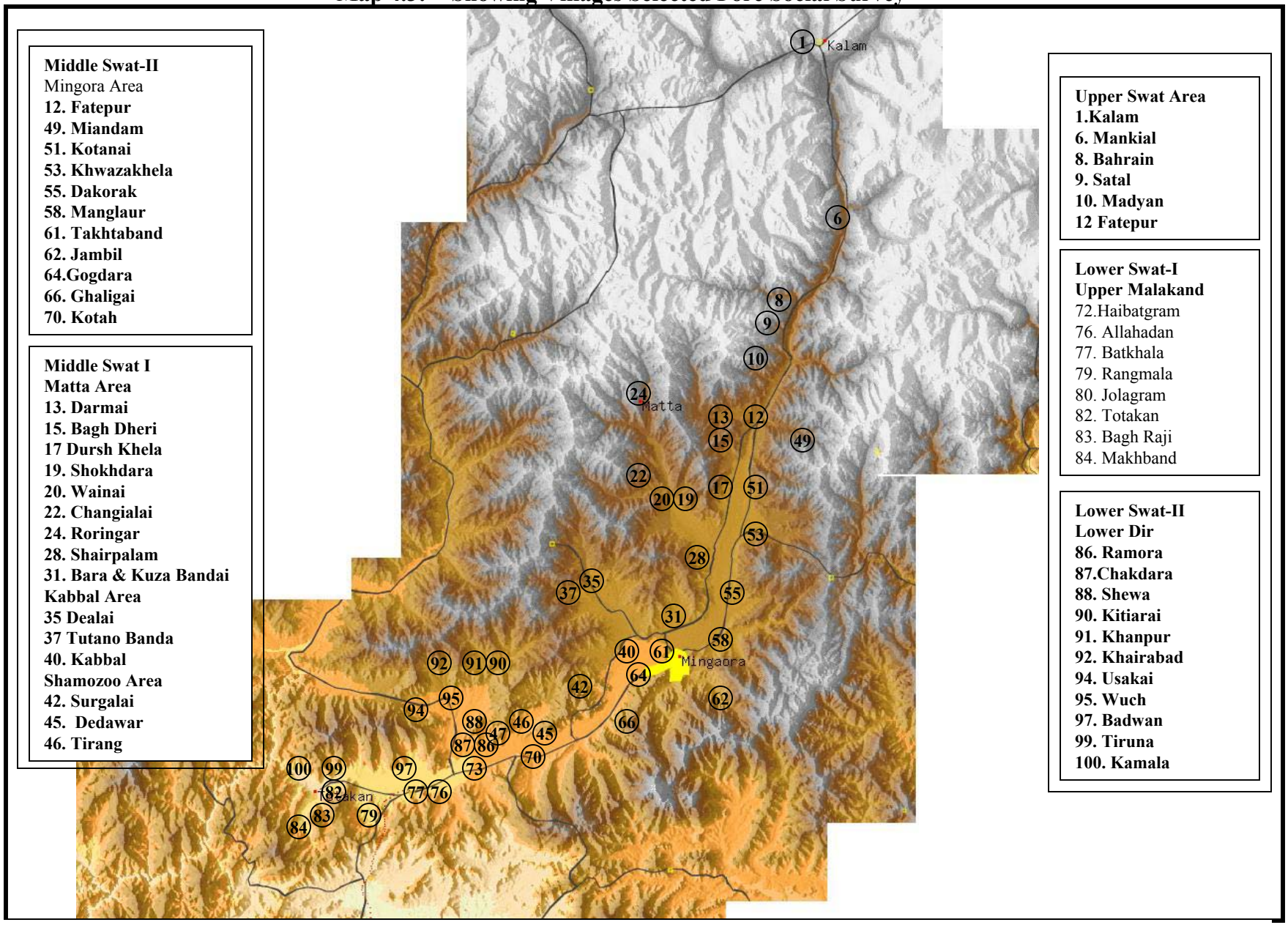
Lower Swat-I
Upper Malakand

43-45	Haibatgram
46-48	Allahadan
29-51	Matkanai
52-53	Makhband

Lower Swat-II
Lower Dir

54-56	**Chakdara**
57	**Kitiarai**
58	**Khairabad**
59	**Usakai**
60-61	**Badwan**
62-63	**Kamala**

Map 4.3:- Showing Villages Selected Fore Social Survey



Middle Swat-II
Mingora Area
12. Fatepur
49. Miandam
51. Kotanai
53. Khwazakhela
55. Dakorak
58. Manglaur
61. Takhtaband
62. Jambil
64.Gogdara
66. Ghaligai
70. Kotah

Middle Swat I
Matta Area
13. Darmai
15. Bagh Dheri
17 Dursh Khela
19. Shokhdara
20. Wainai
22. Changialai
24. Roringar
28. Shairpalam
31. Bara & Kuza Bandai
Kabbal Area
35 Dealai
37 Tutano Banda
40. Kabbal
Shamozoo Area
42. Surgalai
45. Dedawar
46. Tirang

Upper Swat Area
1.Kalam
6. Mankial
8. Bahrain
9. Satal
10. Madyan
12 Fatepur

Lower Swat-I
Upper Malakand
72.Haibatgram
76. Allahadan
77. Batkhala
79. Rangmala
80. Jolagram
82. Totakan
83. Bagh Raji
84. Makhband

Lower Swat-II
Lower Dir
86. Ramora
87.Chakdara
88. Shewa
90. Kitiarai
91. Khanpur
92. Khairabad
94. Usakai
95. Wuch
97. Badwan
99. Tiruna
100. Kamala

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Chapter V
Soil Properties

Soil is an important natural resource. Soil formation is a complex process but very much easy to destroy. Soil degradation is a major concern worldwide. Desertification, erosion, contamination from pollution, and other chemical modification by human activities contribute to reduce soil quality, fertility and productivity (**Montgomery, 2003**). In simple, Soil conservation is maintaining the wealth of its mineral content, essential for maintaining its productivity **(Asif et al 1998)**. For soil conservation it is important to have knowledge of soil type, its physical and chemical nature, vegetation cover and various human activities, institutional and organizational set up as discussed in the chapter VI also. In this chapter an attempt has been made to discuss all possible aspects of physical and chemical nature related to soil conservation.

5.1 Physical Properties

5.1.1 Texture

Soil texture is an important parameter, and playing an important role in soil classification and conservation. It is called the most fundamental soil property, one that most influences other soil traits, is its texture (**Plaster, 1992**).

For this purpose a total of 212 samples were collected from the entire watershed. As mentioned in the previous chapter, dry method was used to separate sand, silt and clay **(Table 5.1 and E.1a-E.1c)**. Looking into the Geology, Physiography (**Chapter –II & III**), natural and accelerated erosion, sand is the dominant feature of all soil types in river Swat watershed. Sand percentage contents decrease down stream River Swat. At Kalam it is high (80%) with only 20% clay and silt (**Table 5.1**). In Lower Dir and Malakand regions it came down to as low as about 28%. Swat watershed is divided into small valleys and sub-valleys. Variation was found inside the valleys also. Near the *Khwar*[1] and flood plain the soil was high in sand contents, some time only sand is there (P**ic-F.8-F.10**). While going away from *Khwar*, on either side an increase was observed in soil thickness with decrease in sand contents.

On the basis of texture the whole watershed can be classified into six major categories, as Loamy sand, sandy loam, sandy clay, sandy clay loam, loam and silt loam. More than seventy

[1] Natural wet/dry water channel

percent the soil was sandy loam (62.26%) and loamy sand (8.01%) (Table. I), and that is why the water holding capacity if the soil is low.

Table-5.1: - Soil texture of selected sample collected form River Swat catchments area.

Region (%age of the total)	Textural Classes	No of Samples	Sand (%)			Silt (%)			Clay (%)		
			Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Upper Swat (8.96%)	Loamy Sand	10	76.28	84.62	80.70	4.40	14.87	10.34	06.96	12.90	8.96
	Sandy Loam	9	59.49	77.61	67.44	7.13	30.36	20.66	06.61	17.90	11.90
Middle Swat Northern side of River Swat (33.96)	Sandy loam	59	54.22	79.92	68.06	4.29	33.37	17.86	05.81	21.64	14.08
	Sandy clay	2	47.49	52.26	49.87	11.39	16.20	13.79	36.32	36.36	36.34
	Sandy clay loam	9	53.43	71.79	64.54	6.11	20.42	13.53	19.32	26.16	21.94
	Loamy sand	2	81.89	84.22	83.05	08.50	08.87	8.68	07.28	9.25	8.26
Middle Swat Southern side of River Swat (30.66)	Sandy clay	2	48.98	52.00	50.49	11.54	14.75	13.14	36.28	36.46	36.37
	Sandy clay loam	6	46.40	69.45	52.86	8.15	38.18	23.27	15.43	27.10	23.87
	Loam	8	34.18	51.81	44.52	32.77	49.13	38.67	10.81	22.05	16.83
	Sandy loam	36	52.61	73.74	61.48	12.12	37.56	25.65	07.11	17.49	12.87
	Loamy sand	5	76.03	78.50	77.06	14.76	17.12	16.16	06.51	07.10	6.78
	Silt loam	8	29.42	43.94	37.68	49.22	57.49	52.90	06.01	13.10	9.43
Lower Swat Northern Side of River Swat (11.79%)	Sandy loam	14	52.66	74.53	61.48	14.22	40.27	24.88	07.08	17.78	13.05
	Loam	6	29.48	48.95	38.90	33.44	47.58	42.07	11.41	24.68	19.03
	Sandy clay loam	5	47.09	50.49	48.69	22.59	27.54	24.08	21.98	31.54	27.22
Lower Swat Southern Side of River Swat (14.63)	Sandy clay loam	3	50.02	58.44	53.31	16.88	28.47	23.08	21.51	24.69	23.61
	Silt loam	2	28.31	34.43	28.87	51.62	52.66	52.14	13.96	24.04	19.00
	Sandy loam	14	53.45	72.76	59.25	10.35	46.08	28.96	07.24	16.90	11.80
	Loam	12	37.72	52.11	45.73	32.72	46.25	38.43	10.05	22.12	15.84

Sandy loam, where the sand percentage ranging between is 50 to 75 %, clay ranges form 10 to 20% and silt 20 to 30%, is the largest class in Swat valley, mostly occupying irrigated land, called *shoulgar* in local language. This is 66% of the total agriculture land. Some *Damani* (rain fed) land also fall in this category, such is Rangmala, Piran, Nul, Gunyar. In these areas 10 percent of the total agriculture land and 40% of irrigated land fall in this category. Loam (also called medium loam) appeared 2nd largest group with 12.26% samples, mostly occupying lower part (Malakand and Lower Dir) and part of southern strip of River Swat. This is the fertile strip with irrigation water, available form River Swat.

Sandy clay loam was found in 10.84% sample. In this way is the third largest group. Most of the area is situated in the Matta side (Northern strip of River Swat) and the surrounding of Mingora (southern strip of River Swat). Other parts include the Kabbal valley where in the surrounding of Tutano Banda sandy clay loam can be found. Middle part of Adenzai Tehsil of Lower dir is also composed of this type of land. On this land usually uses for horticultural.

Loamy sand class appeared 4th in river Swat watershed. A strip of 50 to 300 meters is stretched along the entire length of River Swat. Loamy sand also found in the villages situated in the foothill, such as Landakai where the sand percentage is above 80%. Other areas include part of Lower Dir situated along river Swat. Main villages include, Chakdara, Badwan, Mian-barangola, Tiroona and Kamala, where both irrigated and rain-fed land is of this class.

Other categories with high contents of clay or silt include sandy clay and silt loams are rarely found in the area. This is why the soil is very much susceptible to erosion and land management and soil conservation measures such as agroforestry is required.

5.1.2 Soil Moisture

From conservation point of view, soil moisture is very important to support vegetation (Agriculture and Forest). A germinating seedling needs moisture, temperature and Oxygen to grow through the soil and emerge into air and light. These in turn give support to soil in terms of protection from erosion and storing moisture and other nutrients.

As per results of the soil texture, the moisture holding capacity is low. As observed, after rain/irrigation the soil can remain wet for 2 to 4 days in winter and 1 to 2 days in summer. In Kalam area the soil remains wet through out the year and the moisture contents varies from 7% to 13% (**Table E2a-E.2c**) contributed by climate of the area and soil organic contents. Apart from naturally available moisture, enough water is available for irrigation. In this way from Bahrain onward soil moisture is not a limiting factor. There is a slight change in Bahrain and the land usually remains dry in few months (May-June), while due to sufficient rainfall in the remaining months it is wet. Despite high moisture contents irrigation is required for agriculture crops. As the soil is weak in texture and to avoid heavy erosion, conservation measures, especially plantation is important.

As one came down Fatehpur, River Swat come out from the narrow mountains channel and enters into comparatively plain area. From Kalam till Bahrain there is no thickness in soil and is weak in clay contents. Downward from Fatehpur soil thickness develop and sand contents start decreasing. In this way the moisture holding capacity increases. In Mingora area there is enough moisture in winter, and in summer reaches below 10%. Almost the same trend continues in Malakand area (**Table E.2a-E.2c**).

In terms of moisture contents, the Lowe Dir area is totally different form the remaining watershed. It is a bit away form River Swat. The soil is well developed in terms of texture but because on non-availability of water it is deficient in soil moistures. This is why majority of the agriculture is dependent on natural precipitation and/or tube well. In some areas natural springs are tuned to use it for irrigation.

On the basis of soil texture and moisture contents the whole watershed can be divided into four categories.

a. Kalam to Bahrain soil is rich in moisture content although it is poor in clay contents. Here the high moisture availability is dependent on the high and regular precipitation and low temperature.
b. Bahrain to Fatehpur is moderately low in moistures with low clay contents. Up to some extent the small portion of clay help in the moisture holding capacity.
c. From Fatehpur till Qalangai (Also Kalangai) is Low in soil moistures. Although the area is rich in clay contents. The main reason can be attributed to deforestation in the surrounding mountains. The PRA survey revealed that because of heavy deforestation, seven seasonal springs dried and no more water is there. In two evergreen perennial springs a decrease of 20 to 30% occurred in the last 25 years.
d. The 4th category, which is very low in soil moisture contents, is the Lower Dir area. This is a separate close sub watershed of River Swat. The area has got a thick soil surface layer with high in clay contents. Here even the ground water table is quite deep in the area and not contributing to soil moisture contents. This warrants a special attention to maintain surface vegetation.

Because of variability in soil moisture in the rain fed area of middle and lower parts of Swat valley, there is only one crop per season i.e. wheat. To sustain wheat crop, the main source of moisture in winter season is Mediterranean depression. Again some time delay is there, but

because of low temperature, enough moisture is there to sustain wheat crop and give a chance to wait for rainfall. The maize crop in upper Malakand is always left to chance. Some times there is delay in monsoon rain and the water is not available on time. In Lower Dir, Adnezai Tehsil, due to non-availability of surface water, tube well system exists, which is used to grow vegetables only.

5.1.3 Bulk Density

Knowledge of soil's bulk density plays an important role in soil conservation. When bulk density raise above 1.4-root growth begin to suffer from lack of air and direct physical resistance. The bulk density of an average farm soil ranges form 1.2 to 1.6, at a bulk density of 1.7 roots cannot penetrate the soil (Plaster. 1992).

In our case the laboratory analysis shows that in majority of cases (80% sample) the bulk density is with in the limits of 1.2 to 1.6. Only 20% samples have bulk density 1.6 or above (**Table E.2a-E.2c**). The higher bulk density is usually in the Damani Land, which is because of cultivation of one crop, that remains untouched for a long time (almost 6 months) and results in compaction. In other part such as *shoulgar* and *Jewardara* compaction is there, which is because of mechanized agriculture and construction (roads, buildings) and can be avoided through planning. For example on new construction sites, it may be possible in some cases to limit the area driven on by construction equipment. Landscape architects and designers can also help in controlling pedestrian. People normally prefer shortcuts, walk across field and will avoid the general walkways if they are long. Similarly farmers are trying to cultivate maximum area of their agriculture field and make the *pulla* (Field boundaries) narrow. In this way giving no space to the people passing nearby. Because of which there is compaction and putting the present as well as future crop in jeopardize. This became further aggravated when the farmer practices agroforestry; especially fruits trees.

To avoid soil compaction of the farm, it is possible to break up compaction if no plants are in the way. On the farm deep tillage will break up compaction. In Swat area tillage for Damani land will not be a suitable solution. Because, after wheat harvesting (May-June), there is heavy wind flow that can accelerate soil erosion further. In this way solving soil compaction will contributes to wind erosion, which has got negligible role in erosion at the harvest time. In this way a suitable solution is dual cropping (S**ection 6.2, Agriculture**). Another solution is the

addition of manures to soil, which is in practice in some area of Swat Valley. This can be achieved through organic manure or proper handling of agriculture remains after harvesting (**Pic-F.19**). Due to heavy use of herbicides (**Section 6.32, pesticides**) there is negligible contribution from herbs in terms of organic matte. Due to increasing demand of fodder, the farmers are cutting the crop in the very bottom while, because of modernization, urbanization and non-availability of enough space the use for dumping compost solid waste (*dayran*), a decrease in the use of this sort of manure was observed. In this way it is required to encourage the concept of scientific agroforestry on one hand and proper crop cutting on the other hand to increase crop residue.

5.1.4 Soil Slope

Soil slope is an important physical parameter from soil erosion and conservation point of view. Usually a low slope is preferred when talking about erosion. However, irrigated water is limited and gentle slope is preferred to avoid water loss. Here in this discussion only erosion is considered. Slope becomes more important when soil texture is also taken into account along with erosion.

Slope has two components, length and grade. On a steep slop, water achieves a high runoff velocity, increasing its erosive energy. On a long slope, a greater surface area is collecting water, increasing flow volume and water can also pick up speed. Thus, the steepness of a slope and its length contribute to erosive energy (**Plaster, 1999**). In this discussion only erosion aspect has been considered, for which the following six categories have been identified.

In river swat watershed the height from the mean sea level is 567 meters at Kalangai that go up to 2969 meters at Kalam after covering a distance of 120.36 km. The total difference comes out as 2402 meters. In this way average increase per kilometers is 19.956 meters. If we divide the area into three segments the situation become more clear.

Kalam to Fatehpur the average height is 24 meter per kilometers. While from Fatehpur to Mingora the average increase is 21 meters per kilometers and from Mingora to Kalangai the average increase is 2 meters per kilometers through out along river Swat water channel (**Google earth 2006**).

Slope was determined by GPS, the data was compared with value given in table 5.2. On the basis of slope values, study area was categorises into 6 categories. The *shoulgar* area from

Mingora to Kalangai falls in the 1st category (**Table 5.2and E-5**) where the area appears nearly level. But as the texture ranges form sandy (in the river flood plain) to loamy sand and loam (in *Jewardara*), the area appears susceptible to erosion in flood season (June to September). Because of limited agriculture land, mostly people are taking the risk to use the flood plain for agriculture (**Pic. F.8-F.10, F.13 and F.14,**) and are always subjected to erosion. The *Shoulgarey* and *Jewardara* agriculture land from Miangora to Fatehpur is place in the 2nd category while that from Fathepure till Kalam is category 6th (very steep).

Table 5.2: - Definitions of slope classes

Simple Slopes Classes	Slope gradient limits	
	Lower Percent	Upper Percent
Nearly level	0	3
Gently sloping	4	8
Strongly sloping	9	16
Moderately steep	17	30
Steep	30	60
Very steep	>45	>60
Source: Adopted form Soil Conservation Service. U.S. Department of Agriculture, 1993		

The *Daman* from Fathepure till Kalangai is categories as 3rd (strongly sloping) as the increase in height occur when moving in the left and right direction form the River Swat water channel. The area of Matta valley, Kabbal Valley and foothill from Fathehpure till Kalangai is categories as steep (Category 5th). Where the slope is ranging from 25 to 60%. The area of Lower dir situatied in watershed of Chakdara Khwar (Sub watershed of River Swat is categories as strongly sloping (category 3rd). Category 1st also exist in the middle of the valleys. Most of the former practicing agriculture in the mountains area where the land consists on gravel and maximum sand contents (Pic. **F.22, F.33 & F.34 &** T**able E.1 & E.5**).

In Matta area enough clay (14 to 36% in most cases, table 5.1) is there but the slop is too high and soil is susceptible to erosion. Agriculture land of the study area is divided into three main categories i.e. *Damani*, *Jewardara* and *Shoulgari*. 70% of the total Damani land has got

60% slop, 20% of the same is 10-30% slope and only 10% is 4-16% slope. In this way major part of agriculture is susceptible to erosion (**Pic. F.14, F.15 &F.16**).

In *Damani* land of Lower Dir, the situation is totally different. 60% area has got a low slope ranging from 10-30% while in 20% area the slope is up to 60% and only in 10% the slope is above 60%. The percent slope of 60% *Jewardara* land is 10-30% and that of 40% is 4-16%. *Shoulgari* is a low slope land and in 70% cases the slop is 1-8% and in 30% cases the slope is 0-1%. In some *shoulgar* area the slope is quite high, such as in Jambil area the slope reach 10-30%. As water floe continuously in *Shoulgari* area, therefore, with more slope more fertilizer will be required and erosion is also accelerated (**Section 6.3.1, fertilizers**).

At present the farmers have adopted various measures, such as agroforestry. In Matta Valley more than 60% of the agriculture fields have trees or fruits plants in surroundings. Some farmers are practicing leveling also at the cost of productivity loss for some time (**Pic F.33 & F.34**). Besides, terracing is also practiced by installing weed in the crack of the walls that give support to the wall during rain and water flow.

5.2 Chemical Properties

5.2.1 Electrical Conductivity

Electrical conductivity (EC) is important in soil conservation. Its knowledge can help farmer in fertilizer applications, irrigation, and pesticide applications (Roberson, 2006). EC is indirect measure of water-soluble salts. In water **(Mylavarapu, 2002)** and Soil analysis (**Brady, 1988**) it is used to measure Total Dissolved Solids (TDS). In agricultural practices when EC is greater than 4 dS/m (4000 uS/cm) is considered as saline (**Munshower, 1994**). While National Agriculture research center, Islamabad defined a range from 0-2 ds/m (0-2 ms/cm or 0-2000 us/cm) as safe limit for all crops (**Ryan 2001**).

In River swat watershed the conductivity was found to be ranging from 85-400 uS/cm (**Table E.2a-E.2c**). Only one sample was high in EC. A general trend was observed in the mountainous areas where all the samples were observed to have low conductivity and low dissolved solids, which can be possibly associated with low clay contents and less use of fertilizers. Fertilizer use is low because most of the area grows one crop in a year. While irrigated and semi-irrigated are utilized through out the years, and fertilizers are applied

continuously. Apart from this, it is rich in texture and has got maximum water holding capacity, because of which the conductivity and dissolved soluble appear high.

Increase in EC is directly linked with fertilizer use. Indirectly it is a measure of required fertilizer and can be used as a quick measuring rod. It can be used as an indicator of NO_3 fertilizer, as in 35 out of 63 samples a direct correlation of conductivity exist with NO_3 contents.

5.2.2 pH

Soil pH is an important factor, keeping in view soil's health. Soil pH is an indicator of soil acidity and alkalinity. There are 17 major nutrients considered as essential, out of which 14 are absorbed from soil, the release of which depend on soil pH (**Donald, 2006**). Majority of plant nutrients are available to plants in the pH range of 6-7. (**NSSC, 1998, & Adams, 1999**).

The soil pH in River Swat watershed was found to be ranging forms 6.61 to 7.82 (**Table E.2a-E.2c**), which is quite favorable range. In this pH range no such negative impact can be seen. Variation in soil pH is important for plant growth. This dynamism in pH can be achieved by adding water in soluble salts, such as $CaCO_3$. Looking into to **Table-E-4a-E4c** for cations, calcium concentration appeared quite sufficient. While that in **Table-E-3a-E3c** for anion, the concentration of CO_3 and HCO_3 is also encouraging in this regard. In foothill of mountains (rain fed areas), both, Ca and CO_3/HCO_3 contents are low. So the use of $CaCO_3$ is advised. This pH dynamism is encouraged by rainwater, where pH is ranging from 5.5 –6.5. Which will convert $CaCO_3$ into $CaHCO_3$ and increase pH temporarily. Looking into the pH range it is required to make the various macro and micronutrients available to plant, and crops in particular. A chief source of $CaCO_3$ is available in the study area in the form of waste from marble factories. While using it as soil conditioner will be an effective use of this waste.

5.2.3 Macro Nutrients

There are seventeen elements known to be essential for plant (Some are agreed on sixteen) and microorganism growth. Out of these three account for 95% of all plant needs: Carbon, Oxygen and Hydrogen. These three elements are obtained from air and water. Thirteen elements are obtained from the soil. Plant use six elements in large quantity and are called macronutrients. These are Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and Sulfur. Seven elements are required in small amount and are called micronutrients. These include Boron,

Copper, Chloride, Iron, Manganese, Molybdenum, Zinc and cobalt (**Plaster, 1992**). Other elements, such as silicon, vanadium, and sodium, appear to be helpful for the growth of certain species. Still others, such as iodine and fluorine, have been shown to be essential for animals' growth but are apparently not required by plants (**Brady, 1988**).

A soil used for agriculture, is important to maintain the soil fertility and get agricultural product on sustainable rate. For keeping soil fertility farmer always depend on use of fertilizer. Low dose of fertilizer will reduce agriculture production and is loss of time, money and energy. High doses of fertilizer results in soil contamination on one side and water contamination on the other side. Besides, it is loss of resources as well. To avoid these, it is important to have a soil test for a balance use of fertilizers. For accessing the quality of soil form nutrient point of view selected macro and micronutrients were studied and results presented in Tables E.3 (a-c) and E.4 (a-c). A detail account has been given as:

5.2.3.1 Nitrogen

Nitrogen in soil is available as a result of nitrogen cycle, one of the most efficient bio-geo-chemical cycles (**Anil, 1987**). It is basic and the most fluctuating plant nutrient. Plants can absorb nitrogen in two ionic mode i.e. ammonium (NH_4) and nitrate (NO_3), which are water soluble and having a tendency to leaching. Due to this it is always in limited amount. In comparison of other plants, crops need more nitrogen. This higher demand makes the nitrogen availability a limiting factor in crop production (**Cooper, 2005**). Due to its heavy demand for batter yield farmer always dependent on fertilizer, while both low and high use of artificial fertilizers have negative impact on soil (**Aman & Afzal, 2001**).

absorb

Generally the minimum limit defined for nitrogen is 0-15 ppm, 15-50ppm as medium and value above 50 ppm is called high (**Shuler, 2006**). Sample collected form river swat watershed were analyzed for nitrogen contents and it was observed that in 36.51% samples (23) had nitrogen contents in the range of 4.785-14.285 mg/Kg, in 41.27% samples (26) the range was 15.050 to 46.150 mg/Kg and 22.22% sample (14) the level was high ranging form 50.395 – 64.48 mg/Kg. The medium and high nitrogen contents were observed in irrigated and semi-irrigated areas. In these areas because of agricultural activities heavy use of fertilizer was

observed. Besides, this area is comparatively rich in clay and has got strong correlation with soil texture.

The PRA survey reveled that 25% farmers made over-use of fertilizer and 23 percent under use of fertilizer, while the remaining 52% uses reasonable amount of fertilizers (Table E.9). The over and under use of fertilizer depend on the financial status, awareness and land ownership. It is a common proverb that "the more is sugar the more will be the taste of drink or pudding". The same is applied for fertilizer too. If a farmer is rich enough, will use maximum amount of fertilizer. While a poor will go for maximum fertilizer with the idea to get maximum benefit. As a matter of fact the result is otherwise. This practice is not only cost ineffective bust also lead to loss of fertilizer and contributing toward soil and water contamination.

The farmers of the area are using crop rotation, such as Trifolium repens (called *shwtal in local language)* and pea with out knowing its importance (**Pic. F.38**). Use of organic fertilizer is toward decline. Pond system in the field (for rice paddy) is another method to avoid free flow during irrigation, which is normally practiced, especially, for rice crop. Rice crop need continuous water to grow. By doing this, flushing of soluble nitrogen can be avoided, but the nitrogen content may find its way to ground water or go beyond the access of crop root. Another alternative solution is use of fertilizer in interval.

5.2.3.2 Phosphate

Soil phosphorous is mainly provided from the weathering of certain mineral, primarily the apatite, which is calcium phosphate mineral (**Plaster, 1992**). Phosphate plays a series of functions in the plant metabolism and is one of the essential nutrients required for plant growth and development. (**Marschner, 1993**).

A low P concentration (about 0.2 mg/Kg) in the soil solution is usually adequate for normal plant growth. (**Fox & Kamprath 1970 and Barber, 1995**). Looking into the **Table 5.3**, an optimum level is identified as 21-25 mg/Kg for wheat and alfalfa and 16-20 mg/Kg for all other crops (**Sawyer, 2003**).

Table 5.3: Required level of Phosphate in soil for Good crop Production

Relative Level	Bray P1 and Melich-3 P Methods	
	Wheat Alpha alfalfa (mg/Kg)	All other crops (mg/Kg)
Very low	0-15	0-8
Low	16-20	9-15
Optimum	21-25	16-20
High	26-30	21-30
Very High	31+	31+
J. E. Sawyer and A. P. Mallarino and R. Killorn, , Iowa State University of Science and Technology, Ames, Iowa, 2003		

In this study for phosphate determination Bray P-1 method was applied. Among the analyzed samples, 25.39% (16) were found in a very low range of 4 to 8 mg/Kg, 46.03% (29) samples were in low category (9-15mg/Kg), 22.22% (14) samples were in the ranges of 16 to 20 mg/Kg the optimum level for phosphate, and only 6.36% (4) samples were in the range of 21-30mg/Kg (high). No sample was found to be under the category of Very high (Table E.3a-E.3c). High rate of fertilizer use was observed in the irrigated area, where phosphate contents were to be also observed optimum or high. While in rain-fed area low fertilizer use was observed. To increase agriculture production, balance in fertilizer is required. Only few areas were found on the higher side while under use is quite high and need proper attention. Keeping in mind the soil texture a balance is required, because, due to the low holding capacity of soil as over use may lead to water pollution due to leaching.

5.2.3.3 Sulfate

Sulfur is an important soil nutrient, usually available in the form of sulfate. According to Regional Precision Farming Pilot Project (http://taipan.nmsu.edu/mvpfpp/index.htm) for batter plant growth a range of 3-5 ppm of Sulfate is enough, while the South Dakota State University define different level as given in table. The sulfate as SO_4 level in the study area ranging between 7.96 to 47.94 mg/Kg. Very low level (0-14 mg/Kg) was observed in 12 samples, Low level (15-29mg/Kg) was observed in 27 samples, medium level (30-44mg/Kg) was observed in 23 samples and only one sample was found above 45 mg/kg as high (T**able E.3a-E.3c**).

Table. 5.4 **Required level of Sulfate in soil for Good crop Production**

Relative Level	Sulfate-Sulfur Soil Test		Equ. Sulfate
	Lb/acre-2	mg/Kg (ppm)	
Very Low	0-9	00 - 04.5	0-14
Low	10-19	05 - 09.5	15-29
Medium	20-29	10 -14.5	30 – 44
High	30-39	15 - 19.5	45-59
Very High	>=40	>=20	>=60
Source: Web site of South Dakota State University: http://plantsci.sdstate.edu/soiltest/Nutrient.html#Sulfur			

5.2.3.4 Chloride

Chloride is one of the important essential nutrients. According to Land Resources and Environmental Science Dept Montana State University **(**http://www.inpofos.org/chloride/index.html**) a c**oncentration of about 15 mg/Kg is sufficient for majority of crops. According to South Dakota State University 30 mg/Kg is considered as high (Table 5.5). In the study area Chloride concentration was ranged between 6.98 to 29.78 mg/Kg. In 2 sample it was low, 27 samples low, 15 samples medium and in 19 samples was high (**Table E.3a-E.3c**).

Table. 5.5 **Required level of Chloride in soil for Good crop Production**

Relative Level	Chloride Soil Test	
	lbs/acre - 2'	mg/Kg (ppm)
Very Low	0-15	0-7.5
Low	16-30	8-15
Medium	31-45	15.5 – 22.5
High	46-60	23 – 30
Very High	> 60	>30
Source: Web site of South Dakota State University: http://plantsci.sdstate.edu/soiltest/Nutrient.html#Chloride		

5.2.3.5 Potassium

Potassium is a key nutrient in the soil. Plants consume more potassium than any other nutrients except nitrogen. Potassium comes from a number of common minerals such as feldspars and micas. Weathering lets potassium go directly into the soil solution as the potassium cation (Peacoke, 1999). Looking into the geology these two minerals (feldspars and micas) are

common in the study area (Chapter II and III). The optimum level for all crops is defined as 131-170 ppm as given in the following **Table 5.6**.

For extraction of Potassium from soil samples of the study area Mehlich-3 procedure was used and was determined by flam photometry. The concentration of Potassium in the samples collected form the study area was found in the encouraging level. In rain-fed area where the clay contents are limited the amounts the potassium contents was low. In irrigated and semi-irrigated land where the clay contents relatively higher potassium contents were high. In total 27 samples (42.86%) were within the category of low, 18 samples (28.57%) were observed as optimum and 15 (23.81%) samples were observed as high in potassium contents and only three (4.76%) samples come under the category of very low. (**Table E.4a-E.4c**).

Table 5.6: Level of potassium in soil for all crops

Relative Level	Ammonium acetate or Melich-3 K (Methods) (ppm)
Very low	0-90
Low	91-130
Optimum	131-170
High	171-200
Very High	201+
Sawyer J. E. and Mallarino A. P. and Killorn, R. , Iowa State University of Science and Technology, Ames, Iowa, 2003	

5.2.3.6 **Calcium (Ca)**

Calcium is secondary macronutrient and is relatively abundant in soil and rarely limits crop production. It is present in soil minerals such as amphibole, apatite, calcite, dolomite, feldspar, gypsum and pyroxene (**Kelling and Schulte, 2004**). Its deficiency cause poor yield and its availability is regulated by pH adjustment. The favorite pH range for Calcium avaialblity is 7.0 to 8.5. A decrease in pH cause decrease in exchangeable calcium levels and chances of other element increase such as Aluminum and manganese. The excess of these can become toxic to plants (**Incitiec, 2001**). The required range is 300 to 5000 ppm (**Kelling and Schulte, 2004**).

As majority of the source minerals for calcium are present in the study area. Calcium in the extracted solution was determined by A.A using emission mode and the results are given in table **E.4a-E.4c**. Looking in to availability to plants, the pH is in suitable ranging from 6.4 to 7.7 (**Table E.2a-E.2c**).

5.2.4 Micro Nutrients

Micronutrients

There are various methods of extraction available for analysis of micronutrients in soil. Here an attempt has been made to identify a suitable method, not only to solve a particular problem but also to save time and reduce cost. For this purpose four extraction methods were selected after detail literature survey. These methods were applied to selected samples of various textures (10 in number). The extracted samples were analyzed for micronutrients (Fe, Cu, Zn, Mn, and Mo) and one soil contaminants, cadmium (Cd) using atomic absorption spectrophotometer and the results are given in table 5.6 and E.4a-E.c.

The value of all analyzed elements, except Cadmium, appeared high for aqua Regia in all sample (**Table-E.7**). In Aqua-regia, digestion takes place under highly acidic conditions and extract almost every thing, and is therefore giving high value and give total metals concentration. Therefore, Aqua-regia method is sometime misleading, particularly in agricultural soil analysis. For example comparing the Iron contents with different method, the result of aqua-rigia was the highest and correlated to sand contents. This is because of the various iron containing rocks present in the area. As that of Mehlich-3 and DTPA was correlated to clay contents and appeared suitable for sample extraction.

The values of Ammonium acetate extraction method, in comparison with other methods, appeared lowest for all metals except Zinc and Cadmium. The values of these two metals with Ammonium acetate appeared high (DTPA-Zn appeared zero) in all samples, irrespective of soil texture. Therefore, Ammonium acetate method in comparison with DTPA can be considered for Zn and Cd analysis in soil in comparison with DTPA.

DTPA value for Zn is zero in all samples, while in case of Cd the percentage difference is above 50% in majority of cases. Therefore, DTPA method cannot be recommended for these two metals (Zn and Cd) in soil. The same conclusion was drawn by Kitrina and David (**2004**).

When compared with Melich-3 for Iron, in six samples the Melich-3 iron values were lower than that of DTPA while in four samples DTPA value were higher. By comparing this variety with texture, DTPA correlated well with clay contents and can be considered favorite method for Iron extraction.

The trend for Mehlich-3 values in most cases was correlated with clay contents. In general, in majority of cases its value appeared 2nd to Aqua Regia.

Comparing DTPA with Mehlich-3 for Mn contents, Mehlish-3 values in eight samples appeared high with a %age difference ranging from 1.09 to 15.77%. In two samples (Bahrain and Osakai) the percentage difference is above 30%. In majority of case both, DTAP and Mehich-3 were quite near to each other.

In case of Cu While studying Cu the Mehlich-3 values appeared high from both Ammonium acetate and DTPA method. A positive correlation, (except Allahadand and Rodingar) was observed with clay and appeared best method for copper in soil analysis which is also supported by Katrina & David (**2004**). Molybdenum (Mo) was observed in five samples with Mehlich-3 only and shows effectiveness of Mehlich-3 method.

For River Swat Valley it can be concluded, as Aqua-regia is strong acidic media and should be used for total available stock of metals only. In soil contamination and agriculture, and hence, for soil above50% sand, Aqua-regja will give misleading results. Mehlich-3 gave response for majority of metals and is mostly correlated with clay contents, which is the main nutrients storage region and is therefore recommended for such soil, if only metals have to be analyzed. Therefore, Mehich-3 method was adopted for the analysis of all collected samples.

5.2.4.1 Iron (Fe)

Iron Fe is important for synthesis of chlorophyll. Its deficiency is usually common in calcareous soil (**Morris *et al.* 1990**). Values ranging from 0 to 2.5 ppm is low, 2.6 to 4.5 is considered medium and above 4.5 ppm is considered as high (**Gerwing & Gelderman, 2005**).

The results of analysis given in **Table E.4** show reasonable amount of Iron contents are available ranging form 17**.016 ppm to 424.601 ppm** (**Table E.7**). Here Mehlich-3 was followed. By comparing the values with the above standards, all samples were high in terms of Fe contents (above 4.5 ppm). As those soils are poor in clay contents, and micro fertilizer are not applied, but proper conservation measures can solve the problem of iron deficiency in case there is any.

5.2.4.2 Manganese (Mn)

Manganese is an essential plant nutrient. For better plant growth normal manganese range is 50- 200 ppm on dry weight basis (**Alam, 1985**). However, in majority cases it is found in a

range of 200-300 ppm. The minimum level is 1-2 ppm, below which plants are affected negatively (**Manzoor and Raza, 2001**).

In the study area Manganese was found to be the 2nd abundant microelement after iron. Its behavior toward pH change remain as that of Iron. According to Brady, **1988**, the required range is from 10 – 1000 ppm. Usually toxicity starts above 700 ppm, while below 10 ppm is considered as deficient. The concentrations as per Mehlich-3 ranging form 11.91 to 384.09 ppm. In this way no sample was observed as deficient.

5.2.4.3 Zinc (Zn)

The major source of zinc is fertilizer, mostly in the form of sulfate. Its availability to plants depends on pH. When pH is moving toward alkaline side a decrease occur. A good pH range is between 5.6 to 6.5 (**Manzoor & Raza, 2001**). Other factors contributing to proper release of Zinc and better plant growth include soil organic matter and clay contents (**Martens and Westermann, 1991**).

Zinc deficiency has been detected in most of the alkaline calcareous soils of Pakistan. Up to 85 % of the soils are reported to be either deficient or within the marginal range of Zn. Zn is usually present in the concentration range 10-300 ppm, and occurs in a number of different minerals, on exchange sites o f clay minerals and organic matter or adsorbed on solid surface (**Manzoor & Raza, 2001)**.

In the study area the lowest value was observed as 3.95 ppm while the highest value was 22.59 ppm (**Table E.4**). Low values were observed in rain-fed area while high values were observed in the irrigated land. The high and low values are attributed to over and under fertilizer use. As most of the soil is sandy and Zn is leacable, this is why a continuous observance is required in Zn contents.

5.2.4.4 Cadmium (Cd)

Cadmium (Cd) is a non-essential trace metal occurring in the biosphere (**Alloway, 1995**). Its chimerical characteristics are close to that of Zinc and found Zinc minerals. It is also found in apatite and calcite (**Jansson, 2002**), which are basic raw material for phosphate fertilizer and is an important anthropogenic source of Cd in soil (**Söderström & Eriksson (1996**). Diammonium phosphate, in one of the main contributor of Cd in Soil (**Penney, 2004**), which is

also used in the study area. Normal background levels are 0.01 to 1 ppm. Regular consumption of plant containing 3 ppm Cd can poison man and animals (**Tucker, et al 2005**).

In the study area the value of Cd ranged from 0.01 to 6.59 ppm. In total of 50 sample the level is 1 ppm or above. While only 12 samples fall below 1 ppm. The areas irrigated from sewage or where natural fertilizers were used appeared high in Cd level. During enquiry it came to know that the major source of Cd is P-fertilizer and battery cells. Battery cells are not recycled and thrown to the soil waste dump. The major sources of Cd battery include Mobile, camera and toys. Among these Camera (mostly used by tourists) and toys are the major sources. For this proper awareness is required to regulate the use of Cd based batteries.

5.4.4.5 Copper (Cu)

For batter plant growth the normal copper range is 5-20ppm (Martens and Westermann, 1991; Reed *et al.,* 1993). According to other researcher the level below 0.02 ppm Cu is considered as low and that of 0.2 ppm is high (**Jeffrey et al 2004**).

Copper concentration in the study area ranged between 0.111 mg/kg (ppm) to a maximum of 11.211 mg/kg (**Table E.4a-E.4c**). In area where copper based fungicides are used appeared high in copper level as defined by Jeffery et al 2004. According to Jo and Koh (**2004**) 50 ppm is a warning value above which toxicity may appear. In all 63 soil samples the Mehlich-3 extractable Copper concentration in the study area appeared below the warning level of 50 ppm. In terms of micronutrient, copper concentration in study area was found in sufficient. Out of the total samples analyzed copper was found 4mg/kg or above in forty samples (4.042 to 12.211 mg/kg, **Table-E.4a-E.4c**) while in 22 samples it ranged from 0.033 to 3.818 mg/kg. On comparing with the standard level mentioned above can be termed as below the normal range of 5-20 mg/kg. This is the amount enough for plant growth, and will not lead to deficiency symptom. To keep the level of Cu within normal range, a check is required to regulate the use of Copper oxychloride and copper sulfate, which is used as fungicides in horticulture. Though at present the level of Cu it has no adverse effect, but as the major source of copper is copper oxychloride, which has negative impacts on soil biota, such as earthworm (**Helling et al, 2000 and Eijsackers et al, 2005**). Therefore, proper attention is required to watch copper and other soil contents. To over come on copper deficiency a balance dose of 2-5 kg/ha is recommended, mostly in the form of $CuSO_4$.

5.5.4.6 Molybdenum (Mo)

Molybdenum is an essential element for both plants and animals. Mo deficiency appears below the range of 0.1 ppm **(Alam, 1999).** To avoid Mo deficiency soil is treated with Ammounium Molibdate and Sodium Molybdate @ 1-2 pound/ha. Mo deficiency generally observed in acidic soil which is removed by lime treatment (**Manzoor 1and Raza, 2001)**).

In upper Swat a Zero value was observed (18 samples) while in lower Swat the maximum values goes up to 12.705 ppm. In this way a visible trend was observed in which a decrease has been observed going form south toward north and from the middle toward the sides of River Swat. By comparing with the standards, no such negative impacts are expected. But the area where it appeared deficient likes the upper Swat and the peripheries of River Swat Watershed need attention.

5.6 Pesticides

It is estimated that in Pakistan every year 10-15 percent of the crops are destroyed by pests and disease (**Karim 1991**). In Pakistan linear pesticide use started in 1954. After that a regular increase in its use was observed and the annual usage reached up to seven thousands tons in 1960. To cope with its hazardousness and miss uses, rules regulation were adopted after 1972. Till 1979 sale and distribution was the responsibility of agriculture department, which was latter on handed over to private sector. Due to which a five time increase was recoded in 1980 just in one year time. Unfortunately, because of less effective legislation, lack of awareness of the harmful effects, and technical know how, pesticide usage has not been properly regulated. Therefore, it is very important that pesticide content be regularly monitored in soil, water, and food products (**Rasul et all, 2003**).

In the study area, proper use of pesticides started after 1969 when Swat and Dir state become part of Pakistan. After that a series of agriculture related projects were initiated. In mid of seventies a bulk of pesticides were sprayed from airoplane with the idea to eradicate Malaria and increase agriculture production. With the passage of time pesticides use was encouraged especially after 1980 when it was easily available in the market.

In Swat Valley, initially its use was very much limited and farmers were using it for vegetables. Later on its use was started for horticulture also, especially when peaches were

introduced in the area. Now 60% of pesticides are used in horticulture, while 30% are used on vegetable and 10% are used on other crops.

Pesticides have got negative impacts on health and environment, especially on soil micro organism. (**Rasul et al, 2001**). According to study conducted recently, in Dir (Both, Upper and Lower) the cases of cancer is increasing in the farmers. In 2000, 43.3% (68) cancer cases were found in farmers and in 2004 they were increased to 45% (121). This increasing trend is attributed to pesticides and illiteracy (**Alam et al, 2006**). Looking into these aspects an attempt has been made to analyze soil sample for residual pesticides. Market survey reveals that about 50 different pesticides are in use, most of them are bio-accumulative. Out of that 12 pesticides were found in various soil samples, like dicloroves ranging from 30 to 159, Lindane 3.97 – 139 Iso-proturan 0.34- 123, Diazinon 10.13-172 Heptachlor 0.6 – 137, Parathion-Methyl 12 to 128, Malathion 11.82 – 153, Endosulfan 6.24 – 12.90, Dieldrin 12-162 DDT 3.4 – 164, Methidiathion 12-216, Cypermethrin 32-184(**Table E.8**).

There are 25 pesticides, which are now banned in Pakistan; (FAO, 2005) out of which six were studied (Aldrine, Deldrine, DDT, Lindain, Parathion-Methyl and Heptachlor) and their concentration was observed in soil in all the soil samples. From the market survey and interview, two possible remarks can be attributed. First the impact of heavy spray given during early seventies, and second, the banned pesticides stocks are still available and in use. The second statement is valid for DDT, because it was found in three houses and two shops. While the matter of Deldrin, Lindain and Aldrin is question mark. Two pesticides, Heptachlore and Methyle Parathion have been recently banned in Pakistan coming under Rotterdam Convention but available in the market and the residues were also found in soil. These can be attributed to the various misuses of pesticides. The rarely used pesticides include, Dichlorovos, Isoproturan, Diazinon and Methidiathion. The most widely used pesticides, identified, are Cypermethrin and Endosulfan.

Various associated hazards observed in the study area include improper spray facilities. This is mainly because of lack of awareness. Most of the farmers, although after somany accidents are not adopting proper safety measures (P**ic-F.18 & F.20**). The reason is that any event they considered as temporary. Such as if some one becomes un-conscious or if it is in contact with eye, they considered it as an event. Although most of the pesticides are bio-accumulative, about which the farmer are unaware. Second problem observed was irregular

business and adulteration. It is quite easy to become an authorized dealer. If someone complete three days training he or she can deal pesticides for three years. While to renew licenses, another three days training will be required. Farmers often link increase in crop production to the use of pesticides and this trend often lead to the use of excess of pesticides unnecessarily.

Adulteration is another serious problem because of which pesticides are used in excess. The quality checking in the market the responsibility is given to Agriculture Department. They are supposed to collect sample form the market and send it to a laboratory for Quality. As there is heavy burden on the Laboratory, besides, it is too far from the study area, and hence monitoring is not efficient. It is important to initiate such facilities at district/ Tehsil level, to make the monitoring system efficient. At present there is one Agriculture research center in Mingora, but it has no facility for pesticides analysis.

5.7 Land Capability Classes

Pakistan has defined eight classes for agriculture capabilities (**IUCN- GOP, 1993**). In NWFP, to develop land capability classes, soil survey of Pakistan surveyed 9139 thousands hectares out of total 10174 thousand hectares area. Classes identified for NWFP were Class-I (187.3 thousand hectares), Class-II (524.4 thousand hectares), Class-III (665.8 thousand hectares), Class-IV (581.6 thousand hectares), Class-V (70.1 thousand hectares) Class-VI (827 thousand hectares), Class-VII (2603.8 thousand hectares), Class-VIII (2974 thousand hectares), and unclassified as 704.9 thousand hectares. **(Alim et al 1993)**

Out of the total area 61.03% fall in class-VII and VIII while in the remaining 39% only 0.75% is good forest or range land. On most area poor or moderate Agriculture account for 13.64% of the total surveyed area. Class-I and II account for 7.74% only (**Table 5.7**).

In River Swat watershed the situation is different and is more sensitive. It is combination of District Swat (80.81%) Lower Dir (11.98%) and Malakand 7.21%). For land capability satellite images, aerial photographs and questionnaire survey was conducted. It was observed that 75% area is mountainous and should be used for forestry, while, it is encroached and people are using it for agriculture. Area included in class-I (very good agriculture land) is 7.359% of the studied area. This is the area situated in the surroundings of River Swat and regularly irrigated form River Swat or its tributaries. Class-II area include4 (good agriculture land) 15.862% which lie in surrounding of class-I. This is the area which is good in soil texture but has

got limited agriculture utility because of non availability of water. Class-III (Moderate agriculture land) is that land which is not only deficient in water but also week in terms of texture as well as slope. Class-IV (poor agriculture land) includes mostly encroached areas or area of the flood plain used for agriculture (**Map-G.4**).

