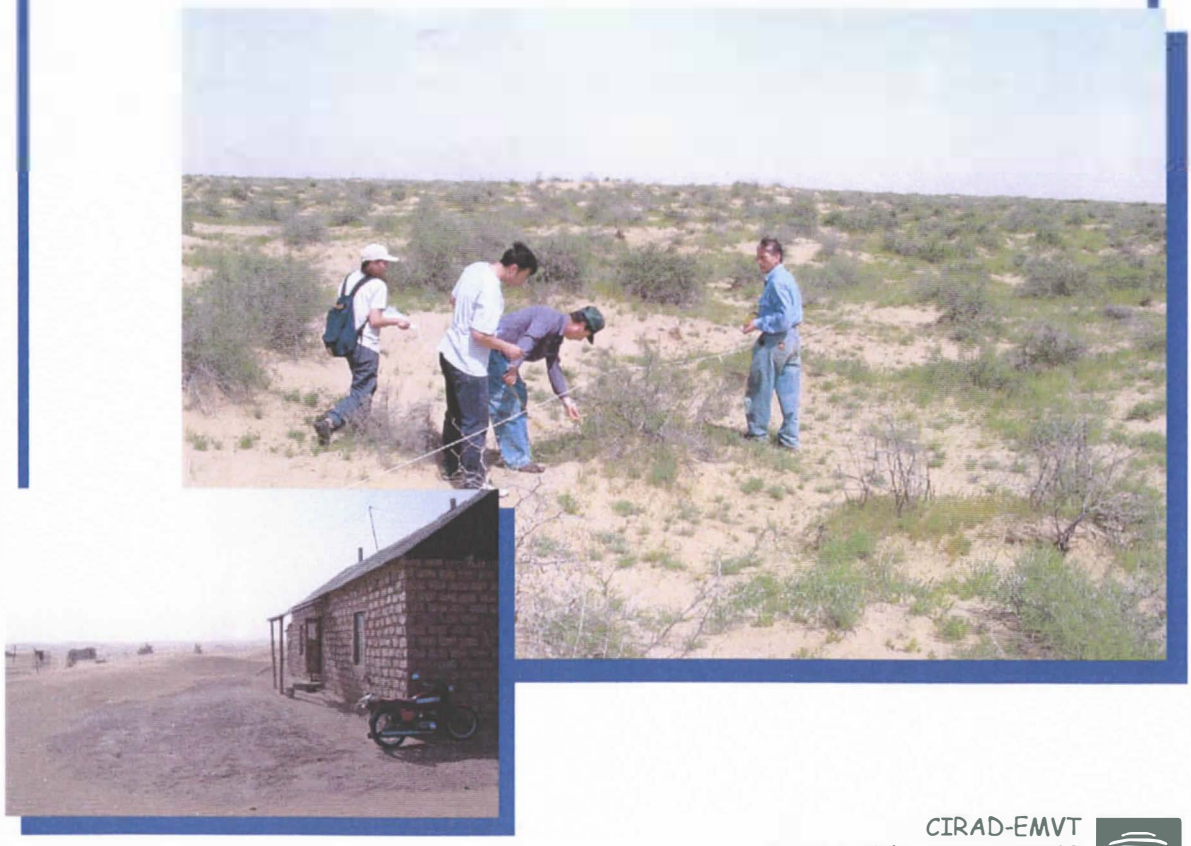
# Project Proposal

# COMBATING DESERTIFICATION IN TURKMENISTAN

## Range survey, assessment and management in Erbent pilot area

## October 2002



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# Project Proposal

# COMBATING DESERTIFICATION IN TURKMENISTAN

## Range survey, assessment and management in Erbent pilot area

by
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In collaboration with:
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## EXECUTIVE SUMMARY

# Project Proposal
# COMBATING DESERTIFICATION IN TURKMENISTAN: RANGE SURVEY, ASSESSMENT AND MANAGEMENT IN ERBENT PILOT AREA

by

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Critical issues: Improving living condition of desert communities to stop desert settlements abandonment and migration of jobless individuals and families to nearby cities.

This project is designed to complement a German GTZ participative project in the Erbent zone (GTZ-CCD-Project – "Support of selected pilot projects for poverty alleviation and combating desertification in Central-Asia / Pilot Project Turkmenistan: Community based resource management in Turkmenistan").

Global objectives of the "Range survey, assessment and management in Erbent pilot area" project: Contribute to re-establishing a sustainable range management system in a key pastoral area in Turkmenistan controlled by the Erbent Peasant Association (EPA) and propose practical actions to combat desertification (range management and rehabilitation, plantation of fuel wood, etc.) based on a combination of indigenous and scientific experience and knowledge, and in close consultation with the local population.

Specific objectives & Expected output (see para. 2):

- A survey and an assessment of the current range condition (maps of vegetation type and biomass available) using satellite imagery and field inventories, maps of the rangelands according to the users,
- A Geographical Information System with information on the vegetation (monitoring sites location and data on biomass measurements and vegetation cover of perennials

related to desertification), settlements, tracks, wells, watering points, etc), developed with local population,

- Proposals for range rehabilitation (range improvement, fuel wood plantation) on selected sites in close consultation and agreement with the local population,
- Proposal for the sustainable range management of the Erbent Pilot area.

| | |
|---|---|
| Project duration: | Spring 2003 – autumn 2005 (30 Months) |
| Man. month (from funding requested): | 30 |
| Contribution to budget requested: | 49,900 Euros |

TÜRKMENISTANYŇ TEBIGATY
GORAMAK MINISTRLIGI

ÇÖLLER, ÖSÜMLIK WE HAÝWANAT
DÜNÝÄSI MILLI INSTITUTY

MINISTRY OF NATURE
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NATIONAL INSTITUTE OF DESERTS,
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"12" 09 2002.

***To whom it may concern***

I, the undersigned, Dr. Muhamet Durikov, Head Laboratory of Forests and Rangelands (NID -FF / LRF) of the National Institute of Deserts, Flora and Fauna (Ashkabat) is willing to collaborate with CIRAD-EMVT on a 30 month project on the Erbent Rangeland project zone entitled " COMBATING DESERTIFICATION IN TURKMENISTAN: RANGE SURVEY, ASSESSMENT AND MANAGEMENT IN ERBENT PILOT AREA" in collaboration with Dr. G. Gintzburger, project coordinator, CIRAD emvt-econap.

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# Budget Proposal for Rangeland Assessment and Management of Erbent Region in Turkmenistan

prepared 6 Sept 2002 — DO NOT QUOTE OR PUBLISH

by Gus Gintzburger

| | | | | | | | Requested | France | Turkmenistan |
|---|---|---|---|---|---|---|---|---|---|
| Duration 2.5 Years | | Spring 2003 - Autumn 2005 | | | ERBENT AREA | | | | |
| Total Area | 80 km * 160 km = 12800 km² | | | | Using Landsat Imagery | | | | |
| Purpose: Rangeland Assessment and Management of Erbent Region in Turkmenistan | | | | | | | | | |
| **Turkmen Contribution (not including local salaries)** | | | | | | | | | |
| *Expedition to Erbent zone* | | | | | | | | | |
| Car | Petrol + other | | | | | | | | 1 000,00 € |
| Landsat Imagery | | 2 Images recent (2002) + 2 "old" (around 1995) | | | | | | | 3 000,00 € |
| Image processing support | | | | | | | | | 500,00 € |
| Field equipment (Stationary , paper bags, balance, etc ) | | | | | | | | | 1 000,00 € |
| | | | | Total Turkmenistan | | | | | |
| **French Contribution and requested funding** | | | | | | | | | |
| ***Training in France*** | | | | | | | | | |
| **2003** | | | | | | | | | |
| Travel (one person) | | Scientist from Turkmenistan (basic knowledge of computer and french) | | | | | 1 200,00 € | | |
| Subsistance and training session | | 3 months @ 2350 Euros / months | 1300 E Bourse + 250 E Assurance + 800 E frais pedagogiques | | | | 7 050,00 € | | |
| **2004** | | | | | | | | | |
| Travel (one person) | | Scientist from Turkmenistan (basic knowledge of computer and french) | | | | | 1 200,00 € | | |
| Subsistance and training session | | 3 months @ 2350 Euros / months | 1300 E Bourse + 250 E Assurance + 800 E frais pedagogiques | | | | 7 050,00 € | | |
| ***Field missions and support*** | | | | | | | | | |
| **2003** | | | | | | | | | |
| Gintzburger | | 2 Missions (Travel) | | | | | | 2 400,00 € | |
| | | Per diem GG | | 2 @ 20 days @ 246 E/jour | | | | 9 840,00 € | |
| | | Honoranum | | 40 days @ 639 E/jour | | | | 25 560,00 € | |
| French student | | 1 mission | Travel | | | | 1 200,00 € | | |
| | | Per diem student | | 60 days @ 50 E/day | | | 3 000,00 € | | |
| | | Training allowance 6 month @ 350 E/month | | | | | 2 100,00 € | | |
| Coordination meeting in Ashkabat | | | | | | | 2 000,00 € | | |
| Field/lab assistant / Interpreter in Turkmenistan | | | | | | | 3 000,00 € | | |
| **2004** | | | | | | | | | |
| Gintzburger | | 2 Missions (Travel) | | | | | | 2 400,00 € | |
| | | Per diem GG | | 2 @ 20 days @ 246 E/jour | | | | 9 840,00 € | |
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| Coordination meeting in Ashkabat | | | | | | | 2 000,00 € | | |
| Field/lab assistant / Interpreter in Turkmenistan | | | | | | | 3 000,00 € | | |
| Miscealenous | | GPS + software Printing reports and Maps | | | | | 10 000,00 € | | |
| Landsat Imagery | | Contibution to Sat images complementary to the ones from Turkmen part | | | | | 800,00 € | 2 200,00 € | |
| | | 1) | Total requested | | | | 49 900,00 € | | |
| | | 2) | Total France | | | | | 77 800,00 € | |
| | | 3) | Total Turkmenistan | | | | | | 5 500,00 € |
| | | % total | | | | | 37,5% | 58,4% | 4,1% |
| | | Project Grand Total (1 + 2 +3) | | | | 133 200,00 € | | | |

