2º Workshop MEDRAP – *Identification of Sensitive Areas*

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INTRODUCTION

This paper sets out the current knowledge of desertification in Turkey based on the sensitivity studies and a local consultation meeting. It also sets out needs and planned activities for improving our knowledge of desertification, and for improving land use practices.

LOCAL CONSULTATION MEETING

A local consultation meeting was organised in Elazıg province, through 19-20 April 2002. The main purpose of this meeting was to provide information on desertification processes in Turkey, by making participation of local community possible into a local desertification problem and looking in detail at one local situation. A secondary purpose was to begin the process of responding to the problem in the province.

Background

Elazig is a city located in East Anatolia. It recorded a population of 520,000 in the 1999 census. Industry is poorly developed, limited to two government-owned factories (sugar and cement), constructed in the late sixties. Closure of these factories is being considered, given their inefficient operation. Sugar beet production is one of the main agricultural activities, and the sugar factory provides a crucial market for this produce, and is an important local employer.

Elazig which was located on plains (surrounded by high mountains (1900m) is 1067 meter higher than the sea level. In Ottoman times the city was limited to surrounding hills (on which the historical castle of Harput takes place). Settlement of the plains was prohibited by the Sultan, protecting the valuable soils for arable use. Over the last twenty years, however, residential development has spread onto these lands.

The climate is very arid, with less than 400 mm annual rainfall, largely falling in early spring. Summers are long and very dry.

The majority of the rural population lives in very small scattered villages, on very steep lands. Due to their slope and shallow soil cover, these lands are not sufficiently fertile for arable use, and the main rural activity is sheep and goat farming. The income of villagers is very low, and farming practices have resulted in land degradation.

[1] The Ministry of Forestry
[2] Ankara University
[3] The General Directorate of Rural Service
[4] The State Meteorological Service
[5] The Ministry of Agriculture and Rural Affairs

Organisation of Meeting

Table 1 sets out the participants in the meeting, which represented all major stakeholder groups.

Table 1: Stakeholder Profile in LCM

Institution Type	Institution Name	Number of Stakeholders
Governmental	Elazig Governorship Elazig Municipality; Line agencies of the Ministry of Environment; the Ministry of Agricultural and Rural Affair; the Ministry of Forestry; the General Directorate of Rural Service;	1 1 2 2 9 1
Non-Governmental	Elazig Chambers of Farmers Chambers of Agricultural Engineers Chambers of Forestry Engineers TEMA Combating Erosion and Afforestation Foundation	1 1 1 1
University	Ankara University Fırat University	1
Mukhtar[6]	Güzesi Village, Sahsuvar Village Pasakonagi Village	1 1 1
Farmers	Villagers	3
Media	National and local TV Station and newspaper agents	7

The consultation process comprised a one-day meeting, followed by a field study.

Participants were requested to fill out a simple questionnaire, modified from the MEDRAP questionnaire.

The meeting commenced with a presentation by Mehmet Sakir Ozdemir, from the Ministry of Forestry, on the process of desertification at global and national scales, the convention, its national implementation and the MEDRAP. The facilitator, Associate Professor Coskun Ceylan from Ankara University, then explained the objectives and expected outputs of the meeting.

[6] A muhtar is an elected village leader

The meeting then discussed the concepts of desertification and land degradation, before focusing on measures to combat desertification.

Recognition of Desertification Problems

It was clear from the discussions, field study and answers to the questionnaire that while representatives from government agencies were aware of desertification issues, knowledge of the convention and desertification issues is low among most other stakeholder groups. Local farmers appear to have little understanding of the causes of the land degradation that they are suffering from, how to counteract it, and the long term effects on them and their children.

Efforts to combat desertification in the region are generally weak. There are few NGO groups focused on this issue, and poor farmer organisation. Farmers are generally waiting for government agencies to provide the answers to rural development problems. They are generally not aware of the extent of their land degradation problems, and not taking steps to combat land degradation.

The very low levels of income from agriculture also have a negative effect on desertification recognition and response. Unsustainable practices, such as excessive stock numbers, are seen as essential for survival. In addition, most families include at least one government employee, and their contribution to the family income is often larger than that from agriculture, reducing the focus on sustainable agriculture as the main long term income for the family.

Levels of Land Degradation

The meeting assessed this using three socio economic indicators:
- Agricultural income
- Migration
- Fuel/forage needs.

Agricultural Income

Agricultural income is the most effective indicator for land degradation, for two reasons.

Firstly, where agricultural income is very low, unsuitable lands are cultivated. In contrast, where good quality land is available, and can provide an adequate income (e.g. sugar beet cultivation) land degradation is reduced.

Secondly, farmers with low incomes use inefficient or inappropriate production methods in order to reduce their production costs. For example, when ploughing their lands on slopes, they plough parallel to the slope so that they can save fuel, thereby increasing erosion.

Migration

There are two types of migration in the province

Some farmers have deserted their land, migrating permanently to urban areas. This results in land that is suitable for agriculture being unused.

Other farmers migrate seasonally to cities, in order to provide their children with improved education. While these farmers continue to work their land, agriculture activities are reduced.

Fuel/Forage Needs

The only affordable domestic fuel source in rural areas is firewood, which is generally harvested from adjacent forestry areas on steep land.

A second major impact on vegetation cover is over-grazing and collection of fodder. Oak leaves comprise a major fodder source, impacting on the predominant woodland species in the region. Two types of over-grazing were identified. One arises from excessive animal numbers, higher than the carrying capacity of the land. The other is the result of commencing grazing too early in the season.

Potential Solutions

The meeting identified two key measures for combating desertification:
- Improving knowledge and technology
- Increasing rural organization

Improving local knowledge and capacity was identified as vital for reducing desertification. Training should begin in schools and continue life-long.

Organization of farmers will serve to both increase farmers' agricultural income levels and improve their knowledge of available land use methods.

CLIMATIC SENSITIVITY

Drought has been a recurrent phenomenon in Turkey for several decades, and is an important factor in desertification.

An annual precipitation map has been developed by the State Meteorological Service. The information provided by this map, and the underlying data, can then be combined with other data such as soils and vegetation, to identify drought-prone areas.

