

## The Pressures on, and the Responses to, the State of Soil and Water Resources of Turkey

### *Türkiye’de Toprak ve Su Kaynaklarının Durumu, Baskılar ve Tepkiler*

Mustafa KÜK<sup>1</sup>, Paul BURGESS<sup>2</sup>

<sup>1</sup>Agriculture and Rural Development Support Institution, Çankaya, Ankara, Turkey

<sup>2</sup>Cranfield University, School of Applied Science Cranfield, Bedfordshire, United Kingdom

**Abstract:** Soil and water resources of Turkey have been under increasing pressures which are driven by increasing of population and demand for the resources and government policies. As a result, soil and water resources have been deteriorated in quality and quantity. To respond the problem, Governments have attempted to address environment problems through regulation, the use of economic instruments, and education since 1990s. However, further efforts needs for sustainable management of soil and water resources of Turkey. In this paper, potential and status of water and soil resources are described. Key driving forces and pressures on the state of the soil and water resources in Turkey are reviewed by using DPSIR framework. The paper then describes the key agriculturally-related drivers and pressures on soil and water resources. These include the use of fertilizers, agricultural machinery and irrigation equipment. The next section considers the current state of the soil and water resources in Turkey. The last section examines the key government responses of the Turkish government to address these issues. The development of appropriate measures to address these issues requires an understanding of the pressures on soil and water resources, the development of possible responses, and the mean of monitoring changes in the state of soil and water resources.

**Key words:** Soil, Water, DPSIR, Turkey, Agriculture, Environment.

**Özet:** Türkiye’de toprak ve su kaynakları, nüfus artışı, bu kaynaklara olan talep artışı ve kamu politikalarının yönlendirdiği artan baskılar altındadır. Bunun sonucunda, toprak ve su kaynaklarının miktar ve kalitesi azalmaktadır. Hükümetlerin 1990’lı yıllardan bu yana yasal düzenlemeler, ekonomik araçlar ve eğitim yoluyla soruna çözüm arayışı yoğunlaşmıştır. Ancak, Türkiye’nin toprak ve su kaynaklarının sürdürülebilir yönetimi için daha çok çabaya ihtiyaç vardır. Bu makalede toprak ve su kaynaklarının potansiyeli ve mevcut durumu irdelenmiş, DPSIR çerçevesi kullanılarak toprak ve su kaynakları üzerindeki önemli baskılar ve bu baskıları yaratan yönlendirici kuvvetler incelenmiştir. Makalede daha sonra tarımsal faaliyetlerin toprak ve su kaynakları üzerindeki etkileri ve bu etkilere yol açan yönlendiriciler ortaya konulmuştur. Gübre kullanımı, tarımsal mekanizasyon ve sulama makinelerinin kullanımındaki artış, tarımın toprak ve su kaynakları üzerindeki baskısını yansıtan göstergelerdendir. Son bölümde ise sorunun çözümüne yönelik başlıca hükümet politikaları incelenmiştir. Toprak ve su kaynaklarının sürdürülebilir yönetimi için uygun önlemlerin geliştirilmesi; bu kaynaklar üzerindeki baskıların anlaşılmasını, çözüm seçeneklerinin geliştirilmesini, toprak ve su kaynaklarının miktar ve kalitesindeki değişikliklerin izlenmesini gerektirmektedir.

**Anahtar kelimeler:** Toprak, Su, DPSIR, Türkiye, Tarım, Çevre.

### 1. Introduction

Turkey is a country of variety and contrasts both in terms of its geography and its economy and political system. Situated between Europe and Asia, it includes Anatolian and Mediterranean agro-ecological zones (Metzger et al. 2005). Politically the country is a pluralist secular democracy bordered by the secular-Christian states of Europe to the West and Islamic states to the East.

In 1923, following the foundation of the Republic, Turkey chose to align itself with Western Europe as the model for its new secular structure (ABGS, 2009). It is a founding member of the of the United Nations, a member of NATO, the Council of Europe, the OECD and an associate member of the Western European Union (ABGS, 2009). Since 1959, Turkey has sought entry to the European Economic Community (EEC). In 1963, the “Ankara Agreement” created an Association Council between The Republic of Turkey and the EEC. This was followed in 1970, by an additional protocol which set out in detail how a Customs Union would be established (ABGS, 2009). In 1987, Turkey applied for full membership under the Treaty of Rome, and in 1995, the Association Council adopted

its decision 1/95 on the completion of the Customs Union between Turkey and the EU in industrial and processed agricultural goods (ABGS, 2009). In 1999, at the Helsinki European Council, Turkey was officially recognised without any precondition as a candidate state on an equal footing with the other candidate states.

In 2001, the Turkish Government announced its own national programme for the Adoption of the EU acquis according to the short and medium term priorities as spelled out in the Accession Partnership. In 2005, accession negotiations were launched with the adoption of the Negotiation Framework by the Council of the European Union.

Since the First Environmental Plan in 1972, the European Union has increasingly incorporated the aim of improving the state of its environment within its treaties, agricultural and rural policies, and directives. Whereas reviews of soil and water resources in the European Union are numerous, studies related to Turkey are more limited.

## 2. Method

This paper seeks to review the key driving forces and pressures on the state of the soil and water resources in Turkey. It does this using the DPSIR framework (Figure 1). The use of the framework takes place within an agro-ecological and socio-economic context, and these are first outlined. The paper then describes the key agriculturally-related drivers and pressures on soil and water resources. These include the use of fertilizers, agricultural machinery and irrigation equipment. The next section considers the current state of the soil and water resources in Turkey. The last section examines the key government responses of the Turkish government to address these issues.