Table 5.7: - Pakistan Land Capability Classes

Land Class		Soil Limitations	Production Potential	Area in million hectares	%age Area
I	Very Good Agriculture Land	None for general agriculture	Very high	5.24	8.47
II	Good Agriculture Land	Minor	High for general agriculture	6.98	11.29
III	Moderate Agriculture Land	Moderate	Moderate for general crops	4.87	7.87
IV	Poor (marginal) agriculture Land	Severe	Low for a few crops only	2.99	4.83
V	Good forest or rangeland	None/Minor for forestry/rangeland	High for forestry/rangeland development	0.17	0.27
VI	Moderate forest or rangeland	Moderate	Moderate for forestry/ range development	1.27	2.05
VII	Poor forest or rangeland	Sever	Low for forestry/ range development	15.41	24.92
VIII	Non Agriculture land	Severe	None fro any type of economic agriculture	23.2	37.52
Xi	Unclassified	-	-	1.78	2.87
Source: IUCN- GOP National Conservation Strategy, 1993					

Class-V to VII are purely mountainous. Class-V (Good forest or rangeland) is mostly situated in the upper Swat, Class-VI (Moderate Forest or rangeland) is situated in the middle Swat and Class-VII (Poor forest or rangeland) is situated in the Lower Swat including upper Malakand and Lowere Dir. (**Table E.9, map-G-4**).

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Chapter VI

Socio Economic Activities in River Swat Watershed

In this chapter a detail account of existing Socio Economic Activities in River Swat watershed have been presented to highlight the importance and role of soil resources its problems and possible solution. For this purpose questionnaire survey (Chapter 4 and Annexure A) and literature survey methods have been utilized.

Human beings are strongly dependent on natural resources and generally all human activities have got direct or indirect impacts on environment and natural resource (**Agarwal. 1996**). Some are within the carrying capacity and some beyond the caring capacity and appear dangerous. Increasing population is having accelerating impacts on environment. Activities like transportation, agriculture, fishing, mining, industrialization etc. are having negative impacts in the form of soil erosion, contamination, species extinction, deforestation etc. Out of this whole lot four major activities having directly negative impact on soil quality are herein discussed in detail. That includes Agriculture, Forestry, mining and tourism.

As human activities and its impact on natural resources, especially soil resources have got a direct relation with population. Therefore a detail account on population has been given below.

6.1 Demographic Analysis

Total area of Pakistan is 796,095 sq.km with a population of 130580 (1998 census). The total area of NWFP is 74521 sq.Km , which is 9.4% of the total area of Pakistan. In term of Population the percentage is 13.6. %. If we look back toward the 1st census report the population of Pakistan was 33816555 and that of NWFP was 4587120 (13.6%). According to population estimate of 2000 the population of Pakistan was 136010 thousand while that of NWFP was 18666 thousands (15.7%) (**Table 6.1**). This is an indication of slight increase in terms of percentage.

The River Swat watershed, the total population living here is 20009 thousand which is 11.82% of the total NWFP (**Table 6.2**). The total area of River Swat Watershed is 8220 sq.km (**Inam & Viaro, 2002)**, which are 11.03 of the total NWFP. The highest growth rate was that of Bunair (3.84%) and Peshawar (3.56%). Lower Dir, Swat and Malakand stand 3rd (4.42%) 4th (3.37) and 5th (3.36%) respectively (**Table E.12**).

Table 6.1: Population of Pakistan in comparison with NWFP

Item	Year	Unit	Pakistan	NWFP	% Share of NWFP
AREA	-	Sq-Kms	796095	74521	9.4
POPULATION					
TOTAL	1998 (Census)	(000)Persons	130580	17738	13.6
Male	-do-	-do-	67840	9086	13.4
Female	-do-	-do-	62740	8652	13.8
Urban	-do-	-do-	42459	2994	7.1
Rural	-do-	-do-	88121	14744	16.7
Estimated Population	1999-2000	-do-	136010	18666	13.7
Population density	-do-	Persons/Km^2	171	250	-
Source: - 1998 Census (Provisional Results) Population Census Organization, Islamabad., Monthly Statistical Bulletin, Federal Bureau Of Statistics, Govt: of Pakistan (March 2001) and Economic Survey of Pakistan, 2000-01.					

Table. 6.2 population (000) of district/Thesil situated in River Swat Watershed

Tehsil/Distt	1998	1999	2000	2001	2002
Swat Ranizai	260	272	282	292	302
Sam Ranizai	192	200	207	213	220
Total Malakand Distt	452	273	489	505	522
Swat	1006	1052	1088	1125	1163
Matta	252	262	271	280	289
Swat Distt:	1258	1314	1359	1405	1452
Timergara S/D	528	553	571	591	611
Jandool S/D	189	198	205	212	219
Total Lower Dir	717	726	751	776	803
Total River Swat Watershed	2040	2139	2212	2288	2365
Total NWFP	17738	18408	18927	19460	20009
%age	11.50	11.62	11.68	11.75	11.82
Note, Sama Ranizai and Jandool are excluded because it is not part of River Swat Watershed.					
Source: NWFP district Census Reports, 1998 published by department of Population Census, Govternment of Pakistan, Islamabad. http://www.nwfpbos.sdnpk.org/nwfpds/2000/13.htm					

In 1998 the average population density of NWFP was 236 persons per Km^2. In terms of population density Peshawar appeared on the top with a population density of 1606 persons per Km^2. Population density of Lower Dir, Swat and Malakand were 453, 236 and 475 persons per Km^2 respectively. Considering the demographic trend, a tremendous increase in population occurred, where people are mainly attached with agriculture, which has ultimately negative impacts on natural resources.

According to the questionnaire survey conducted in 50 selected villages, (**Table-E.13**) only 25% household size is five or below, while 50% household size is ranging from 9-11. Similarly the numbers of children are on increasing side, which is 35% of the population size.

The work force is 16-25 and 26-50 year of age, which account for 40% of the total while almost half of that is female and a very limited portion of that is part of the work force. According to PRA survey, it is estimated that almost 50% in rural area and 10% in urban areas observed as female workers. In rural areas women folk are active in fuel wood collection, and in some area like lower Dir and Malakand they are also visible in the agriculture field. In urban area mostly females are housewives and some are government employees. In this way limited workforce is available in the study area, which need proper attention.

6.2 Agriculture

Pakistan is an agricultural country and its economy mainly dependent on agriculture. According to official statistics of government of Pakistan (GOP) about one fourth of grass domestic products (GDP) come form this sector and provide employment to about half of the lanbour force. In rural areas agriculture seventy percent of population are directly dependent on agriculture (**Manzoor, 2001**), but the area available for this activity is very limited (Chapter I, Section 1.1). Pakistan is broadly divided into 12 agriculture zones (Map 6.1). The study area fall in the northern half of NWFP, partly in category VI (wet mountains) and partly in category VII (Dry mountain). The area of Lower Dir and Upper Malakand situated in VII and while District Swat come under category VI (**Map 6.1**).

Malakand division comprises of six districts namely Swat, Dir (lower and Upper), Malakand, Bunair and Chitral. Malakand Division has a wide range of agro-ecological zones from the semi- arid sub-humid tropical southern plains of Malakand Agency at an elevation of 500 meters to the dry, cold temperate valleys of Chitral District at an elevation up to 2,500 meters. The total cultivated area of Malakand Division is just 11.8% of which 56.6% is irrigated (**Parsons, 1990**). If we keep over selves limited to the study area "River Swat watershed" about 20% area is cultivated (**Inam & Viaro, 2002**).

River Swat watershed has very much fertile and productive soil. But because of increasing population there is increase in demand of land. In this way people are toward encroachment, and acquiring unproductive land or land which is suitable for other type of activities (**Pic. F.27, F.34 & F.36**). This trend of encroachment is not only toward mountainous area but also toward the flood plain of River Swat and other *Khwar* **(Pic F.8 & F.9)**. The visual interpretation of satellite image shows that about 33% area is under cultivation. According to

agriculture statistics of Pakistan 33.71% of the total 700800 hectare reported area is cultivated area, of which, 21.75% is net sown cultivation (**Table-6.3**).

Table 6. 3:District Wise land Utilization Statistics of the Study area, 1999-2000 (In Hectares)

Distt.	Reported Area	CULTIVATED AREA			UN-CULTIVATED AREA			
		Total	Net Sown	Current Fallow	Total	Culturable Waste	Forest	Not Available for cultivation
Malakand	52134	45681	36249	9432	6453	1035	4622	796
Swat	506528	95281	78582	16699	411247	80569	135427	195251
Lower Dir	142138	44432	37614	6818	97706	745	91480	5481
Total	700800	236243	152445	32949	145406	82349	231529	201528
Source: - Director Agriculture Statistics, NWFP, Peshawar, 2002								

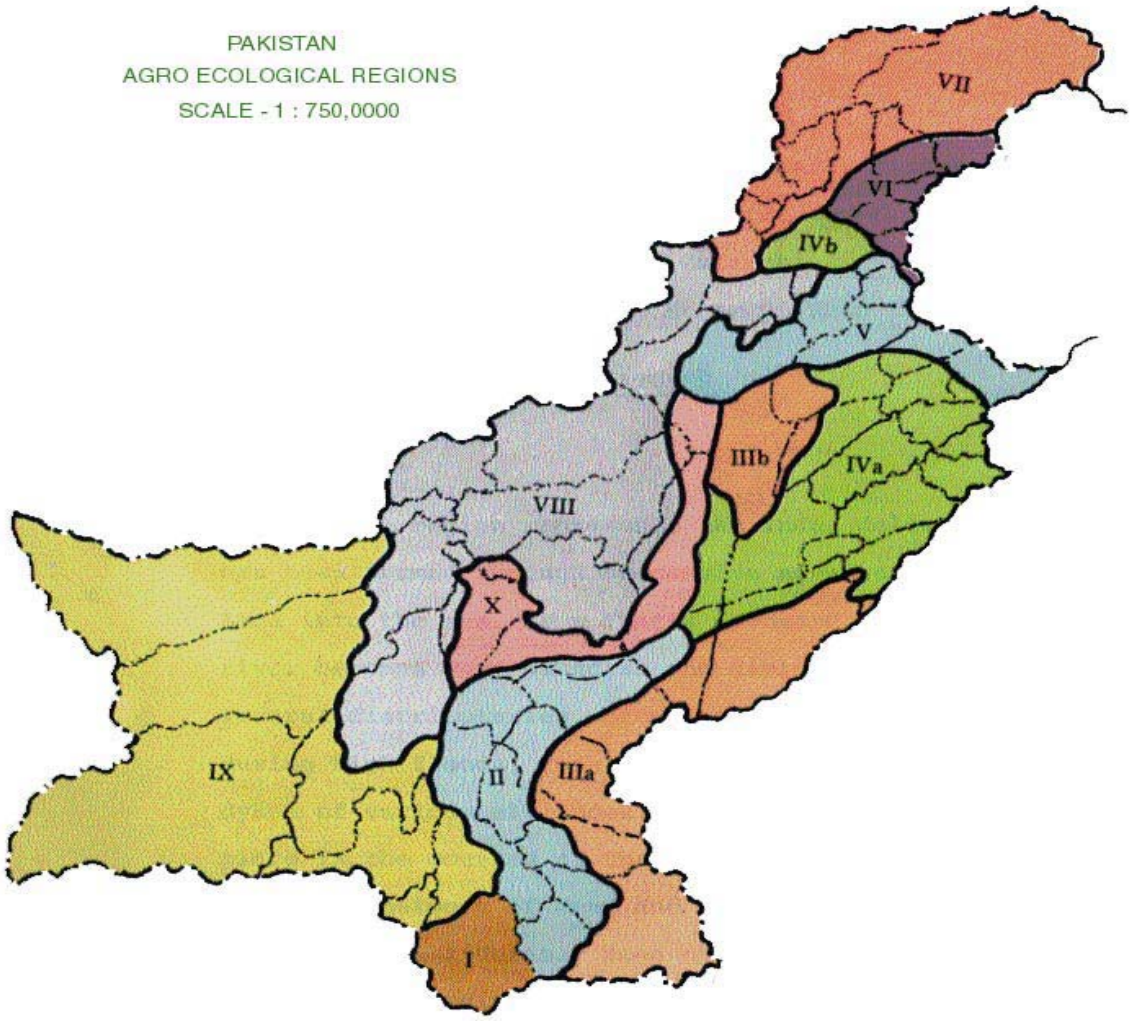
6.3 Agriculture Associated Problems

6.3.1 Fertilizer

Proper use of fertilizer playing an important role in sustainable agriculture production (**Amanullah and Afzal, 2001**). In general an increase has been observed in the study area (**Table 6.4**). Identification of a balance dose for a particular agriculture field is a technical task. Both, over fertilization and under fertilization affect agriculture production negatively, while in case of over fertilization, soil contamination and loss of money are the obvious factors. As observed in the study area (**Table E.11**), proper fertilizer identification is another problem. Some time one fertilizer is required, while farmer use another one. This practice not only affects agriculture production but also create environmental problems (**Amanullah & Afzal, 2001**). In river Swat watershed, majority of the farmer are illiterate and improper use of fertilizer was observed.

In major fertilizer include Urea 50%, Ammonium Nitrate 13%, Ammonium Sulfate 10% Dia ammonium Phosphate (DAP) 25%. Fertilizer available for Potassium include sulfate, nitrate but their use is very limited. As majority of the irrigated and semi irrigated areas are given by the landowner on *Ijara* (land rented to tenant on fixed rent/year) to another farmer or tenants and are trying to get maximum production. For this purpose usually over fertilizers are used by the

Map 6.1: Agriculture Zone of Pakistan



Key

I- Indus Delta	V - Barani Lands	IX - Dry Western Plateau
II - Southern Irrigated Plain	VI - Wet Mountains	X - Sulaiman Piedmont
III - Sandy Desert (a&b)	VII - Northern Dry Mountains	
IV - Northern Irrigated Plain (a & b)	VIII – Western Dry Mountains	

Source: Social Sciences Division & Crop Sciences Division, Pakistan Agricultural Research Council (PARC)

tenant. On the contrary in rain fed areas there is lower use of fertilizer than actually required as usually grown by the owner or given to tenant on *Brakha* (the owner get share ranging form 25-50% of the production) and less attention is given to the land. In this way fertilizer use is more in irrigated and Semi irrigated area as compare to rain fed. These areas are under continuous irrigation, where nutrient trapping is a problem, while Rain fed land remaining covered (by crop) for a short period (3 to 4 months) only, and water-soluble nutrients are flushed by monsoon rain.

Table 6.4: - District Wise Sale of Fertilizer in the Study area From 1997-98 TO 1999-2000 (M. Tons)

	1997-98				**1998-99**				1999-2000			
District	N	P2 05	K	Total	N	P2 05	K	Total	N	P2 05	K	Total
Malakand	1876	246	18	2140	3557	186	-	3743	3452	419	-	3871
Swat	8270	1321	53	9644	10276	1538	-	11814	12951	1825	10	14786
Dir	6939	878	11	7828	6186	949	-	7135	7936	1478	-	9414
Total NWFP	**10146**	**1567**	**71**	**11784**	**13833**	**1724**	**-**	**15557**	**16403**	**2244**	**10**	**18657**
Source: Agriculture Development Authority, Peshawar**.**												

6.3.2 Pesticides

Pesticides area another important agro-chemicals, very much in use in use in River Swat watershed. In total 12 pesticides have been identified in selected soil samples of , River Swat Watershed analyzed for this purpose (**Chapter 4, Table E.8**). The main problems identified in the study areas include its impacts on human health and migratory birds.

Impacts on human beings are very common due to lack of awareness and as such farmers are not adopting proper safety measures (**section 5.6, Pic F.20, Table E.8 and Table E.11**). Another impact is on species diversity. As a result of overuse major portion of pesticides is wasted that has got negative impact on soil organism, and other flora and fauna (**Pic. F.23, F.24 and Table E.11**). The most dominant example is of Honeybee. At present no one in river swat watershed enjoys natural honey, which is because of two reason, habitat loss and pesticides. Now a day only cultured honey production is common, again the bees are at risk and usually sugar is

fed to the honeybee, which affect the quality of honey and hence is not considered a reliable business. The natural honey is on the decline since 1970, when District Swat became part of Pakistan and agro-chemicals were introduced in the area and it was about late nineties when natural honey disappeared in the market (**Table E.11**). Now a day it is completely absent from the market and seldom available in rural areas. All the honey presently available in the market is cultured only.

Similarly pesticides have negative impacts on migratory birds and fish population also, where there is illegal fishing. The most dominant migratory specie is sterling, which is negatively affected by over hunting as well as over use of pesticides. Similarly for fishing people usually use pesticides in the shallow water of River Swat, Khwar and Streams, which are feeding and breeding places for fish. In this way affecting fish population too.

6.4 Forest

Forest cover directly affects soil quality in terms of erosion and nutrients loss. Total forest cover in Pakistan is 4.8% (4.224 mha) of the total area (**Qiang, 1999**), which is considered as poor (**Table 6.5**). For batter economy and balance ecology of a country must have at least 20-25% forest cover (**Anwar. 2002**). Comparatively North West Frontier Province (NWFP) appeared lucky in terms of forest cover. The total forest cover of this area is 17% (**Yar and Rafiq, 1997**).

In river Swat watershed the forest is protected forest and under the control of forest department subjected to the payment of royalty ranging from 60to 80% (**Chapter II, Section 2.4**). The forest resources of the study area are under severe pressure. It is used as fuel, as well as, as al livelihood (**Pic. F.3& F.4**).

The area is mountainous and the soil is week in texture therefore, there the forest cover must be above 40%. The PRA survey reveled that in upper Malakand the deciduous forest is decreased by 55% in Lower Dir by 65% and Swat 35% in the last 30 years (**Table E.11**). Now Malakand appeared poor most when compared with other three districts, where only 5% of mountain has got scattered forest. The figure in lower Dir is 10% and in Swat 20%. In Swat 50% of the timber forest is converted into rangeland in the last 30 years. It is still on the way toward decline. Which is a serious threat to soil resources.

Table 6.5. Area of Major Forest Type of Pakistan (Km^2)

Forest Cover/Land Use Class	AJK	Baluchistan	Northern Area	NWFP	Punjab	Sindh	Total Area
Conifer	160	420	6600	9400	300	-	1,9130
Scrub	10	5040	-	5390	1320	-	1,1910
Riverain	-	200	-	130	270	1120	1730
Mangrove	-	20	-	-	-	2050	2070
Irrig. Plantation	70	10	-	-	790	230	1030
Farmland trees	-	230	60	700	3060	540	4660
Linear planting	100	-	-	20	140	-	160
Misc. Planting	2410	-	-	1200	200	50	1550
Total	2750	5920	6660	1,6840	6080	3990	4,2240 (4.8%)
Source: FAO, 1999, http://www.fao.org/docrep/x2613e/x2613e2s.htm#pakistan							

6.5 Reasons of Deforestation

One of the reasons is population burden. Forest is removed for fuel wood, construction and livelihood. This area (lower Swat), although have no forest, is coming under the category of protected forest. Forest department (in Malakand and Lowe Dir) have no such forest stuff to earn revenue form it. Most of the revenue is coming form the check-post used to stop smuggling for running their office.

Almost 30% area of the lower Swat covered by mountain. Mountain area and is considered as common property or state property. In this way no one is taking care, although, forest department is trying their best to rehabilitate these barren mountain. But support from the community is non-existing, although they are using it for grazing and as source of fuel wood. The main reason behind that is ownership. There are some areas where mountain has been acquired as individual property, where dense plantation is visible. These areas include Amandara, Dahdara, Khairabad etc. (**Pic. F.22, F.27, F.31 &F.32**). As observed during interview survey, in upper Swat such as Miandam and Sarai, people are hesitant to go for plantation and preferring to use it as agriculture land. This is because trees are considered as state property and agriculture products are considered as individual property, which they can utilize for their personal use, and can also cash it in the market. Therefore, one of the solutions is to consider mountain as individual property, at least in the area where mountains are clear barren. Commercial and unscientific forest harvesting is one of the big drain toward deforestation.

Forest in the River Swat watershed is used as revenue. In 1984-85 the revenue generated was 138.166 million rupees generated, which was increased to 461.580 million rupees up to 1995-96 (**Table-6.6**).

The third reason is subsistence agriculture, which is again a linkage with population increase. The rain fed area is steep (25-60%) (**Section 5.3.4, slope**) is used for agriculture. The dominants area includes upper Swat, Matta, where 70% of the Damani land is used for agriculture. In the lower Swat 30% of the Damani land has got high slop and is not suitable for agriculture. People are behind encroachment to acquire land for houses and agriculture activities (**Pic. F.15, F. 16, F.22, F.33 & F. 34**).

Un-employment and lake of education in the rural community is another reason, that results in illegal cutting. Proper awareness may work, but will take time. Other reason includes, forest fire (**Pic. F.3 & F.5**), snow fall and land sliding, non-participatory approach of forest department, over cutting, that need proper attention.

Table-6.6: Annual Revenue of NWFP Forest Department (in million Rs)

S No	Year	Expenditure	Revenue
1	1984-85	44.713	138.166
2	1985-86	55.490	157.061
3	1986-87	72.446	145.069
4	1987-88	85.493	186.500
5	1988-89	76.043	178.810
6	1989-90	100.841	311.420
7	1990-91	106.431	297.966
8	1991-92	131.794	369.799
9	1992-93	130.919	409.961
10	1993-94	146.862	351.892
11	1994-95	173.514	503.000
12	1995-96	178.552	461.580

6.6 Over Grazing

Grazing is another problem affecting soil quality negatively. Due to the lack of time, this aspect has been analyzed only qualitatively. The middle and lower part of River Swat watershed always remained under pressure from over grazing. In summer this area was receiving nomads from Afghanistan and in winter from the Upper Dir and Upper Swat. While the people of the area themselves have cattles for milk. According to the PRA survey till eighties every house had

got two to four sheep and/or one cow (**Table E.11**), which decreased with the passage of time. Now some people have adopted cattle keeping as profession. Nomads form Afghanistan are no more visiting Pakistan. Since 1970 it started decreasing and after nineties almost completely stopped. While nomads from upper Dir and Swat-Kohistan are still visiting lower regions in winter.

Through out the history there exist no evidence where grazing has been regulated. Besides, nomads there are Gujar (profession buffalos keeping using milk as livelihood) in each village, have adopted cattle farming as a profession and still utilizing the mountains for grazing. In lower Swat they are there for a long stay (June – September) along with their cattles. During their stay they allow the cattles for open grazing, while collect grasses daily, and also store it in dry form for rainy days. open grazing is also active through out the year (**Pic. F.12**).

6.7 Tourism

The mountains of NWFP are decorated with natural scenic beauty, (**Pic. F.1, F.2, F.35 &F.37**) rich in historic and ancient religious monuments, famous for rivers, springs, forest and wild life, due to which has got the ability to attract tourists (UNSICAP, 2002). To encourage tourism, Pakistan Tourism Development Corporation (PTDC) and Sarhad Tourism Corporation (STC) are with all efforts to encourage this activity (**PTDC, 2003 and STC, 2003)**. In this way till 1999 a visible increase was observed (GOP, 2006).

After the event of 11 September when the two business tower of USA was hit, a lot of changes occurred in tourism industry worldwide, especially in Muslim countries. Pakistan being a partner in the war against terrorism also affected and because of security problem the foreigner tourists were discouraged (**Hakeem, 2003**). Swat, which is an historic place, was always full of foreigners, now a days, rarely some one is visible in Swat Valley. During 2004-07 more than 10 fields surveys were conducted in different seasons, but observed no single foreigner.

The Nifaz-i-Shariat movement (enforcement of Islamic system in the courts) had a negative impact on internal tourism (tourist coming form other parts of Pakistan). In summer, people from all parts of the country used to visit Swat Valley **(Inam and Viaro, 2002),** which is in competition with Murry, Abatabad, and Galyat. To divert people from Swat Valley other people in the business used negative propaganda against Nifaz-i-Shariat movement to create cultural uncertainty for tourists, due to which there was decrease in the tourists in Swat Valley.

Although the people of Swat are soft spoken and trust worthy people and always respected the gusts.

To enhance the socio-economic capability of the people living in Swat Valley, the concept of eco-tourism should be initiated. Recreation facilities appeared in some areas, like in Fiza Gat, Malam-Jaba, Chakdara, where people go for picnic and recreation. These can be extended further to water sports for which the entire stretch downstream of River Swat can be exploited. If tourism is properly managed, it can decrease pressure on natural resources, especially soil resources. This is possible with the maximum involvement of the local people in tourist activities. At present, people form other areas are benefiting from tourism, in terms of jobs and income level. Majority of the local poor community are totally ignored.

6.8 How to promote and encourage Tourism

To encourage tourism land use planning is required go ensure that a reasonable piece of land is set aside for tourism (**Toit, 2001**). At present there is only one planned township in the whole River Swat Watershed, Kanju Town Ship. Therefore, implementation of the Land Use Planning and Environmental Management Programme is required. There is a haphazard situation of developmental activities in all cities, like Malakand, Batkhala, Thana, Chakdara, Barikot, Minagora, Khwazakhalia, Matta, Madayen, Bahrain and Kalam. Apart from this there is no proper management program for sewage treatment and solid waste disposal. As a result the beauty of Swat is affected badly. All sorts of wastes are flushed away in River Swat. In this regards the establishment of regional office of Environmental Protection Agency in Swat, Malakand and Dir districts can play an important role.

An integrated resource management and environmental enhancement plan is required, to identify area of specific use. Such is mountain tracking in Kalam, Water Sports in Middle Swat and hunting etc in the lower Swat. For this purpose a comprehensive plan is required in cooperation and coordination with the people of the area.

Construction of roads, telephone is vital for efficient tourism. At present all road going toward north of NWFP are under construction. That includes, Malakand Pass, Dir, and upper Swat, with out synchronized planning. Work on all roads started simultaneously and no tourist could enjoy tourism properly in the years 2005-06. The main reason was heavy construction in

all parts of Swat Valley and its surrounding. To encourage tourism there should be proper repair and maintenance work going on regular bases, so such mega construction can be avoided.

The promotion of a Visitor Awareness Program for the priority tourism development areas of other part of Pakistan in general and Swat valleys in particular is very much important. Besides, the courses, related to environment and tourism should be initiated in the universities and colleges situated in the Swat Valley.

6.9 Aqua Culture

Swat Valley has got enough water resources and can offer good opportunity for aquaculture. If properly utilized, it can help to up-lift socio-economic condition of the people of the area. Such activities will also release pressure on soil activities and will help the farmer in soil conservation also.

Considering country statistics, NWFP is very week in fish production. The inland fisheries produce about 15% of Pakistan's total fish catch. The province of sindh account for 70% of the inland fish catch. Next comes Punjab with 27%. The share of NWFP is just 1 percent. In River Swat and its tributaries 12 different species of commercial importance are found (**Table-6.7**). Illegal fishing is practiced through the entire stretch of River Swat. That includes use of pesticides, electric currents, and use of explosive. On the road toward Kalam, there are more than 100 huts offering fish to the people. Unfortunately 70% fish comes form Turbala Dam and Punjab. This is very much unfortunate, that some one is sitting on the bank of River Swat but could not enjoy its fish.

Table-6.7 Major Fish Species of River Swat

S No	Local Name	Zoological name
1	Mahasheer	Barbus Putiutura Tarp pititora
2	Swati	Shizothorax Palgiostomus
3	Thalk	Shizothorax spp
4	Chunr	Shixothorax esocnus
5	Marmahai	Mestacembelus armatus
6	Karasarary	Channa punctutus
7	Degai	Gara gotyla
8	Singi	Triplophysa naziri (loaches)
10	Braitai –I	Triplophysa chorai
11	Braitai –II	Triplophysa alipidata
12	Gulabi	Glyptothorax stoki
Source: Shaheen 1999		

Chemical analysis of River Swat shows that water quality is fit for aquaculture (**Nafees, 2004).** The entire stretch of River Swat can offer itself for this purpose. People are using the flood plain for agriculture and because of flood in July-August suffer financially. This belt can possibly be used for aquaculture activities. Efforts are already underway (**Pic. F.39 & F.40**) but mainly focused on trout fish, which can survive in the upper Swat region only, while other species are ignored.

Trout was introduced in 1916 in Gilgit from Europe. So far two major species of trout are cultured in Pakistan (T**able. 6.8)**. According to 1994 statistics (**Naveed, 1994**) there were two trout fish hatcheries in Swat Valley, the share of which was of 43.3% of the total trout production.

At present Fisheries department run 14 hatcheries of trout and carp, as compared to 604 private farms. To encourage aquaculture in NWFP and adjacent tribal areas (FATA), fisheries department announced a comprehensive package of 145.5 million rupees in 2002. In this package fourteen big schemes were approved (Dawn, 2002) but its implementation is still awaited.

Table 6.8: Trout hatcheries in the NWFP

Name of hatchery	Production capacity in million
*Shinu (Mansehra)	0.300
Madyan (Swat)	0.600
*Alpuri (Swat)	0.050
Dubair (Kohistan)	0.100
**Kalkot (Dir)	0.100
Jaghoor (Chitral)	0.120
Bombret (Chitral)	0.130
Alai (Batgram)	0.100
Total	1.500
Source: Naveed, 1994	

According to the official statistics of NWFP Directorate of fisheries department total revenue generated in 1999-2000 was Rs. 33279026 in which the contribution from River Swat was Rs. 10613300 (31.89% of the total NWFP). In the same years 823 licenses issued to the people, which were 1688 in 1997-98. The revenue generated from fishing for the year 1999-2000 from River Swat was Rs. 630759 thousands (16.8% of the total NWFP**).** A decrease in Licenses issued in River Swat was observed indicating of increase in illegal fishing.

According to Shaheen and Shabanm (**1999-2000)**, a 5-8-time increase in the number of visitor for fishing was observed. While there is decrease in licenses, therefore a review of licenses issuing procedure is required on one hand and on the other hand the fisheries department is required to encourage aquaculture activities. In this way agriculture in the flood plain will decrease, which will be a good contribution to soil conservation efforts. Besides, the use of pesticides for fishing will decrease and will be a good step to keep river swat safe and healthy.

6.10 Mining

Mining is an important economic activity and if not practiced properly, has got negative environmental impacts. The negative environmental impacts include bulk of mining waste, siltation in stream and rivers, and clearing of forest cover, which make soil top cover susceptible to erosion.

There is a lot of precious mineral resources in Pakistan that include marble, lime stone, gypsum, coal and gem stones like emerald etc. However, due to lack of technical know-how, availability of modern technology and lack of foreign investors this sector is not exploited properly and contributing only 0.4% to the GDP (**GOP, 2003**).

According to Geological Survey of Pakistan (GSP) the various minerals found in Swat Valleys includes, Iron, Lead, Nickel, Chromium, and Corundum. Various precious stones are also found. In which emerald is important one. However, so far no systematic survey has been conducted to utilize these resources properly. (**Inam, 2005**)

In River Swat watershed important mining activities are of emerald, china clay and marble. Country's 50% Marble is extracted from Malakand Division. The main district includes, Bunair, Swat and Shangla (**Inam, 2005,).** In Swat and Malakand district there are about eight marble industries (five in Swat and three in Malakand). Due to un-scientific mining a lot of waste appeared that is causing environmental problem. Also, the cutting and polishing is producing milky water, due to heavy load of suspended solids of calcium rock, which is adding to River Swat and causing pollution.

Emerald mining was started in 1958. It is spread out over an area of 183-acre area. However, it was never utilized in the best possible way. Since 1998, because of various inter organizational problems; lack of technical know-how the plant is closed.

The china clay exists at "Kathyar" in Nekpikheil (on the road that leads to Shahderai at a distance of 15 miles from Mingora). This is the largest mine, having the finest quality, of China clay in Pakistan. The clay is mined here, and is transported to Shaidu, Nawshehra (which is at a distance of around 100 miles from Swat) (**Qayum, 2002**). It is not so advantageous for the local people, because they have no opportunity to work in the industries situated outside the district.

Another mining, which is common through out the River Swat Watershed is mining for construction. This is un-registered and un-organized like most mining sector of mining (P**ic F.6 &F.7**). In River Swat watershed any one can go anywhere and can practice mining of any kind of construction material. The method (mostly dynamite) used for this is dangerous and is not environment friendly. Because of this the forest resources get disturbed and also accelerate erosion process.

6.11 Soil Erosion

Soil degradation in the form of soil erosion poses a serious threat to the agricultural sustainability in River Swat watersheds. Soil Erosion appeared as a major threat to soil in NWFP in general and in River Swat Watershed in particular. Factor responsible for erosion in the study area includes, agriculture, deforestation, and irregular mining activities and live stock grazing. The various impacts observed are, soil loss, water pollution, siltaiton in irrigation canals, soil nutrients loss.

Forrest cover is playing an important role in erosion control. As mentioned before deforestation appeared as a continuous process in the study area. The forest of River Swat is called protected forest, which is owned and regulated by forest department.

Agriculture is another major activity in the study area, where more than 70% people are attached with agriculture. The major threat is due to agriculture practices in the mountains (**Pic F.22, F. 33 & 34**). Where increasing slope (**Chapter V section 2.7**) appeared as a threat to soil loss. Ninety percent of rain fed area is growing one crop. In this way it exposed to rainfall for five to six month due to non-cultivation. In Malakand 55% area is rain fed, in Lower Dir 90% area and Swat 45% of the agriculture land is rain fed. Where remaining Irrigated and semi-irrigated remain covered with crops through out the years. Besides, the slope is also below 30% and is not that much sensitive to erosion. Still in Monsoon season (July-August) the River Swat and irrigation canal overflow causing erosion in irrigated area.

Two types of mining activities are identified in the project area. One is for mineral, such as China Clay, marble and Emerald. The other is by resident of the area to extract construction materials such as stone, stone crush and sand. The mining activity appeared in haphazard way. The mining activities and mining waste handling are unscientific. There is blasting which is affecting the surrounding area sensitive to future precipitation. Besides, building material, sand is taken away form the flood plain of river and Khwar (Seasonal streams), which make the surrounding agriculture fields sensitive to erosion.

In the study area water appeared as major agent responsible for erosion (**Pic. F.11**). The contribution of wind is negligible. By interviewing various soil experts its percentage appeared below one percent. As per PRA study, the contribution of deforestation in erosion is 45%; the percentage of agriculture is 35%, over grazing 15% mining and construction 10%. No effective arrangements exist in the River Swat watershed for soil conservation.

As mentioned in the chapter IV, to evaluate erosion problem River Swat water was analyzed for suspended load. In low flow season (October-March) suspended load fluctuates between 19 and 116 mg/l while in high flow season (April-September) the suspended load fluctuates between 137 and 692 mg/l. According to our estimation (with out flood event) the average annual suspended load was 0.855 tones/acre/year for the year 2004. This figure shoots up to 1.628 tons/acre/year with flood events (**Table E.6).**

6.12 Institutional involvement and related issues

In this section an attempt has been made to address institutional problems with reference to soil conservation and resource management. This include legislation, organization setup (governmental and non governmental organization) and public involvement in the form of social institution and code of conducts related to soil and natural resource conservation

Various rehabilitation and resource conservation projects are active in the Swat area that includes soil conservation, social forestry, water management, etc. However, economic development and progress of production has not been adequately responsive to the objective of maintaining a clean and healthy environment. As a result the River Swat watershed is under stress of various problem, ranging from deforestation, soil erosion and species extinction to water, soil and noise pollution.

The basic causes of these environmental problems can be attributed to varied and complex human activities, the major one is listed below.

1. More emphasize on quantity over quality. Such as plantation of fast growing plant species.
2. The failure of environmental resource accounting
3. The failure to take environmental factors into account as an integral part of our planning and decision making
4. Lack of inter-dependence, inter-relation, cooperation and coordination among different organization.

6.12.1 Legislation

Stockholm conference on human and environment is a milestone in the way toward environmental stability and Natural Resource Conservation (**UNO, 2002**). A number of steps have been taken by Pakistan in this regard, like soil erosion control, deforestation, fisheries and wild life etc. Rules and regulations were formulated in the form of different acts, even before the creation of Pakistan, relevant to Environment. Thee are Canal and Drainage Act 1873, Explosive Act 1884 Forest Act 1927, Factories Act 1934, etc. (**Jawad, 2002**).

After independence the two important districts "Dir and Swat" were separate princely states and were ruled by Nawabi Dir and Walli Swat respectively. While District Malakand was Agency at that time and was part of Federal Administer Tribal Area (FATA), administered by a political agent. The various acts such as West Pakistan Fisheries Ordinance 1961, Motor Vehicle Ordinance 1965 and related rules existent before the creation of Pakistan were not applicable to these districts situated in the river Swat Watershed.

During this period both the Walli of Swat and Nawabi Dire were strongly against tree cutting. In Dir a total monopoly was there while in Swat justified cutting was allowed. Similarly in Swat hunting and fishing were not allowed in specific area, and was reserved for Royal family and their guests only. In Malakand Agency the then political agent was with a regular check on land and forest resources. Till the existence of official Jarga (1975), Khan and Malak of each village ha to look after the forest resources (**Inam and Viaro, 2002**). The head quarter (Malakand) still presenting itself as evidence, where lush green forest is still there (**Pic. F.1& F.2**). However it is a matter of fact that till 1969 all these three districts remained out side of the

circle of developmental activities initiated by Govt. of Pakistan. When Dir and Swat were merged in to Pakistan (1969) and Malakand was converted to PATA (Provincial Administered Tribal Area) in 1980 the area was used to supply raw material to various industries and a little attention was paid to these districts. In this way the resources remained under pressure.

During 1979-82 Malakand Agency was converted to Malakand district. Various facilities were given to the area to compensate bane on poppy crop. That included subsidized rate for fertilizers and pesticides promotion of education, opening of Banks, electricity to remote area, loan for tube wells etc. Various agriculture projects were also initiated, such as Malakand citrus Project and promotion of nurseries. Irrigation department initiated demonstrative agriculture project etc. but all were for a very shot terms and the objective was not to promote the people or develop the area, but was for the purpose to keep them silent after banning poppy cultivation.

In this way by the end of 1990 all soil related (directly/indirectly) organizations were there in the watershed of river swat. Looking into soil related problems, it can be inferred that these organization were not that effective to solve these problems.

6.12.2 Institutional problems and issues

As mentioned in section 6.12, in River Swat watershed a number of institutional issues were identified that can be placed in five areas that is i) soil, ii) water, iii) mining industry, iv) human settlements, and v) forest and wildlife. These institutional issues could not be resolved effectively as a result of various constraints, like:

In soil conservation the main institutional problems can be sum up as:

- To address and streamline the hierarchical complexity that exist at national level for example soil conservation department attached with agriculture department, ministry of agriculture and livestock and watershed management doing the same work is attached with irrigation and power department of Water and Power Development Authority (WAPDA). Similarly Malakand Fisheries is attached with Environment department while in Lower Dir it is attached with agriculture department.
- There is lack of coordination among different organization, for the reason every department posing itself as a separate autonomous body with the mandate receiving from the concerned ministries. In this way there appeared duplication. For example aforestation and re-forestation are the major activities of both soil conservation

department attached with Ministry of Agriculture & Livestock and forest department attached with ministry of forest and wild life.

- Another complexity exists in hierarchy at provincial and district level. For example forest department at provincial level it is a separate department while in Swat district it is attached with Ministry of environment.
- A department identifies and allocates targets area with out consultation with other relevant department and/or defines a problem and activities in isolation according to the available professional know-how. Due to which there is overlapping and repetition or some time an area is completely ignored. For example soil erosion for watershed management is different from the soil erosion of soil conservation department. Watershed management working on water channels, while soil conservation department is focusing on agriculture fields. On the other hand forest department has to increase forest cover, irrespective of land degradation caused by erosion. In this way somewhere they are working in isolation, and there are areas where all the three departments are active. This leads to not only repetition but also misuse of available limited funds.
- Each organization considering itself as a separate wing of the national economy and not adopting an holistic approach due to which the function of an organization is scattered or some time kept narrow and cannot address a soil related problem properly. Considering irrigation and fisheries departments, for both water pollution is not part of their priority list. Environmental protection on the other hand is dealing with all sorts of pollution as well as forestation and soil erosion control.
- PC-I restriction: each organization stats its work under some program of specific period defined in Project Commissioning Proformas (PC-I). During monitoring and evaluation, when a deficiency is pointed out, there is no possibility of its removal. As observed in water management project run by agriculture department. According tp PC-I they cannot touch any agriculture field where other organization, governmental or non-governmental have worked for some time. Besides this the WMP is contributing only 15% of the total cost. Due to which farmers are not taking interest in this project.

- Political interference: department like forest, soil conservation, watershed management are always forced by political figure in the area. In this way there is no process to identify area as of special importance and to prepare priority list.
- Lack of Public participation: people are not actively participating in developmental activities in general and soil related activities in part6iocular. They are totally ignorant even the majority of the activities ignorant on in their area. The most dominant example is of watershed management activities, Farmers Field school (FFS) etc. the main reason is communication gap, lack of cooperation form the department and official procedures, which takes time and discouraging farmers to participate in governmental activities and maximize the benefit.

6.12.3 Role of Non Governmental Organization

NGOs are actively involved in environmental protection and resources conservation in NWFP. Generally NGO enter in a community through governmental organization or through community or some time involving both and remained successful. According to the list issued by institute of Rural management, Islamabad, there are 40 local registered NGOs, 12 international NGO and 16 UN Agencies and donors working in NWFP in the field of Environment. According to sustainable development network Pakistan there are 39 local NGOs 17 international NGOs and 18 UN and international agencies. In the project area there are four NGOs active, including HUJRA, EPS, ESP and National Rural Support Program. Some international NGOs like IUCN, WWF have their branches in the study area. UN and International Agencies are working through their head offices based in Islamabad and Peshawar through NGOs or governmental organizations. Besides, in each village there are one to three welfare organizations working. These welfare organizations help both, governmental and non-governmental organization and can be utilized to facilitate community participation.

In Swat area Community involvement started in 1980 under the social forestry program and other projects has encouraged volunteers to organize groups and help in projects activities. These groups are called community based organization (CBOs) and village organization (VOs) playing significant role in successful implementation of a project.

6.12.4 Problem faced by NGOs

i. The response from community is weak because people are not trusting as they see a hidden agenda. It is always a problem for an NGO to convince a particular community. In this way success of any developmental activity take time. The major hurdles are culture, and religion. The NGOs appeared a bit liberal, especially in the case of women. To encourage public participation and successful developmental activities they are required to work in the community by placing a circle of culture and religion.
ii. Another problem is lack of funding. Some time an activities is initiated which look very good. But that activity is stopped suddenly and an NGO windup its office. Next time that particular NGO is not respected.
iii. There are always interference form political bodies for developmental activities. Area is not selected on research basis and is always on the recommendations of a politician. In this way on one side the NGOs got support to work, on the other hand lose credibility in another area.

6.12.5 Social Institution

The three districts of River Swat watrershid are part of *Pukhtoon* belt and characterized by tribal *Phuktoon* code of conducts and traditions (Rome, 2005). *Roarwali* (matual cooperation), *Ashar* (collective efforts) and *Nagha* (mutually agreed ban for protection of natural resources) are some of the golden code of conducts usually used to help each other and cope with difficult situation. *Jarga* was the most effective and well-organized forum and was a strong decision making body. Various problems were solved collectively through Ashar (collective effort), which is still in practice in some villages of Malakand. Repaired and cleaning of irrigation canal through Ashar is a living example (**Pic.F.17, F.18, F.21 & F.26**). Because of government interference, and technological advancement, social institution appeared weak. The official *Jarga* and Ashar are no more permanent social institution, but available on temporary basis. Now a day whenever there is a problem, Jarga is constituted for solving that very problem only. It has got no permanent structure now. Similarly the farmers were using Ashar for canal cleaning, leveling of agriculture fields, and other activities in harvesting season. Now a day only for limited activities it is utilized that need re-activation. Another main problem is the move toward individualism. Because of which Hujra an important place of social gathering is

disappearing. Now the one place of gathering are masques (Jumat or masjid), which according to Islamic principles, cannot be used for common affairs. But still is a source to collect people and to communicate each other about a particular problem.

A new trend has started in the form of social welfare organization, where young and old aged people gather and use to discuss local problems and its possible solution. But their meetings are not frequent and participation is also limited. Similarly Agriculture and forest departments are also in the process to develop village development community to collect and mobilize people for batter management. In this regard the Farmer Field School (FFS) can play its role.

Looking into the available departments (Agriculture, Forest, Irrigation, and Environment), NGOs and legislations, the institutional set up is almost complete. The main thing, which is required, is to make them efficient and effective. Inter cooperation and coordination, is a missing link. All organizations are working in isolation. They are for the benefits of the people, but the people are unaware of their activities. So many departments adopted this as a policy to keep a particular developmental activities secret with a reason to avoid any kind of public and political interference. Not only this, almost all departments are unaware of the activities of the others. This lead to repetition and duplication, which is not only loss of time but also loss of resources. This trend needs to be changed, for which we have to channellize the institutional set up and make all conservation efforts participatory by involving community, NGOs and other governmental organization. The concerned departments are required to undertake technical assessment and for proper implementation seek community help. For example environmental Protection Agency (EPA) cannot do every thing, but a link is needed to be established with other departments. Such as for getting information on soil status agriculture department can help, similarly forest department can help in forest related problems and fisheries department can help in fish production and water quality related issues. In the same way EPA can help these departments in terms of monitoring and adaptation of control measures and should provide coordination and monitoring function. Different NGOs working in the study area have already published various literatures to increase awareness and educate the local people about the natural resource conservation and environmental protection. Further work is required to introduce these at school level for which encouragement from government organization is required. In this way the local people may become part of various developmental activities.

6.12.6 Social Code of Conduct

During survey two code of conduct were identified i.e. Ashar (collective efforts) and *Nagha* (ban). These two can be utilized effectively by the utilizing the above social institution. Ashar was tried in pesticide use and was quite effective to reduce the pesticide use. In this way can become part of integrated pest management (IPM). Similarly *Nagha* can be use in Forest Protection to mutually ban a particular forest for some sort of use. This was observed in Gunyar (Malakand) area, where *Nagha* was used for banning grazing in the nearby mountain. When it was difficult to manage, they use Ashar to protect each plant (**Pic. F.12**). This was made possible through local social welfare organization and was also encouraged by Forest Department and IUCN.

Similarly *Ashar* was observed in the Village Dheri Allahadan. It has *Ashar* has two broad categories. One is that when a host request neighboring farmers, relative and/or friends for help in a particular activity that may be too heavy for him. The 2nd is that when there is a facility jointly used by the farmers, such as canal cleaning (**Pic-F.26**). A person or two inform other and ask to do it collectively. This form of Ashar still exist and in practice for canal cleaning. The first form of Ashar is toward decline

It was used an all aspect of life, (**Inam-ur-Rahim, and Alain 2002**) and still in use, but limited. In agriculture, the story is a little different. It was used in harvesting, canal cleaning and repair (**Pic-F.26**) weeding and howing etc. for example the village Dheri Allhaadand has got a canal diverted form river Swat. The farmers clean this each year by using *Ashar*. The whole village is called on the same day by announcement in the masques. In this way this cleaning of about 8 Km canal takes only two days. Aashar was also used in herbs removal from agriculture field. In this regards three important crops are of worth mentioning, rice, maize and onion. Agriculture field and associated herbs and its removal of all these are of different nature. In case of rice paddy cleaning no instruments is involved, it is manual and a person can work in rice paddy for about three to four hours. After this the wrest become free and the person need one day rest, at least. But he can work in maize field, where tools are required. As both these crop got the same growing season, therefore, is a good combination to work collectively one day in paddy and next day in the maize field and *Ashar* facilitate this combination. In case of onion, the continuous seating is the major difficulty. In this way when a group of people is there, finished an agriculture field in short time.

With the passage of time the mechanization in agriculture change this trend toward individualism. Pesticides gave the 2nd hit. Because in weeding a group of people was involved to clear a particular agriculture field quickly. Now herbicides can do it more quickly and discourage the use of *Ashar*. The second factor is cost of *Ashar*. In *Ashar* no labor cost is there, but food arrangement for the same day is by the host farmer. Which cost the host 500 to 1000 rupees per day @Rs. 70/ person (two time tea and one lunch), while the cost of pesticide appeared less than 500 rupees. Looking into the hazardous nature of pesticides, biological pest control was introduced, that was rarely practiced in the study area. But the concept of integrated pest management (IPM) is in experimental stages and *Ashar* can become part of it.

6.13 Land tenure System

In this section problem associated to tenure system have been discussed. In lower part of River Swat watershed two type of land ownership exist i.e. common property an individual property. For this purpose to identify positive and negative impacts Village Alladand Dheri was analyzed.

6.13.1 Background

One of the elements that maintained the integrity of Afghan tribal societies in the absence of a centralized cohesive mechanism (state) was to devise circulatory land tenure (*Garzinda wesh*) that on one side enabled their integrated response to external (invading tribes) and internal threats (revolt by the majority subjugated tribes or tenants). In this system, initially large landscapes were exchanged between *Samma* (Mardan and Sawabi) and Swat (Swat, Malakand and Adinzai area of Lower Dir). This was followed by a system of *Tappa* level (medium landscape), village level and finally within the village *Garzinda wesh*. The *Samma/Swat* level *wesh* terminated shortly due to disputes among the two sub-tribes of Yousafzai occupying the territories (probably before 1600 AD), while the *Tappa* level *wesh* ended arbitrarily with occupation of Malakand by British, *Adinzai* by *Nawab* of Dir during 1880-1900 AD. After the establishment of Swat State in 1917 the first Wali of Swat worked to strategically abolish the *wesh* system (Sultan-i-Rome, 2005) to weaken the integrity of Yousafzai tribe and establish the writ of his State. In Malakand Agency (Now District Malakand), within the village *wesh*

however, still continues in some villages including the two adjoining villages of Alladand and Dheri. In this district there are two main *tappas*, called Baizai and Ranizai. In Baizai *tappa* the *wesh* has already been abolished. Which in the Ranizai *tappa* it exist in half of the villages. These villages include, Jolagram, Khar, Totakan and Alladand and Dherai now commonly known as Alladand Dherai.

