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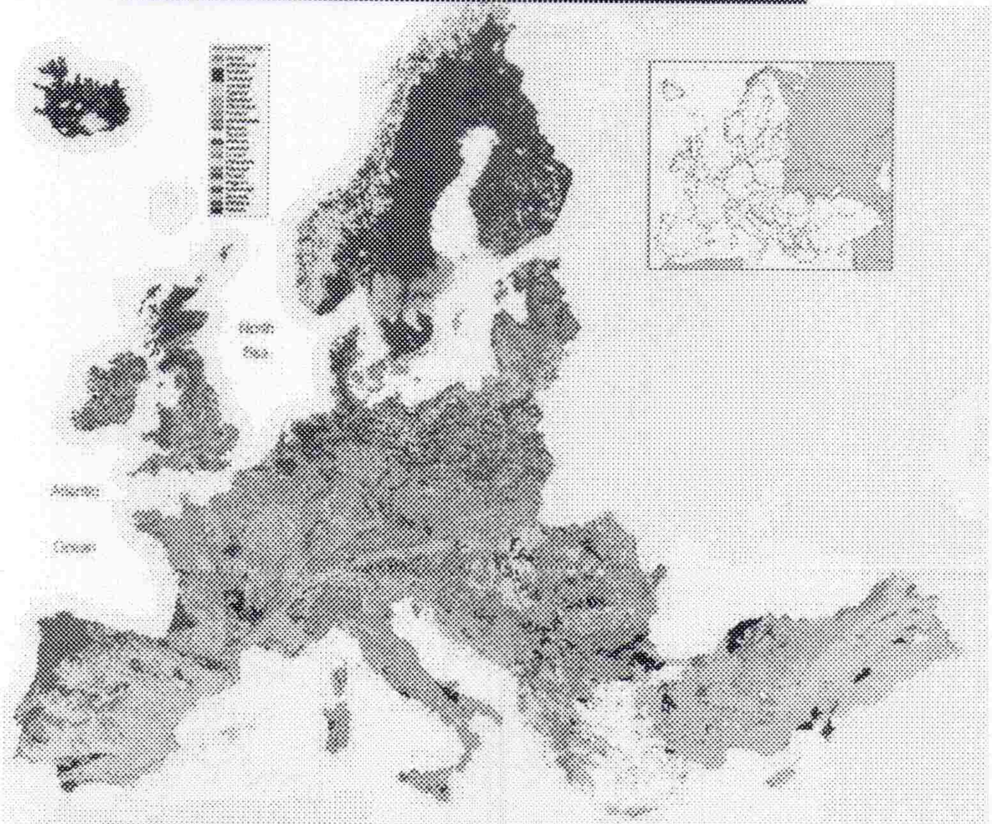
Workshop 10-B

Land degradation

Robert J. A. Jones
Luca Montanarella (eds.)



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THE JRC ENLARGEMENT ACTION

Land degradation

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Edited by

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LAND DEGRADATION IN TURKEY

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ABSTRACT

Turkey, with a total of 28.054.000 ha arable land, is still an agricultural country with prime soils covering only 17.5% of this figure. The rest of the country comprises diverse topographical features with an average of 1100m elevation and more than 6% slopes. Soil sealing and raw material exploitation –the irreversible losses- which are the outcomes of high population increase and migrations throughout the country along with erosion and salinity build-up are the main factors inducing land degradation that also give rise and accelerate deforestation, overgrazing, improper tillage and excess irrigation. The decline of organic matter, contamination due to overuse of fertilizers and industrial waste products, loss of biodiversity and hydro-geological risks, such as floods and landslides -the relatively reversible losses of land and soil still fulfilling functions in a reduced way- are also the current problems of land degradation in Turkey.

Despite the struggle of the governmental bodies against poverty, the actual land use in Turkey both reduces the quality of soils and induces the loss of natural resources, thus the welfare of the rural dwellers ie 40% of the population.

OVERVIEW

The total arable land of Turkey is 28.054.000 ha. The main income of the country is agriculture and agriculture based industry. However, the prime soils cover only 17.5% of the total land surface and the productivity of the rest of the soils is limited by topographical, chemical (eg high calcium carbonate content, alkalinity and low organic matter), and physical (eg. water logging, texture) attributes.

The diverse topography along with deforestation and unsuitable tillage and irrigation management have been inducing the rate of erosion in the country for centuries. The majority of the country's soils (76.5%) are prone to erosion risk due to the dominant steep slopes (>6%), and 72% of the soils are more or less affected from water and wind erosion (CCD-TURKEY, 2003). Alongside these unsuitable conditions, the misuse of lands, ie soil sealing, exploitation of the soils for raw materials, over use of fertilizers and irrigation, improper use of indigenous environmental friendly (Kapur and Akça, 2003) agro-ecosystems, constantly degrade the soils of the country.

The high population increase in the urban regions and conversely the decrease in the rural, cause the intensive use of arable land around the former. According to the census of 2000, 40% of the country's population lives in rural areas (23.797.653 out of the total 67.803.927) with an average of 1.21ha/man arable land, mostly allocated for cereal production (country average ~2000kg/ha). This is equivalent to a low net income rate, which results to migration from the rural areas to urban, particularly from the east of the country to the west. The Government Statistics Institute (2003) data reveals that from 1990 to 2000, the urban population increased by 30%, ie from 33.656.275 to 44.006.274, whereas the rural increased at a much lower rate (4.3%).

The data above reveals the pressure of both natural and human induced factors on soils and land urgently in need of sustainable land management policies along with legislations, since, the rate of quality loss of land and soil, in the coming decades will ultimately be the common jeopardy in the country.

TOPOGRAPHY AND EROSION

The climate, vegetation, population, economic life and particularly soils of Turkey are highly affected by the diverse topography of the country. Major causes of this diversity are due to the tectonic movements of the recent geologic periods and accumulation of volcanic products, which have created an elevated mass with an average altitude of 1132m. Thus, plains of 0 to 250m altitude cover only one tenth of the country, whereas places higher than 800m cover two third and half of the country is higher than 1000m (Izbirak, 1975; Dinç et al. 1997) (Figure 1). Most mountain ranges extend from west to east and great ranges appear in forms of arches. Among these, are the ranges in northern, eastern, western and southern Anatolia. The Taurus Mountains in the south set a good example of this sort. The highlands and basins among them have formed similar geomorphologic features.

