

Turkish Republic Country Report on Forest and Water Resources Management

# Forestry for Establishing Sustainable Water Resources Management Policies in Turkey

*Under coordination of*

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## **1. Introduction**

Forests have very important effects on the quality, regime, and quantity of streamwater depending on ecological conditions. Numerous experiments have been conducted on these hydrological functions of forest ecosystems around the world. The beginning of these studies goes back to late 1800s in Europe and North America. Yet, in Turkey, the first stun forest-water relationship has been started in late 1950s (Balci, 1958). Many but insufficient amount of researches have been implemented to characterize differences among various ecosystems. These studies generally consisted of measurements of interception capacities, stemflow, surface runoff, subsurface and base

flow, and quantity of forest floor in various types of forest ecosystems (Balci, 1958; Arol, 1959; Çepel, 1965; Irmak and Çepel, 1968; Çepel, 1971; Özyuvacı, 1976; Özhan, 1982). Results of these experiments pointed out that various types of forest ecosystems significantly differed from each other in terms of evapotranspiration loss depending on tree species that compose forest ecosystems, their ages, heights, and canopy densities. Not only forests but also forestry activities affect water quality, regime and yield in watersheds. The strong influence of forests ecosystems on water cycle makes forestry a significant aspect of watershed management since vegetation management is a major part or objective of forestry activities. The primary rationale behind vegetation management concept is the predicted water scarcity in some regions of the world including the Middle East. For example, Turkey has to make long-term plans and arrangements to meet the future needs of its growing population.

The question is; to what extent the management of vegetation, particularly forests, for water production objective can mitigate the predicted water scarcity in a region. According to the results of many hydrologic studies; water yield, quality, and regime can be optimized in a region considerably with the application of certain forestry treatments.

The hydrological functions of forests are sometimes, particularly in older literature, over or underestimated or limited just to water yield, disregarding the regulating role of forests. Recent studies however suggest that forest ecosystems can reduce the frequency of floods of short return periods (1-5 years) and also increase the rate of subsurface and baseflow rates in annual flow. Therefore, vegetation management concept should be perceived as a package and investigated from all aspects prior to application. This point also has been emphasized in watershed management definitions. For example Brooks et al. (1997) defines watershed management as a process for guiding and organizing natural resources on a watershed in order to provide desired goods and services without affecting soil and water resources adversely. Interrelationships among land use, vegetation, soil and water and linkages between upland and downstream have also been recognized in the watershed management concept.

Watershed management is embedded in the European Union Water Framework Directive as River Basin Management. It has similarities with River Basin management concept that has been implemented in North America for a relatively longer time.

The methodology of Watershed Management lies on the integration of all disciplines, people, and agencies working on water resources management. Therefore, it should be considered as a practical

tool to harmonize efforts and sources for the dissemination of knowledge towards ensuring the sustainability of water and natural resources.

Turkey is located on a land characterized with rough topography and variable ecologic, economic, and social conditions. This situation caused the formation of a heterogeneous forest cover throughout the country, existence of diverse ecosystems, and therefore need for different forest management strategies. The rapid increase in population increased human demands and anthropogenic effects together with human demands on forest resources have become the major threat on the implementation of a sustainable management policy particularly around large cities.

In this report we aimed to present the forest and water resources of Turkey, and integration possibilities for a sustainable and efficient management framework.

## 2. Forest and Water Resources of Turkey

### 2.1. Forest Resources

According to land capability classification 46 percent of the land area of Turkey is in VIth class which can only accommodate non-productive forests and pastures. A 34 percent is suitable for agriculture but only 6.5 percent is in the first class (Table 1).

Table 1. Land capability classification and areal coverage in Turkey (Topraksu, 1978; KHGM, 2003).