J. Domenech
Directeur

CIRAD-EMVT
Centre de coopération internationale en recherche agronomique pour le développement

# COMBATING DESERTIFICATION IN TURKMENISTAN: RANGE SURVEY, ASSESSMENT AND MANAGEMENT IN ERBENT PILOT AREA

## INTRODUCTION

Livestock production is one of the major economic and subsistence activities of Turkmenistan. This is due to the large area (about 80-85%) covered by the Karakum Desert in the country. The main economic value of these Karakum Desert pasture is the feed availability for livestock, primarily sheep and camels. Recent history, human and ensuing livestock population increase on desert settlements has cause much damage and degradation on these desert pastures. Overgrazing and firewood collections by local population are two main reasons for rangeland degradation in Erbent State Farm.

Sustainability is related to many factors i.e. determination of carrying capacity, timely use on the basis of range readiness having phenology of the key species, selection of the most suitable grazing systems adapted to the selected range, and supply of well distributed watering spots. Part of these practices is based on traditional methodologies used in old Turkmen range management and local shepherds will play a pivotal role in the proposed study.
Participatory action research will be conducted in four phases:

- Diagnosis of environmental and socio-economic characteristics of the survey area (www.gtz.de/desert)
- Range survey, assessment, and mapping
- Proposal for combating desertification near the settlements in close consultation with the local population.
- Proposal for range management in consultation with the livestock owners and shepherd.

This proposal is focusing on the range survey, mapping, rehabilitation and management in collaboration with local communities and authorities with the GTZ-CCD-Project – "Support of selected pilot projects for poverty alleviation and combating desertification in Central-Asia / Pilot Project Turkmenistan: Community based resource management in Turkmenistan" (http://www.gtz.de/themen/ebene3.asp?Thema=12&ProjectId=153&Reihenfolge=3&spr=2)

## 1) PRESENTATION OF THE PROJECT AREA (after J. Annaklycheva 2001)

### 1.1) A brief introduction to the History and socio-economics of the area

Throughout centuries nomads had significant knowledge of their environment, vegetation, scarce water supply and other resources that allows them to survive harsh desert conditions. The herds of camels and sheep were best suited to hot climate and often-saline water. Shepherds were able to cope to the biological cycles of vegetation and pressure on feed was limited on the range. Animal production helped making nomads life close to self-sufficient. Sheep, goats and camels produced meat; sheep wool was used for making felts, sacks, ropes, and many other things; sheepskin was used for making fur-coats, fur caps and footwear for cold winter. Wool was essential for all clothes. But camels were also key element in trade, and transport for caravans along the famous Silk Road from Northern China to the Syrian coast, throughout middle and Central Asia.
The society evolved and in the late 19th to early 20th century, three main social emerged in the desert areas of actual Turkmenistan and neighbouring regions: i.e. rich livestock-owners and religious authorities, a middle-class and poor peasants. Prior to the revolution of 1917, different nomadic groups strictly protected their own grazing territories. The wells, a key element in desert survival, were constructed and maintained by rich owners. Up to 1930s, the animals grazed in the desert moving from pastures to pastures following seasonal north –south patterns, using the wells when the desert vegetation dried up, and moving from the deep desert to the hills and the mountains as the dry season settled in, coming back to the desert as the rain came back in autumn to green the desert.

Late in the 19th century, the Russian Empire extended its borders to Central Asia. However, the colonial Russian regime did not interfere much with the local economy in its southern provinces, looking more for other resources such as gas, oil and other minerals than pastures. Starting in the late 19th century, a number of expeditions were organised by the Russian Academy of Science followed soon by Russian migration middle Asia and establishment of new settlements. Slowly and forcibly, the new soviet regime imposed the collectivisation and the establishment of *kolkhozes* (collective farm) and *sovkhozes* (soviet farm). The forced transfer of all livestock to state farms accompanied the change to a sedentary life and collectivisation imposed upon the local population on the best and most productive areas of the country. Slowly, the small nomads population roaming the desert had to register, settle and abandon their transhumance patterns and join the state or collective farms where they had access to more facilities but lost their mean of subsistence and freedom. The imposed sedentary life largely affected their habits, customs and ways of managing their pasture. The availability of modern facilities (schools, roads, medical facilities, water points, electricity, etc) on new settlements encouraged nomads to settle and population increased in the desert areas with ensuing degradation around settlements (overgrazing, fuel wood collection, sand dunes movements, wells salinization, etc). At this time, private traders carried out most of the marketed production but were considered a serious obstacle to the modern development of the livestock sector in the new soviet republic. Civil unrest during the establishment of the Turkmen Soviet Republic (1924–1926) saw the number of livestock dropped sharply to less than 50 % of the livestock population of the pre-Soviet period.

At the beginning of the Second World War, the collectivisation process was provisionally abandoned.
After the war, the second and strong collectivisation wave was enforced under the Stalin regime and completed in the late 50's, with cotton cropping based on artificial irrigation becoming the leading activity in the country. The traditional Turkmen livestock industry suffered from this competition. During the whole soviet period, traditional and ecologically sound transhumance

was totally abandoned giving way to modern rangelands management theories and practices forcing "settled nomads" to use a well defined limited grazing territory mostly in the desert.
At the fall of the soviet system and with independence gained in 1991, the pastoral society gained again momentum, especially when a Presidential Decree (1994) replaced kolkhozes and sovkhozes with *peasant associations*. The land, livestock, property of all kinds, and monetary funds previously belonging to kolkhozes and sovkhozes were transferred to the newly established peasant associations. The bigger part of state-owned livestock was given to individuals on long-term leases. After the abolishment of the state farm system in 1994, the grazing management slowly evolved in the desert communities. Feeling more autonomous, and weakly supported by the authorities, they renewed with traditional practices and regain confidence in some sort of flock movements, transhumance and on their own professional skills and experience. Some groups reorganized longer migrations with their herds, spending almost the whole year on the pastures, relying less and less on expensive complementary feeding not easily accessible. The old settlements and their population are in poor condition, constantly under attacked and pressure from mobile dunes, having difficulties to locate fresh water, feed and fuel wood supplies for their daily needs.
People, who have decided to stay in desert settlements or have no other options but to stay, are now trying to get organized to regain confidence in their environment severely damaged by years of mismanagement and abuse. This is where we intend to support their battle against the desert and to restore with them as much as possible the availability of essential and sustainable desert resources

1.2) The Erbent Peasant Association Pilot area

The Turkmen authorities have selected the Erbent Peasant Association (EPA) for testing the participatory approach in combating desertification in Turkmenistan in the Central Karakum (see location map). It is located some 80 –100 km north of Ashgabat on the Ashgabat-Dashoguz highway. The main village is Bakhardok, the administrative center of the EPA. Other villages within the borders of the EPA are Erbent, Yarma, Chalysh, Mamed-Yar, and Sovma .

Why this choice?

