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History and Status of Soil Survey Programs In Turkey and Suggestions on Land Management

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Abstract: The history of soil survey programs in Turkey dates back to the early 1950's, with Soil Taxonomy being widely used by research centres and universities since the development of its first approximation. The FAO/UNESCO system with its recent World Reference Base has also been frequently used on many occasions and soil correlation meetings throughout Turkey. Detailed soil analyses are being undertaken in a number of research laboratories and university departments. The University of Çukurova, Department of Soil Science together with the General Directorate of Rural Affairs are conducting a study on the updating of the Turkish Soil Map using earlier reconnaissance surveys accomplished by the latter and other research establishments.

This paper also summarises the need for a sustainable land management approach based on agroecological zones, which have been developed by considering the historical indigenous knowledge of Anatolia.

I. -Introduction

The late Prof. Dr Kerim Ö. Çağlar pioneered in Turkey in the early 1950's modern research in soil science and soil survey, which was summarised in his study on "Turkish Soils". The work contained a schematic soil colour map showing 11 soil classes, which included among others, the dry and Chestnut Dark Yellowish Soils, the Mediterranean – Aegean and South East Anatolian zone of Red Soils, the North Eastern Anatolia and Eastern Black Sea Region with Black Soils (Çağlar, 1958).

Oakes (1958) undertook another soil survey work, which yielded to a soil map of 1:800.000 scale. This reconnaissance survey, which was accomplished in a relatively short period of time, was based on the geologic and topographic maps of the country comprising also soil analyses for selected Great Soil Groups. The author classified the Turkish soils according to Baldwin et al's (1938) Soil Classification System with mapping units showing soil phases such as slope, stoniness, drainage and salinity.

In the early 1960's, the task of classifying and mapping soils in Turkey, to be accomplished at a more detailed level than in the past, was conveyed to the former General Directorate of Soil and Water (GDSW) or the present General Directorate of Rural Services (GDRS). These studies were meant to be part of the small-scale reconnaissance soil map of Europe, which was prepared from 1966 to 1971 using 1:25,000 scaled topographic maps. For more detailed work on land use planning, the Great Groups established according to Baldwin et al (1938) system, together with selected phases, were used for provincial (1:100,000) as well as basin mapping purposes (1:200,000).

The primary soil studies using the earlier version of Soil Taxonomy (Soil Survey Staff, 1975) were accomplished by De Meester (1970) and Boxem and Wielemaker (1972) on the Konya Plain (Central Anatolia) and the Küçük Menderes Valley (Western Anatolia) respectively. From 1973 to 1984, many soil survey reports of the GDRS enabled planners to develop the strategies needed for solving problems related to land use planning and accomplishing the proper legislation (State Planning Office –SPO, 1973; 1979; 1984) and 1995 (Official Gazette, 1995).

However, land use legislation was rarely applied in reality due to political reasons, as well as uncoordinated actions by the government agencies. This caused the mismatch between land quality (LQ) and land use (LU) resulting in land resource consumption (Kapur et al. 1998; Cangir et al, 2000) and increasing land degradation in the country. The following are some examples of land degradation resulting from the mismatch between land quality and land use.

a) The whole urbanised and industrialised Kocaeli region (Western Turkey), is based on areas prone to earthquake occurrence risks (with 20,000 casualties of the 17th August 1999 earthquake) (Cangir et al. 1999; Ekinci, 1999), which are the fertile lands that could have been used for agricultural development.
b) The historical Mersin City (on the Mediterranean Coast, Southern Turkey) (Dinç et al, 1996) has had its major and significant expansion in the last 3 decades. Almost all of its surrounding fertile arable lands were used for urban buildings. The city area increased approximately 4.3 times from 1963 to 1975, 3.6 times from 1975 to 1993 and 15.7 times from 1963 to 1993.
c) The cotton textile industry, as well as the urbanisation in Kahramanmaraş (Southwest of Turkey), has consumed high quality agricultural lands throughout the province. The city was established about 3,000 years ago and historical records suggest that the city area was about 28 ha in the 15th century. In 1950, the area was about 200 ha and increased to 1,800 ha by 1978. The GDRS study (1996) showed that the current area is about 3,300 ha. Almost all the changes in 1985 resulted in the reduction of surface areas of Land Capability Classes (LCC) I, II and III (Gündoğan et al, 1999).