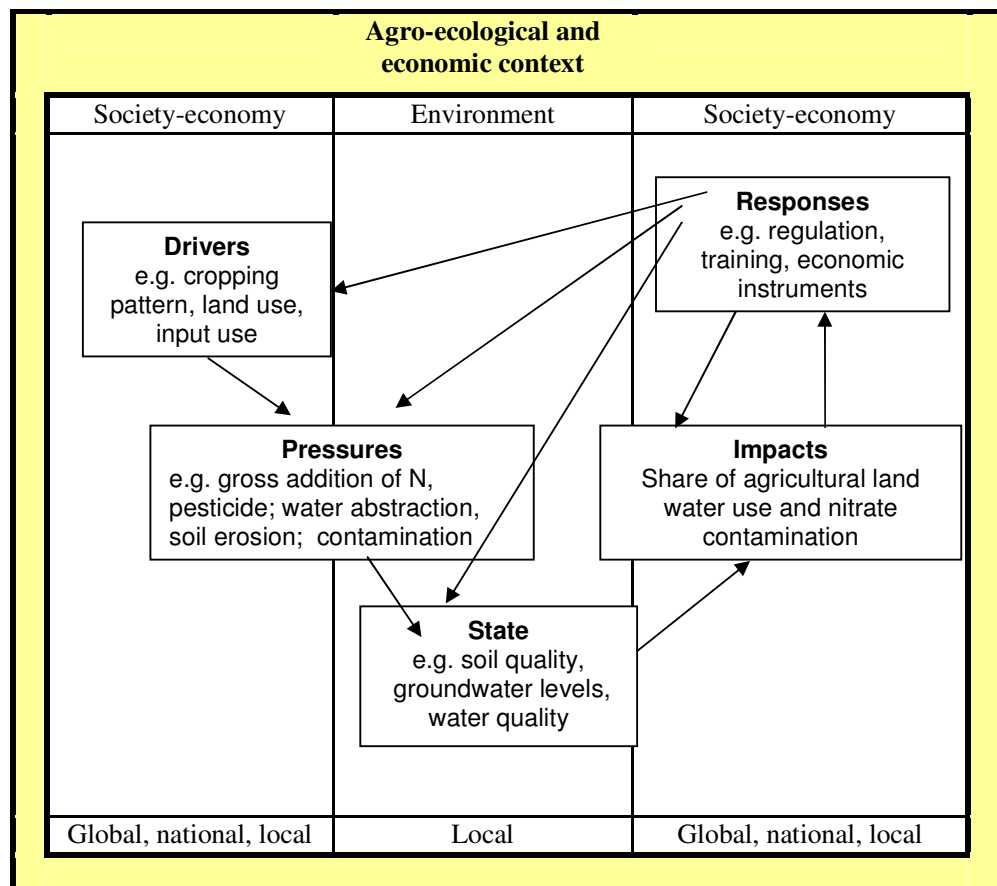


Figure 1. Schematic diagram of the DPSIR framework using the domains suggested by European Environment Agency.

### 3. Agro-Ecological Context

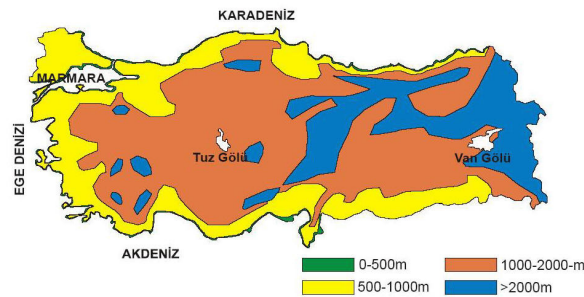
The framework of Drivers (D), Pressures (P), Status (S), Impacts (I) and Responses (R) takes placed in a specific context of agro-ecological and socio-economic constraints. In this paper, the context is the physical and social characteristics of Turkey.

Turkey extends over an area of about 78 million ha of which 1 million ha is inland water. The spatial changes in climate, soil and topography across Turkey result in a diversity of terrestrial and aquatic ecosystems. Over 55% of the country is above an altitude of 1000 m (Figure 2a). In fact the mean altitude (1,131 m) is substantially higher than the means of 330 m and 1050 m for Europe and Asia respectively (COB, 2004). The mean temperature is 13.4°C (COB, 2004). The mean annual precipitation is 643 mm, but the mean annual total ranges from 250 mm in the South East to 2500 mm in the North East next to the Black Sea coast (Figure 2b).

About 64% of Turkey has a slope greater than 12%, and 67% of the land has a soil depth shallower than 50 cm. It is estimated that 37% is shallower than 20 cm (COB, 2004). A classification of rural land capability has identified the intensity of land use that a soil is capable of sustaining without degradation. It is estimated that only 4.8 million ha is Class 1, i.e. it requires no particular soil conservation measure. About 6.0 million ha is Class 2, where soil conservation practices such as strip cropping, conservation tillage, and adequate crop rotations are necessary. This suggests that the remaining 67 m ha is Class 3 or above requiring either permanent crop or tree cover or structural soil conservation works such as graded banks and waterways to minimise soil degradation (Sonter and Lawrie 2007; Haktanir et al. 2000; TCV, 1995).

The gross renewable freshwater potential of the country has been estimated as 234 billion m<sup>3</sup>, i.e. about 0.3 m<sup>3</sup> m<sup>-2</sup>. This comprises 193 billion m<sup>3</sup> of surface water and 41 billion m<sup>3</sup> of groundwater. Moreover many of the rivers, such as the Euphrates and Tigris are both important to Turkey and neighbouring countries like Syria and Iraq. Management of these rivers and river basin required cross-country collaborations.

#### a) Altitude



#### b) Rainfall

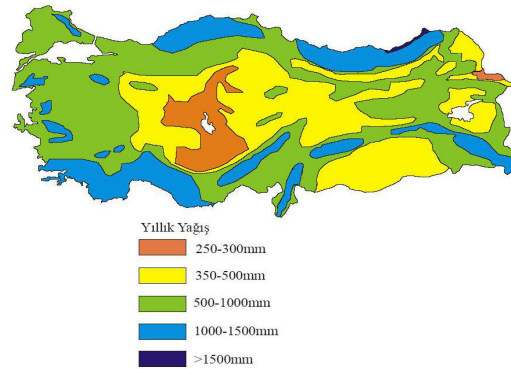


Figure 2. Maps of a) the altitude, b) the annual rainfall in Turkey (Ozden et al. 2001).

#### 4. Economic Context

Turkey is a developing country with a high rate of population growth. The population increased from 13.6 million in 1927 to 73 million in 2006 (Figure 3a). During this period whereas the rural population increased about three-fold from 10.3 to 27.2 million and the urban population has increased 14-fold from 3.3 to 45.7 million.