- The EPA zone is typical of the sandy desert zone in the Central Karakum.
- Different kinds of ecological stresses peculiar to the desert conditions can be observed in the study area (degradation of vegetation, soil erosion, shifting sands).
- The local communities are typical and skilled desert livestock-breeders (Sheep and camels) combining their activities with irrigation farming mostly for forage production.
- Irrigation is available from the Karakum canal to support livestock industries and forestry activities.
- The highway Ashgabat-Dashaguz runs across the EPA territory and offers easy access from Ashkabat, rendering uncomplicated communication with the settlements and frequent visits to the pilot area

*Location*
The EPA controls a territory of some 9000 km² located in the middle part of the Central Karakum including mostly sand dunes desert (75-80 % of Turkmenistan), some small areas under irrigation producing fodder crops, cereals and some vegetables for the EPA population.
The Erbent EPA includes five main centers or farms: Bakhardok, Mamed-Yar, Erbent, Bory, Dingly. Each central farm is surrounded by a number of smaller villages inhabited by shepherd families with both private and state owned livestock. The main center, Bakhardok about 370 families with a population of approximately 2000 people), is located 90 km north of Ashkabat along the Ashgabat-Dashoguz highway.

*Population and Migration*

The EPA gathers some 8,000 people (1998 census) mostly concentrated along in large settlements along the main asphalt road Ashgabat-Dashoguz. The villages have water and electricity that attract people from more remote and isolated desert settlements. Bakhardok has the biggest school in the region, a hospital and some basic shopping facilities. The road facilitates communication and easy access to the main market places near Ashkabat to deliver animal products. Migration from desert settlements due to lack of job opportunities and mostly from young generation to largest settlement and to the capital is strong but faces many constraints such as again lack of job opportunities and accommodation facilities in new migration target areas. There is no doubt that out-migration is simply triggered by the lack of serious and sustainable job opportunities than environmental difficulties.

*Education*

The EPA has both primary and secondary schools. However, secondary schools are located in the large villages and the farms' centers. The Bakhardok boarding secondary school was unfortunately closed in 1998 and stopped providing education to children from neighboring villages and small isolated settlements. A dangerous trend is observed with children not anymore attending school because of the lack of transportation to and from school.

*Transportation*

The asphalt road crossing Turkmenistan from south to north makes communication with the desert settlements easy. Buses and trade trucks supply Bakhardok and other settlements along the road. Transversal sandy tracks are usually extremely difficult as they are often covered with mobile dunes rendering communication and exchanges with larger centers difficult. The trade trucks passing through the EPA and commuting from the northern oasis to Ashgabat's markets service the roadside villages. Villagers buy or most of the times barter necessary products they do not produce on the EPA. Prices are usually lower than in Ashkabat.

*Water Supply*

It is the key element to survival in desert condition. Since ancient time, shepherds and desert population use to rely on limited water obtained from shallow wells and water harvesting systems on takyrs. Most of the water from local shallow wells cannot be used for safe drinking and irrigation, they are often salty or "bitter" as qualified by the population and available in any case in small quantity barely suitable for irrigation of small garden.

*Traditional Methods of Water harvesting*

An old method of collection and storage of rainfall and other precipitation (snow melting) is still been practiced in a few settlements and on remote desert zones. During the rainfall season precipitation was collected on large and nearly flat area called "takyr". Takyr are usually inter-dunes flats with a soil that is compacted clay soil preventing water infiltration. If the amount of precipitation reaches at least 5-6 mm, it starts flowing towards the lower end of the Takyr in an artificial pool ("oi"), filtered through a sand patch and is further stored in an under-ground constructed cistern ("sardob"). The volume of fresh water collected in this way depends on the amount of rain and the size of the water catchment. This water collected on takyr is usually good and reasonably suitable for animal and human consumption. This was a very much-needed water supply for shepherds and flocks at the end of the spring when flocks were moving back towards the greener pastures in the hills, and out of the dried desert pastures.

However, this water harvesting method requires the good maintenance of the takyr, i.e. keeping the area totally bare and clean, devoid or stones or vegetation that can stop the water flow.

The crusted and compacted topsoil is nowadays often damaged by all sorts of vehicle (motor bikes, cars and trucks) roaming the desert and using frequently the takyr that are flat and easy ways for communication, as by caravans in the ancient time.

Slowly this traditional method of water harvesting was almost abandoned because of other easier water supply available in modern time. The availability of water trucks during the soviet time changed the perspective for desert population and livestock owners.

*Modern water supply*

Prior to the installation of the water supply in 1979, the EPA population use water brought from the capital, or from well by trucks and some limited supply harvested on takyrs. It is still common to find families buying fresh and good quality drinking water that is kept in cisterns attached to their house. Nowadays, and after the construction of water pipeline, the EPA population is getting free fresh water from the Karakum Canal supplied with water from the far-away Amu-Darya River. However, and despite a filtering and purification units being established on the pipe, the water quality is not really good enough for human consumption. It is mostly used for irrigation and livestock watering. The latter use not being satisfactory as shepherd blame the water quality for sheep diseases and other troubles. The piped water is mostly used then for the irrigation of some 900 ha of fodder crop and private small patches of private land; This creates problems as of the initially planned discharge of 600–700 l/sec to reach the EPA area, only 200–250 l/sec are available for the EPA. The population seriously blames the wear and tear and poor maintenance of the pipeline.

Climatology and biogeography of the region (after Babaev 1994, Orlovsky 1994, Kharin 1994, Rustamov 1994, Gintzburger et al, in press)

The Karakum sand covers some 360,000 km² in Turkmenistan (see map) between the Uzboi in the west, the Amu-Darya River in the east, the Kopetdag and Paropamiz mountains in the south, and Kwarazm (or Khiva) Oasis in the north. This vast territory is divided into Trans-Unguz and Lowland Karakum: the latter, in turn, is divided into the Central Karakum (GokTepe – Erbent) and the Southeast Karakum (Mary – Ravnina – Repetek). It extends into the southern Kyzylkum into Uzbekistan to the North East and East.

The Central Karakum expand northward from the hills below the Kopetdag. Elevations vary from 20 m in the west to 200 m in the east. Long north-south ridges of sand dunes (10 km long and 15–40 m high) appear north from the Kopetdag piedmont with elongated patches of takyrs in inter-dunes depression and salty flats ("Solonchak").

*Temperature, precipitation and wind*

The climate is definitely continental with a continentality index (Thermal amplitude between the mean daily maximum of the warmest month and the mean daily minimum of the coldest month) of some 45-50°C.

The absolute maximum of air temperature varies from +25 to +40 °C in winter and +41 to +47 °C in summer. The coldest months are December and January when the minimum temperature may reach •26 to •30 °C. The absolute minimum of air temperature ranges from •4 to •30 °C in October–April and •4 to •16 °C in May–September. The average monthly soil temperature in July varies from 32–38°C and, in some days, may reach a maximum of +76 –78 °C on the soil surface. The average annual temperature of soil surface varies from 18 °C to 20 °C in the Central Karakum. The average annual mean of air temperature of the over the territory of the Central Karakum varies from +14,8 °C in the north (Darvaza), and increase southward reaching +15,8 °C in the central part (Bakhardok, Erbent – Fig. 1, Fig. 2). The sum of temperatures varies from 4,900 °C to 6,900 °C, both at the soil surface and at a depth of 20 cm. Another characteristic of the Karakum desert is the long duration of solar radiance, which makes up in average 2,800–3,100 hours yearly. In January the duration of solar radiance is 100–150 hours and in July reaches 80–90 % of maximum possible duration, i.e. 320–400 hours.

The central Karakum receive an average total precipitation (rain and snow) of 80-140 mm /year. Most precipitation falls during the second half of winter and first part of spring. The summer is always dry and very hot. Therefore the Karakum is classified in the cold arid Mediterranean bioclimate. Fifteen to twenty % of precipitation is falling as snow, 60–70 % fall as rain mostly in spring. As most arid zones of the world, the inter-annual and intra-annual total amount of precipitations variability is high. The annual evapotranspiration is high, over 2,100 mm that is about 20 times the total annual precipitations.
Northeastern anticyclones dominate during winter while western and northwestern cyclones prevail during warm season. The winds with low and moderate velocity (0–5 m/sec) are prevailing throughout the year, but winter and spring winds are the strongest (> 15 m/sec– during 10-15 days). In Bakhardok, eastern winds prevail from October till March. Afterwards, the wind blows from west and north generating some strong sand storm. This is the time when sand dunes are moving.

