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**A survey of land, vegetation and irrigation systems in
North Afghanistan and neighboring Tajikistan**

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This paper describes the results of a field expedition work along the rivers Vakhsh and Pyandzh in Tajikistan and Afghanistan within the framework of a Joint Research Project: *Investigation of natural resources of Central Asia and reconstruction of agriculture in Afghanistan*, supported by the Ministry of Education and Culture in Japan and represented by professor Tsuneo Tsukatani, Department of Natural Resources and the Environment, Kyoto Institute of Economics, Kyoto University, Japan; also supported by a Grant in Aid for Scientific Research, The Ministry of Education and Culture of Japan, 2003 (Monbusho International Scientific Joint Research Program, No. 15252002), represented again by professor Tsuneo Tsukatani. The field expedition was carried out in September 2003 according to the Joint Project Research Program to study the natural resources and the contemporary state of irrigation systems in the Pyandzh River basin.

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A survey of land, vegetation and irrigation systems in North Afghanistan and neighboring Tajikistan

By
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Summary

The purpose of this paper is to discuss the results of a field expedition along the riparian basin of Amu-Darya river from near its origin at Pyandzh in Tajikistan, and through north Afghanistan where it reaches the land near Mazar Sharif. The peculiarities of the land, its cover vegetation and existing irrigation systems, and methods of land and/or water use through this vast area are described. Also by performing this survey, we could further examine our preliminary studies on the potentials for agriculture using Subsurface Drip Irrigation (SDI) technique on the left bank of Amu-Darya River. We also interviewed many of the local farmers, pastoralist communities, and some of the agricultural authorities and governmental leaders to help understand the history of their irrigation infrastructures, their concerns on the issue of land use and agricultural activities, and their outlook and desires for the future. We hope that our collaborative research having involved Uzbek, Tajik, and Japanese researchers, can efficiently use the data collected in expeditions like this to complement the required information and make the necessary recommendations for establishment of a sustainable agricultural development in the region and assist with the ongoing processes to revive Afghanistan and its neighboring states of Central Asia.

Keywords:

Agriculture, Desertification, Environmental policy, Farming system, Irrigation system, North Afghanistan, Pyandzh River, Rangelands improvement, Subsurface Drip Irrigation (SDI), Water quality.

Introduction

In Central Asia, there is a rich supply of water resources in the valleys of Amu-Darya, Zerafshan and Syr-Darya Rivers. Unfortunately a long history of human interventions has led to the partial degradation of this land due to careless use of water resources.

At the beginning of the 21st Century, a new stage has started that may help regenerate this area with less energy and power but through the help of new

technologies. We undertook this expedition and organized an international joint research team with such a hope.

The main objectives of this survey were:

- To study the landscape and physiographic features of the arid/semiarid north Afghanistan region;
- To provide a geo-botanical description of the cover vegetation and species diversity both on the virgin territories and irrigated lands;
- To analyze the water quality (of drinking, irrigation and collector-drainage water) on the territories of both Afghanistan (North-West; Kunduz province) and Tajikistan (Kumsangir district);
- To evaluate the situation of irrigation networks and technologies currently used for agriculture in the region;
- To determine the optimum locations for introduction of SDI (subsurface drip irrigation) technology for crops cultivation;
- To make practical recommendations for revitalization and improvement of degraded desert ecosystems, as well as rangelands improvement and reconstruction of the farming and irrigation systems.

The main participants of the expedition were the following people:

Munimjan Abbdusamatov, Dr.; Chief of Specialized Inspection of the State Control on Water Use and Preservation of Water Resources, the Ministry of Nature Protection, the Republic of Tajikistan; also an academician and a member of the Engineering Academy of the Republic of Tajikistan

Kristina Toderich, Dr.; Department of Desert Ecology and Water Resources Research, Samarkand Division of the Academy of Sciences, the Republic of Uzbekistan

Abdulatif Rahimulloi; Third Secretary of the Embassy of Afghanistan in the Republic of Tajikistan

Marziya Nasredinshoeva; Deputy Director of the Tajik Branch of the Regional Center of Ecology of Central Asia

Timur Khujanazarov, MSc ; Tashkent State Technical University

The following individuals also became involved in the field expedition work and played a role in some way or another in its completion:

A- The Afghan side:

Shah Mohamad Mohagig; North and Northeast land use manager, ICARDA (Kunduz office)

Mamadislom; Deputy chief, the Department of Plant Production in Kunduz province

Davronshoh; Chief, the Department of Mechanization and Management of Agriculture

Lutfiddin; Head, the Department of Hydrology and Management of Water Resources
 Abdusator; Head, the Department of Agriculture in Kunduz province
 Said Azam; Manager, the Department of Agriculture

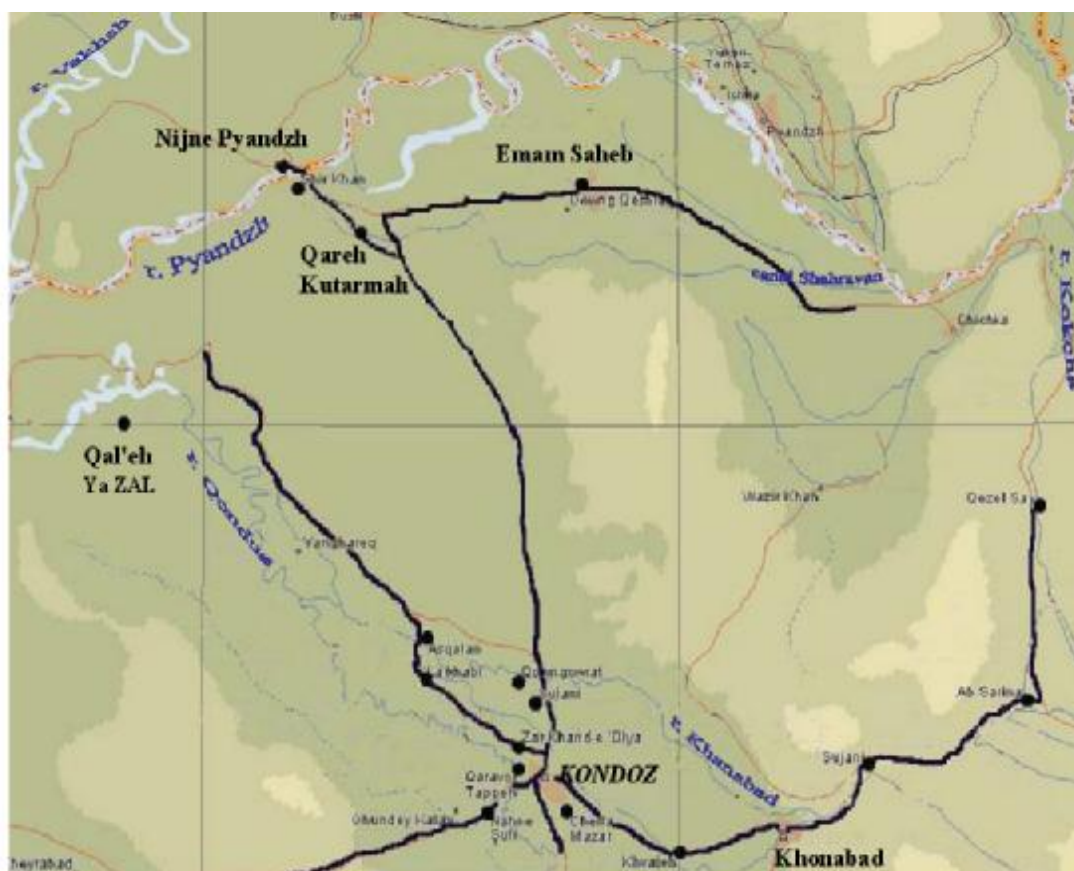
B- The Tajik side:

Musayabsho Nazriev; Chairman of Kusangir district
 Nuriddin Sadridinov; Chief, the Department for Reconstruction and Management of Irrigation Systems in Kumsangir district.
 Zainullo Kadirov; Chief Engineer, the Department for Reconstruction and Management of Irrigation Systems in Kumsangir district

The Route of expedition (Fig. 1):

Khudjent – Dushanbe – Kumsangir – Nijne Pyandz – Qarokutermah – Imam-Soheb – Kunduz – Khonabad – Kholm (Afghanistan). The time period we did this expedition was from 20.09.2003 till 28.09.2003.