A soil moisture deficiency map has also been produced. This was designed to spatially define areas where drought gains a persistent behaviour and becomes a naturally occurring phenomenon.

The spatial distribution of precipitation in Turkey is highly variable. Topographic features (mainly mountain chains and depressions), proximity to major pressure systems, and continentality determine the amount and distribution of precipitation each location. In general annual precipitation decreases from the coastal regions toward the interior, where most of the precipitation fall as snow.

The Black Sea region receives the highest annual precipitation, averaging around 750 mm a year. At the eastern end of the region, annual precipitation values reach a maximum of 2500 mm in some years. Precipitation in the Black Sea region is mainly controlled by frontal systems in winter and by orographic features in summer.

Next wettest regions are the Mediterranean and Aegean, which are greatly dominated by Mediterranean precipitation regimes. In these two regions, annual precipitation exceeds 600 mm on average. Precipitation mostly falls in the winter months, as a result of the Atlantic depressions originating from Eastern Europe. In the summer months, these two regions are under the influence of Azor and Basra low-pressure systems which greatly reduce precipitation. Another region where the annual precipitation amount exceeds 600 mm is the Marmara region which is partially influenced by the Mediterranean precipitation regime.

Toward the interior, annual precipitation decreases rapidly. In eastern and central parts, annual precipitation tends to decrease sharply. In eastern Turkey, annual precipitation averages around 400 mm, and this figure goes below 400 mm in central Turkey, which is surrounded by high mountain ranges. Since the region is closed to moist-air sources, major precipitation-producing system are mostly of convective origin, and precipitation falls mainly in the spring.

A warming trend begun in the early 1990s has generally continued in recent years, with annual mean temperatures remaining above average over the last 5 years. A significant drought was observed during 1999 and 2000, associated with a lack of precipitation during the winter and spring, which normally are the wettest seasons. Almost two thirds of the country, particularly Southeastern and Central Anatolia, experienced severe drought in 1999, and the drought continued in the year 2000 with slight differences in regional coverage. While central parts recovered slightly, the effects were felt more dramatically in the eastern and western parts. Moreover, the drought shifted towards the north, extending further into parts of the Black-Sea region, normally the wettest region in the country.

The soil moisture deficiency map indicates that drought is still a major concern in central and south-eastern regions, as a result of the combination of low and variable rainfall and high temperatures.

SOIL AND EROSION SENSITIVITY

Soils represent a significant natural resource for Turkey. Their rational utilization, conservation and the maintenance of their multipurpose functionality have particular significance in the Turkish national economy and in environmental protection. Good planning and implementation of sustainable land use requires adequate information on soils: precisely defined soil and land properties, with characterization of their spatial (vertical, horizontal) and temporal variabilities, soil processes and pedotransfer functions.

Soil maps were formed by the General Directorate of Soil and Water (now the General Directorate of Rural Services). This was the first such compilation of available information at a national level, and it highlighted important problems related to soils and their distribution. Today this study is the main resource which can be applied to problems and uses of Turkey's soils.

Drawing on this original work, three national scale maps are now completed:

- National Soil Geographical Database (1:25 000)
- Erosion Map Of Turkey (1:1 000 000)
- Soil Management of Turkey (1:1 000 000)

The methodology used for preparing these maps is set out in Appendix 2.

There are also plans underway to continue to enhance and improve the basic soil mapping resource in Turkey. It is anticipated that a national programme of detailed surveys will be commenced to more precisely measure key factors (e.g. soil type, land use, land capability and fertility levels). Other projects are also planned to correct the limitations of the current soil mapping, which lacks fully comprehensive geo-located profile observations to validate the map separates.

The greatest challenge for land resource management in the future will come from salinity, waterlogging and erosion. Any comprehensive and sustainable rural policy must accommodate measures designed to ameliorate or reduce these factors. Yet, as the pace of development and the demands on the rural economy increase, the balance is harder to maintain. Furthermore, the strain placed upon GDRS resources by the recent earthquake disasters has made the process of allocating resources and identifying priorities even more difficult.

VEGETATION SENSITIVITY

A study is underway to allow the use of satellite imagery to identify areas of vegetation which are under stress. Key stress factors in Turkey include drought, floods, frosts, and over-grazing. . Detecting stressed areas earlier and warning decision makers and farmers, potentially improves the timeliness of remedial measures. This will be particularly valuable for dry farming on the Anatolian Plateau.

The methodology being used is a Normalised Difference Vegetation Index (NDVI). This is detailed in Appendix 3. The initial focus of the work is to produce an NDVI archive of the country.

There are problems in using this in Turkey. These include inadequate trained staff for database management, inadequate ground truthing for interpreting the satellite data, and a lack of past data related to erosion.

An area of future development will be to combine the vegetation data with other data, particularly climate data.

FOREST FIRE SENSITIVITY

Turkey’s forest area covers 20.7 million hectares. The forestry sector contributes a modest 1.7% of GNP, but it also contributes to the conservation of soil resources, the sustainability of wildlife habitat, the promotion of tourism, and the maintenance of Turkey’s remarkable botanical diversity.

The areas with the highest risk of forest fires are the Aegean Region (41% of all fires), the Mediterranean Region (24%) and Marmara Region (22%).

Knowledge of fire risk is an important basis for developing effective prevention and management strategies. For this reason a fire sensitivity map was produced by the Ministry of Forestry, using data on fire numbers and area burnt, and taking into account fire frequency, averages of moisture and temperatures, tree species and human activities.

Further details of the methodology are set out in appendix 4.

There is a need to further develop the fire danger rating system, including by including a wider range of factors (e.g. types of forests, values, topography, weather conditions, fuel loadings). This is an important tool for efficient fire management and planning, particularly for allocating fire-fighting resources.

Most forest fires in the country (97%) are caused by deliberate or accidental human interventions. While there is already voluntary work to address this problem, further activities to reduce human-induced fires are required.

SUMMARY

Work undertaken in Turkey indicates high levels of existing and potential land degradation and desertification.