In the *Garzinda wesh* land are allotted through *Khasanray* (drawing lot). The *wesh* include the *Ghar* (hillside) land and Sam (plain area including *Damana, Jewardaara* and *Shoulgara*) land in the territory of village landscape (*Dawtar*) (Inam-ur-Rahim, and Viaro 2002). With the gradual extension of initially the British and then the Pakistan State to the Malakand Agency, the elders (*Masharaan*) of the landowner tribes strategically abolished the *Garzinda wesh* either absolutely or in partially (adopted in Alladand Dheri). In the AlladandDheri village the *Damana* (rain fed) was permanently divided in the first phase (in mid of 20th century). However during the early seventies the forced occupation of the land by the tenants and inability of the individual landowner families to maintain their ownership, the permanent distribution (*Toriraan wesh*) of the *Jewaardara* (semi-irrigated) and *Shoulgara* (irrigated) was avoided/delayed.

6.13.2 Contemporary trends

Traditional societies have produced a rich, flexible legal systems well adapted to local circumstances. Indigenous law offered the population residing in a particular environment, a range of suitable solutions to their needs (Verhelst, 1992). The Garzinda wesh system provided a base for survival for almost 5 centuries in conflicting tribal environment to the local people. On the other hand in the marginal areas community's highest priorities were issues that carried the most immediate implications for their survival and well being (Fussel, 1995). Hence there is a need for better quantitative information and assessment of the social and economic causes and consequences of land degradation (Sombroek, 1996).

Village based partial fixation of the circulatory tenure started in 1919 in upper and middle part of Swat Valley and was completed till 1929 (Sultan-i-Rome, 2005) due to the interest of the Wali of Swat. Malakand Agency appeared as a separate administrative unit during 1895-96 (Azim, 2002), hence such fixation could not be extended to the lower swat valley being a separate administrative unit. Therefore, the process of land distribution through drawing lots

remained in some villages of the lower part of Swat Valley (*Swat Ranazai*) and is still continued in some areas such as Alladand Dheri, Khar and Totakan etc. The system has both positive and negative implications, not only for soil use but other natural resources as well, such as forest, wild life etc and a direct reflection on the socio-economic condition of the people particularly the landowner group.

The freezing of w*esh* system may on one hand provide new opportunities for medium and long-term investment in agriculture and housing development (Taddese, 2001), and on the other hand it initiated conflicts on land ownership elsewhere between villages and with in villages, (Kusters, et al 2007) particularly among *Pukhtun* cousins. Further the refusal of the tenants in some southern part of the valley to pay rent to the individual landowners, abolished circulatory land tenure led to several armed encounters with bloodshed, between the landowners and tenants particularly during late seventies. Tenants in Malakand had organized themselves politically under the slogan of peasant movement called *Kissan Tehrik*, while freezing of *wesh* could not facilitate the landowners to have a unified stand as it was possible during circulatory land tenure.

In case of permanent distribution and population explosion the land share of individual household become smaller to the extent that its cultivation does not remain economically viable. The low on farm income and seasonality in production for small landholders compels their youth to migrate to down cities and abroad for remittances. This causes remittances dependent population explosion, fragmentation of land, extension of crops to marginal land, and lack of working labor during peak periods (Inam-ur-Rahim, 2000). This makes the indigenous agriculture to be gradually becoming from secondary to tertiary activity. Land is mainly viewed as a salable asset or a zone for future residence construction. Most of the accessible small parcels of fertile lands available in the valley under permanent distribution are therefore increasingly encroached by concrete buildings including residences and shops (Inam and Viaro, 2002). Being under circulatory *wesh* the *shoulgarey* of Alladand-Dheri are the only large cultivated landscape left in the entire valley that may have the same fate in the absence of appropriate land use planning after abolishment of the *wesh*.

In the village Alladand-Dheri because of conflict on re-allotment in 1982, this system could not continue and the people are still possessing piece of land allotted in 1978. Due to the fear of redistribution, despite the possession of land units from the last 30 year, they can not use it for any kind of construction, horticulture or other perennial plantation, hence have economic

disadvantage for the individual landholder family. On the other hand the circulatory tenure may also offer the opportunities to develop a large-scale fully mechanical communal agricultural enterprise with profit for the different landowners according to their shares in line with the collectivization trends of the developed economies, if appropriately strategize as suggested Ashutosh and Tadao (**2001**) for Japanese irrigation common-pool resources by following Ostrom's eight design principles. The small-dispersed parcels of land as a result of permanent distribution may serve as salable assets or covered through concrete buildings, but it may also lead to more effective investment in physical improvement particularly of large pieces of land leading to more economical benefits for the landholding households.

6.13.3 Conflicts

Landowners being resource managers divided landscape into sites comprising of one to several soil series having different production capacities (Archer and Smeins, 1991), hence the land division in *Garzinda wesh* included different productivity zones. Such land zones are also differentiated on the criteria of slope (Pratt et al., 1997) and accessibility. During distribution and re-allotment soil fertility is the main factor considered and a person with less fertile land called *Kayeena* get extra land attached with that called *Ewaz* (benefit), which is 30% of the total leading to the possession of large piece of land. While for the person with fertile land called *Gwariza* the land share is small. Such zonation promoted equity in distribution of the benefits in a particular time frame but is now a reason for conflict. Currently there are people having big piece of land and presently occupying *Gwariza* land are not interested in *Khasanray*. The people presently with big piece of land in the form of *kayeena* and expecting a small piece of *Gwariza* in re-allotment are also not interested in the *khasanray*. People with small land of *Gwariza* and one expecting a big piece of land in re-allotment or people with maximum land of maize-grown land and minimum rice-grown land are interested in *khasanray*. Similarly people presently allotted land along the road sides are also not interested in the re-drawing of lots, while those at a distance from the road also favor redistribution of land. All the interviewed people are therefore looking to their personal interest and not to the collective advantage or disadvantage of the circulatory tenure.

In 1982 the WAPDA (Water and Power Development Authority) passed a 66 KV electric line through the land under circulatory distribution and paid Rs.30, 000 per pole to each landowner. They were unaware of the situation and paid the money to the shareholders in possession of land at the time of erecting the electric pools. Later on during re-allotment in 1988, people who were supposed to get that land with electric line poles in re-allotment, asked for share in the paid money of Rs. 30,000, while the previous possessors were not willing to pay. This led to the postponement of *Khasanray*. When the people met again in 1998 the paid stakeholders showed their willingness to pay Rs.30, 000 for distribution. In response the people asked for provision of the money according to the inflation rate of the previous ten years. In this way the landowners got divided on the issue of redistribution. In one part (Dheri) *Khasanray* took place and the other part (Alladand) is still in conflict.

This conflict can go against natural resources as revealed from the study conducted in Indonesia, where a conflict arose in the mid of 1998 on land tenure between local communities and tree plantation companies, and also between local communities and the forestry department. The hazard appeared in the form of un-wanted fires and forest degradation related smoke and gas emissions, environmental and economic losses (Suyanto. 2006). Another study regarding common property was conducted in Ethiopia and was considered good for the natural resource conservation and the people (Zelealem and Williams, 2005) in conflict free situation. On the other hand in, Zimbabwe conflict emerged on communal property during post independent period from 1980. The indigenous system was continued for about 20 years that put pressure on land and other natural resources, and was ultimately changed as a result of peasant movement in 2000. This led to the release burden on natural resources and uplift of socio-economic condition when the communal land was re-allocated (Moyo, 2005). Individual property ownership has also been supported by Xingmei Liu et al, 2004. They studied the impact of management change that took place in 1970, wherein an attempt was made to put responsibility on household and shift from the collective farming system to individual family farm. An increase in the yield was observed with decrease in soil fertility for which proper use of fertilizers was suggested.

6.13.4 Final Remarks

This system of *Khasanray* was looked after by *jirga*, which is no not existing in its original form. Besides, looking into the historical prospective, literature review, the system of

revolving ownership in the current socio-political environment is not supporting natural resource conservation, especially forest and soil and no conservation measure seems productive under uncertain land tenure situation. In addition, a minority of the landowners is interested in continue the *Garzinda wesh*, while majority is willing for its abolishment. It is therefore proposed to abolish the *Garzinda wesh* on permanent basis, not only in the village Alladand Dheri, but also in the surrounding villages, like Jolagaram, Khar and Totakan etc after appropriate participatory land use planning. Another option may be retaining the communal ownership but avoid rotation. In this case the land ca be rented out (20 years or above) for corporate farming system, and rent money distributed according to shares.

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Chapter VII
Conclusion and Recommendations

This chapter, identified soil related problems in River Swat Watershed are highlighted with suitable solution and have been discussed. Soil, the major natural resource base and related activities including agriculture, mining, forestry, aquaculture, apiculture, and tourism are the various activities of economic importance River Swat Watershed have been discussed in relation to environmental protection, resource conservation and socioeconomic development.

The various findings can be summarized as follow:

1. The climate of the middle and lower parts of study area is subtropical characterized by uneven rain fall, high temperature variation and evaporation in summer. The soil physical parameters, especially in the mountainous area show that sand is the main characteristic of the soil in the study area and is very much sensitive to erosion. In Upper Swat water is not a limiting factor but soil slope and deforested mountains are presenting a difficult picture.
2. Maximum area of land capability classes is Class-VII (Poor Forest or Rangeland), which need proper repairs.
3. Unscientific grazing, as also discussed by various researchers (Chapter-III, section 3.2, 3.4& 3.5) is one of the major problems contributing to loss of vegetation cover and soil erosion. The lower part of River Swat watershed is arid and the soil texture is mostly sandy loam (almost the entire watershed). Water availability for irrigation is irregular in rain fed areas and has boosting various factors like grazing impacts and inhibiting soil, rangeland and forest conservation.
4. Deforestation is quite fast which is further boosting the erosion phenomenon. On the total land 17% is forested. Looking into fragility and population pressures there must be forest on at least 40% on mountainous area.
5. In river swat watershed water erosion rate is about 1.62 tones per acre per year (**Table E.6b**). Looking into the soil texture, slope and forest cover, this is higher rate and need to be arrested.
6. Because of versatile geology, micronutrients are not a problem. In terms of macronutrients (Nitrate) the soil appeared deficient. Because of sandy nature the soil cannot hold water-soluble nutrients. In this way large quantity of fertilizer is required, people are there with pooling agriculture field, especially for rice paddy in plain area to arrest the nutrients. In most area people are also practicing crop rotation. But because of lack of awareness the practices are unscientific.

7. A check is required on increasing level of Cadmium (Cd), which was found in majority of soil samples.
8. Soil slope is another problem; most of the farmers have tried to reduce the slope. Some time the field boundaries are erected with stonewalls. To make these wall stronger, grass are grown to give support. Still majority of the area is not fit for agriculture and it is required to be utilized for forestry, agro forestry (**Pic.F.29 & F.30**) or rangeland.
9. Irregular mining, which is accelerating erosion need proper attention.
10. Activities like aquaculture, social and agro-forestry, apiculture (**Pic. F.25**) and tourism are identified as potential activities to reduce pressure on soil resources and up-lift the socio economic status of the people on one hand and bring environmental stability on the other hand.
11. The institutional setup including required department, legislation is complete. To regulate economic activities there is need to create inter departmental links and create a culture of public consultation.

To achieve sustainable use of soil resources and make aqua culture, tourism and miming effective, proper institutional arrangement will play an important role. For this it is important to encourage local people, coordinate and consult them and strengthen, encourage and trust social institutions

Looking into the present situation, no doubt, soil resources are utilized to the maximum, with low economic benefit and adverse environmental impacts that are badly affecting the socio-economic aspects. All these three wings of development are quite deficient and weak. If the present trend continued it will be come difficult to reverse the damages. Therefore, there is an urgent need to go for concrete steps. The most important one is the involvement of local people in all sort of developmental activities and to make them part of policy and decision making process. For the sake of simplicity the discussion has been divided into four main categories.

7.1 Land Resources

Human activities resulted in soil degradation include encroachment of forest or range land for agricultural activities, mining industry, and overgrazing, which lead to soil erosion, while excess/irrational uses pesticides and fertilizers contaminating soil and food cycle. Vast area (75% of the total) in the study area consists on mountains. The increasing rate of soil degradation in the form of erosion is of great concern. In this way limited land is available for agriculture. The people of the

area are poor and dependent on this limited soil resources with high population growth rate. Due to which there is ever increase burden on soil resources. To increase agriculture production there is increase in fertilizer and pesticides uses. Because of unique texture the accumulative capacity is very low and leaching in watercourses on regular basis. Which is not only future problem of the area but also for the people leaving down stream. About 168200-hectare land get irrigated down stream including Southeastern Charsada (54200 hectare), Northwest of Peshawar (84000 hector) in the plain area of Mardan, Swabai, Nowshera (**Nafees, 2004**). Where there are also heavy agriculture practices with bulk use of pesticides and fertilizer. The agriculture runoff will further boost the hazards, especially where the pesticides are bio-accumulative (**Karam et al, 2000**).

Annually 1.63 million tone of soil is washed form the area. Because of which there is loss in soil fertility and ultimately loss in production. Because of which there is ever increase in fertilizer. To lessen the effect of erosions, measures for soil protections are requires. This is not only responsibility of an individual but also the various governmental and non-governmental organizations active in the area.

Recommendation related to various problems such as soil erosion, use agrochemicals, nutrient loss and institutional development are embedded in the discussion (Chapter V and VII). To reduce soil degradation, some of the identified recommendations related to policy matter are as follows:

- Agriculture is needed to be regulated, especially, in rain-fed area. The concept of farm-forestry, agro-forestry should be encouraged along with schemes of irrigation.
- Proper management of overgrazing is needed by adopting planned rotational grazing according to the carrying capacity of range land. For this social institution should be exploited to reactivate the use of *Nagha* (ban) (**Pic. F.12**).
- It is required to assess the present status of degradation by using satellite remote sensing and develop GIS data base, available to all governmental organizations, NGOs, researcher and public. This will help to start and facilitate environmental accounting system in the area.
- For promotion of agricultural activities the agriculture department is required to develop a strategy in consultation with local farmer. Focus is required on the concept of common property and state own property. This is a major cause of conflict between government and local people and is a big hurdle in soil conservation.
- Mining activities need specific attention. To tune mining activities there is an urgent need to formulate and implement legislation for identification of mining sites, and make rehabilitation and reclamation of mining sites which should be obligatory for all companies and individuals.

- Need to identify and design sites for safe disposal of solid waste for urban areas such as Mingora, Matta, Barikote, Thana, Batkhala.
- The Sarhad Provincial Conservation Strategy (SPCS) prepared in 1996, which was aimed to provide a technical and institutional frame work for environmental protection and resource conservation. However the implementation process is slow and must be expedited.
- The various organizations like agriculture, forest, fisheries and environment need to be strengthened to monitor and control environmental degradation. As soil is common in all these, therefore inter departmental cooperation and coordination should be emphasized.
- Initiate concrete public awareness program, especially among farmer community so that to ensure public participation in various conservation activities.
- There is an urgent need of rational use of soil fertilizer and pesticides.

Water Resources

Water has got a direct coo-relation with soil. Any soil conservation measure seems incomplete with out water. Water resource is not coming directly under the scope of this study, but based on literature review, prior experience and study of the researcher are here in discussed.

In terms of water resources, the northern half of North West Frontier Province (NWFP) has been potentially the richest area in Pakistan. Three types of water are available in the study area, i.e. surface water, ground water and precipitation. A demand of water for agriculture is mainly met from the surface water sources (River Swat, springs, streams and *Khwar*). For drinking water, the people usually use ground water (**Nafees, 2004**). The rain fed land is dependent on precipitation and low in moisture contents. Through out the area there is no proper arrangement for water storage. Lower parts of River Swat watershed, especially the rain fed areas of Malakand and Lower Dir are facing water shortage every year in the months of September-November and April-June.

River Swat is a major river of the of the study area, where more than 80 percent of the population of its watershed is directly or indirectly dependent on it. The Plain area of River Swat (Middle and lower Swat) provides greatest opportunity for the exploitation of its land and water resources to provide a capability to increase agriculture production and for raising the power generation capacity of the country in general and the area in particular. The watershed contained abundant land and water resources and need to be used in a balance manner to serve the needs of its people. It is an eventual sink for pollutants from almost all the districts situated in its watershed system. It is the recipient of untreated sewage from big cities like, Kalam, Bahrain, Madayen,

Mingora, Matta, Barikot, Thana, Chakdara, wouch, Batkhala and Totakan and the villages situated along the banks of River Swat and its Tributaries.

Sediment load is now a distinguishing characteristic of River Swat and its tributaries. The sediment load of River Swat is very high in summer (2000 ppm) and low in winter (20-200 ppm) (**Nafees, 2004**), while in the present study it was found 19 ppm to 667 in normal flow and reached up 4236 ppm during flood event.

There are about 320 small and large hotels discharging their untreated waste directly or indirectly in the river (**The News, 2005**). It also receive agricultural run-off through out its entire stretch that includes pesticides and fertilizer and other salts contents (Nafees, 2004). In the light of the above, the river cannot be considered as unpolluted or clean.

According to other parameters like Conductivity, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Coliform Bacteria, Swat River appeared clean (**Nafees, 2004**).

Some of the measures related to soil conservation could be undertaken as follows:

- The irrigation system is quite week and need proper attention, especially for the rain fed area.
- Proper monitoring program should be initiated for surface and ground water quality assessment along with identification of pollution sources
- To safeguard River Swat ecology by proper utilization. For the irrigation department need to establish annual water budgeting system.
- Strengthening soil, water and environment related organization in terms of trained manpower, enforcing existing laws, regulations and standards. River Swat watershed is quite narrow and is very much sensitive and may not absorb heavy industrial effluents. In this way, to avoid water pollution only small-scale industry should be encouraged in the study area.

7.3 Forest Resources and Bio-diversity

Decrease of forest cover is a major threat to soil resources of River Swat watershed and must be placed on priority. Increased human activities combined with forest fires (Pic- F.5) have accelerated forest loss which contributing to erosion and decrease soil fertility affecting agriculture production negatively. This continuous land degradation and forest-loss has negative impacts on bio-diversity on both flora and fauna. River Swat watershed is rich in medicinal plants and need preservation. To safeguard forest cover and avoid negative impacts on bio-diversity some recommendations in this regards are given below:

- It is required to prepare list of rare and endangered species of flora and fauna, prepare an action plan to encourage plantation of indigenous plant specie.
- Organization like forest, agriculture, environment etc. should be made stronger for the sake of initiation, development and implementation of conservation strategies for mountain, soil, forest, bio-diversity and fresh water resources.
- Adopt proper mechanism for conflict resolutions. As mentioned earlier the tenure and resource ownership is a big problem in the area. Because of strict behavior of Forest Department, people prefer agriculture activities, even on the area not suitable for agriculture. The reason is they cannot cash tree freely, grown on their own field, while in agriculture product they have no such difficulty.
- Forest and biodiversity mapping using Geographic Information System (GIS) will help in planning and decision making process. In this regards Forest Management Center, Peshawar already started GIS activities that should be encouraged and accelerated.
- Eco-tourism could be developed to tune human activities in relation to ecology, which in turn will support income generating activities in the locality.
- Work on development of a culture of cooperation and coordination between government, NGOs and public in order to conserve forest resources in River Swat Watershed.

7.4 Income Generating Activities

To reduce pressure on soil, the various activities identified in the area are Agriculture, horticulture, forestry, fishery, mining, hoteling and tourism. Majority of the people are attached with agriculture, which appeared as burden on soil resources due to ever increase in the use of fertilizer and pesticides. Besides, people of the area are acquiring land, which is not fit for agriculture, and accelerating soil erosion. While looking into other activities minor portion of the population is attached with these professions, while government jobs are limited. Therefore, to produce sustainability in these is of prime concern.

- More people should be employed in forestry related activities from the local areas.
- To make women part of income generating activities, special program should be initiated in schools and colleges such as embroidery.
- Tourism is one of the potential industries that can accommodate major portion of population and needed to be streamlines. At present mostly people from outside have occupied this industry. PTDC, and STC are required to prepare such program to involve local people in this

industry. The main attractions for tourism includes identifying areas for fishing, tracking, scatting, hunting, stadium, water sports, plain area tracking, cycling, historical monuments, areas of special season, and culture festival.

- Fishery is another potential activity that can accommodate people. The present situation is very much drastic, if continued, is a great threat to fish bio-diversity.
- Migratory birds visiting the area including starling, ducks and Finches are under threats. To protect migratory birds, and make tourism attractive, hunting needed to be regulated and area should be identified for bird seeing.
- Apicultural activities also need encouragement and will be helpful to uplift socio-economic condition and also to release pressure on soil resources in terms of subsistence agriculture.

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Table E.1a:- Soile texture of selected Soil Sample Collected From River Swat Watershed during 2005

Sample No	Serial No	Sub Sample No	Village	Sample Wt (g)	Sand	Sand %age	Clay	%age Clay	Silt	%age Silt	Texture Class
1	1	1	Kalam	90.562	75.040	82.860	7.154	7.900	8.368	9.240	Loamy sand
2	2	2	Pashmal	80.983	68.876	85.050	5.418	6.690	6.697	8.270	Loamy sand
3	3	3	Asharopatai	95.456	78.980	82.740	7.255	7.600	9.221	9.660	Loamy sand
4	4	4	Laikot	105.134	86.073	81.870	9.262	8.810	9.788	9.310	Loamy sand
5	5	5	Asrit	110.142	95.350	86.570	12.721	11.550	2.071	1.880	Loamy sand
6	6	6	Mankial	102.431	85.089	83.070	10.899	10.640	6.443	6.290	Loamy sand
7	7	7	Kedam	91.231	71.735	78.630	7.207	7.900	12.280	13.460	Loamy sand
8	8	8-A Irrigated	Bahrain	94.234	73.078	77.550	15.143	16.070	6.012	6.380	Loamy sand
	9	8-B Rainfed		82.234	64.545	78.490	5.000	6.080	12.689	15.430	Loamy sand
9	10	9-A Irrigated	Satal	85.872	67.401	78.490	5.221	6.080	13.250	15.430	Loamy sand
	11	9-B Rainfed		85.345	65.673	76.950	4.668	5.470	15.004	17.580	Loamy sand
	12	10-A Irrigated	Madyan	88.284	66.001	74.760	16.386	18.560	5.906	6.690	Loamy sand
10	13	10-B Rainfed		86.634	64.690	74.670	16.123	18.610	5.839	6.740	Loamy sand
11	14	11-A Danman	Jare	81.234	53.290	65.600	4.443	5.470	23.501	28.930	Sandy loam
	15	11-B Jewardara		90.231	55.203	61.180	7.679	8.510	27.349	30.310	Sandy loam
	16	11-C Shoulgar		92.315	53.995	58.490	10.385	11.250	27.935	30.260	Sandy loam
12	17	12-A Danman	Fatepur	90.172	55.609	61.670	15.347	17.020	19.207	21.300	Sandy loam
	18	12-B Jewardara		96.391	58.172	60.350	16.406	17.020	21.804	22.620	Sandy loam
	19	12-C Shoulgar		85.235	56.553	66.350	13.731	16.110	14.950	17.540	Sandy loam
13	20	12-A Danman	Darmai	87.561	66.433	75.870	10.376	11.850	10.752	12.280	Sandy loam
	21	12-B Jewardara		90.342	66.094	73.160	9.883	10.940	14.364	15.900	Sandy loam
	22	12-C Shoulgar		86.234	63.399	73.520	11.529	13.370	11.297	13.100	Sandy loam
14	23	14	Sakhra	81.284	58.362	71.800	9.388	11.550	13.534	16.650	Sandy loam
15	24	12-A Danman	Bagh Dheri	92.315	58.223	63.070	14.595	15.810	19.497	21.120	Sandy loam
	25	12-B Jewardara		90.172	55.717	61.790	13.706	15.200	20.749	23.010	Sandy loam
	26	12-C Shoulgar		96.391	65.748	68.210	13.475	13.980	17.167	17.810	Sandy loam
16	27	12-A Danman	Asharai	91.191	58.928	64.620	13.031	14.290	19.232	21.090	Sandy loam
	28	12-B Jewardara		92.134	65.728	71.340	11.480	12.460	14.926	16.200	Sandy loam
	29	12-C Shoulgar		91.152	66.541	73.000	12.187	13.370	12.424	13.630	Sandy loam
17	30	12-A Danman	Dursh Khela	80.217	57.475	71.650	9.506	11.850	13.236	16.500	Sandy loam
	31	12-B Jewardara		80.328	52.679	65.580	9.519	11.850	18.130	22.570	Sandy loam
	32	12-C Shoulgar		83.326	55.037	66.050	13.932	16.720	14.365	17.240	Sandy loam
18	33	12-A Danman	Sambat	85.921	60.454	70.360	11.488	13.370	13.979	16.270	Sandy loam
	34	12-B Jewardara		95.532	62.392	65.310	11.321	11.850	21.810	22.830	Sandy loam
	35	12-C Shoulgar		92.724	67.206	72.480	10.431	11.250	15.095	16.280	Sandy loam
19	36	12-A Danman	Shokhdara	91.982	57.424	62.430	14.257	15.500	20.291	22.060	Sandy loam
	37	12-B Jewardara		105.334	63.580	60.360	15.684	14.890	26.060	24.740	Sandy loam
	38	12-C Shoulgar		109.221	77.612	71.060	18.262	16.720	13.347	12.220	Sandy loam
20	39	20	Wainai	98.872	72.414	73.240	17.431	17.630	9.027	9.130	Sandy loam
21	40	21	Chuprial	91.772	67.875	73.960	15.344	16.720	8.553	9.320	Sandy loam
22	41	22	Changialai	93.341	73.907	79.180	12.769	13.680	6.674	7.150	Sandy loam
23	42	23	Gwalarai	87.918	69.842	79.440	12.027	13.680	6.049	6.880	Sandy loam
24	43	24	Roringar	88.922	71.947	80.910	11.889	13.370	5.077	5.710	Sandy loam
25	44	25	Fazal Banad	81.833	65.589	80.150	12.185	14.890	4.051	4.950	Sandy loam
26	45	26	Sarkarai	91.863	74.464	81.060	13.963	15.200	3.445	3.750	Sandy loam
27	46	27	Kalagai	82.342	63.049	76.570	12.516	15.200	6.777	8.230	Sandy loam
28	47	12-A Danman	Shairpalam	81.927	56.284	68.700	10.208	12.460	15.427	18.830	Sandy loam
	48	12-B Jewardara		92.934	57.350	61.710	15.250	16.410	20.325	21.870	Sandy loam
	49	12-C Shoulgar		82.782	59.239	71.560	12.583	15.200	10.969	13.250	Sandy loam
29	50	12-A Danman	Shakar Dara	85.912	57.235	66.620	13.840	16.110	14.846	17.280	Sandy loam
	51	12-B Jewardara		83.398	53.592	64.260	9.883	11.850	19.924	23.890	Sandy loam
	52	12-C Shoulgar		93.893	66.786	71.130	16.553	17.630	10.554	11.240	Sandy loam
30	53	12-A Danman	Ningulai	84.362	52.482	62.210	12.562	14.890	19.319	22.900	Sandy loam
	54	12-B Jewardara		95.663	56.183	58.730	16.865	17.630	22.615	23.640	Sandy loam
	55	12-C Shoulgar		80.755	57.627	71.360	13.010	16.110	10.119	12.530	Sandy loam
31	56	12-A Danman	Bara & Kuza Bandai	94.592	55.204	58.360	16.393	17.330	23.005	24.320	Sandy loam
	57	12-B Jewardara		84.902	49.787	58.640	11.097	13.070	24.019	28.290	Sandy loam
	58	12-C Shoulgar		82.107	43.599	53.100	10.731	13.070	27.777	33.830	Sandy loam
32	59	12-A Danman	Sigram	79.246	48.205	60.830	17.339	21.880	13.702	17.290	Sandy clay loam
	60	12-B Jewardara		90.532	62.440	68.970	18.432	20.360	9.651	10.660	Sandy clay loam
	61	12-C Shoulgar		85.931	59.894	69.700	14.892	17.330	11.145	12.970	Sandy loam
33	62	12-A Danman	Kanju	96.921	66.808	68.930	12.668	13.070	17.446	18.000	Sandy loam
	63	12-B Jewardara		82.983	51.292	61.810	17.402	20.970	14.290	17.220	Sandy clay loam
	64	12-C Shoulgar		85.342	60.610	71.020	14.790	17.330	9.942	11.650	Sandy loam
34	65	34	Kala	83.876	56.096	66.880	13.512	16.110	14.267	17.010	Sandy loam
35	66	35	Deolai	93.229	60.310	64.690	16.157	17.330	16.772	17.990	Sandy loam
36	67	36	Tal	93.723	70.077	74.770	11.678	12.460	11.968	12.770	Sandy loam
37	68	37	Tutano Banda	83.933	56.621	67.460	17.861	21.280	9.451	11.260	Sandy clay loam
38	69	38	Sarsanai	87.434	46.751	53.470	20.460	23.400	20.223	23.130	Sandy clay loam
39	70	12-A Danman	Gul Jaba	91.949	60.990	66.330	20.679	22.490	10.280	11.180	Sandy clay loam
	71	12-C Shoulgar		93.444	48.012	51.380	34.649	37.080	10.783	11.540	Sandy clay

Table E.1a. Cont....

Table E.1a:- Soile texture of selected Soil Sample Collected From River Swat Watershed during 2005

Sample No	Serial No	Sub Sample No	Village	Sample Wt (g)	Sand	Sand %age	Clay	%age Clay	Silt	%age Silt	Texture Class
40	72	12-A Danman	Kabbal	82.281	54.577	66.330	18.505	22.490	9.199	11.180	Sandy clay loam
	73	12-B Jewardara		81.459	38.074	46.740	30.458	37.390	12.928	15.870	Sandy clay
	74	12-C Shoulgar		83.657	55.916	66.840	13.987	16.720	13.753	16.440	Sandy loam
41	75	41	Kotlai	87.493	64.780	74.040	15.425	17.630	7.297	8.340	Sandy loam
42	76	42	Surgalai	91.563	76.492	83.540	6.959	7.600	8.122	8.870	Loamy sand
43	77	12-A Danman	Parrai	88.445	63.601	71.910	10.481	11.850	14.363	16.240	Sandy loam
	78	12-B Jewardara		95.658	59.978	62.700	22.384	23.400	13.287	13.890	Sandy clay loam
	79	12-C Shoulgar		89.904	55.588	61.830	6.015	6.690	28.311	31.490	Sandy loam
44	80	12-A Danman	Nagwa	80.009	68.888	86.100	5.353	6.690	5.769	7.210	Loamy sand
	81	12-B Jewardara		84.558	60.045	71.010	9.766	11.550	14.747	17.440	Sandy loam
	82	12-C Shoulgar		87.565	62.101	70.920	19.965	22.800	5.499	6.280	Sandy clay loam
45	83	12-A Danman	Dedawar	81.783	49.789	60.880	13.919	17.020	18.074	22.100	Sandy loam
	84	12-B Jewardara		91.657	46.644	50.890	24.234	26.440	20.769	22.660	Sandy clay loam
	85	12-C Shoulgar		93.598	67.746	72.380	15.650	16.720	10.202	10.900	Sandy loam
46	86	12-A Danman	Tirang	90.932	57.824	63.590	16.304	17.930	16.795	18.470	Sandy loam
	87	12-B Jewardara		84.674	45.182	53.360	11.067	13.070	28.425	33.570	Sandy loam
	88	12-C Shoulgar		87.153	53.956	61.910	4.767	5.470	28.429	32.620	Sandy loam
47	89	12-A Danman	Chongai	81.563	60.683	74.400	9.918	12.160	10.970	13.450	Sandy loam
	90	12-B Jewardara		80.756	47.097	58.320	14.480	17.930	19.180	23.750	Sandy loam
	91	12-C Shoulgar		94.291	61.214	64.920	5.450	5.780	27.627	29.300	Sandy loam
48	92	48	Sarai	84.542	44.106	52.170	31.348	37.080	9.088	10.750	Sandy clay
49	93	49	Miandam	91.667	43.505	47.460	14.722	16.060	33.431	36.470	Sandy clay
50	94	12-A Danman	Shin	93.569	48.085	51.390	13.932	14.890	31.542	33.710	Loam
	95	12-B Jewardara		90.182	42.755	47.410	10.145	11.250	37.281	41.340	Loam
	96	12-C Shoulgar		96.291	52.074	54.080	11.709	12.160	32.508	33.760	Sandy loam
51	97	12-A Danman	Kotanai	85.238	65.812	77.210	4.663	5.470	14.763	17.320	Loamy sand
	98	12-B Jewardara		80.667	38.712	47.990	14.956	18.540	26.999	33.470	Loam
	99	12-C Shoulgar		80.934	50.300	62.150	9.591	11.850	21.043	26.000	Sandy loam
52	100	12-A Danman	Chalyar	94.557	70.549	74.610	9.928	10.500	14.080	14.890	Sandy loam
	101	12-B Jewardara		84.424	43.765	51.840	22.068	26.140	18.590	22.020	Sandy clay loam
	102	12-C Shoulgar		94.538	67.245	71.130	16.667	17.630	10.626	11.240	Sandy loam
53	103	12-A Danman	Khwazakhela	84.533	57.060	67.500	10.795	12.770	16.687	19.740	Sandy loam
	104	12-B Jewardara		91.977	38.354	41.700	5.316	5.780	48.306	52.520	Silt loam
	105	12-C Shoulgar		93.543	66.163	70.730	12.797	13.680	14.583	15.590	Sandy loam
54	106	12-A Danman	Gulibagh	90.172	58.197	64.540	15.897	17.630	16.078	17.830	Sandy loam
	107	12-B Jewardara		84.568	41.058	48.550	23.645	27.960	19.865	23.490	Sandy clay loam
	108	12-C Shoulgar		95.774	61.631	64.350	8.150	8.510	25.993	27.140	Sandy loam
55	109	12-A Danman	Dakorak	80.634	56.581	70.170	11.523	14.290	12.539	15.550	Sandy loam
	110	12-B Jewardara		94.548	49.326	52.170	25.575	27.050	19.638	20.770	Sandy clay loam
	111	12-C Shoulgar		92.315	55.971	60.630	13.746	14.890	22.599	24.480	Sandy loam
56	112	12-A Danman	Charbagh	90.172	65.600	72.750	8.224	9.120	16.348	18.130	Sandy loam
	113	12-B Jewardara		96.391	44.831	46.510	20.213	20.970	31.346	32.520	Loam
	114	12-C Shoulgar		99.543	53.425	53.670	10.283	10.330	35.826	35.990	Sandy loam
57	115	57	Tilgram	98.273	60.536	61.600	15.832	16.110	21.905	22.290	Sandy loam
58	116	12-A Danman	Manglaur	80.883	33.437	41.340	17.212	21.280	30.234	37.380	Loam
	117	12-B Jewardara		82.832	32.097	38.750	7.049	8.510	43.686	52.740	Silt Loam
	118	12-C Shoulgar		91.377	56.544	61.880	10.828	11.850	23.996	26.260	Sandy loam
59	119	12-A Danman	Dangram	85.733	36.565	42.650	4.690	5.470	44.478	51.880	Silt loam
	120	12-B Jewardara		94.737	50.893	53.720	16.702	17.630	27.142	28.650	Sandy loam
	121	12-C Shoulgar		86.644	58.987	68.080	15.535	17.930	12.121	13.990	Sandy loam
60	122	12-A Danman	Sangota	84.994	28.983	34.100	11.109	13.070	44.902	52.830	Silt Loam
	123	12-B Jewardara		97.558	35.814	36.710	11.268	11.550	50.477	51.740	Silt loam
	124	12-C Shoulgar		91.114	48.983	53.760	15.508	17.020	26.624	29.220	Sandy loam
61	125	12-A Danman	Takhtaband	94.215	27.049	28.710	12.031	12.770	55.135	58.520	Silt loam
	126	12-B Jewardara		93.018	38.509	41.400	5.935	6.380	48.574	52.220	Silt loam
	127	12-C Shoulgar		85.118	46.142	54.210	6.988	8.210	31.996	37.590	Sandy loam
62	128	12-A Danman	Jambil	87.442	68.633	78.490	5.316	6.080	13.492	15.430	Loamy sand
	129	12-B Jewardara		88.783	59.929	67.500	9.447	10.640	19.408	21.860	Sandy loam
63	130	12-A Danman	Bologram	84.516	45.622	53.980	14.900	17.630	23.994	28.390	Sandy loam
	131	12-B Jewardara		87.216	36.700	42.080	14.050	16.110	36.465	41.810	Loam
	132	12-C Shoulgar		88.443	47.175	53.340	15.327	17.330	25.940	29.330	Sandy loam
64	133	12-A Danman	Gogdara	85.625	48.370	56.490	9.890	11.550	27.366	31.960	Sandy loam
	134	12-B Jewardara		91.363	30.862	33.780	16.381	17.930	44.119	48.290	Loam
	135	12-C Shoulgar		84.125	57.811	68.720	15.344	18.240	10.978	13.050	Sandy loam
65	136	12-A Danman	Pajigram	81.835	48.283	59.000	14.428	17.630	19.133	23.380	Sandy loam
	137	12-B Jewardara		95.593	47.452	49.640	35.742	37.390	12.398	12.970	Sandy clay
	138	12-C Shoulgar		78.286	53.751	68.660	18.084	23.100	6.451	8.240	Sandy clay loam
66	139	12-A Danman	Ghaligai	96.928	58.797	60.660	15.906	16.410	22.226	22.930	Sandy loam
	140	12-B Jewardara		86.075	27.639	32.110	9.683	11.250	48.761	56.650	Silt Loam
	141	12-C Shoulgar		99.946	53.961	53.990	15.492	15.500	30.494	30.510	Sandy loam
67	142	12-A Danman	Manyar	98.628	66.031	66.950	16.786	17.020	15.810	16.030	Sandy loam

Table E.1a. Cont....

Table E.1a:- Soile texture of selected Soil Sample Collected From River Swat Watershed during 2005

Sample No	Serial No	Sub Sample No	Village	Sample Wt (g)	Sand	Sand %age	Clay	%age Clay	Silt	%age Silt	Texture Class
67	143	12-B Jewardara	Manyar	102.664	51.671	50.330	27.771	27.050	23.223	22.620	Sandy clay loam
	144	12-C Shoulgar		105.515	60.724	57.550	12.187	11.550	32.604	30.900	Sandy loam
68	145	12-A Danman	Barikot	108.627	70.705	65.090	12.221	11.250	25.701	23.660	Sandy loam
	146	12-B Jewardara		110.492	51.854	46.930	20.485	18.540	38.153	34.530	Loam
	147	12-C Shoulgar		101.446	62.217	61.330	8.329	8.210	30.900	30.460	Sandy loam
69	148	12-A Danman	Abua	81.176	64.235	79.130	5.179	6.380	11.762	14.490	Loamy sand
	149	12-B Jewardara		91.736	61.922	67.500	11.715	12.770	18.109	19.740	Sandy loam
	150	12-C Shoulgar		93.783	52.415	55.890	11.976	12.770	29.401	31.350	Sandy loam
70	151	12-A Danman	Kotah	90.447	70.413	77.850	5.228	5.780	14.806	16.370	Loamy sand
	152	12-B Jewardara		84.872	56.678	66.780	9.803	11.550	18.392	21.670	Sandy loam
	153	12-C Shoulgar		87.078	46.839	53.790	7.410	8.510	32.828	37.700	Sandy loam
71	154	12-A Danman	Landakai	113.702	86.959	76.480	10.631	9.350	16.112	14.170	Loamy sand
	155	12-B Jewardara		108.536	65.089	59.970	10.984	10.120	32.463	29.910	Sandy loam
	156	12-C Shoulgar		101.445	58.554	57.720	7.243	7.140	35.648	35.140	Sandy loam
72	157	72-A Danman	Haibatgram	103.245	60.625	58.720	23.055	22.330	19.565	18.950	Sandy clay loam
	158	72-B Jewardara		102.366	37.108	36.250	15.897	15.530	49.361	48.220	Silt loam
	159	72-C Shoulgar		98.286	47.610	48.440	13.023	13.250	37.653	38.310	Sandy loam
73	160	73-A Danman	Thana	105.556	36.480	34.560	22.568	21.380	46.508	44.060	Silt loam
	161	73-B Jewardara		115.583	46.048	39.840	12.656	10.950	56.878	49.210	Loam
	162	73-C Shoulgar		112.667	66.102	58.670	13.081	11.610	33.485	29.720	Sandy loam
74	163	74	Nal	114.347	78.065	68.270	14.431	12.620	21.852	19.110	Sandy loam
75	164	75	Gunyar	109.494	62.817	57.370	15.187	13.870	31.490	28.760	Sandy loam
76	165	76-A Danman	Allahadan	104.367	46.631	44.680	19.788	18.960	37.948	36.360	Loam
	166	76-B Jewardara		107.573	50.097	46.570	17.040	15.840	40.437	37.590	Loam
	167	76-C Shoulgar		112.783	59.042	52.350	12.226	10.840	41.515	36.810	Sandy loam
77	168	77-A Danman	Batkhala	115.828	48.231	41.640	22.876	19.750	44.721	38.610	Loam
	169	77-B Jewardara		102.416	43.875	42.840	17.185	16.780	41.356	40.380	Loam
	170	77-C Shoulgar		194.017	102.305	52.730	23.010	11.860	68.701	35.410	Sandy loam
78	171	78	Piran	145.008	86.236	59.470	15.835	10.920	42.937	29.610	Sandy loam
79	172	79	Rangmala	109.048	67.250	61.670	11.614	10.650	30.184	27.680	Sandy loam
80	173	80-A Danman	Jolagram	104.754	50.931	48.620	11.670	11.140	42.153	40.240	Loam
	174	80-B Jewardara		98.227	42.964	43.740	10.275	10.460	44.988	45.800	Loam
	175	80-C Shoulgar		103.648	51.575	49.760	12.583	12.140	39.490	38.100	Loam
81	176	81-A Danman	Matkani	107.734	49.288	45.750	20.383	18.920	38.062	35.330	Loam
	177	81-B Jewardara		109.934	56.979	51.830	17.414	15.840	35.542	32.330	Loam
	178	81-C Shoulgar		108.733	63.870	58.740	13.755	12.650	31.109	28.610	Sandy loam
82	179	82-A Danman	Totakan	103.453	51.085	49.380	22.687	21.930	29.681	28.690	Sandy clay loam
	180	82-B Jewardara		125.573	55.968	44.570	23.583	18.780	46.023	36.650	Loam
	181	82-C Shoulgar		124.456	60.685	48.760	14.014	11.260	49.758	39.980	Loam
83	182	83	Bagh Raji	114.657	60.344	52.630	21.716	18.940	32.597	28.430	Sandy clay loam
84	183	87-A Irrigated	Makhband	129.567	67.155	51.830	10.132	7.820	52.280	40.350	Sandy loam
	184	87-B rainfed		112.344	69.372	61.750	8.718	7.760	34.254	30.490	Sandy loam
85	185	85-A Danman	Kalangai	124.457	85.091	68.370	19.129	15.370	20.237	16.260	Sandy loam
	186	85-B Jewardara		105.453	68.386	64.850	13.424	12.730	23.643	22.420	Sandy loam
	187	85-C Shoulgar		117.562	68.985	58.680	12.074	10.270	36.503	31.050	Sandy loam
86	188	86-A Danman	Ramora	86.627	68.972	79.620	6.055	6.990	11.599	13.390	Loamy sand
	189	86-B Jewardara		99.375	60.857	61.240	11.478	11.550	27.040	27.210	Sandy loam
	190	86-C Shoulgar		98.466	67.558	68.610	17.655	17.930	13.254	13.460	Sandy loam
87	191	86-A Danman	Chakdara	102.828	70.951	69.000	14.375	13.980	17.501	17.020	Sandy loam
	192	86-B Jewardara		105.534	57.073	54.080	12.833	12.160	35.628	33.760	Sandy loam
	193	86-C Shoulgar		91.616	42.519	46.410	5.845	6.380	43.243	47.200	Sandy loam
88	194	88	Shewa	94.533	26.838	28.390	24.134	25.530	43.551	46.070	Loam
89	195	89	Tindo Dag	84.722	30.102	35.530	19.825	23.400	34.795	41.070	Loam
90	196	90	Kitiarai	94.408	46.543	49.300	17.503	18.540	30.352	32.150	Loam
91	197	91	Khanpur	84.336	56.910	67.480	14.354	17.020	13.072	15.500	Sandy loam
92	198	92	Khairabad	91.665	55.705	60.770	15.326	16.720	20.634	22.510	Sandy loam
93	199	93	Chikhoo	82.086	42.586	51.880	20.957	25.530	18.543	22.590	Sandy clay loam
94	200	94	Usakai	91.997	47.148	51.250	21.251	23.100	23.597	25.650	Sandy clay loam
95	201	95	Wuch	85.783	39.820	46.420	27.639	32.220	18.323	21.360	Sandy clay loam
96	202	96-A Irrigated	Gadar	94.236	34.735	36.860	20.053	21.280	39.457	41.870	Loam
	203	96-B Rainfed		86.873	31.969	36.800	13.995	16.110	40.908	47.090	Loam
97	204	97-A Daman	Badwan	87.223	56.486	64.760	7.161	8.210	23.576	27.030	Silt Loam
	205	97-B Shoulgar		86.703	46.074	53.140	8.956	10.330	31.664	36.520	Sandy loam
98	206	98-A Daman	Mian Barangola	86.992	50.899	58.510	14.806	17.020	21.287	24.470	Sandy loam
	207	98-B Shoulgar		99.873	60.923	61.000	7.281	7.290	31.670	31.710	Sandy loam
99	208	99-A Daman	Tiruna	102.923	53.788	52.260	5.949	5.780	43.197	41.970	Sandy loam
	209	99-B Jewardara		91.564	44.839	48.970	25.327	27.660	21.399	23.370	Sandy clay loam
	210	99-C Shoulgar		93.978	58.097	61.820	17.705	18.840	18.175	19.340	Sandy loam
100	211	100-A	Kamala	90.434	42.052	46.500	28.035	31.000	20.339	22.490	Sandy clay loam
	212	100-B		84.289	55.445	65.780	14.093	16.720	14.751	17.500	Sandy loam

Table E.1a. Cont....