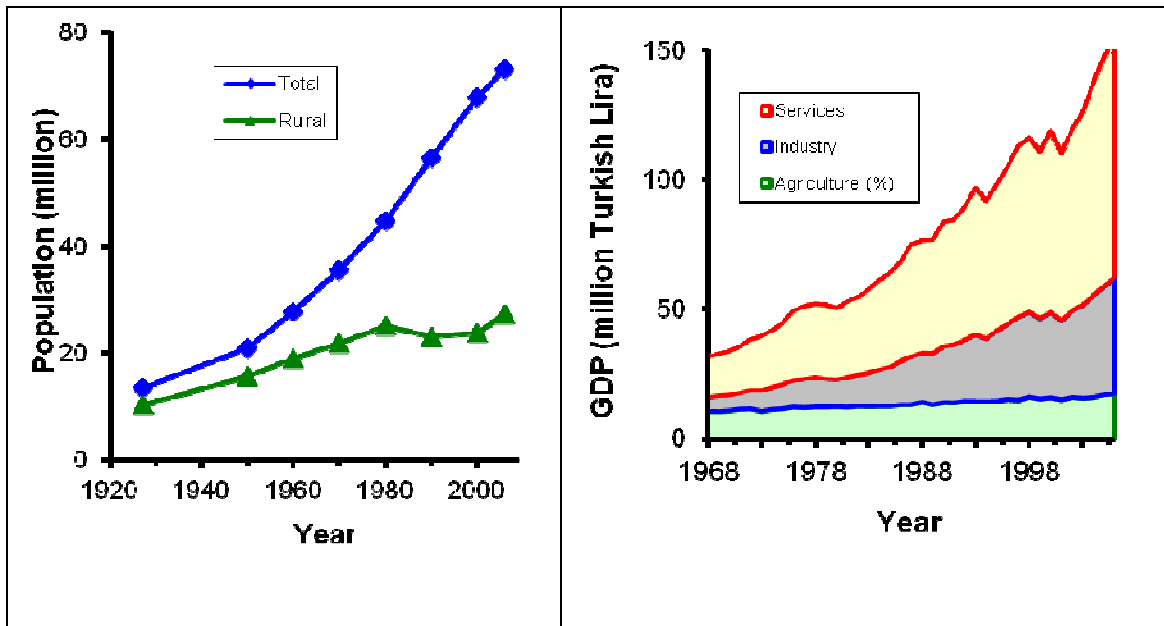


Figure 3. a) Urban and rural population in Turkey between 1927 and 2006 (DİE 2003a; TÜİK, 2007b), and b) GDP of the agricultural, industrial and service sectors between 1968 and 2006 (1987 Constant prices) (DİE, 2001; TÜİK, 2008).

The share of the agriculture sector in GDP has decreased rapidly as a consequence of economic development (Figure 4). Between 1980 and 2006, the Gross Domestic Product (GDP) per capita increased from \$1539 to \$5477 (TÜİK, 2008). During the same period the GDP per capita in the agricultural sector increased from \$611 to \$1429 (DİE, 2001).

#### 5. Driving Forces and Pressure on Soil and Water Quality

The driving forces and pressures on soil and water quality are considered in terms of land use, the increased use of agricultural inputs and the increased use of water.

##### *Land use*

Turkey has a land area of 77 million ha and 1 million ha of internal water surfaces. The area of arable land increased from 13 million ha in 1938 to 23-24 million ha between 1960 and 2005 (Figure 5).

Similarly the area of forested land increased from 10 million ha in 1938 to about 25 million ha in 1990, before declining to about 22 million in 2007. By contrast, the area of pasture and permanent meadows has declined by 70% from 41 million ha in 1938 to about 14 million ha in 2005 (Figure 4). The area categorized for other purposes such as horticulture, housing, infrastructure, and water increased from 11 million ha in 1980 to 18 million ha in 2005. Between 1990 and 2005, the horticultural area comprising vegetables, olives, fruits, and beverages has stayed relatively constant at 3.5-3.6 million ha. Due to the role of public institutions (DSI and KHGM) the irrigated area has increased from 1.7 million ha in 1980 to 4.1 million ha in 2007. A further 1.0 million ha have been privately developed. In 2007 the irrigated area of 5.17 million ha represents about 25% of the arable area; with the potential area estimated to be about 8.5 million ha (DSI, 2009a).

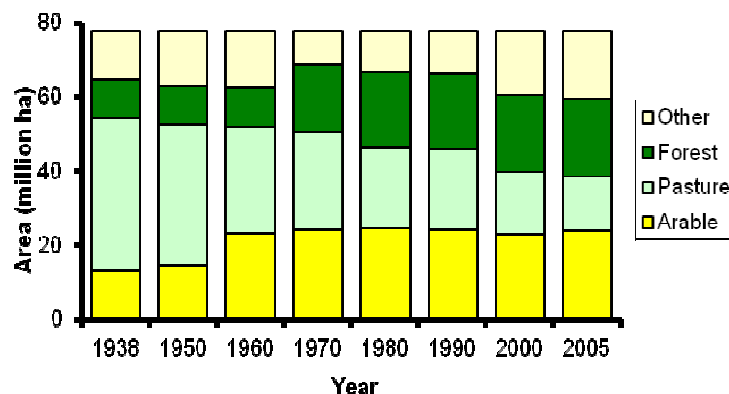


Figure 4. Land use changes in Turkey (DIE, 2003b; Tekeli et al., 2005).

In 2007, the major arable crops in Turkey were wheat (8.1 million ha) and barley (3.4 million ha). Other significant crops are maize, sunflower, chickpeas, lentils, cotton and sugar beet, all occupying 0.3-0.5 million ha. There are also significant areas of tea, bananas, hazelnuts, pomegranates, dry figs, apricots, and olives, and Turkey is the second largest producer of sultanas, cherries and peppers. Between 1961 and 1980, the number of cattle and sheep increased (Figure 5). This increased grazing pressure was associated with increased soil erosion. From 1980 to 2000, the number of cattle and sheep decreased steadily. For example the number of sheep declined from 48.6 million in 1980 to 25.3 million in 2000 (Figure 5). Over the same period the number of goats declined from 11 million to 6.5 million. There has been a tendency to move from livestock systems reliant on grazing to systems such as poultry production which rely on cereal production. For example the annual weight of poultry meat produced in Turkey has increased from 0.270 million tonnes in 1995 to 1.059 million tonnes in 2007.

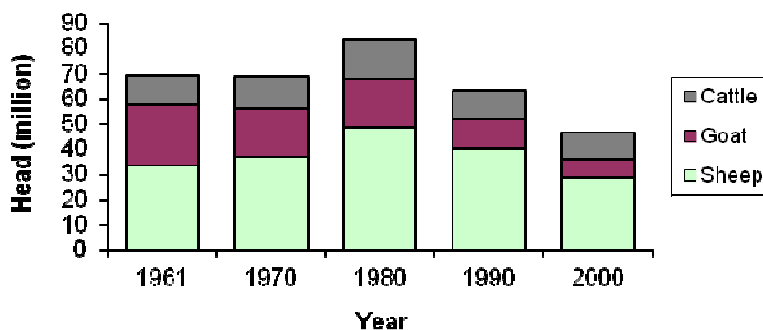


Figure 5. Livestock numbers in Turkey (DIE, 2003b; Tekeli et al., 2005).