Fig.1 This map shows the path of the fieldwork expedition through North Afghanistan.



Results:

1- Floodplain and desert ecosystems

The left bank of Pyandzh River (on its upper reaches) in the territory of Afghanistan is characterized by a typical floodplain landscape. The whole Pyandzh delta on the Tajik-Afghan boundary is strongly affected by aeolian erosion, which has added neogenic sand, deposits to the Shirmohi and Ayraton deserts. The soils are deep alluvial with low salinity and a considerable amount of silt.

The site looks like a large band along the river where the riparian forest ecosystem fragments have been maintained in a reasonably pristine state. This ecosystem however has been drastically altered by human activity. Dense vegetation and high animal diversity is found in regularly flooded areas of the Pyandzh river basin. In places where the water table reaches the soil surface, resistant annual and perennial grasses like *Phragmites australis*, *Erianthus*, *Typha*, *Scirpus* and *Arundo* grow. Here, depending on the frequency of inundation, tugai vegetation includes the rare *Tamarix* trees, *Salix* spp., *Hippophae rhamnoides*, *Lonicera*, *Berberis*, *Clematis* and a plant community with dominant xero-halophytes (e.g. *Karelinia*, *Limonium*, *Lycium*, *Nitraria*, *Equisetum*, *Capparis*, *Alhagi*, *Glycyrrhiza*, *Zygophyllum*) that are associated with the halophytes (*Suaeda*, *Aeluropus*, *Climacoptera*, *Halostachys*, *Halocnemum*). It is difficult to estimate the pastoral and fodder value of this vegetation, but generally it is poor.

Along the banks of Pyandzh and Kokcha rivers on well-drained areas with deep soils, many of the wild ancestors of cultivated fruit trees occur. These include the apple *Pomus* spp., pear *Pyrus* spp. and almond *Amygdalis* spp. *Fraxinus* spp., *Acer* spp., and *Plantanus* spp. is also found here. Along dry riverbeds there are frequent thorny belts of *Stocksia brahuica*, *Amygdalis communis* and *Convolvulus spinosus*. The floristic characteristics of the region are very variable and depend on humidity, the length of winter, sand composition, wind force and grazing pressure. More humid places have some denser vegetation with richer species in their composition (Fig. 2, 3).

Fig. 2. Floodplain area at the left bank of Pyandzh (Afghan side)



Fig. 3. Scarce vegetation at the Pyandzh River banks (Afghan-Tajik boundary, (Nijniy-Pyandzh frontier-guard post)



The semi-desert plains on a distance of more than 10 km from the dry riverbanks occupy isolated, small sites that are more and less suitable for crops cultivation. Most of hydromorphic soils in this region have reduced sandy-loamy, rarely sandy clayey texture; and an uneven profile distribution of sand particles has evolved from alluvial, colluvial or eolian loessic deposits that not much on the parent rock. In these conditions, the soils are heavier with a higher content of fine silt and clay particles originating from alluvial deposits. In some irrigated lands, especially around small settlements, the profile distribution of silt and clay particles is uniform. Upper quaternary alluvial and contemporary of loamy, rarely sandy loam deposits compose the basic soil cover of riverbanks in Korakuturma region. This region, however, is strongly affected by strong hot dry dusty winds called “Afghanet” that possibly originate from the open sandy desert immediately located at the left side of Pyandzh River. There is no doubt that such dry/dusty winds occurring usually on 70-90 days per year can induce various respiratory diseases and allergies among local people. However the physicochemical characteristics of soils should be studied for the purpose of agricultural development because irrigation water is mainly possible from the Pyandzh River.

It was noted that each separate area takes its name from a main settlement. The territory between Nijne-Pyandzh (left side) and Qorakutermah settlement (Dashti Archi region) was the prime target for crops development by private farmers or co-operatives for about 4-5 years, till the war started. The reclamation and agriculture development (cultivation of various crops under irrigation) of this plainly semi-desert areas during 1990’s was directed by Rahim Pavlon (army commander) by using manual labor and through the construction of three small water resources and the using of water-pumping stations installed on the river banks of the Pyandzh river (Fig. 4). The height of water rise at the location of the former water-pump station

does not exceed 6-7m. Some water could get through the two failing canals from the riverbank, where water used to flow (the result of natural sedimentation). The irrigation of 4-5 thousand ha of virgin lands was accomplished in this way. As can be seen in Fig. 5, water in the vicinity of Qarakutermah site used to flow from the main canal with a length of 400 m.



Fig. 4. Remains of pumping (small water pools in Pyandzh' floodplain)



Fig. 5. The main water canal in Korakuturma (partially destroyed)

It was further distributed through the left and dextral networks of shallow ground canals that can still be differentiated (Fig.6, 7).



Fig. 6. Farming irrigated lands on the dry river bank of Pyandzh



Fig. 7. Network of ground canals in the Pyandzh floodplain near Qarakutermah

These canals form a network from which water flows by its own accord (flooding control) into more distant plots. The water pumping station currently is completely destroyed, and the main canal is in ruins. However, the distributive network has been kept almost intact. This system used to provide sprinkling and potable water for more than 450 local families with their children, who now have to look for a way of

survival and to live under extremely harsh conditions. This is mostly because of a lack of financial resources to repair the water usage system from the river Pyandzh and to spend on reconstruction of the main canal. In our opinion, they can basically start with a small investment for reconstruction of the former water intake system, the main canal and the already existing distributive canals. Some areas with a certain population living in them are ready for reconstruction of the abovementioned system by using the distributive network of canals, electricity, human reserves and gathered funds (Fig. 8, 9). Thus, cost of reconstruction of the system will not be a high figure and it can help prevent from migration of the population.

Fig. 8. Cultivation of crops by using artesian underground water (the route of destroyed Qorakutermah canal is shown)



Fig. 9. Small plots after harvesting



Fig. 10. Household farming in Qorakutermah settlement



Fig.11. Former experimental station near Qorakutermah that before war belonged to the Water and Agriculture Kunduz Division (not functioning today).



Under the created situation in this arid/semiarid zone (Qorakutermah, Dashti-Archistepes), underground and artesian (natural springs) water in some places represent the only available source of water for agricultural development.

The aboriginal population is compelled to utilize underground water resources by construction of wells with a depth of 12-20m mainly intended for drinking water (Fig.12, 13).

Wells are mostly built with manual labor, but in some sites of Kunduz province there are many local cooperatives that engage in manufacturing separate parts to help

construct a mechanical design of wells. Most of them work under financial support of different International Agencies, such as US agency for International Development (USAID) and the Canadian-based International Development Research Center.

Fig. 12, & 13. Different types of wells widely popular in Kunduz province, used for drinking purpose



In very exceptional cases local people attempt to use underground water both for drinking and irrigation purposes by constructing an autonomous system of underground man-made waterways or wells that collect subsurface waters,

equivalent of 'Kariz' in China, 'Kanat' in Iran and the Middle East, or 'Foggara' in North Africa (Fig. 14, 15).

Fig. 14, & 15. A scheme of the built of subsoil water reservoirs (only a few families manage it for their private use)



As seen on Fig.16 and 17, water from such subsoil reservoirs is distributed by means of pipes. We found the quality of such water to be very high; its mineralization exceeds 0.5-2.0 g/l. A peculiarity of underground water formation in Pyandzh river valley (on Afghanistan side) is its unique mechanism of natural drainage from all adjoining territories. The rocks containing the water possess high filtration ability and as a result, the reserves of fresh water are increasing, which basically are pressure less waters. Underground water is an attractive method with many having a great interest both for water supply and irrigation in the flood plain of upper stream of Amu-Darya Basin. The interactions of underground water with surface waters as well as the formation, distribution and use of underground waters in Archi and Kunduz provinces, however, still has not been studied enough. There is no doubt that

this type of water reserves could be an additional source for land reclamation and agricultural development of plain desert zones in all riparian countries.