*The Water table in the Karakum*

Despite lacking surface water and being extremely dry, the Central Karakum has abundant underground water often slightly saline. They form a large water table called the "Karakum flow" that allows the growth of numerous large phreatophytic and slightly halophytic small trees, bushes and shrubs (mostly *Haloxylon* sp.). Depending on the topography and geology, the water table can be reached at the depth of 10–25 m, and may be close to the surface (0.4–1 m) in solonchak depressions especially during the winter. The water table is fed by infiltration from the Amu-Darya River and the endoreic deltas of the Murgab and Tedjen rivers in the eastern part of the desert. The Kopet-Dag Mountains and recently, the Karakum Canal in the south part of the desert contributes largely to the water supply to the "Karakum flow", as well as precipitation collected on takyrs and sand dunes. All this water percolates to the saline water table, a long lasting resources that is used by the desert dwellers since ancient time knowing were to access with wells in the desert. However, the salinity increases from south (diluted with water from the Karakum Canal flowing to the West -North West) to the north and may reach 40 g/l in the Northern Karakum, rendering this resource inappropriate for any utilization either by human or animals. There the water table is close to the surface forming salty marshes known as "tepiz" and salty flat "Solonchak" with strong salt deposits and halophytic vegetation.

*Soils*

The soils of this region are mostly grey-brown, desert, sand and takyrs soils. Soils of the sandy desert are medium to fine-textured sands. The fertility is low, and organic matter content hardly reaches 0.5 %. The halomorphic azonal soils are present on typical takyr, and hydromorphic, solonchak, and solonetz as well. The takyr soils, present on ancient alluvial delta and colluvial foothill plains have a distinctive clay texture, forming polygonal cracks and saline deposits in summer. Solonchak and derived solonetz (formed under poor irrigation practices and inadequate leaching) formed by salt deposition and clay dispersion under strong saline condition are common on ancient alluvial deposits throughout the Central Karakum. Salinization of irrigated areas is a common problem throughout the region.

*Vegetation Cover and utilization*

The distinctive features of sandy deserts that differentiate them from other desert types are due to the properties of the sand, i.e. a high water infiltration rate, a mobile substrate, significant condensation ability, and low salinity. Moreover, the sandy substrate differs from other substrates by having a more favourable water regime that allows a long period of plant growth because of easily available water stored in the soil profile. Conversely, a number of negative aspects affect the plant cover on sandy soils such as sand mobility that limits plant establishment, poor soil structure and low organic matter. The trampling by grazing livestock

easily loosens it. It is also subject to high temperatures as during the summer when the soil surface may reach 60–70 °

The psammophytes, the most common plants in the Karakum, are adapted to the particular conditions of sandy soils in a desert environment , and include a variety of plant forms, i.e. annuals, shrubs and trees. The landscape physiognomy and vegetation structure is similar to the fixed sand dunes of the Djeffara plain in Libya (Gintzburger 1986), in spite of noticeable differences in climate.

Many plants from this desert have also some summer activity though annual and ephemeral vegetation will grow during the end of the winter and in spring. Many woody species are specifically summer active, very likely because of their ability to extend their roots deep (10–30 m) into the soil, and into the high or perched water table common in the Kyzylkum (and Karakum) desert, as represented by *Haloxylon aphyllum, H. persicum* and *H. ammodendron*. This is a definite environmental advantage that few other plants have in other hot deserts of the world (Gintzburger and Le Houérou in press).

About 60 basic plant associations are found in the sandy desert. Most are ligneous associations making up 30% of the Karakum flora:

- micro-nanophanerophytes: *Haloxylon persicum, H. aphyllum, Ammodendron conollyi, Salsola richteri* and *S. paletzkiana* over sand dunes
- nano-phanerophytes: *Salsola arbuscula, S. arbusculiformis, Calligonum* spp., *Ephedra strobilacea, Astragalus unifoliolatus, A. paucijugus* and *A. villosissimus* on fixed dunes
- chamaephytes: *Convolvulus divaricatus, C. hamadae* (characteristic of inter-dune depressions with compacted sands), *Mausolea eriocarpa, Artemisia diffusa, Halothamnus subaphylla, Acantophyllum borsczowii, A. elatius, A. turanica* and *S. orientalis*
- ephemeroids and grasses (about 10%): *Carex physodes* and *Poa bulbosa* which frequently make a continuous carpet over sand dunes with a 2–4 cm mat of superficial densely interwoven roots dominating the vegetation cover. Also remarkable is *Ferula assa-foetida*, a large plant of the Apiaceae
- perennial grasses (20%) dominated by *Aristida pennata* and *A. karelinii*, growing over mobile sand; they are good sand-fixing pioneer plants
- annual summer plants make up about 40% of sandy desert flora: *Agriophyllum latifolium, A. minus, Corispermum lehmannianum* and *Salsola paulsenii, S. praecox, S. aperta, Climacoptera lanata, C. crassa* and *C. turkomanica*
- ephemerals like *Eremopyrum distans, E. orientale, E. bonaepartis, Senecio subdentalis, Malcolmia grandiflora, M. africana, Isatis violascens, I. minima, Tetracme recurvata, Stretoloma desertorum, Matricaria lamellata*, etc.

The sandy desert rangeland is considered the major source of fodder rangeland for Karakul sheep and camels. The essential feature of this sandy desert pasture is the relative yield stability and use all year round, but with low production (in spring: 0.2–0.5 t DM/ha, rarely 0.6–0.9 t DM/ha. The rangelands of the south eastern Karakum are mostly used as autumn-winter pastures as they offer good protection against winter storm, but with an unreliable productivity of 0.1–0.9 t DM/ha, depending on annual rainfall, vegetation cover and diversity of palatable plants (Momotov 1973).

The vegetation cover of this saline desert is highly heterogeneous due to the diversity of soil conditions. It is also highly dynamic due to constant changes in underground water regime and salinity type. The driest areas are occupied by salt-tolerant species of *Artemisia*, various succulent hyper-halophytes of the Chenopodiaceae such as *Salicornia, Halostachys, Kalidium, Halocnemum* and many species of *Salsola, Halimocnemis* and *Anabasis*. When the water table

reaches the soil surface, resistant annual and perennial herbaceous graminaceous (Poaceae), *Aeluropus litoralis*, *Phragmites communis* and *Erianthus* sp. become abundant.
The average productivity of such pastures is usually low (0.3–0.5 t DM/ha) and may vary from year to year according to precipitation and climatic conditions. Most of the time, camels use halophytic rangelands during autumn and winter, when the excess salt is leached away by precipitation.

## 2) WHAT SHALL WE DO ON RANGELAND OF THE ERBENT PEASANT ASSOCIATION?

### The basic of range management and rehabilitation activities

In view of the current poor management conditions of Central Asian rangelands, in close collaboration with the pastoral communities, the present proposal will aim at significantly increasing their efforts to rehabilitate rangelands in the fight against desertification. Our role must be to simultaneously address the feed issue for the local population and the environmental problem of desertification. We must provide readily accessible and relevant information to local farming and pastoral communities. This is to help managing, maintaining or restoring their rangeland natural resources in a sustainable manner, in agreement and with the full support of the national, regional and international authorities.

Community Participation, Public Policy and Land Tenure issues are also key topics that must also received major consideration and priority in our study. We anticipate that natural resources assessment and rehabilitation are the first priorities where we must put our priorities in the very near future if we want the Pilot area to draw full benefits from their rangelands.

To develop proper range management research activities, three main thrusts are to be developed simultaneously with permanent interconnections.

### 2.1) Rangeland assessment / vegetation resources inventory & monitoring of the erbent peasant association's rangeland (Turkmenistan)

Rangeland management is based on a strict inventory of available range feed resources to organize a sustainable utilization. This is the general purpose of the following activities. NARC must get this basic information before engaging in further more elaborated and complex research. These are unfortunately often lacking or not regularly updated in most of the countries of the region.

Proper range management by local communities in the region can only be achieved by being able to locate, quantify and correlate soil, climate, natural vegetation and current land use on topic and composite maps. This is a multidisciplinary work requiring support and collaboration with vegetation and soil specialists, agro-climatologists, livestock experts and Socio-economists.

General objective: an appropriate support to rangeland management by identifying (What is available?), locating (Where and when?) and quantifying (How much?) the natural resources available.

This is achieved by developing:

2.1.1) General information on the Erbent rangelands

*2.1.1.1) Support to the Herbarium and Arid Plant Database*

Specific objective: collect range plants specimen from the Erbent region and link it to a GIS system available to the scientific community

This could be part of a national Turkmen effort on Rangeland Biodiversity run in collaboration with Genetic Resources Unit from International organization.