Similar other examples of misuse could be given for other areas throughout the country. They all indicate the deficiency in the application of legislation and lack of co-ordination.

The General Directorate of Rural Services is the responsible government agency for soil survey and mapping. Using the GDRS maps and making translations to the USDA Soil Taxonomy new versions (Soil Survey Staff, 1975 and 1999) has been the usual practice for many Turkish Universities. However, it is primarily the Department of Soil Science of the University of Çukurova in Adana that provides the major contribution in mapping and soil survey. The Department works in close collaboration with the Working Group on Land Degradation and Desertification (WGLDD, Secretariat at the Çukurova University) of the International Union of Soil Sciences (IUSS) and European Soils Bureau (ESB) Network initiated by the CIHEAM-Bari of the European Union. Other soil surveys and land use studies are also undertaken by the Soil Science Departments of the Universities of Aegean and Ankara.

II. - Institutions and research centres on soils in the country

Over the last three decades, soil surveys have received particular attention especially for the purposes of land use planning and the sustainable management of natural resources.

Turkey has a total land area of 78 million ha. About 28 million ha are used for arable farming, however the farmland is threatened by a rapidly growing gigantic transportation and construction industry which is in need of large spaces, mainly on prime soils that have access to marketing centres and metropolitan areas.

Thus, the country is primarily in need to consider the re-establishment and renovation of the previously functioning Soil Survey Service transformed as the GDRS. The major emphasis should be given towards the development of interdisciplinary management plans for the different agro-ecosystems of the country.

The renovation of the soil survey activities of GDRS in Turkey could follow the example of the earlier Macaulay Soil Research Institute (MSRI) to its updated version of the Macaulay Land Use Research Institute (MLURI) in Aberdeen, Scotland. The Ministry of Agriculture and Forestry, and GDRS are also linked with long-term research and monitoring sites and stations with some of them described below:

- The GDRS Karapınar Erosion Control Station (Central. Turkey) with a current project undertaken on the “Biodiversity, Soil Development and Monitoring of Land Degradation versus Husbandry Conservation” (Akça et al. 2000). The monitoring part concerns a span of 35 years of reclamation of the Karapınar Desertification Site and aims to develop measures of land degradation versus sustainable land use.

- The Akyatan Lagoon Agroforestry Project, which investigates the attributes of soil development on sand dunes in relation with tree associations of the area. A significant part of the project is linked to economic analyses (Baki et al, 1998; Tatar et al. 1998; Serteser, 1999).

The General Directorate of Rural Services (GDRS)

The GDRS is the responsible government agency for all the aspects of rural development. Its main tasks are soil survey and mapping, watershed management, development of rural and agricultural infrastructure, roads, drinking water, and management of sewage system in rural areas. The agency has set up a network of twelve Research Institutes and has trained a scientific staff needed for addressing agriculture services, and specifically emphasising on environmental protection.

The present GDRS activities and responsibilities in the area of soils are to sustain soil and water management, monitor soil fertility of agricultural soils, make environmental impact assessments, and create the national soil database. To foster these activities, within the GDRS, in 1999 were established the National Information Centre of Soil and Water Resources. This centre is now digitising available soil maps at scale of 1:25,000 and is setting up the national database for soil and water resources.

The Çukurova University

The Department of Soil Science of the University has carried out soil surveys of the Çukurova region (337,000 ha, 1:25,000 scale) and Northern Cyprus (326,000 ha, 1:25,000 scale). To accomplish these surveys, additional information was obtained from the Remote Sensing Laboratory of the University, which is equipped with the latest software and hardware technology.

In addition, in collaboration with the State Farms Agency, the University has surveyed a total of 24 State Farms of the Ministry of Agriculture (361,980 ha, 1:25,000 scale) together with 14 basins (853.188 ha) of the Southeastern Anatolian Irrigation project area (Turkish acronym GAP Project) funded by the GDRS. The only maps available in digitised format at 1:25.000 scale at present are from the GAP area and are prepared by the GDRS and the University of Çukurova (Dinç et al. 1993).