Fig. 16 & 17. Construction and distribution of surface pipes through which underground water is directed to cropping fields



Shirmohi sandy desert, limited by Obdon dry steppe on the southeast side, occupies an area of 23050 ha and extends as a narrow belt to the northeast to the Ayraton and other connecting links of sandy desert which represent low lying plains with a gently rolling character in the Afghan-Turkistan region, from Mazar Sharif with a border marked by Amu-Darya on the Uzbek-Afghan boundary. These northwestern deserts resemble the southern dry and dusty Registan and Dasht Marg (deserts of death), which encloses a heterogeneous environment comprising sandy hills with an elevation between 200 to 380 m, extremely rare gypseous flats, and clay depressions. It undergoes extreme continental arid conditions with a limited and unreliable winter precipitation, a high level of evapotranspiration, sharply daily, seasonal and annual fluctuations of the air temperature, soils with a low content of salinity and gypsum,

and finally as a result of all these extreme conditions, a sparse and not diverse psammophytic cover vegetation.

The landscape physiognomy and vegetation structures are considerably different from the fixed dunes of Kattakum and Kyzylkum (Uzbekistan, Northern Kazakhstan), Karakum (Turkmenistan) and Taklamakan (in China), which represent a unique geographical link of Central Asian deserts. The distinctive features of Shirmohi-Ayraton- (near Mazar Sharif) deserts that help differentiate them from other sandy desert types are the sand properties: a high amount of mechanical silt/dust particles with a low salinity and humus content (0.2-0.4%). Many negative factors influence the plant cover on sandy soils such as sand mobility along with a high water infiltration rate and condensation limiting plant establishment and growth, poor soil structure and low content of organic matter. The trampling of grazing livestock also loosens sandy substrate.

Nevertheless the gradual sedimentation of clayey and dusty particles resulting from watering (adjoin irrigated field) decreases the deflation of sands, and in the meantime improves the water holding capacity of soil, promoting a large accumulation of humus and nutritional elements in the soil (Fig. 18, 19, 20, 21).

Fig. 18. Barren sandy dunes of Shirmohi desert (Afghanistan)



Fig. 19. Sandy Kattakum desert with sparse native vegetation (Uzbekistan)



Fig. 20. Central Kyzylkum sandy dunes covered with *Haloxylon aphyllum* plant communities (Uzbekistan)



Fig. 21. Karakum desert near Erbent settlement



We noted that almost all Shirmohi-Ayraton desert territories are in the form of active sand dunes covered by open vegetation or more often by barren lands. The flora here is scarcely modified by man. The main plants are *Haloxylon persicum*, *Calligonum spp.* and perennial *Aristida spp.* In patchy lower lying saline areas, *Chenopodiaceae* are dominant and represented by *Haloxylon salicornicum*, *Salsola spp.*, as well *Ephedra scoparia* (*Ephedraceae*) and *Tamarix spp.* (*Tamaricaceae*).

Common physiognomic features of the plants of this desert region are gray or white hairs, gray bark that is particularly thick at the base, reduction of leaf area and

cushion like growths to protect the plants against a strong isolation, and a dry wind and sand-drift that threaten to dry them out. Spiny stems and leaves or glands containing etheric oils or other elements that render them unpalatable to the animals have exerted a heavy impact on the flora and have been frequent features of these plants for centuries.

Due to degradation of grassland, the grasses have become shorter and sparser, the overall biological productivity has been reduced and the quality of the grasses has deteriorated (Hasanyar, 2000). All these conditions adversely affect livestock and create dramatic changes in the patterns of wildlife populations so that the balance of the sensitive desert grassland ecosystem has, to some extent, been destroyed.

The disappointing features of Afghan sandy desert pastures are their extremely low yielding fodder capacity and especially deficiencies in summer feed. Some strains of *Asteraceae*, *Poaceae*, *Chenopodiaceae* and *Fabaceae* represent the largest number of plants that are willingly grazed or eaten by all livestock. Different species of *Artemisia* (about 5% among 100 species common among the flora in Afghanistan) and the *Alhagi*-herbaceous plant community are the most valuable in terms of yielding capacity, fodder value and plant palatability. Perennials, ephemeroïds and ephemerals species from *Poaceae* including the genera *Stipa*, *Aristida*, *Agropyron* (wheatgrass), *Poa* (bluegrass), *Arundo* (grainreed), *Cymbopogon* (lemon grass) and *Andropogon* (bluestem) produce and store satisfactory quantities of fodder biomass for animals. Another important source of forage on patchy sandy/saline lands is represented by different species of *Chenopodiaceae*, especially *Salsola*, *Arthrophytum*, *Halostachys*, *Halocharis*, *Agriophyllum*. *Anabasis* pastures despite their poor palatability are, perhaps used as fodder reserves for the autumn-winter period (Fig. 22).

Fig. 22. Sandy dunes with sparse low shrubby/herbs vegetation (Shirmohi desert)



At present, some pastures are either abandoned or are extremely dangerous to use. As a result, especially in the past three years, the loss of these pastures has severely affected the lives of hundreds of thousands of nomads and semi-nomads that rely on it. This phenomenon is most serious in the Dashti –Archi and Obdon virgin steppe areas, and has caused mass migration towards urban centers in Kunduz, Khonabad and Mazar Sharif.

Furthermore, careless and ill-considered use of land, areas of open land for growing crops, reclamation on steep slopes, and over-utilization of bushes and grasses as fuel wood, all leave the fragile soils exposed to the action of wind and water, and are frequently the direct causes responsible for the serious erosion observed.

However the long-term war coupled with the worst meteorological drought, overgrazing and with uprooting and cutting of vital semi-shrubs/herbs by local population for fuel wood and other needs have also strongly devastated the seed stock of wild-growing desert vegetation (Fig. 23, 24).

During an interview with the local people it was learned that the worst nightmare of Afghans working on their fields or taking their livestock to pastures is the risk of landmines. The presence of a large number of landmines makes Afghanistan the world's most deadly minefield. According to a survey on 37 communities of Afghan people in 1994 that was conducted by CIET International, landmines had affected the lives of 12% of all households (Anderson et al., 1995).

Fig. 23. Fuel wood and herbs collection by local people on Shirmohi desert



Fig. 24. Range damaged by overgrazing and civil war actions



All these features lead the decision makers and well-informed scientists to take urgent measures to protect the desert wild biodiversity, raise and improve the current frequently low productivity, and re-vegetate what has been damaged by inconsiderate human activities, especially military actions and chemical residues.

Restoration of natural sandy desert ecosystems in our opinion could be realized by artificial phytocenoses. The natural vegetation remaining on the salinized or contaminated sandy lands can serve as a model for creation of man-made ecosystems, as well as a source of seeds. Reintroduction of the vanished wild vegetation in suitable habitats will allow the formation of seed banks and the natural dissemination of vegetation.

The Obdon steppe with about 70 thousand ha of virgin semidesert lands is the most important grazing area where a large number of nomads graze their livestock on a seasonal basis. The landscape as seen on Fig. 25 and 26 is characterized by flat stony and loamy sandy soils that mostly are not fixed by vegetation.