*2.1.1.2) The NARC Rangeland publication and maps Data base*

Specific objective: Support the effort to build up a reference library of Erbent rangeland and resources maps.

Activities: locate, collect, identify and store in the National NARC Library all publications related to Erbent rangeland activities.

Output:

- The Erbent Range Library Catalogue,
- A computerized database of national rangeland related publications and maps available to all.

2.1.2) Rangeland inventory and monitoring of Erbent pilot zone

We will develop the following

*2.1.2.1) Range RS-GIS and mapping*

With the support of the MTD (Maison de la Télédétection – CIRAD Montpellier France) and in collaboration the National Institute of Deserts: Flora and Fauna, we will help developing a reliable and properly serviced Geographical Information System (GIS) associated with a simple but efficient mapping service having access to commercial Remote Sensing (RS) material (Aerial photos and satellite images).

*Specific objective:* an RS-GIS mapping support for rangeland works in the Erbent region

*Activities:* contribute to establishing a functional Remote Sensing-GIS / Mapping facility with the appropriate hardware and software and database.

*Output:* produce thematic and composite maps for range management and other purpose (fuel wood plantation, fodder reserves plantation, protected areas, etc).

*2.1.2.2) Phyto-ecological surveys*

The support of the Remote Sensing unit the GIS and Mapping section for this activity is essential. Field surveys will be supported by a preparatory phase using recent satellite imagery.

*Specific objectives*: identify, describe qualitatively and quantitatively, and locate the main range vegetation unit.

*Activities:* vegetation surveys to identify rangelands and characterize the current condition of range plant communities in relation to soil, climate, land use, water resources and access road and tracks.

*Output:* thematic vegetation and range maps at operational scale (1/100000 to 1/50000) for future planning purpose and range and land management activities (See attached vegetation and biomass maps of the Ravnina region – Turkmenistan).

*2.1.2.3) Photosynthetic activities on the range – Range phenology*

Specific objective: a thematic map on the season of use of the main range type using the "Vegetation" satellite information freely available on www.vgt.@vito.be allowing us to identify « annual vegetation » and « perennial vegetation" photosynthetic activities (Image available at 10 days interval since spring 1998)

*Activities:* Process the "Vegetation" satellite image to identify photosynthetic activities and relate these to range potential utilisation,
*Output:* Seasonal utilization (grazing or harvesting period for seed collection),

*2.1.2.4) Range monitoring and aboveground biomass measurements*

This is an essential activity that will help range managers to evaluate the current stocking rates
Specific objectives: range status, desertization and degradation or improvement trends in terms of plant cover and aboveground biomass.

*Activities:*

- Monitoring range condition using image processing at different scale and from different time as well as simple methods like the Line Interception Transects (% vegetation cover).
- Quantifying range biomass of major range vegetation types of the region (See Range Biomass map of the Ravnina region – Turkmenistan)

*Output:*

- Validate and produce range biomass maps,
- Monitor rangeland trends (% vegetation cover, desertization trends, etc),
- Develop simple models linking seasonal biomass production, Soil water budget, soil type and simple climatic factors (rainfall and temperature),
- Establish the seasonal maximum allowable stocking rate and period of utilization by the local flocks in consultation with the pastoralists.

2.2) Rangeland rehabilitation and restoration ecology

Once we have these information (Range species ecology, phenology, biomass, rangelands trends, current stocking rates, wells location and water quality, active wind or water erosion sites, sand dunes movements, etc.), we will be in a position to act on where, when, with what kind of plants and how, we should approach the range rehabilitation task. This must be after consultation and in full collaboration with the pastoral community. Especially important is the urgent establishment of local desert trees (*Haloxylon* sp. And *Ammodendron* sp.) for plantation close to the villages for fuel wood supply and protection against sand dune encroachment. This will be organized with the permanent input from the local communities and the GTZ project.

A number of actions are necessary to launch without further delays.

2.2.1) Collection, evaluation and seed production of promising rangeland plant material for restoration
Specific objective: make available appropriate native and exotic species to use on range restoration projects,
Activities:

- Identify, collect, evaluate plant material from rangeland of the pilot area,
- Develop seed and seedling production units and nurseries with school children, local population and government agencies

Output:

- Range plant and seed collection,
- Seed and nursery of appropriate Range species for restoration projects,
- Vegetation surveys,
- Species data base information (in relation to SEPASAL, IPGRI) will permit to choose the proper plant material to be (re)-established in a specific environment in relation to the future use by the local population (grazing, erosion control, fuel harvesting, wild life stimulation or re-establishment, etc).

This part must be developed in collaboration with the National Plant Genetic Resources units, local plant breeders and foresters to collect, evaluate, demonstrate, produce in large quantity seeds or seedlings of adequate plant material for arid land plantation and rehabilitation on degraded areas or on sand dunes areas near villages.

2.2.2) Range rehabilitation techniques development

Specific objective: a list of appropriate and economic technical package to use on range restoration projects after having selected appropriate sites using field ecological and socio-economical data and GIS to locate the appropriate site for range restoration and fuel wood plantations,
Activities: test different and simple sand dune fixation restoration techniques by combined biological and physical means (oil waste spray on mobile dunes, local soil treatments – soil / water storage, transplantation of seedlings, use of cuttings, pre-germination, etc.)
Output: a set of technical package for different ecological and socio-economical environments and demonstration with local population

2.2.3) Management of restored areas in collaboration with the local population

The local and social rules of natural resources management by different users must be first understood through proper survey. Management proposals will then be developed based upon natural resources available and carried out after consultation and in agreement with the local population and potential users. Failing to do so is leading to conflicts between users and costly failures

*Specific objective:* a sustainable management of restored area projects,
*Activities:* survey, describe and understand the local rules of land management by local population, propose acceptable options to improve sustainability of the new measures, test proposed new rules,
*Output:* a map and methodology for developing sustainable range management rules in agreement with the request from the local community.

This information is to be used to discuss with the local authorities and the pastoral communities to propose range management plans. Their realistic assessment emphasized the importance of a participatory approach to ensure that new technologies will respond to real community needs.

## 2.3) Range management strategy

It is essential to have the appropriate GIS information including topographic features, local infrastructures (Watershed limits, settlement and camp sites, roads, tracks, water points and facilities), vegetation maps (type, seasonal biomass availability), communities' boundaries (administrative, grazing territories, transhumant roads, etc.).

Specific objective: Develop sustainable range management option for livestock production in consultation with the local population and authorities
Activities: Integrated biological (plant – livestock) and socio-economic constraints using GIS-RS technologies,
Output: Contribute to optimise range utilization in a sustainable way by local communities in agreement with the local authorities.

COLLABORATORS

1. National Institute of Deserts: Flora and Fauna (Ashkabat)
   Laboratory of Forests and Rangelands (NID –FF / LRF)
   - Dr. Mahamet Durikov, Head Laboratory
   - Dr Batyr Mamedov, Senior Research Scientist, Land management and conservation specialist
   - Prof. M. Nurberdiyev, Agro-meteorologist / Range rehabilitation specialist
   - Jamal Annaklycheva, Socio-economist
   - Mrs Natalia Medvedeva, GIS-RS specialist

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   Fax + 993 12 39 86 01
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   Two students from Turkmenistan specialising in the field of Range ecology – management / RS & GIS will be trained during the duration of this project.

2. CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) – EMVT (Département d'Elevage et de Medecine Vétérinaire)
   - Dr G. Gintzburger, Directeur de Recherche, Agro-pastoralist (Mediterranean region and Central Asia), CIRAD –EMVT
   - Dr A. Bégué, Directeur de Recherche, Directeur du Laboratoire Cirad-Amis GEOTROP (GIS and RS),
   - M. Despinoy, RS-GIS specialist, Cirad-Amis GEOTROP
   - Ms V. Soti, RS specialist, CIRAD-EMVT SILAT Trainee (Image processing) and other students.