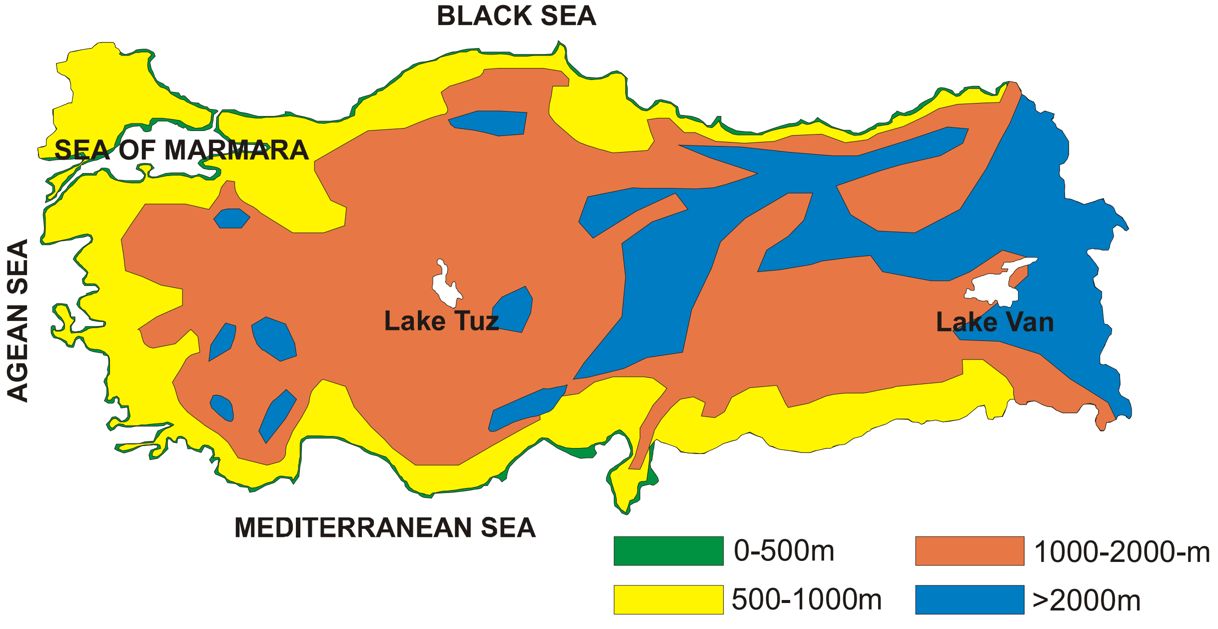

Figure 1. Elevation of Turkey (modified from Izbirak, 1975; Darkot and de Agostini, 1980)

Erosion is one of the most severe rural environmental problems affecting 81% of the total land surface in varying levels of severity (Figure 2). About 73% of the cultivated land and 68% of the prime agricultural land (Klingebiel and Montgomery's (1961) land capability classification –LCC- classes of I through IV) are prone to erosion. Stream bank erosion affects 57.1 million ha while wind erosion degrades another 466,000 ha. As a result, about one billion tons of soil is transported to the sea every year. The share of severe erosion is also relatively larger in areas where agriculture is practiced without any soil conservation measures. Conversely the actual erosion rate in the eastern part of the country is lower due to the dominant pastures (Figure 3). Erosion has other negative impacts, such as reducing the life of dams through siltation, in spite of the abatement programs initiated 25 years ago by the Ministry of Forestry, SHW[1] and GDRS[2], they have only been applied to 2.2 million ha area (CCD-TURKEY, 2003).

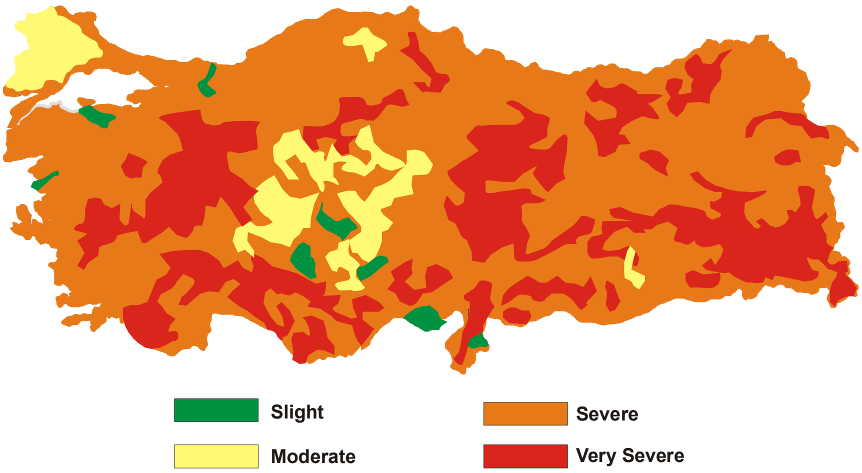

Figure 2. The simplified erosion map of Turkey (modified from GDRS, 1981)

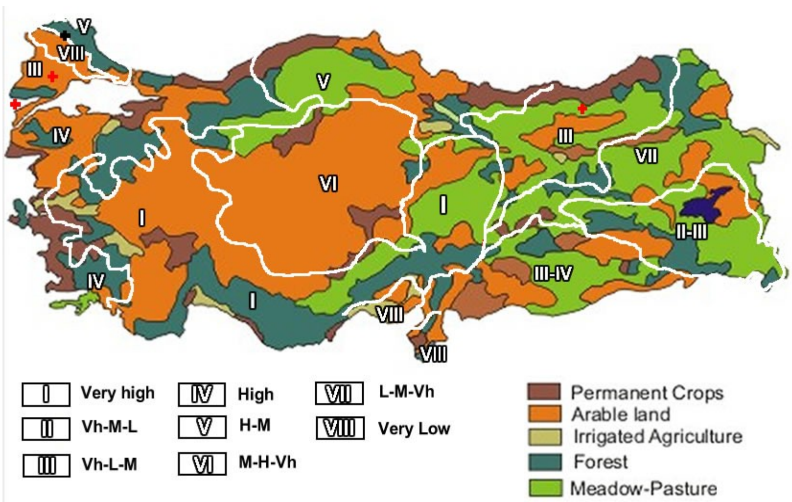

Figure 3. The landuse and simplified actual/potential erosion map of Turkey (modified from GDRS, 1982)