Fig. 25. Landscape of Obdon steppe (foothills semidesert range)



Fig. 26. *Artemisia herba-alba* –ephemerals (degraded rangeland)



These soils are low in organic matter, lack basic nutrients and have a high content of carbonate and perhaps gypsum. The granulometric composition varies from heavy clay to loamy sands. In many places, this steppe area forms a transition to the adyr - foothills, semidesert areas, that are extended to an elevation of 300-1200 m. This process has transformed the native grazing land to areas of useless and unstable plant formation with decreased long-term productivity, and disordered function resulting finally to the loss and a waste of natural resources and potentials. The poor management or destruction of appropriate native woody shrubs/dwarf shrubs vegetation or forestry plantations in many arid/semiarid areas of Afghanistan dry steppe is leading to land degradation with damages resulting from wind and water erosion, that prevents from natural regeneration of rangeland plants.

The low lying flat Obdon steppes towards Kunduz city is dominated by an open vegetation of *Artemisia herba-alba* and other species of this genus, *Zygophyllum spp.*, *Acantholimon spp.*, *Acanthophyllum spp.*, *Atriplex spp.*, *Alhagi camelorum*, and *Cousinia spp.* The *Artemisia* range is closely associated with a sparsely carpet of *Carex spp.* and *Poa bulbosa* annual herbaceous species such as *Bromus*, *Eremopyrum*, *Festuca* and other commonly present species. All mentioned types are the preferred rangelands of most shepherds for grazing. The fat-tailed sheep are a staple of Afghan life, supplying skins and wool for clothing and meat and fat for food; goats, large horned cattle and camels are also of economic significance.

The available grazing, however, consists essentially of *Artemisia*, ephemeroïds and ephemerals plants. The presence in the vegetation cover of ephemeroïds and ephemerals characterizes such pastures as highly seasonal and so can be suitable for sheep, camels and small ruminants only in spring and summer. The *Artemisia* – ephemeral rangelands seem to be valuable to small ruminants in autumn and winter when feed is in short supply.

Unfortunately, this type of plant formation tends to disappear under excessive and permanent grazing and also because currently it is heavily uprooted for fuel wood.

Heavy grazing and fuel wood collection have reduced the shrubs and led to an increase of annual plants.

Agriculture, livestock and handicraft are the main occupations for the inhabitants of the Northwest Afghan provinces. Agriculture in this region is mostly rain-fed, although a small proportion of the land is irrigated through channels and springs. Cereals, leguminous crops, vegetables and fruits are the common local products. Livestock is the main occupation and the main source of income in here. The quantity of water in canals is too little for irrigation. Therefore, the yield of irrigated land has substantially decreased.

The water level in shallow wells has also declined and in a number of places they have dried. No water can be seen in the traditional water reservoirs, which are usually used for drinking water and for livestock. The grazing lands in the provinces we surveyed have also largely dried.

Livestock are left with no water and no fodder crop. Therefore, owners of livestock have sold their animals for very low prices. Some livestock owners have taken their animals to other provinces and countries with better grazing conditions. Very few animals are left in the province.

Population movements to other provinces and countries have occurred since early last summer. Most of the youth in the province emigrated to other provinces or countries in search of employment and income.

The prices of all essential commodities are very high for drought-affected people who have been facing war and uncertainty for a very long time. Due to the lack of seeds and unfavorable climate, most of the lands in these dry steppes have not been sown. Therefore, even with sufficient rain and snowfall there will be no agricultural products in the upcoming season.

The livestock situation remains unchanged too. Services of the few existing veterinary clinics are insufficient or simply do not exist.

The Obdon and a part of Dashti-Archi steppes were quickly damaged as the native vegetation has entirely disappeared in the recently over trampled areas, because of military movements using heavy war machinery.

Wind erosion can be observed in many places. Severe food and water shortage (the only source is sparsely distributed artesian wells) is common.

In many cases local people are forced to get water for their living needs from canals that usually are located far away (some as far as 50-200 kilometers) from their settlements. Any such operations are poorly managed and in the majority of cases are done manually (Fig. 27).

All features mentioned above might become a major threat to the foothill Dashtiarchi semidesert and Obdon steppe in the same way that happened to similar areas in Karnabchuli (Uzbekistan) *Artemisia* steppe, in North Africa and in the Middle East. Measures for conservation of Obdon steppe are urgently needed and sound strategies should be developed and implemented.

Fig. 27. Local people taking water for drinking needs (Canal Govkush, Kunduz province)



It is equally important to refine methods for plant community rehabilitation and/or regeneration of degraded graminous-*Artemisia* formations, as well as shrub-semishrubby rangelands on sandy desert and dry riverbank areas.

There are many researches and papers in the literature about range improvement and rehabilitation in Uzbekistan (Sovetkina and Korovin, 1941, Shamsutdinov et al., 1958, 1969, Morozova, 1959, Sal'manov, 1964, 1969, Gaevskaya, Sal'manov, 1975, Sinkovskii & Madaminova, 1989, Gintzburger & Toderich, 2003) and Turkmenistan (Nechaeva, 1985) that have lessons to be learned and used for regeneration of natural arid/semiarid ecosystems in Afghanistan.

The unique water source for rehabilitation of Obdon rangelands and crops reclamation in opinion of the local experts on water and agriculture economy of Archi and Kunduz provinces, would be water of the rivers Kokcha and Kunduz, which flow into the river Amu Darya.

The water of Kokcha River should be enough for irrigation of more than 15 thousand hectares of lands of guberniya Archi and foothill semidesert Obdon steppe. However permanent irrigation canals and large scale irrigation system seen on the right bank of the Amu Darya these days could hardly be seen here.

Qanat or Karez systems of subsurface water channels existed to help with the lives of local people, but those water resources were not enough for cultivating and support of agriculture development in Obdon steppe.

2. Irrigated Agriculture Development

The first marginal and transitional zone extending on about 5000 ha of land between desert/steppe dry lands and irrigated agricultural fields of Askalon area. Warfare during the 1980s and 90s, however, damaged a large percentage of these arable lands. Double cropping was common in those semi-arid regions. Largely subsistence crops include wheat, corn and other grains, sugar beet, small areas of vegetables, leguminous and melon plantation and gourd fields. Cotton is cultivated privately as by small farming or household plots. Grazing is still of great importance in the economy of this area. Occasionally a little diversity of fruit trees is seen on the banks of small and dry beds of canals.

Imam-Sohib district located southeast of Askalon is one of the advantageous and developed agricultural regions in northeastern Afghanistan. The main canal Shahravon, originating from the river Pyandzh and proceeding to the southern part of the Imam-Sohib district represents the basic sources of water for crops reclamation of lands between Imam-Soheb and Dashtiarchi region (Fig. 28, 29, 30).

Fig. 28. Graminous and leguminous field after harvest



Fig. 29. Different types of irrigation (furrow ground channels and self-flooding)



Fig. 30. A circuit of small ground channels found in private farms of Imam-Saheb district



Aboriginal inhabitants believe the lack of irrigated fields on its eastern part, is the sharply steep foothills of Obdon steppe landscape.

Closer to Kunduz there are well-irrigated sites due to the use of waters of small river Olchin and canal Govkosh (Fig. 31, 32, 33, 34).

Fig. 31, 32, 33, 34. Different views of rivers Olchin and Govkush near Kunduz; The construction of bridge and management of water intake infrastructures are under the control of different International Donor Organizations.





Local inhabitants use territories surrounding both river Govkush and Olchin for cultivation of various traditional cultural crops of which the most common are grains and bogharic crops (Fig.35).

Fig. 35. Co-operative farms activity (near Kunduz city); Crops diversification is well distinguished in here.



The basic source of water for agricultural reclamation of dry/semidry lands surrounding Kunduz city is the river Kunduz (Baglan), which is fed from the rivers Khonobad and Talikan. Water allocation in the Khonobad district is managed through a series of small canals (Fig. 36).

Fig.36. Networks of canals near Khonobad. A view of the irrigation system used for farming rice and fruit-trees



The most advanced crops cultivation is observed in the Khonobad district that is considered the best-specialized center of rice cultivation in Northwest Afghanistan (Fig.37).

Fig. 37. The general view of a rice field near Khonobad



The experiments on introduction of foreign sorts of rice have not shown positive results yet. A drainage network consisting of small channels between rice cropping fields has been manually constructed. An analysis of the physical parameters of water from this source did not show salinity (Fig. 38, 39).