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## CAPABILITIES AND LOCAL RESOURCES

CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) – EMVT (Département d'Elevage et de Médecine Vétérinaire) www.cirad.fr

The CIRAD is a large French research organization dealing with Agricultural Research and development in the developing World. Within the CIRAD, the EMVT (Département d'Elevage et de Médecine Vétérinaire) is conducting research in the field of Animal Health, Animal production and Wild life and Range Management.
Dr G. Gintzburger is a range specialist with some 25 years experience of range survey, monitoring and management (see recent publications) in the Mediterranean arid zones, with long assignments and residence in Algeria (2 years), Libya (5 years), Australia (5 years), and Syria (7 years). He extended his range expertise during the last 8 years in Middle and Central Asia working exclusively in Uzbekistan (book on the Uzbek Rangelands in preparation), Baluchistan (Pakistan), and is currently working on a EU project Turkmenistan and Kazakhstan (DARCA - Desertification and Regeneration: Modelling the Impact of Market Reforms on Central Asian Rangelands / http://www.macaulay.ac.uk/darca/Index.htm ) in charge of the Vegetation Assessment and Desertification Monitoring. In his work, he is supported by Dr Agnés Bégué and M. Despinoy (Remote Sensing GIS & specialists) from the "Maison de la Télédétection - MTD", www.teledetection.fr , http://www.teledetection.fr/pages/Geotrop_E.pdf ), with extensive experience in image processing and training capabilities in their field.

National Institute of Deserts: Flora and Fauna (Ashkabat) - Laboratory of Forests and Rangelands (NID –FF / LRF)

The National Institute of Deserts: Flora and Fauna (Ashkabat - Turkmenistan) has been for over half a century and still is a centre of excellence and leading internationally famous desert research institute working all over the Middle and Central Asia and other arid zones of the World.

The team of the Laboratory for Rangeland and Forestry is composed of Dr. Mahamet Durikov (Head of Unit), Dr Batyr Mamedov (Senior Research Scientist, Land management and conservation specialist), Prof. M. Nurberdiyev (Agro-meteorologist / Range rehabilitation specialist), and assistants, Ms Jamal Annaklycheva (Socio-economist) and Mrs Natalia Medvedeva (GIS-RS specialist). They are currently working on a project on a participative rangeland project in the Erbent zone in collaboration with the German GTZ (GTZ-CCD-Project - Support of selected pilot projects for poverty alleviation and combating desertification in Central-Asia / Pilot Project Turkmenistan: Community based resource management in Turkmenistan).

Our project proposal is organized to support and strengthen the GTZ collaborative project in the Erbent zone by providing necessary expertise in the field of Range survey and management in collaboration with our Turkmen colleagues.

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# ANNEX

Planning
Range survey, assessment and management in Erbent pilot area
Map of Turkmenistan
Figure 1 : Climatogram Erbent
Figure 2 : Climatogram Bakhardok
Vegetation map
Above-ground biomass
Photographies

## Planning

- Project duration: 30 months (2,5 Years)
- Starting: March 2003 (Spring 2003)

| Action (month of the year) | Semester 1 | | | | | | Semester 2 | | | | | | Semester 3 | | | | | | Semester 4 | | | | | | Semester 5 | | | | | | IN CHARG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | |
| 2.1) RANGELANDS RESOURCES INVENTORY, MONITORING AND MANAGEMENT OF THE ERBENT PEASANT ASSOCIATION'S RANGELAND (TURKMENISTAN) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.1.1) General information on the Erbent rangelands | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF & CIRAD-EMVT |
| *2.1.1.1) Support to the Herbarium and Arid Plant Database* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF |
| *2.1.1.2) The NARC Rangeland publication and maps Data base* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF |
| 2.1.2) Rangeland inventory and monitoring of Erbent pilot zone | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | CIRAD – EMVT & NID-FF – LRF |
| *2.1.2.1) Range RS-GIS and mapping* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | CIRAD - EMVT |
| *2.1.2.2) Phyto-ecological surveys* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | CIRAD - EMVT |
| *2.1.2.3) Photosynthetic activities on the range – Range phenology* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | CIRAD - EMVT |

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| *2.1.2.4) Range monitoring and aboveground biomass measurements* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | CIRAD - EMVT |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Action (month of the year) | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | In charge |
| 2.2) RANGELAND REHABILITATION AND RESTORATION ECOLOGY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF & CIRAD-EMVT |
| *2.2.1) Collection, evaluation and seed production of promising rangeland plant material for restoration* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF |
| *2.2.2) Range restoration techniques development* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF |
| *2.2.3) Management of restored areas in collaboration with the local population* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NID-FF – LRF |
| 2.3) RANGE MANAGEMENT STRATEGY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | CIRAD – EMVT & NID-FF – LRF |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coordination meeting in Turkmenistan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turkmen training in France | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| French students in Turkmenistan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Field work in Turkmenistan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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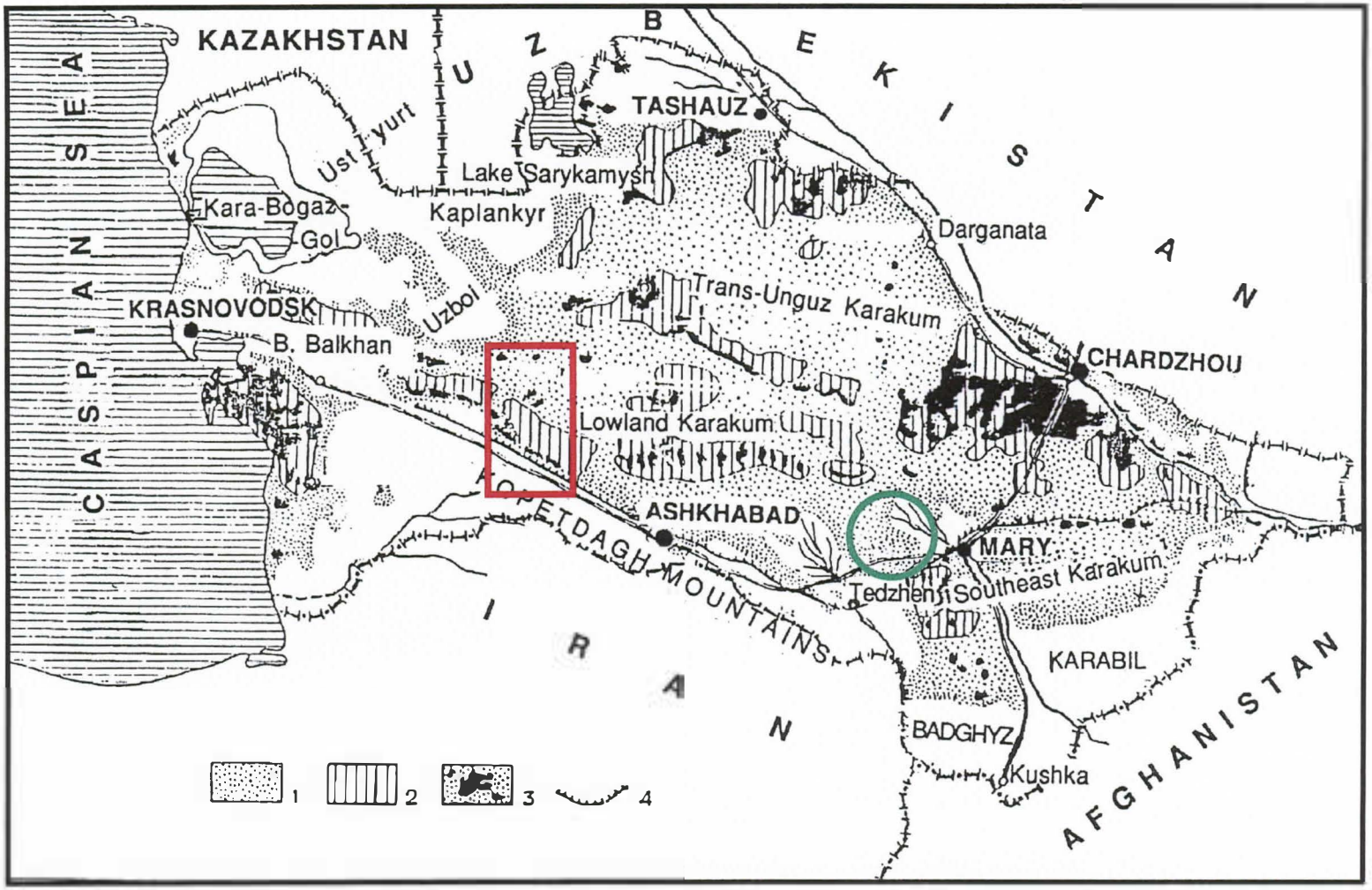
# Combating desertification in Turkmenistan:

# Range survey, assessment and management in Erbent pilot area

| | Man.month | Total | On project funds requested |
|---|---|---|---|
| **1. National Institute of Deserts: Flora and Fauna (Ashkabat) Laboratory of Forests and Rangelands** | | | |
| Covered by the Turkmen Institute | | | |
| - Dr. Mahamet Durikov, Head Laboratory | 4 | | 0 |
| - Dr Batyr Mamedov, Senior Research Scientist, Land management and conservation specialist | 10 | | 0 |
| - Prof. M. Nurberdiyev, Agro-meteorologist / Range rehabilitation specialist | 10 | | 0 |
| - Jamal Annaklycheva, Socio-economist | 10 | | 0 |
| - Mrs Natalia Medvedeva, GIS-RS specialist | 10 | | 0 |
| | | 44 | 0 |
| | | | 0 |
| | | | |
| **2. CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) (Département d'Elevage et de Medecine Vétérinaire) et AMIS-Geotrop** **EMVT-Econap** | | | |
| **Covered from other funding sources** | | | |
| - Dr G. Gintzburger, Directeur de Recherche, Agro-pastoralist (Mediterranean region and Central Asia), CIRAD –EMVT | 12 | | 0 |
| - Dr A. Bégué, Directeur de Recherche, Directeur du Laboratoire Cirad-Amis GEOTROP (GIS and RS). | 2 | | 0 |
| - M. Despinoy, RS-GIS specialist, Cirad-Amis GEOTROP | 2 | | 0 |
| - Ms V. Soti, RS specialist, CIRAD-EMVT SILAT Trainee (Image processing) | 6 | | 0 |
| - Scientists from Turkmenistan | 0 | | 6 |
| - Field / Lab assistants from Turkmenistan | 0 | | 12 |
| - Students from France | 0 | | 12 |
| | | 22 | 30 |
| | | | |
| Total man.month | | 66 | 30 |
| | | | |
| Grand total | | | 96 |




MAP OF TURKMENISTAN (After Fet & Atmuradov 1994)

Legend: 1) Stable sand 2) semi-mobile sand 3) Mobile dunes 4) Karakum Canal 5) Erbent Pilot zone 6) Ravnina area

**Figure 1: Climatogram ERBENT (Gök Tepe)**
**(N39 16.444 E58 35.076) -TURKMENISTAN (1936-1980/5)**

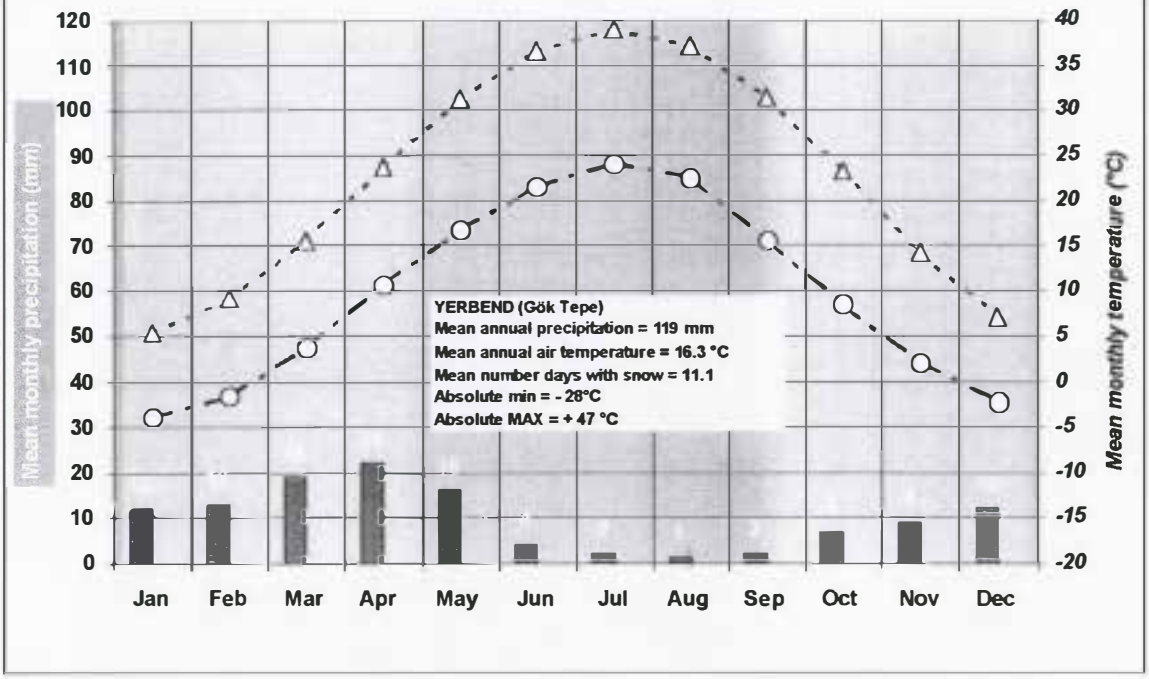
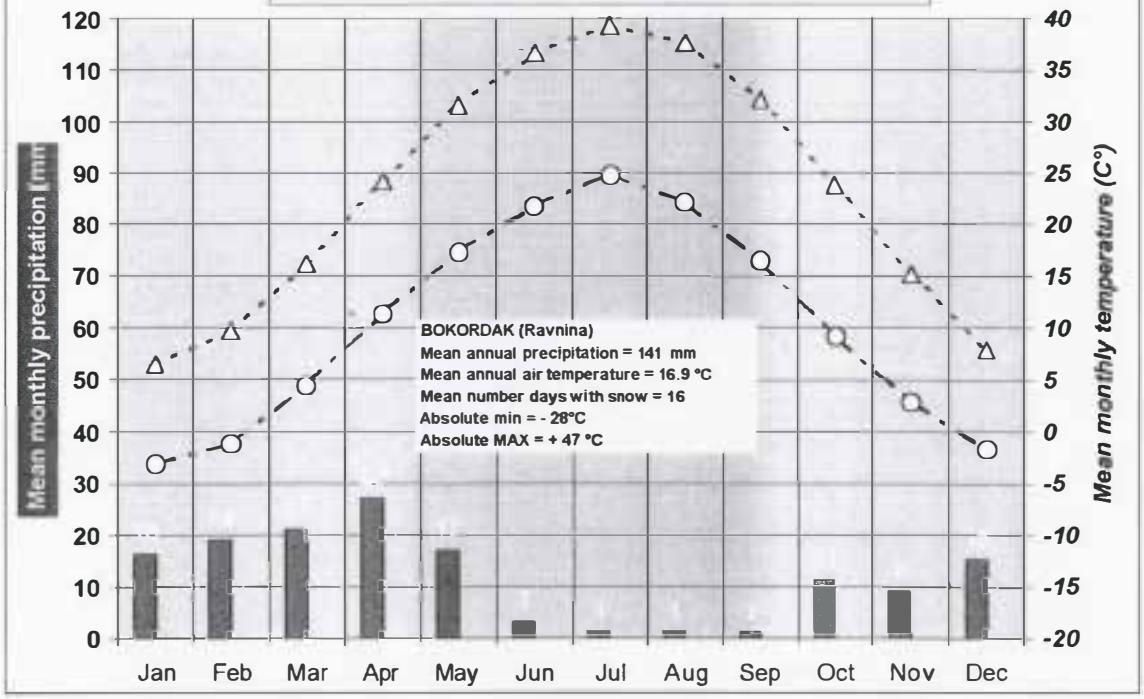
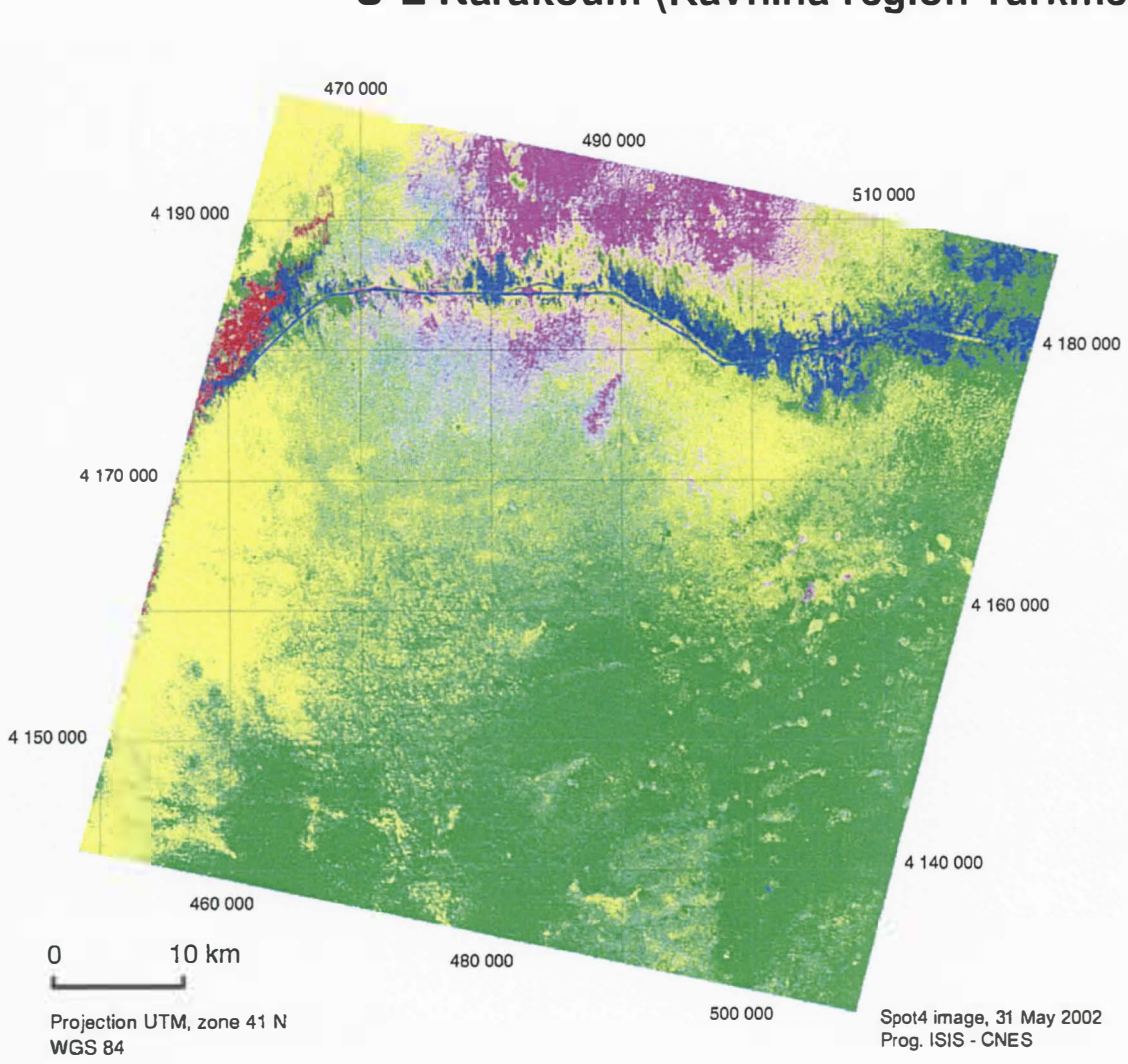