GDRS's National Information Centre of Soil and Water Resources and the Çukurova University are jointly preparing the most recent project which will utilise a bottom-top approach, making a synthesis for the GAP area of the earlier GDRS soil maps of 1:25.000 scale with a final product of 1:1.000.000 scaled map. The project to be accomplished by the year 2003 will comprise translation of the most recent version of the Soil Taxonomy (Soil Survey Staff, 1999), FAO (FAO/UNESCO, 1990) and WRB classifications (FAO-ISRIC-ISSS, 1998). The first stage of the project ie preparation of the Soil Typological Unit (STU) map based on the WRB for the ESB (Lambert et al. 2000) soil database has already been completed.

Further on, the Department of Soil Science of the University of Çukurova has accomplished several soil survey studies related to environmental management. These include the coastal-wetlands (Silifke Natural Park and Akyatan lagoon), karstic zones (Kızkalesi Archaeological Park), mountainous regions (Taurus Mountains), and sites with significant type of soil moisture regimes as the GDRS's Karapınar Erosion Control Station (13,000 ha).

The General Directorate of State Hydraulic Works

The Agency has completed maps at the scale of 1:25.000 showing soil suitability for irrigation of several large basins of the country. These maps have been successfully used in water management of these basins.

The Aegean University

The Department of Soil Science of the Aegean University has undertaken local soil surveys of the Küçük and Büyük Menderes Basins of the Aegean Region (Western. Turkey), as well as the

preparation of the salinity map of these basins. A recent task undertaken by the Department is the assessment of the management parameters for the deltas of the Aegean Region. A research group is conducting erosion studies, assessing the movement of the sand dunes and its environmental impacts.

The Ankara University

The initial studies on soil surveys in the country using the Baldwin et al (1938) system of soil classification were started by the Agricultural Faculty of Ankara University. Presently, the Department of Soil Science of the Faculty is affiliated in many countrywide studies aiming the assessment of soil erosion and its impact on the environment. Specific studies are being performed in collaboration with the GDRS. They include the preparation of soil and land use maps of the Beypazarı region (Central Turkey) and the Çubuk Basin (Central Turkey).

III. - Laboratory methods used for soil analyses

Laboratory methods used for soil analyses by the GDRS and Universities are as follows:

- Particle Size Distribution Analyses by Bouyocous (1962)
- pH in 1:1 and 1:10 soil water, soil $CaCl_2$ solution, Soil KCl solution
- Calcium Carbonate, by Schlichting and Blume (1966)
- Cation Exchange Capacity, by U.S. Salinity Laboratory Staff (1954)
- Organic Carbon, by Schlichting and Blume (1966)
- Total Nitrogen, by Kjeldahl (Bremner, 1965)
- Free iron oxides, by Jackson (1979)
- Clay minerals, by Jackson (1979)
- Micronutrients, by Lindsay and Norwell (1978)
- Available P, by Olsen (1954)
- Salinity, by U.S Salinity Laboratory Staff (1954)
- Micromorphology analyses, by FitzPatrick (1993)
- Microbiological analyses (Black, 1965)
- CO_2 production (Black, 1965)
- Dehydrogenase (Black, 1965)
- Saccaraze enzyme activity, by Hoffman and Pallauf (1965)
- Total and denitrification bacteria count, by Tomlinson-Hochstein (1972)
- Mineral nitrogen content (Black, 1965)
- Nitrate, by Fabig et al (1978)
- Nitrite, by Nicholas and Nason (1957)
- Ammonium, by Deutche Einheitsverfahren (1983)
- Bulk density (Black, 1965)
- Porosity and pore size distribution (Vomocil, 1965)
- Saturated hydraulic conductivity (Klute, 1965)
- Unsaturated hydraulic conductivity (Klute, 1965)
- Infiltration rate (Bertrand, 1965).
- Potassium (Pratt, 1965)
- Gypsum, by X-ray powder diffractometry

IV. - Major soil constraints and their impact on agricultural production and on the environment

There certainly are numerous problems related to environmental quality and land degradation occurring nationwide on the intensively cultivated 28.053.000ha of land. The implications of environmental degradation and constraints on agricultural productivity can be listed as follows:

soil erosion is a menace in almost 73.8% of the cultivated land accelerated by the average elevation of Turkey which is about 1,100m. The process has started since the Neolithic period (app. 8,000 years BP), with increased paces during the Greek, Roman, Byzantine and Ottoman periods. Erosion is quite severe especially on the widely extensive sloping lands with shallow soils.