Fig. 38,39. Collector-drainage canals (the participants of expedition doing water analysis in the field).



A larger variety of traditional agriculture products is seen in this region than previously described by surveyors. Besides rice and grains, various vegetables, legumes and melons, fruit trees, vineyard, and cotton are cultivated in a large variation here in this region.

The Kholm province towards Mazar Sharif practically has the same features of an irrigated landscape marked around Kunduz and Khonobod.

Our summarized data collected during the mission suggest that the agriculture is the largest and most important sector of the economy in Afghanistan, a country with about 22 million people. Studying the former agricultural conditions and evaluating the current situation of local agriculture in Afghanistan (in the north-western region) has helped us gather the required information to develop the best course of action for long-term sustainability.

According to the Food and Agriculture Organization of the United Nations (FAO) there are 65 million hectares of land in Afghanistan. Of this, about 30 millions hectares are rangelands for livestock and 8 million hectares are cultivated.

The agricultural sector in Afghanistan (based on observations in alkh, Kunduz and Archi provinces) consists of three types of farms: large scale private farms, small number of collective farms, and household plots. The state sector keeps the grains production under its responsibility especially wheat which makes up 80% of the nation's grain production.

Household plots generate a large share of livestock (in the sandy desert and foothill semidesert with grasslands and sparse vegetation areas) and vineyard, fruits (mostly pistachio), melon and gourds crops, potatoes and vegetables. These types of farming activity are most common in the Imam Soheb, Khonobod, Kunduz and Balkh croplands and irrigated areas (Fig. 40).

Fig. 40. A typical household farm frequently found in the Imam Saheb district.



The present political changes in Afghanistan, however, have affected all areas of human life and the relationships between humans and natural resources as of both the wild ecosystem and irrigated farming lands. There is a lack of low-cost technological alternatives and choices farmers and producers can opt to respond to market signals. Much of the Afghanistan's agricultural heritage may have been lost because of the war conditions coupled with the region's worst drought of three years duration, in at least 40 years. This has devastated Afghanistan food-production capabilities and depleted critical seed stock of native crops, leaving the nation heavily dependent upon food aid from international donors.

Famine has been a continuous and chronic problem in Afghanistan since the Soviet invasion in 1979. The United States military action against Taliban beginning from October 2001 made the problem worse. According to press releases of the United Nations World Food Programme (WFP), six millions of Afghans depend on food assistance from the international societies.

Food assistance may temporary satisfy Afghans' hunger, but it cannot resolve the absolute scarcity of agricultural food production. The long-term Reconstruction and rehabilitation of domestic agriculture in Afghanistan are critical for the resolution. This is what we stand for as our main purpose of the current field expedition mission. Actually, several rehabilitation plans are ongoing.

The United Nations Food and Agriculture Organization (FAO) has distributed 1500 tons of wheat seeds to approximately 30,000 families in rural areas of northern Afghanistan. FAO estimated that Afghan farmers would be able to harvest around 16,000 tons of wheat from the seeds distributed.

WFP is also set to shift the focus of its operations from relief to rehabilitation. WFP has announced a new nine-month emergency operation that uses innovative food aid projects to help millions of Afghans reestablish their shattered lives and build the future for their devastated country.

The first priority of USAID and ICARDA offices that we visited in Kunduz, Kholm and Imam- Soheb provinces was to restore critical farming activities, especially to support the landscape rehabilitation and the development of seed production of various crops and to restore the nation's seed supply (Fig. 41).

This includes seed production the farmers will achieve to replenish their country's seed stock that is important for domestic food security and market development. ICARDA (International Center for Agriculture Development of Arid/semiarid lands) has the potential to provide the largest seed recovery efforts trying to replenish damaged seed and irrigation systems, both for short-term requirements and long-term sustainability.

The lead Organization known as the future Harvest Consortium to rebuild Agriculture in Afghanistan attempts to ensure that agriculture reconstruction efforts are based on the best scientific practices and has involved teams of experts with extensive experience working in Central Asia.

Fig. 41. USAID/OFDA rehabilitation project (Imam-Soheb district)



In Kunduz there is a special experimental station where local scientists with support of ICARDA and FAO reintroduce not only traditional wheat, maize, barley, chickpeas, lentils and other seeds that have been used by Afghan farmers for centuries, but also seeds improved through breeding to be more productive and disease tolerant as well as new seed varieties that have been bred to grow in conditions similar to those in Afghanistan so that crop diversification can be introduced.

The special horticultural and cropping projects have been initiated in Kunduz under the leadership of the Ministry of Agriculture and Water Economy of the Republic of Afghanistan. These Projects are supported by ICARDA, UNDP and FAO (Fig. 42, 43).

Fig. 42,43. A horticultural project sign, and a meeting at the office of Kunduz Experimental Agricultural Center



Training and involvement of local scientists and technicians for the realization of international projects are well developed. A dataset of 3 years of climate and edaphic data is stored in the computer database of this center (Fig.44).

Fig.44. A meteorological station located in the territory of the Agricultural Center



Of great interest is the rehabilitation of the Afghanistan national agricultural gene banks; a facility used to safely store seeds and other phytogenetic resources that were destroyed during the civil war.

There is also an urgent need to focus not only on the long-term rebuilding process, but also on the near-term requirements of farmers for basic food consumption and nutrition. For such purpose there is a large fruit trees and pistachios seedling nursery in the center of Kunduz managed by the local scientists and farmers under the financial support of International Agricultural Developments Agencies; as seen in Fig. 45, 46.

Fig. 45, 46. The experimental station for seedlings and legumes development for framers needs



The scientists focus mainly on silvicultural (pistachios, nuts, coniferous) and horticultural (fruits and vegetables) sectors (Fig. 47). These international programs seek to ensure that Afghan farmers receive the appropriate seedlings or seed material and tools for their specific farming needs.

Fig. 47. Seedlings of coniferous at the growing stage (Kunduz city)



Besides, the ICARDA offices in Afghanistan as the one in Kunduz (Fig. 48) provide farmers with vaccines to prevent diseases in Afghan livestock, as well as land in water management.

Fig. 48. A meeting at the ICARDA office in Kunduz



Another priority for the international donor organizations is the land and water management, especially in northwestern provinces that are affected most by the drought. We concluded that much of the region's irrigation infrastructures need reconstruction.

The farming irrigation techniques, however, are still too simple and improvement has been insignificant. The monitoring system whether of the water supply or allocation of water is not completely developed.

The basic traditional and historically oldest irrigation technology used in large-scale in Afghanistan is the furrow/grooved (network of open ground canals) irrigation system. Water reaches the crops through a manually created furrow network. Water from any water source is transported into a net of inter-district canals using simple pumping equipment through an irrigation main line canal. The management of water is further regulated through a net of small ground canals from which the water flow is directed into furrows arranged transversally or longitudinally. Each watering furrow has a height of 15-17 cm and is 200-300m in length. The distribution and water management are done manually.

Nowadays however, local farmers prefer using the flooding irrigation technique for cultivation of arable crops, citric and fruit trees, grapes etc.

Afghan irrigated agriculture in fact is characterized by low average crop yields compared with other Central Asian riparian countries. This apparent failure can be attributed in part to the insufficient use of water resources from the Amu-Darya River.

Farmers generally harvested wheat or barley in winter and cotton, beet, or melon in summer by lift brook irrigation. The permanent irrigation canals we can see these days on the right bank of Amu Darya could hardly be seen in Afghanistan. Qanat or karez, which is a subsurface water channel, is used to help with the lives of local people, but these water resources are not enough to harvest crops.