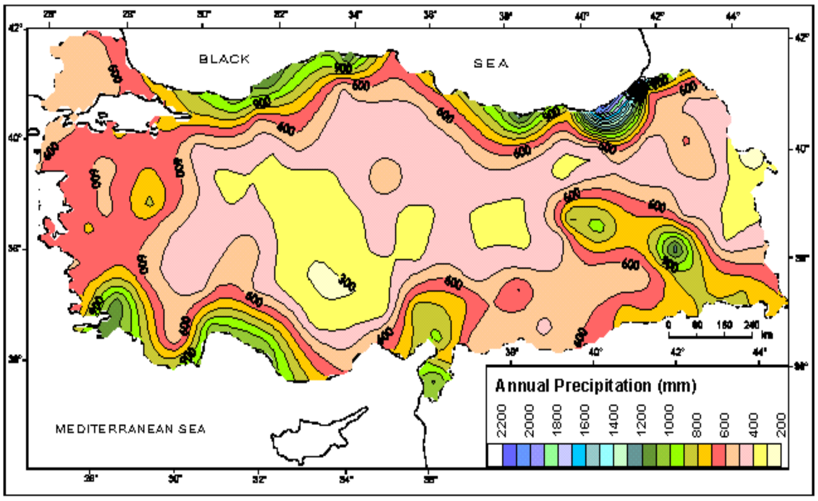
Our knowledge of degradation and risk is being steadily increased, including through the use of new data management techniques, satellite imagery, and digitised mapping. This improved knowledge will allow more effective and efficient responses to the problems to be developed.

Local consultation has clearly identified the knowledge, the attitudes and capacity of local populations as a key factor in reducing land degradation. Future work will need to improve understanding and enhance the ability of farmers to use sustainable land management techniques, while addressing underlying poverty problems.

APPENDICES

APPENDIX 1
METHODOLOGY FOR CLIMATE SENSITIVITY MAPPING

ANNUAL AVERAGE PRECIPITATION DISTRIBUTION

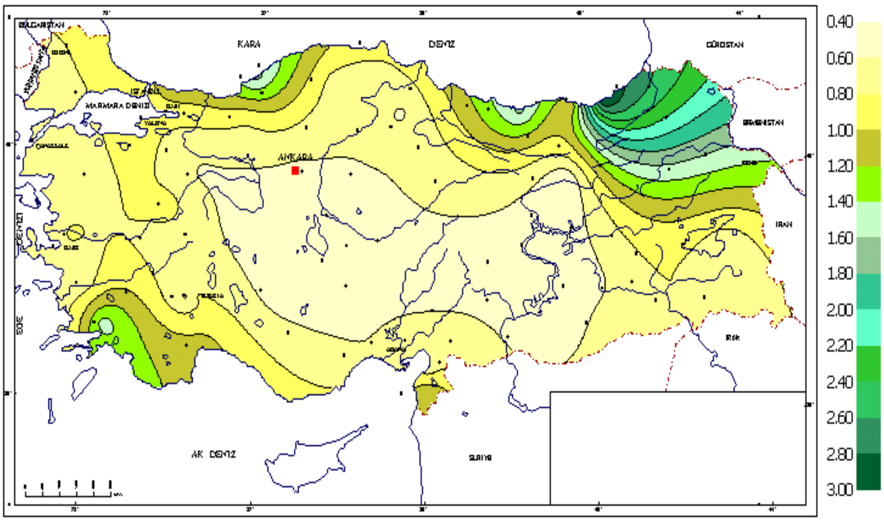


Long Term Annual Precipitation Map

The long-term annual precipitation distribution map was produced using the Surfer Drawing Software Package where long-term precipitation data covering 1930-1999 period for 62 stations across Turkey was used. Most of the procedures in Surfer require either an XYZ data [.DAT] file, a grid [.GRD] file or a USGS DEM file before you perform the desired operation. In the list below the commands are grouped by the type of files that are required when you perform that operation.

Contour maps and surface plots require that your data is in a grid [.GRD] or USGS DEM file format. To produce a grid file you must first create an XYZ data file. A grid [.GRD] file can then be produced using the Data command from the Grid menu. Once you have created your grid file you can then perform many of the Surfer operations. These include smoothing, blanking, volume calculations, creating cross sections, and creating contour maps and surface plots.

ARIDITY ASSESSMENT OF TURKEY BASED ON (P/PET) RELATION



Assessing Drought-Prone Areas

In assessing drought-prone areas, the UNCCD suggests use of precipitation/ evapotranspiration ratio (P/PET) as indicators of water availability in any given region. In this approach, we take ratio of annual precipitation over annual evapotranspiration using long-term data covering 1930 to 1999 period for 62 stations. The results were plotted on map using Surfer Drawing Software Package described in previous section. Purpose of creating this map was to determine arid and semi-arid regions of the country which are vulnerable to drought and desertification from climatic perspective. Here we used computerized version of the original Thornthwaite water balance model, which was developed by Willmot. The model requires data on precipitation, temperature, soil-water holding capacity, heat index, and latitude of a given station and computes potential and actual evapotranspiration, soil moisture deficits, and soil moisture surplus for a predetermined time period.

Potential evapotranspiration (PET) is defined as the water loss from a large homogenous, vegetation-covered area that never suffers from a lack of moisture and is primarily a function of climatic conditions.

The Thornthwaite method for estimating monthly PET may be written as

$$PET = 16\left(\frac{l_1}{12}\right)\left(\frac{N}{30}\right)\left(\frac{10T_a}{I}\right)^{a_1} \qquad (1)$$

where l is actual day length (h), N is the number of days in month, T_a is the mean monthly air temperature (°C), and a_1 is defined as

$$a_1 = 6.75 \times 10^{-7} I^3 - 7.71 \times 10^{-5} I^2 + 1.79 \times 10^{-2} I + 0.49 \qquad (2)$$

where I is a heat index derived from sum of 12 monthly index values, i , obtained from

$$i = \left(\frac{T_a}{5} \right)^{1.514} \qquad (3)$$

Coefficient of Variation

Another approach used to indicate drought variability using the precipitation data is coefficient of variation (C_v). Basically, coefficient of variation is the standard deviation expressed as a percentage of the mean or average value and is used as another measure of precision. The coefficient of variation provides a relative measure of data dispersion compared to the mean:

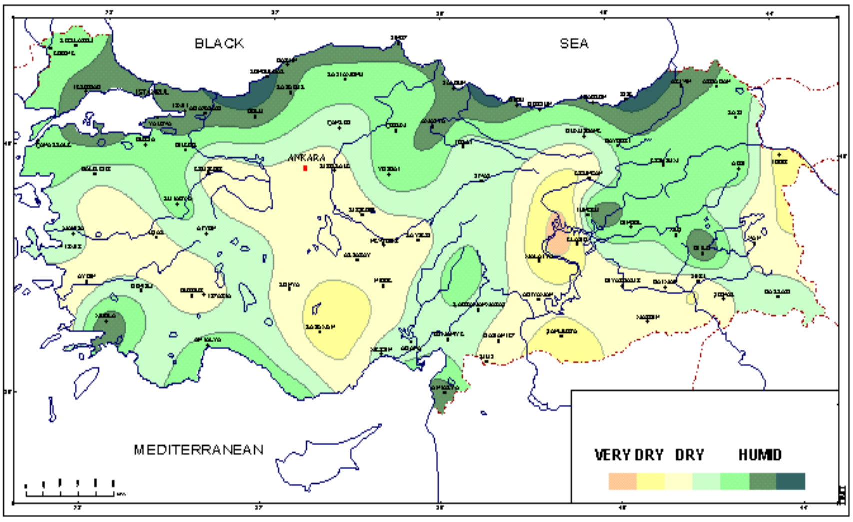
C_v =s/X

where s indicates standard deviation and X indicates mean.

The coefficient of variation has no units. It may be reported as a simple decimal value or it may be reported as a percentage. When the Cv is small, the data scatter compared to the mean is small. When the Cv is large compared to the mean, the amount of variation is large.

Based on the method, we produced a interannual precipitation variability map of Turkey. Purpose of creating this map is get some idea about interannual variability of rainfall so that the regions which tend to indicate very variable rainfall behavior can be identified in terms of dryness and wetness. The map shows that particularly the southeastern, central and Mediterranean region portray highly variable rainfall behavior, which means the rainfall may vary to a large extent from year to year. That makes those regions more vulnerable to drought and desertification combined with other surface characteristics.

LONG-TERM DROUGHT CONDITIONS IN TURKEY



Soil Moisture Deficiency

To compute soil moisture deficiency in a given region, we used a computerized version of the original Thornthwaite water balance model, which was developed by Willmot. The model used here is the modified version of the original model and includes a snowpack option. The model requires data on precipitation, temperature, soil-water holding capacity, heat index, and latitude of a given station and computes potential and actual evapotranspiration, soil moisture deficits, and soil moisture surplus for a predetermined time period.

In its most basic form, the water-balance method developed by Thornthwaite is a monthly, weekly, or daily comparison of water supply (precipitation) with the climatic demand for water. The typical data requirements for the model are monthly-average temperature and precipitation, field capacity, and latitude of the study area. The procedure involves three independent variables - precipitation (P), potential evapotranspiration (PE), and soil-moisture storage (ST). Potential evapotranspiration is defined as the water loss from a large homogenous, vegetation-covered area that never suffers from a lack of moisture and is primarily a function of climatic conditions. Other variables in the Thornthwaite's water-balance method include change in soil-moisture (ST), actual evapotranspiration (AE), water deficit (D), water surplus (S), and runoff (RO), all of which function depending on the three independent variables.

Whenever precipitation exceeds the climatic demand for water, the soil moisture begins to increase. When the soil moisture reaches field capacity, a water surplus develops resulting in increased runoff from the area. Thus, surplus is the excess of P-PE whenever ST is at field capacity. In other words when P exceeds PE, AE is equal to PE, and the excess water of PE replenishes ST. It, however, should be noted that surplus does not always occur when P-PE is positive. No surplus can develop as long as soil moisture storage is below the field capacity. On the other hand, if precipitation fails to supply the climatic demand for water, the soil moisture will be depleted faster than it can be replenished and a moisture deficit may result. In other words, a water deficit (D) occurs when P and soil-moisture withdrawal are less than PE. By comparing precipitation and potential evapotranspiration for a given time period, it is possible to obtain quantitative estimates of soil water storage, water surplus or excess water above climatic demands (which will be contributed to oceans and streams as runoff) and water deficit or climatic demands for water not supplied by available precipitation or stored as soil moisture.

APPENDIX 2
METHODOLOGY FOR SOIL MAPPING

Turkey Development Soil Map

The General Directorate of Soil and Water prepared the Turkey Development Soil Map (TDSM), based on topographical map at the reconnaissance level (1966-1971). In this study, map units were recorded relating to the 1938 American Soil Classification System based on soil groupings incorporating land determinants including depth, slope, stoniness, erosion degree, salinity, alkalinity, land use, land capability classes and other similar characteristics. After evaluating the data, two maps were produced. Firstly, the 'Soil Resource Inventory Map' was published for every province. Secondly, the 'Watershed Soil Map and Report' was produced for 26 major watersheds of the country. After evaluating Soil Resource Inventory Map data, the Erosion Map of Turkey and Soil Management Map of Turkey were produced. The Turkey Soils Potential Survey and Non Agriculture Aims Land Usage Planning Project was replaced with the Turkey Development Soil Map Surveys by the General Directorate of Soil and Water between 1982-1984. These reports identified differences in soil depth, soil stoniness, soil erosion levels, and distributions in all of the provincial Great Soil Groups, supported by data obtained from field trips. In addition, differences in drainage, saltiness, alkalinity problems, land usage and land feasibility classes were identified, bringing the maps up to date by incorporating readings made at the scale of 1:25,000 from field studies.

National Soil Geographical Database Project;

An immediate task facing the Soil and Water Resources National Information Centre (NIC) team has been to commence the systematic capture and integration of the paper-based national soil map into the information system. The 1:25,000 soil maps of Turkey are being digitized. The principal sources of this key national dataset are pencil tracings and annotations on transparent material. The soil map legend represents a wide range of environmental parameters, as each unit was labeled with a compound alphanumeric symbol giving information on various soil and site attributes. To complete digitisation of all the 1:25,000 scale soil maps (over 5547 map sheets) is a task requiring significant resources.