Land capability classes and attributes		Area (ha)		Ratio in total (%)		
Attribute	Produc. (%)	Class	1965-71	1982-84	1965-71	1982-84
Suitable to tillage and agriculture	100	I	5 012 537	5 086 084	6.4	6.5
Fairly suitable to tillage and agriculture	83	II	6 758 702	6 712 873	8.7	8.7
Agriculture without tillage	66	III	7 574 330	7 282 763	9.7	9.3
Specific products with specific measures	50	IV	7 201 016	7 425 045	9.3	9.5
<b>Total</b>			26 546 585	26 556 768	34.1	34
Non-productive flat lands	33	V	165 547	127 934	0.2	0.16
Suitable for pasture and forest	20	VI	10 238 533	10 825 762	13.2	13.9
Non productive pasture and forest	10	VII	36 288 553	35 836 350	46.6	46.0
<b>Total</b>			46 692 633	46 790 036	60.0	60.0
Only recreation and wildlife	0	VIII	3 455 513	4 542 896	5.9	5.8
<b>Total (without water surfaces)</b>			76 694 731	76 741 591	100.0	100.0

Turkey's land surface totals about 78 million hectares. 21.2 million hectares are covered by forests and other woodlands. The share of high forests and coppices are given in Table 2. More than 15

million hectares are high forests (Table 3). The non-productive high forests and coppices constitute half of the total forested areas. The main cause of degraded forests is human impacts. Due to long term utilization of woodlands for fuelwood and construction, anthropogenic steppe areas have been formed and characterized particularly in Central and Eastern Anatolia.

Table 2. Forest cover and types of Turkey (OGM, 2004).

Forest type	Area (ha)
Productive high forests	8 940 214
Non-productive high forests	6 499 380
<b>Total</b>	<b>15 439 594</b>
Productive coppices	1 681 006
Non-productive coppices	4 068 146
<b>Total</b>	<b>5 749 152</b>
<b>Total forest area</b>	<b>21 188 746</b>
<b>Total country area</b>	<b>77 846 000</b>

Because of poor ecologic conditions timber production is not efficient and therefore forestry contributes little to the economy, but it holds potential for future development. Official statistics indicate that forests have doubled in size since 1950; the figures do not reflect actual growth in forested areas but rather continuing survey efforts and the inclusion of less productive wooded areas under the jurisdiction of the forestry administration. The most productive lumber area is the Black Sea region, followed by southern, western Anatolia, Marmara region, central, eastern, and south-eastern Anatolia, where mostly pine wood is produced. The forests in the eastern part of the country are in poor condition and yield little besides firewood. Only about 20 percent of the total forested area is commercially exploitable.

Fifty percent of the forest areas are dominated by coniferous species while Firat (Euphrate) and Dicle (Tigris) Basins in SAP (Southeastern Anatolia Project) are mostly non-productive deciduous particularly oak. Forested areas in Dicle and Firat Basins are 27.52 and 18.65 percent respectively (Table 3, Figure 2) but because they are mostly degraded 20 million tonnes of sediment from Tigris and 19.1 M tonnes from Euphrate basins are carried into dams every year (Hızal, 1989).

The insufficient forest cover in terms of areal coverage and productivity causes very significant hydrologic problems including;

- Difficulties in preventing extreme flows (both high and low),
- Difficulties in establishing water quality regulating measures,

- Disturbances in watershed hydrologic systems and fluctuations in monthly flows due to increased surface runoff. Reduced concentration times and system memories,
- Deficiencies in the erosion prevention function of vegetation.

Table 3. Forest cover in river basins (Serengil et al., 2008).

Basin	Area (km <sup>2</sup> )	Sorted for area	Mean flow km <sup>3</sup> /year	Forest cover ha	Forest cover %	Sorted for forest cover
Fırat	127304	1	31.61	23737,6	18,65	21
Kızılırmak	78180	2	6.48	15043	19,24	20
Sakarya	58160	3	6.40	18440,8	31,71	14
Dicle	57614	4	21.33	15855,3	27,52	18
Konya	53850	5	4.52	3454,4	6,41	24
Yeşil ırmak	36114	6	5.80	13326	36,90	9
Batı Karadeniz	29598	7	9.93	13862	46,83	3
Aras	27548	8	4.63	2305,7	8,37	22
Büyük Menderes	24976	9	3.03	8045,9	32,21	12
Marmara	24100	10	8.33	9885,9	41,02	8
Doğu Karadeniz	24077	11	14.90	10493,5	43,58	5
Susurluk	22399	12	5.43	11668,8	52,10	1
Doğu Akdeniz	22048	13	11.07	11145,9	50,55	2
Ceyhan	21982	14	7.18	7945,9	36,15	10
Batı Akdeniz	20953	15	8.93	8700,7	41,52	7
Seyhan	20450	16	8.01	5650,1	27,63	17
Çoruh	19872	17	6.30	5780,1	29,09	15
Antalya	19577	18	11.06	8240,7	42,09	6
Van	19405	19	2.39	574,4	2,96	26
Gediz	18000	20	1.95	6354,5	35,30	11
Meriç Ergene	14560	21	1.33	970,4	6,66	23
Kuzey Ege	10003	22	2.90	2820,9	28,20	16
Asi	7796	23	1.17	3450,6	44,26	4
Akarçay	7605	24	0.49	455,4	5,99	25
Küçük Menderes	6907	25	1.19	2201,5	31,87	13
Burdur	6374	26	0.50	1470	23,06	19
<b>Average</b>	<b>29979</b>		<b>7.19</b>	<b>8149</b>	<b>29,61</b>	