Single crop rice fields with bunded irrigation had been seen near cities of Khanabad and Kunduz in Kunduz province. Bunded irrigation uses temporal reservoirs surrounded by low height ditches (1~2m). When the level of river water is high in early summer, farmers build ditches near the stream and store water for irrigation. Lift irrigation systems by waterwheel were hardly seen in this area. That was because the slope of river was very gentle even though the volume of water was rich. Permanent canals were not seen either. Large scale irrigation systems like those on the right bank of the Amu Darya were not necessary for Afghan local agriculture sustaining a small local population.

Lift irrigation is a typical method for local agriculture in northern Afghanistan. There were many waterwheels along the Balkh River near the city of Mazar Sherif. Local farmers used the waterwheels to pump up river water for irrigated crops and to grind grains into flour. Gradient of the river was steep to provide strong flow rotating a waterwheel. On the other hand, there were few waterwheels on the left bank of Amu Darya (Afghanistan) because hydraulic gradient was too gentle to rotate the

waterwheel. This was one of the reasons why the left bank of Amu Darya had not been irrigated.

New models of irrigation systems (sprinkler, conjunctive, subsurface drip irrigation etc.) technologies for utilization of underground water, improving seed and food production through crop diversification and conservation tillage practice, as well as usage of new alternative crops and their varieties (grains, fodder legumes, vineyard and other crops) have been tested on small experimental plots at the Experimental Agriculture Center in Kunduz (Fig. 49, 50, 51,52).

Fig. 49-- 52. Crops cultivation by using of different new irrigation technologies (Kunduz, ICARDA Experimental Agriculture Center)



In recent years the rural agricultural production system in Afghanistan has become increasingly dependent on groundwater pumped from private tube wells. However except for a few studies, little is known how water markets operate presently and what the social and environmental consequences of privatization will be. The private

sector of tube well water extraction and operations is not monitored or regulated. Earlier research by the International Irrigation Management Institute (IIMI) led to statements of strong reservation about the likely impact on the sustainability of irrigated agriculture with the turnover of public sector tube wells to the private sector (Johnson & Vander Velde 1992, Murray-Rust 1994, Merrey 1997). The research activities in many south Asiatic and Indus Basin countries, however, demonstrate how susceptible the groundwater use by owners of private wells is to the government energy pricing policies, technology promotion programs, and canal allocation rules (Kikuchi et al, 1992). Further research is needed in these issues.

The construction of small reservoir water tanks (natural and/or artificial) for water collection, conventionally in Balkh and Kholm provinces supported by ICARDA water and land management programs serve as an additional source for improvement and/or development of arable lands in these areas.

The operation will also fund a series of rapid impact programs designed to reconstruct basic infrastructures or to involve new irrigation systems. Nevertheless, all these irrigation systems require much water from watercourses including the Amu Darya and its tributaries such as the Kunduz, Kokcha, Shiva, Akcha and Pyandzh Rivers. Nevertheless, there are excellent opportunities to add to the value of agricultural output, especially in the plains and foothills areas of the northwestern part of Afghanistan. On the other hand, several trends point to a future possibility that the productive agriculture of the whole Amu Darya Basin would have suffered at first.

As long as Afghanistan does not participate in an interstate agreement for transboundary water resources of Amu Darya River, there is a potential of international conflicts between Afghanistan and any of the Central Asian riparian states. In the worst case, these conflicts might bring another tragedy to Afghanistan. Therefore, it is necessary to arrange an interstate coordination for transboundary water use among all riparian Republics before the rehabilitation plan for Afghan irrigation systems is promoted.

Many researches on operation and management for the transfer of irrigation systems, however, indicate a considerable gap and lack of integrated activity between local and International researchers, policy markers, managers, and farmers both in Afghanistan and other Central Asian countries.

At last we would like to attract attention to the role and position of women that today is still one of the hottest controversies of North Afghan society. Traditionalists, who have had a strong impact on Afghan society for decades, are now witnessing an improvement of women's status in legal and social terms. It has been perceived as a threat to tradition, which might cause unrest in family and community life.

A woman describes losing her husband in the war and today she takes care of seven children. She also says: "everyone in the village lost two or three members of their family during the fighting ..." but things are much better now because she has found some job that is of great help for her family (Fig. 53).

Fig. 53. Discussing the social changes with Afghani women



Discussion and Recommendations

Having completed our first expedition mission on the left Bank of Pyandzh River, we have the impression that the current political changes in Afghanistan has affected all areas of human life and also the relations between man and natural resources whether of the wild ecosystem or the irrigated farming lands. Malnutrition and poverty mostly loom on the devastated landscapes of the marginal territories.

The main problems that northwestern Afghanistan faces today are those of wind and soil erosion, deterioration of rangelands productivity, pollution from trans-boundary airborne particulates and the epidemic spread of biological agents causing diseases. Abandoning the lands, poor reclamation schemes, overgrazing and destruction of vegetation for fuel wood have all aggravated the desertification process.

All of these in turn contributed to a decline in the number and the varieties of the wildlife and the destruction of fragile arid/semiarid ecosystems that would be extremely difficult to restore (Daud Saba, 2001).

Until now, no environmental study has been carried out over there to reveal the true extent of the environmental crisis or propose a solution. The lack of information on the wild ecosystems, soil, water, vegetation, farmland and other environmental factors could be attributed to the lack of relevant organizations or agencies in this part of the country. The volume of work done by international agencies is still scant, and hardly addresses all these issues. In this context, this paper can be considered a reconnaissance of a problem that has not yet been addressed and requires diligent

research on environmental issues in Central Asian riparian countries in general, and in Northwestern Afghanistan in particular.

Since the inhabitants of these areas are engaged in rain-fed agriculture and livestock breeding, more attention is required to revive these sectors. Farmers and livestock owners have not received enough assistance for such purposes.

The purchasing power of the inhabitants of these provinces is already low due to the problems of unemployment, a low level of production, and inflation. Considering the probable consequences of the last year's meteorological drought, the situation is expected to deteriorate further.

There is a lack of alternative low-cost technological solutions from which pastoralists, farmers and producers could choose to respond to market signals. The entire agricultural infrastructure, from seed production to roads and markets, has collapsed. Only a small area (less than 8%) is suitable for farming and just a part of that arable land is irrigated.

Critical depletion of the seed stock of native crops and food-production capabilities has left the population of North Afghanistan heavily dependent upon food aid from international donors.

Moreover the long-term war coupled with the worst three year long drought, and overgrazing along with uprooting and cutting of vital semi-shrubs/herbs by local population for fuel wood and other needs have strongly devastated the seed stock of the wildly growing desert vegetation. It was estimated that about 60 percent of the population (urban, rural and nomadic) have been severely affected.

The shortage of water in rivers and the rapid fall of water tables have resulted in an acute scarcity of drinking water in the rural areas. Large sections of the rural population and their livestock in the affected provinces have started migrating to other areas in search of water. An estimated several hundreds of nomadic livestock owners are reported to have lost their only source of livelihood.

This phenomenon has caused mass migration towards urban centers in Herat, Konduz and Mazar Sharif. It has exposed more than a million people to the risk of starvation and has raised serious humanitarian concerns for the international agencies (Cohn, 2001).

All these features lead the decision makers and well-informed scientists to think of urgent measures to protect the desert wild biodiversity, raise and improve the sometimes low current range productivity, and re-vegetate what has been damaged by unconsidered human activities, especially military actions and chemical residues (Anderson et al. 1995).

There are still serious problems with the management and sustainable development of the immense territories of desert/semidesert lands of Obdon and Dashti-Archi steppes that represent harsh, and expansion prone fragile environments.

Drought is a constant threat; water scarcity is growing; soils are poor and land degradation is increasing. Risks are pervasive and greater than in any other important food production system.

Rural population having no other alternative employment opportunities outside the agricultural sector has had a lot of difficulties related to the very poor land quality that requires major investment in reclamation. Lack of machinery, equipment, livestock for land processing and knowledge of farming operations and commercial activity of their own coupled with absence or destruction of the irrigation systems have had a negative effect on overall productivity of natural desert rangelands and arable lands in these two regions.