#### ***Increased use of agricultural inputs***

The agricultural policy of Turkey has primarily been focused on increasing agricultural production and productivity. The government has supported this by reducing the costs of agricultural inputs and agricultural credit, or increasing the price of crops. Support has also been provided for education and extension, and infrastructure (e.g. irrigation, drainage, village-field roads and electricity). In response, the area of arable land, the use of agricultural inputs (fertilizers, pesticides, and machinery), and the level of crop production has increased. For example, the number of agricultural tractors increased rapidly (24 fold) between 1970 and 2005 (Figure 6a). In Turkey, 92% of area is irrigated by surface irrigation and 8% is irrigated by pressurized irrigation (Bülbul et al.,

1999; DSI, 2009c). The number of motor pumps (an indicator of potential water abstraction) increased 88-fold between 1952 and 2005. Similarly the consumption of chemical fertilisers increased by about 100 times between 1960 and 1990, before stabilising at a relatively constant level (Figure 6b). Consumption of Potassium-based fertilisers has remained relatively low, as most Turkish soils are high in Potassium.

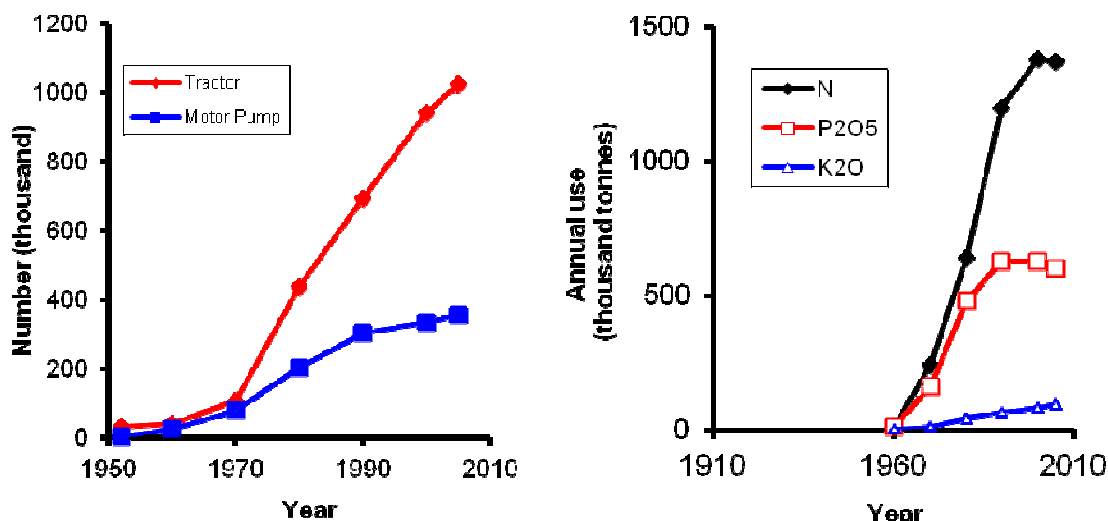


Figure 6. Number of a) agricultural tractors and motor pumps in Turkey (DIE, 2003b; TUIK., 2007a), b) annual consumption of chemical fertiliser (DIE 2001; DIE 2003b; TUIK 2007a).

### *Increased use of water*

DSI (2009a) have estimated that 98 billion m<sup>3</sup> of surface water and 14 m<sup>3</sup> of groundwater could technically be developed for consumption purposes per year. Irrigation water use increased from 22.0 billion m<sup>3</sup> in 1990 to 31.5 billion m<sup>3</sup> in 2000 (Table 1). This includes the initial effects of the Southeast Anatolian Project (GAP) which will add an additional 1.82 million ha of irrigation. Over a similar period, industrial and domestic water consumption increased from 8.6 billion m<sup>3</sup> to 10.5 billion m<sup>3</sup> (Table 1). Hence the proportion of water used for irrigation has increased from 72% (1990) to 75% (2000). This compares to 32% for the EU.

It is estimated that 150 Liters per day per person is a sustainable level of domestic water consumption (DSI, 2009b). As the population has increased from 28 million in 1960 to 73 million in 2006, the potential daily utilisable water per person has declined from 10.7 m<sup>3</sup> to about 4.1 m<sup>3</sup> (DSI, 2009a). The domestic water reservoirs for some of the large cities like Istanbul and Ankara are no longer sufficient to meet maximum demand, and domestic water was cut-off in Ankara for part of 2007. To address the large water demand of Ankara, water is now being diverted from Kızılırmak, one of the main river of Turkey.

Table 1. Annual water consumption (billion m<sup>3</sup>) of key sectors in Turkey (DPT, 2001).

Sector	Water consumption (billion m <sup>3</sup> )	
	1990	2000
Irrigation	22.0	31.5
Domestic	5.1	6.4
Industry	3.5	4.1
Total	30.6	42.0

## 6. Current State of Soil and Water Resources

The state of the soil and water resources of Turkey is considered in terms of soil fertility and water quality.

### *Soil fertility*

Soil fertility is usually taken to be the capacity of the soil to produce vegetation. It is primarily based on the physical, chemical and biological status of the soil, and the maintenance of a specific depth and area of soil. These factors are considered in turn.

### *Physical status of soil*

The four principal soil types in Turkey are calisols, cambisols, leptosols, and fluvisols (Figure 7). The cambisols in North-East Turkey are relatively young and can be agriculturally productive. Calcisols in the central and eastern regions are found in drier areas and are characterised by significant accumulation of calcium carbonate. Leptosols found in the South and the West are shallow soils over hard rock, and are indicative of high rates of erosion. The fluvisols have formed from deposition of soil in flood plains, and they tend to be relatively fertile.