Table E.1b:-Soile texture of selected Soil Sample Collected From River Swat Watershed during 2006

Serial No	Sample No	Sub Sample No	Village	Sample Wt (g)	Total Sand	T. Sand %age	Clay	%age Clay	Silt	%age Silt	Texture Class
1	1	1	Kalam	92.212	74.286	80.560	7.838	8.500	10.088	10.940	Loamy sand
2	2	2	Pashmal	85.172	71.698	84.180	6.158	7.230	7.316	8.590	Loamy sand
3	3	3	Asharopatai	81.542	64.932	79.630	6.931	8.500	9.679	11.870	Loamy sand
4	4	4	Laikot	92.562	73.707	79.630	7.905	8.540	10.950	11.830	Loamy sand
5	5	5	Asrit	95.322	78.698	82.560	10.028	10.520	6.596	6.920	Loamy sand
6	6	6	Mankial	98.326	78.897	80.240	9.469	9.630	9.960	10.130	Loamy sand
7	7	7	Kedam	95.824	73.152	76.340	5.941	6.200	15.773	16.460	Loamy sand
8	8	8-A Irrigated	Bahrain	91.544	71.606	78.220	6.619	7.230	13.320	14.550	Loamy sand
9	8	8-B Rainfed		85.143	64.990	76.330	6.113	7.180	14.040	16.490	Sandy Loam
10	9	9-A Irrigated	Satal	80.175	61.510	76.720	5.716	7.130	12.948	16.150	Sandy Loam
11	9	9-B Rainfed		82.135	62.718	76.360	5.027	6.120	14.390	17.520	Loamy sand
12	10	10-A Irrigated	Madyan	85.426	64.249	75.210	14.719	17.230	6.458	7.560	Sandy loam
13	10	10-B Rainfed		82.241	64.049	77.880	5.913	7.190	12.279	14.930	Loamy sand
14	11	11-A Danman	Jare	83.134	56.215	67.620	5.254	6.320	21.665	26.060	Sandy loam
15	11	11-B Jewardara		85.136	52.980	62.230	6.266	7.360	25.890	30.410	Sandy loam
16	11	11-C Shoulgar		90.348	54.652	60.490	11.041	12.220	24.656	27.290	Sandy loam
17	12	12-A Danman	Fatepur	88.724	55.408	62.450	14.870	16.760	18.446	20.790	Sandy loam
18	12	12-B Jewardara	Fatepur	93.426	58.139	62.230	15.453	16.540	19.834	21.230	Sandy loam
19	12	12-C Shoulgar	Fatepur	90.374	58.951	65.230	15.680	17.350	15.743	17.420	Sandy loam
20	13	13-A Danman	Darmai	82.307	62.833	76.340	10.181	12.370	9.292	11.290	Sandy loam
21	13	13-B Jewardara	Darmai	85.673	61.924	72.280	9.638	11.250	14.110	16.470	Sandy loam
22	13	13-C Shoulgar	Darmai	87.193	62.997	72.250	11.047	12.670	13.149	15.080	Sandy loam
23	14	14	Sakhra	80.347	58.822	73.210	9.859	12.270	11.666	14.520	Sandy loam
24	15	15-A Danman	Bagh Dheri	90.528	58.961	65.130	13.063	14.430	18.504	20.440	Sandy loam
25	15	15-B Jewardara	Bagh Dheri	92.336	57.849	62.650	13.139	14.230	21.348	23.120	Sandy loam
26	15	15-C Shoulgar	Bagh Dheri	94.224	62.527	66.360	11.731	12.450	19.966	21.190	Sandy loam
27	16	16-A Danman	Asharai	93.327	60.784	65.130	12.552	13.450	19.991	21.420	Sandy loam
28	16	16-B Jewardara	Asharai	90.872	63.120	69.460	12.104	13.320	15.648	17.220	Sandy loam
29	16	16-C Shoulgar	Asharai	94.326	67.764	71.840	11.159	11.830	15.403	16.330	Sandy loam
30	17	17-A Danman	Dursh Khela	84.620	59.124	69.870	10.442	12.340	15.054	17.790	Sandy loam
31	17	17-B Jewardara	Dursh Khela	86.872	55.876	64.320	10.633	12.240	20.363	23.440	Sandy loam
32	17	17-C Shoulgar	Dursh Khela	82.157	53.690	65.350	12.751	15.520	15.717	19.130	Sandy loam
33	18	18-A Danman	Sambat	82.142	56.629	68.940	10.547	12.840	14.966	18.220	Sandy loam
34	18	18-B Jewardara	Sambat	91.683	60.639	66.140	11.231	12.250	19.813	21.610	Sandy loam
35	18	18-C Shoulgar	Sambat	91.638	65.824	71.830	9.934	10.840	15.881	17.330	Sandy loam
36	19	19-A Danman	Shokhdara	88.529	54.746	61.840	13.058	14.750	20.725	23.410	Sandy loam
37	19	19-B Jewardara	Shokhdara	93.725	57.285	61.120	14.274	15.230	22.166	23.650	Sandy loam
38	19	19-C Shoulgar	Shokhdara	88.257	63.863	72.360	13.980	15.840	10.414	11.800	Sandy loam
39	20	20	Wainai	92.615	67.322	72.690	15.263	16.480	10.030	10.830	Sandy loam
40	21	21	Chuprial	87.364	63.365	72.530	13.664	15.640	10.335	11.830	Sandy loam
41	22	22	Changialai	88.236	69.548	78.820	11.444	12.970	7.244	8.210	Sandy loam
42	23	23	Gwalarai	85.145	66.950	78.630	10.924	12.830	7.271	8.540	Sandy loam
43	24	24	Roringar	86.364	68.167	78.930	10.934	12.660	7.263	8.410	
44	25	25	Fazal Banad	83.742	66.952	79.950	12.787	15.270	4.003	4.780	Sandy loam
45	26	26	Sarkarai	87.651	69.183	78.930	14.226	16.230	4.216	4.810	Sandy loam
46	27	27	Kalagai	85.375	64.322	75.340	12.149	14.230	8.905	10.430	Sandy loam
47	28	28-A Danman	Shairpalam	82.273	55.798	67.820	9.437	11.470	17.039	20.710	
48	28	28-B Jewardara	Shairpalam	90.652	56.322	62.130	14.169	15.630	20.170	22.250	Sandy loam
49	28	28-C Shoulgar	Shairpalam	85.473	60.036	70.240	12.539	14.670	12.898	15.090	Sandy loam
50	29	29-A Danman	Shakar Dara	82.145	55.661	67.760	12.716	15.480	13.768	16.760	Sandy loam
51	29	29-B Jewardara	Shakar Dara	84.766	55.200	65.120	11.223	13.240	18.343	21.640	Sandy loam
52	29	29-C Shoulgar	Shakar Dara	88.262	63.858	72.350	12.569	14.240	11.836	13.410	Sandy loam
53	30	30-A Danman	Ningulai	91.352	57.780	63.250	12.460	13.640	21.111	23.110	Sandy loam
54	30	30-B Jewardara	Ningulai	92.326	55.506	60.120	15.012	16.260	21.807	23.620	Sandy loam
55	30	30-C Shoulgar	Ningulai	82.382	57.931	70.320	12.506	15.180	11.945	14.500	Sandy loam
56	31	31-A Danman	Bara & Kuza Bandai	92.145	52.771	57.270	14.716	15.970	24.105	26.160	Sandy loam
57	31	31-B Jewardara	Bara & Kuza Bandai	85.334	48.171	56.450	10.385	12.170	26.778	31.380	Sandy loam
58	31	31-C Shoulgar	Bara & Kuza Bandai	85.318	47.198	55.320	10.033	11.760	28.087	32.920	Sandy loam
59	32	32-A Danman	Sigram	78.316	48.901	15.029	14.387	62.440	18.370	19.190	Sandy loam
60	32	32-B Jewardara	Sigram	89.342	62.227	69.650	16.314	18.260	10.801	12.090	Sandy loam
61	32	32-C Shoulgar	Sigram	90.241	63.403	70.260	13.771	15.260	13.067	14.480	Sandy loam
62	33	33-A Danman	Kanju	95.241	64.040	67.240	11.572	12.150	19.629	20.610	Sandy loam
63	33	33-B Jewardara	Kanju	84.536	52.683	62.320	18.040	21.340	13.813	16.340	Sandy clay loam
64	33	33-C Shoulgar	Kanju	82.135	57.322	69.790	15.129	18.420	9.684	11.790	Sandy loam
65	34	34	Kala	84.724	56.977	67.250	13.158	15.530	14.589	17.220	Sandy loam
66	35	35	Deolai	91.143	57.675	63.280	15.048	16.510	18.420	20.210	Sandy loam
67	36	36	Tal	91.145	66.499	72.960	13.900	15.250	10.746	11.790	Sandy loam
68	37	37	Tutano Banda	85.142	58.944	69.230	18.867	22.160	7.331	8.610	Sandy clay loam
69	38	38	Sarsanai	90.236	52.761	58.470	17.930	19.870	19.545	21.660	Sandy loam
70	39	39-A Danman	Gul Jaba	89.736	58.185	64.840	20.765	23.140	10.786	12.020	Sandy clay loam

Table E.1b:-Soile texture of selected Soil Sample Collected From River Swat Watershed during 2006

Serial No	Sample No	Sub Sample No	Village	Sample Wt (g)	Total Sand	T. Sand %age	Clay	%age Clay	Silt	%age Silt	Texture Class
71	39	39-C Shoulgar	Gul Jaba	91.172	48.440	53.130	32.494	35.640	10.239	11.230	Sandy clay
72	40	40-A Danman	Kabbal	84.147	54.586	64.870	17.595	20.910	11.966	14.220	Sandy clay loam
73	40	40-B Jewardara	Kabbal	82.354	39.719	48.230	29.030	35.250	13.605	16.520	Sandy clay
74	40	40-C Shoulgar	Kabbal	84.172	56.673	67.330	12.845	15.260	14.654	17.410	Sandy loam
75	41	41	Kotlai	85.225	61.635	72.320	12.937	15.180	10.653	12.500	Sandy loam
76	42	42	Surgalai	90.335	72.467	80.220	7.516	8.320	8.031	8.890	Loamy sand
77	43	43-A Danman	Parrai	84.415	61.074	72.350	10.324	12.230	13.017	15.420	Sandy loam
78	43	43-B Jewardara	Parrai	93.226	59.152	63.450	19.894	21.340	14.180	15.210	Sandy clay loam
79	43	43-C Shoulgar	Parrai	85.919	53.545	62.320		7.440	25.982	30.240	Sandy loam
80	44	44-A Danman	Nagwa	86.827	71.493	82.340	6.833	7.870	8.500	9.790	Loamy sand
81	44	44-B Jewardara	Nagwa	88.343	64.694	73.230	10.822	12.250	12.827	14.520	Sandy loam
82	44	44-C Shoulgar	Nagwa	86.927	63.309	72.830	18.455	21.230	5.163	5.940	Sandy clay loam
83	45	45-A Danman	Dedawar	83.819	52.068	62.120	13.302	15.870	18.449	22.010	Sandy loam
84	45	45-B Jewardara	Dedawar	88.179	49.345	55.960	22.803	25.860	16.031	18.180	Sandy clay loam
85	45	45-C Shoulgar	Dedawar	90.184	66.069	73.260	13.879	15.390	10.236	11.350	Sandy loam
86	46	46-A Danman	Tirang	91.667	57.191	62.390	14.969	16.330	19.507	21.280	Sandy loam
87	46	46-B Jewardara	Tirang	94.281	52.081	55.240	12.096	12.830	30.104	31.930	Sandy loam
88	46	46-C Shoulgar	Tirang	82.142	51.232	62.370	5.052	6.150	25.858	31.480	Sandy loam
89	47	47-A Danman	Chongai	82.327	61.935	75.230	10.925	13.270	9.468	11.500	Sandy loam
90	47	47-B Jewardara	Chongai	82.142	49.400	60.140	13.085	15.930	19.657	23.930	Sandy loam
91	47	47-C Shoulgar	Chongai	82.318	53.821	65.382	5.861	7.120	22.637	27.500	Sandy loam
92	48	48	Sarai	82.344	42.687	51.840	29.504	35.830	10.153	12.330	Sandy clay
93	49	49	Miandam	89.436	40.550	45.340	13.219	14.780	35.667	39.880	Loam
94	50	50-A Danman	Shin	90.447	47.240	52.230	11.062	12.230	32.145	35.540	Sandy loam
95	50	50-B Jewardara	Shin	92.273	44.605	48.340	9.569	10.370	38.100	41.290	Loam
96	50	50-C Shoulgar	Shin	93.473	49.344	52.790	10.132	10.840	33.996	36.370	Sandy loam
97	51	51-A Danman	Kotanai	84.553	63.288	74.850	6.959	8.230	14.306	16.920	Loamy sand
98	51	51-B Jewardara	Kotanai	80.247	37.499	46.730	13.522	16.850	29.226	36.420	Loam
99	51	51-C Shoulgar	Kotanai	82.732	53.139	64.230	10.135	12.250	19.459	23.520	Loam
100	52	52-A Danman	Chalyar	95.142	69.330	72.870	11.550	12.140	14.262	14.990	Sandy loam
101	52	52-B Jewardara	Chalyar	86.153	45.859	53.230	21.418	24.860	18.876	21.910	Sandy clay loam
102	52	52-C Shoulgar	Chalyar	92.156	65.191	70.740	14.994	16.270	11.971	12.990	Sandy loam
103	53	53-A Danman	Khwazakhela	85.134	56.069	65.860	9.722	11.420	19.342	22.720	Sandy loam
104	53	53-B Jewardara	Khwazakhela	90.216	39.136	43.380	5.629	6.240	45.451	50.380	Silt loam
105	53	53-C Shoulgar	Khwazakhela	92.172	65.682	71.260	11.411	12.380	15.079	16.360	Sandy loam
106	54	54-A Danman	Gulibagh	92.538	58.697	63.430	14.769	15.960	19.072	20.610	Sandy loam
107	54	54-B Jewardara	Gulibagh	83.348	39.040	46.840	21.871	26.240	22.437	26.920	Sandy clay loam
108	54	54-C Shoulgar	Gulibagh	92.124	57.808	62.750	9.341	10.140	24.975	27.110	Sandy loam
109	55	55-A Danman	Dakorak	81.245	55.953	68.870	10.294	12.670	15.168	18.670	Sandy loam
110	55	55-B Jewardara	Dakorak	93.872	47.715	50.830	24.388	25.980	21.769	23.190	Sandy clay loam
111	55	55-C Shoulgar	Dakorak	90.174	55.141	61.150	11.028	12.230	24.004	26.620	Sandy loam
112	56	56-A Danman	Charbagh	92.162	64.633	70.130	9.419	10.220	18.110	19.650	Sandy loam
113	56	56-B Jewardara	Charbagh	96.273	42.225	43.860	22.268	23.130	31.780	33.010	Loam
114	56	56-C Shoulgar	Charbagh	87.392	45.776	52.380	9.814	11.230	31.802	36.390	Sandy loam
115	57	57	Tilgram	84.746	50.212	59.250	12.153	14.340	22.381	26.410	Sandy loam
116	58	58-A Danman	Manglaur	84.382	35.626	42.220	16.758	19.860	31.998	37.920	Loam
117	58	58-B Jewardara	Manglaur	85.234	31.400	36.840	7.270	8.530	48.268	56.630	Silt Loam
118	58	58-C Shoulgar	Manglaur	92.173	56.096	60.860	9.540	10.350	26.537	28.790	Sandy loam
119	59	59-A Danman	Dangram	86.157	38.969	45.230	7.082	8.220	40.106	46.550	Silt loam
120	59	59-B Jewardara	Dangram	92.133	50.811	55.150	14.032	15.230	27.290	29.620	Sandy loam
122	60	60-A Danman	Sangota	83.225	30.244	36.340	9.879	11.870	43.102	51.790	Silt Loam
123	60	60-B Jewardara	Sangota	95.136	36.285	38.140	8.724	9.170	50.127	52.690	Silt loam
124	60	60-C Shoulgar	Sangota	95.136	49.033	51.540	15.098	15.870	31.005	32.590	loam
125	61	61-A Danman	Takhtaband	94.145	28.356	30.120	12.644	13.430	53.145	56.450	Silt loam
126	61	61-B Jewardara	Takhtaband	93.134	39.330	42.230	7.292	7.830	46.511	49.940	loam
127	61	61-C Shoulgar	Takhtaband	86.133	46.400	53.870	8.682	10.080	31.051	36.050	Sandy loam
128	62	62-A Danman	Jambil	87.135	66.336	76.130	6.343	7.280	14.456	16.590	Loamy sand
129	62	62-B Jewardara	Jambil	88.478	57.750	65.270	10.104	11.420	20.624	23.310	Sandy loam
130	63	63-A Danman	Bologram	85.342	44.608	52.270	13.177	15.440	27.557	32.290	Sandy loam
131	63	63-B Jewardara	Bologram	87.135	35.612	40.870	12.948	14.860	38.575	44.270	Loam
132	63	63-C Shoulgar	Bologram	87.521	45.397	51.870	13.539	15.470	28.584	32.660	loam
133	64	64-A Danman	Gogdara	86.817	47.081	54.230	9.072	10.450	30.664	35.320	Sandy loam
134	64	64-B Jewardara	Gogdara	92.247	31.890	34.570	14.261	15.460	46.096	49.970	loqm
135	64	64-C Shoulgar	Gogdara	84.548	56.098	66.350	14.153	16.740	14.297	16.910	Sandy loam
136	65	65-A Danman	Pajigram	86.854	50.757	58.440	12.898	14.850	23.199	26.710	Sandy loam
137	65	65-B Jewardara	Pajigram	93.233	45.050	48.320	32.781	35.160	15.402	16.520	Sandy clay
138	65	65-C Shoulgar	Pajigram	82.383	57.858	70.230	17.894	21.720	6.632	8.050	Sandy clay loam
139	66	66-A Danman	Ghaligai	93.231	58.046	62.260	13.854	14.860	21.331	22.880	Sandy loam
140	66	66-B Jewardara	Ghaligai	88.152	30.368	34.450	9.468	10.740	48.316	54.810	Silt Loam
141	66	66-C Shoulgar	Ghaligai	95.182	49.904	52.430	12.621	13.260	32.657	34.310	Sandy loam
142	67	67-A Danman	Manyar	96.232	61.810	64.230	15.243	15.840	19.179	19.930	Sandy loam

Table E.1b:-Soile texture of selected Soil Sample Collected From River Swat Watershed during 2006

Serial No	Sample No	Sub Sample No	Village	Sample Wt (g)	Total Sand	T. Sand %age	Clay	%age Clay	Silt	%age Silt	Texture Class
143	67	67-B Jewardara	Manyar	98.146	47.984	48.890	24.978	25.450	25.184	25.660	Sandy clay loam
144	67	67-C Shoulgar	Manyar	92.341	51.582	55.860	9.169	9.930	31.590	34.210	Sandy loam
145	68	68-A Danman	Barikot	96.142	61.406	63.870	10.422	10.840	24.314	25.290	Sandy loam
146	68	68-B Jewardara	Barikot	83.214	38.170	45.870	14.080	16.920	30.964	37.210	Loam
147	68	68-C Shoulgar	Barikot	95.314	57.064	59.870	9.093	9.540	29.157	30.590	Sandy loam
148	69	69-A Danman	Abua	84.430	65.737	77.860	6.011	7.120	12.681	15.020	Loamy sand
149	69	69-B Jewardara	Abua	85.447	56.267	65.850	9.937	11.630	19.243	22.520	Sandy loam
150	69	69-C Shoulgar	Abua	90.462	51.762	57.220	12.972	14.340	25.727	28.440	Sandy loam
151	70	70-A Danman	Kotah	91.351	69.016	75.550	6.614	7.240	15.722	17.210	Loamy sand
152	70	70-B Jewardara	Kotah	86.348	55.798	64.620	9.360	10.840	21.190	24.540	
153	70	70-C Shoulgar	Kotah	85.162	46.200	54.250	7.103	8.340	31.859	37.410	Sandy loam
154	71	71-A Danman	Landakai	98.241	74.526	75.860	7.967	8.110	15.768	16.050	Loamy sand
155	71	71-B Jewardara	Landakai	83.233	50.631	60.830	7.191	8.640	25.411	30.530	Sandy loam
156	71	71-C Shoulgar	Landakai	93.356	56.312	60.320	7.319	7.840	29.725	31.840	Sandy loam
157	72	72-A Danman	Haibatgram	93.284	53.983	57.870	22.239	23.840	17.062	18.290	Sandy clay loam
158	72	72-B Jewardara	Haibatgram	85.235	30.071	35.280	12.657	14.850	42.507	49.870	Loam
159	72	72-C Shoulgar	Haibatgram	86.413	45.661	52.840	9.799	11.340	30.953	35.820	Sandy loam
160	73	73-A Danman	Thana	91.218	22.011	24.130	20.843	22.850	48.364	53.020	Silt loam
161	73	73-B Jewardara	Thana	92.423	37.588	40.670	12.440	13.460	42.394	45.870	Loam
162	73	73-C Shoulgar	Thana	93.218	55.782	59.840	10.599	11.370	26.837	28.790	Sandy loam
163	74	74	Nal	85.327	58.671	68.760	9.318	10.920	17.338	20.320	Sandy loam
164	75	75	Gunyar	94.527	56.943	60.240	13.924	14.730	23.660	25.030	Sandy loam
165	76	76-A Danman	Allahadan	84.742	37.990	44.830	16.898	19.940	29.855	35.230	Loam
166	76	76-B Jewardara	Allahadan	92.426	41.906	45.340	15.491	16.760	35.029	37.900	Loam
167	76	76-C Shoulgar	Allahadan	92.363	52.499	56.840	10.114	10.950	29.750	32.210	Sandy loam
168	77	77-A Danman	Batkhala	83.272	30.369	36.470	17.346	20.830	35.557	42.700	Loam
169	77	77-B Jewardara	Batkhala	80.273	34.389	42.840	12.820	15.970	33.064	41.190	Loam
170	77	77-C Shoulgar	Batkhala	86.792	45.366	52.270	10.302	11.870	31.124	35.860	Sandy loam
171	78	78	Piran	86.723	53.127	61.260	11.083	12.780	22.513	25.960	Sandy loam
172	79	79	Rangmala	85.437	48.981	57.330	8.997	10.530	27.459	32.140	Sandy loam
173	80	80-A Danman	Jolagram	86.352	40.041	46.370	10.595	12.270	35.715	41.360	Loam
174	80	80-B Jewardara	Jolagram	95.726	43.584	45.530	10.788	11.270	41.354	43.200	Loam
175	80	80-C Shoulgar	Jolagram	93.329	49.222	52.740	10.108	10.830	34.000	36.430	Sandy loam
176	81	81-A Danman	Matkani	85.939	38.887	45.250	16.560	19.270	30.491	35.480	Loam
177	81	81-B Jewardara	Matkani	97.473	46.709	47.920	15.430	15.830	35.334	36.250	Loam
178	81	81-C Shoulgar	Matkani	84.752	44.368	52.350	10.814	12.760	29.570	34.890	Sandy loam
179	82	82-A Danman	Totakan	93.637	47.231	50.440	21.939	23.430	24.467	26.130	Sandy clay loam
180	82	82-B Jewardara	Totakan	90.447	43.270	47.840	16.697	18.460	30.481	33.700	Loam
181	82	82-C Shoulgar	Totakan	87.627	42.438	48.430	8.281	9.450	36.908	42.120	Loam
182	83	83	Bagh Raji	88.932	43.461	48.870	18.525	20.830	26.946	30.300	loam
183	84	87-A Irrigated	Makhband	84.256	38.994	46.280	7.069	8.390	38.193	45.330	Loam
184	84	87-B rainfed	Makhband	90.335	58.293	64.530	7.877	8.720	24.165	26.750	Sandy loam
185	85	85-A Danman	Kalangai	84.728	60.911	71.890	13.446	15.870	10.371	12.240	Sandy loam
186	85	85-B Jewardara	Kalangai	96.693	57.900	59.880	14.475	14.970	24.318	25.150	Sandy loam
187	85	85-C Shoulgar	Kalangai	88.429	47.513	53.730	7.746	8.760	33.170	37.510	Sandy loam
188	86	86-A Danman	Ramora	86.341	65.127	75.430	10.654	12.340	10.560	12.230	Sandy loam
189	86	86-B Jewardara	Ramora	95.637	56.923	59.520	11.878	12.420	26.836	28.060	Sandy loam
190	86	86-C Shoulgar	Ramora	91.647	60.148	65.630	14.068	15.350	17.431	19.020	Sandy loam
191	87	86-A Danman	Chakdara	84.736	57.417	67.760	10.389	12.260	16.930	19.980	Sandy loam
192	87	86-B Jewardara	Chakdara	92.484	48.813	52.780	10.599	11.460	33.072	35.760	Sandy loam
193	87	86-C Shoulgar	Chakdara	95.658	45.457	47.520	11.890	12.430	38.311	40.050	loam
194	88	88	Shewa	98.458	30.099	30.570	23.453	23.820	44.907	45.610	Loam
195	89	89	Tindo Dag	85.938	32.175	37.440	19.456	22.640	34.306	39.920	Loam
196	90	90	Kitiarai	97.647	47.427	48.570	16.327	16.720	#REF!	34.710	Loam
197	91	91	Khanpur	85.639	56.128	65.540	13.505	15.770	16.006	18.690	Sandy loam
198	92	92	Khairabad	95.744	58.921	61.540	14.965	15.630	21.858	22.830	Sandy loam
199	93	93	Chikhoo	93.258	45.631	48.930	25.040	26.850	22.587	24.220	Sandy clay loam
200	94	94	Usakai	85.639	42.588	49.730	17.847	20.840	25.204	29.430	Loam
201	95	95	Wuch	86.465	39.186	45.320	26.683	30.860	20.596	23.820	Sandy clay loam
202	96	96-A Irrigated	Gadar	86.927	29.764	34.240	18.029	20.740	39.135	45.020	Loam
203	96	96-B Rainfed	Gadar	91.472	32.171	35.170	15.331	16.760	43.971	48.070	Loam
204	97	97-A Daman	Badwan	94.584	59.957	63.390	10.234	10.820	24.393	25.790	Silt Loam
205	97	97-B Shoulgar	Badwan	93.233	49.852	53.470	10.983	11.780	32.398	34.750	Sandy loam
206	98	98-A Daman	Mian Barangola	94.452	53.243	56.370	14.621	15.480	26.588	28.150	Sandy loam
207	98	98-B Shoulgar	Mian Barangola	94.284	58.862	62.430	8.410	8.920	27.012	28.650	Sandy loam
208	99	99-A Daman	Tiruna	87.237	46.829	53.680	7.214	8.270	33.194	38.050	Sandy loam
209	99	99-B Jewardara	Tiruna	87.732	44.094	50.260	21.907	24.970	21.731	24.770	Sandy clay loam
210	99	99-C Shoulgar	Tiruna	93.263	59.987	64.320	15.594	16.720	17.683	18.960	Sandy loam
211	100	100-A	Kamala	91.634	43.682	47.670	26.464	28.880	21.488	23.450	Sandy clay loam
212	100	100-B	Kamala	87.387	56.574	64.740	12.566	14.380	18.246	20.880	Sandy loam

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Avg/SDV	Total Sand (g)	Sand %age	Clay (g)	%age Clay	Silt (g)	%age Silt
1	1	Kalam	Average	74.66	81.71	7.50	8.20	9.23	10.09
			SDV	0.53	1.63	0.51	0.45	1.22	1.20
2	2	Pashmal	Average	70.29	84.62	5.79	6.96	7.01	8.43
			SDV	2.00	0.62	0.52	0.38	0.44	0.23
3	3	Asharopatai	Average	71.96	81.19	7.09	8.05	9.45	10.77
			SDV	9.93	2.20	0.23	0.64	0.32	1.56
4	4	Laikot	Average	79.89	80.75	8.58	8.68	10.37	10.57
			SDV	8.74	1.58	0.96	0.19	0.82	1.78
5	5	Asrit	Average	87.02	84.57	11.37	11.04	4.33	4.40
			SDV	11.77	2.84	1.90	0.73	3.20	3.56
6	6	Mankial	Average	81.99	81.66	10.18	10.14	8.20	8.21
			SDV	4.38	2.00	1.01	0.71	2.49	2.72
7	7	Kedam	Average	72.44	77.49	6.57	7.05	14.03	14.96
			SDV	1.00	1.62	0.90	1.20	2.47	2.12
8	8-A Irrigated	Bahrain	Average	72.34	77.89	6.73	7.25	13.81	14.87
			SDV	1.04	0.47	0.16	0.03	0.70	0.45
9	8-B Rainfed		Average	64.77	77.41	5.56	6.63	13.36	15.96
			SDV	0.31	1.53	0.79	0.78	0.96	0.75
10	9-A Irrigated	Satal	Average	64.46	77.61	5.47	6.61	13.10	15.79
			SDV	4.17	1.25	0.35	0.74	0.21	0.51
11	9-B Rainfed		Average	64.20	76.66	4.85	5.80	14.70	17.55
			SDV	2.09	0.42	0.25	0.46	0.43	0.04
12	10-A Irrigated	Madyan	Average	65.13	74.99	15.55	17.90	6.18	7.13
			SDV	1.24	0.32	1.18	0.94	0.39	0.62
13	10-B Rainfed		Average	64.37	76.28	11.02	12.90	9.06	10.84
			SDV	0.45	2.27	7.22	8.08	4.55	5.79
14	11-A Danman	Jare	Average	54.75	66.61	4.85	5.90	22.58	27.50
			SDV	2.07	1.43	0.57	0.60	1.30	2.03
15	11-B Jewardara		Average	54.09	61.71	6.97	7.94	26.62	30.36
			SDV	1.57	0.74	1.00	0.81	1.03	0.07
16	11-C Shoulgar		Average	54.32	59.49	10.71	11.74	26.30	28.78
			SDV	0.46	1.41	0.46	0.69	2.32	2.10
17	12-A Danman	Fatepur	Average	55.51	62.06	15.11	16.89	18.83	21.05
			SDV	0.14	0.55	0.34	0.18	0.54	0.36
18	12-B Jewardara	Fatepur	Average	58.16	61.29	15.93	16.78	20.82	21.93
			SDV	0.02	1.33	0.67	0.34	1.39	0.98
19	12-C Shoulgar	Fatepur	Average	57.75	65.79	14.71	16.73	15.35	17.48
			SDV	1.70	0.79	1.38	0.88	0.56	0.08
20	13-A Danman	Darmai	Average	64.63	76.11	10.28	12.11	10.02	11.79
			SDV	2.55	0.33	0.14	0.37	1.03	0.70
21	13-B Jewardara	Darmai	Average	64.01	72.72	9.76	11.10	14.24	16.19
			SDV	2.95	0.62	0.17	0.22	0.18	0.40
22	13-C Shoulgar	Darmai	Average	63.20	72.89	11.29	13.02	12.22	14.09
			SDV	0.28	0.90	0.34	0.49	1.31	1.40
23	14	Sakhra	Average	58.59	72.51	9.62	11.91	12.60	15.59
			SDV	0.33	1.00	0.33	0.51	1.32	1.51
24	15-A Danman	Bagh Dheri	Average	58.59	64.10	13.83	15.12	19.00	20.78
			SDV	0.52	1.46	1.08	0.98	0.70	0.48
25	15-B Jewardara	Bagh Dheri	Average	56.78	62.22	13.39	14.68	21.05	23.07
			SDV	1.51	0.61	0.35	0.63	0.42	0.08
26	15-C Shoulgar	Bagh Dheri	Average	64.14	67.29	12.60	13.22	18.57	19.50
			SDV	2.28	1.31	1.23	1.08	1.98	2.39
27	16-A Danman	Asharai	Average	59.86	64.88	12.79	13.87	19.61	21.26
			SDV	1.31	0.36	0.34	0.59	0.54	0.23
28	16-B Jewardara	Asharai	Average	64.42	70.40	11.79	12.89	15.29	16.71
			SDV	1.84	1.33	0.44	0.61	0.51	0.72
29	16-C Shoulgar	Asharai	Average	67.21	72.48	11.67	12.60	13.86	14.92
			SDV	0.79	0.91	0.73	1.09	2.18	1.99
30	17-A Danman	Dursh Khela	Average	58.30	70.76	9.97	12.10	14.14	17.15
			SDV	1.17	1.26	0.66	0.35	1.29	0.91
31	17-B Jewardara	Dursh Khela	Average	54.28	64.95	10.08	12.05	19.25	23.01
			SDV	2.26	0.89	0.79	0.28	1.58	0.62
32	17-C Shoulgar	Dursh Khela	Average	54.36	65.70	13.34	16.12	15.04	18.19
			SDV	0.95	0.49	0.84	0.85	0.96	1.34
33	18-A Danman	Sambat	Average	58.54	69.65	11.02	13.11	14.47	17.25
			SDV	2.70	1.00	0.67	0.37	0.70	1.38

Table E.1c Cont.

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Year	Total Sand	Sand %age	Clay	%age Clay	Silt	%age Silt
34	18-B Jewardara	Sambat	Average	61.52	65.73	11.28	12.05	20.81	22.22
			SDV	1.24	0.59	0.06	0.28	1.41	0.86
35	18-C Shoulgar	Sambat	Average	66.51	72.16	10.18	11.05	15.49	16.81
			SDV	0.98	0.46	0.35	0.29	0.56	0.74
36	19-A Danman	Shokhdara	Average	56.09	62.14	13.66	15.13	20.51	22.74
			SDV	1.89	0.42	0.85	0.53	0.31	0.95
37	19-B Jewardara	Shokhdara	Average	60.43	60.74	14.98	15.06	24.11	24.20
			SDV	4.45	0.54	1.00	0.24	2.75	0.77
38	19-C Shoulgar	Shokhdara	Average	70.74	71.71	16.12	16.28	11.88	12.01
			SDV	9.72	0.92	3.03	0.62	2.07	0.30
39	20	Wainai	Average	69.87	72.97	16.35	17.06	9.53	9.98
			SDV	3.60	0.39	1.53	0.81	0.71	1.20
40	21	Chuprial	Average	65.62	73.25	14.50	16.18	9.44	10.58
			SDV	3.19	1.01	1.19	0.76	1.26	1.77
41	22	Changialai	Average	71.73	79.00	12.11	13.33	6.96	7.68
			SDV	3.08	0.25	0.94	0.50	0.40	0.75
42	23	Gwalarai	Average	68.40	79.04	11.48	13.26	6.66	7.71
			SDV	2.05	0.57	0.78	0.60	0.86	1.17
43	24	Roringar	Average	70.06	79.92	11.41	13.02	6.17	7.06
			SDV	2.67	1.40	0.68	0.50	1.55	1.91
44	25	Fazal Banad	Average	66.27	80.05	12.49	15.08	4.03	4.87
			SDV	0.96	0.14	0.43	0.27	0.03	0.12
45	26	Sarkarai	Average	71.82	80.00	14.09	15.72	3.83	4.28
			SDV	3.73	1.51	0.19	0.73	0.55	0.75
46	27	Kalagai	Average	63.69	75.96	12.30	14.68	7.87	9.37
			SDV	0.90	0.87	0.21	0.63	1.46	1.50
47	28-A Danman	Shairpalam	Average	56.04	68.27	9.82	11.96	16.23	19.77
			SDV	0.35	0.63	0.54	0.69	1.14	1.33
48	28-B Jewardara	Shairpalam	Average	56.84	61.92	14.71	16.02	20.25	22.06
			SDV	0.73	0.30	0.76	0.55	0.11	0.27
49	28-C Shoulgar	Shairpalam	Average	59.64	70.90	12.56	14.94	11.93	14.17
			SDV	0.56	0.93	0.03	0.37	1.36	1.30
50	29-A Danman	Shakar Dara	Average	56.45	67.19	13.28	15.80	14.31	17.02
			SDV	1.11	0.81	0.80	0.45	0.76	0.37
51	29-B Jewardara	Shakar Dara	Average	54.40	64.69	10.55	12.55	19.13	22.77
			SDV	1.14	0.61	0.95	0.98	1.12	1.59
52	29-C Shoulgar	Shakar Dara	Average	65.32	71.74	14.56	15.94	11.19	12.33
			SDV	2.07	0.86	2.82	2.40	0.91	1.53
53	30-A Danman	Ningulai	Average	55.13	62.73	12.51	14.27	20.22	23.01
			SDV	3.75	0.74	0.07	0.88	1.27	0.15
54	30-B Jewardara	Ningulai	Average	55.84	59.43	15.94	16.95	22.21	23.63
			SDV	0.48	0.98	1.31	0.97	0.57	0.01
55	30-C Shoulgar	Ningulai	Average	57.78	70.84	12.76	15.65	11.03	13.52
			SDV	0.22	0.74	0.36	0.66	1.29	1.39
56	31-A Danman	Bara & Kuza Bandai	Average	53.99	57.82	15.55	16.65	23.55	25.24
			SDV	1.72	0.77	1.19	0.96	0.78	1.30
57	31-B Jewardara	Bara & Kuza Bandai	Average	48.98	57.55	10.74	12.62	25.40	29.84
			SDV	1.14	1.55	0.50	0.64	1.95	2.18
58	31-C Shoulgar	Bara & Kuza Bandai	Average	45.40	54.22	10.38	12.42	27.93	33.38
			SDV	2.54	1.56	0.49	0.93	0.22	0.64
59	32-A Danman	Sigram	Average	48.55	61.64	15.86	20.13	14.37	18.24
			SDV	0.49	1.14	2.09	2.48	0.94	1.34
60	32-B Jewardara	Sigram	Average	62.33	69.31	17.37	19.31	10.23	11.38
			SDV	0.15	0.48	1.50	1.48	0.81	1.01
61	32-C Shoulgar	Sigram	Average	61.65	69.98	14.33	16.30	12.11	13.73
			SDV	2.48	0.40	0.79	1.46	1.36	1.07
62	33-A Danman	Kanju	Average	65.42	68.09	12.12	12.61	18.54	19.31
			SDV	1.96	1.20	0.77	0.65	1.54	1.85
63	33-B Jewardara	Kanju	Average	51.99	62.07	17.72	21.16	14.05	16.78
			SDV	0.98	0.36	0.45	0.26	0.34	0.62
64	33-C Shoulgar	Kanju	Average	58.97	70.41	14.96	17.88	9.81	11.72
			SDV	2.32	0.87	0.24	0.77	0.18	0.10
65	34	Kala	Average	56.54	67.07	13.34	15.82	14.43	17.12
			SDV	0.62	0.26	0.25	0.41	0.23	0.15
66	35	Deolai	Average	58.99	63.99	15.60	16.92	17.60	19.10
			SDV	1.86	1.00	0.78	0.58	1.17	1.57

Table E.1c Cont.

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Year	Total Sand	Sand %age	Clay	%age Clay	Silt	%age Silt
67	36	Tal	Average	68.29	73.87	12.79	13.86	11.36	12.28
			SDV	2.53	1.28	1.57	1.97	0.86	0.69
68	37	Tutano Banda	Average	57.78	68.35	18.36	21.72	8.39	9.94
			SDV	1.64	1.25	0.71	0.62	1.50	1.87
69	38	Sarsanai	Average	49.76	55.97	19.19	21.64	19.88	22.40
			SDV	4.25	3.54	1.79	2.50	0.48	1.04
70	39-A Danman	Gul Jaba	Average	59.59	65.59	20.72	22.82	10.53	11.60
			SDV	1.98	1.05	0.06	0.46	0.36	0.59
71	39-C Shoulgar	Gul Jaba	Average	48.23	52.26	33.57	36.36	10.51	11.39
			SDV	0.30	1.24	1.52	1.02	0.39	0.22
72	40-A Danman	Kabbal	Average	54.58	65.60	18.05	21.70	10.58	12.70
			SDV	0.01	1.03	0.64	1.12	1.96	2.15
73	40-B Jewardara	Kabbal	Average	38.90	47.49	29.74	36.32	13.27	16.20
			SDV	1.16	1.05	1.01	1.51	0.48	0.46
74	40-C Shoulgar	Kabbal	Average	56.29	67.09	13.42	15.99	14.20	16.93
			SDV	0.54	0.35	0.81	1.03	0.64	0.69
75	41	Kotlai	Average	63.21	73.18	14.18	16.41	8.98	10.42
			SDV	2.22	1.22	1.76	1.73	2.37	2.94
76	42	Surgalai	Average	74.48	81.88	7.22	7.95	8.08	8.88
			SDV	2.85	2.35	0.41	0.53	0.06	0.01
77	43-A Danman	Parrai	Average	62.34	72.13	10.40	12.04	13.69	15.83
			SDV	1.79	0.31	0.11	0.27	0.95	0.58
78	43-B Jewardara	Parrai	Average	59.56	63.08	21.13	22.36	13.73	14.55
			SDV	0.58	0.53	1.75	1.44	0.63	0.93
79	43-C Shoulgar	Parrai	Average	54.57	62.08	6.01	7.07	27.15	30.87
			SDV	1.44	0.35	#DIV/0!	0.53	1.65	0.88
80	44-A Danman	Nagwa	Average	70.19	84.22	6.09	7.28	7.13	8.50
			SDV	1.84	2.66	1.05	0.83	1.93	1.82
81	44-B Jewardara	Nagwa	Average	62.37	72.12	10.29	11.90	13.79	15.98
			SDV	3.29	1.57	0.75	0.49	1.36	2.06
82	44-C Shoulgar	Nagwa	Average	62.71	71.88	19.20	22.01	5.33	6.11
			SDV	0.85	1.35	1.06	1.10	0.24	0.24
83	45-A Danman	Dedawar	Average	50.93	61.50	13.61	16.45	18.26	22.06
			SDV	1.61	0.88	0.44	0.81	0.26	0.06
84	45-B Jewardara	Dedawar	Average	47.99	53.43	23.52	26.15	18.40	20.42
			SDV	1.91	3.59	1.01	0.41	3.35	3.17
85	45-C Shoulgar	Dedawar	Average	66.91	72.82	14.76	16.06	10.22	11.13
			SDV	1.19	0.62	1.25	0.94	0.02	0.32
86	46-A Danman	Tirang	Average	57.51	62.99	15.64	17.13	18.15	19.88
			SDV	0.45	0.85	0.94	1.13	1.92	1.99
87	46-B Jewardara	Tirang	Average	48.63	54.30	11.58	12.95	29.26	32.75
			SDV	4.88	1.33	0.73	0.17	1.19	1.16
88	46-C Shoulgar	Tirang	Average	52.59	62.14	4.91	5.81	27.14	32.05
			SDV	1.93	0.33	0.20	0.48	1.82	0.81
89	47-A Danman	Chongai	Average	61.31	74.82	10.42	12.72	10.22	12.48
			SDV	0.89	0.59	0.71	0.78	1.06	1.38
90	47-B Jewardara	Chongai	Average	48.25	59.23	13.78	16.93	19.42	23.84
			SDV	1.63	1.29	0.99	1.41	0.34	0.13
91	47-C Shoulgar	Chongai	Average	57.52	65.15	5.66	6.45	25.13	28.40
			SDV	5.23	0.33	0.29	0.95	3.53	1.27
92	48	Sarai	Average	43.40	52.01	30.43	36.46	9.62	11.54
			SDV	1.00	0.23	1.30	0.88	0.75	1.12
93	49	Miandam	Average	42.03	46.40	13.97	15.42	34.55	38.18
			SDV	2.09	1.50	1.06	0.91	1.58	2.41
94	50-A Danman	Shin	Average	47.66	51.81	12.50	13.56	31.84	34.63
			SDV	0.60	0.59	2.03	1.88	0.43	1.29
95	50-B Jewardara	Shin	Average	43.68	47.88	9.86	10.81	37.69	41.32
			SDV	1.31	0.66	0.41	0.62	0.58	0.04
96	50-C Shoulgar	Shin	Average	50.71	53.44	10.92	11.50	33.25	35.07
			SDV	1.93	0.91	1.11	0.93	1.05	1.85
97	51-A Danman	Kotanai	Average	64.55	76.03	5.81	6.85	14.53	17.12
			SDV	1.78	1.67	1.62	1.95	0.32	0.28
98	51-B Jewardara	Kotanai	Average	38.02	47.42	14.19	17.70	28.02	34.95
			SDV	0.74	0.98	0.94	1.20	1.70	2.09
99	51-C Shoulgar	Kotanai	Average	51.49	63.19	9.77	12.00	20.20	24.82
			SDV	2.34	1.47	0.51	0.36	1.04	1.83

Table E.1c Cont.

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Year	Total Sand	Sand %age	Clay	%age Clay	Silt	%age Silt
100	52-A Danman	Chalyar	Average	69.79	73.74	10.72	11.32	14.14	14.94
			SDV	0.65	1.23	1.18	1.16	0.17	0.07
101	52-B Jewardara	Chalyar	Average	44.49	52.54	21.58	25.50	18.59	21.97
			SDV	1.94	0.98	0.23	0.91	0.40	0.08
102	52-C Shoulgar	Chalyar	Average	66.08	70.94	15.80	16.95	11.28	12.12
			SDV	1.25	0.28	1.13	0.96	0.98	1.24
103	53-A Danman	Khwazakhela	Average	56.09	66.67	10.17	12.10	17.88	21.23
			SDV	0.02	1.14	0.63	0.95	2.07	2.11
104	53-B Jewardara	Khwazakhela	Average	39.40	42.53	5.57	6.01	47.72	51.45
			SDV	0.37	1.20	0.09	0.33	3.20	1.51
105	53-C Shoulgar	Khwazakhela	Average	65.78	71.00	12.08	13.03	14.80	15.98
			SDV	0.14	0.37	0.94	0.92	0.39	0.54
106	54-A Danman	Gulibagh	Average	58.45	63.99	15.33	16.80	17.57	19.22
			SDV	0.35	0.78	0.80	1.18	2.12	1.97
107	54-B Jewardara	Gulibagh	Average	39.99	47.70	22.73	27.10	21.12	25.21
			SDV	1.35	1.21	1.21	1.22	1.86	2.43
108	54-C Shoulgar	Gulibagh	Average	59.53	63.55	8.72	9.33	25.40	27.13
			SDV	2.43	1.13	0.88	1.15	0.60	0.02
109	55-A Danman	Dakorak	Average	56.37	69.52	10.93	13.48	13.88	17.11
			SDV	0.59	0.92	0.90	1.15	1.83	2.21
110	55-B Jewardara	Dakorak	Average	48.63	51.50	25.04	26.52	20.75	21.98
			SDV	1.30	0.95	0.92	0.76	1.44	1.71
111	55-C Shoulgar	Dakorak	Average	55.56	60.89	12.39	13.56	23.30	25.55
			SDV	0.59	0.37	1.92	1.88	0.99	1.51
112	56-A Danman	Charbagh	Average	65.12	71.44	8.82	9.67	17.23	18.89
			SDV	0.68	1.85	0.85	0.78	1.25	1.07
113	56-B Jewardara	Charbagh	Average	43.53	45.19	21.24	22.05	31.56	32.77
			SDV	1.84	1.87	1.45	1.53	0.31	0.35
114	56-C Shoulgar	Charbagh	Average	47.39	53.03	9.62	10.78	32.33	36.19
			SDV	2.28	0.91	0.27	0.64	0.75	0.28
115	57	Tilgram	Average	54.03	60.42	13.64	15.23	21.66	24.35
			SDV	5.40	1.65	2.11	1.25	1.02	2.91
116	58-A Danman	Manglaur	Average	35.53	41.78	17.50	20.57	32.02	37.65
			SDV	0.13	0.62	1.05	1.00	0.03	0.38
117	58-B Jewardara	Manglaur	Average	31.64	37.80	7.14	8.52	45.83	54.69
			SDV	0.34	1.35	0.19	0.01	3.44	2.75
118	58-C Shoulgar	Manglaur	Average	56.25	61.37	10.17	11.10	25.24	27.53
			SDV	0.21	0.72	0.89	1.06	1.84	1.79
119	59-A Danman	Dangram	Average	37.65	43.94	5.87	6.85	42.15	49.22
			SDV	1.87	1.82	1.71	1.94	2.89	3.77
120	59-B Jewardara	Dangram	Average	50.69	54.44	15.31	16.43	27.13	29.14
			SDV	0.17	1.01	1.81	1.70	0.22	0.69
121	59-C Shoulgar	Dangram	Average	60.28	69.16	14.90	17.11	11.97	13.74
			SDV	2.31	1.52	0.77	1.17	0.11	0.35
122	60-A Danman	Sangota	Average	29.47	35.22	10.44	12.47	43.78	52.31
			SDV	1.09	1.58	0.79	0.85	0.96	0.74
123	60-B Jewardara	Sangota	Average	35.98	37.43	9.97	10.36	50.20	52.22
			SDV	0.43	1.01	1.77	1.68	0.11	0.67
124	60-C Shoulgar	Sangota	Average	49.03	52.65	15.31	16.45	28.82	30.91
			SDV	0.01	1.57	0.30	0.81	3.08	2.38
125	61-A Danman	Takhtaband	Average	27.71	29.42	12.34	13.10	54.15	57.49
			SDV	0.91	1.00	0.43	0.47	1.43	1.46
126	61-B Jewardara	Takhtaband	Average	38.95	41.82	6.62	7.11	47.58	51.08
			SDV	0.53	0.59	0.95	1.03	1.52	1.61
127	61-C Shoulgar	Takhtaband	Average	46.28	54.04	7.84	9.15	31.53	36.82
			SDV	0.17	0.24	1.20	1.32	0.67	1.09
128	62-A Danman	Jambil	Average	67.38	77.31	5.82	6.68	13.95	16.01
			SDV	1.48	1.67	0.74	0.85	0.71	0.82
129	62-B Jewardara	Jambil	Average	58.62	66.39	9.74	11.03	19.95	22.59
			SDV	1.23	1.58	0.51	0.55	0.96	1.03
130	63-A Danman	Bologram	Average	45.02	53.13	14.01	16.54	25.72	30.34
			SDV	0.58	1.21	1.17	1.55	2.59	2.76
131	63-B Jewardara	Bologram	Average	36.14	41.48	13.49	15.49	37.51	43.04
			SDV	0.75	0.86	0.77	0.88	1.51	1.74
132	63-C Shoulgar	Bologram	Average	46.22	52.61	14.41	16.40	27.23	31.00
			SDV	1.16	1.04	1.23	1.32	1.92	2.35

Table E.1c Cont.

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Year	Total Sand	Sand %age	Clay	%age Clay	Silt	%age Silt
133	64-A Danman	Gogdara	Average	47.72	55.36	9.48	11.00	29.01	33.64
			SDV	0.91	1.60	0.58	0.78	2.33	2.38
134	64-B Jewardara	Gogdara	Average	31.78	34.18	15.54	16.70	45.68	49.13
			SDV	0.16	0.56	1.80	1.75	0.58	1.19
135	64-C Shoulgar	Gogdara	Average	57.02	67.54	14.77	17.49	12.65	14.98
			SDV	1.31	1.68	0.87	1.06	2.33	2.73
136	65-A Danman	Pajigram	Average	50.88	58.72	14.07	16.24	21.70	25.05
			SDV	0.17	0.40	1.66	1.97	2.11	2.35
137	65-B Jewardara	Pajigram	Average	46.14	48.98	34.18	36.28	13.87	14.75
			SDV	1.54	0.93	1.98	1.58	2.16	2.51
138	65-C Shoulgar	Pajigram	Average	56.16	69.45	18.11	22.41	6.58	8.15
			SDV	2.40	1.11	0.30	0.98	0.07	0.13
139	66-A Danman	Ghaligai	Average	58.18	61.46	14.82	15.64	21.69	22.91
			SDV	0.20	1.13	1.36	1.10	0.51	0.04
140	66-B Jewardara	Ghaligai	Average	29.01	33.28	9.58	11.00	48.55	55.73
			SDV	1.92	1.65	0.16	0.36	0.33	1.30
141	66-C Shoulgar	Ghaligai	Average	51.73	53.21	14.00	14.38	31.46	32.41
			SDV	2.58	1.10	1.95	1.58	1.70	2.69
142	67-A Danman	Manyar	Average	63.99	65.59	16.03	16.43	17.51	17.98
			SDV	3.08	1.92	1.12	0.83	2.36	2.76
143	67-B Jewardara	Manyar	Average	49.72	49.61	26.32	26.25	24.16	24.14
			SDV	2.45	1.02	1.89	1.13	1.46	2.15
144	67-C Shoulgar	Manyar	Average	53.34	56.71	10.11	10.74	30.59	32.56
			SDV	2.49	1.20	1.34	1.15	1.42	2.34
145	68-A Danman	Barikot	Average	62.64	64.48	10.73	11.05	23.77	24.48
			SDV	1.74	0.86	0.44	0.29	0.78	1.15
146	68-B Jewardara	Barikot	Average	39.06	46.40	14.93	17.73	30.18	35.87
			SDV	1.26	0.75	1.20	1.15	1.11	1.90
147	68-C Shoulgar	Barikot	Average	58.69	60.60	8.58	8.88	29.52	30.49
			SDV	2.29	1.03	0.72	0.94	0.51	0.15
148	69-A Danman	Abua	Average	64.98	78.50	5.59	6.75	12.22	14.76
			SDV	1.08	0.90	0.59	0.52	0.65	0.37
149	69-B Jewardara	Abua	Average	58.47	66.67	10.71	12.20	18.50	21.13
			SDV	3.12	1.15	1.09	0.81	1.05	1.97
150	69-C Shoulgar	Abua	Average	51.94	56.56	12.44	13.56	27.48	29.90
			SDV	0.25	0.94	0.75	1.11	2.48	2.06
151	70-A Danman	Kotah	Average	69.64	76.70	5.92	6.51	15.25	16.79
			SDV	0.88	1.63	0.99	1.03	0.67	0.59
152	70-B Jewardara	Kotah	Average	56.01	65.70	9.54	11.20	19.72	23.11
			SDV	0.29	1.53	0.26	0.50	2.09	2.03
153	70-C Shoulgar	Kotah	Average	46.54	54.02	7.26	8.43	32.36	37.56
			SDV	0.48	0.33	0.22	0.12	0.71	0.21
154	71-A Danman	Landakai	Average	80.74	76.17	9.30	8.73	15.94	15.11
			SDV	8.79	0.44	1.88	0.88	0.24	1.33
155	71-B Jewardara	Landakai	Average	57.86	60.40	9.09	9.38	28.94	30.22
			SDV	10.22	0.61	2.68	1.05	4.99	0.44
156	71-C Shoulgar	Landakai	Average	57.43	59.02	7.28	7.49	32.69	33.49
			SDV	1.59	1.84	0.05	0.49	4.19	2.33
157	72-A Danman	Haibatgram	Average	57.30	58.30	22.65	23.09	18.31	18.62
			SDV	4.70	0.60	0.58	1.07	1.77	0.47
158	72-B Jewardara	Haibatgram	Average	33.59	35.77	14.28	15.19	45.93	49.05
			SDV	4.98	0.69	2.29	0.48	4.85	1.17
159	72-C Shoulgar	Haibatgram	Average	46.64	50.64	11.41	12.30	34.30	37.07
			SDV	1.38	3.11	2.28	1.35	4.74	1.76
160	73-A Danman	Thana	Average	29.25	29.35	21.71	22.12	47.44	48.54
			SDV	10.23	7.38	1.22	1.04	1.31	6.34
161	73-B Jewardara	Thana	Average	41.82	40.26	12.55	12.21	49.64	47.54
			SDV	5.98	0.59	0.15	1.77	10.24	2.36
162	73-C Shoulgar	Thana	Average	60.94	59.26	11.84	11.49	30.16	29.26
			SDV	7.30	0.83	1.75	0.17	4.70	0.66
163	74	Nal	Average	68.37	68.52	11.87	11.77	19.60	19.72
			SDV	13.71	0.35	3.62	1.20	3.19	0.86
164	75	Gunyar	Average	59.88	58.81	14.56	14.30	27.58	26.90
			SDV	4.15	2.03	0.89	0.61	5.54	2.64
165	76-A Danman	Allahadan	Average	42.31	44.76	18.34	19.45	33.90	35.80
			SDV	6.11	0.11	2.04	0.69	5.72	0.80

Table E.1c Cont.