Thus, one of the key issues in Northwest regions of Afghanistan is the necessity of a search for innovative solutions for the rehabilitation of the traditional irrigation infrastructures and strengthening of water resources management.

Mismanagement and negligible infrastructure of water irrigation systems in all surveyed areas have contributed to massive population displacement, increased opium production, conflicts over land and grazing and consequently breakdown of traditional socio-economic networks.

The population (rural and nomadic) of these two provinces uses the underground and artesian (natural springs) water that represent the only source of water for crop farming needs. There is no doubt that such methods of water reservation could be an additional source to help with the reclamation and agriculture development of this plainly desert zone.

The people's needs to mitigate the impact of drought have led to a proliferation of wells. Various agencies, both domestic and International, have been digging wells throughout all territories of Northwest Afghanistan in order to alleviate immediate needs; however, there has been no coordinating body, and perhaps deeper wells have had some adverse effects on shallower springs and wells supplying water in other parts of the country.

Besides, these wells provide an access to non-renewable ground waters, and the traditional water rights turn into the individual properties of some who have more money and stronger pumps. This in return increases the risk of rural community disintegration.

Since the majority of the rural populations in the desert and semidesert areas lack inadequate access to clean water and sanitation, they are forced to get water from canals that are usually located far away (some as far as 50-200 kilometers) from settlements. These canals are used for irrigation, human consumption, and animal consumption, and more often than not, are polluted before they reach villages. This may become a source of major threats with a risk of high incidence rates of water-borne diseases such as typhoid fever, dysentery, viral hepatitis A, and intestinal infections, especially among children.

Interactions of underground water with surface waters, as well as the formation, distribution and use of underground waters in Northern Afghanistan, however, still has not been studied enough.

Farming methods have not improved at all; and in many places, people still use the same technologies that their ancestors would use thousands of years ago. No help has

been provided to the farmers who live in desert areas or in narrow valleys to terrace the slopes in order to reduce erosion.

In the area of agriculture, few efforts have been made to conduct pilot projects to obtain the best possible results with the least damage to the environment.

Dams and complicated canals system for managing the flow of water in some areas have been planned. However, none of the programs has been seriously implemented to improve the existing land conditions or to prepare new lands for use in the agricultural sector or as livestock pastures.

Agricultural production methods have remained traditional, and closely tailored to the environmental conditions of the land, but with such a traditional technology, natural resources are not properly used in a sustainable system to take account of present changes.

Research should therefore be directed at developing appropriate technologies for sustainable intensification of agriculture in risk prone areas for the benefits of the millions of poor people who live in these areas.

The development of productive and sustainable farming systems, however, will require integrated strategies to maintain and enhance rangelands improvement, and soil and water management. Such approach will not only reverse environmental degradation, but also offer farmers some new opportunities to generate cash income.

In our opinion an urgent and strong diagnostic assessment is needed before designing interventions for long-term Rebuilding of Agriculture in the Northwest parts of Afghanistan. Such an assessment should comprehended at least four principal themes:

- Seed production and crop improvement;
- Soil and water management;
- Rangelands rehabilitation, animal feeds and livestock development;
- Agricultural (horticulture, viticulture, silviculture, etc.) diversification, employment and gender issues.

In the long term it is important to develop a strategy with a sound technical base that will ensure a close integration of local relief, rehabilitation and development activities and ultimately include the new government of Afghanistan, that will support the development of sustainable and productive agriculture in Afghanistan.

There is also an urgent need to focus not only on the long-term rebuilding of Agricultural processes, but also on the near-term requirements of farmers for basic food consumption and nutrition.

In the immediate future, multiplication and delivery of high quality seed of adapted varieties to farmers and building of an effective regulatory system, with Afghan partners, that enforces the standards and promotes the use of high quality seed and varieties should be considered a prime target for restoration of agriculture in Northwest Afghanistan.

As the first step, it is necessary to formulate some regulatory guidelines related to seeds and other planting material, to protect farmers from imported pests or unsuitable seeds. Such regulatory guidelines have a significant role especially in the processes of production and distribution, as practiced in various areas of Africa and West Asia (Grass & Turner eds., 1998).

The establishment of Research and Experiment Stations, range assessment and seed processing laboratories, and meteorological stations in the northwestern parts of Afghanistan would be a high priority for the Afghanistan Ministry of Agriculture and Livestock. A good example might be the experience of Darul Aman research station (near Kabul) and ICARDA experimental horticulture/siviculture station in Kunduz. The integration of the local knowledge and experiences of village *Shurah's* (local leadership councils) through NGO partnerships and different World Food Programs should also be taken into consideration.

It is interesting to note that individual crops farming system in Northwest Afghanistan, however, is flourishing thanks to private initiatives. Most farmers own less than 2 hectares of arable lands.

Unfortunately, neither national statistics (existing today in the Kunduz province) nor our surveys provide the full information necessary for current analysis of farming systems. Regional statistical data only enables us to make a crude comparison between the state sector (i.e. statehold farms) led by the Governor of the Kunduz province and individual farms (mainly household plots).

A noteworthy feature is that the individual sector, especially in the desert/semidesert areas of Kunduz and Dashti Archi provinces, especially near cities and water sources (around small rivers) produces more than 40% of agricultural outputs.

These sharp differences between household farming and state agricultural sector might be related to the institutional production and marketing arrangements.

Only a limited number of individuals (farmers) are free to decide what to produce and what to sell, while state directed farms are strictly bound by state /governor orders on the relatively large areas of these two systems analyzed by in the provinces we visited and it seems that there is not much room for private initiatives.

However, for the majority of rural population in the territories we surveyed it was nearly impossible to borrow money to buy needed grain, livestock, and other farming tools. The banks currently operating in this region have no way either to issue credit (as capital for banks is virtually nonexistent) or to effectively manage loans even if capital was available.

Considering the lack of any stable credit system, many Afghan farmers have had to sell virtually all their assets (homes, land, livestock, etc.) just to buy food. This phenomenon has created a new class of poor nomads in the desert plains of Afghanistan.

Based on the first fieldwork expedition mission in the North Afghanistan, the following priorities can be suggested:

1- Water resources assessment, management and investment in water should be at the forefront of any development agenda.

The information on water resources, irrigation and water supply systems currently available is over 20 years old. Basic information is needed to estimate the necessary scale of rehabilitation in water management and water supply schemes, to secure the recovery of agriculture and livestock production as well as the delivery of safe water for domestic purposes.

New analysis of water resources must be coupled with a survey on infrastructures of irrigation and agricultural systems and should ensure that development is undertaken in a way that takes full account of environmental, traditional, social and economic issues. This will also require serious coordination of data about water resources throughout Afghanistan. Appropriate reforms should follow and be applied to all water resources crossing the boundaries of all riparian countries.

Another priority is for the analysis and the seasonal monitoring of water quality in Pyandz, Kokcha, Govkush, Kunduz, Khonabad, Talikan Rivers. The following parameters can be taken into consideration: pH, electrical conductivity, turbidity, dissolved oxygen, water temperature, salinity, dissolved inorganic nitrogen, ammonium, nitrate and nitrite, dissolved inorganic phosphorus, sodium, potassium, magnesium, calcium, chloride, sulfate, and heavy metals.

2- Short-term projects including repair of irrigation canals and existing systems, especially in areas located in river basins and the main sources of cultivation

In this regard, we propose to start with a small investment for reconstruction of former water intake system through installation of water-pumping stations on the riverbanks of Pyandzh river and repair of the ruined main canal keeping intact the left and dextral networks of shallow ground canals which can still be used. For such purpose Qorakutermah district (N 37°09'49. 7''; E 068°41'24. 4'') located about 10-15 km from the border of River Pyandzh (Northwest Afghanistan) can serve as a model site for reclamation and agricultural development (cultivation of various crops under irrigation). Qorakutermah Project would pump water from Pyandzh River into a canal to be transported to thousands of hectares of virgin lands in Obdon and Dashti-Archi dry steppes.