## 2.2. Water Resources

The freshwater potential in the world is 0.035 billion km<sup>3</sup>, a 2.5 % of the total water. The larger portions of fresh water are trapped in ice on poles and glaciers (77.23 %) or deep groundwater (22.21 %). Only a very small part of the freshwater potential is readily available for consumption by humans.

When compared to precipitation: the total amount of precipitation in the world is 110 000 km<sup>3</sup> and 9 000 km<sup>3</sup> of it is technically and economically available (DPT, 2007).

The main reasons of water scarcity in the world are;

- Scarcity in amount of water resources,
- Water misuse and deterioration of existing resources,
- The rapid global rise in living standards combined with population growth.

During the 20<sup>th</sup> century water consumption increased 6 times while global population increased 3 times. In around 80 countries water supply can not compensate water demand of 40 % population. The situation is the worst in Africa (Table 4).

Table 4. Ratio of population that have access to healthy water to total population (%) (DPT, 2007).

<b>World average</b>	<b>82</b>
Developed countries	99
Developing countries	66
Africa	38
Asia and Pacific	63
Latin America and Caribbean	77
North Africa and Middle East	77
Turkey	93

When classified, countries that have less available water per capita than 1000 m<sup>3</sup>/year are considered as poor, between 1000 m<sup>3</sup>/year and 2000 m<sup>3</sup>/year as not enough and over 8000 m<sup>3</sup>/year are as rich in water resources.

The average precipitation in Turkey is 643 mm varying between 200 and 2500 mm throughout the country (Figure 1). The renewable water potential of Turkey is estimated to be 234 billion m<sup>3</sup>/year and almost half of it (112 billion m<sup>3</sup>) has potential for development (SHW, 2007). However, only 47.8 % of this developable portion has yet been available with the investments since 1950s and the rest of it requires more investment than it has been done until today. In other words, readily available resources have been developed in the first hand and now the resources that are subject to development require much more investment and engineering work which means that a hundred percent utilization of available water resources can never be possible or feasible. Therefore, considering the increasing population in Turkey, we may never witness an available fresh water per

capita value over 1500 m<sup>3</sup>/year which is between 1400-1700 m<sup>3</sup> per capita per year now, calculated according to 2000 census data DPT, 2001) (Table 5).