Urbanisation remains the biggest threat to the fertile farmland of the country. Land resource consumption, resulting from the mismatch of land quality with land use, such as occupation of prime land by urban buildings and infrastructure, is more evident than ever.

Loss of bio-diversity resulting from the misuse of agricultural marginal lands, such as wetlands, sand dunes, and conservation areas.

Exploitation of soil as a non-renewable resource by the construction industry, namely as a) dam wall filling material, b) brick production by quarrying and land stripping.

Excess use of fertilisers leading to:

- soil and water pollution;
- over exploitation of limited phosphorous resources which are expected to be depleted in the near future following the probable extinction of world P resources;
- decrease of soil chemical quality by occupation of exchange sites of lattice clays;
- development of micro-nutrient deficiencies;
- accumulation of Cd,
- decrease of the biological quality of the soil by impeded activity of mycorrhiza.

Overgrazing, cultivation and stubble burning, causing the destruction of soil organic matter and reduction of biological and physical soil qualities by loss of biomass, soil organic carbon and soil structure destruction together with the enhancement of atmospheric carbon.

Over irrigation, causing salinity and destruction of soil physical properties.

Irrigation of steppe-mild aridic lands in Central and East Anatolia (Newhall, 1972) causing interferences in the hydrologic cycle since the Neolithic.

Irrigation of indigenous tree crops, like olives and pistachio causing destruction of soil structure and resistance to erosion, reduction of mycorrhizal activity, decreased resistance to disease and disturbances in the hydrologic cycle.

V. - Suggestions for optimal soil and crop management

The highly variable climate and topography of the country is responsible for the development of a wide range of soil types. For example, in the Black Sea region, there are areas with annual precipitation of more than 1,600 mm. Consequently Spodosols/Podzol and Ultisols/Podzoluvisol-Acrisol occur, whereas the Central part of Turkey has places averaging 200 mm/year precipitation, which is characteristic for the formation of Aridisols/Cambisol-Calcisol.

In between these two extremes, Entisols/Leptosol - Fluvisol, Vertisols/Vertisols-Fluvisols, Inceptisols/Cambisol - Calcisol - Andosol, Mollisols/ Cambisol-Calcisol - Kastanozem, Alfisols/Luvisol and rarely Histosols/Histosol are distributed throughout the country. Therefore, the land use concepts should be based on the variability and quality of soils, along with climatic and topographic properties. Other important aspects impacting the natural ecosystems, such as population pressures, marketing and industrial development, are to be considered as well. Thus, the determination of agro-ecosystem/agro-forestry zones for Turkey could denote the following belts, which could stand against the misuse of natural resources (Eswaran, et al. 1996, 1998) (Figure1);

The tea - hazelnut zone in the Black Sea region (Northern Turkey) characterised by acid soils (Ultisols/Podzoluvisol-Acrisol and Spodosols/Podzols).

Barn feeding and/or limited rangelands. - Oak Forest belts in the Central and Eastern regions of Turkey, on marly steppe soils (Inceptisol-Mollisol/Calcisol-Cambisol) and Entisols – Andisols/Leptosol - Andosol) respectively.

Olive, pistachio, carob, and almond tree belt in the Mediterranean, Aegean regions (West, South and Southeast Turkey) (Mollisols-Alfisols-Inceptisols-Entisols/Cambisol-Luvisols-Calcisols-Leptosols).

Cereal belt, Barn feeding and/or limited range lands in Central Turkey on Mollisols/Cambisol-Calcisol, Vertisols-Aridisols-Inceptisols/Vertisol-Fluvisol-Cambisol-Calcisol.

Vineyard and fig tree belt in the Aegean Region on Alfisols-Mollisols and Entisols/Luvisol-Cambisol-Calcisol and Leptosol.

Cotton, maize belt in South and Southeast of Turkey on Vertisols/Vertisol-Fluvisol.