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Year	Total Sand	Sand %age	Clay	%age Clay	Silt	%age Silt
166	76-B Jewardara	Allahadan	Average	46.00	45.96	16.27	16.30	37.73	37.75
			SDV	5.79	0.87	1.10	0.65	3.82	0.22
167	76-C Shoulgar	Allahadan	Average	55.77	54.60	11.17	10.90	35.63	34.51
			SDV	4.63	3.17	1.49	0.08	8.32	3.25
168	77-A Danman	Batkhala	Average	39.30	39.06	20.11	20.29	40.14	40.66
			SDV	12.63	3.66	3.91	0.76	6.48	2.89
169	77-B Jewardara	Batkhala	Average	39.13	42.84	15.00	16.38	37.21	40.79
			SDV	6.71	0.00	3.09	0.57	5.86	0.57
170	77-C Shoulgar	Batkhala	Average	73.84	52.50	16.66	11.87	49.91	35.64
			SDV	40.26	0.33	8.99	0.01	26.57	0.32
171	78	Piran	Average	69.68	60.37	13.46	11.85	32.73	27.79
			SDV	23.41	1.27	3.36	1.32	14.44	2.58
172	79	Rangmala	Average	58.12	59.50	10.31	10.59	28.82	29.91
			SDV	12.92	3.07	1.85	0.08	1.93	3.15
173	80-A Danman	Jolagram	Average	45.49	47.50	11.13	11.71	38.93	40.80
			SDV	7.70	1.59	0.76	0.80	4.55	0.79
174	80-B Jewardara	Jolagram	Average	43.27	44.64	10.53	10.87	43.17	44.50
			SDV	0.44	1.27	0.36	0.57	2.57	1.84
175	80-C Shoulgar	Jolagram	Average	50.40	51.25	11.35	11.49	36.74	37.27
			SDV	1.66	2.11	1.75	0.93	3.88	1.18
176	81-A Danman	Matkani	Average	44.09	45.50	18.47	19.10	34.28	35.41
			SDV	7.35	0.35	2.70	0.25	5.35	0.11
177	81-B Jewardara	Matkani	Average	51.84	49.88	16.42	15.84	35.44	34.29
			SDV	7.26	2.76	1.40	0.01	0.15	2.77
178	81-C Shoulgar	Matkani	Average	54.12	55.55	12.28	12.71	30.34	31.75
			SDV	13.79	4.52	2.08	0.08	1.09	4.44
179	82-A Danman	Totakan	Average	49.16	49.91	22.31	22.68	27.07	27.41
			SDV	2.73	0.75	0.53	1.06	3.69	1.81
180	82-B Jewardara	Totakan	Average	49.62	46.21	20.14	18.62	38.25	35.18
			SDV	8.98	2.31	4.87	0.23	10.99	2.09
181	82-C Shoulgar	Totakan	Average	51.56	48.60	11.15	10.36	43.33	41.05
			SDV	12.90	0.23	4.05	1.28	9.09	1.51
182	83	Bagh Raji	Average	51.90	50.75	20.12	19.89	29.77	29.37
			SDV	11.94	2.66	2.26	1.34	4.00	1.32
183	87-A Irrigated	Makhband	Average	53.07	49.06	8.60	8.11	45.24	42.84
			SDV	19.91	3.92	2.17	0.40	9.96	3.52
184	87-B rainfed	Makhband	Average	63.83	63.14	8.30	8.24	29.21	28.62
			SDV	7.83	1.97	0.59	0.68	7.13	2.64
185	85-A Danman	Kalangai	Average	73.00	70.13	16.29	15.62	15.30	14.25
			SDV	17.10	2.49	4.02	0.35	6.98	2.84
186	85-B Jewardara	Kalangai	Average	63.14	62.37	13.95	13.85	23.98	23.79
			SDV	7.42	3.51	0.74	1.58	0.48	1.93
187	85-C Shoulgar	Kalangai	Average	58.25	56.21	9.91	9.52	34.84	34.28
			SDV	15.18	3.50	3.06	1.07	2.36	4.57
188	86-A Danman	Ramora	Average	64.56	74.53	9.75	11.26	12.32	14.22
			SDV	0.80	1.28	1.28	1.53	2.50	2.81
189	86-B Jewardara	Ramora	Average	58.70	60.38	11.64	11.99	26.85	27.64
			SDV	2.51	1.22	0.33	0.62	0.02	0.60
190	86-C Shoulgar	Ramora	Average	63.89	67.12	15.87	16.64	15.35	16.24
			SDV	5.29	2.11	2.55	1.82	2.94	3.93
191	86-A Danman	Chakdara	Average	58.48	68.50	11.20	13.12	15.78	18.50
			SDV	1.50	1.05	1.15	1.22	1.62	2.09
192	86-B Jewardara	Chakdara	Average	46.00	53.43	10.16	11.81	30.02	34.76
			SDV	3.98	0.92	0.63	0.49	4.32	1.41
193	86-C Shoulgar	Chakdara	Average	43.95	46.97	10.69	11.41	38.91	41.63
			SDV	2.14	0.78	1.70	1.45	0.85	2.23
194	88	Shewa	Average	28.47	29.48	23.80	24.68	44.24	45.84
			SDV	2.30	1.54	0.49	1.21	0.95	0.33
195	89	Tindo Dag	Average	31.08	36.49	19.60	23.03	34.48	40.50
			SDV	1.56	1.35	0.21	0.54	0.24	0.81
196	90	Kitiarai	Average	48.02	48.95	17.29	17.62	32.79	33.43
			SDV	0.84	0.53	1.36	1.27	1.56	1.81
197	91	Khanpur	Average	56.55	66.51	13.94	16.40	14.55	17.10
			SDV	0.60	1.37	0.61	0.88	2.06	2.26
198	92	Khairabad	Average	59.35	61.16	15.71	16.18	22.00	22.67
			SDV	0.61	0.54	1.05	0.77	0.20	0.23

Table E.1c Cont.

Table E.1C:- Average Texture Value of selected Soil Sample Collected
From River Swat Watershed (2004-05

Serial No	Sub Sample No	Village	Year	Total Sand	Sand %age	Clay	%age Clay	Silt	%age Silt
199	93	Chikhoo	Average	47.06	50.41	24.45	26.19	21.85	23.41
			SDV	2.02	2.09	0.83	0.93	1.04	1.15
200	94	Usakai	Average	42.92	50.49	18.67	21.98	23.42	27.54
			SDV	0.46	1.07	1.17	1.61	2.52	2.67
201	95	Wuch	Average	39.42	45.87	27.11	31.54	19.42	22.59
			SDV	0.34	0.78	0.60	0.96	1.66	1.74
202	96-A Irrigated	Gadar	Average	30.42	35.55	17.99	21.01	37.22	43.45
			SDV	0.93	1.85	0.06	0.38	2.71	2.23
203	96-B Rainfed	Gadar	Average	33.28	35.99	15.19	16.44	43.99	47.58
			SDV	1.58	1.16	0.20	0.46	0.02	0.69
204	97-A Daman	Badwan	Average	58.15	64.08	8.76	9.52	24.17	26.41
			SDV	2.56	0.97	2.09	1.85	0.31	0.88
205	97-B Shoulgar	Badwan	Average	50.21	53.31	10.41	11.06	33.57	35.64
			SDV	0.50	0.23	0.82	1.03	1.66	1.25
206	98-A Daman	Mian Barangola	Average	53.90	57.44	15.25	16.25	24.70	26.31
			SDV	0.93	1.51	0.88	1.09	2.66	2.60
207	98-B Shoulgar	Mian Barangola	Average	55.31	61.78	7.25	8.05	26.93	30.18
			SDV	5.02	0.93	1.65	1.23	0.11	2.16
208	99-A Daman	Tiruna	Average	46.02	52.97	6.11	7.03	34.75	40.01
			SDV	1.14	1.00	1.57	1.76	2.20	2.77
209	99-B Jewardara	Tiruna	Average	43.26	49.62	22.93	26.32	20.99	24.07
			SDV	1.18	0.91	1.45	1.90	1.05	0.99
210	99-C Shoulgar	Tiruna	Average	59.41	63.07	16.76	17.78	18.04	19.15
			SDV	0.82	1.77	1.65	1.50	0.51	0.27
211	100-A	Kamala	Average	42.97	47.08	27.46	30.10	20.92	22.92
			SDV	1.01	0.83	1.41	1.72	0.81	0.75
212	100-B	Kamala	Average	56.01	65.26	13.33	15.55	16.50	19.19
			SDV	0.80	0.74	1.08	1.65	2.47	2.39

Table E.1c Cont.

Table E.2a:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From River Swat Watershed for the Year 2005

Serial No	Reference. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
1	1	1	Kalam	7.02	306.32	179	1.62	2.835	13.37
2	2	2	Pashmal	7.23	275.54	174	1.65	2.244	8.88
3	3	3	Asharopatai	7.35	221.11	131	1.61	2.552	7.86
4	4	4	Laikot	7.67	304.24	151	1.59	0.716	8.84
5	5	5	Asrit	6.85	210.72	126	1.56	0.513	7.82
6	6	6	Mankial	7.51	336.33	198	1.57	0.407	7.81
7	7	7	Kedam	7.34	304.87	180	1.56	0.372	11.79
8	8	8-A Irrigated	Bahrain	7.25	273.72	162	1.93	1.542	9.72
9		8-B Rainfed		6.98	242.61	144	1.64	0.521	9.75
10	9	9-A Irrigated	Satal	7.36	230.61	145	1.60	2.632	12.74
11		9-B Rainfed		6.95	256.41	154	1.64	2.352	10.72
12		10-A Irrigated	Madyan	7.35	254.91	146	1.63	2.622	11.70
13	10	10-B Rainfed		6.92	270.43	159	1.61	0.725	12.69
14	11	11-A Danman	Jare	6.96	312.31	186	1.63	0.622	8.67
15		11-B Jewardara		7.26	233.95	188	1.56	2.527	10.51
16		11-C Shoulgar		6.99	378.72	187	1.52	2.042	11.63
17	12	12-A Danman	Fatepur	7.18	236.32	158	1.46	1.929	9.62
18		12-B Jewardara		7.03	478.37	282	1.46	2.473	13.62
19		12-C Shoulgar		7.02	327.73	243	1.48	2.473	12.58
20	13	13-A Danman	Darmai	6.97	376.73	229	1.53	1.097	8.56
21		13-B Jewardara		7.44	328.55	192	1.54	1.375	11.59
22		13-C Shoulgar		6.91	274.64	182	1.52	1.743	10.29
23	14	14	Sakhra	7.18	233.66	142	1.54	1.292	8.51
24	15	15-A Danman	Bagh Dheri	7.25	122.62	85	1.48	1.128	10.49
25		15-B Jewardara		6.82	122.34	73	1.48	2.334	10.77
26		15-C Shoulgar		7.14	146.36	88	1.50	1.939	11.46
27	16	16-A Danman	Asharai	7.26	170.86	98	1.49	1.843	9.43
28		16-B Jewardara		7.29	234.42	126	1.53	2.749	8.43
29		16-C Shoulgar		7.09	208.44	188	1.51	1.653	11.80
30	17	17-A Danman	Dursh Khela	7.37	142.14	89	1.52	1.505	7.40
31		17-B Jewardara		7.26	266.46	158	1.52	2.468	12.37
32		17-C Shoulgar		7.34	291.17	172	1.47	3.463	13.57
33	18	18-A Danman	Sambat	7.32	315.39	186	1.51	1.647	9.34
34		18-B Jewardara		7.69	339.13	228	1.52	2.186	12.32
35		18-C Shoulgar		7.34	263.48	184	1.54	2.852	15.30
36	19	19-A Danman	Shokhdara	6.98	387.26	218	1.48	1.914	8.67
37		19-B Jewardara		6.97	317.34	212	1.48	1.896	13.27
38		19-C Shoulgar		6.85	235.45	147	1.48	3.185	12.25
39	20	20	Wainai	6.94	460.04	271	1.46	1.763	6.25
40	21	21	Chuprial	7.15	260.73	152	1.49	2.612	12.22
41	22	22	Changialai	7.91	252.53	140	1.53	1.942	9.02
42	23	23	Gwalarai	7.68	329.22	188	1.53	1.937	8.18
43	24	24	Roringar	7.46	216.52	137	1.53	1.338	6.17
44	25	25	Fazal Banad	7.23	323.67	286	1.52	1.202	8.15
45	26	26	Sarkarai	7.22	362.43	172	1.52	1.246	9.14
46	27	27	Kalagai	7.27	241.56	167	1.51	1.206	9.11
47	28	28-A Danman	Shairpalam	7.21	264.64	148	1.53	1.915	10.62
48		28-B Jewardara		7.28	278.33	136	1.47	1.978	12.08
49		28-C Shoulgar		7.24	292.36	124	1.49	3.906	15.06
50	29	29-A Danman	Shakar Dara	7.48	318.37	186	1.48	1.902	7.43
51		29-B Jewardara		7.22	338.44	200	1.52	2.837	14.26
52		29-C Shoulgar		7.26	319.44	162	1.47	2.893	15.22
53	30	30-A Danman	Ningulai	7.29	340.57	201	1.48	1.839	6.19
54		30-B Jewardara		7.38	241.37	153	1.46	2.842	13.59
55		30-C Shoulgar		7.31	247.28	158	1.50	2.277	15.54
56	31	31-A Danman	Bara & Kuza Pandai	7.27	253.47	158	1.46	2.155	7.29
57		31-B Jewardara		7.39	261.63	152	1.49	2.871	14.09

Table E.2a Cont....

Table E.2a:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From River Swat Watershed for the Year 2005

Serial No	Reference No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
58		31-C Shoulgar		7.41	267.65	165	1.49	2.865	14.64
59	32	32-A Danman	Sigram	7.35	374.43	189	1.42	1.213	12.23
60		32-B Jewardara		7.48	280.42	172	1.46	2.857	14.80
61		32-C Shoulgar		7.53	318.43	182	1.48	1.863	14.84
62	33	33-A Danman	Kanju	7.51	294.93	178	1.53	1.846	7.41
63		33-B Jewardara		7.43	311.56	173	1.44	2.429	13.52
64		33-C Shoulgar		7.27	207.72	135	1.49	2.837	13.70
65	34	34	Kala	7.52	293.67	190	1.49	1.353	6.65
66	35	35	Deolai	7.33	220.77	135	1.47	2.309	10.62
67	36	36	Tal	7.62	327.62	213	1.54	1.264	7.29
68	37	37	Tutano Banda	7.34	233.67	185	1.45	1.822	12.54
69	38	38	Sarsanai	7.51	314.58	192	1.41	0.438	4.93
70	39	39-A Danman	Gul Jaba	7.32	145.65	89	1.44	2.542	10.39
71		39-C Shoulgar		7.21	153.37	92	1.34	2.326	13.50
72	40	40-A Danman	Kabbal	7.42	223.26	132	1.48	1.254	8.36
73		40-B Jewardara		7.31	367.24	216	1.32	2.364	13.33
74		40-C Shoulgar		7.45	258.45	113	1.49	2.827	13.28
75	41	41	Kotlai	7.25	349.67	205	1.49	3.176	9.25
76	42	42	Surgalai	7.19	140.54	88	1.62	1.755	10.19
77	43	43-A Danman	Parrai	7.39	332.18	195	1.53	1.362	13.15
78		43-B Jewardara		7.52	223.88	179	1.43	3.017	11.21
79		43-C Shoulgar		7.46	214.65	146	1.59	2.663	13.14
80	44	44-A Danman	Nagwa	7.37	105.35	83	1.65	0.317	11.19
81		44-B Jewardara		6.56	247.96	155	1.54	1.957	15.61
82		44-C Shoulgar		7.34	288.55	170	1.44	2.604	13.29
83	45	45-A Danman	Dedawar	7.25	127.89	83	1.46	0.521	12.89
84		45-B Jewardara		7.32	270.15	159	1.38	1.715	11.88
85		45-C Shoulgar		7.34	262.58	155	1.47	2.618	13.38
86	46	46-A Danman	Tirang	7.29	121.74	79	1.47	1.665	12.64
87		46-B Jewardara		7.45	244.93	145	1.48	1.552	9.11
88		46-C Shoulgar		6.99	245.32	143	1.63	1.557	11.47
89	47	47-A Danman	Chongai	6.97	127.66	87	1.54	1.536	10.63
90		47-B Jewardara		7.09	218.55	130	1.45	2.425	12.59
91		47-C Shoulgar		6.93	309.87	165	1.63	2.247	11.55
92	48	48	Sarai	6.67	201.33	120	1.33	0.833	11.50
93	49	49	Miandam	6.82	257.44	150	1.33	1.753	12.46
94	50	50-A Danman	Shin	7.29	262.87	171	1.45	1.746	8.42
95		50-B Jewardara		7.17	267.22	173	1.50	2.327	11.37
96		50-C Shoulgar		7.26	239.67	154	1.50	3.074	12.93
97	51	51-A Danman	Kotanai	7.23	113.29	75	1.66	1.328	10.29
98		51-B Jewardara		7.01	185.58	110	1.43	2.119	15.24
99		51-C Shoulgar		6.98	187.78	112	1.53	1.916	16.04
100	52	52-A Danman	Chalyar	6.94	119.16	83	1.51	1.585	9.16
101		52-B Jewardara		7.15	192.35	113	1.38	1.492	12.11
102		52-C Shoulgar		6.88	195.32	114	1.49	2.283	14.07
103	53	53-A Danman	Khwazakhela	7.25	197.55	115	1.53	1.075	11.88
104		53-B Jewardara		6.82	200.37	117	1.59	1.625	17.86
105		53-C Shoulgar		7.21	187.66	110	1.52	2.835	10.94
106	54	54-A Danman	Gulibagh	7.24	174.35	104	1.47	0.727	10.10
107		54-B Jewardara		7.27	151.58	95	1.37	1.027	14.86
108		54-C Shoulgar		7.31	149.35	87	1.58	2.716	14.81
109	55	55-A Danman	Dakorak	7.27	113.23	75	1.51	0.744	11.75
110		55-B Jewardara		7.36	121.06	78	1.38	2.417	13.27
111		55-C Shoulgar		7.32	131.66	85	1.45	2.919	11.68
112	56	56-A Danman	Charbagh	7.28	98.96	66	1.59	0.562	12.41
113		56-B Jewardara		7.45	415.91	325	1.40	1.775	14.60

Table E.2a Cont....

Table E.2a:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From River Swat Watershed for the Year 2005

Serial No	Referenc e. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
114		56-C Shoulgar		7.51	230.93	143	1.53	2.828	15.16
115	57	57	Tilgram	7.44	113.55	85	1.48	0.766	9.51
116	58	58-A Danman	Manglaur	7.52	122.84	86	1.40	1.515	11.47
117		58-B Jewardara		7.72	430.66	212	1.53	2.727	14.26
118		58-C Shoulgar		7.43	231.84	165	1.53	1.714	14.83
119	59	59-A Danman	Dangram	7.41	138.55	118	1.60	0.718	9.40
120		59-B Jewardara		7.47	246.21	172	1.45	1.556	11.82
121		59-C Shoulgar		7.42	253.56	175	1.48	2.095	14.35
122	60	60-A Danman	Sangota	7.44	161.16	117	1.45	0.466	8.22
123		60-B Jewardara		7.42	269.25	181	1.48	1.559	13.67
124		60-C Shoulgar		6.88	276.74	184	1.46	3.515	13.25
125	61	61-A Danman	Takhtaband	7.49	124.18	114	1.45	0.255	8.81
126		61-B Jewardara		7.41	291.25	189	1.58	1.963	11.04
127		61-C Shoulgar		6.92	299.19	192	1.57	2.916	14.54
128	62	62-A Danman	Jambil	7.51	107.57	75	1.65	1.702	9.52
129		62-B Jewardara		7.42	214.36	168	1.54	1.482	11.93
130	63	63-A Danman	Bologram	7.52	121.11	106	1.45	1.265	8.63
131		63-B Jewardara		7.41	228.52	165	1.44	2.624	11.24
132		63-C Shoulgar		7.35	235.57	169	1.44	2.842	12.36
133	64	64-A Danman	Gogdara	7.55	112.29	66	1.52	1.635	9.37
134		64-B Jewardara		7.36	249.08	151	1.41	2.426	13.29
135		64-C Shoulgar		7.27	256.19	152	1.47	2.208	13.14
136	65	65-A Danman	Pajigram	7.52	163.47	69	1.46	0.954	9.79
137		65-B Jewardara		7.52	270.08	153	1.33	1.782	14.49
138		65-C Shoulgar		7.46	277.03	158	1.44	1.568	14.79
139	66	66-A Danman	Ghaligai	7.34	114.63	57	1.48	1.354	9.48
140		66-B Jewardara		7.15	291.13	152	1.48	1.362	13.68
141		66-C Shoulgar		7.27	283.03	156	1.47	2.653	13.26
142	67	67-A Danman	Manyar	7.35	105.65	66	1.48	1.272	10.50
143		67-B Jewardara		7.64	212.63	118	1.38	1.774	14.31
144		67-C Shoulgar		7.42	119.56	137	1.52	2.928	14.26
145	68	68-A Danman	Barikot	7.52	112.95	67	1.53	0.386	10.22
146		68-B Jewardara		7.67	414.66	249	1.43	2.175	12.74
147		68-C Shoulgar		7.33	343.15	278	1.58	2.717	13.13
148	69	69-A Danman	Abua	7.39	117.92	67	1.65	1.373	9.91
149		69-B Jewardara		7.56	476.95	340	1.53	1.303	12.49
150		69-C Shoulgar		7.49	375.54	183	1.49	2.306	14.52
151	70	70-A Danman	Kotah	7.63	116.04	126	1.66	1.253	9.21
152		70-B Jewardara		7.67	264.06	156	1.54	2.622	12.29
153		70-C Shoulgar		7.54	312.52	163	1.56	3.182	13.57
154	71	71-A Danman	Landakai	7.29	138.94	71	1.65	0.927	9.83
155		71-B Jewardara		7.22	362.69	195	1.56	1.735	11.72
156		71-C Shoulgar		7.28	378.63	193	1.60	2.096	14.76
157	72	72-A Danman	Haibatgram	7.27	118.98	62	1.41	0.718	9.70
158		72-B Jewardara		7.32	130.77	70	1.45	1.225	12.67
159		72-C Shoulgar		7.41	134.66	72	1.49	1.337	12.18
160	73	73-A Danman	Thana	7.65	126.24	71	1.34	1.216	5.75
161		73-B Jewardara		7.42	128.14	69	1.49	1.715	11.31
162		73-C Shoulgar		7.41	140.18	79	1.53	1.214	13.48
163	74	74	Nal	7.43	123.16	67	1.54	1.632	7.46
164	75	75	Gunyar	7.23	102.55	54	1.48	1.317	5.02
165	76	76-A Danman	Allahadan	7.34	126.13	79	1.41	0.818	7.36
166		76-B Jewardara		7.58	162.63	95	1.45	1.334	12.32
167		76-C Shoulgar		7.36	158.33	92	1.52	2.448	14.27
168	77	77-A Danman	Batkhala	7.43	122.33	68	1.38	0.726	9.24
169		77-B Jewardara		7.43	170.07	102	1.44	1.993	11.19
170		77-C Shoulgar		7.45	178.65	103	1.53	1.939	14.40

Table E.2a Cont....

Table E.2a:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From River Swat Watershed for the Year 2005

Serial No	Reference. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
171	78	78	Piran	7.53	92.64	59	1.52	1.057	5.20
172	79	79	Rangmala	7.42	189.77	108	1.52	0.521	4.58
173	80	80-A Danman	Jolagram	7.53	116.92	75	1.48	0.527	8.15
174		80-B Jewardara		7.12	198.33	122	1.49	1.758	10.72
175		80-C Shoulgar		7.61	198.22	116	1.51	1.562	12.29
176	81	81-A Danman	Matkani	7.68	121.22	72	1.40	0.527	6.86
177		81-B Jewardara		7.35	121.08	88	1.45	1.338	12.26
178		81-C Shoulgar		7.62	232.15	119	1.48	2.307	13.75
179	82	82-A Danman	Totakan	7.53	118.22	69	1.39	0.618	10.63
180		82-B Jewardara		7.48	144.55	99	1.41	1.088	11.39
181		82-C Shoulgar		7.44	227.64	139	1.52	1.942	13.36
182	83	83	Bagh Raji	7.82	78.73	53	1.41	0.375	10.63
183	84	87-A Irrigated	Makhband	7.54	92.08	49	1.59	1.618	8.25
184		87-B rainfed		7.83	162.22	103	1.62	0.719	11.64
185	85	85-A Danman	Kalangai	7.98	124.83	72	1.49	0.418	7.49
186		85-B Jewardara		7.88	172.33	81	1.48	1.338	12.46
187		85-C Shoulgar		7.14	224.66	126	1.55	2.445	12.29
188	86	86-A Danman	Ramora	8.11	95.88	42	1.56	0.634	8.94
189		86-B Jewardara		7.24	180.65	141	1.52	1.436	11.33
190		86-C Shoulgar		8.17	285.66	170	1.48	2.206	13.28
191	87	86-A Danman	Chakdara	7.62	119.95	87	1.52	1.346	8.40
192		86-B Jewardara		8.23	296.44	176	1.50	1.536	10.90
193		86-C Shoulgar		7.46	314.66	157	1.52	1.363	12.90
194	88	88	Shewa	7.44	113.86	68	1.35	1.414	7.03
195	89	89	Tindo Dag	7.32	133.87	80	1.38	1.918	7.98
196	90	90	Kitiarai	7.41	153.22	81	1.44	1.914	6.22
197	91	91	Khanpur	7.28	144.18	79	1.48	0.194	5.50
198	92	92	Khairabad	7.32	94.65	41	1.48	0.287	4.20
199	93	93	Chikhoo	7.36	115.63	67	1.38	0.817	5.46
200	94	94	Usakai	7.31	135.33	96	1.42	1.825	8.46
201	95	95	Wuch	7.23	153.54	71	1.35	1.255	8.86
202	96	96-A Irrigated	Gadar	7.32	175.63	118	1.33	1.575	6.36
203		96-B Rainfed		8.23	296.65	176	1.43	2.072	6.94
204	97	97-A Daman	Badwan	8.12	74.44	45	1.59	1.352	6.86
205		97-B Shoulgar		7.91	83.66	51	1.52	1.662	11.36
206	98	98-A Daman	Mian Barangola	7.86	73.18	44	1.46	1.322	5.25
207		98-B Shoulgar		7.45	87.95	53	1.60	2.357	10.28
208	99	99-A Daman	Tiruna	7.61	84.85	47	1.61	1.536	6.38
209		99-B Jewardara		7.29	98.96	59	1.37	1.337	8.29
210		99-C Shoulgar		7.36	125.17	73	1.44	1.753	12.27
211	100	100-A	Kamala	7.24	72.97	42	1.36	0.746	6.26
212		100-B		7.11	128.96	76	1.46	0.625	8.24

Table E.2a Cont....

Table E.2b:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From RIver Swat Watershed for the Year 2006

Serial No	Ref. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids	B Density (g/cm3)	Organic Matter	Soil Moisture
1	1	1	Kalam	7.13	311	183	1.61	2.452	15.34
2	2	2	Pashmal	7.33	278	178	1.63	1.824	9.87
3	3	3	Asharopatai	7.43	226	133	1.60	1.836	9.75
4	4	4	Laikot	7.48	335	127	1.55	0.624	7.94
5	5	5	Asrit	7.11	224	133	1.50	0.427	6.82
6	6	6	Mankial	7.42	332	195	1.53	0.372	7.66
7	7	7	Kedam	7.27	312	185	1.61	0.347	9.78
8	8	8-A Irrigated	Bahrain	7.28	276	167	1.56	0.873	8.77
9		8-B Rainfed		7.11	249	151	1.60	0.407	8.75
10	9	9-A Irrigated	Satal	7.24	241	155	1.62	3.127	10.33
11		9-B Rainfed		7.12	253	151	1.65	3.047	11.15
12		10-A Irrigated	Madyan	7.42	258	148	1.53	2.122	12.70
13	10	10-B Rainfed		7.11	275	163	1.61	0.328	10.82
14	11	11-A Danman	Jare	7.13	323	189	1.60	0.728	7.66
15		11-B Jewardara		7.15	223	178	1.54	1.728	9.66
16		11-C Shoulgar		7.11	365	174	1.50	2.715	12.86
17	12	12-A Danman	Fatepur	7.23	239	159	1.46	1.035	10.12
18		12-B Jewardara		7.14	397	263	1.47	3.093	14.12
19		12-C Shoulgar		7.24	324	233	1.47	3.093	11.58
20	13	13-A Danman	Darmai	7.22	364	214	1.51	1.073	7.58
21		13-B Jewardara		7.25	316	184	1.53	2.172	10.54
22		13-C Shoulgar		7.16	276	185	1.53	2.294	10.25
23	14	14	Sakhra	7.23	242	148	1.53	1.196	9.14
24	15	15-A Danman	Bagh Dheri	7.27	129	88	1.49	1.147	8.29
25		15-B Jewardara		7.28	133	78	1.49	1.975	9.47
26		15-C Shoulgar		7.24	152	91	1.52	2.015	12.45
27	16	16-A Danman	Asharai	7.15	175	101	1.50	1.297	10.54
28		16-B Jewardara		7.16	224	122	1.51	3.725	9.42
29		16-C Shoulgar		7.23	198	176	1.52	3.383	9.40
30	17	17-A Danman	Dursh Khela	7.35	133	82	1.53	1.539	8.39
31		17-B Jewardara		7.53	255	151	1.51	1.539	13.69
32		17-C Shoulgar		7.42	282	166	1.48	1.746	12.35
33	18	18-A Danman	Sambat	7.45	309	182	1.52	1.446	8.47
34		18-B Jewardara		7.43	323	219	1.51	2.152	12.71
35		18-C Shoulgar		7.28	258	178	1.55	2.622	14.30
36	19	19-A Danman	Shokhdara	7.54	378	214	1.47	1.352	7.44
37		19-B Jewardara		7.56	302	205	1.46	2.272	12.27
38		19-C Shoulgar		7.43	229	141	1.49	1.731	12.25
39	20	20	Wainai	7.63	455	266	1.50	1.682	7.21
40	21	21	Chuprial	7.23	254	145	1.50	1.944	11.22
41	22	22	Changialai	7.45	249	133	1.54	2.352	1.06
42	23	23	Gwalarai	7.34	318	181	1.46	2.362	10.53
43	24	24	Roringar	7.38	228	141	1.54	0.967	7.11
44	25	25	Fazal Banad	7.33	313	282	1.51	0.894	6.84
45	26	26	Sarkarai	7.42	352	169	1.50	0.925	7.13
46	27	27	Kalagai	7.33	233	164	1.53	1.189	8.11
47	28	28-A Danman	Shairpalam	7.42	259	146	1.53	1.193	9.09
48		28-B Jewardara		7.25	273	134	1.48	2.157	13.75
49		28-C Shoulgar		7.37	286	118	1.47	2.562	14.57
50	29	29-A Danman	Shakar Dara	7.44	317	184	1.42	2.518	8.04
51		29-B Jewardara		7.46	329	193	1.51	2.669	14.14
52		29-C Shoulgar		7.37	324	156	1.50	3.233	14.22
53	30	30-A Danman	Ningulai	7.35	335	192	1.51	1.874	7.09
54		30-B Jewardara		7.26	238	148	1.47	2.314	14.13
55		30-C Shoulgar		7.25	240	162	1.50	1.799	16.71
56	31	31-A Danman	Bara & Kuza Bandai	7.26	249	155	1.47	2.439	8.74

Table E.2b Cont..

Table E.2b:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From RIver Swat Watershed for the Year 2006

Serial No	Reference. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
57		31-B Jewardara		7.46	258	150	1.48	1.393	13.40
58		31-C Shoulgar		7.25	261	162	1.51	1.624	15.56
59	32	32-A Danman	Sigram	7.28	364	183	1.44	1.518	13.91
60		32-B Jewardara		7.52	273	169	1.47	2.252	15.87
61		32-C Shoulgar		7.47	325	186	1.48	2.285	14.26
62	33	33-A Danman	Kanju	7.45	282	174	1.52	1.574	8.34
63		33-B Jewardara		7.33	323	176	1.42	2.318	14.31
64		33-C Shoulgar		7.22	212	138	1.48	2.272	12.26
65	34	34	Kala	7.43	285	155	1.47	1.262	5.45
66	35	35	Deolai	7.34	232	138	1.45	2.703	11.11
67	36	36	Tal	7.53	318	209	1.51	1.344	6.58
68	37	37	Tutano Banda	7.42	22189	181	1.43	1.155	11.29
69	38	38	Sarsanai	7.44	324	195	1.44	1.298	5.71
70	39	39-A Danman	Gul Jaba	7.34	154	93	1.43	1.927	11.31
71		39-C Shoulgar		7.43	157	95	1.35	1.854	14.39
72	40	40-A Danman	Kabbal	7.32	236	137	1.45	1.352	9.36
73		40-B Jewardara		7.51	354	210	1.34	2.827	12.37
74		40-C Shoulgar		7.25	255	110	1.51	3.325	11.27
75	41	41	Kotlai	7.18	338	202	1.50	2.575	8.24
76	42	42	Surgalai	7.27	147	93	1.62	1.634	11.57
77	43	43-A Danman	Parrai	7.34	323	191	1.53	1.284	13.14
78		43-B Jewardara		7.43	218	176	1.44	2.928	10.46
79		43-C Shoulgar		7.33	221	148	1.57	2.572	12.51
80	44	44-A Danman	Nagwa	7.26	112	84	1.62	0.229	13.34
81		44-B Jewardara		7.56	234	147	1.53	1.875	14.53
82		44-C Shoulgar		7.46	283	166	1.45	2.846	12.86
83	45	45-A Danman	Dedawar	7.35	135	86	1.47	0.744	11.79
84		45-B Jewardara		7.38	263	154	1.39	1.626	10.61
85		45-C Shoulgar		7.31	267	156	1.49	1.869	11.31
86	46	46-A Danman	Tirang	7.32	124	81	1.47	1.474	12.73
87		46-B Jewardara		7.24	234	138	1.49	2.227	10.06
88		46-C Shoulgar		7.22	233	134	1.61	2.073	12.64
89	47	47-A Danman	Chongai	7.32	116	83	1.53	1.917	11.21
90		47-B Jewardara		7.13	212	123	1.47	1.744	13.77
91		47-C Shoulgar		7.22	312	171	1.60	2.731	13.34
92	48	48	Sarai	7.74	211	121	1.34	0.762	10.50
93	49	49	Miandam	7.45	252	153	1.44	1.702	13.45
94	50	50-A Danman	Shin	7.36	259	173	1.50	1.694	7.06
95		50-B Jewardara		7.32	262	174	1.51	2.268	12.62
96		50-C Shoulgar		7.42	234	153	1.51	2.952	13.32
97	51	51-A Danman	Kotanai	7.11	119	77	1.59	1.276	9.28
98		51-B Jewardara		7.27	188	112	1.45	2.067	14.31
99		51-C Shoulgar		7.65	183	107	1.50	2.057	15.03
100	52	52-A Danman	Chalyar	7.56	112	85	1.53	1.537	11.47
101		52-B Jewardara		7.32	184	109	1.40	1.449	11.29
102		52-C Shoulgar		7.69	184	109	1.51	2.232	13.62
103	53	53-A Danman	Khwazakhela	7.32	188	112	1.53	0.952	12.06
104		53-B Jewardara		7.65	199	116	1.58	2.075	16.75
105		53-C Shoulgar		7.33	183	107	1.53	3.064	12.92
106	54	54-A Danman	Gulibagh	7.13	182	107	1.49	0.631	11.89
107		54-B Jewardara		7.36	158	98	1.38	1.422	13.74
108		54-C Shoulgar		7.42	146	86	1.55	2.773	15.27
109	55	55-A Danman	Dakorak	7.35	125	79	1.53	0.663	11.69
110		55-B Jewardara		7.45	117	81	1.38	3.446	12.63
111		55-C Shoulgar		7.52	126	88	1.52	3.107	12.74

Table E.2b Cont..

Table E.2b:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From RIver Swat Watershed for the Year 2006

Serial No	Reference. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
112	56	56-A Danman	Charbagh	7.47	89	62	1.55	0.717	13.31
113		56-B Jewardara		7.32	424	327	1.39	1.084	13.75
114		56-C Shoulgar		7.38	235	145	1.52	3.335	16.54
115	57	57	Tilgram	7.32	117	86	1.49	0.626	10.13
116	58	58-A Danman	Manglaur	7.42	125	87	1.41	1.224	11.83
117		58-B Jewardara		7.65	439	215	1.52	1.966	15.86
118		58-C Shoulgar		7.34	238	169	1.54	2.092	15.37
119	59	59-A Danman	Dangram	7.33	143	121	1.55	0.655	8.14
120		59-B Jewardara		7.33	253	175	1.48	2.085	12.61
121		59-C Shoulgar		7.62	258	176	1.48	2.087	13.24
122	60	60-A Danman	Sangota	7.43	156	121	1.48	0.512	8.44
123		60-B Jewardara		7.33	263	184	1.52	2.017	11.57
124		60-C Shoulgar		7.85	269	179	1.46	2.718	14.38
125	61	61-A Danman	Takhtaband	7.22	138	118	1.45	0.334	9.72
126		61-B Jewardara		7.22	282	184	1.55	1.782	12.08
127		61-C Shoulgar		7.81	286	185	1.53	3.356	13.71
128	62	62-A Danman	Jambil	7.72	114	78	1.62	1.646	8.15
129		62-B Jewardara		7.63	224	172	1.54	1.358	11.54
130	63	63-A Danman	Bologram	7.34	125	108	1.47	1.478	9.84
131		63-B Jewardara		7.46	233	168	1.45	2.869	12.25
132		63-C Shoulgar		7.26	243	171	1.47	3.795	13.69
133	64	64-A Danman	Gogdara	7.36	123	69	1.53	1.582	10.73
134		64-B Jewardara		7.63	242	147	1.42	2.368	12.33
135		64-C Shoulgar		7.44	252	149	1.48	3.155	14.40
136	65	65-A Danman	Pajigram	7.47	159	65	1.49	1.134	10.60
137		65-B Jewardara		7.55	266	149	1.33	1.873	15.26
138		65-C Shoulgar		7.24	269	154	1.44	2.515	15.57
139	66	66-A Danman	Ghaligai	7.23	118	57	1.48	1.462	10.14
140		66-B Jewardara		7.44	279	146	1.48	2.216	12.42
141		66-C Shoulgar		7.32	290	148	1.49	1.626	13.38
142	67	67-A Danman	Manyar	7.31	114	68	1.49	1.225	11.39
143		67-B Jewardara		7.13	223	121	1.39	2.818	14.30
144		67-C Shoulgar		7.23	125	141	1.53	3.038	15.69
145	68	68-A Danman	Barikot	7.36	127	72	1.53	1.037	10.97
146		68-B Jewardara		7.55	408	245	1.44	1.952	13.65
147		68-C Shoulgar		7.41	336	274	1.54	1.824	13.51
148	69	69-A Danman	Abua	7.35	121	70	1.63	1.712	10.07
149		69-B Jewardara		7.32	485	345	1.54	1.733	11.37
150		69-C Shoulgar		7.23	363	178	1.49	1.726	14.43
151	70	70-A Danman	Kotah	7.42	114	124	1.63	1.095	9.57
152		70-B Jewardara		7.44	254	152	1.54	2.464	11.57
153		70-C Shoulgar		7.44	304	159	1.65	2.864	15.71
154	71	71-A Danman	Landakai	7.32	140	69	1.61	1.203	9.11
155		71-B Jewardara		7.25	368	195	1.56	2.572	11.76
156		71-C Shoulgar		7.44	373	198	1.58	2.427	13.36
157	72	72-A Danman	Haibatgram	7.34	124	67	1.41	0.825	9.69
158		72-B Jewardara		7.34	133	72	1.45	1.627	11.75
159		72-C Shoulgar		7.45	133	70	1.51	1.822	13.83
160	73	73-A Danman	Thana	7.73	124	67	1.36	1.767	6.38
161		73-B Jewardara		7.44	126	67	1.49	2.263	11.06
162		73-C Shoulgar		7.43	142	82	1.53	2.362	12.48
163	74	74	Nal	7.47	113	65	1.54	1.326	6.15
164	75	75	Gunyar	7.27	105	56	1.48	1.253	5.92
165	76	76-A Danman	Allahadan	7.43	126	75	1.41	0.723	9.48
166		76-B Jewardara		7.63	159	92	1.44	1.655	13.31
167		76-C Shoulgar		7.33	163	95	1.52	1.838	15.62

Table E.2b Cont..

Table E.2b:- Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic Matter and Soil Moistures of Selected Soil Samples Collected From RIver Swat Watershed for the Year 2006

Serial No	Reference. No	Sub Sample No	Village Name	pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
168	77	77-A Danman	Batkhala	7.42	119	64	1.38	0.908	8.93
169		77-B Jewardara		7.47	169	98	1.44	2.443	10.25
170		77-C Shoulgar		7.42	175	106	1.51	2.027	13.13
171	78	78	Piran	7.56	88	53	1.51	1.135	4.91
172	79	79	Rangmala	7.44	192	112	1.52	0.404	4.74
173	80	80-A Danman	Jolagram	7.55	118	79	1.48	0.483	9.41
174		80-B Jewardara		7.36	196	118	1.50	1.192	10.64
175		80-C Shoulgar		7.64	204	122	1.51	1.946	12.14
176	81	81-A Danman	Matkani	7.54	119	68	1.41	0.433	5.57
177		81-B Jewardara		7.44	119	79	1.45	1.592	12.32
178		81-C Shoulgar		7.68	228	113	1.49	2.098	14.29
179	82	82-A Danman	Totakan	7.62	122	71	1.40	0.722	9.57
180		82-B Jewardara		7.43	136	92	1.43	1.173	11.27
181		82-C Shoulgar		7.33	233	143	1.52	1.882	14.29
182	83	83	Bagh Raji	7.73	81	48	1.41	0.322	7.14
183	84	87-A Irrigated	Makhband	7.44	87	45	1.54	1.557	7.78
184		87-B rainfed		7.72	159	98	1.58	0.805	12.30
185	85	85-A Danman	Kalangai	7.94	118	69	1.50	0.362	6.49
186		85-B Jewardara		7.79	165	74	1.49	1.046	11.43
187		85-C Shoulgar		7.24	218	118	1.55	1.762	12.57
188	86	86-A Danman	Ramora	7.84	93	39	1.55	0.553	8.36
189		86-B Jewardara		7.38	178	139	1.51	1.373	11.15
190		86-C Shoulgar		7.86	278	165	1.52	1.808	12.27
191	87	86-A Danman	Chakdara	7.53	123	90	1.53	1.533	8.23
192		86-B Jewardara		7.72	283	168	1.51	2.253	11.61
193		86-C Shoulgar		7.43	298	142	1.49	2.354	13.61
194	88	88	Shewa	7.32	122	71	1.36	2.196	6.03
195	89	89	Tindo Dag	7.33	138	81	1.38	2.052	6.05
196	90	90	Kitiarai	7.36	145	78	1.45	2.513	7.08
197	91	91	Khanpur	7.44	134	83	1.49	0.287	4.39
198	92	92	Khairabad	7.55	92	40	1.48	0.674	5.65
199	93	93	Chikhoo	7.45	124	71	1.39	0.634	6.59
200	94	94	Usakai	7.42	140	99	1.42	1.733	7.85
201	95	95	Wuch	7.43	165	76	1.35	1.083	7.82
202	96	96-A Irrigated	Gadar	7.54	178	121	1.38	2.899	8.07
203		96-B Rainfed		7.94	287	173	1.42	2.151	5.39
204	97	97-A Daman	Badwan	7.95	82	48	1.54	1.824	7.26
205		97-B Shoulgar		7.72	86	53	1.51	1.158	10.36
206	98	98-A Daman	Mian Barangola	7.56	86	51	1.48	1.914	6.79
207		98-B Shoulgar		7.31	91	56	1.56	1.786	9.32
208	99	99-A Daman	Tiruna	7.36	92	51	1.55	1.229	7.31
209		99-B Jewardara		7.24	102	61	1.38	1.572	9.75
210		99-C Shoulgar		7.33	113	68	1.47	0.829	11.83
211	100	100-A	Kamala	7.28	78	46	1.37	0.429	7.25
212		100-B		7.32	122	72	1.48	0.372	10.35

Table E.2b Cont..