Taking water from Amudarya, however, requires the using of modern technologies of land and water use (SDI in particular) in order to overcome some difficult features of the arid/semiarid fragile landscape (Zonn, 2003).

The agricultural reclamation of the foothill semidesert Obdon and Dashti-Archi steppes can be promoted using water from Kukcha River that finally flows into the Pyandzh, being the result of the change in the Amu Darya river course during the past geological periods. It seems that dry riverbanks of Pyandzh river over the long run have developed a special mechanism of drainage, known as a natural mechanism of desalinization, similar to Surkhandarya and Sherabad Uzbek steppes (at the right bank of Amu Darya River). In this case, however, groundwater would flow into the

river. Since the groundwater table rose, the level of their salinisation and mineralisation did not increase.

These phenomena suggest the potential of water from Amu-Darya River for promotion of a subsurface irrigation system in all riparian countries of Amu Darya River Basin (Afghanistan, Uzbekistan, Turkmenistan, and Tajikistan).

3. Reviving agriculture through seed production on the ground relief, also education and extension programs directly involving farmers, and their families

The rehabilitation of the abandoned agricultural research station in the vicinity of Korakurturma settlement is necessary. Plans should be set to establish research trial fields (small-scale experimental plots) and to cultivate native drought tolerant plants, as well as seed varieties that have been tested in the desert conditions of Kyzylkum (Uzbekistan) and Karakum (Turkmenistan) deserts. No doubt that the existing technologies on drylands crops farming in these countries would be adaptable and useful for Northwest Afghanistan that has almost similar edafic-geographical conditions. Seeds and crop improvement teams including experts both from neighboring riparian countries and Afghan scientists would primarily focus on testing, multiplying and distributing drought-resistant plants and crop varieties to farmers.

Abandoned arable lands surrounding Khonobad, Konduz and Kholm could be reclaimed through systematic studies and utilization of modern technologies. They could then be turned into fruit orchards or other suitable crop fields to compensate for the increase in the rural population and to prepare more usable land for refugees who are willing to return home, but currently have no such incentive.

If all the rural refugees return, however, numerous problems of land ownership and inadequacy of arable land will arise (The Swedish Committee for Afghanistan, 1993); a contingency that requires thorough understanding of the ecosystems and land management practices in order to avoid further degradation of the existing land through overuse. This is another serious problem that needs to be addressed by international development agencies. So, they can be prepared for and provide an adequate understanding of future developments of the rural infrastructures in Northwest Afghanistan.

Women's participation in the revival of agriculture, public and community life, formal education, and in the labor force that has been strongly resisted by some traditions, should be promoted instead. In our opinion Afghan women could be involved and taught about new methods of seed production, seed storage and reproduction, i.e. how to be a farmer. They can actively engage in operation of seed processing (germination rate, planting, plant disease control, harvesting, seed distribution etc.).

We believe that any education and training programs on development of a proper seed production system and its management will significantly help introduce both wild native species and crop diversification. In addition, women who have been denied the opportunity to work and feed their families will also become educators,

especially in crop-farming sector that is just timely for Northwest Afghanistan. Afghan women are eager and ready to take this great personal risk and resume their active participation in the life of their country.

Production of seed material to be planted by farmers for replenishing the country's seed stocks is very important for domestic food security and market development.

In addition new Afghan government should stay committed to eradicating poppy cultivation that keeps the illegal drug trade thriving. Afghanistan will need to move quickly to provide farmers with sound alternatives to displace poppies if Afghanistan is going to get back on its feet or to diminish dependency on international food aid programs. Fast-growing fruits and vegetables are a good way to do so because they can be grown quickly and command a higher return than most other food crops.

4- Reestablishment of native rangelands productivity in a war-torn landscape

The most valuable technique for shrub establishment and rehabilitation of rangelands of Pyandz River Valley (left side) appears to be the reseedling of native range species and creation of artificial phytocenoses. Some benefits can be obtained by range improvement through creation of pastoral shelters, windbreaks and tree belts of *Haloxylon* ssp., *Calligonum* ssp. *Pinus eldarica* (Afghanistan pine, *Populus*) and other tree-like species used for erosion control and reclamation of severely disturbed sites. Due to their low seed germination and/or destruction of seedlings at an early stage of root fixing, it would be reasonable to apply the vegetative method for their reproduction with the subsequent transplantation of seedlings on degraded sites of natural sandy fields. The proposed rangelands project would be not only useful for increasing pastures productivity but also to fix the moving sand dunes and protect oases and settlements from sand encroachment and strong winds.

Protection of the natural vegetation and avoidance of overgrazing, especially in grassland areas of Dashti-Archi and Obdon desert plains, are very important. On a land that is already damaged, trees, bushes and grasses strongly resistant to the severe natural conditions should be grown from endemic or similar stocks. Shelter belts have to be established around fragile grasslands and pastures to increase their vegetation cover and protect them from the effects of the constant wind and overgrazing. Special efforts should be made and extended for restoration of the wetland ecosystems.

A pilot collaborative Project for stream bank stabilization and wildlife plantings in the floodplain areas of Pyandz River both from Tajik and Afghanistan sides could be of great significance. Measures must be taken to make sure that riparian (Tugai) forests being cut down for commercial use are replanted immediately.

5. Risk Communication and Health Promotion on Water Related Health Problems of Northwest Afghan Population

Epidemiological surveys on drinking water quality should be done within the experimental Qorakuterma's area. Afghan women should take an active part on

dissemination of data related to sanitation, hygiene and human health problems in the region.

For instance, no study has been conducted yet to show the effects of used pesticides on the life of the people who have been exposed to them in the last few decades. In this regard, importance has to be given to a national program to assess the quality of pesticides, their persistence in the environment and safe and regulated methods for their use.

6- Environmental Policies for Conservation and Sustainable Utilization of Afghanistan Desert/semidesert “pristine” Ecosystems

Today's mountains, rivers, forests, farmlands and pastures are the backbone of the ecosystems and economy in major areas of the country, though archaeological studies and evidence reveal that, at least until 2000 BCE, the territory of today's Afghanistan was partially covered with forests (Ponting, 1990, Denniston, 1995). The failure of Afghans to understand the extent of the environmental crisis may be due to the fact that they have not paid much attention to the ecological risks (Holling, 1986) of the land, compared to the overwhelming amount of attention paid to wars. Through ignorance, people have never tried to look for other causes of their failure to sustain society's peaceful and self-sufficient way of life. Consequently, they put the whole blame on the war, which they witnessed and participated in almost every day. Such ignorance by itself is a tragedy that has to be overcome today.

In order to protect the natural environment in Northwest Afghanistan and put its development on a sound and sustainable path, a series of laws and regulations have to be adopted. The necessity and significance of protecting the nature and environment have to be promoted by education that also reflects the limits of nature and ecosystems. At the same time, a public program has to be adopted to raise awareness of how to protect and improve the environment. There are abundant resources of endemic and non-endemic wild plants and animals in Afghanistan that have to be studied systematically. The public has to be educated through national and local media of the importance of these wildlife biodiversities and their protection. An efficient management strategy has to be adopted to establish and promote natural reserves and protect the valuable natural resources for the well being of both present and future generations.

Rapidly expanding the regional and global economy challenges not only the people of Afghanistan but also the international community, to adopt a strategy for this land in an attempt to keep the balance between resources, environment, population and economic development in the face of a dramatic increase in demand. This is an extremely important issue for the sustainable development of the country.

The people of Afghanistan are still desperately in need of help to repair their natural habitat and preserve their fragile natural resources. The international community is morally obliged to give them a helping hand in order to revive this ‘wounded’ country, but the initiative should come from the aboriginal population.

Finally, we would like to thank the local Afghan authority and especially Said Muhamad Davud, the vice-governor of Kunduz province who strongly supported our field expedition work (Fig.54, 55).

Fig.54. Meeting with local authority of Kunduz province



Fig. 55. Participants of the field expedition (from Afghanistan side) before departure



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