TURKEY SOIL INFORMATION SYSTEM (Soil Geographic Data Base (SGDB))
POLYGON ATTRIBUTE TABLE OF SOIL MAP UNIT (SOIL TABLE)

Field Name	Description
BTG	Great Soil Group
TOK	Soil Characteristics Combination
DTO	Other Soil Characteristics
ERZ	Erosion Degree
SAK	Land Use
AZT	Land Type
AKK	Land Use Capability Class
ATS	Land Use Capability Subclass
BTG_TOK	BTG and TOK Combination
DCV	Other Geographic Data
ADI	Name of Other Geographic Data

SOIL EROSION MAP OF TURKEY

Erosion Map Of Turkey;

After evaluating Soil Resource Inventory Map data, the Erosion Map of Turkey was produced. Soil Loss indicator was used to define erosion degree for this map. The degree of erosion was assessed qualitatively during soil surveys. The classes of accelerated erosion that follow apply to both water and wind erosion. They are not applicable to landslip or tunnel erosion. The classes pertain to the proportion of upper horizons that have been removed. These horizons may range widely in thickness; therefore, the absolute amount of erosion is not specified (Soil Survey Staff, 1993).

Class 1. (No or Slight Erosion); This class consists of soils that have lost some, but on the average less than 25 percent, of the original A and/or E horizons or of the uppermost 20 cm if the original A and/or E horizons were less than 20 cm thick. Throughout most of the area, the thickness of the surface layer is within the normal range of variability of the uneroded soil. Scattered small areas amounting to less than 20 percent of the area may be modified appreciably.

Class 2. (Moderate Erosion) ; This class consists of soils that have lost, on the average, 25 to 75 percent of the original A and/or E horizons or of the uppermost 20 cm if the original A and/or E horizons were less than 20 cm thick. Throughout most cultivated areas of class 2 erosion, the surface layer consists of a mixture of the original A and/or E horizons and material from below. Some areas may have intricate patterns, ranging from uneroded small areas to severely eroded small areas. Where the original A and/or E horizons were very thick, little or no mixing of underlying material may have taken place.

Class 3. (Severe Erosion) ; This class consists of soils that have lost, on the average, 75 percent or more of the original A and/or E horizons or of the uppermost 20 cm if the original

A and/or E horizons were less than 20 cm thick. In most areas of class 3 erosion, material below the original A and/or E horizons is exposed at the surface in cultivated areas; the plow layer consists entirely or largely of this material. Even where the original A and/or E horizons were very thick, at least some mixing with underlying material generally took place.

Class 4. (Very Severe Erosion) ; This class consists of soils that have lost all of the original A and/or E horizons or the uppermost 20 cm if the original A and/or E horizons were less than 20 cm thick. In addition, Class 4 includes some or all of the deeper horizons throughout most of the area. The original soil can be identified only in small areas. Some areas may be smooth, but most have an intricate pattern of gullies.

Soil Management of Turkey

After evaluating Soil Resource Inventory Map data, the Soil Management Map of Turkey was produced. Management groups were defined using the following factors: Erosion Degree (above), Slope, Soil Depth, Land Capability Classes, Soil Loss and Erosion Control Measures. The management groups relate to proposed erosion control measures.

Slope Classes and Description

Classes	Description	%
A	Nearly level or Very gently slope	0-2
B	Gently slope	2-6
C	Moderately slope	6-12
D	Moderately steep	12-20
E	Steep	20-30
F	Very Steep	30 +

Soil Depth Classes and Description

Classes	Depth (cm)
Deep	90+
Medium Deep	90-50
Shallow	50-20
Very Shallow	20-0

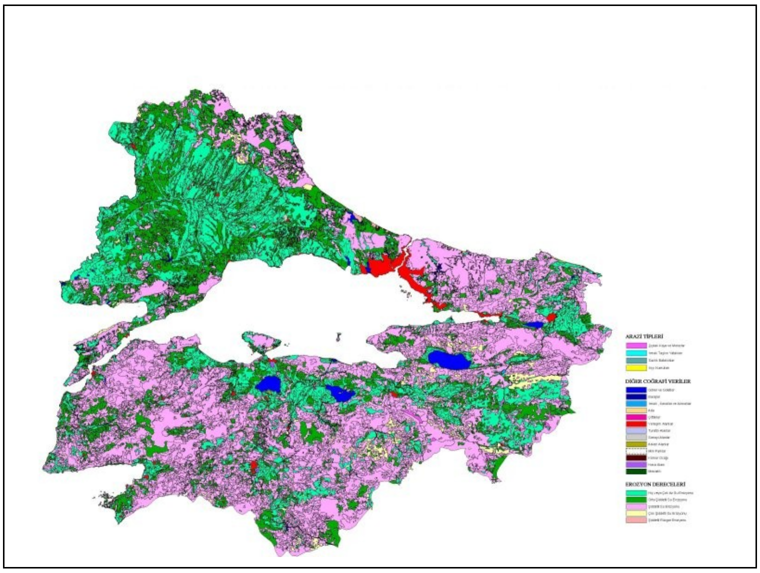
Erosion Degrees (ERZ)

<table>
<tr><th colspan="2">Water Erosion</th><th colspan="2">Wind erosion</th></tr>
<tr><td>1</td><td>None or Very Slight</td><td>R1</td><td>Slight</td></tr>
<tr><td>2</td><td>Moderate</td><td>R2</td><td>Moderate</td></tr>
<tr><td>3</td><td>Severe</td><td rowspan="2">R3</td><td rowspan="2">Severe</td></tr>
<tr><td>4</td><td>Very Severe</td></tr>
</table>