[1] SHW: State Hydraulic Works (DSI, Turkish Acronym)
[2] GDRS: General Directorate of Rural Services (KHGM, Turkish Acronym)

CLIMATE

Turkey is under the influence of two rather contrasting climatic types, namely the temperate climate with a year round precipitation and the Mediterranean with dry summers. However, 10 subdivisions of the two main climatic types have been established by Izbirak (1975) due to the effect of topography on climate (Figure 4).

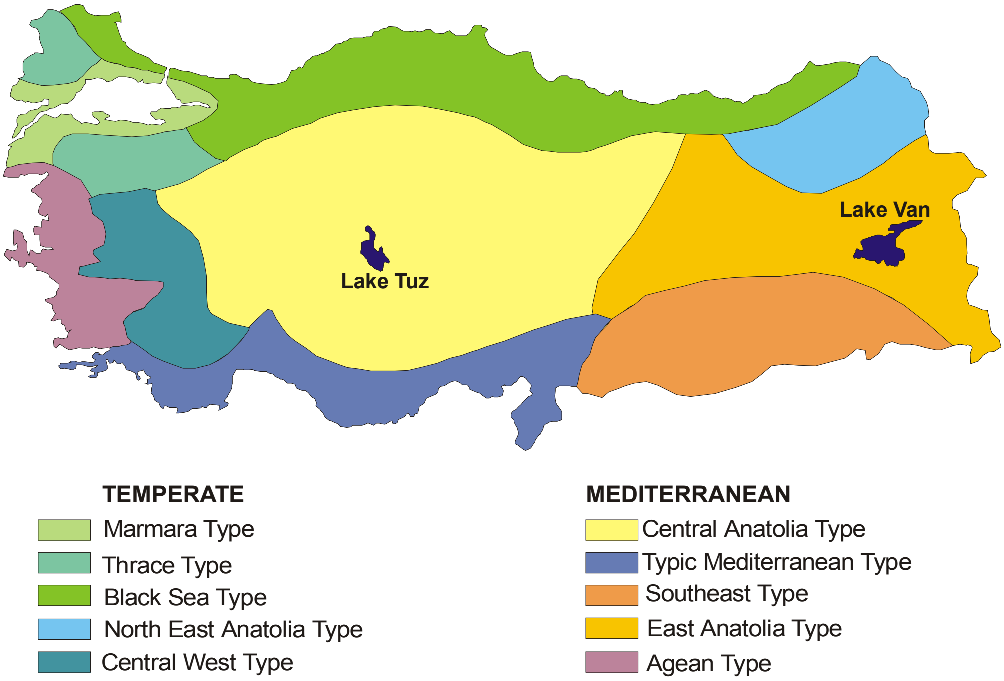

Figure 4. The climatic subdivisions of Turkey (modified from Izbirak, 1975; Darkot and de Agostini, 1980)

LANDUSE

Agriculture

The land use of the country is determined by its diverse topography and climate (Figure 2, 4), thus with various types of land use and crops eg while citrus being the main tree crop in Mediterranean region, tea is the main in the northern part (Figure 3).

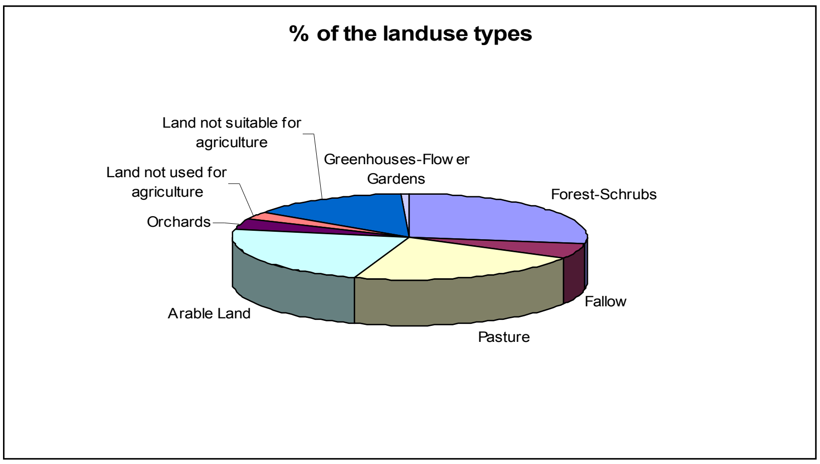

Figure 3. Distribution of landuse types

The available water for irrigation is also an important factor limiting land use priorities. The water resources of Turkey (26 Basins, 186.5km^3 annual) are quite high when compared to the countries in the Mediterranean Basin (State Hydraulic Works, 2003) (Figure 5). In spite of the abundant water resources in the country, the economically viable irrigated land is only 8.5% of the total arable land. Therefore, rainfed cereal production has been the major practice since centuries. Followed by the use of the extensive rangelands mainly for small ruminant production particularly in the Eastern parts, which has been an indigenous practice (Figure 3).