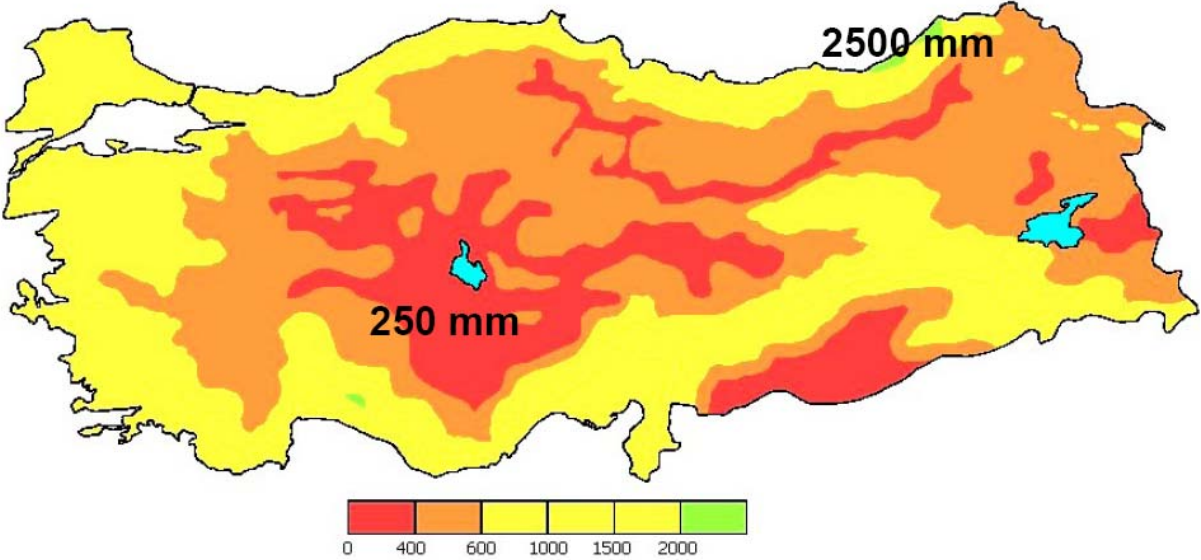


Figure 1. Distribution of precipitation in Turkey.



Figure 2. Basins in Turkey (Türkiye Çevre Atlası, 2004).

With rapid population growth water withdrawals have tripled over the last 50 years. This trend is explained largely by the rapid increase in irrigation development stimulated by food demand in the 1970s and by the continued growth of agriculture-based economies (WWDR, 2009). In

Mediterranean region water demands of Turkey and Egypt are expected to increase significantly in the next decades (Figure 4).

Table 5. Available water per capita compared to world average (DPT, 2001).

Country or region	Water per capita (m3/yr)
Turkey	1 735
Asia	3 000
Western Europe	5 000
Africa	7 000
South America	23 000
World average	7 600

A footprint concept is introduced in World Water Development Report 3 (2009). The concept of a water footprint helps show the extent and locations of water use in relation to consumption patterns. The water footprint is defined as the total volume of water used in the production of the goods and services consumed by an individual or community or produced by a business. A country’s water footprint is the volume of water used in the production of all the goods and services consumed by inhabitants of the country. The global water footprint is 1,240 m3 per capita a year. The four major factors determining a country’s water footprint are volume of consumption, consumption pattern (for example, high or low meat consumption), climate (growing conditions) and agricultural practices (water use efficiency). Water footprints of countries are given in Figure 3.

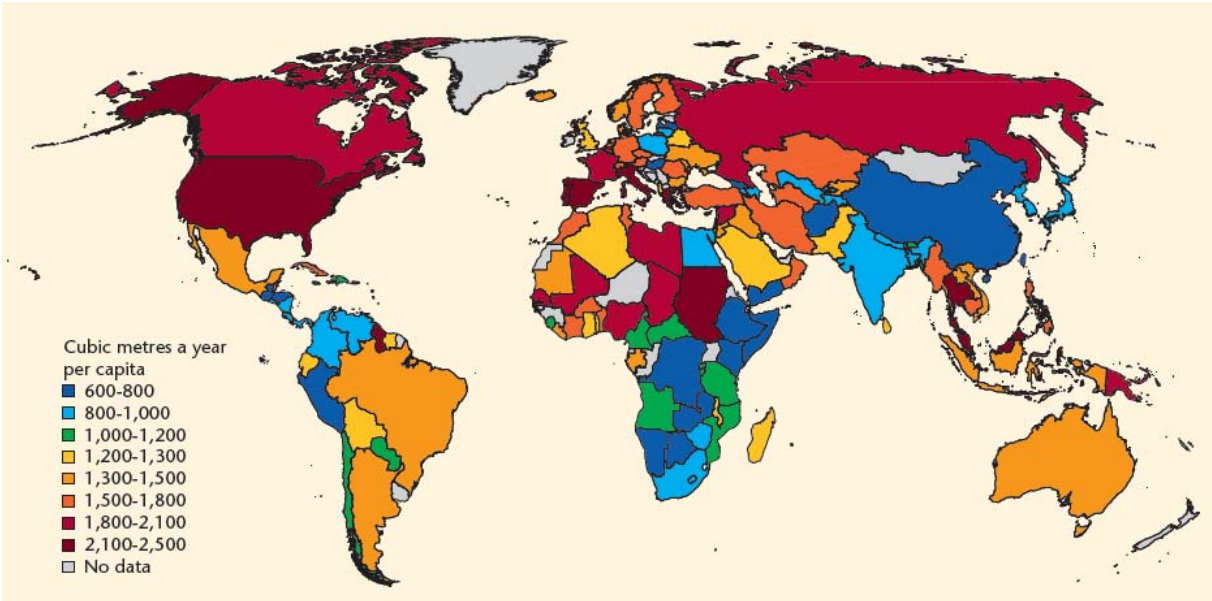


Figure 3. Average national water footprint per capita, 1997-2000 (WWDR, 2009)