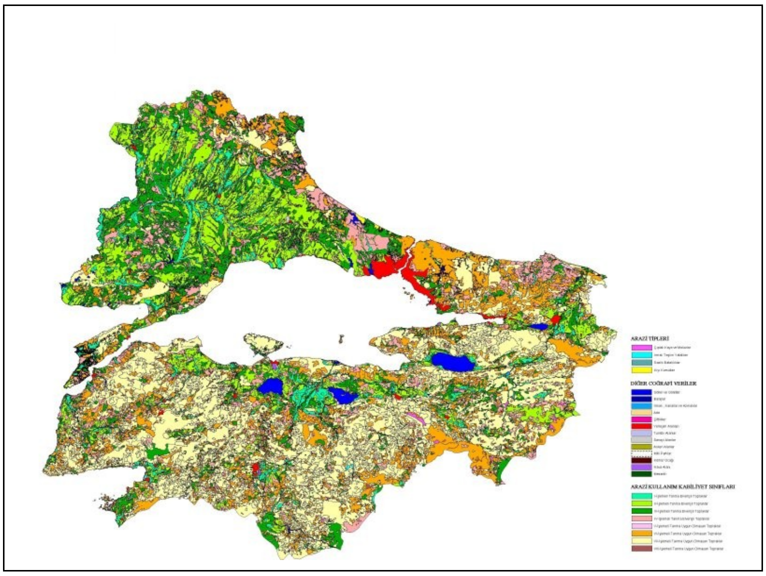
Land Use Capability Classification (AKK)

Symbol	Description
I – II – III – IV	Suitable Lands for Cultivation
V – VI – VII	Non Suitable Lands for Cultivation
VIII	Non Suitable Lands for Agriculture

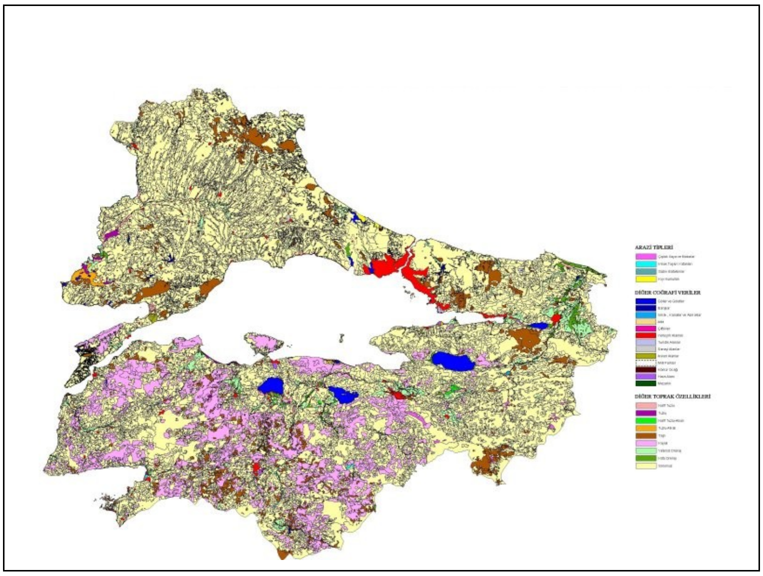
Erosion Degrees Of Marmara Region



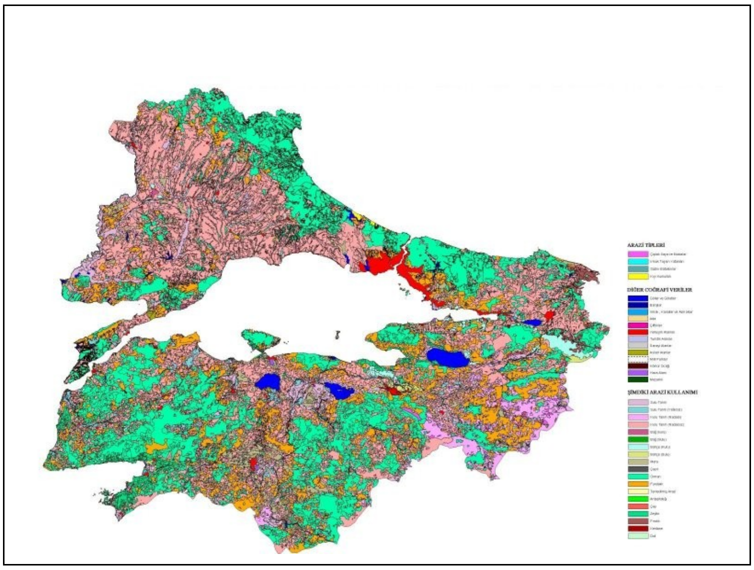
Land Use Capability Classes Of Marmara Region



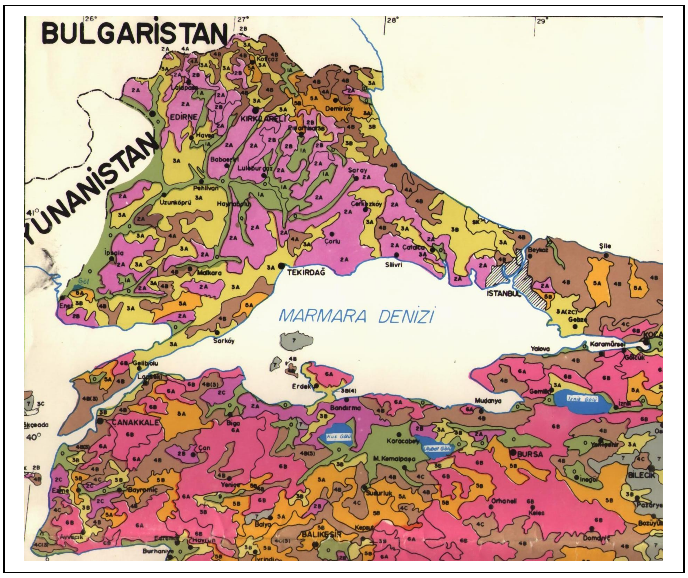
Soil Characteristic (Salinity, Alkalinity, Stoniness Of Marmara Region