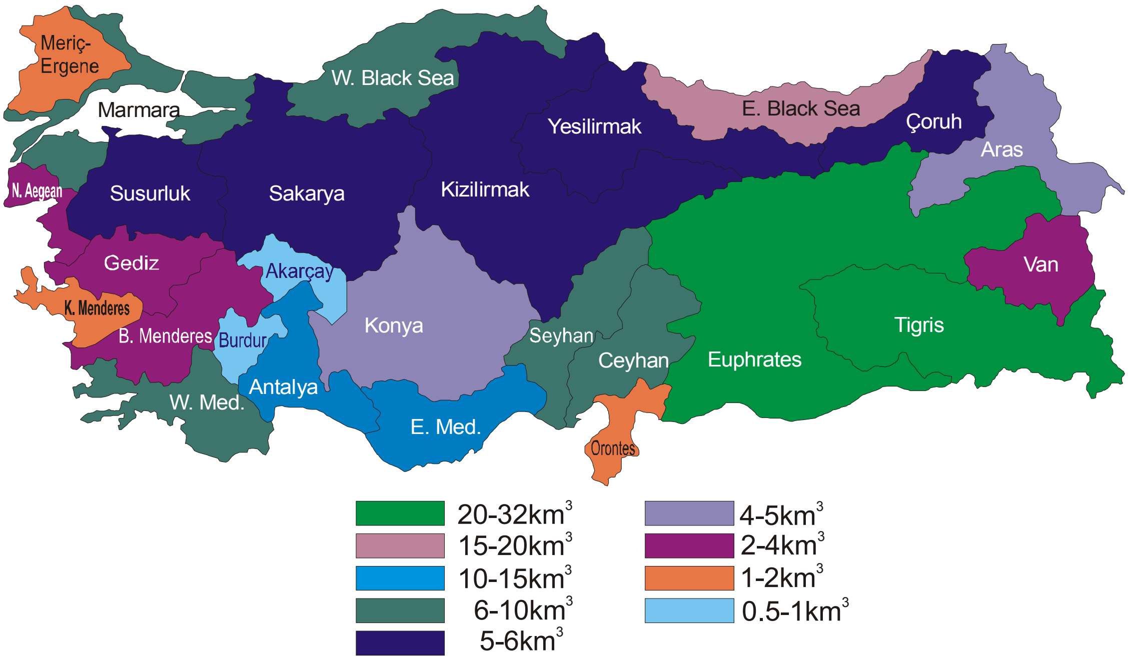

Figure 5. The river basins of Turkey (av. annual flow –km^3) (SHW, 2003)

Intensive production for two or three crops a year, along with greenhouse practices, are mainly undertaken in the alluvial plains of the country in the Mediterranean and Aegean regions with high yielding capacity due to the favorable climatic and soil conditions (Figure 3), whereas, constraints of production arising from the low amounts of organic matter contents throughout the country apart from the forest areas –the highlands- have to be considered together with minimal/optimal tillage, irrigation, green manuring and fertilizer use for conservation management (Figure 6, 7). The sharp increase in irrigated lands and fertilizer use in 1960 illustrated in Figure 7, is compatible to the increase in the construction of water reservoirs throughout the country and shift of crop patterns. The drawbacks that could develop from the increased use of fertilizers (other than nitrogen), especially phosphorous, may result to the increase of toxic Cd in the soils. However, a detailed zinc (mainly associated with Cd in soils and rocks) survey undertaken (Ozus, 2001, Eyüpoglu et al. 1995) in the soils of the country has revealed its deficiency which may also point out to the non-toxic levels (low risk) of Cd apart from soils developed on volcanic and metamorphic rocks.

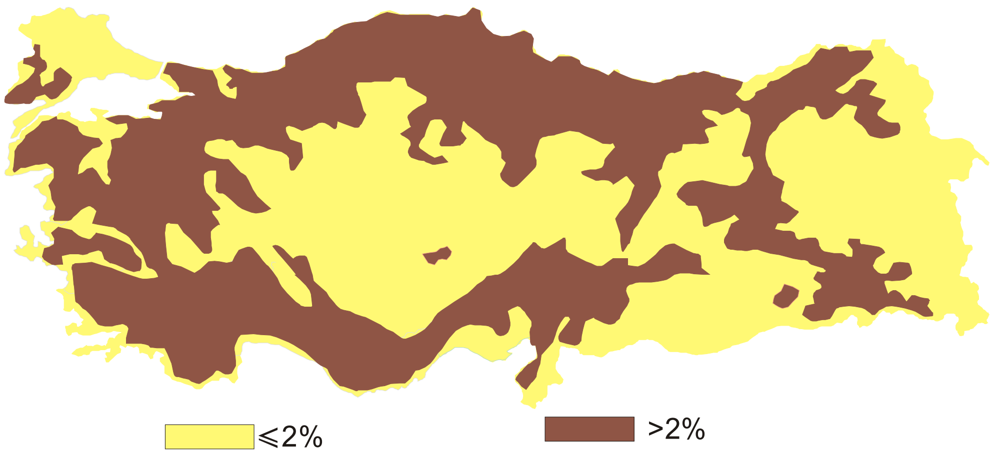

Figure 6. Organic matter distribution of Turkey (modified from Izbirak, 1975; General Directorate of Forestry -GDF, 2003; GDRS, 2003)

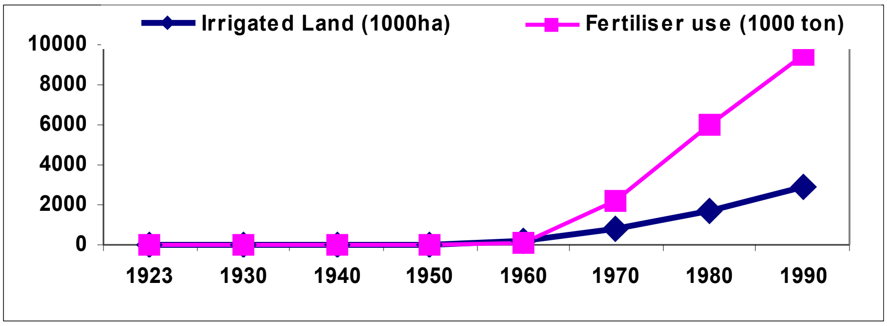

Figure 7. Irrigated Land and fertiliser use (SIS, 2003)

Pesticide Use

Despite the present overuse of pesticides in parallel to intensive agriculture, a potential risk exists for the near future particularly in the Mediterranean, Aegean and Marmara Regions of the country (Figure 8). The highest pollution risk is in the south due to the consumption of 40% of the total agricultural chemicals, whereas the risk in the East is relatively low due to the landuse ie the natural pastures (Figure 3).