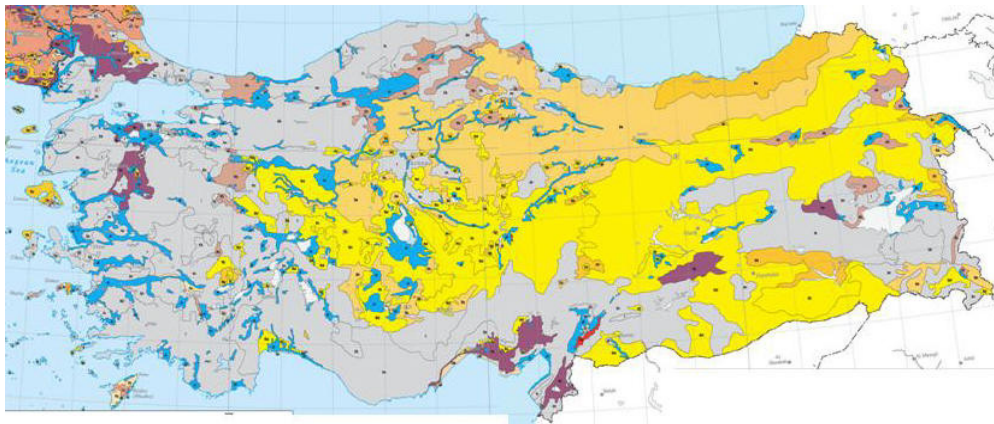


Figure 7. Map of the principal soil types in Turkey (European Commission and European Soil Bureau Network, 2006); calisols (yellow), cambisols (orange) and leptosols (grey), and fluvisols (blue).

### *Chemical status of soil*

The principal chemical problem associated with Turkish soils is salinity and sodicity, which is estimated to affect 1.5 million ha (30%) of the current irrigated area of 5.1 million ha (COB, 2004). In specific areas, Boron contamination has become a problem caused by irrigation with waste water. Haktanir (1997) estimates that 81 thousand ha is affected in the Balıkesir, Kesput and Karacabey plains of North West Turkey.

### *Biological status of the soil*

Approximately 19% of Turkish soils have organic matter content below 1% (Table 2) (Haktanir et al, 2000:207). Soils with this level of organic matter are often considered to be in a pre-desertification stage (Commission of European Communities, 2002).

Table 2. Organic matter content of Turkey's Soils (Toprak ve Gübre Araştırma Enstitü Müdürlüğü, 1988).

Organic matter (%)	< 1	1-2	2-3	3-4	>4
Proportion of soils (%)	19.2	49.8	22.4	5.6	3.0

### *Soil loss*

Soil loss is partly dependent on soil type and topography, but it can be accelerated by agricultural cultivation and the lack of soil conservation measures. It is estimated that on average about 500-616 million tonnes of soil is lost from Turkey annually; equivalent to a mean of 6.5-8.0 t ha<sup>-1</sup>. This compares to average values of 0.84, 2.73, 4.91, and 6.10 t ha<sup>-1</sup> in Europe, Australia, America and Asia respectively (Dogan, 1995). Haktanir (1999) estimates from surveys that only 13.8 % of the

area had no or low erosion. 20.2 % of the area has medium, of 36.4 area has intense and of 22.2 % area has very severe (intense) erosion (Table 3). JRC (2008) shows that with Europe, the highest rates of erosion risk were in Mediterranean areas with local hot-pots where the annual erosion risk is in excess of 20 t ha<sup>-1</sup>.

Table 3. Categorisation of the erosion risk to Turkey's soils (KHGM, 1987; Haktanir et al, 2000).

Erosion category	Typical quantity of soil loss (t ha <sup>-1</sup> a <sup>-1</sup> )	Area (million ha)	Proportion of land (%)
0-1 Slight	1.5	10.78	13.8
2 Medium	3.0	15.59	20.0
3 Severe	4.5	28.34	36.4
4 Very Severe	6.0	17.37	22.3
Bare Rocks		2.93	3.7
Wind erosion		0.51	0.6

Erosion causes both a loss of soil productivity and sedimentation problems in surface water reservoirs. In Turkey the volume of reservoirs of many lakes and dams are decreasing rapidly owing to sedimentation. For example, two-thirds of capacity of the Çubuk reservoir has been filled by sedimentation in 35-40 years. Similarly the capacity of the Keban reservoir has rapidly decreased due to poor vegetation management (Ceritli, 1997)

#### **Water quality**

Water pollution has been identified as one of three key environmental issues in 74 of Turkey's 81 provinces (COB, 2008). The principal sources of water pollution relate to domestic and industrial processes; however agriculture was nevertheless responsible for 26% of the pollution incidences in 2008 (Table 4). Nitrate concentrations are a key area of concern. For example Yesilnacar et al. (2008) report that almost all groundwater samples from the Harran Plain in South East Turkey had nitrogen concentrations significantly above 50 mg L<sup>-1</sup>. Baltaci et al. (2008) reports that SHW (DSI) water quality has identified deterioration in most inland water resources. Muhammetoglu and Yardimci (2006) report high levels of nitrogen, phosphorus and salinity in the soil water and groundwater of the Kumluca Plain in South West Turkey. Ozsoy et al. (2008) have reported particularly high ammonium, phosphate and nitrate concentrations in the Goksu and Seyhan Deltas of Southern Turkey. Sariyildiz et al. (2008) have also reported reductions in surface water quality in the Gediz river in western Turkey between 1986 and 2003. Similar work has been reported for the major rivers flowing into the Black Sea.

Table 4. Causes of pollution of water resources (surface and ground waters) which are subjected to pollution in 2005-06 (COB, 2008).

Sources of pollution	Number of cases	Sources of pollution	Number of cases
Domestic liquid waste	445	Erosion	30
Domestic solid waste	232	Fishery	7
Industrial waste	276	Construction and excavation	6
Agricultural activities	356	Animal husbandry	5
Marine activities	18	Others	18

## **7. Government Responses**

Government can attempt to address environment problems through regulation, the use of economic instruments, and education. The final section of the paper deals with the policy and legislative framework that the Turkish government has developed to address the state of soil and water quality.

#### **Government strategies**

Since 2000, agricultural policies have increasingly focused on food safety, environmental protection and the development of agricultural systems that are sustainable and environmentally sensitive. Within Turkey, the five year development plans are key strategy documents that guide government policy and outline what is expected of the private sector. A key feature of the "Eighth 5-



year Development Plan (2001-2005)” was the “National Action Plan for Combating Desertification”. This recognised that combating desertification and soil erosion required an integration of rural land use, the water demands of settlements, and the provision of rural livelihoods and rural infrastructure (DPT, 2000:234). The “Ninth 5-year Development Plan (2006-2011)” included the main principle that “natural and cultural assets and the environment” should be conserved for future generations. A main aim was the development of an agricultural sector that “ensures food security and safety” with the “sustainable use of natural resources”. It proposes that land use planning should help prevent erosion by focussing production on “high fertile agricultural lands” (DPT, 2006:77).