Land Cover and Land Use Of Marmara Region

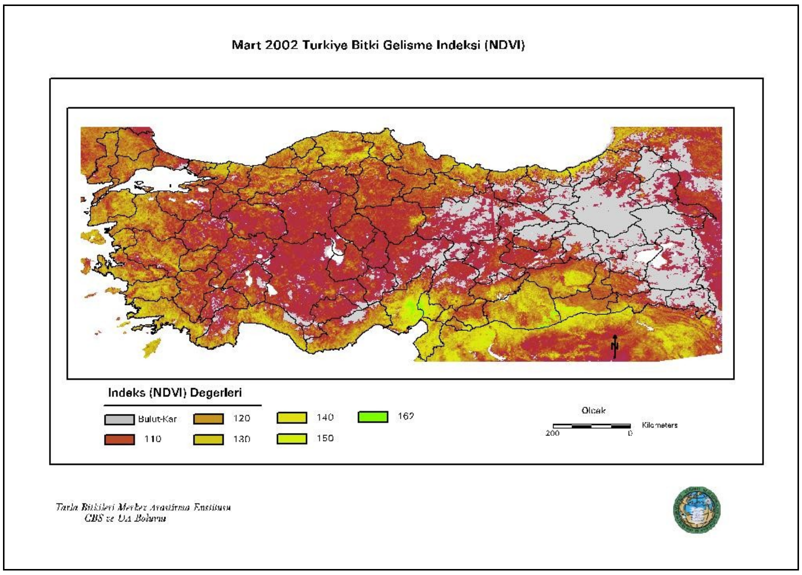


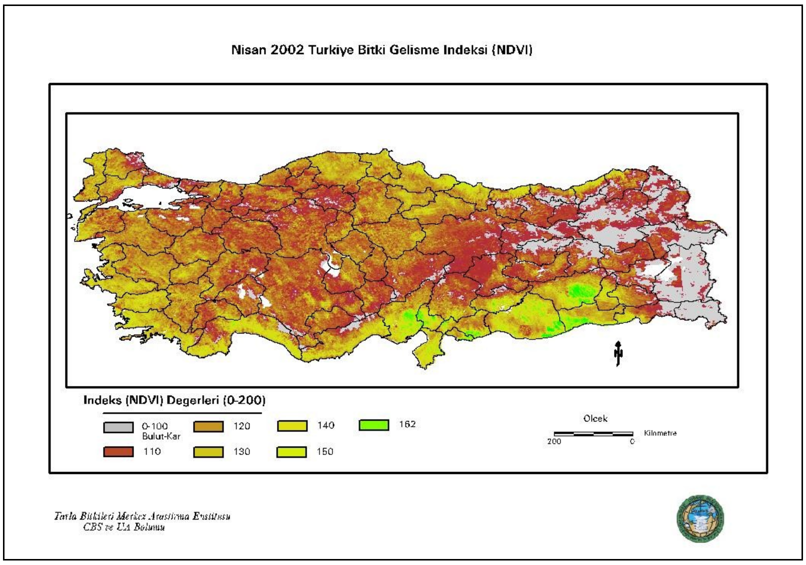
Soil Management Map Of Marmara Region



Amenajman Grubu Management Group		Tanım Dextription	Yayılım hektar Area, hectares	Önerilen koruyucu önlemler Proposed Erosion Control Measures
1A		**Düze yakın eğimli, hafif aşınımlı, derin - orta derin topraklar** Nearly, level slightly eroded, deep and moderately deep soils	2 375 832	**ÖNLEM GEREKMEZ, yahut eğime AYKIRI SÜRÜM** No measures needed or contour farming
1B		**Düze yakın eğimli, hafif orta aşınımlı, sığ - çok sığ topraklar** Nearly level, slight to moderately eroded, shallow very shallow soils	404 861	**AYKIRI SÜRÜM ve/veya RİPERLEME** Contour farming and/or ripping
2A		**Hafif eğimli, hafif orta aşınımlı, derin topraklar** Gently sloping, slightly to moderately eroded deep soils	1 919 566	**AYKIRI SÜRÜM ya da ŞERİTSEL EKİM** Contour farming or strip cropping
2B		**Hafif eğimli, hafif orta aşınımlı, orta derin topraklar** Gently sloping, slightly to moderately eroded, moderately deep soils	2 024 914	**ŞERİTSEL EKİM ya da SEKİLEME** Strip cropping or Terracing
2C		**Hafif eğimli, orta aşınımlı, sığ - çok sığ topraklar** Gently sloping, Moderately roded, shallow and very shallow soils	2 778 017	**RİPERLEME ya da SEKİLEME** Ripping or Terracing
3A		**Orta eğimli, orta aşınımlı, derin orta derin topraklar** Sloping, moderately aroded, deep and moderately deep soils	4 485 314	**SEKİLEME** Terracing
3B		**Orta eğimli, orta - şiddetli aşınımlı, sığ topraklar** Sloping, moderately to severely eroded, shallow soils	4 361 133	**SEKİLEME, otlak - fundaıkta ÖRTÜ GELİŞTİRME** Terracing, cover improvement in range and bushland
3C		**Orta eğimli, şiddetli aşınımlı, çok sığ topraklar** Sloping, severely eroded, very shallow soils	1 667 806	**Kuru tarım : OTLAK - ORMANA DÖNÜŞTÜRME Otlak - Funda (ÖRTÜ GELİŞTİRME)** Dry farming : Convert to permanent vegetation range and bush : Cover improvement
4A		**Dik eğimli, orta aşınımlı, orta derin topraklar** Moderately steep, moderately eroded, moderately deep soils	1 489 734	**SEKİLEME** Terracing
4B		**Dik eğimli, orta şiddetli aşınımlı, sığ topraklar** Moderately steep, moderately to saverely eroded, shallow soils	6 157 684	**SEKİLEME, ÖRTÜ GELİŞTİRME (OTLAK - FUNDA vb.)** Terracing, cover improvement in range and bushland
4C		**Dik eğimli, şiddetli - çok şiddetli aşınımlı, sığ - çok sığ topraklar** Moderately steep, severely to very severely eroded, shallow and very shallow	3 100 179	**Kuru tarım : OTLAK ve ORMANA DÖNÜŞTÜRME, Diğer : ÖRTÜ GELİŞTİRME** Dry farming : Convert to permanent vegetation others; Cover improvement
5A		**Çok dik eğimli, şiddetli aşınımlı, sığ topraklar** Steep, severely eroded, shallow soils	5 498 581	**SEKİLEME yahut OTLAK ve ORMANA DÖNÜŞTÜRME, Otlak - Funda : ÖRTÜ GELİŞTİRME** Terracing or change to permanent cover, range and bush; cover improvement
5B		**Çok dik eğimli, şiddetli, çok şiddetli aşınımlı, çok sığ topraklar** Steep, saverely to very severely eroded, very shallow soils	7 870 285	**Otlak - Funda vb. KORUMA ve ÖRTÜ GELİŞTİRME, Kuru tarım : OTLAK VE ORMANA DÖNÜŞTÜR** Range or bush : Protection and improvement Dry farming; Convert to permanent cover
6A		**Sarp eğimli, şiddetli - çok şiddetli aşınımlı, sığ topraklar** Very steep, severely to very severely eroded, shallow soils	3 997 999	**Otlak Funda vb. KORUMA VE ÖRTÜ GELİŞTİRME, Kuru tarım : OTLAK ve ORMANA DÖNÜŞTÜR** Range or bush : Proctection and improvement, Dry farming - Convert to permanent cover
6B		**Sarp eğimli, şiddetli - çok şiddetli aşınımlı, çok sığ topraklar** Very steep, severely to very severely ercded, very shallow soils	7 001 400	**Otlak funda vb. KORUMA ve KISITLI KULLANMA, Kuru tarım -: OTLAK ve ORMANA DÖNÜŞTÜRM** Range or bush : Protection and restricted use, Dry farming : Convert to permanent cover
7		**Sarp, eğimli, çok şiddetli aşınımlı, kaya vb. üzerinde 10 cm. den sığ topraklar** Very steep, very severely eroded soils which are shallower than 10 cm.	9 085 337	**Otlak, Funda vb. KORUMA ve ÇOK KISITLI KULLANMA. Kuru tarım : OTLAK ve ORMANA DÖNÜŞ TÜRME** Range or bush : Protection and very restricted use, Dry farming : Convert to permanent co
ÇK		**Çıplak kaya yüzeyleri ve molozlar** Rock surfaces and debris	2 930 933	**Olduğu gibi KORUMA** Protection under natural conditions
8R		**Rüzgar aşınımı etkisindeki (SK: Kıyı kumulları içinde) topraklar** Soils under wind erosion effect	565 452	**AĞAÇLANDIRMA, ÇİTLER, YELKIRAN ŞERİTLERİ vb.** Fences, afforestation, windbreaks etc.
9		**Etek arazi toprakları : Koluvyal, % 1 - 12 eğimli** Colluvial soils 1 - 12 % slopes	2 753 570	**AYKIRI SÜRÜM ya da SEKİLEME** Contour farming or terracing
0		**Düz taban arazi toprakları Aluvyal, % 0 - 2 eğimli** Level bottomland soils	5 358 952	**KORUYUCU ÖNLEM GEREKMEZ, yaşlık, tuzluluk sorunu olabilir.** No measures needed, wettness and salinity problems may occur.