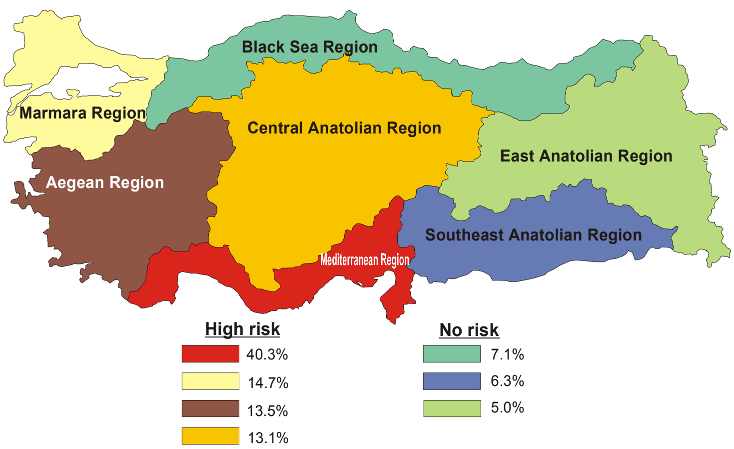

Figure 8. The use of pesticides in Turkey (Ministry of Agriculture, 2001)

Soil Sealing

Soil sealing in Turkey has started in the 1950s and accelerated by the 1960s due to the unplanned industrial sprawl/ordeal upon agriculture (Figure 9). Thus, the mismanagement of the natural resources (Figure 10) was an absolute outcome of the implementations of the shortsighted profit based policies that induced mass migration from rural areas to the urban. The data of the State Statistics Institute (2001) revealed a 30% increase of urban population from 33.656.275 in 1990 to 44.006.274 in 2000, whereas the rural increased at a much lower rate (4.3%).

The second rush of migration of the 1980s to relatively developed areas, namely urban and sub-urban regions of southern, western and central parts of the country, have had more drastic impacts on the environment and soils around the towns with adverse resilient effects on the abandoned soils of the rural areas by the secondary

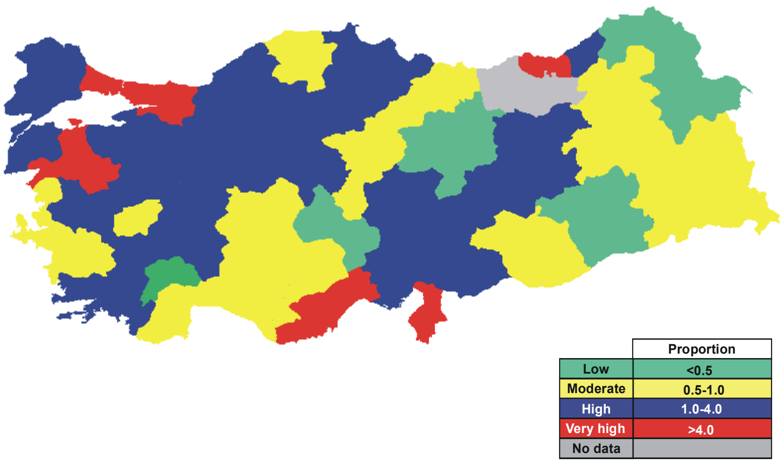

Figure 9. Proportion of agricultural land sealed for urban purposes (Cangir et al. 2000)

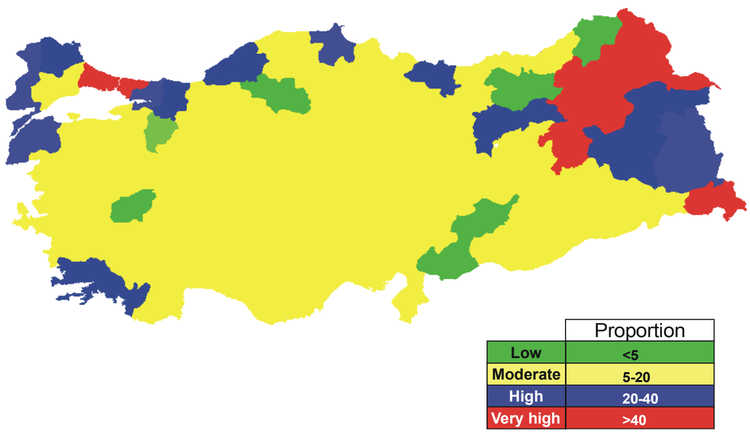

Figure 10. Proportion of agricultural mismanaged land (Cangir et al .1998)

Raw Material Exploitation

The use of productive soils, particularly of the fertile alluvial plains, as raw material sources for the construction of ultra and infrastructures has been a menace following the demographic changes of the 1950s and 1960s. The main consumption of soil resources are for the brick and ceramic industry with app. 440 factories consuming (Figure 11) 2.000.000tonnes/year out of the 60.000.000 tonnes reserve. These factories are mainly located on the arable land and fertile shallow Mediterranean Red

Soils (Luvisol-Cambisol) ie the fertile soils of the Mediterranean shrub agro-ecosystems of olives, carobs, vines, figs, citrus, almond and apricots.

Moreover, the vast amount of soils (468.902.550tonnes) used for the dam walls of the large and small reservoirs (app.504), which is equivalent to 213.138ha topsoil of degraded forest areas and marginal agro-ecosystems, are also one of the main irreversible resource consumptions in the country along with sealing.