### ***Laws and regulation***

The Law related to underground water in 1960, outline that underground waters belong to the State. A new constitution for Turkey, as outlined in the Fundamental Law of 1982, was approved by referendum in 1982. It clearly outlines the role of the state to maintain and improve the soil resources of the country (Table 5). The Environment Law in 1983 provides the framework for environment policy and legislation. It has the aim of protecting and conserving the environment, and introduces the Polluter-Pays-Principle, some nine years before the Rio Summit. The Soil Conservation and Land Use Law from 2005 provided a framework for the State to regulate land uses leading to significant soil deterioration. The Agriculture Law from 2006 sets out the framework for State intervention in the agricultural sector (Table 5).

Table 5. Examples of laws to improve the state of soil and inland water resources in Turkey.

Law	Key developments
The Law Related to Underground Waters (Dated 16.12.1960 and numbered 167):	The aim of the Law is to protect/conservе underground water resources and to encourage the public to use the underground water practically (in best situation). According to the Law, underground waters belongs the State, and water abstraction is subject to permission of state Hydraulic Works.
Fundamental Law (1982)	Article 43. Property rights of coasts belong to the State Article 44: The State shall take measures to maintain and develop operating soil efficiently, to avoid soil loss by erosion ... Article 45: It is the State’s duty to prevent agricultural lands and pastures and meadows against being used for other purposes and deterioration Article 56: Everyone have the right to live in healthy and balanced environment Article 166: Property rights of natural fortunes and resources belong to the State
Environment Law (1983)	The Law is an attribute of base of environmental policy of Turkey. 9.8.1983 dated and 2872 Numbered Environment Law (Amended by 26.4.2006 dated and 5491 Numbered Law) determines the aim of the law as “to protect/conservе the environment, which is the asset of all living organisms, in conformity with the principles of sustainable environment and sustainable development”. “PPP principle” and “sustainable development principle” is introduced (adopted) by the Law.
Soil Conservation and Land Use Law (dated 03.07.2005 and numbered 5403)	The aim of law is to conservе and develop soil quality and quantity while using soil. The law requires soil users (holders) to take precautions that indicated in the Law to protect/conservе soil functions while using their property rights. The Law requires MARA (Ministry of Agriculture and Rural Affairs) to prepare land use plan and ban (restrain) the use of agricultural lands for other purposes than indicated in the land use plans, save for exceptions indicated in the Law.
Agriculture Law (18.04.2006 dated and 5488 numbered):	The aim of the Law is to determine policies and to make regulations for development and support of agriculture sector and rural area (to direction of) development plans and strategies. Sustainability and sensitiveness to human health and environment is determined as one of principle of agricultural policies. Developing and rational use of soil and water resources is determined one of priority of agricultural policies.

The “Regulation related to controlling Soil Pollution” from 2005 regulated the use of sewage and compost and implemented the Polluter-Pays-Principle. The “Regulation related to the Programme for the Conservation of Agricultural Lands for Agricultural Purposes” from 2005 describes a programme of incentives for farmers who maintain their land in good agricultural and environmental condition.

Table 6. Examples of regulations to improve the state of soil and water resources in Turkey.

Law	Regulation	Key developments
-441 numbered and 07.08.1991 dated Decree of Cabinet (which has force as law) relating to Organisation and Function of Ministry of Agriculture and Rural Affairs - Soil Conservation and Land Use Law (dated 03.07.2005 and numbered 5403)	Regulation Relating to Chemical Fertilisers Used for Agriculture (Issued in Official Gazette dated 18.03.2004, numbered 25406):	The Regulation is introduced (prepared) compatible with EU Directives for determining types and compositions of chemical fertilisers, styling, packaging and inspecting them. According to the Regulation, use and trading of unregistered/unlicensed is banned. The Regulation contributes to protect soil and water resources against harmful substances which may be used as fertilisers.
-441 numbered and 07.08.1991 dated Decree of Cabinet (which has force as law) relating to Organisation and Function of Ministry of Agriculture and Rural Affairs -6968 Numbered Law of Agricultural Combat and Quarantine -5179 Numbered Decree of Cabinet (which has force as law) relating to Production, Consumption and Inspection of Food	Regulation Relating to Good Agricultural Practices (08.09.2004 dated and 25577 numbered Official Gazette):	The Regulation is prepared to aim an agricultural production which is not harmful to environment, human and animal health, conserving natural resources, agricultural traceability and sustainability, and achieve food safety. The Regulation requires GAP to be done by using ICM and IPM techniques and under the control (inspection) of TKB and control and certification institutions authorized by TKB.
-09.08.1983 dated and 2872 numbered Environment Law - 01.05.2003 dated and 4856 numbered Law relating to Organisation and Function of Ministry of Environment and Forestry	Regulation Relating to Controlling Water Pollution (Issued in 31 December 2004 dated and 25687 numbered Official Gazette)	The aim of the Regulation is to take required legal and technical measures compatible with goals of sustainable development in conserving and optimal use of groundwater and surface water potential, preventing water pollution. The Regulation comprises quality classifications and intended use of waters, planning base and prohibitions relating to conserving water quality, discharge principles and discharge permit base of wastewaters and procedures and bases of monitoring and inspection (control) to prevent water pollution.
-09.08.1983 dated and 2872 numbered Environment Law - 01.05.2003 dated and 4856 numbered Law relating to Organisation and Function of Ministry of Environment and Forestry	Regulation Relating to Controlling Soil Pollution (issued in 31.05.2005 dated and 25831 numbered Official Gazette)	The aim of the Regulation is to take required measures compatible with goals of sustainable development in preventing soil pollution, removing soil pollution, using sewage and compost in soil. The regulation bans to give all types of waste and leftover in receiving environment. Limits of soil pollution parameters and maximum heavy metal contents of stabilized sewage are determined by the Regulation. PPP is adopted for polluted soils.
-441 numbered and 07.08.1991 dated Decree of Cabinet (which has force as law) relating to Organisation and Function of Ministry of Agriculture and Rural Affairs -03.07.2005 dated and 5403 numbered Soil Conservation and Land Use law	The Regulation Related to Programme for Conservation of Agricultural Lands for Environmental Purposes (Issued in 15.11.2005 Dated and 25994 numbered Official Gazette):	The regulation aims; to protect soil and water quality, sustainability of renewable natural resources to avoid erosion and to abate negative effects of agriculture. The Regulation allows (requires) to pay farmers who commit to do certain environmentally sustainable practices (good agricultural practices) under (gift) agreement.
-441 numbered and 07.08.1991 dated Decree of Cabinet (which has force as law) relating to Organisation and Function of Ministry of Agriculture and Rural Affairs - MoEF - 01.05.2003 dated and 4856 numbered Law relating to Organisation and Function of Ministry of Environment and Forestry	Regulation Related to Protection of Waters from Nitrate Pollution (Coming from) Agriculture:	The aim of the regulation is to determine, abate and prevent agricultural nitrate contamination of waters. The Regulation requires determining areas (zones) vulnerable to nitrate, to encourage good agricultural practices to abate nitrate pollution and to prepare action plans.