Table E.2c:- Average value of Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic matters and Soi Moistures (2005-06)

Serial No	Ref. No	Sub Sample No	Village Name		pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter	Soil Moisture (%age)
1	1	1	Kalam	Average	7.08	308.42	181.32	1.61	2.644	14.36
				SDV	0.08	2.97	2.85	0.01	0.271	1.39
2	2	2	Pashmal	Average	7.28	276.85	176.26	1.64	2.034	9.37
				SDV	0.07	1.85	2.82	0.01	0.297	0.70
3	3	3	Asharopatai	Average	7.39	223.47	132.27	1.60	2.194	8.81
				SDV	0.06	3.34	1.44	0.01	0.506	1.34
4	4	4	Laikot	Average	7.58	319.81	138.92	1.57	0.670	8.39
				SDV	0.13	22.02	17.54	0.03	0.065	0.64
5	5	5	Asrit	Average	6.98	217.40	129.50	1.53	0.470	7.32
				SDV	0.18	9.45	4.50	0.04	0.061	0.71
6	6	6	Mankial	Average	7.47	334.35	196.69	1.55	0.390	7.73
				SDV	0.06	2.80	2.38	0.02	0.025	0.10
7	7	7	Kedam	Average	7.31	308.62	182.80	1.59	0.360	10.79
				SDV	0.05	5.30	3.35	0.03	0.018	1.42
8	8	8-A Irrigated	Bahrain	Average	7.27	274.62	164.67	1.75	1.208	9.24
				SDV	0.02	1.27	3.30	0.26	0.473	0.67
9		8-B Rainfed		Average	7.05	245.57	147.60	1.62	0.464	9.25
				SDV	0.09	4.18	4.43	0.03	0.081	0.71
10	9	9-A Irrigated	Satal	Average	7.30	235.71	150.28	1.61	2.880	11.53
				SDV	0.08	7.22	7.01	0.01	0.350	1.70
11		9-B Rainfed		Average	7.04	254.57	152.58	1.64	2.700	10.94
				SDV	0.12	2.60	2.34	0.01	0.491	0.31
12		10-A Irrigated	Madyan	Average	7.39	256.27	146.94	1.58	2.372	12.20
				SDV	0.05	1.92	1.79	0.07	0.354	0.70
13	10	10-B Rainfed		Average	7.02	272.90	161.23	1.61	0.527	11.75
				SDV	0.13	3.49	2.84	0.00	0.281	1.32
14	11	11-A Danman	Jare	Average	7.05	317.87	187.75	1.62	0.675	8.17
				SDV	0.12	7.86	1.95	0.02	0.075	0.71
15		11-B Jewardara		Average	7.21	228.44	183.26	1.55	2.128	10.08
				SDV	0.08	7.79	7.05	0.01	0.565	0.60
16		11-C Shoulgar		Average	7.05	371.93	180.47	1.51	2.379	12.25
				SDV	0.09	9.60	9.61	0.01	0.476	0.87
17	12	12-A Danman	Fatepur	Average	7.21	237.49	158.49	1.46	1.482	9.87
				SDV	0.04	1.65	1.31	0.00	0.632	0.35
18		12-B Jewardara		Average	7.09	437.60	272.44	1.46	2.783	13.87
				SDV	0.08	57.66	13.88	0.01	0.438	0.35
19		12-C Shoulgar		Average	7.13	325.63	237.70	1.47	2.783	12.08
				SDV	0.16	2.97	7.19	0.01	0.438	0.71
20	13	13-A Danman	Darmai	Average	7.10	370.54	221.02	1.52	1.085	8.07
				SDV	0.18	8.76	10.60	0.01	0.017	0.70
21		13-B Jewardara		Average	7.35	322.48	187.94	1.54	1.774	11.06
				SDV	0.13	8.58	6.07	0.01	0.564	0.74
22		13-C Shoulgar		Average	7.04	275.29	183.47	1.52	2.019	10.27
				SDV	0.18	0.91	1.55	0.01	0.390	0.03
23	14	14	Sakhra	Average	7.21	237.74	145.35	1.53	1.244	8.83
				SDV	0.04	5.77	4.44	0.01	0.068	0.45
24	15	15-A Danman	Bagh Dheri	Average	7.26	125.67	86.93	1.48	1.138	9.39
				SDV	0.01	4.32	2.09	0.01	0.013	1.56
25		15-B Jewardara		Average	7.05	127.51	75.73	1.48	2.155	10.12
				SDV	0.33	7.30	3.49	0.01	0.254	0.92
26		15-C Shoulgar		Average	7.19	149.35	89.55	1.51	1.977	11.96
				SDV	0.07	4.23	2.58	0.01	0.054	0.70
27	16	16-A Danman	Asharai	Average	7.21	173.08	99.76	1.49	1.570	9.98
				SDV	0.08	3.13	2.14	0.01	0.386	0.79
28		16-B Jewardara		Average	7.23	229.40	124.11	1.52	3.237	8.92
				SDV	0.09	7.10	2.50	0.01	0.690	0.70
29		16-C Shoulgar		Average	7.16	203.39	182.16	1.51	2.518	10.60
				SDV	0.10	7.14	8.08	0.01	1.223	1.70
30	17	17-A Danman	Dursh Khela	Average	7.36	137.68	85.86	1.52	1.522	7.89
				SDV	0.01	6.31	4.95	0.01	0.024	0.70
31		17-B Jewardara		Average	7.40	260.87	154.41	1.51	2.004	13.03
				SDV	0.19	7.90	4.48	0.01	0.657	0.93
32		17-C Shoulgar		Average	7.38	286.66	169.16	1.47	2.605	12.96
				SDV	0.06	6.38	4.14	0.01	1.214	0.86
33	18	18-A Danman	Sambat	Average	7.39	312.42	184.27	1.51	1.547	8.90
				SDV	0.09	4.20	3.05	0.01	0.142	0.61
34		18-B Jewardara		Average	7.56	331.25	223.71	1.51	2.169	12.51
				SDV	0.18	11.14	6.36	0.01	0.024	0.27
35		18-C Shoulgar		Average	7.31	260.55	181.26	1.54	2.737	14.80
				SDV	0.04	4.13	4.28	0.01	0.163	0.71
36	19	19-A Danman	Shokhdara	Average	7.26	382.85	215.95	1.48	1.633	8.06
				SDV	0.40	6.24	3.10	0.01	0.397	0.87
37		19-B Jewardara		Average	7.27	309.79	208.86	1.47	2.084	12.77

Table E.2c Continued

Table E.2c:- Average value of Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic matters and Soi Moistures (2005-06)

Serial No	Ref. No	Sub Sample No	Village Name		pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
				SDV	0.42	10.67	4.78	0.01	0.266	0.71
38		19-C Shoulgar		Average	7.14	232.02	144.29	1.48	2.458	12.25
				SDV	0.41	4.86	4.15	0.01	1.028	0.00
39	20	20	Wainai	Average	7.29	457.72	268.76	1.48	1.723	6.73
				SDV	0.49	3.27	3.53	0.03	0.057	0.68
40	21	21	Chuprial	Average	7.19	257.41	148.79	1.50	2.278	11.72
				SDV	0.06	4.70	4.88	0.01	0.472	0.71
41	22	22	Changialai	Average	7.68	250.54	136.80	1.53	2.147	5.04
				SDV	0.33	2.82	4.89	1.55	0.290	1.55
42	23	23	Gwalarai	Average	7.51	323.37	184.76	1.50	2.150	9.35
				SDV	0.24	8.27	4.96	0.05	0.301	1.66
43	24	24	Roringar	Average	7.42	222.43	139.02	1.53	1.152	6.64
				SDV	0.06	8.35	3.40	0.01	0.263	0.67
44	25	25	Fazal Banad	Average	7.28	318.14	283.78	1.51	1.048	7.49
				SDV	0.07	7.82	3.05	0.01	0.218	0.93
45	26	26	Sarkarai	Average	7.32	357.45	170.53	1.51	1.086	8.13
				SDV	0.14	7.05	2.38	0.01	0.227	1.42
46	27	27	Kalagai	Average	7.30	237.46	165.53	1.52	1.198	8.61
				SDV	0.04	5.81	2.41	0.01	0.012	0.71
47	28	28-A Danman	Shairpalam	Average	7.32	261.79	146.97	1.53	1.554	9.86
				SDV	0.15	4.04	1.92	0.00	0.511	1.08
48		28-B Jewardara		Average	7.27	275.49	134.96	1.47	2.068	12.91
				SDV	0.02	4.02	1.95	0.01	0.127	1.18
49		28-C Shoulgar		Average	7.31	289.02	121.36	1.48	3.234	14.82
				SDV	0.09	4.73	4.35	0.01	0.950	0.35
50	29	29-A Danman	Shakar Dara	Average	7.46	317.57	184.98	1.45	2.210	7.73
				SDV	0.03	1.13	2.05	0.04	0.436	0.43
51		29-B Jewardara		Average	7.34	333.80	196.50	1.51	2.753	14.20
				SDV	0.17	6.56	5.44	0.01	0.119	0.08
52		29-C Shoulgar		Average	7.32	321.50	159.25	1.49	3.063	14.72
				SDV	0.08	2.91	4.20	0.02	0.240	0.71
53	30	30-A Danman	Ningulai	Average	7.32	337.93	196.84	1.50	1.857	6.64
				SDV	0.04	3.74	6.50	0.02	0.025	0.64
54		30-B Jewardara		Average	7.32	239.91	150.56	1.47	2.578	13.86
				SDV	0.08	2.06	2.98	0.01	0.373	0.38
55		30-C Shoulgar		Average	7.28	243.42	159.89	1.50	2.038	16.12
				SDV	0.04	5.47	2.45	0.00	0.338	0.83
56	31	31-A Danman	Bara & Kuza Bandai	Average	7.27	251.01	156.76	1.46	2.297	1.46
				SDV	0.01	3.49	2.13	0.00	0.201	1.03
57		31-B Jewardara		Average	7.43	259.59	150.95	1.48	2.132	13.75
				SDV	0.05	2.89	2.00	0.01	1.045	0.49
58		31-C Shoulgar		Average	7.33	264.39	163.83	1.50	2.245	15.10
				SDV	0.11	4.61	2.21	0.02	0.878	0.65
59	32	32-A Danman	Sigram	Average	7.32	368.98	185.55	1.43	1.366	13.07
				SDV	0.05	7.71	4.23	0.02	0.216	1.19
60		32-B Jewardara		Average	7.50	276.67	170.38	1.47	2.555	15.34
				SDV	0.03	5.30	2.59	0.01	0.428	0.75
61		32-C Shoulgar		Average	7.50	321.50	184.00	1.48	2.074	14.55
				SDV	0.04	4.34	2.30	0.00	0.298	0.41
62	33	33-A Danman	Kanju	Average	7.48	288.69	176.05	1.52	1.710	7.88
				SDV	0.04	8.83	2.94	0.01	0.192	0.65
63		33-B Jewardara		Average	7.38	317.15	174.40	1.43	2.374	13.92
				SDV	0.07	7.91	2.59	0.01	0.078	0.56
64		33-C Shoulgar		Average	7.25	209.68	136.54	1.48	2.555	12.98
				SDV	0.04	2.77	1.68	0.01	0.400	1.02
65	34	34	Kala	Average	7.48	289.46	172.13	1.48	1.308	6.05
				SDV	0.06	5.96	24.91	0.02	0.064	0.85
66	35	35	Deolai	Average	7.34	226.15	136.45	1.46	2.506	10.87
				SDV	0.01	7.61	2.72	0.01	0.279	0.35
67	36	36	Tal	Average	7.58	322.99	211.30	1.52	1.304	6.93
				SDV	0.06	6.55	2.64	0.02	0.057	0.50
68	37	37	Tutano Banda	Average	7.38	227.78	183.00	1.44	1.489	11.91
				SDV	0.06	8.33	2.31	0.02	0.472	0.88
69	38	38	Sarsanai	Average	7.48	319.16	193.74	1.42	0.868	5.32
				SDV	0.05	6.47	2.08	0.02	0.608	0.56
70	39	39-A Danman	Gul Jaba	Average	7.33	149.74	91.27	1.43	2.235	10.85
				SDV	0.01	5.78	2.85	0.01	0.435	0.65
71		39-C Shoulgar		Average	7.32	155.15	93.42	1.34	2.090	13.94
				SDV	0.16	2.52	1.55	0.01	0.334	0.63
72	40	40-A Danman	Kabbal	Average	7.37	229.41	134.83	1.46	1.303	8.86
				SDV	0.07	8.69	3.55	0.03	0.069	0.70
73		40-B Jewardara		Average	7.41	360.41	213.06	1.33	2.596	12.85
				SDV	0.14	9.67	4.68	0.01	0.327	0.67
74		40-C Shoulgar		Average	7.35	256.50	111.52	1.50	3.076	12.27
				SDV	0.14	2.76	2.70	0.02	0.352	1.42

Table E.2c Continued

Table E.2c:- Average value of Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic matters and Soi Moistures (2005-06)

Serial No	Ref. No	Sub Sample No	Village Name		pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
75	41	41	Kotlai	Average	7.22	344.00	203.59	1.49	2.876	8.74
				SDV	0.05	8.02	2.45	0.01	0.425	0.72
76	42	42	Surgalai	Average	7.23	143.94	90.60	1.62	1.695	10.88
				SDV	0.06	4.80	3.02	0.00	0.086	0.98
77	43	43-A Danman	Parrai	Average	7.37	327.47	193.36	1.53	1.323	13.14
				SDV	0.04	6.66	2.79	0.00	0.055	0.01
78		43-B Jewardara		Average	7.48	221.07	177.81	1.43	2.972	10.84
				SDV	0.06	3.98	2.01	0.00	0.062	0.54
79		43-C Shoulgar		Average	7.40	217.94	146.97	1.58	2.618	12.83
				SDV	0.09	4.65	1.84	0.02	0.064	0.44
80	44	44-A Danman	Nagwa	Average	7.32	108.50	83.55	1.63	0.273	12.27
				SDV	0.08	4.45	0.99	0.02	0.062	1.52
81		44-B Jewardara		Average	7.06	240.81	151.31	1.54	1.916	15.07
				SDV	0.71	10.12	5.62	0.01	0.058	0.76
82		44-C Shoulgar		Average	7.40	285.60	168.24	1.45	2.725	13.07
				SDV	0.08	4.17	2.71	0.01	0.171	0.31
83	45	45-A Danman	Dedawar	Average	7.30	131.48	84.48	1.47	0.633	12.34
				SDV	0.07	5.08	2.68	0.01	0.158	0.78
84		45-B Jewardara		Average	7.35	266.52	156.86	1.39	1.671	11.24
				SDV	0.04	5.14	3.43	0.01	0.063	0.89
85		45-C Shoulgar		Average	7.33	264.91	155.47	1.48	2.244	12.34
				SDV	0.02	3.30	1.21	0.01	0.530	1.47
86	46	46-A Danman	Tirang	Average	7.31	122.95	80.06	1.47	1.570	12.68
				SDV	0.02	1.70	1.99	0.00	0.135	0.06
87		46-B Jewardara		Average	7.35	239.34	141.60	1.49	1.890	9.59
				SDV	0.15	7.91	4.62	0.01	0.477	0.68
88		46-C Shoulgar		Average	7.11	238.99	138.46	1.62	1.815	12.05
				SDV	0.16	8.96	5.99	0.01	0.365	0.83
89	47	47-A Danman	Chongai	Average	7.15	121.59	84.91	1.54	1.727	10.92
				SDV	0.25	8.58	3.16	0.01	0.269	0.41
90		47-B Jewardara		Average	7.11	215.46	126.53	1.46	2.085	13.18
				SDV	0.03	4.38	4.68	0.01	0.482	0.84
91		47-C Shoulgar		Average	7.08	310.77	167.95	1.61	2.489	12.44
				SDV	0.21	1.27	4.84	0.02	0.342	1.27
92	48	48	Sarai	Average	7.21	205.99	120.39	1.34	0.798	11.00
				SDV	0.76	6.58	1.21	0.00	0.050	0.71
93	49	49	Miandam	Average	7.14	254.54	151.77	1.39	1.728	12.95
				SDV	0.45	4.10	2.12	0.08	0.036	0.70
94	50	50-A Danman	Shin	Average	7.33	260.76	171.58	1.47	1.720	7.74
				SDV	0.05	2.98	1.44	0.04	0.037	0.96
95		50-B Jewardara		Average	7.25	264.79	173.06	1.50	2.298	12.00
				SDV	0.11	3.44	0.73	0.01	0.042	0.88
96		50-C Shoulgar		Average	7.34	236.61	153.21	1.51	3.013	13.12
				SDV	0.11	4.33	0.59	0.01	0.086	0.28
97	51	51-A Danman	Kotanai	Average	7.17	115.91	75.74	1.63	1.302	9.78
				SDV	0.08	3.71	1.09	0.05	0.037	0.71
98		51-B Jewardara		Average	7.14	186.93	111.24	1.44	2.093	14.78
				SDV	0.18	1.90	1.42	0.02	0.037	0.66
99		51-C Shoulgar		Average	7.32	185.23	109.55	1.51	1.987	15.53
				SDV	0.47	3.61	3.08	0.02	0.100	0.72
100	52	52-A Danman	Chalyar	Average	7.25	115.62	83.87	1.52	1.561	10.31
				SDV	0.44	5.01	1.90	0.01	0.034	1.64
101		52-B Jewardara		Average	7.24	188.17	111.26	1.39	1.471	11.70
				SDV	0.12	5.91	2.99	0.01	0.030	0.59
102		52-C Shoulgar		Average	7.29	189.45	111.85	1.50	2.258	13.84
				SDV	0.57	8.30	3.66	0.02	0.036	0.32
103	53	53-A Danman	Khwazakhela	Average	7.29	192.95	113.62	1.53	1.014	11.97
				SDV	0.05	6.51	2.47	0.00	0.087	0.13
104		53-B Jewardara		Average	7.24	199.53	116.76	1.58	1.850	17.30
				SDV	0.59	1.19	0.73	0.01	0.318	0.78
105		53-C Shoulgar		Average	7.27	185.30	108.76	1.53	2.950	11.93
				SDV	0.08	3.34	2.23	0.01	0.162	1.40
106	54	54-A Danman	Gulibagh	Average	7.19	178.40	105.85	1.48	0.679	10.99
				SDV	0.08	5.72	2.13	0.01	0.068	1.27
107		54-B Jewardara		Average	7.32	154.62	96.76	1.37	1.225	14.30
				SDV	0.06	4.30	2.26	0.01	0.279	0.79
108		54-C Shoulgar		Average	7.37	147.65	86.36	1.56	2.745	15.04
				SDV	0.08	2.41	1.11	0.02	0.040	0.33
109	55	55-A Danman	Dakorak	Average	7.31	119.00	77.27	1.52	0.704	11.72
				SDV	0.06	8.16	2.88	0.01	0.057	0.04
110		55-B Jewardara		Average	7.41	119.10	79.40	1.38	2.932	12.95
				SDV	0.06	2.77	1.62	0.00	0.728	0.46
111		55-C Shoulgar		Average	7.42	128.87	86.74	1.48	3.013	12.21
				SDV	0.14	3.95	2.08	0.05	0.133	0.74

Table E.2c Continued

Table E.2c:- Average value of Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic matters and Soi Moistures (2005-06)

Serial No	Ref. No	Sub Sample No	Village Name		pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
112	56	56-A Danman	Charbagh	Average	7.38	93.87	64.27	1.57	0.640	12.86
				SDV	0.13	7.20	2.81	0.02	0.110	0.63
113		56-B Jewardara		Average	7.39	419.78	326.21	1.40	1.430	14.17
				SDV	0.09	5.47	1.32	0.01	0.489	0.60
114		56-C Shoulgar		Average	7.45	232.96	144.34	1.52	3.082	15.85
				SDV	0.09	2.87	1.27	0.01	0.359	0.98
115	57	57	Tilgram	Average	7.38	115.10	85.76	1.48	0.696	9.82
				SDV	0.08	2.18	0.67	0.01	0.099	0.44
116	58	58-A Danman	Manglaur	Average	7.47	124.15	86.71	1.40	1.370	11.65
				SDV	0.07	1.85	0.81	0.01	0.206	0.25
117		58-B Jewardara		Average	7.69	434.69	213.76	1.53	2.347	15.06
				SDV	0.05	5.70	2.10	0.00	0.538	1.13
118		58-C Shoulgar		Average	7.39	235.12	166.98	1.53	1.903	15.10
				SDV	0.06	4.63	2.33	0.01	0.267	0.38
119	59	59-A Danman	Dangram	Average	7.37	140.94	119.77	1.57	0.687	8.77
				SDV	0.06	3.38	2.12	0.03	0.045	0.89
120		59-B Jewardara		Average	7.40	249.53	173.07	1.46	1.821	12.21
				SDV	0.10	4.69	2.13	0.02	0.374	0.55
121		59-C Shoulgar		Average	7.52	255.59	175.57	1.48	2.091	13.80
				SDV	0.14	2.86	0.98	0.00	0.006	0.78
122	60	60-A Danman	Sangota	Average	7.44	158.72	119.22	1.46	0.489	8.33
				SDV	0.01	3.45	2.87	0.02	0.033	0.16
123		60-B Jewardara		Average	7.38	265.92	182.58	1.50	1.788	12.62
				SDV	0.06	4.71	2.48	0.03	0.324	1.49
124		60-C Shoulgar		Average	7.37	272.81	181.47	1.46	3.117	13.81
				SDV	0.69	5.56	3.04	0.00	0.564	0.80
125	61	61-A Danman	Takhtaband	Average	7.36	131.21	116.29	1.45	0.295	9.27
				SDV	0.19	9.94	2.94	0.00	0.056	0.64
126		61-B Jewardara		Average	7.32	286.86	186.83	1.56	1.873	11.56
				SDV	0.13	6.22	3.39	0.02	0.128	0.73
127		61-C Shoulgar		Average	7.37	292.69	188.74	1.55	3.136	14.13
				SDV	0.63	9.20	4.83	0.03	0.311	0.59
128	62	62-A Danman	Jambil	Average	7.62	111.00	76.49	1.64	1.674	8.83
				SDV	0.15	4.84	2.79	0.03	0.040	0.97
129		62-B Jewardara		Average	7.53	219.07	170.31	1.54	1.420	11.74
				SDV	0.15	6.65	2.86	0.00	0.088	0.28
130	63	63-A Danman	Bologram	Average	7.43	123.23	107.22	1.46	1.372	9.23
				SDV	0.13	2.99	1.43	0.01	0.151	0.86
131		63-B Jewardara		Average	7.44	230.57	166.41	1.44	2.747	11.74
				SDV	0.04	2.90	1.79	0.01	0.173	0.71
132		63-C Shoulgar		Average	7.31	239.33	169.87	1.45	3.319	13.03
				SDV	0.06	5.32	1.91	0.02	0.674	0.94
133	64	64-A Danman	Gogdara	Average	7.46	117.66	67.65	1.52	1.609	10.05
				SDV	0.13	7.59	2.44	0.01	0.037	0.96
134		64-B Jewardara		Average	7.50	245.37	149.24	1.42	2.397	12.81
				SDV	0.19	5.25	2.82	0.01	0.041	0.68
135		64-C Shoulgar		Average	7.36	254.04	150.77	1.47	2.682	13.77
				SDV	0.12	3.04	2.13	0.00	0.670	0.89
136	65	65-A Danman	Pajigram	Average	7.50	161.07	66.58	1.47	1.044	10.20
				SDV	0.04	3.39	2.81	0.02	0.127	0.57
137		65-B Jewardara		Average	7.54	268.18	150.91	1.33	1.828	14.87
				SDV	0.02	2.69	2.31	0.00	0.064	0.55
138		65-C Shoulgar		Average	7.35	272.94	155.60	1.44	2.042	15.18
				SDV	0.16	5.79	2.86	0.01	0.670	0.55
139	66	66-A Danman	Ghaligai	Average	7.29	116.33	57.06	1.48	1.408	9.81
				SDV	0.08	2.40	0.13	0.00	0.076	0.47
140		66-B Jewardara		Average	7.30	284.96	149.24	1.48	1.789	13.05
				SDV	0.21	8.73	4.24	0.00	0.604	0.89
141		66-C Shoulgar		Average	7.30	286.29	152.05	1.48	2.140	13.32
				SDV	0.04	4.61	5.20	0.01	0.726	0.09
142	67	67-A Danman	Manyar	Average	7.33	110.05	66.87	1.48	1.249	10.94
				SDV	0.03	6.22	1.90	0.01	0.033	0.63
143		67-B Jewardara		Average	7.39	217.84	119.80	1.38	2.296	14.30
				SDV	0.36	7.37	2.02	0.01	0.738	0.01
144		67-C Shoulgar		Average	7.33	122.36	139.15	1.52	2.983	14.97
				SDV	0.13	3.96	2.43	0.01	0.078	1.01
145	68	68-A Danman	Barikot	Average	7.44	120.09	69.83	1.53	0.712	10.60
				SDV	0.11	10.09	3.48	0.00	0.460	0.53
146		68-B Jewardara		Average	7.61	411.30	247.26	1.43	2.064	13.19
				SDV	0.08	4.75	2.84	0.01	0.158	0.65
147		68-C Shoulgar		Average	7.37	339.40	276.04	1.56	2.271	13.32
				SDV	0.06	5.31	3.25	0.02	0.631	0.27
148	69	69-A Danman	Abua	Average	7.37	119.60	68.53	1.64	1.543	9.99
				SDV	0.03	2.37	1.68	0.01	0.240	0.11
149		69-B Jewardara		Average	7.44	481.16	342.76	1.53	1.518	11.93

Table E.2c Continued

Table E.2c:- Average value of Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic matters and Soi Moistures (2005-06)

Serial No	Ref. No	Sub Sample No	Village Name		pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
				SDV	0.17	5.95	3.67	0.01	0.304	0.79
150		69-C Shoulgar		Average	7.36	369.10	180.36	1.49	2.016	14.48
				SDV	0.18	9.11	3.93	0.00	0.410	0.06
151	70	70-A Danman	Kotah	Average	7.53	114.79	125.27	1.64	1.174	9.39
				SDV	0.15	1.77	1.36	0.02	0.112	0.26
152		70-B Jewardara		Average	7.56	259.01	153.90	1.54	2.543	11.93
				SDV	0.16	7.14	3.33	0.00	0.112	0.50
153		70-C Shoulgar		Average	7.49	308.31	161.28	1.60	3.023	14.64
				SDV	0.07	5.96	2.81	0.06	0.225	1.52
154	71	71-A Danman	Landakai	Average	7.31	139.30	69.95	1.63	1.065	9.47
				SDV	0.02	0.51	1.84	0.03	0.195	0.51
155		71-B Jewardara		Average	7.24	365.22	194.86	1.56	2.154	11.74
				SDV	0.02	3.57	0.40	0.01	0.592	0.02
156		71-C Shoulgar		Average	7.36	375.59	195.69	1.59	2.262	14.06
				SDV	0.11	4.30	3.60	0.01	0.234	1.00
157	72	72-A Danman	Haibatgram	Average	7.31	121.50	64.76	1.41	0.772	9.70
				SDV	0.05	3.56	3.50	0.00	0.076	0.01
158		72-B Jewardara		Average	7.33	131.97	70.85	1.45	1.426	12.21
				SDV	0.01	1.69	1.00	0.01	0.284	0.65
159		72-C Shoulgar		Average	7.43	133.80	71.33	1.50	1.580	13.00
				SDV	0.03	1.22	1.33	0.01	0.343	1.17
160	73	73-A Danman	Thana	Average	7.69	125.06	68.98	1.35	1.492	6.06
				SDV	0.06	1.67	3.33	0.01	0.390	0.45
161		73-B Jewardara		Average	7.43	127.05	68.27	1.49	1.989	11.19
				SDV	0.01	1.55	1.41	0.00	0.387	0.18
162		73-C Shoulgar		Average	7.42	141.20	80.51	1.53	1.788	12.98
				SDV	0.01	1.44	2.76	0.00	0.812	0.71
163	74	74	Nal	Average	7.45	117.97	65.56	1.54	1.479	6.80
				SDV	0.03	7.35	1.39	0.00	0.216	0.93
164	75	75	Gunyar	Average	7.25	103.86	55.26	1.48	1.285	5.47
				SDV	0.03	1.85	1.36	0.00	0.045	0.63
165	76	76-A Danman	Allahadan	Average	7.39	125.96	76.87	1.41	0.771	8.42
				SDV	0.06	0.24	2.33	0.00	0.067	1.50
166		76-B Jewardara		Average	7.61	160.65	93.42	1.44	1.495	12.81
				SDV	0.04	2.81	1.55	0.01	0.227	0.70
167		76-C Shoulgar		Average	7.35	160.65	93.84	1.52	2.143	14.95
				SDV	0.02	3.27	2.12	0.00	0.431	0.96
168	77	77-A Danman	Batkhala	Average	7.43	120.49	66.09	1.38	0.817	9.08
				SDV	0.01	2.60	2.34	0.00	0.129	0.22
169		77-B Jewardara		Average	7.45	169.31	100.07	1.44	2.218	10.72
				SDV	0.03	1.08	2.32	0.00	0.318	0.66
170		77-C Shoulgar		Average	7.44	176.60	104.77	1.52	1.983	13.76
				SDV	0.02	2.90	2.21	0.02	0.062	0.89
171	78	78	Piran	Average	7.55	90.28	55.98	1.52	1.096	5.06
				SDV	0.02	3.34	3.90	0.01	0.055	0.20
172	79	79	Rangmala	Average	7.43	190.91	110.33	1.52	0.463	4.66
				SDV	0.01	1.61	2.96	0.00	0.083	0.12
173	80	80-A Danman	Jolagram	Average	7.54	117.63	77.35	1.48	0.505	8.78
				SDV	0.01	1.00	2.68	0.00	0.031	0.89
174		80-B Jewardara		Average	7.24	196.99	120.32	1.49	1.475	10.68
				SDV	0.17	1.90	3.05	0.00	0.400	0.05
175		80-C Shoulgar		Average	7.63	201.14	119.25	1.51	1.754	12.21
				SDV	0.02	4.12	4.26	0.00	0.272	0.10
176	81	81-A Danman	Matkani	Average	7.61	119.95	70.35	1.41	0.480	6.21
				SDV	0.10	1.80	2.81	0.01	0.066	0.91
177		81-B Jewardara		Average	7.40	119.82	83.84	1.45	1.465	12.29
				SDV	0.06	1.79	6.28	0.00	0.180	0.04
178		81-C Shoulgar		Average	7.65	230.04	115.61	1.49	2.203	14.02
				SDV	0.04	2.98	4.34	0.01	0.148	0.38
179	82	82-A Danman	Totakan	Average	7.58	120.17	70.31	1.40	0.670	10.10
				SDV	0.06	2.75	1.26	0.01	0.074	0.75
180		82-B Jewardara		Average	7.46	140.50	95.44	1.42	1.131	11.33
				SDV	0.04	5.73	4.50	0.01	0.060	0.09
181		82-C Shoulgar		Average	7.39	230.26	140.90	1.52	1.912	13.82
				SDV	0.08	3.71	3.22	0.00	0.042	0.66
182	83	83	Bagh Raji	Average	7.78	79.84	50.05	1.41	0.349	8.88
				SDV	0.06	1.57	3.51	0.00	0.037	2.46
183	84	87-A Irrigated	Makhband	Average	7.49	89.76	47.00	1.57	1.588	8.02
				SDV	0.07	3.28	2.33	0.04	0.043	0.33
184		87-B rainfed		Average	7.78	160.39	100.40	1.60	0.762	11.97
				SDV	0.08	2.60	3.06	0.03	0.061	0.47
185	85	85-A Danman	Kalangai	Average	7.96	121.48	70.51	1.49	0.390	6.99
				SDV	0.03	4.74	2.80	0.01	0.040	0.71
186		85-B Jewardara		Average	7.84	168.49	77.53	1.48	1.192	11.94
				SDV	0.06	5.43	5.49	0.01	0.206	0.73

Table E.2c Continued

Table E.2c:- Average value of Soil pH, Electrical Conductivity, Dissolved Solids, Bulk Density, Organic matters and Soi Moistures (2005-06)

Serial No	Ref. No	Sub Sample No	Village Name		pH	E.Cond µS/cm	Dissolved Solids (mg/kg)	B Density (g/cm3)	Organic Matter (%age)	Soil Moisture (%age)
187		85-C Shoulgar		Average	7.19	221.36	121.90	1.55	2.104	12.43
				SDV	0.07	4.67	6.07	0.00	0.483	0.20
188	86	86-A Danman	Ramora	Average	7.98	94.27	40.82	1.56	0.594	8.65
				SDV	0.19	2.28	2.19	0.01	0.057	0.41
189		86-B Jewardara		Average	7.31	179.44	140.34	1.52	1.405	11.24
				SDV	0.10	1.72	1.54	0.01	0.045	0.12
190		86-C Shoulgar		Average	8.02	281.96	167.58	1.50	2.007	12.78
				SDV	0.22	5.24	3.18	0.03	0.281	0.71
191	87	86-A Danman	Chakdara	Average	7.58	121.52	88.74	1.52	1.440	8.31
				SDV	0.06	2.21	2.24	0.01	0.132	0.12
192		86-B Jewardara		Average	7.98	289.76	172.29	1.50	1.895	11.26
				SDV	0.36	9.45	5.54	0.00	0.507	0.50
193		86-C Shoulgar		Average	7.45	306.56	149.86	1.50	1.859	13.26
				SDV	0.02	11.46	10.50	0.02	0.701	0.50
194	88	88	Shewa	Average	7.38	117.95	69.47	1.35	1.805	6.53
				SDV	0.08	5.78	2.63	0.01	0.553	0.71
195	89	89	Tindo Dag	Average	7.33	136.05	80.56	1.38	1.985	7.02
				SDV	0.01	3.08	1.28	0.00	0.095	1.36
196	90	90	Kitiarai	Average	7.39	148.93	79.80	1.45	2.214	6.65
				SDV	0.04	6.07	2.07	0.01	0.424	0.61
197	91	91	Khanpur	Average	7.36	138.98	81.22	1.48	0.241	4.94
				SDV	0.11	7.36	2.85	0.01	0.066	0.79
198	92	92	Khairabad	Average	7.44	93.44	40.41	1.48	0.481	4.92
				SDV	0.16	1.72	1.04	0.00	0.274	1.02
199	93	93	Chikhoo	Average	7.41	120.04	69.33	1.38	0.726	6.03
				SDV	0.06	6.23	2.98	0.00	0.129	0.80
200	94	94	Usakai	Average	7.37	137.53	97.49	1.42	1.779	8.16
				SDV	0.08	3.10	1.94	0.00	0.065	0.43
201	95	95	Wuch	Average	7.33	159.16	73.88	1.35	1.169	8.34
				SDV	0.14	7.94	3.45	0.00	0.122	0.74
202	96	96-A Irrigated	Gadar	Average	7.43	176.87	119.76	1.36	2.237	7.22
				SDV	0.16	1.75	2.16	0.04	0.936	1.21
203		96-B Rainfed		Average	8.09	291.99	174.48	1.43	2.112	6.16
				SDV	0.21	6.59	2.61	0.01	0.056	1.10
204	97	97-A Daman	Badwan	Average	8.04	78.11	46.77	1.57	1.588	7.06
				SDV	0.12	5.18	2.03	0.03	0.334	0.28
205		97-B Shoulgar		Average	7.82	85.04	52.34	1.52	1.410	10.86
				SDV	0.13	1.94	1.29	0.01	0.356	0.71
206	98	98-A Daman	Mian Barangola	Average	7.71	79.42	47.79	1.47	1.618	6.02
				SDV	0.21	8.82	4.76	0.01	0.419	1.09
207		98-B Shoulgar		Average	7.38	89.59	54.73	1.58	2.072	9.80
				SDV	0.10	2.31	1.96	0.02	0.404	0.68
208	99	99-A Daman	Tiruna	Average	7.49	88.49	49.23	1.58	1.383	6.84
				SDV	0.18	5.14	2.82	0.04	0.217	0.66
209		99-B Jewardara		Average	7.27	100.55	60.25	1.38	1.455	9.02
				SDV	0.04	2.25	1.39	0.01	0.166	1.03
210		99-C Shoulgar		Average	7.35	118.86	70.42	1.46	1.291	12.05
				SDV	0.02	8.92	2.96	0.02	0.653	0.31
211	100	100-A	Kamala	Average	7.26	75.60	44.35	1.36	0.588	6.75
				SDV	0.03	3.71	2.81	0.01	0.224	0.70
212		100-B		Average	7.22	125.70	74.29	1.47	0.499	9.29
				SDV	0.15	4.61	2.63	0.02	0.179	1.49

Table E.2c Continued

Table E.3a:- Analytical Results of Major Anions in Selected Soil Samples Collected Form River Swat Watershed during 2005

Serial No	Soil Ref No	Sub Sample Number	Village	NO_3 (mg/Kg)	PO_4 (mg/Kg)	SO_4 (mg/Kg)	Cl (mg/Kg)	CO_3 (mg/Kg)
1	1	1	Kalam	18.52	12.44	15.00	2.45	2446.16
2	6	6	Mankial	20.43	13.33	12.67	2.15	1147.14
3	8	8-A Irrigated	Bahrain	12.44	24.22	15.43	1.65	2645.32
4		8-B Rainfed		10.15	10.44	12.76	2.95	2132.88
5	9	8-A Irrigated	Satal	13.43	11.57	14.57	2.14	2459.31
6		8-B Rainfed		7.12	10.28	13.67	2.45	2180.83
7	10	10-A Irrigated	Madyan	25.33	15.75	16.65	5.45	3170.30
8		10-B Rainfed		10.21	15.34	15.72	1.45	3199.12
9	12	12-A Danman	Fatepur	10.55	12.57	15.17	2.25	3132.05
10		12-B Jewardara		23.33	16.55	24.69	2.45	3329.47
11		12-C Shoulgar		45.47	22.35	37.44	3.25	3595.14
12	15	15-A Danman	Bagh Dheri	17.33	10.33	25.33	3.44	4184.51
13		15-B Jewardara		26.72	12.35	33.57	4.56	4205.02
14		15-C Shoulgar		52.34	16.57	36.12	6.46	4165.66
15	19	19-A Danman	Shokhdara	15.35	10.33	22.54	5.55	3205.59
16		19-B Jewardara		26.77	12.44	33.95	6.57	3330.88
17		19-C Shoulgar		57.63	20.44	47.36	7.56	4511.54
18	28	28-A Danman	Shairpalam	8.53	10.12	15.34	4.45	2136.68
19		28-B Jewardara		33.57	12.34	32.47	5.56	3211.37
20		28-C Shoulgar		56.72	18.77	36.33	7.44	4178.82
21	40	40-A Danman	Kabbal	12.18	6.55	26.62	4.32	2260.26
22		40-B Jewardara		29.23	10.14	35.42	5.45	6449.08
23		40-C Shoulgar		53.65	20.34	37.57	6.32	6556.74
24	45	45-A Danman	Dedawar	12.51	5.35	15.26	2.34	1575.23
25		45-B Jewardara		30.73	7.57	23.45	4.66	2130.55
26		45-C Shoulgar		65.74	15.56	36.78	6.77	2522.84
27	49	49-Daman	Miandam	53.72	4.35	23.33	2.13	3614.06
28	53	53-A Danman	Khwazakhela	13.32	5.45	23.74	2.35	3529.06
29		53-B Jewardara		23.74	10.33	37.74	4.54	2467.90
30		53-C Shoulgar		63.62	15.33	45.56	7.23	3813.95
31	58	58-A Danman	Manglaur	6.68	6.45	13.72	2.34	2628.25
32		58-B Jewardara		18.54	10.34	23.64	4.32	5283.99
33		58-C Shoulgar		44.35	17.63	37.45	6.93	5494.96
34	66	66-A Danman	Ghaligai	10.09	6.44	13.45	2.36	4079.64
35		66-B Jewardara		23.94	10.43	27.54	3.46	5338.97
36		66-C Shoulgar		47.53	16.57	35.94	6.47	6125.50
37	68	68-A Danman	Barikot	9.97	4.56	12.23	3.34	6034.13
38		68-B Jewardara		19.82	11.56	16.45	5.34	19214.60
39		68-C Shoulgar		33.75	18.75	38.13	7.45	5164.54
40	70	70-A Danman	Kotah	6.76	5.47	13.76	2.73	2302.15
41		70-B Jewardara		23.45	15.25	27.53	4.34	6345.80
42		70-C Shoulgar		54.34	20.56	35.45	6.57	7113.46
43	72	72-A Danman	Haibatgram	5.52	5.44	12.67	2.39	5476.30
44		72-B Jewardara		22.56	12.33	26.37	5.67	5122.50
45		72-C Shoulgar		48.87	18.57	38.57	7.73	4772.89
46	76	76-A Danman	Allahadan	4.67	4.55	10.23	2.26	3679.92
47		76-B Jewardara		44.57	11.34	17.35	4.67	4001.17
48		76-C Shoulgar		56.78	18.59	35.33	7.56	4230.88
49	81	81-A Danman	Matkani	8.22	6.44	12.37	2.14	1936.62
50		81-B Jewardara		45.56	12.58	26.45	4.67	3569.29
51		81-C Shoulgar		62.63	21.78	34.63	7.58	3630.56
52	84	87-A Irrigated	Makhband	14.23	10.45	13.53	3.57	2643.80
53		87-B rainfed		4.35	6.15	7.34	2.45	2655.21
54	87	86-A Danman	Chakdara	10.63	5.56	12.33	2.44	3302.00
55		86-B Jewardara		57.47	13.19	23.84	4.35	3269.54
56		86-C Shoulgar		62.53	19.67	35.85	7.46	3325.92
57	90	90	Kitiarai	15.66	6.78	14.75	2.37	4318.30
58	92	92	Khairabad	6.44	8.37	14.25	1.78	1601.20
59	94	94	Usakai	15.23	10.56	36.84	2.53	3484.72
60	97	97-A Daman	Badwan	12.82	8.44	25.34	1.57	1360.33
61		97-B Shoulgar		38.57	12.83	32.84	5.75	2337.28
62	100	100-A Daman	Kamala	6.72	6.79	36.23	2.78	2270.52
63		100-B Irrigated		23.84	15.33	13.33	6.93	2227.53

Table E.3b:- Analytical Results of Major Anions in Selected Soil Samples Collected Form River Swat Watershed during 2006

Serial No	Ref No	Sub Sample Number	Village	NO_3 (mg/Kg)	PO_4 (mg/Kg)	SO_4 (mg/Kg)	Cl (mg/Kg)	CO_3 (mg/Kg)
1	1	1	Kalam	16.73	14.15	16.00	3.38	2467.45
2	6	6	Mankial	23.34	15.22	15.44	2.48	1135.03
3	8	8-A Irrigated	Bahrain	14.63	24.53	17.75	2.48	2616.37
4		8-B Rainfed		9.22	9.37	15.12	2.68	2158.39
5	9	8-A Irrigated	Satal	15.14	15.23	15.24	2.28	2420.57
6		8-B Rainfed		6.11	12.34	15.11	3.38	2316.35
7	10	10-A Irrigated	Madyan	27.53	13.44	18.23	4.78	3242.14
8		10-B Rainfed		12.44	17.33	16.14	2.18	3212.38
9	12	12-A Danman	Fatepur	12.23	13.22	13.76	2.13	3150.47
10		12-B Jewardara		25.45	17.57	26.22	2.68	3301.08
11		12-C Shoulgar		57.55	24.47	39.22	3.78	1807.60
12	15	15-A Danman	Bagh Dheri	14.56	11.34	23.78	3.56	4216.02
13		15-B Jewardara		25.33	12.87	35.34	4.67	4181.50
14		15-C Shoulgar		48.45	17.11	34.75	6.37	4157.17
15	19	19-A Danman	Shokhdara	12.23	11.25	23.83	5.68	3234.35
16		19-B Jewardara		28.13	13.65	35.22	6.86	3308.11
17		19-C Shoulgar		52.53	23.23	48.51	6.77	4483.96
18	28	28-A Danman	Shairpalam	10.12	10.56	13.84	4.78	2163.19
19		28-B Jewardara		32.81	13.75	35.11	5.13	3242.23
20		28-C Shoulgar		57.43	20.53	37.45	6.83	4207.36
21	40	40-A Danman	Kabbal	11.34	8.34	24.87	3.27	2241.06
22		40-B Jewardara		27.34	11.24	36.47	6.22	6429.08
23		40-C Shoulgar		57.21	21.57	38.32	7.47	6527.86
24	45	45-A Danman	Dedawar	10.82	4.67	13.87	3.35	1548.18
25		45-B Jewardara		33.21	8.45	25.34	5.23	2163.29
26		45-C Shoulgar		63.22	17.33	37.27	6.92	2557.66
27	49	49-Daman	Miandam	56.13	5.66	24.56	2.76	3595.67
28	53	53-A Danman	Khwazakhela	12.23	7.65	25.22	3.12	3494.13
29		53-B Jewardara		26.13	10.57	38.23	5.37	2429.58
30		53-C Shoulgar		65.13	17.58	42.33	7.66	3844.66
31	58	58-A Danman	Manglaur	8.08	7.33	15.22	2.57	2637.58
32		58-B Jewardara		20.23	11.78	25.44	4.73	5257.13
33		58-C Shoulgar		47.43	18.16	38.27	7.34	5503.16
34	66	66-A Danman	Ghaligai	8.97	7.26	11.87	2.87	4108.31
35		66-B Jewardara		25.12	12.67	28.12	3.59	5374.53
36		66-C Shoulgar		44.77	18.35	37.23	7.26	6100.83
37	68	68-A Danman	Barikot	10.23	6.78	15.33	4.67	6057.92
38		68-B Jewardara		21.13	13.89	17.74	5.57	19193.70
39		68-C Shoulgar		36.14	20.54	36.97	7.68	5172.41
40	70	70-A Danman	Kotah	7.08	6.79	12.34	2.56	2333.02
41		70-B Jewardara		24.33	17.33	28.13	5.57	6331.53
42		70-C Shoulgar		57.15	21.38	33.23	7.72	7132.39
43	72	72-A Danman	Haibatgram	7.53	6.23	15.22	2.76	5444.23
44		72-B Jewardara		24.14	14.67	27.48	6.78	5092.67
45		72-C Shoulgar		52.44	20.14	39.14	8.44	4751.80
46	76	76-A Danman	Allahadan	6.13	5.16	8.93	1.97	3659.89
47		76-B Jewardara		46.22	13.55	18.47	5.82	4023.97
48		76-C Shoulgar		58.24	20.22	33.84	7.33	4266.71
49	81	81-A Danman	Matkani	6.87	6.67	13.55	2.17	1924.40
50		81-B Jewardara		44.77	13.55	26.94	4.74	3581.32
51		81-C Shoulgar		64.25	22.79	35.14	8.63	3591.18
52	84	87-A Irrigated	Makhband	16.33	12.78	12.23	3.86	2626.60
53		87-B rainfed		5.22	5.87	8.57	2.66	2688.21
54	87	86-A Danman	Chakdara	12.11	4.33	11.45	3.15	3326.93
55		86-B Jewardara		55.92	12.89	25.23	5.23	3278.18
56		86-C Shoulgar		60.12	20.45	37.34	8.27	3337.93
57	90	90	Kitiarai	16.37	7.44	16.27	2.24	4285.89
58	92	92	Khairabad	5.32	9.45	13.17	2.29	1551.98
59	94	94	Usakai	14.87	12.35	38.27	2.74	3521.92
60	97	97-A Daman	Badwan	14.11	9.22	23.92	1.92	1382.09
61		97-B Shoulgar		40.12	14.77	35.24	6.36	2357.09
62	100	100-A Daman	Kamala	7.24	7.12	36.34	3.73	2313.04
63		100-B Irrigated		25.12	14.84	14.47	7.35	2177.40

Table E.3c: Average Valuses of Major Anions in Selected soil samples of River Swat Watershed (2005-06)

Serial No	Soil Ref No	Sub Sample Number	Village		NO_3 (mg/Kg)	PO_4 (mg/Kg)	SO_4 (mg/Kg)	Cl (mg/Kg)	CO_3 (mg/Kg)
1	1	1	Kalam	Average	17.63	13.30	15.50	2.92	2456.80
				SDV	1.27	1.21	0.71	0.66	15.06
2	6	6	Mankial	Average	21.89	14.28	14.06	2.32	1141.08
				SDV	2.06	1.34	1.96	0.23	8.56
3	8	8-A Irrigated	Bahrain	Average	13.54	24.38	16.59	2.07	2630.84
				SDV	1.55	0.22	1.64	0.59	20.47
4		8-B Rainfed		Average	9.69	9.91	13.94	2.82	2145.64
				SDV	0.66	0.76	1.67	0.19	18.04
5	9	8-A Irrigated	Satal	Average	14.29	13.40	14.91	2.21	2439.94
				SDV	1.21	2.59	0.47	0.10	27.39
6		8-B Rainfed		Average	6.62	11.31	14.39	2.92	2248.59
				SDV	0.71	1.46	1.02	0.66	95.83
7	10	10-A Irrigated	Madyan	Average	26.43	14.60	17.44	5.12	3206.22
				SDV	1.56	1.63	1.12	0.47	50.80
8		10-B Rainfed		Average	11.33	16.34	15.93	1.82	3205.75
				SDV	1.58	1.41	0.30	0.52	9.38
9	12	12-A Danman	Fatepur	Average	11.39	12.90	14.47	2.19	3141.26
				SDV	1.19	0.46	1.00	0.08	13.03
10		12-B Jewardara		Average	24.39	17.06	25.46	2.57	3315.28
				SDV	1.50	0.72	1.08	0.16	20.07
11		12-C Shoulgar		Average	51.51	23.41	38.33	3.52	2701.37
				SDV	8.54	1.50	1.26	0.37	1263.98
12	15	15-A Danman	Bagh Dheri	Average	15.95	10.84	24.56	3.50	4200.26
				SDV	1.96	0.71	1.10	0.08	22.28
13		15-B Jewardara		Average	26.03	12.61	34.46	4.62	4193.26
				SDV	0.98	0.37	1.25	0.08	16.63
14		15-C Shoulgar		Average	50.40	16.84	35.44	6.42	4161.42
				SDV	2.75	0.38	0.97	0.06	6.01
15	19	19-A Danman	Shokhdara	Average	13.79	10.79	23.19	5.62	3219.97
				SDV	2.21	0.65	0.91	0.09	20.34
16		19-B Jewardara		Average	27.45	13.05	34.59	6.72	3319.50
				SDV	0.96	0.86	0.90	0.21	16.10
17		19-C Shoulgar		Average	55.08	21.84	47.94	7.17	4497.75
				SDV	3.61	1.97	0.81	0.56	19.50
18	28	28-A Danman	Shairpalam	Average	9.33	10.34	14.59	4.62	2149.94
				SDV	1.12	0.31	1.06	0.23	18.74
19		28-B Jewardara		Average	33.19	13.05	33.79	5.35	3226.80
				SDV	0.54	1.00	1.87	0.30	21.82
20		28-C Shoulgar		Average	57.08	19.65	36.89	7.14	4193.09
				SDV	0.50	1.24	0.79	0.43	20.18
21	40	40-A Danman	Kabbal	Average	11.76	7.45	25.75	3.80	2250.66
				SDV	0.59	1.27	1.24	0.74	13.57
22		40-B Jewardara		Average	28.29	10.69	35.95	5.84	6439.08
				SDV	1.34	0.78	0.74	0.54	14.15
23		40-C Shoulgar		Average	55.43	20.96	37.95	6.90	6542.30
				SDV	2.52	0.87	0.53	0.81	20.42
24	45	45-A Danman	Dedawar	Average	11.67	5.01	14.57	2.85	1561.70
				SDV	1.20	0.48	0.98	0.71	19.13
25		45-B Jewardara		Average	31.97	8.01	24.40	4.95	2146.92
				SDV	1.75	0.62	1.34	0.40	23.15
26		45-C Shoulgar		Average	64.48	16.45	37.03	6.85	2540.25
				SDV	1.78	1.25	0.35	0.11	24.63
27	49	49-Daman	Miandam	Average	54.93	5.01	23.95	2.45	3604.87
				SDV	1.70	0.93	0.87	0.45	13.01
28	53	53-A Danman	Khwazakhela	Average	12.78	6.55	24.48	2.74	3511.59
				SDV	0.77	1.56	1.05	0.54	24.70
29		53-B Jewardara		Average	24.94	10.45	37.99	4.96	2448.74
				SDV	1.69	0.17	0.35	0.59	27.10
30		53-C Shoulgar		Average	64.38	16.46	43.95	7.45	3829.31
				SDV	1.07	1.59	2.28	0.30	21.71
31	58	58-A Danman	Manglaur	Average	7.38	6.89	14.47	2.46	2632.92
				SDV	0.99	0.62	1.06	0.16	6.60
32		58-B Jewardara		Average	19.39	11.06	24.54	4.53	5270.56
				SDV	1.20	1.02	1.27	0.29	18.99

Table E-3 Average Anions Values continue

Table E.3c: Average Valuses of Major Anions in Selected soil samples of River Swat Watershed (2005-06)