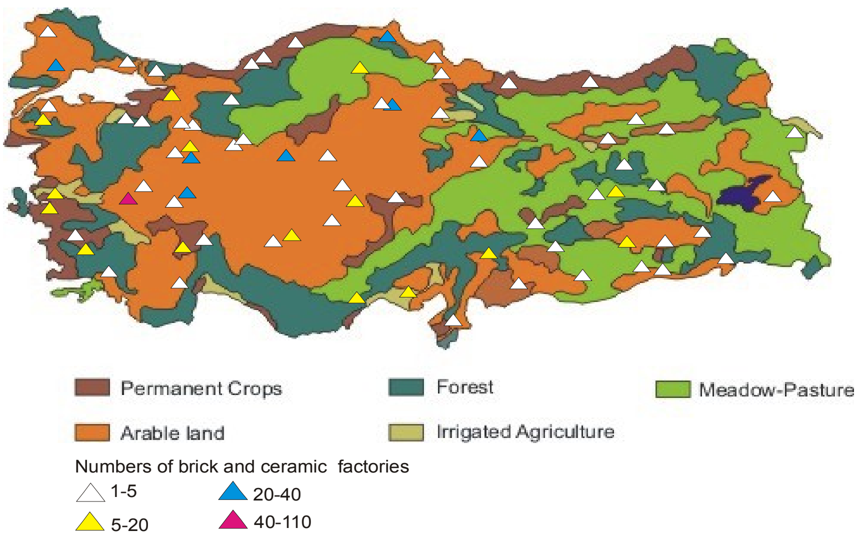

Figure 11. The distribution of brick and ceramic factories on landuse patterns (modified from Sakarya, 1989; MTA[3], 2003)

Salinity and Its Management

Turkey is lushly using its rich water resources in the last 5 decades in spite of the predicted gradual decrease in precipitation and increase in temperature especially in the Mediterranean region of the country (Eswaran et al, 1998, IPCC, 2001). Thus, numerous irrigation systems have been functioning since the 1950s contributing to the increase of welfare of the rural areas. However, the lack of sustainable land and water management tools together with participatory action led to the development of salinity at prime soils of the country and particularly in some basins of the recently established immense GAP[4] irrigation system which seeks to irrigate 1.7M ha of land, and completed in the near future. In spite of the completed baseline data, related to biophysical components such as soils and vegetation, the high risk of salinity build-up exists in the area due to the high clayey smectitic Vertisols (Figure 12) (Kapur et al. 1993) and semi-arid climate with a low leaching capacity of soils (Figure 13).

The Great Konya Basin of Central Anatolia is prone to secondary salinity due to its topography, which is bound to the existence of a much larger salt lake during the Late Pleistocene around its present remnant -the Lake Tuz (Louis, 1938). The area is an indigenous land of cereal and fodder production since the Neolithic (Atalay, 2002). However, future irrigation practices, with the use of excess water, within this area, may create drastic consequences due to the existing potential

[3] Turkish acronym for the Mineral Research and Exploration Institute
[4] Turkish acronym for the Southeast Anatolian Irrigation Project

salinity related to high saline water tables (SHW, 2003) linked to the ancient topography of the southern part of the closed Central Anatolian steppe basin. Thus, the indigenous cereal species of Aegilops speltoides, Triticum boeoticum, Triticum dicoccoides, Triticum aestivum, Triticum monococcum and dicoccum should be considered for rainfed traditional cropping at natural and anthropogenic steppes together with Salvia halophila hedge, Salvia viridis, spp, Salsoletum enermi, Frankenio-Limenietum iconiae, Haliminietum veruciferae, the natural halophytes of the steppes (Davis, 1965; GDAR, 1998; Atalay, 2002). Moreover, the present halobiome vegetation of endemic Salvia halophila hedge, Salsola platyhecal, Frankenia hirsute spp. – hispida-Statica iconiae etc should also be maintained in the area where salinity is a potential risk. Similarly, shifting to irrigated agriculture and overlooking the unique potential of the GAP region, as a natural heritage area, and a gene pool for cereals, fodders and legumes (GDAR, 1998) will hasten the process of salinisation. Hence, the management of the indigenous species of Aegilos speltoides, Triticum boeoticum and Triticum dicoccoides of the GAP area should be considered within the concept of the *Gene Management Zones* of UNDP (2003), which contain both protection and cultivated ecosystems.

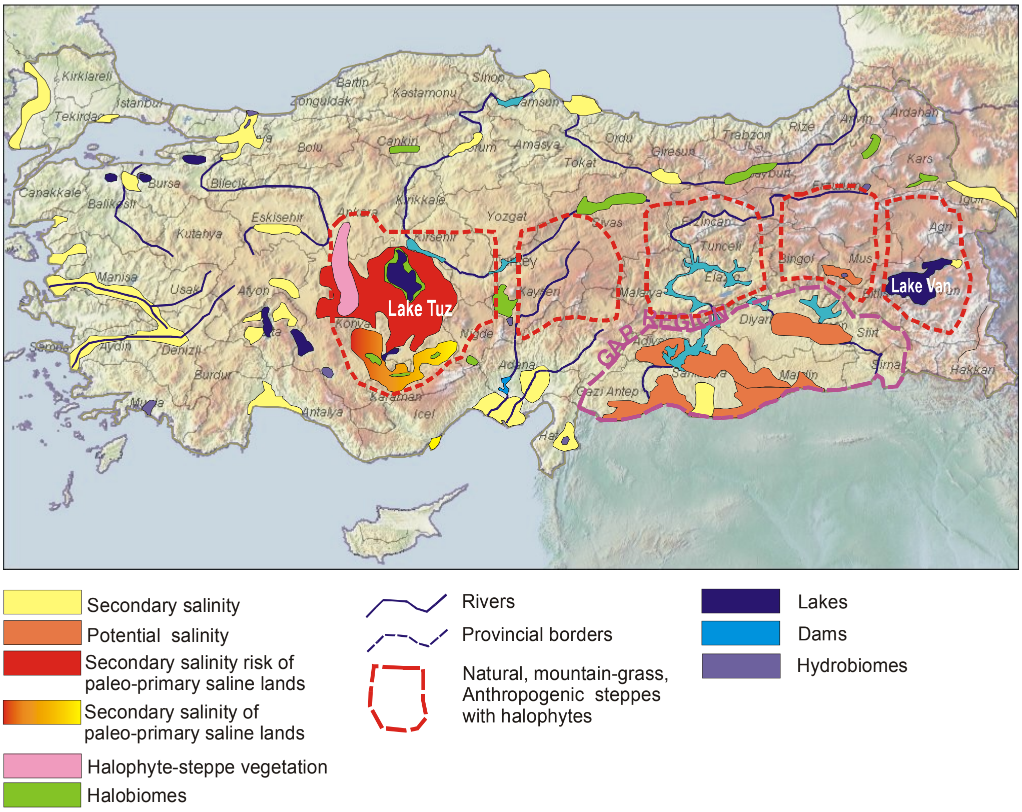

Figure 12. The salinity and halophyte map of Turkey
(modified from GDAR, 1998; SHW, 2002; Atalay, 2002)