### ***Economic instruments***

The Turkish government have also used economic instrument to help protect and improve and soil and water resources (Table 6). In the beginning of 2000s input subsidies and price supports, which have negative effects on environment, were abolished in Turkey. Instead, direct payments and agri-environment payments were introduced.

These measures include area-based direct payments, interest subsidies and investment subsidies for good agricultural practices. In addition water charges for drip irrigation is lower than other irrigation methods. Agricultural products produced by organic agriculture and good agricultural practices are protected against other products by labelling.

Table 7. Agricultural payments for Good Agricultural Practices for 2008 Year (TUGEM, 2009) .

Type of support	Topic of Payment	Amount of Payment
Direct payments	Organic agriculture	18.00 TL/Dakar
	Good Agricultural Practices	18.00 TL/Dakar
	Soil Analysis	2.25 TL/Dakar
	Programme for Conservation of Agricultural Lands for Environmental Purposes	54.00-121.50 TL/Dakar
Interest subsidies	Organic Agriculture	60% of Interest
	Good Agricultural Practices	60% of Interest
	Pressurized Irrigation Systems	100% of Interest
Grants for Rural Development	Pressurised Irrigation Systems	50% of Investment

### ***Promoting best practice through education***

Education (training) and extension activities relating to soil and water protection/conservation and improvement have increased (intensified) since 2000. Training programmes comprise training of trainers and consultants of farmers, inspection and certification staff, and training of farmers. Extension is activities to spread new information and technologies to farmers and other persons. These activities have been executed mainly by Ministry of Agriculture and Rural Affairs and its province organisations. Training topics include organic agriculture, good agricultural practices, irrigation systems and techniques, direct drilling and conservation tillage, agri-environment and water pollution, soil conservation.

## **8. Conclusions**

The soil and water resources of Turkey are in a deteriorating state. Water contamination of nutrients and pesticides is worse in EU countries than in Turkey because of intensification of agriculture (intensive dairy production, use of fertilizers and pesticides) in these countries is higher than in Turkey. However, consuming of fertilizers and pesticides are stabilizing and tend to decrease in EU countries. The development of appropriate measures to address these issues requires an understanding of the pressures causing the contamination, the development of possible responses, and the mean of monitoring changes in the state of soil and water resources.

The inventory of natural resources (soil, water, flora/fauna, biodiversity, agricultural diversity) of Turkey should be prepared. Quantity and quality parameters of these resources should be determined and monitored. The effects of agricultural activities on environment and natural resources should be determined and monitored.

The system of transmission and distribution of water; water pricing, irrigation methods should be sustainable, environmentally friendly and efficient.

Erosion of agricultural lands should be determined and cost of erosion should be determined. Conservative agriculture should be encouraged and supported to reduce soil erosion and enhance soil quality.

Land and water management should be integrated and management should be on basin. Farm basin management is also important. Farmers and farmers' trainers and consultants should be

educated. Agricultural payments should be paid on condition certain environmental protection including keeping soil in good agricultural and environmental conditions.

### References

- ABGS 2009. History of Turkey-EU Relations, Secretariat General for EU Affairs, Turkey, <http://www.abgs.gov.tr>, 05.03.2009.
- Baltacı F. et al. 2008. Water Quality Monitoring Studies of Turkey with Present and Probable Future Constraints and Opportunities. *Desalination, Periodical*, Volume: 226, p: 321-327.
- Bülbül M, Beşparmak F and Güneş D. 1999. Türkiye’de Sulama Yatırımları. *Tarımda Su Kullanımı ve Yönetimi Sempozyumu*, Türk Ziraat Yüksek Mühendisleri Birliği ve Vakfı, Ankara/Turkey, p: 109-118.
- Ceritli, I. 1997. Türkiye’nin Toprak Sorunu. *Ekoloji Periodical*, Volume: 22, p: 4-8
- Commission of the European Communities, 2002. Towards a Thematic Strategy for Soil Protection, a Communication, Brussels. <http://europa.eu.int/eur-lex/en/com/pdf/>, 27.12.2004.
- ÇOB 2004. Türkiye Çevre Atlası, Çevre ve Orman Bakanlığı ÇED ve Planlama Genel Müdürlüğü, Ankara. <http://www.cedgm.gov.tr/dosya/cevreatlasi.htm>, 25.02.2009.
- ÇOB 2008. *Türkiye Çevre Sorunları ve Öncelikleri Envanteri Değerlendirme Raporu (2005-2006)*. ÇED ve Planlama Genel Müdürlüğü, Edition Number: 6, Ankara.
- DİE 2001. *Tarımsal Göstergeler 1923-1998*. Devlet İstatistik Enstitüsü, Ankara, 539 pages.
- DİE 2003a. *2000 Genel Nüfus Sayımı, Nüfusun Sosyal ve Ekonomik Nitelikleri*. Devlet İstatistik Enstitüsü, Ankara, 305 pages.
- DİE 2003b. *İstatistik Göstergeler 1923-2002*. Devlet İstatistik Enstitüsü, Ankara, 641 pages.
- DİE 2004. *Genel Tarım Sayımı, Tarımsal İşletmeler (Hanehalkı)*. Devlet İstatistik Enstitüsü, Ankara, 667 pages.
- Doğan O. 1995. Türkiye’de Toprak Kaynakları Sorunlar ve Çözümler. *Standart*, Periodical, May 1995, p: 73.
- DPT 2000. *Uzun Vadeli Strateji ve Sekizinci Beş Yıllık Kalkınma Planı (2001-2005)*. Official Gazette of Republic of Turkey dated 5th of July 2000 and numbered 24100, Ankara, 226 pages. <http://rega.basbakanlik.gov.tr/>, 19.10.2007
- DPT 2001. *Sekizinci Beş Yıllık Kalkınma Planı, Su Havzaları Kullanımı ve Yönetimi Özel İhtisas Komisyonu Raporu*. Devlet Planlama Teşkilatı, DPT:2555-ÖİK:571, Ankara, 2001, 189 pages.
- DPT 2006. *Dokuzuncu Kalkınma Planı (2007-2013)*. Decision of Parliament of Republic of Turkey, Official Gazette dated 1st of July 2006 and numbered 26215.
- DSİ 2009a. *Toprak ve Su Kaynakları*. Devlet Su İşleri Genel Müdürlüğü, <http://www.dsi.gov.tr/topraksu.htm>, 16.03.2009.
- DSİ 2009b. *İçme ve Kullanma Suyu*. Devlet Su İşleri Genel Müdürlüğü, <http://www.dsi.gov.tr/hizmet/icmekulsu.htm>, 16.03.2009.
- DSİ 2009c. *Tarım Sektörü*. Devlet Su İşleri Genel Müdürlüğü, <http://www.dsi.gov.tr/hizmet/tarim.htm>, 16.03.2009.
- EEA (European Environment Agency) 2005. *Agriculture and Environment in EU-15 – the IRENA Indicator Report*. EEA Report 6/2005. Copenhagen: EEA. [http://reports.eea.eu.int/eea\\_report\\_2005\\_6/en](http://reports.eea.eu.int/eea_report_2005_6/en)
- EEA (European Environment Agency) 2006a. *Integration of Environment into EU Agriculture Policy – the IRENA Indicator-based Assessment Report*. ISSN 1725-9177. Copenhagen: EEA [http://reports.eea.eu.int/eea\\_report\\_2006\\_2/en/tab\\_content\\_RLR](http://reports.eea.eu.int/eea_report_2006_2/en/tab_content_RLR)
- European Commission 2008. *Turkey 2008 Progress Report*. COM(2008) 674, Brussels, [http://ec.europa.eu/enlargement/pdf/press\\_corner/keydocuments/reports\\_nov\\_2008/turkey\\_progress\\_report\\_en.pdf](http://ec.europa.eu/enlargement/pdf/press_corner/keydocuments/reports_nov_2008/turkey_progress_report_en.pdf), 20.04.2009.