Serial No	Soil Ref No	Sub Sample Number	Village		NO_3 (mg/Kg)	PO_4 (mg/Kg)	SO_4 (mg/Kg)	Cl (mg/Kg)	CO_3 (mg/Kg)
33		58-C Shoulgar		Average	45.89	17.90	37.86	7.14	5499.06
				SDV	2.18	0.37	0.58	0.29	5.80
34	66	66-A Danman	Ghaligai	Average	9.53	6.85	12.66	2.62	4093.98
				SDV	0.79	0.58	1.12	0.36	20.27
35		66-B Jewardara		Average	24.53	11.55	27.83	3.53	5356.75
				SDV	0.83	1.58	0.41	0.09	25.15
36		66-C Shoulgar		Average	46.15	17.46	36.59	6.87	6113.16
				SDV	1.95	1.26	0.91	0.56	17.45
37	68	68-A Danman	Barikot	Average	10.10	5.67	13.78	4.01	6046.02
				SDV	0.18	1.57	2.19	0.94	16.82
38		68-B Jewardara		Average	20.48	12.73	17.10	5.46	19204.15
				SDV	0.93	1.65	0.91	0.16	14.78
39		68-C Shoulgar		Average	34.95	19.65	37.55	7.57	5168.47
				SDV	1.69	1.27	0.82	0.16	5.57
40	70	70-A Danman	Kotah	Average	6.92	6.13	13.05	2.65	2317.58
				SDV	0.23	0.93	1.00	0.12	21.83
41		70-B Jewardara		Average	23.89	16.29	27.83	4.96	6338.66
				SDV	0.62	1.47	0.42	0.87	10.09
42		70-C Shoulgar		Average	55.75	20.97	34.34	7.15	7122.93
				SDV	1.99	0.58	1.57	0.81	13.39
43	72	72-A Danman	Haibatgram	Average	6.53	5.84	13.95	2.58	5460.26
				SDV	1.42	0.56	1.80	0.26	22.68
44		72-B Jewardara		Average	23.35	13.50	26.93	6.23	5107.59
				SDV	1.12	1.65	0.78	0.78	21.09
45		72-C Shoulgar		Average	50.66	19.36	38.86	8.09	4762.34
				SDV	2.52	1.11	0.40	0.50	14.91
46	76	76-A Danman	Allahadan	Average	5.40	4.86	9.58	2.12	3669.91
				SDV	1.03	0.43	0.92	0.21	14.16
47		76-B Jewardara		Average	45.40	12.45	17.91	5.25	4012.57
				SDV	1.17	1.56	0.79	0.81	16.12
48		76-C Shoulgar		Average	57.51	19.41	34.59	7.45	4248.80
				SDV	1.03	1.15	1.05	0.16	25.34
49	81	81-A Danman	Matkani	Average	7.55	6.56	12.96	2.16	1930.51
				SDV	0.95	0.16	0.83	0.02	8.64
50		81-B Jewardara		Average	45.17	13.07	26.70	4.71	3575.31
				SDV	0.56	0.69	0.35	0.05	8.51
51		81-C Shoulgar		Average	63.44	22.29	34.89	8.11	3610.87
				SDV	1.15	0.71	0.36	0.74	27.85
52	84	87-A Irrigated	Makhband	Average	15.28	11.62	12.88	3.72	2635.20
				SDV	1.48	1.65	0.92	0.21	12.17
53		87-B rainfed		Average	4.79	6.01	7.96	2.56	2671.71
				SDV	0.62	0.20	0.87	0.15	23.33
54	87	86-A Danman	Chakdara	Average	11.37	4.95	11.89	2.80	3314.46
				SDV	1.05	0.87	0.62	0.50	17.62
55		86-B Jewardara		Average	56.70	13.04	24.54	4.79	3273.86
				SDV	1.10	0.21	0.98	0.62	6.11
56		86-C Shoulgar		Average	61.33	20.06	36.60	7.87	3331.93
				SDV	1.70	0.55	1.05	0.57	8.49
57	90	90	Kitiarai	Average	16.02	7.11	15.51	2.31	4302.10
				SDV	0.50	0.47	1.07	0.09	22.92
58	92	92	Khairabad	Average	5.88	8.91	13.71	2.04	1576.59
				SDV	0.79	0.76	0.76	0.36	34.81
59	94	94	Usakai	Average	15.05	11.46	37.56	2.64	3503.32
				SDV	0.25	1.27	1.01	0.15	26.31
60	97	97-A Daman	Badwan	Average	13.47	8.83	24.63	1.75	1371.21
				SDV	0.91	0.55	1.00	0.25	15.38
61		97-B Shoulgar		Average	39.35	13.80	34.04	6.06	2347.19
				SDV	1.10	1.37	1.70	0.43	14.00
62	100	100-A Daman	Kamala	Average	6.98	6.96	36.29	3.26	2291.78
				SDV	0.37	0.23	0.08	0.67	30.07
63		100-B Irrigated		Average	24.48	15.09	13.90	7.14	2202.47
				SDV	0.91	0.35	0.81	0.30	35.45

Table E-3 Average Anions Values continue

Table E.4a:- Results of Macro and Micro Cations (mg/Kg) of Selected Sample Collected Form River Swat Watershed (2005)

Serial No	Soil Ref No	Sub Sample Number	Village	K (mg/kg)	Ca (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Mo (mg/kg)
1	1	1	Kalam	101.262	2508.878	137.327	237.530	11.067	1.738	6.436	0.004
2	6	6	Mankial	98.427	1176.551	436.925	147.473	14.661	1.682	10.419	0.001
3	8	8-A Irrigated	Bahrain	123.912	2713.144	173.298	388.832	10.363	4.762	6.121	0.014
4		8-B Rainfed	Bahrain	112.713	2187.573	151.293	318.227	6.346	2.432	1.622	0.012
5	9	8-A Irrigated	Satal	101.512	2522.368	163.428	89.213	10.162	2.877	5.626	0.121
6		8-B Rainfed	Satal	115.417	2236.749	124.522	82.319	11.467	3.435	6.062	0.084
7	10	10-A Irrigated	Madyan	128.522	3251.592	135.579	67.088	9.769	2.393	6.506	0.076
8		10-B Rainfed	Madyan	145.262	3281.147	134.431	64.317	7.186	2.172	4.829	1.092
9	12	12-A Danman	Fatepur	115.626	3212.358	136.463	246.854	11.441	1.933	7.152	12.187
10		12-B Jewardara	Fatepur	123.572	3414.839	135.356	243.356	8.391	1.912	7.479	11.244
11		12-C Shoulgar	Fatepur	132.547	3687.321	142.246	193.945	16.259	1.890	8.528	9.631
12	15	15-A Danman	Bagh Dheri	130.324	4291.802	182.319	131.529	15.746	1.687	7.172	10.799
13		15-B Jewardara	Bagh Dheri	143.364	4312.841	153.422	215.754	18.232	1.480	7.914	13.675
14		15-C Shoulgar	Bagh Dheri	153.372	4272.477	154.212	182.749	14.219	1.826	6.146	9.282
15	19	19-A Danman	Shokhdara	113.316	3287.787	153.412	124.386	8.206	0.328	0.830	0.941
16		19-B Jewardara	Shokhdara	162.327	3416.291	163.231	174.859	13.692	0.315	0.853	0.831
17		19-C Shoulgar	Shokhdara	173.283	4627.221	144.321	172.133	15.927	1.186	0.760	0.487
18	28	28-A Danman	Shairpalam	118.322	2191.469	221.234	122.498	12.665	1.739	0.087	0.802
19		28-B Jewardara	Shairpalam	166.314	3293.714	162.312	108.922	12.152	2.172	0.895	0.076
20		28-C Shoulgar	Shairpalam	178.218	4285.966	124.163	112.183	11.907	0.154	0.525	0.133
21	40	40-A Danman	Kabbal	123.216	2318.214	122.341	122.820	11.122	0.167	0.354	0.163
22		40-B Jewardara	Kabbal	142.255	6614.445	104.667	280.683	10.611	1.653	10.370	6.174
23		40-C Shoulgar	Kabbal	176.252	6724.861	118.431	266.327	12.462	1.201	7.214	3.402
24	45	45-A Danman	Dedawar	97.813	1615.617	254.214	49.177	10.821	1.458	12.151	2.711
25		45-B Jewardara	Dedawar	127.435	2185.178	235.173	52.169	12.307	1.338	11.765	2.645
26		45-C Shoulgar	Dedawar	165.393	2587.525	132.324	57.138	13.783	1.473	6.278	1.249
27	49	49-Daman	Miandam	93.613	3706.733	255.256	241.459	13.463	5.219	6.094	0.000
28	53	53-A Danman	Khwazakhela	123.512	3619.547	129.123	132.378	12.531	3.251	3.593	1.146
29		53-B Jewardara	Khwazakhela	142.252	2531.176	154.441	244.800	17.306	1.476	6.611	6.119
30		53-C Shoulgar	Khwazakhela	165.352	3911.746	79.279	312.824	8.511	1.812	7.037	12.174
31	58	58-A Danman	Manglaur	116.264	2695.638	124.312	152.739	6.248	0.414	1.482	0.000
32		58-B Jewardara	Manglaur	163.524	5419.473	147.686	261.421	8.805	6.008	7.171	0.000
33		58-C Shoulgar	Manglaur	172.542	5635.855	162.153	264.636	13.647	7.256	6.254	0.000
34	66	66-A Danman	Ghaligai	95.434	4184.251	62.178	103.421	4.261	0.140	0.757	0.000
35		66-B Jewardara	Ghaligai	182.452	5475.865	88.217	117.372	9.492	1.176	0.137	
36		66-C Shoulgar	Ghaligai	192.526	6282.563	77.162	128.293	14.237	1.167	0.372	0.000
37	68	68-A Danman	Barikot	112.463	6188.855	108.611	171.632	8.670	1.384	6.188	3.655
38		68-B Jewardara	Barikot	152.672	19707.282	61.787	205.193	9.951	5.588	6.966	0.000
39		68-C Shoulgar	Barikot	192.633	5296.961	75.831	172.745	10.988	2.199	2.540	0.000
40	70	70-A Danman	Kotah	102.115	2361.176	71.450	157.396	5.266	2.106	5.169	6.223
41		70-B Jewardara	Kotah	162.752	6508.512	96.640	172.634	10.878	2.030	7.619	11.417
42		70-C Shoulgar	Kotah	197.633	7295.856	121.496	130.411	13.248	1.772	7.176	1.347
43	72	72-A Danman	Haibatgram	92.674	5616.717	65.920	131.737	10.162	5.740	8.600	0.869
44		72-B Jewardara	Haibatgram	182.172	5253.850	117.002	128.590	12.416	1.759	4.847	0.756
45		72-C Shoulgar	Haibatgram	192.683	4895.268	280.494	53.203	10.299	3.644	8.193	0.868
46	76	76-A Danman	Allahadan	102.217	4336.276	21.672	33.289	5.815	0.125	0.273	0.024
47		76-B Jewardara	Allahadan	142.272	4103.762	27.512	20.104	9.653	4.543	2.361	0.013
48		76-C Shoulgar	Allahadan	183.732	4339.365	26.155	16.673	23.454	6.236	3.846	0.123
49	81	81-A Danman	Matkani	112.723	1986.274	18.219	12.073	4.236	0.182	0.321	0.093
50		81-B Jewardara	Matkani	142.227	2980.520	82.698	251.303	11.787	2.192	6.636	3.906
51		81-C Shoulgar	Matkani	193.712	3723.648	77.320	237.749	12.726	1.183	4.564	2.427
52	84	87-A Irrigated	Makhband	92.433	2711.593	78.476	116.569	3.916	0.135	0.580	0.171
53		87-B rainfed	Makhband	82.863	2723.295	375.201	138.628	10.956	1.721	9.286	1.913
54	87	86-A Danman	Chakdara	92.226	3386.670	116.750	171.217	8.625	1.809	5.992	13.169
55		86-B Jewardara	Chakdara	162.235	3353.377	124.362	149.196	11.214	1.660	4.223	9.069
56		86-C Shoulgar	Chakdara	182.216	3411.202	119.129	153.059	12.538	1.045	2.860	6.687
57	90	90	Kitiarai	87.236	4429.026	142.071	196.111	8.762	3.979	5.420	0.468
58	92	92	Khairabad	72.315	1642.259	140.362	196.133	9.097	1.581	6.821	9.129
59	94	94	Usakai	172.743	3574.067	43.675	61.976	3.216	0.834	4.161	4.719
60	97	97-A Daman	Badwan	125.375	1395.215	88.051	72.191	4.722	0.463	1.243	1.424
61		97-B Shoulgar	Badwan	192.254	2397.215	103.215	102.317	7.653	0.127	0.360	1.562
62	100	100-A Daman	Kamala	112.513	2328.736	64.290	33.238	3.783	0.086	0.429	0.216
63		100-B Irrigated	Kamala	168.166	2284.651	81.901	82.809	5.247	0.070	0.167	0.892

Table E.4b:- Results of Macro and Micro Cations (mg/Kg) of Selected Sample Collected Form River Swat Watershed (2006)

Serial No	Soil Ref No	Sub Sample Number	Village	K (mg/kg)	Ca(mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Mo (mg/kg)
1	1	1	Kalam	97.237	2530.717	143.154	245.243	12.327	1.367	5.845	0.002
2	6	6	Mankial	102.472	1164.132	412.276	157.743	16.362	1.367	9.615	0.002
3	8	8-A Irrigated	Bahrain	125.672	2683.455	163.928	377.353	11.622	4.823	5.826	0.012
4		8-B Rainfed	Bahrain	114.633	2213.735	142.935	323.227	4.833	1.854	1.233	0.032
5	9	8-A Irrigated	Satal	97.243	2482.633	143.848	82.785	11.634	3.235	4.735	0.123
6		8-B Rainfed	Satal	117.549	2375.743	133.128	79.264	10.532	2.928	5.685	0.123
7	10	10-A Irrigated	Madyan	126.748	3325.274	132.487	65.747	8.656	1.965	5.843	0.114
8		10-B Rainfed	Madyan	155.242	3294.746	142.633	66.117	6.845	1.764	3.279	2.192
9	12	12-A Danman	Fatepur	112.743	3231.256	129.782	235.726	10.726	1.626	6.574	10.833
10		12-B Jewardara	Fatepur	127.764	3385.726	133.724	241.534	7.927	1.737	6.358	10.485
11		12-C Shoulgar	Fatepur	137.714	3715.246	134.754	212.193	14.764	1.028	7.628	8.372
12	15	15-A Danman	Bagh Dheri	131.532	4324.125	165.724	143.244	16.547	1.242	6.614	9.275
13		15-B Jewardara	Bagh Dheri	140.434	4288.713	162.355	205.737	16.624	1.374	5.922	11.735
14		15-C Shoulgar	Bagh Dheri	157.352	4263.766	152.846	193.247	13.816	1.094	4.874	7.868
15	19	19-A Danman	Shokhdara	117.154	3317.286	162.674	119.746	6.924	0.288	0.694	0.673
16		19-B Jewardara	Shokhdara	159.512	3392.938	154.765	168.547	14.723	0.287	0.593	0.907
17		19-C Shoulgar	Shokhdara	175.384	4598.937	138.835	165.975	16.199	1.095	0.935	0.668
18	28	28-A Danman	Shairpalam	121.162	2218.654	213.973	118.935	13.753	1.036	0.148	0.746
19		28-B Jewardara	Shairpalam	162.773	3325.365	157.636	113.142	14.543	1.762	0.672	0.133
20		28-C Shoulgar	Shairpalam	172.374	4315.237	118.875	121.933	13.282	0.140	0.276	0.073
21	40	40-A Danman	Kabbal	124.327	2298.528	127.427	118.673	13.765	0.079	0.278	0.154
22		40-B Jewardara	Kabbal	147.714	6593.927	113.295	272.427	13.286	1.256	9.824	5.926
23		40-C Shoulgar	Kabbal	172.364	6695.237	115.874	267.275	14.274	1.347	5.936	2.842
24	45	45-A Danman	Dedawar	103.402	1587.872	243.835	38.768	11.062	1.538	9.754	3.157
25		45-B Jewardara	Dedawar	132.385	2218.763	227.924	51.764	11.784	1.282	10.658	2.784
26		45-C Shoulgar	Dedawar	162.735	2623.245	138.626	47.689	12.488	1.353	4.812	1.476
27	49	49-Daman	Miandam	95.125	3687.865	264.576	238.737	11.642	4.635	5.826	0.000
28	53	53-A Danman	Khwazakhela	125.245	3583.725	132.535	124.762	14.254	2.542	2.854	1.074
29		53-B Jewardara	Khwazakhela	145.435	2491.875	148.827	252.137	18.747	1.764	5.815	4.744
30		53-C Shoulgar	Khwazakhela	164.415	3943.242	74.868	318.127	9.473	2.236	5.732	9.965
31	58	58-A Danman	Manglaur	114.235	2705.215	122.758	154.264	5.785	0.736	1.076	0.000
32		58-B Jewardara	Manglaur	165.254	5391.923	153.247	257.743	7.464	4.867	5.960	0.000
33		58-C Shoulgar	Manglaur	168.245	5644.264	157.875	258.474	16.459	5.942	4.782	0.000
34	66	66-A Danman	Ghaligai	105.732	4213.647	57.766	112.156	3.855	0.084	0.585	0.000
35		66-B Jewardara	Ghaligai	186.642	5512.343	78.925	115.826	10.272	1.063	0.084	0.000
36		66-C Shoulgar	Ghaligai	196.442	6257.257	75.948	124.976	12.972	1.543	0.242	0.000
37	68	68-A Danman	Barikot	118.627	6213.248	115.735	164.852	9.828	1.047	4.846	2.956
38		68-B Jewardara	Barikot	158.728	19685.846	65.286	195.927	10.247	4.735	5.854	0.000
39		68-C Shoulgar	Barikot	198.247	5305.035	68.373	183.217	9.234	1.952	1.747	0.000
40	70	70-A Danman	Kotah	107.287	2392.844	84.732	147.725	3.953	1.923	3.894	4.785
41		70-B Jewardara	Kotah	165.248	6493.873	93.848	164.758	12.137	1.733	5.927	9.758
42		70-C Shoulgar	Kotah	201.467	7315.273	134.056	125.765	11.854	1.386	5.865	1.245
43	72	72-A Danman	Haibatgram	93.754	5583.826	65.237	127.364	9.773	4.898	7.938	0.676
44		72-B Jewardara	Haibatgram	183.452	5223.254	108.227	126.243	10.127	1.826	5.655	0.628
45		72-C Shoulgar	Haibatgram	193.474	4873.644	273.264	55.217	11.076	3.763	9.537	0.748
46	76	76-A Danman	Allahadan	98.514	4353.738	25.247	35.846	7.426	0.757	0.714	0.017
47		76-B Jewardara	Allahadan	148.428	4127.144	28.165	18.094	11.546	3.854	2.273	0.032
48		76-C Shoulgar	Allahadan	178.367	4376.116	25.163	17.944	21.744	5.824	4.237	0.353
49	81	81-A Danman	Matkani	128.512	1973.742	15.813	11.752	3.674	0.135	0.275	0.079
50		81-B Jewardara	Matkani	148.623	2973.153	85.947	253.746	10.926	2.087	7.225	4.531
51		81-C Shoulgar	Matkani	198.307	3683.257	68.257	243.246	13.257	1.075	3.868	1.736
52	84	87-A Irrigated	Makhband	94.472	2693.947	72.758	107.874	4.147	0.094	0.628	0.078
53		87-B rainfed	Makhband	84.152	2757.138	362.932	126.877	12.267	1.247	6.947	1.093
54	87	86-A Danman	Chakdara	96.417	3412.231	112.325	163.533	6.862	1.125	4.928	11.532
55		86-B Jewardara	Chakdara	167.713	3362.235	118.277	138.244	10.746	1.837	4.527	8.245
56		86-C Shoulgar	Chakdara	186.626	3423.523	113.243	162.363	11.754	1.647	3.736	7.235
57	90	90	Kitiarai	86.137	4395.788	133.721	187.416	7.164	2.342	4.725	1.187
58	92	92	Khairabad	75.713	1591.772	145.145	187.843	8.932	1.136	5.444	8.742
59	94	94	Usakai	178.688	3612.230	52.252	54.869	6.727	0.629	3.475	3.427
60	97	97-A Daman	Badwan	127.286	1417.525	87.263	75.374	5.467	0.635	1.523	1.072
61		97-B Shoulgar	Badwan	193.734	2417.525	98.844	107.428	8.728	0.364	0.652	1.236
62	100	100-A Daman	Kamala	116.125	2372.353	68.922	28.948	4.531	0.217	0.312	0.175
63		100-B Irrigated	Kamala	169.324	2233.232	73.083	78.344	3.928	0.121	0.522	0.434

Table E.4c: Average Values of Macro and micro Cations (ppm by wt/wt) 2005-2006

Serial No	Soil Ref No	Sub Sample Number	Village		K (mg/kg)	Ca(mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Mo (mg/kg)
1	1	1	Kalam	Average	99.250	2519.798	140.240	241.386	11.697	1.553	6.140	(mg/kg)
				SDV	2.846	15.443	4.120	5.454	0.891	0.262	0.417	0.001
2	6	6	Mankial	Average	100.450	1170.342	424.601	152.608	15.511	1.524	10.017	0.001
				SDV	2.860	8.782	17.430	7.262	1.202	0.223	0.568	0.000
3	8	8-A Irrigated	Bahrain	Average	124.792	2698.299	168.613	383.092	10.993	4.792	5.974	0.013
				SDV	1.245	20.993	6.625	8.117	0.890	0.043	0.209	0.001
4		8-B Rainfed	Bahrain	Average	113.673	2200.654	147.114	320.727	5.589	2.143	1.428	0.022
				SDV	1.358	18.499	5.910	3.536	1.070	0.409	0.275	0.014
5	9	8-A Irrigated	Satal	Average	99.378	2502.501	153.638	85.999	10.898	3.056	5.181	0.122
				SDV	3.019	28.097	13.845	4.546	1.041	0.253	0.630	0.001
6		8-B Rainfed	Satal	Average	116.483	2306.246	128.825	80.791	11.000	3.182	5.874	0.103
				SDV	1.508	98.283	6.085	2.160	0.661	0.359	0.267	0.027
7	10	10-A Irrigated	Madyan	Average	127.635	3288.433	134.033	66.418	9.213	2.179	6.175	0.095
				SDV	1.254	52.101	2.186	0.948	0.787	0.303	0.469	0.026
8		10-B Rainfed	Madyan	Average	150.252	3287.947	138.532	65.217	7.016	1.968	4.054	1.642
				SDV	7.057	9.616	5.800	1.273	0.241	0.289	1.096	0.778
9	12	12-A Danman	Fatepur	Average	114.185	3221.807	133.123	241.290	11.084	1.780	6.863	11.510
				SDV	2.039	13.363	4.724	7.869	0.506	0.217	0.409	0.957
10		12-B Jewardara	Fatepur	Average	125.668	3400.283	134.540	242.445	8.159	1.825	6.919	10.864
				SDV	2.964	20.586	1.154	1.288	0.328	0.123	0.792	0.537
11		12-C Shoulgar	Fatepur	Average	135.131	3701.283	138.500	203.069	15.512	1.459	8.078	9.002
				SDV	3.654	19.746	5.298	12.903	1.057	0.610	0.636	0.890
12	15	15-A Danman	Bagh Dheri	Average	130.928	4307.964	174.022	137.387	16.146	1.464	6.893	10.037
				SDV	0.854	22.855	11.734	8.284	0.567	0.314	0.395	1.078
13		15-B Jewardara	Bagh Dheri	Average	141.899	4300.777	157.889	210.746	17.428	1.427	6.918	12.705
				SDV	2.072	17.061	6.317	7.083	1.137	0.075	1.408	1.371
14		15-C Shoulgar	Bagh Dheri	Average	155.362	4268.121	153.529	187.998	14.018	1.460	5.510	8.575
				SDV	2.814	6.159	0.966	7.423	0.285	0.517	0.900	1.000
15	19	19-A Danman	Shokhdara	Average	115.235	3302.537	158.043	122.066	7.565	0.308	0.762	0.807
				SDV	2.714	20.859	6.549	3.281	0.907	0.029	0.096	0.190
16		19-B Jewardara	Shokhdara	Average	160.920	3404.614	158.998	171.703	14.208	0.301	0.723	0.869
				SDV	1.991	16.513	5.987	4.463	0.729	0.019	0.183	0.054
17		19-C Shoulgar	Shokhdara	Average	174.334	4613.079	141.578	169.054	16.063	1.140	0.847	0.577
				SDV	1.486	20.000	3.880	4.354	0.192	0.065	0.124	0.128
18	28	28-A Danman	Shairpalam	Average	119.742	2205.062	217.604	120.716	13.209	1.388	0.117	0.774
				SDV	2.008	19.223	5.134	2.520	0.769	0.498	0.043	0.040
19		28-B Jewardara	Shairpalam	Average	164.544	3309.540	159.974	111.032	13.347	1.967	0.784	0.104
				SDV	2.504	22.381	3.307	2.984	1.691	0.290	0.158	0.040
20		28-C Shoulgar	Shairpalam	Average	175.296	4300.602	121.519	117.058	12.594	0.147	0.400	0.103
				SDV	4.132	20.698	3.739	6.894	0.972	0.010	0.176	0.043
21	40	40-A Danman	Kabbal	Average	123.772	2308.371	124.884	120.747	12.444	0.123	0.316	0.158
				SDV	0.786	13.920	3.596	2.932	1.868	0.063	0.054	0.006
22		40-B Jewardara	Kabbal	Average	144.985	6604.186	108.981	276.555	11.949	1.455	10.097	6.050
				SDV	3.860	14.509	6.101	5.838	1.891	0.281	0.386	0.175
23		40-C Shoulgar	Kabbal	Average	174.308	6710.049	117.153	266.801	13.368	1.274	6.575	3.122
				SDV	2.749	20.947	1.809	0.671	1.281	0.103	0.904	0.396
24	45	45-A Danman	Dedawar	Average	100.608	1601.745	249.024	43.973	10.942	1.498	10.952	2.934
				SDV	3.952	19.618	7.340	7.360	0.171	0.056	1.695	0.315
25		45-B Jewardara	Dedawar	Average	129.910	2201.971	231.548	51.966	12.045	1.310	11.211	2.714
				SDV	3.500	23.748	5.125	0.286	0.370	0.039	0.783	0.098
26		45-C Shoulgar	Dedawar	Average	164.064	2605.385	135.475	52.414	13.135	1.413	5.545	1.362
				SDV	1.879	25.258	4.456	6.682	0.916	0.085	1.037	0.161
27	49	49-Daman	Miandam	Average	94.369	3697.299	259.916	240.098	12.552	4.927	5.960	0.000
				SDV	1.069	13.342	6.591	1.925	1.288	0.413	0.189	0.000
28	53	53-A Danman	Khwazakhela	Average	124.379	3601.636	130.829	128.570	13.392	2.897	3.223	1.110
				SDV	1.225	25.330	2.412	5.385	1.218	0.501	0.523	0.051
29		53-B Jewardara	Khwazakhela	Average	143.844	2511.526	151.634	248.469	18.027	1.620	6.213	5.431
				SDV	2.251	27.790	3.970	5.189	1.019	0.204	0.562	0.972
30		53-C Shoulgar	Khwazakhela	Average	164.884	3927.494	77.073	315.475	8.992	2.024	6.385	11.069
				SDV	0.663	22.271	3.119	3.749	0.680	0.300	0.922	1.562
31	58	58-A Danman	Manglaur	Average	115.250	2700.426	123.535	153.502	6.016	0.575	1.279	0.000
				SDV	1.435	6.773	1.099	1.078	0.328	0.228	0.287	0.000
32		58-B Jewardara	Manglaur	Average	164.389	5405.698	150.466	259.582	8.134	5.438	6.566	0.000

Table E.4 Continue

Table E.4c: Average Values of Macro and micro Cations (ppm by wt/wt) 2005-2006

Serial No	Soil Ref No	Sub Sample Number	Village		K (mg/kg)	Ca(mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Mo (mg/kg)
				SDV	1.223	19.480	3.932	2.601	0.948	0.807	0.856	0.000
33		58-C Shoulgar	Manglaur	Average	170.394	5640.059	160.014	261.555	15.053	6.599	5.518	0.000
				SDV	3.038	5.946	3.025	4.357	1.988	0.929	1.040	0.000
34	66	66-A Danman	Ghaligai	Average	100.583	4198.949	59.972	107.789	4.058	0.112	0.671	0.000
				SDV	7.282	20.786	3.120	6.177	0.288	0.039	0.121	0.000
35		66-B Jewardara	Ghaligai	Average	184.547	5494.104	83.571	116.599	9.882	1.119	0.111	0.000
				SDV	2.963	25.794	6.571	1.094	0.551	0.079	0.037	0.000
36		66-C Shoulgar	Ghaligai	Average	194.484	6269.910	76.555	126.635	13.604	1.355	0.307	0.000
				SDV	2.769	17.894	0.859	2.345	0.894	0.266	0.092	0.000
37	68	68-A Danman	Barikot	Average	115.545	6201.051	112.173	168.242	9.249	1.216	5.517	3.306
				SDV	4.359	17.248	5.037	4.794	0.818	0.238	0.949	0.494
38		68-B Jewardara	Barikot	Average	155.700	19696.564	63.537	200.560	10.099	5.161	6.410	0.000
				SDV	4.282	15.157	2.474	6.552	0.210	0.603	0.787	0.000
39		68-C Shoulgar	Barikot	Average	195.440	5300.998	72.102	177.981	10.111	2.076	2.143	0.000
				SDV	3.970	5.709	5.274	7.404	1.240	0.174	0.561	0.000
40	70	70-A Danman	Kotah	Average	104.701	2377.010	78.091	152.560	4.610	2.015	4.532	5.504
				SDV	3.657	22.392	9.392	6.839	0.928	0.129	0.902	1.016
41		70-B Jewardara	Kotah	Average	164.000	6501.193	95.244	168.696	11.507	1.881	6.773	10.588
				SDV	1.765	10.351	1.974	5.570	0.890	0.210	1.196	1.173
42		70-C Shoulgar	Kotah	Average	199.550	7305.564	127.776	128.088	12.551	1.579	6.521	1.296
				SDV	2.711	13.730	8.882	3.285	0.986	0.273	0.927	0.072
43	72	72-A Danman	Haibatgram	Average	93.214	5600.272	65.579	129.550	9.968	5.319	8.269	0.773
				SDV	0.764	23.257	0.483	3.092	0.275	0.596	0.468	0.136
44		72-B Jewardara	Haibatgram	Average	182.812	5238.552	112.614	127.417	11.271	1.792	5.251	0.692
				SDV	0.905	21.635	6.205	1.660	1.619	0.047	0.571	0.091
45		72-C Shoulgar	Haibatgram	Average	193.079	4884.456	276.879	54.210	10.688	3.704	8.865	0.808
				SDV	0.559	15.290	5.112	1.424	0.550	0.084	0.951	0.085
46	76	76-A Danman	Allahadan	Average	100.366	4345.007	23.460	34.568	6.620	0.441	0.494	0.021
				SDV	2.618	12.347	2.528	1.808	1.139	0.446	0.312	0.005
47		76-B Jewardara	Allahadan	Average	145.350	4115.453	27.839	19.099	10.599	4.199	2.317	0.023
				SDV	4.353	16.533	0.461	1.421	1.339	0.487	0.062	0.013
48		76-C Shoulgar	Allahadan	Average	181.050	4357.741	25.659	17.308	22.599	6.030	4.042	0.238
				SDV	3.794	25.987	0.701	0.898	1.210	0.291	0.276	0.162
49	81	81-A Danman	Matkani	Average	120.618	1980.008	17.016	11.913	3.955	0.158	0.298	0.086
				SDV	11.165	8.861	1.702	0.227	0.397	0.033	0.033	0.010
50		81-B Jewardara	Matkani	Average	145.425	2976.836	84.323	252.525	11.356	2.140	6.931	4.219
				SDV	4.523	5.210	2.297	1.727	0.609	0.074	0.417	0.442
51		81-C Shoulgar	Matkani	Average	196.010	3703.453	72.789	240.497	12.992	1.129	4.216	2.082
				SDV	3.249	28.561	6.408	3.887	0.375	0.076	0.492	0.489
52	84	87-A Irrigated	Makhband	Average	93.453	2702.770	75.617	112.221	4.031	0.114	0.604	0.125
				SDV	1.442	12.478	4.043	6.149	0.163	0.029	0.034	0.065
53		87-B rainfed	Makhband	Average	83.508	2740.216	369.067	132.752	11.612	1.484	8.117	1.503
				SDV	0.911	23.931	8.675	8.310	0.928	0.335	1.654	0.579
54	87	86-A Danman	Chakdara	Average	94.322	3399.451	114.537	167.375	7.744	1.467	5.460	12.350
				SDV	2.963	18.074	3.128	5.433	1.246	0.483	0.752	1.157
55		86-B Jewardara	Chakdara	Average	164.974	3357.806	121.320	143.720	10.980	1.748	4.375	8.657
				SDV	3.874	6.263	4.303	7.744	0.331	0.126	0.215	0.583
56		86-C Shoulgar	Chakdara	Average	184.421	3417.362	116.186	157.711	12.146	1.346	3.298	6.961
				SDV	3.118	8.712	4.162	6.578	0.555	0.426	0.620	0.387
57	90	90	Kitiarai	Average	86.687	4412.407	137.896	191.764	7.963	3.160	5.073	0.828
				SDV	0.777	23.503	5.904	6.148	1.130	1.157	0.492	0.508
58	92	92	Khairabad	Average	74.014	1617.016	142.754	191.988	9.015	1.359	6.132	8.936
				SDV	2.403	35.700	3.382	5.861	0.117	0.315	0.974	0.273
59	94	94	Usakai	Average	175.716	3593.149	47.963	58.423	4.972	0.732	3.818	4.073
				SDV	4.204	26.986	6.065	5.025	2.483	0.145	0.485	0.913
60	97	97-A Daman	Badwan	Average	192.994	1406.370	87.657	73.782	5.095	0.549	1.383	1.248
				SDV	1.047	15.776	0.557	2.250	0.527	0.122	0.198	0.249
61		97-B Shoulgar	Badwan	Average	192.994	2407.370	101.029	104.872	8.190	0.245	0.506	1.399
				SDV	1.047	14.361	3.091	3.614	0.760	0.168	0.206	0.230
62	100	100-A Daman	Kamala	Average	114.319	2350.544	66.606	31.093	4.157	0.152	0.370	0.196
				SDV	2.554	30.842	3.275	3.033	0.529	0.093	0.082	0.029
63		100-B Irrigated	Kamala	Average	168.745	2258.941	77.492	80.576	4.588	0.096	0.344	0.663
				SDV	0.819	36.359	6.235	3.158	0.933	0.036	0.252	0.324

Table E.4 Continue

Table E.5: Soil Slope of selected villages of River Swat Watershed

Serial No	Sample Ref No	Village N	Sub Soil Type	Percent agriculture	Total Percent	% Slope Range Range					
						0-3	1 to 8	4 to 16	10 to 30	20 To 60	Above 60
1	1	Kalam	wet	1.5	1.5	0	0	0	2	8	90
2	6	Mankial	wet	1.5	1.5	0	0	0	1	6	93
3	8	Bahrain	Irrigated	3.5	5.3	0	0	0	10	35	45
4			Rainfed	1.8		0	0	0	2	30	38
5	9	Satal	Irrigated	3.5	5	0	0	0	3	35	62
6			Rainfed	1.5		0	0	0	1	40	59
7	10	Madyan	10-A Irrigated	2.8	4.5	0	0	0	2	40	58
8			10-B Rainfed	1.7		0	0	0	2	40	58
9	12	Fatepur	12-A Danman	5.5	15	0	0	3	4	45	46
10			12-B Jewardara	3.4		0	0	5	15	45	30
11			12-C Shoulgar	6.1		0	0	10	20	55	10
	Total Average of the Upper Swat				**5.47**	**0.00**	**0.00**	**1.64**	**5.64**	**34.45**	**53.55**
12	15	Bagh Dhe	15-A Danman	5.5	18.5	5	25	15	15	10	30
13			15-B Jewardara	4.5		25	45	28	2	0	0
14			15-C Shoulgar	8.5		45	30	23	2	0	0
15	19	Shokhdara	12-A Danman	6.5	21	5	25	15	15	10	30
16			12-B Jewardara	5.5		25	45	28	2	0	0
17			12-C Shoulgar	8.5		45	30	23	2	0	0
18	28	Shairpalai	12-A Danman	12	30	5	25	15	15	10	30
19			12-B Jewardara	8		25	45	28	2	0	0
20			12-C Shoulgar	10		45	30	23	2	0	0
21	40	Kabbal	12-A Danman	7	45	5	25	15	15	10	30
22			12-B Jewardara	16		25	45	28	2	0	0
23			12-C Shoulgar	23		45	30	23	2	0	0
24	45	Dedawar	12-A Danman	8	16	2	8	15	10	45	20
25			12-B Jewardara	3		5	25	30	20	10	10
26			12-C Shoulgar	5		40	45	15	0	0	0
27	49	Miandam	Rainfed	9	9	2	3	10	20	25	40
28	53	Khwazakl	12-A Danman	15	33	10	10	15	20	20	25
29			12-B Jewardara	13		35	25	25	15	0	0
30			12-C Shoulgar	10		45	35	10	10	0	0
31	58	Manglaur	12-A Danman	9	15	15	10	15	15	15	30
32			12-B Jewardara	4		25	10	10	25	25	5
33			12-C Shoulgar	2		30	15	10	30	15	0
34	66	Ghaligai	12-A Danman	8	24	5	15	15	25	25	15
35			12-B Jewardara	8		25	35	40	0	0	0
36			12-C Shoulgar	8		35	35	30	0	0	0
37	68	Barikot	12-A Danman	14	26	5	10	15	30	25	15
38			12-B Jewardara	8		25	25	25		0	25
39			12-C Shoulgar	4		40	35	25	0	0	0
40	70	Kotah	12-A Danman	18	34	10	25	15	15	15	20
41			12-B Jewardara	10		40	35	15	10	0	0
42			12-C Shoulgar	6		45	45	10	0	0	0
	Total Average of the Middle Swat				**24.68**	**23.84**	**27.29**	**19.65**	**10.70**	**8.39**	**10.48**
43	73	Haibatgra	73-A Danman	20	40	15	30	20	15	10	10
44			73-B Jewardara	10		45	35	15	5	0	0
45			73-C Shoulgar	10		55	40	5	0	0	0
46	76	Allahadan	76-A Danman	20	40	5	15	30	35	10	5
47			76-B Jewardara	15		40	35	20	5	0	0
48			76-C Shoulgar	5		50	35	15	0	0	0
49	82	Matkani	82-A Danman	13	33	5	15	15	30	10	25
50			82-B Jewardara	12		35	30	30	5	0	0
51			82-C Shoulgar	8		40	45	15	0	0	0
52	84	Makhband	87-A Irrigated	6	9	0	0	20	30	25	25
53			87-B rainfed	3		0	5	35	35	20	5
54	87	Chakdara	86-A Danman	18	33	10	10	30	45	5	0
55			86-B Jewardara	10		30	30	35	5	0	0
56			86-C Shoulgar	5		35	45	20	0	0	0
57	90	Kitiarai	-	13	13	5	5	35	25	20	10
58	92	Khairabad	-	12	12	2	3	15	30	35	15
59	94	Usakai	-	33	33	10	35	25	10	10	10
60	97	Badwan	97-A Daman	6	9	5	5	20	30	30	10
61			97-B Shoulgar	3		30	30	40	0	0	0
62	100	Kamala	100-A	10	16	10	35	25	15	10	5
63			100-B			40	30	30	0	0	0
	Total Average of the Lower Swat				**23.80**	**22.24**	**24.43**	**23.57**	**15.24**	**8.81**	**5.71**
	Total Average (%aga)				**20.06**	**19.14**	**21.57**	**17.81**	**11.34**	**13.08**	**16.41**

Table E-6a: Suspended load of River Swat With out Flooded events

Month	Discharge m3/s 2004	SS (ppm)	Load in Kg/day	Average daily load Kg/day	Load Kg/m per month
January	34.21	22	65026.368		
	30.89	22	58715.712		
	32.31	19	53040.096	58927.392	1826749.152
February	34.4	34.9	103728.384		
	135	96	1119744		
	89.76	82	635931.648	619801.344	17354437.63
March	77.66	91	610593.984		
	93.47	85	686443.68		
	131.7	114	1297192.32	864743.328	26807043.17
April	101.7	137.7	1209953.376		
	157.8	184	2508641.28		
	169.4	243	3556586.88	2425060.512	72751815.36
May	219.1	298	5641211.52		
	229	360	7122816		
	349.8	453	13690892.16	8818306.56	273367503.4
June	304.3	415	10910980.8		
	390.6	603	20349947.52		
	526.1	692	31454887.68	20905272	627158160
July	442.7	667	25512269.76		
	437.3	620	23425286.4		
	212.4	369	6771651.84	18569736	575661816
August	295.9	438	11197802.88		
	228.4	375	7400160		
	283.4	433	10602334.08	9733432.32	301736401.9
September	166	340	4876416		
	176.8	275	4200768		
	148.1	238	3045409.92	4040864.64	121225939.2
October	94.95	116	951626.88		
	166.4	97	1394565.12		
	143.9	108	1342759.68	1229650.56	38119167.36
November	122	89	938131.2		
	101.2	74	647032.32		
	93.75	69	558900	714687.84	21440635.2
December	92.89	72	577850.112		
	72.72	55	345565.44		
	79.55	43	295544.16	406319.904	12595917.02
					2090045585

Total suspened load in Kg	2090045585
Total Discharge metric ton	2090045.585
Total Area in Acres	2445601
Erosion Tone/per acres/yea	0.854614299

Table E-6b: Suspended Load of River Swat with Flood Events (2001-04)

Month	Average Discharge (M3/Sec)2001-04	Average SS Load (mg/l) 2001-04	Average daily SS (Kg) Load	Average Monthly SS Load (Kg)	SS Load per year (Kg)
January	30.87	49.00	130680.65	4051100.09	
	28.95	25.75	64407.96	1996646.76	
January	30.81	44.25	117783.23	3651280.25	
	28.82	31.75	79065.88	2451042.34	
January	29.86	37.69	97236.24	3014323.36	3037517.361
February	29.40	46.25	117482.40	3289507.20	
	46.78	77.50	313238.88	8770688.64	
February	46.43	37.00	148427.42	4155967.87	
	53.45	66.00	304774.27	8533679.62	
February	42.87	52.69	195138.59	5463880.47	6187460.832
March	74.43	47.00	302235.19	9369290.95	
	98.06	103.00	872611.06	27050942.74	
	81.28	112.33	788903.52	24456009.12	
	189.22	183.67	3002641.44	93081884.64	
	97.95	162.00	1370986.56	42500583.36	
March	42.87	52.69	195138.59	6049296.24	39291742.16
April	112.32	113.00	1096578.22	32897346.48	
	161.54	121.50	1695729.82	50871894.48	
	322.15	206.25	5740757.55	172222726.50	
	187.65	65.75	1065987.92	31979637.54	
	305.60	172.33	4550261.76	136507852.80	
April	210.89	131.46	2395356.02	71860680.65	84895891.56
May	261.69	102.00	2306199.60	71492187.60	
	256.70	257.50	5711005.98	177041185.38	
May	329.45	129.75	3693294.31	114492123.49	
	327.89	234.75	6650446.84	206163852.10	
	262.39	67.00	1518923.23	47086620.19	
May	294.77	174.61	4447079.90	137859476.96	123255193.8
June	373.64	3774.50	121849465.86	3655483975.80	
	368.82	4236.75	135009394.00	4050281820.06	
	395.47	357.50	12215354.58	366460637.40	
	505.66	847.25	37015525.58	1110465767.52	
June	473.18	5847.00	239043134.88	7171294046.40	2295673050
	253.33	91.50	2002686.12	62083269.72	
	411.30	2716.57	96537564.74	2992664506.92	
July	376.17	153.50	4988850.70	154654371.58	
	446.45	202.25	7801445.88	241844822.28	
	460.22	306.25	12177487.35	377502107.85	
	358.52	126.25	3910763.43	121233666.33	
	330.25	74.25	2118587.72	65676219.44	
July	545.45	224.25	10568202.84	327614288.04	
	335.60	268.75	7792515.90	241567992.90	
	277.60	193.00	4629035.52	143500101.12	
	294.50	249.00	6335755.20	196408411.20	
July	393.02	195.55	6640136.42	205844229.04	447704523.4
August	238.18	76.75	1579435.79	48962509.61	
	268.79	106.75	2479103.93	76852221.77	

Table E-6b: Suspended Load of River Swat with Flood Events (2001-04)

Month	Average Discharge (M3/Sec)2001-04	Average SS Load (mg/l) 2001-04	Average daily SS (Kg) Load	Average Monthly SS Load (Kg)	SS Load per year (Kg)
	271.60	1661.50	38988439.99	1208641639.75	
	269.92	1481.25	34544041.65	1070865291.15	
	371.88	1321.00	42443730.00	1315755630.00	
August	261.08	1517.50	34230065.40	1061132027.40	
	210.10	2156.00	39137091.84	1213249847.04	
	231.40	2850.50	56989932.48	1766687906.88	
	208.30	90.00	1619740.80	50211964.80	
August	261.28	1054.87	23813080.06	738205482.01	868039893.2
September	170.62	54.75	807089.02	24212670.66	
	104.01	179.75	1615239.25	48457177.56	
	110.86	120.75	1156554.13	34696623.78	
	112.36	193.25	1876010.71	56280321.18	
September	198.05	347.50	5946253.20	178387596.00	
	112.80	64.50	628611.84	18858355.20	
	98.89	28.50	243494.42	7304832.72	
	76.39	14.00	92395.30	2771858.88	
September	121.88	132.34	1393626.14	41808784.20	46371179.5
October	65.91	111.50	634950.58	19683467.86	
	160.12	111.50	1542532.03	47818492.99	
	72.77	975.75	6135071.06	190187202.80	
October	70.88	37.50	229635.00	7118685.00	
	89.89	38.50	298993.46	9268797.38	
October	88.21	299.68	2283919.79	70801513.50	54815329.21
November	79.57	131.25	902323.80	27069714.00	
	64.66	63.50	354764.34	10642930.20	
November	56.40	74.50	363019.43	10890582.84	
	55.69	58.25	280276.63	8408298.96	
	35.86	25.00	77457.60	2323728.00	
November	62.36	77.03	415034.92	12451047.50	11867050.8
December	47.68	26.75	110186.46	3415780.26	
	42.51	21.75	79889.49	2476574.19	
December	43.49	19.00	71397.29	2213315.93	
	44.46	32.50	124836.66	3869936.46	
	297.30	353.00	9067412.16	281089776.96	
December	55.53	41.40	198619.65	6157209.04	58613076.76
					3981138832
		Annual Load in Kg		3981138832	
		Annual Load in in M Ton		3981138.832	
		Total Area in Acres		2445601	
		Erosion per acre/year		1.627877496	

Table E.7:- Result of Heavy metals of Selected Soil Samples Collected Form River Swat Watershed, extracted with different Method of Extraction

SNo	Village	Metal	Fe (mg/Kg)		Mn (mg/Kg)		Zn (mg/Kg)		Cd (mg/Kg)		Cu (mg/Kg)		Mo (mg/Kg)	
		Method	Mean	STDEV	Mean	STDEV	Mean	STDEV	Mean	STDEV	Mean	STDEV	Mean	STDEV
		Aqua	11450.000	6.364	369.616	1.505	30.130	2.503	1.064	0.250	2.375	23.620	0.000	0.000
		NH_4CH_3OO	1.352	0.141	28.192	0.570	0.427	0.101	0.403	0.010	0.340	0.071	0.000	0.000
		Mehlich-3	214.789	1.164	200.368	2.741	9.555	3.784	1.938	0.378	1.961	1.941	0.000	0.000
1	Kalam	DTPA	523.201	6.181	198.200	0.190	0.000	0.000	0.134	0.020	0.127	0.604	0.000	0.000
		Aqua	10724.500	5.657	330.006	1.765	37.811	3.266	1.248	0.327	2.268	10.602	0.000	0.000
		NH_4CH_3OO	1.351	0.098	1.435	0.511	0.357	0.060	0.361	0.006	0.186	0.094	0.000	0.000
		Mehlich-3	173.298	3.554	288.832	6.734	10.363	3.837	4.762	0.384	3.801	0.806	0.000	0.000
2	Bahrain	DTPA	491.300	7.398	214.516	0.257	0.000	0.000	0.182	0.043	0.198	0.282	0.000	0.000
		Aqua	10925.000	5.657	279.559	1.475	28.181	1.034	1.043	0.103	2.414	18.889	0.000	0.000
		NH_4CH_3OO	1.361	0.397	12.662	0.567	0.436	0.227	0.401	0.023	0.262	0.090	0.000	0.000
		Mehlich-3	255.256	2.748	241.459	4.552	13.463	1.938	5.219	0.194	5.301	3.303	0.000	0.000
3	Main Dam	DTPA	342.100	4.243	164.200	0.147	0.000	0.000	0.104	0.010	0.372	0.351	0.000	0.000
		Aqua	11575.000	5.657	222.562	1.694	27.919	4.059	1.198	0.406	1.706	17.468	0.000	0.000
		NH_4CH_3OO	1.319	0.303	14.536	0.554	0.721	0.056	0.392	0.006	0.217	0.183	0.000	0.000
		Mehlich-3	183.758	3.316	85.482	2.803	9.626	2.073	1.982	0.207	1.633	5.219	0.563	0.217
4	Rodingar	DTPA	627.900	4.426	94.000	0.110	0.000	0.000	0.078	0.006	0.509	0.063	0.000	0.000
		Aqua	9425.000	4.243	251.919	2.674	31.543	2.370	1.891	0.237	2.196	8.119	0.000	0.000
		NH_4CH_3OO	0.128	0.018	0.284	0.146	0.197	0.105	0.399	0.010	0.210	0.285	0.000	0.000
		Mehlich-3	108.611	3.130	171.632	1.957	8.670	0.875	1.384	0.088	1.543	1.968	3.655	0.738
5	Barikot	DTPA	0.000	0.000	198.700	0.144	0.000	0.000	0.102	0.005	1.044	1.998	0.000	0.000
		Aqua Regia	10800.000	5.657	233.130	1.263	28.777	3.989	0.893	0.399	1.608	11.904	0.000	0.000
		NH4NO3	1.221	0.273	0.337	0.544	0.205	0.050	0.385	0.005	0.192	0.347	0.000	0.000
		Mehlich-3	88.051	3.272	172.096	2.638	8.781	3.585	1.865	0.358	1.784	2.743	8.023	1.281
6	Dedawar	DTPA	4.100	1.874	161.000	0.133	0.000	0.000	0.094	0.002	0.852	0.199	0.000	0.000
		Aqua Regia	9350.000	4.243	253.976	1.587	18.894	2.195	1.122	0.220	2.325	5.639	0.000	0.000
		NH_4CH_3OO	1.315	0.619	1.173	0.591	0.214	0.093	0.418	0.009	0.213	0.237	0.000	0.000
		Mehlich-3	117.002	3.289	198.590	2.934	9.594	1.632	2.075	0.163	2.020	1.719	0.000	0.000
7	Haibatatgram	DTPA	63.400	3.132	204.500	0.201	0.000	0.000	0.142	0.028	0.593	1.494	0.000	0.000
		Aqua Regia	10850.000	5.657	200.005	1.137	66.949	5.120	0.804	0.512	2.028	13.078	0.000	0.000
		NH_4CH_3OO	1.463	0.583	1.649	0.502	0.186	0.078	0.355	0.008	0.184	0.278	0.000	0.000
		Mehlich-3	21.672	3.114	73.724	7.248	8.565	1.948	5.125	0.195	2.905	0.399	0.000	0.000
8	Allahadand	DTPA	586.800	4.243	34.600	0.124	0.000	0.000	0.088	0.016	0.217	0.462	0.000	0.000
		Aqua Regia	8150.000	2.828	189.412	2.421	16.152	3.125	1.712	0.312	1.795	6.810	0.000	0.000
		NH_4CH_3OO	1.170	0.057	0.381	0.542	0.222	0.025	0.383	0.003	0.220	0.164	0.000	0.000
		Mehlich-3	43.675	1.735	161.976	1.179	3.216	0.497	0.834	0.050	1.223	0.663	4.719	1.030
9	Osakai	DTPA	5.258	1.601	112.700	0.096	0.000	0.000	0.068	0.028	0.597	0.309	0.000	0.000
		Aqua Regia	10325.000	2.828	245.953	1.455	25.729	2.162	1.029	0.216	1.739	8.606	0.000	0.000
		NH_4CH_3OO	1.298	0.303	0.389	0.508	1.747	1.280	0.359	0.128	0.180	0.304	0.000	0.000
		Mehlich-3	87.698	1.861	284.573	2.210	8.966	1.932	1.563	0.193	2.197	0.385	6.840	1.628
10	Matkanai	DTPA	50.800	0.464	274.800	0.167	0.000	0.000	0.118	0.010	0.096	0.512	0.000	0.000