Halophyte utilization both in primary and secondary saline areas in Turkey may be considered for sustainable natural management along with rainfed cereals and grazing (Malcolm, 1993; Leith and Mochtchenko, 2002) to save freshwater sources for human consumption.

SOILS OF TURKEY

The country comprises 32 soil associations i.e. SMU's each with two to three STU's and a few with one (Table 1) (Ozden et al. 2002). The Leptosols are the dominant soils followed by the Calcisols, Fluvisols, Cambisols, Vertisols, Kastanozems, Regosols, Arenosols, Alisols and Acrisols.

Table 1. Distribution of Soil Mapping Units (according to Lambert et al. 2000)

SMU	Distribution (%)
Umbric Leptosol/Dystric Cambisol	2.286
Mollic Fluvisol/Eutric Vertisol	0.224
Calcaric Fluvisol/Vertic Cambisol/Calcic Vertisol	7.019
Calcaric Regosol/Calcaric Cambisol	0.066
Mollic Leptosol/Petric Calcisol/Calcic Vertisol	2.475
Mollic Leptosol/Lithic Leptosol	17.736
Lithic Leptosol/Chromic Luvisol	1.424
Salic Fluvisol/Eutric Vertisol	0.138
Haplic Calcisol/Mollic Leptosol	1.363
Luvic Calcisol/Eutric Leptosol	0.959
Lithic Leptosol	7.094
Calcic Vertisol/Calcaric Fluvisol	0.203
Rendzic Leptosol/Haplic Cambisol/Luvic Kastanozem	7.588
Haplic Andosol	0.173
Haplic Arenosol	0.180
Haplic Kastanozem/Haplic Cambisol	3.376
Eutric Vertisol/Vertic Cambisol	1.119
Dystric Leptosol/Haplic Kastanozem	0.036
Chromic Luvisol / Haplic Alisol / Haplic Acrisol	2.224
Haplic Calcisol/Vertic Cambisol	6.027
Calcic Vertisol/Petric Calcisol/Luvic Calcisol	1.286
Calcaric Cambisol/Eutric Leptosol	9.468
Mollic Leptosol/Vertic Cambisol	0.201
Mollic Leptosol/Haplic Cambisol/Haplic Andosol	0.625
Vertic Cambisol	0.630
Eutric Cambisol	0.010
Eutric Leptosol/Hapic Cambisol/Eutric Vertisol	3.780
Luvic Calcisol/Calcic Vertisol	0.615
Luvic Calcisol/Petric Calcisol/Calcic Vertisol	3.102
Luvic Calcisol/Petric Calcisol	0.629
Luvic Calcisol/Haplic Calcisol	16.405
Eutric Fluvisol	0.191
Water Bodies	1.337
Marsh	0.012