- European Commission and European Soil Bureau Network 2006. *Soil Atlas of Europe*. ISBN / ISSN: ISBN 10 928948120X, Office for Official Publications of the European Communities, Luxembourg. [http://eusoils.jrc.it/projects/soil\\_atlas/index.html](http://eusoils.jrc.it/projects/soil_atlas/index.html), 16.03.2009.
- Haktanır, K. et al. 2000. *Toprak Kaynakları ve Kullanımı*. V. Türkiye Ziraat Mühendisliği Teknik Kongresi, 17-21 Ocak 2000, TMMOB Ziraat Mühendisleri Odası, Ankara, p: 203-230.
- Haktanır, K. 1997. *Doğal Kaynak Olarak Toprak*. İnsan Çevre Toplum, İmge Kitapevi Yayınları, Ankara, p: 193-235.
- Haktanır, K. 1999. *Soil, Environmental Profile of Turkey*. Environment Foundation of Turkey, Ankara, p: 133-168.
- JRC 2008. *Pan European Soil Erosion Risk Assessment – PESERA*. European Commission Commission Joint Research Center, [http://eusoils.jrc.ec.europa.eu/ESDB\\_Archive/pesera/pesera\\_data.html](http://eusoils.jrc.ec.europa.eu/ESDB_Archive/pesera/pesera_data.html), 16.03.2009.
- KHGM 1987. *Türkiye Genel Toprak Amenajmanı Planlaması*. Köy Hizmetleri Genel Müdürlüğü, Ankara.
- Metzger, M.J., Bunce, R.G.H., Jongman, R.H.G., Múcher, C.A. & Watkins, J.W. 2005. A climatic stratification of the environment of Europe. *Global Ecology and Biogeography* 14: 549-563.
- Muhammetođlu, A. and Yardımcı, A. 2006. A Fuzzy Logic Approach to Assess Groundwater Pollution Level below Agricultural Fields. *Environmental Monitoring and Assessment*, Volume 118, Issue 1-3, p: 337-354.
- Özsoy, T. et al, 2008. *A Study of Ionic Composition and Inorganic Nutrient Fluxes from Rivers Discharging into the Cilician Basin, Eastern Mediterranean*. Environmental Monitoring and Assessment, Volume 145, Issue 1-3, 2006, p: 17-29.
- Sarıyıldız, A. et al. 2008. *Gediz Nehri Su Kalitesi Parametrelerinin Egilim Analizi*. Çevre ve Orman Bakanlığı, Devlet Su İşleri Genel Müdürlüğü, Havza Kirliliği Konferansı, 26-27<sup>th</sup> of June 2008, Izmir/Turkey, p: 23-30.
- Sonter, R.O. ve Lawrie, J.W. 2007. Soils and Rural Land Capability. *Soils their Properties and Management*, Edited by Peter E.V. Charman and Brian W. Murphy, Third Edition, Oxford University Press, Australia.
- TÇV 1995. *Environmental Profile of Turkey*. Environmental Foundation of Turkey, Ankara/Turkey.
- Tekeli, S. et al. (2005). Meraların Korunma ve Kullanımı. Türkiye Ziraat Mühendisliği VI. Teknik Kongresi, 3-7th of January 2005, TMMOB Ziraat Mühendisleri Odası, Tarım Haftası 2005, Ankara/Turkey.
- TKB 2006. *Türkiye’de Tarım Sektörü*. Tarım ve Köyişleri Bakanlığı, Rapor. [www.tarim.gov.tr](http://www.tarim.gov.tr)>>e-kütüphane, 23.06.2006.
- Toprak ve Gübre Araştırma Enstitüsü Müdürlüğü, (1988). *Türkiye Gübre ve Gübreleme Rehberi*, Ankara.
- TÜİK (Türkiye İstatistik Kurumu) 2007a. *Tarımsal Yapı 2005*. Türkiye İstatistik Kurumu, Ankara/Turkey.
- TÜİK (Türkiye İstatistik Kurumu) 2007b. *Nüfus Konut ve Demografi*>>Nüfus İstatistikleri ve Projeksiyonları [www.tuik.gov.tr](http://www.tuik.gov.tr)., 15.11.2007.
- TÜİK (Türkiye İstatistik Kurumu) 2008. *Üretim Yöntemiyle GSMH*, <http://www.tuik.gov.tr>>>Ulusal Hesaplar>>Üretim Yöntemiyle GSMH>>Veri/Bilgi, 02.01.2008.
- TUGEM (Tarımsal Üretim ve Geliştirme Genel Müdürlüğü) 2009. *Tarımsal Destekler*, [www.tugem.gov.tr](http://www.tugem.gov.tr), 16.03.2009.
- Yeşilnacar, M.I. 2008. Natural Network Prediction of Nitrate in Groundwater of Harran Plain, Turkey. *Environmental Geology*, Volume 56, Issue 1, November 2008, p:19-25.