**Figure 2: Climatogram BAKHARDOK (Gök Tepe)**
**(N38 44.432 E58 28.566) - TURKMENISTAN (1935-85/86)**



# Carte simplifiée de la végétation / A simple vegetation map
# S-E Karakoum (Ravnina region Turkmenistan)

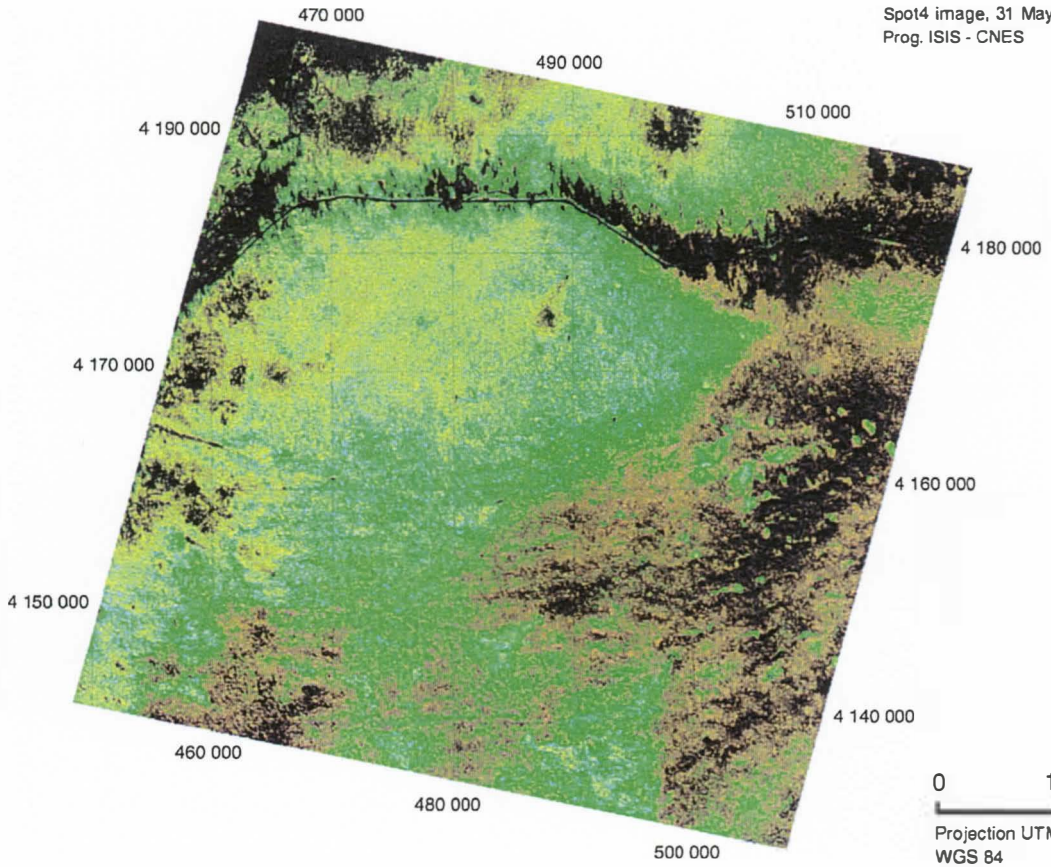



- **Sols nus et salés, dunes mobiles, faible couvert végétal** / Bare soil and saline areas, mobile dunes, low vegetation cover.
- **Végétation à dominante d'annuelles (*Bromus sp., Cutandia, etc...*) et éphéméroïdes (*Poa Bulbosa, Carex Physodes*) sur dunes moyennes fixées par *Haloxylon et Calligonum*** / Annual vegetation (*Bromus sp., Cutandia, etc...*) and ephemeroid (*Poa Bulbosa, Carex physodes*) vegetation on low dunes fixed with *Haloxylon and Calligonum*.
- **Végétation à dominante de pérennes (*Haloxylon, Calligonum, Ephedra, Convolvulus, Astragalus sp., etc...*) sur hautes dunes fixées** / Perennial vegetation (*Haloxylon, Calligonum, Ephedra, Convolvulus, Astragalus sp., etc*) on high fixed dunes.
- **Formation dense à Haloxylon sp. (*A. aphyllum, A. persicum*)** / Dense stand of Haloxylon sp. (*H. Aphyllum et H. Persicum*).
- **Cultures irriguées** / irrigated farming.
- **Marécages, zones inondées, cours d'eau et canal du Karakoum** / Marshes, flooded areas, rivers and Karakum canal.

Vegetation survey and concept : G. Gintzburger (Cirad-emvt / econap) & H. Handjaev ( IAHVD )
Field survey : V. Soti, G. Gintzburger (Cirad-emvt / econap), H. Handjaev, A. Cherkezov, D. Orazlgeldiev, B. Sopwiew ( IAHVD ).
Remote sensing, GIS and mapping : V. Soti (Cirad-emvt / econap), M. Despinoy, A. Bégué (CIRAD-amis / geotrop).
Map and GIS preparation : V. Soti ( Aug. 2002).

Emvt-econap
&
Amis-geotrop
CIRAD
Maison de la Télédétection, Montpellier.

# Biomasse végétale aérienne / Above-ground biomass
## S-E Karakum (Ravnina region -Turkmenistan)




Spot4 image, 31 May 2002
Prog. ISIS - CNES

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**Matière sèche / Dry matter (B) (kg/ha)**

- 250 < B < 350
- 351 < B < 450
- 451 < B < 550
- 551 < B < 650
- Non classée / Not classified

0 10 km

Projection UTM, zone 41 N
WGS 84


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Emvt-econap
&
Amis-geotrop
Maison de la Télédétection, Montpellier.






**Legend** (Photo Gintzburger, Mission Turkmenistan 2002)

Photo 1: In a sand storm between Erbent and Bokordak
Photo 2: Sand dunes encroaching on Ayer (Desert Settlement)
Photo 3: Range assessment (Vegetation cover and biomass measurement) in Gök Tepe region
Photo 4: Vegetation cover measurement on sand dunes in Erbent zone
Photo 5: A villager's plantation of *Ammodendron conollyi* at Ayer
Photo 6: A 'tepiz' north west of Ayer settlement