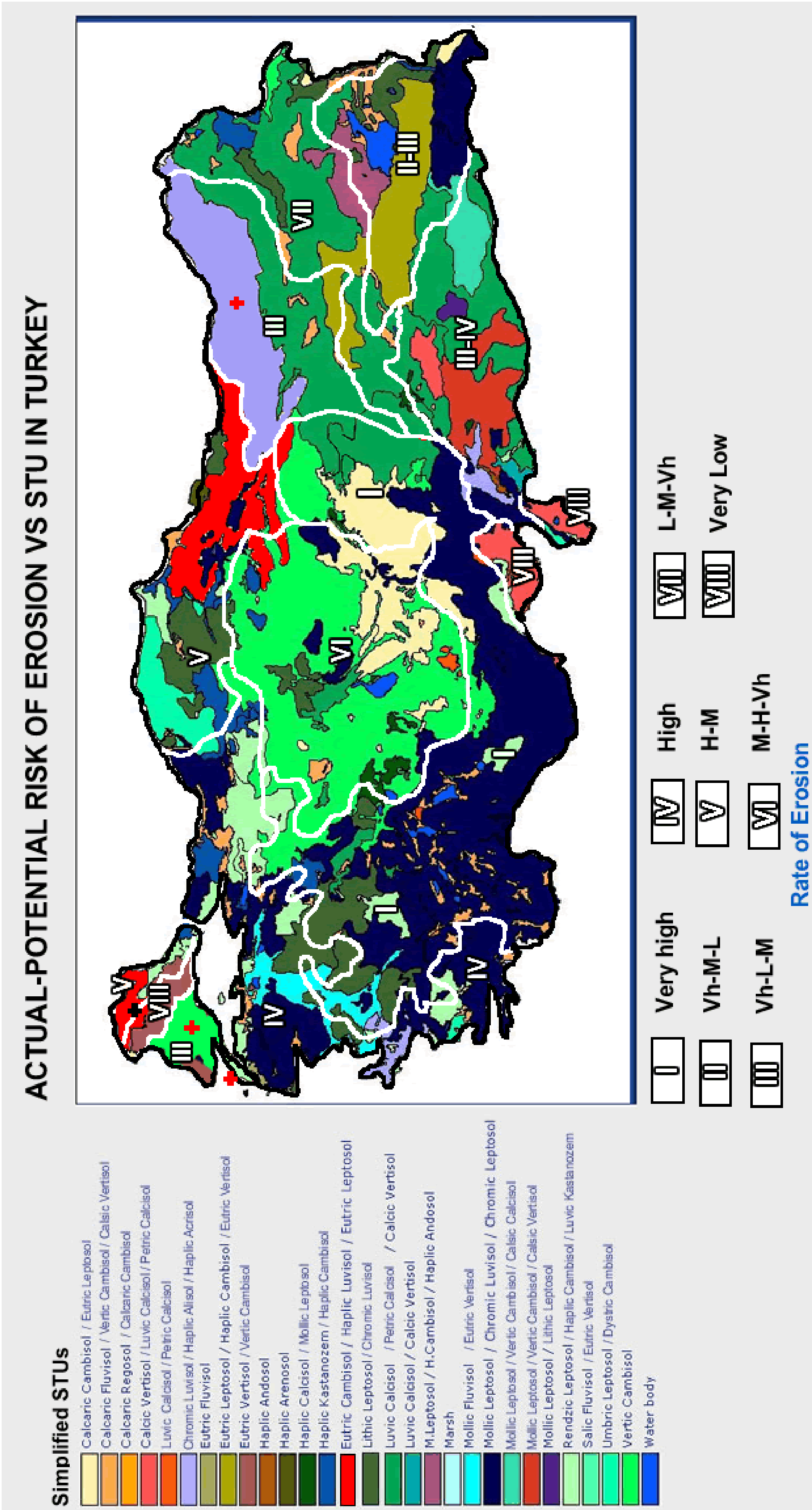

Figure 13. The simplified STUs and actual/potential erosion map of Turkey (Özden et al. 2002)

LEPTOSOLS

The abundance of Leptosols is the outcome of the vigorous Anatolian tectonic activities since the Miocene (Neotectonics) resulting to the development of steep slopes and their inevitable consequence causing mass transportation of soils and continuous destruction of the landscape (Erol, 1981).

CALCISOLS

Calcisols are the next dominant soils of Turkey taking place in the drier parts of the country, particularly developed on ancient lake basins and mudflow deposits developing to tectonically induced terraces of the Quaternary (Dinç et al. 1997).

FLUVISOLS

The Fluvisol association ie the widely distributed SMU's throughout Turkey along river valleys and lake basins are not determined in southeastern Turkey –the northern part of the Arabian Shield- which is covered by the materials transported following Neotectonic activities. Thus, the widespread Calcaric Fluvisols associating with Vertic Cambisols and Calcaric Vertisols are a good example for catenary sequential continuum encountered in countries with vigorous and frequent tectonic movements causing formation of prominent topographic/geomorphologic features/soils that are subjected to a long history of exploitation since the Neolithic.

CAMBISOLS

Cambisol associations, the soils of the slightly more temperate areas than the typical Mediterranean, associating with Leptosols and Kastanozems, are frequently located at the northern fringes of the Calcisols, which embrace the coastal areas of the north and south Mediterranean Basin.

VERTISOLS

The Calcic Vertisols with less prominent cracking features and gilgai due to the coarse calcite and palygorskite contents have developed from the transported Petric Calcisols ie the Quaternary mudflow surfaces designated as the "glacis" ie the colluvials (Dinç et al. 1997; Kapur et al. 1990).

ACRISOLS

One of the minor soil groups of Turkey are the Acrisols (Haplic) (Table 1) associating to Eutric Cambisols overlying volcanic and metamorphic parent materials with the highest annual rainfall in the area (1500-2000mm) and annual average temperatures of 12°C to 15°C, (northeast Black Sea coastal) needs detailed filed trials and description of new profiles for the ultimate differentiation from Podzols to Acrisols (Dinç et al. 1997).

REGOSOLS

The Calcaric Regosol and Calcaric Cambisol association covers a small part of the country (Table 1) and is located at a similar climate as the Lithic Leptosol/Chromic Luvisol association of the Mediterranean Region (Dinç et al. 1997).

ARENOSOLS

The Haplic Arenosol association represents the coastal sand dunes being on the ancient and/ or present courses of the large rivers of Anatolia intergrading to the coastal beach sands of the Mediterranean covering a relatively small part of the country (Dinç et al. 1978; Dinç et al. 1997, Akça, 2001).

ANDOSOLS

The Haplic Andosol STU has been recently defined in eastern Turkey and previously at the northeast, south and western parts of the country (Kapur et al. 1980; Dinç et al. 1997).

The use of especially the major class levels of the parent materials 3000 and 3300 of Version 4.0 of the ESB/WRB has provided more inside in the development of a more geologically oriented concept for the designation of Andosols that have developed on or in pyroclastic rocks (tephra).

CONCLUSIONS

Land degradation, particularly pollution in Turkey, is not very severe and an immediate threat when compared to other Western and Central European countries. However, the diverse topography when coupled with precipitation, is responsible for the high rate of erosion which is a major factor of natural degradation induced by human activities in the country. The erosion of productive topsoil decreases the net income of the agriculture-bound people and results migrations to industrialized urban areas causing the sealing of prime soils. The irreversible consequence of soil sealing which is also accelerated with the high population increase, causes shifting of forest areas, wetlands, primary saline zones and other fragile environments to agriculture.

Excess use of irrigation water is responsible for the development of secondary salinity in the primary (geologically) saline zones as well as the fertile alluvial plains of Turkey, which are actually the gene zones of numerous crops particularly cereals, legumes and halophytes. Thus, irrigation management plans should not only be based on the concept of conventional cash crop production but also for the crops present on environmentally friendly and stable indigenous rainfed agro-ecosystems, which necessitate the incorporation of the halophyte production in Central Anatolia (steppe), the olive-carob-vine production in the semi-arid Mediterranean (karstic), and cereals in the Southeast Anatolian Regions (calcrete). This paradigm in sustainable landuse management aims to increase the welfare of the urban people and decrease the threat of excess water use in fragile steppe, karstic and calcrete topographies, which are also the carbon pools of the world. Hence, the concept of agro-ecosystem based landuse assessment should primarily be considered in the development of sustainable land management strategies particularly with the incorporation of indigenous environmental friendly technical knowledge.

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