APPENDIX 3
VEGETATION MAPPING





The Normalized Difference Vegetation Index (NDVI)

Many techniques have been developed to study quantitatively and qualitatively the status of the vegetation from satellite images. Based on the reflectance difference that green vegetation displays between the visible region and the near infrared region of the electromagnetic spectrum, in channels 1 and 2 of the AVHRR images of the NOAA satellites, the Normalized Difference Vegetation Index (NDVI) has been obtained. The NDVI formula has the following form in the context of AVHRR derived data:

$$NDVI = \frac{\rho_2 - \rho_1}{\rho_2 + \rho_2}$$

Where ρ_1 and ρ_2 are the reflectance values measured in the AVHRR channel 1 (red) and channel 2 (near infrared), respectively. AVHRR channel 1 (0.58-0.68 um) senses an area of the spectrum which shows an inversely proportional relationship to the amount of green vegetation present. As green (photosynthetically active) vegetation absorbs red light, the amount of red light reflected decreases with the increasing density of vegetation. On the other hand, AVHRR channel 2 (0.725-1.0 um) senses a region of the spectrum with reflectance directly proportional to the density of photosynthetically active vegetation. The denser and more vigorous the vegetation is, the higher the reflectance of near-IR radiation. The range of values obtained by the NDVI is between -1 and +1. Only the positive values correspond with vegetated zones.

Data Processing

Cloud-free AVHRR observations of the land surface are necessary for monitoring the vegetation conditions by NDVI. Images that provided clear observation of the selected regions at reasonable nadir viewing angles are included in the analysis. It was, however, impossible to find completely cloud-free images for the selected regions at desired time intervals.

AVHRR data is processed to produce NDVI using the standard formula given in the previous section. Procedure for producing the final NDVI involves several steps. In this study, Map-X Ocean software was used to process the raw images. The process to elaborate a Vegetation Index (NDVI) begins with the acquisition of a NOAA satellite image. We then choose a subset of the image to create the NDVI. In first step, a quick look of the raw data is obtained. Then, the data is georeferenced to assign map coordinates to the image. After geo-encoding and calibrating the each band and correcting for solar zenith angle and satellite zenith angle, AVHRR visible bands 1 and 2 are used to produce a Normalized Differenced Vegetation Index (NDVI) image using the standard formula given earlier. Using various coloring and enhancement techniques the product takes its final form. The image products are 10 bit data files and viewable 8 bit images are generated after the process.

APPENDIX 4
FIRE MAPPING

This map was produced principally based on local enterprises boundaries, and boundaries of valuable areas such as coniferous forests, recreational and tourism areas, and areas important for national defense.

Sensitivity classification was made according to annual average of numbers of forest fires within the enterprise territory. This average was calculated from total forest fire numbers for last 20 years. Five sub-group were classified by the danger degree. Tree species, altitude, moisture, wind velocity, and precipitation were also taken into account .

Fire Sensivity Degree	Group	Annual average forest fire
1	Highest fire risk	10.1 and more
2	Significant fire risk	6.1 – 10.0
3	Medium fire risk	3.1 - 6.0
4	Low fire risk	1.1 – 3.0
5	Very low fire risk	1.0 and less

There was significant involvement of local fire control officers during the preparation of the map.