Table E.8:- Residual Pesticides (mg/Kg) in Selected Soil Sample Collected From River Swat Watershed (2005)

S No.	Pesticides/Village	Kalam	Bahrain	Mian Dam	Shokhdara	Manglawar	Barikot	Par-ri	Thana	Allahadand	Totakan	Oosakai	Kamala	Rt time
1	**Dichlorvos**	0	0	47	80	30	123	143	159	84	105	115	30	3.45
2	**Lindane**	0	3.97	22	65	34	137	122	123	139	41	82	63	9.33
3	**Isoproturan**	0	0.83	0.34	76	32	123	113	126	85	67	108	43	10.082
4	**Diazinon**	24	32	12	137	48	172	135	142	152	49	113	64	10.13
5	**Heptachlor**	2.5	0.6	10	125	37	124	73	137	65	23	34	18	10.69
6	**Parathion-Methy**	12	34	32	122	91	76	63	45	128	47	33	45	10.98
7	**Malathion**	42	47	32	118	52	153	76	132	145	22	45	33	11.82
8	**Endosulfan**	0	0	0	12.04	0	6.24	8.32	0	12.63	0	0	0	12.9
9	**Dieldrin**	13	53	12	162	32	89	66	83	59	21	14	24	13.44
10	**2,4-DDT**	3.4	5	23	43	18	157	23	32	164	53	27	35	14.33
11	**Methidiathion**	38	32	55	34	26	216	113	125	182	12	31	23	16.08
12	**Cypermethrin**	43	56	34	165	34	125	184	47	28	26	32	37	19.04

Table E-9: Land capability classes of River Swat Watershed

Land Class		Production Potential	Area in hectares	%age Area	Remarks
I	Very Good Agriculture Land	Very high	23865	7.359	This includes area of Shoulgar and Jewardara, which is situated in the plain area and comparatively less susceptible to erosion. Major portion of this category is situated in Lower Dir area.
II	Good Agriculture Land	High for general agriculture	51440	15.862	This includes area of Shoulgar and Jewardara, which is situated in the plain area and comparatively less susceptible to erosion. Major portion of this category is situated in Lower Dir area.
III	Moderate Agriculture Land	Moderate for general crops	55339	17.064	This includes area of Shoulgar and Jewardara, which is situated in the plain area and comparatively less susceptible to erosion. Major portion of this category is situated in Lower Dir area.
IV	Poor (marginal) agriculture Land	Low for a few crops only	33729	10.401	This is the land from where cover has been removed and situated in the slope area and is sensitive to erosion. Found in upper Swat such is Kalam to Bahrain, Miandam, Northern part of Matta
V	Good forest or rangeland	High for forestry/rangeland development	110417	34.047	This category mainly occupies the Sulatan Valley situated in the North of Matta and Upper Swat including Kalam Bahrain, Madayan, Malam Jaba, and Miandam area.
VI	Moderate forest or rangeland	Moderate for forestry/ range development	18377	5.667	This category mainly occupies the Sulatan Valley situated in the North of Matta and Upper Swat including Kalam Bahrain, Madayan, Malam Jaba,, Miandam area and Middle Swat
VII	Poor forest or rangeland	Low for forestry/ range development	31139	9.602	The is the mountainous area, which was forest area, but now the forest has been cleared and appeared in the form of barren mountain surrounding the river Swat and contributing silt to the river on regular basis and is of no use. The main areas include Thana, Batkhala of Upper Malakand and Chakdara, Khairabad, Asbanr of lower Dir.
VIII	Non Agriculture land	Not suitable for any type of economic agriculture	NA	NA	This type of land was not quantified but it was observed that it is situated along the bank of river Swat and various other perennial and seasonal streams which is totally not fit for agriculture but is used for agriculture.
	Total		324306	100	

Table E-10: People's major occupation and income generating activities of 50 selected villages in River Swat Watershed

Serial No	Sample Ref No	Village Name	No of Respondents	Population	Work force	Agriculture	Govt jobs	foreign	Forestry	Hotling and	Fisheries	Shop keeping and
1	1	Kalam	10	94	38	14	7	6	3	4	1	3
2	6	Mankial	8	87	34	13	5	4	4	4	0	4
3	8	Bahrain	21	230	86	18	12	13	21	16	0	6
4	9	Satal	8	96	37	8	4	6	7	4	2	6
5	10	Madyan	18	175	71	21	9	11	9	12	4	5
6	12	Fatepur	18	160	62	19	8	6	8	12	2	7
7	13	Darmai	25	260	68	25	10	12	6	5	1	9
8	15	Bagh Dheri	21	236	95	34	16	22	8	8	1	6
9	17	Dursh Khela	22	230	92	34	14	26	6	4	0	8
10	19	Shokhdara	22	228	88	35	12	18	7	7	1	8
11	20	Wainai	18	114	45	17	5	9	10	0	0	4
12	22	Changialai	15	160	62	32	4	12	12	0	0	2
13	24	Roringar	15	174	66	24	6	16	14	0	0	6
14	28	Shairpalam	22	245	91	46	8	14	12	4	0	7
15	31	Bara & Kuza Bandai	25	280	102	52	12	19	5	6	0	8
16	35	Deolai	21	240	86	42	10	18	6	2	2	6
17	37	Tutano Banda	15	155	64	34	6	17	4	0	0	3
18	40	Kabbal	16	150	59	27	12	12	2	2	0	4
19	42	Surgalai	12	140	56	34	4	6	4	0	0	8
20	45	Dedawar	14	150	62	36	9	8	2	1	2	4
21	46	Tirang	12	184	72	38	8	12	4	1	3	6
22	49	Miandam	21	250	97	41	8	18	14	8	0	8
23	51	Kotanai	15	186	71	29	8	15	8	6	0	5
24	53	Khwazakhela	22	285	103	44	10	12	15	12	2	8
25	55	Dakorak	12	146	57	24	8	9	6	4	2	4
26	58	Manglaur	13	164	60	29	10	12	2	2	0	5
27	61	Takhtaband	21	268	97	39	15	16	5	6	4	12
28	62	Jambil	18	220	83	35	6	18	12	8	0	4
29	64	Gogdara	18	236	86	38	12	10	8	6	4	8
30	66	Ghaligai	21	270	99	42	13	14	6	10	4	10
31	68	Barikot	22	272	99	28	14	17	8	12	8	12
32	70	Kotah	20	257	93	30	8	25	8	6	8	8
33	73	Haibatgram	25	320	119	47	28	16	4	4	8	12
34	76	Allahadan	22	286	103	45	17	22	5	2	5	7
35	77	Batkhala	25	330	119	51	22	18	6	6	4	12
36	79	Rangmala	16	180	63	38	7	12	2	0	0	4
37	82	Matkanai	18	216	89	46	8	19	2	0	6	8
38	83	Bagh Raji	12	176	64	38	3	15	4	0	0	4
39	84	Makhband	16	180	62	32	5	16	7	0	0	2
40	86	Ramora	18	225	86	40	7	21	8	2	4	4
41	87	Chakdara	22	280	104	48	18	18	2	4	6	8
42	88	Shewa	24	325	84	39	12	21	3	1	0	8
43	90	Kitiarai	16	185	66	36	4	18	4	0	0	4
44	91	Khanpur	21	155	95	58	8	19	6	1	0	3
45	92	Khairabad	14	162	60	36	6	12	4	0	0	2
46	94	Usakai	14	162	62	36	4	10	6	2	0	4
47	95	Wuch	22	290	107	55	14	21	4	2	0	11
48	97	Badwan	14	170	64	27	5	16	4	0	8	4
49	99	Tiruna	18	215	81	42	6	18	3	0	8	4
50	100	Kamala	14	172	63	31	3	18	3	0	4	4
		Total	**892**	**10371**	**3872**	**1727**	**470**	**743**	**323**	**196**	**104**	**309**

Table E-11: Summary of Findings of Participatory Rural Appraisal (PRA) Survey

S No	Issues/ problem	Techniques used	Findings
1	Incident of pollution in River Swat	Semi Structured Interview	Pollution in the form of suspended solid was observed, which is high during the months from May to September. For the rest of the months suspended solids appeared ocasionaly, and were associated with rainfall and soil erosion.
2	Crops planted by the villagers	Diagrammatic Techniques	Rice, Wheat and maize are the major crops and were preferred by the villagers because of the daily requirements. Other crops being cultivated there are tobacco, fodder, and vegetables.
3	Income Generating Activities and Seasonal Birds	Seasonal Calendar	Sterling and wild ducks are the two major visiting appearing in the area during December-March. Sterling is more abundant in the months of December to March. Its pollution was noticed toward decreasing remarkable. Similarly wild ducks, visiting the area during the months of December
4	Income Generating Activities and Fisheries	Seasonal Calendar	Fishing is no more an income generating activity while people are hesitant to shift toward Aquaculture activities.
5	Income Generating Activities and Honey bee		Honeybee culture is a common practice, while natural honeybees are almost absent in the whole watershed. The decrease is associated with the use of pesticides.
6	Water sources and its uses as Drinking water	Matrix scooping	Three main water resources were identified, i.e. River, Spring and Dig-well. Majority of the people are using dig-well and water supply from tube well. People leaving in remote area are using spring water as a source of drinking water. River water is used, some time for drinking. Although no hesitation was observed when the water is not turbid. River Swat is not used for drinking when other water is available.
7	Water Resources and its uses (Irrigation)	Matrix Scooping	Three sources were identified as Canal from river Swat, tube well and spring water, available in different area. River Swat irrigates its entire stretch through canal and covering a width of 500 meters to 3 Km in the plain areas. Spring water is used in those areas where river water can not reach. Such as upper Swat, Matta, Tutano Banda and some art of Upper Malakand. Tube well is used in Lower Dir only, where, because of topography river swat water can not reach and sring water is not available through out the area. Some area enjoying spring water such as Khairabad and Khanipur etc. From quality point of view no reference as observed. Although because of expense people refer canal or spring water.

Table E.11 continued

S No	Issues/ problem	Techniques used	Findings
8	Change in agriculture in the last 20 years	Time line	Agriculture becomes more mechanized. People in the area are preferring horticulture especially peaches because of which in upper Malakand Citrus trees found toward decreasing and in middle Swat Apple trees were found toward decreasing. The concept of agro forestry was found toward increasing but only in shougar and Jewardara area where enough water is available. In Daman area agro forestry is not encouraging. Decrease has been occurring in the use of natural fertilizer.
9	Use of agro-chemicals	Time line	Use of Agrochemical found toward increasing especially Pesticides. A 10 time increase has been occur in the use of Pesticides which is because of Peaches, which need at least one spray per month from flowering till fruit. While in normal situation one spray after two moths is given. As the peach tree is sensitive and some time attacked by pest and extra spray is required. Similarly, fertilizer is also used in irregular manner. 25% farmers made over-use of fertilizer and 23 percent under use of fertilizer, while the remaining 52% uses reasonable amount of fertilizers.
10	Help from various organizations	Semi structure interview	The role of Agriculture people was not encouraging. Majority of the former even said that they have not seen these people even in their life. Some people although are benefiting from agriculture department. Some have visited agriculture office also but was called a bad experience.
11	Change in Forest Cover	Time line & Seasonal Calendar	Deforestation was observed characteristic feature of the area and majority of the people blamed forest department and people coming from out side. Almost 55% decrease in forest cover was observed in Malakand, 65% in Lower Dir and 35% in Swat in the last 30 years. Because of which majority of the mountains are barren or converted to agriculture field where accessible.
12	Recommendation by the People		The Government and some non governmental organizations are working in isolation. They are required to inform the people on time and joint hand with the people and work according to our requirements. The fisheries department is required to initiate aquaculture facilities in the area, especially encourage the people having land along the bank of river Swat.

Table E.12. N.W.F.P., 1981 1998 (Census, District Wise Area, Population, Density, and Growth.

Division/District	Area (000-mha)	Populaiton (1000)		Percent Change	Population Density		Growth Rate (%)
		1881	1998		1881	1998	
N.W.F.P	7452.2	11062.3	17737.6	60	148	238	2.82
PESHAWAR DIV.	400.1	2281.8	3915.9	72	570	979	3.23
Peshawar	125.7	1113.3	2019.1	81	886	1606	3.56
Nowshera	174.8	537.6	874.4	63	308	500	2.9
Charsadda	99.6	630.8	1022.4	62	633	1027	2.88
MARDAN DIVISION	317.5	1506.5	2486.9	65	474	783	2.99
Mardan	163.2	881.5	1460.1	66	540	895	3.01
Swabi	154.3	625.0	1026.8	64	405	666	2.96
KOHAT DIVISION	701.4	758.8	1308.0	72	108	186	3.25
Kohat	254.5	326.6	562.6	72	128	221	3.25
Hangu	109.7	182.5	314.5	72	166	287	3.25
Karak	337.2	249.7	430.8	73	74	128	3.26
HAZARA DIVISION	1706.4	2701.3	3505.6	30	158	205	1.54
Abbottabad	196.7	647.6	880.7	36	329	448	1.82
Haripur	172.5	479.0	692.2	45	278	401	2.19
Mansehra	457.9	770.2	1152.8	50	168	252	2.4
Battagram	130.1	339.1	307.3	-9	261	236	-0.58
Kohistan	749.2	465.2	472.6	2	62	63	0.09
BANNU DIVISION	439.1	711.8	1167.4	64	162	266	2.95
Bannu	122.7	423.0	677.3	60	345	552	2.81
Lakki	316.4	288.8	490.0	70	91	155	3.16
D.I.KHAN DIVISION	900.5	635.5	1091.2	72	71	121	3.23
D.I.Khan	732.6	494.4	853.0	73	67	116	3.26
Tank	167.9	141.1	238.2	69	84	142	3.13
MALAKAND DIVISION	2987.2	2466.8	4262.7	73	83	143	3.27
Malakand Agency	95.2	257.8	452.3	75	271	475	3.36
Chitral	1485	208.6	318.7	53	14	22	2.52
Upper Dir	369.9	362.6	575.9	59	98 *	156	2.76
Lower Dir	158.3	404.8	717.6	77	256	453	3.42
Buner	186.5	265.5	506.0	91	142	271	3.86
Swat	533.7	715.9	1257.6	76	134 *	236	3.37
Shangla	158.6	251.5	434.6	73	159	274	3.27
Source: NWFP Census Report 1998, Censis Organization, Islamabad							

Table E.13:- House Hold Size and Age pattern of 64 Villages Selected from River Swat Villages

Serial No	Sample Ref No	Village Name	No of Responde	House hold siize				Total Population			Age Pateren			
				>5	6 - 8	9 - 11	12 <	Male	Female	Total	>5	6 - 20	21 - 50	50 <
1	1	Kalam	10	2	2	4	2	48	46	94	18	22	42	12
2	6	Mankial	8	0	2	4	2	45	42	87	18	15	39	15
3	8	Bahrain	21	3	8	7	3	118	112	230	58	53	85	34
4	9	Satal	8	0	2	3	3	49	47	96	22	20	43	11
5	10	Madyan	18	3	5	6	4	92	83	175	32	45	74	24
6	12	Fatepur	18	4	4	7	3	79	81	160	35	40	66	19
7	13	Darmai	25	2	6	10	7	132	128	260	43	47	68	22
8	15	Bagh Dhe	21	3	4	10	4	118	118	236	45	52	97	42
9	17	Dursh Kh	22	4	3	9	6	116	114	230	46	52	94	38
10	19	Shokhdara	22	5	4	10	3	115	113	228	52	52	88	36
11	20	Wainai	18	3	3	8	4	58	56	114	23	21	49	21
12	22	Changiala	15	2	4	6	3	81	79	160	36	48	56	20
13	24	Roringar	15	3	3	5	4	87	87	174	42	52	62	18
14	28	Shairpalai	22	3	4	10	5	123	122	245	63	67	77	38
15	31	Bara & K	25	4	5	12	4	142	138	280	75	83	82	40
16	35	Deolai	21	2	4	12	3	120	120	240	68	82	64	26
17	37	Tutano Ba	15	0	3	8	4	78	77	155	27	36	58	34
18	40	Kabbal	16	1	4	9	2	75	75	150	32	34	62	22
19	42	Surgalai	12	0	1	10	1	70	70	140	27	25	64	24
20	45	Dedawar	14	1	4	7	2	76	74	150	25	30	68	27
21	46	Tirang	12	0	2	8	2	93	91	184	40	45	74	25
22	49	Miandam	21	1	5	7	8	148	115	263	58	92	97	16
23	51	Kotanai	18	0	11	3	4	105	91	196	31	73	77	15
24	53	Khwazakl	22	3	6	7	6	111	101	212	47	73	74	18
25	55	Dakorak	12	1	2	6	3	77	69	146	20	45	43	12
26	58	Manglaur	13	2	9	0	2	47	46	93	20	33	34	6
27	61	Takhtabar	21	3	4	10	4	123	85	208	29	92	66	21
28	62	Jambil	18	0	4	8	6	110	110	220	54	52	72	42
29	64	Gogdara	18	2	4	8	4	123	113	236	28	82	88	10
30	66	Ghaligai	21	2	4	9	6	132	138	270	32	63	50	17
31	68	Barikot	22	3	5	8	6	137	135	272	74	72	81	45
32	70	Kotah	20	2	3	11	4	129	128	257	71	67	77	42
33	73	Haibatgra	25	5	7	9	4	158	162	320	81	89	98	52
34	76	Allahadan	22	2	5	10	5	142	144	286	80	88	70	48
35	77	Batkhala	25	4	5	12	4	166	164	330	91	95	86	58
36	79	Rangmala	16	1	3	7	5	91	89	180	54	52	42	32
37	82	Matkanai	18	2	4	8	4	108	108	216	61	65	53	37
38	83	Bagh Raji	12	0	3	7	2	89	87	176	48	58	48	22
39	84	Makhban	16	3	5	8	0	90	90	180	55	54	39	32
40	86	Ramora	18	2	4	8	4	112	113	225	53	54	80	38
41	87	Chakdara	22	4	7	9	2	138	142	280	72	67	95	46
42	88	Shewa	24	3	8	9	4	162	163	325	56	64	58	47
43	90	Kitiarai	16	1	6	7	2	92	93	185	52	53	48	32
44	91	Khanpur	21	2	5	9	5	78	77	155	75	72	74	44
45	92	Khairabad	14	1	2	9	2	80	82	162	44	45	48	28
46	94	Usakai	14	2	2	8	2	81	81	162	47	46	42	30
47	95	Wuch	22	3	6	9	4	146	144	290	75	76	86	53
48	97	Badwan	14	1	3	7	3	85	85	170	42	44	54	30
49	99	Tiruna	18	2	4	8	4	108	107	215	53	54	67	41
50	100	Kamala	14	0	3	8	3	85	87	172	45	44	51	32
		Total	**895**	**102**	**216**	**394**	**183**	**5168**	**5022**	**10190**	**2375**	**2785**	**3310**	**1494**

Pic-F.1 Malakand Pass, en Entrance to River Swat Watershed. Picture taken from Dargai situated west side of Malakand

Pic-F.2 Malakand Head Quarter with a lush green forest, a pleasant Entrance to River Swat Watershed. Picture taken from East Side Looking toward Malakjand from Piran Side. Big Stones are of Malakand Granite, a Rich Source of Potassium (K)

Pic. F.3:- Burned Forest. In Barikote. For This Fir Forest Department Local People Blaming Each Other. Anyhow it was Not an Accident, But Appeared as a Result of Conflict Between Local People and Forest Department. Picture Taken From karakar Pass Joining District Bunair with District Swat. This is the 3rd main Entrance to River Swat
Watershed.

Pic. F.4:- Fuel Wood a Routine Business. Picture Taken in Village Katkala, District Dir, When Coming From Talash to Chakdara. It is the 3rd main entrance to River Swat Watershed.

Pic. F.5:- Control Forest Become Wild and Destroy every Thing in the Mountain of Malakand.This Fir was Started on 10 June, 2006 and Was Continued Till 16 June. Picture Taken From Malakand Pass Looking Toward South.

Pic. F.6:- Mining for Building Stone in Ghalagai Village. Where the Mountain is already cleared from Forest. In this Way Erosion is Accelerated further. Picture taken when Looking Toward South. On the back Side is River Swat.

Pic. F.7:- Mining For Building Material Near Bagh Dahari, Matta Area. Pic Taken Looking Toward North From Main Road Matta. On the Back Side is River Swat.

Pic. F.8:- Agriculture in the Flood Plain of River Swat Near Chakdara, Which need to be Replaced with Planting Tree and Production of Pulses. Picture Taken From Chartchal Picket, Looking Toward South

Pic. F.9. Another View From Charchal Picket Looking Toward South With a Slight Different Angle, Where the Agriculture Field is Surrounded By River Swat

Pic. F.10:- A closed View of Pic. 15. Agriculture Field Situated Between Different Streamlet of River Swat Recently Rice Crop is Harvested Rice, Almost degraded next Standing crop is Onion

Pic. F.11:- Soil Erosion in Village Allahadand, Where Mountains were Completely Cleared in the Last 30 Years.. 30 Years Before this Seasonal Stream was Just 25-30 feet wide, now it is more than 300 feet wide. While Further Increase may Occur. Picture Taken At Allahadand Looking Toward North.

Pic. F.12:- Picture Taken in Gunyar Village Situated in the South-West of Thana Village. Free Grazing is here Also, Where Each Sapling is Protected by Erecting Protection Wall.

Pic. F.13:- Forest and Agriculture in More-Pandi Village Near Madyan Where River Swat is Still within limits, Forest is toward decline. Picture Taken From the Northern Side Look Toward West.

Pic. F.14:- Soil slope reduction in Sulatanr Valley, Where Because of Deforestation, Soil Erosion is Toward Increasing. As The Area is Mountainous, and Limited Area is Available for Agriculture. .Picture Taken at Manadal Village, Looking Toward North.

Pic. F. 15:- A View of Sulatan Valley, Where most of The Mountainous (Forest) Area Has Been Converted to Agriculture Land. Haraonai Khwar is Emerging here. Picture Taken From Chagnglali Village, Looking Toward North.

Pic. F. 16:- Darmai Village, Toward Aforestation. Picture Taken From Jaray Village, On the Way Toward Bahrain, Looking Toward North from Main GT-Road

Pic. F. 17:- Meeting with the Former in the Field, weeding even after the use of Pesticides. The Farmer blamed the dealer for adulteration. Because of which more Pesticides are required. This is loss of money and time and also contaminating soil. Picture taken in the foots hills of Chakdara South Side

Pic.F. 18:- Meeting with a Farmer in The Field. The person With a White Cap is Affected Twice with Pesticides. People are Using Pesticide With Out Any Safety Measure. Picture Taken in Allahadand Village Looking Toward Chakdara in the North

Pic. F.19:- Plants Residue is a Major Sources of Soil Organics. In Plant Residue decompose is slow and needed Organic Manure as supplement. Picture Taken In Batkhalah Shoulgari Land.

Pic. F.20:- Spraying Pesticides With Out Adopting Any Protective Measures, Even Feeling Headache For an Hour or Two After Spay.

Pic. F.21:- An Interview With a Farmer In Onion Field. The Farmer Used Ripcord and Cypermethrin Pesticides. Total 26 Bottle (13of Ripcord & Cypermethrin) each of 250 ml were used for a total of 17700 Kg Onion was used. In this way About 2 ml per kg was used. While Half Kg Herbicide" Rodamill Gold" Was Also used. Picture Taken in the Foof Hill of Chakdara toward Allahadand Village.

Pic. F.22:- Vegetation is visible on Part of the Mountain which is given to an individual (1), While above that is community Property and is Barran (2). Another Field next to that is also ready to be Green(3). Picture taken at Nal Village A Minor Entrance to River Swat Watershed From South (Shakot Pass).

Pic. F.23:- Sterling is one of the Migratory Bride Visiting The River Swat Watershed in Winter.

Pic.F.24:- Sterling the Most Affected Bird, Because of Hunting and Heavy Use Pesticides, Its Population Is Toward decrease. Picture Taken After Tracing a Hunter in the Plain Area of Thana and Allahadand Village

Pic. F. 25:- Honey Bee Keeping, A wide Use Business, But Pesticides is an Hazard, Therefore The People Trying to Keep it Away From Such Activities. To Keep Bee Survive, Sugar has been feed, destroying Honey Quality. While Natural Honey is almost Absent from the Area. Picture Taken in Mankyal Looking Toward South.

Pic. 26:- Cleaning Irrigation Canal, An Example of Collective Work, Called Hasher in Pusto. This Canal is About 25 Km long, Each Segment Has Been Given to Differentn People And Will take Only One Day to Clean it and Make Water Available to Agriculture Field. Pic Taken In Dheri Village Near Thana, Looking Toward South.

Pic. F.27:- Sargali Village, Where Mountains are Divided and is converted to Personal Property. Where People are Planting Trees. Picture Taken On the Way From Sargali village Toward Dahdarah.

Pic. F.28:- Farmers Busy in The Field, In the Back Ground Kala Kot Village is Visible Along With Deforested Mountains Taken Near Chashma Hotal, On The Way From Saray Down Ward

Pic. F.29:- A Good Example of Agro Forestry, Where the former enjoyed crop for 10 years along With Fruits On Regular Basis and the Soil is Covered Also to Avoid Soil erosion.

Pic. F.30:- Un-Scientific Way Agro Forestry, Where the former enjoyed crop for 4 years only While the Tree Growth was Found Slow When Compared With The Surrounding Trees

Pic. F.31:- A Lush green Forest at Malam Jaba. Picture Taken At Kishwara Village When Going Toward Malam-Jaba. Here Tree Cutting is Strictly Prohibited and Greenry is Toward Increasing. But The Farmers are Trying To Acquire Agriculture Land at the Cost of Forest.

Pic. F.32:- Aforestation in Allahadand Village, A Good step of by Forest Department. The Part of Mountain Was Banned For 5 Years With the Help of Local People And was Opened After 5 Years For Open Grazing and Cutting, Which is Again Toward Decline.

Pic. F.33:- Terracing in Nal Village Where 100% land is Rain fed and More than 50% Agriculture Land is Mountainous. Picture Taken In Nal Village Looking Toward West

Pic. F.34 Terracing in Barikot. Picture Taken on the Way at The Toward Karakar Pass, looking Toward West From the Main Road.

Pic. F.35:- Ghalaygai Stupa An Historical Monument of Past. In The Background Scattered Vegetations is Visible With Shining Mountain Consist of Mica Schist. Picture Taken From the Main Peshawar-Mingora GT Road, Looking Toward South

Pic F.36:- 30 Years Agro Agriculture was Started in the Foothills in Malakand Area, with out Adopting Conservation Measures. Because of Which lost its Clay Contents and Now Barren for the Last 10 Years. Picture Taken in Village Dheri Allahadand, Looking Toward West of Allahadand Village.

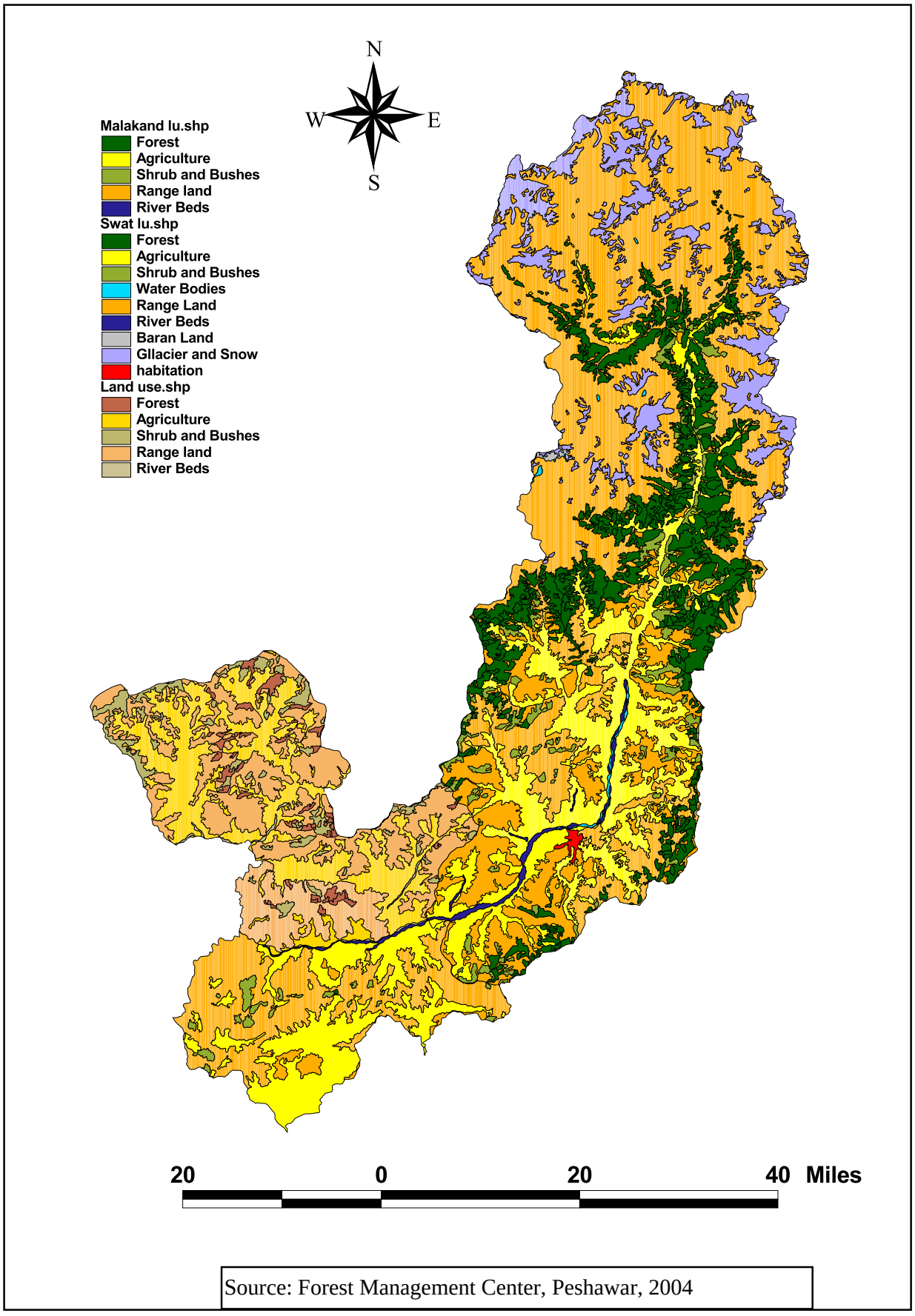
Pic. F. 37:- Charchal Packet Near Chaskdara Under Dir Scout With Limited Vegetation. The Mountain Consist on Genesis. Picture Taken When Looking Toward North of GT-Road Near Chakdara Bridge.

Pic. F. 38:- Pea Crop but the former is unaware of the role of Pea in soil fertility. Therefore, It is Required to Encourage Crop Rotation. Picture Taken At Amanadara, Batkhala, Looking Toward South Near GT-Road, At Amandara

Pic F.39:- Fish Pond Established in 12 Years for Near Thana Village. Picture Taken in Fisheries Office Situated Opposite of Chakdara Fishing Hut.

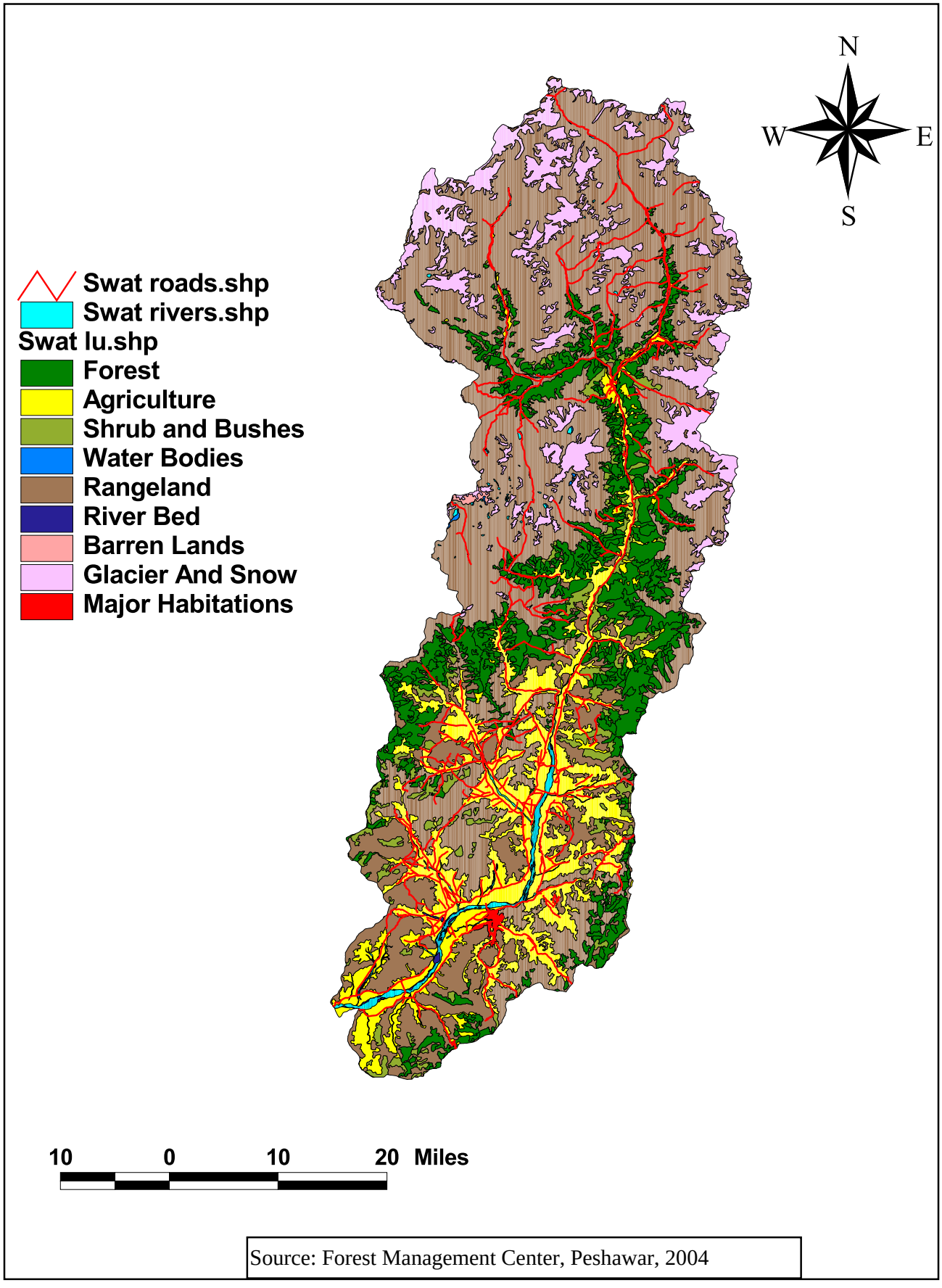
Pic. F. 40:- Fish Pond Under Construction, Which Will Receive Mashair Fish (One of the Endanger Specices of Malakand Division) From Pond Shown in Picture 67. After the Construction of these Ponds it is hoped that Aquaculture will start in Dir, Swat and Malakand Still a Long Way to go. Picture Taken in Fisheries Office Situated Opposite of Chakdara Fishing Hut.

Map G.1:- Land Use of River Swat Watershed



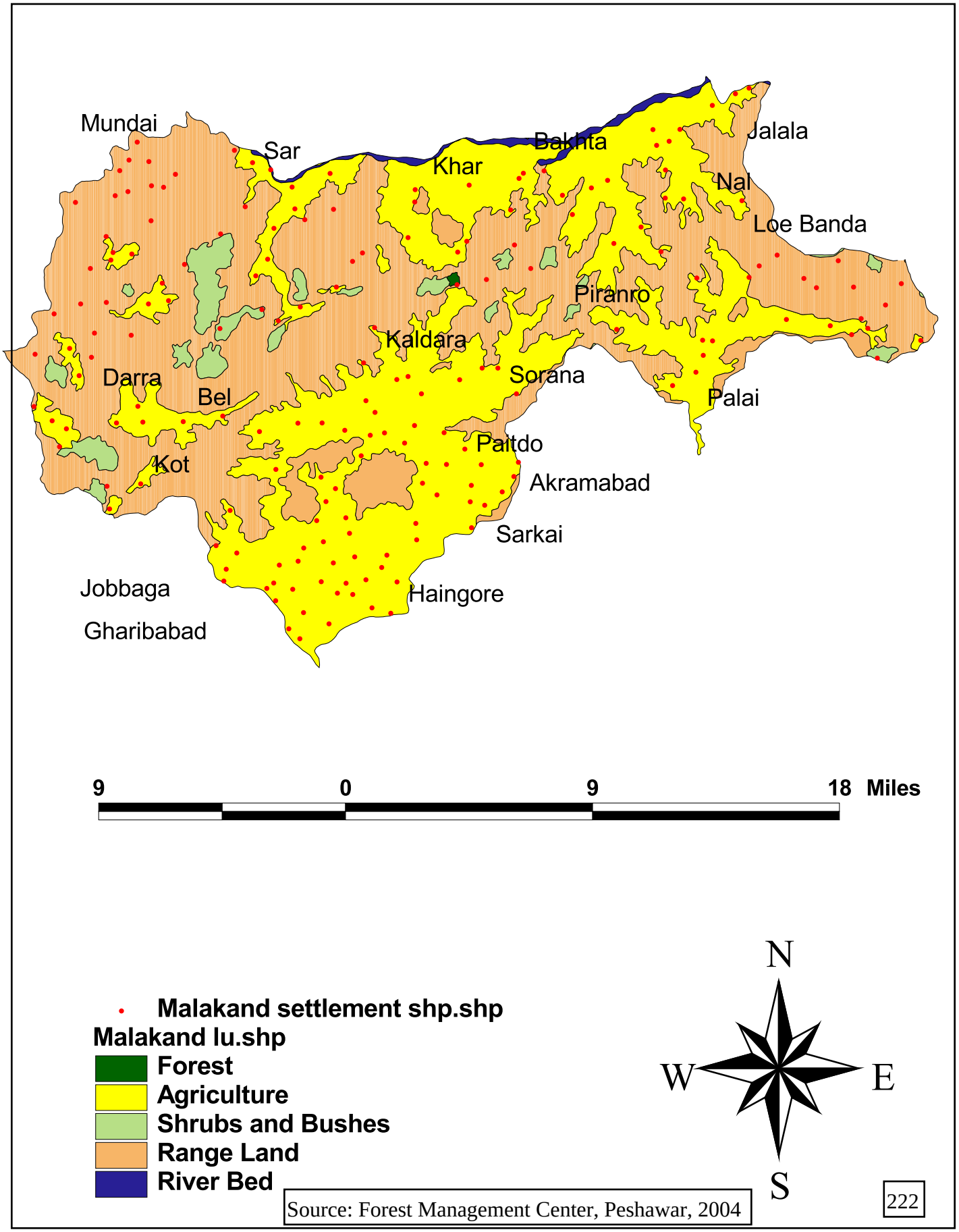
Source: Forest Management Center, Peshawar, 2004

Map G.2:- Land Use of Distriuct Swat



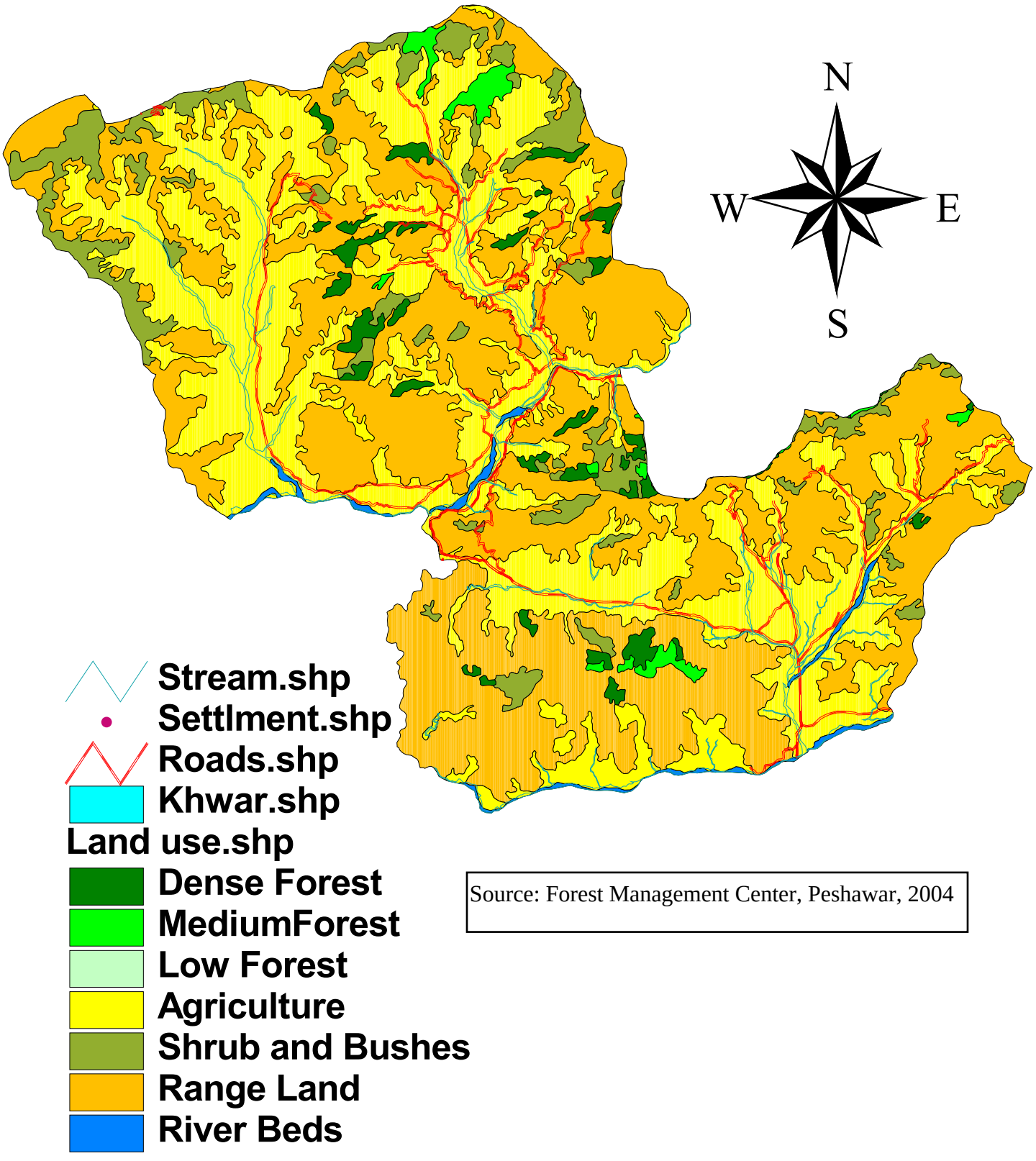
Source: Forest Management Center, Peshawar, 2004

Map G.3:- Land Use of District Dir Lower

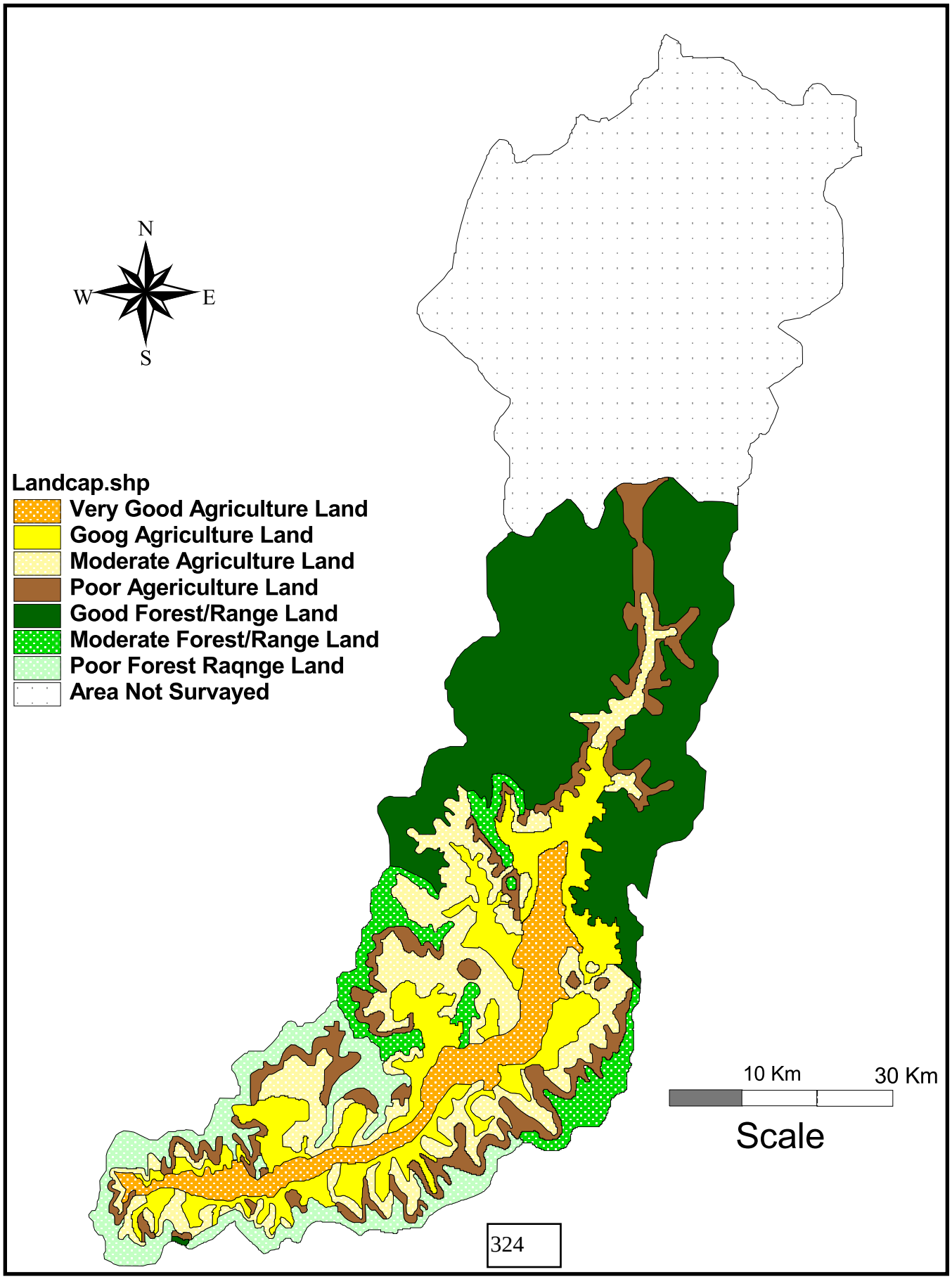


Source: Forest Management Center, Peshawar, 2004

Map G.4:- Land Use of District Dir Lower



Map G5:-Land Caspability MClasses of RIver Swat Watershed



Questionnaire schedule for field visit

Appendix A

Date: / / 2oo

1. **Village** _____

2. **Respondent** _____

3. **Household size**

S.NO	Male	Female	Total	Age Pattern				Major Occupation of other family members				
				>5	5-20	21-50	51<	Far	G	H	For	O
1												
2												
3												

Far: Farmer G: Govt. Job, H: Hostelling, For: Forestry, O; Other

5. Major Soil Division and its uses

S.NO	Name of land type	Irrigation Sources	Main crops
1	Irrigated		
2	Semi-irrigated		
3	Rain-fed		

6. Agro-chemicals

Fertilizer			Pesticides	Crop
S.NO	Type an name	Crops	Type	
1	Urea		Insecticides	
2	DAP		Herbicides	
3	NPK		Fungicides	
4	Other		Other	
Help from Agriculture Department				

7.Main threats to the land

a. ----------
b. ----------
c. ----------
---
d. ----------

8. Forest associated problem

S.NO	Type	Approximate Size	Associated problems
1	Mountains		
2	Farm Forest		
3	Horticulture Agro-forest		

9. Techniques of indigenous nature, which are in use for, soil protection

S.NO	
1	
2	
3	

10. Social code of conduct

S.NO	Use in soil related activities
1	
2	
3 4 5	

11. Fisheries and wild life

S.NO	Name	Associated problem
1		
2		
3 4 5		

11. Any other comments