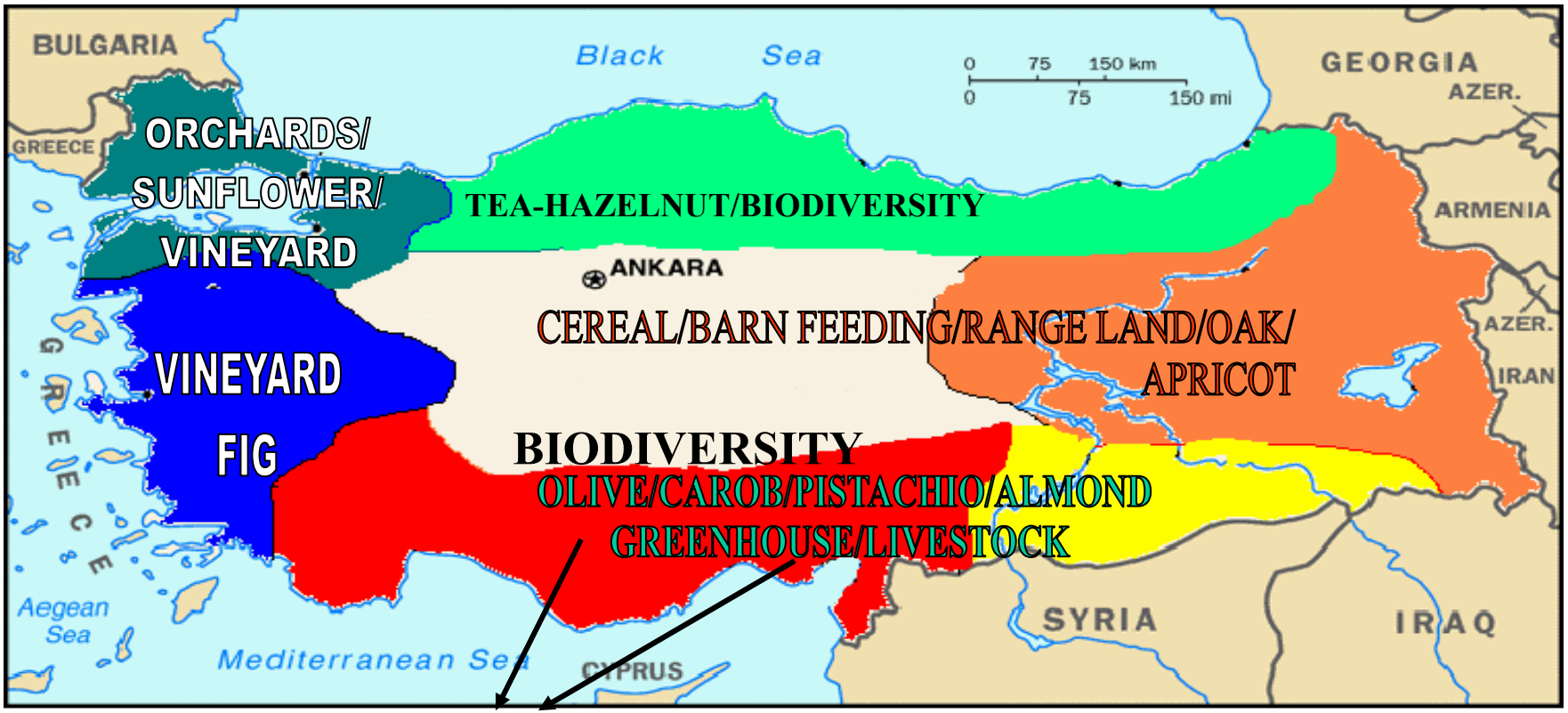
Greenhouse, livestock farming on Mediterranean vegetation (maquis of oak/carob/pistachio/olive/myrtus) in the karstic ecosystem of the Mediterranean region of Turkey on Alfisols-Entisols and Mollisols/Luvisol-Leptosol and Cambisol.

Biodiversity, agroforestry in the wetland / sand dune ecosystem with tree vegetation (Pinus pinea, Acacia cyanophylla) in the South and West of Turkey on Entisols/Leptosol-Fluvisol.

Orchards/vineyards and sunflower belt in the Northwest of Turkey on Mollisols and Vertisols/Cambisol and Vertisol-Fluvisol.

Preservation of indigenous technical knowledge (ITK) and crops available since the Neolithic period against the so-called cash crops of high income is very important. This could be done in collaboration with International Institutes and Research Centres.

Figure 1. AGROECOLOGICAL ZONES OF TURKEY



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