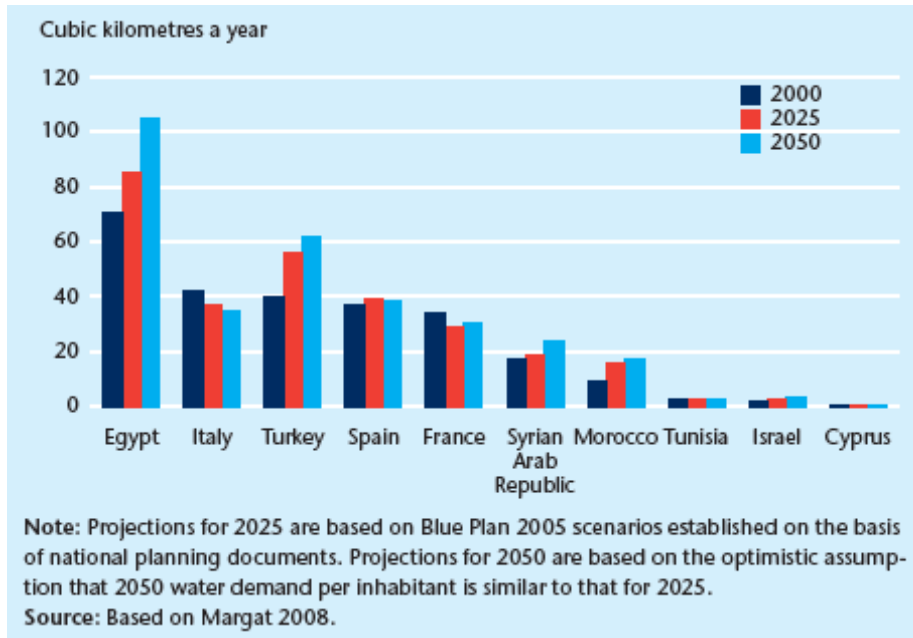


Figure 4. Future water demands in Mediterranean region countries (WWDR, 2009)

Irrigation holds the highest rate of water consumption with around ¾ percent, followed by domestic use (Table 6). A substantial amount of investment is planned to meet the increasing water demand in Turkey (Table 7)

Table 6. Water consumption for various sectors in Turkey (DSI, 2005).

Years	Total consumption		Sectors					
			Irrigation		Domestic use		Industry	
	10 <sup>6</sup> m <sup>3</sup>	%	10 <sup>6</sup> m <sup>3</sup>	%	10 <sup>6</sup> m <sup>3</sup>	%	10 <sup>6</sup> m <sup>3</sup>	%
1990	30 600	27	22 016	72	5 141	17	3 443	11
2000	39 300	35	29 300	75	5 800	15	4 200	10
2004	40 100	36	29 600	74	6 200	15	4 300	11

Table 7. Water Resources Development targets of Turkey for 2030.

Developments until	2030 targets	Development rate
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	2005		(%)
Irrigation	4.9 M ha	8.5 M ha	58
Hydropower	45.3 M k Wh	127.3 B kWh	36
Drinking, industrial and other consumptions	10.5 B m <sup>3</sup>	38.5 B m <sup>3</sup>	27

### 2.3. Forest hydrology studies in Turkey to aid water management

Studies that aim to utilize vegetation management tool in water resources development started in late 19<sup>th</sup> century and intensified in the second part of the 20th century. Paired watershed experiments in North America provided the most knowledge on hydrological consequences of various forest management treatments. However, there is still a lot to evaluate on forest hydrology side due to changing forestry approaches.

The hydrologic cycle is usually described in four major components; precipitation (P), evaporation (from soil, water and vegetation surfaces) (E), transpiration (T), and flows (surface, subsurface, and groundwater) (R). Evaporation and transpiration are sometimes lumped together as Evapotranspiration (ET).

Many forest structure parameters (age, crown closure, leaf area, species composition etc.) affect the hydrologic cycle components particularly interception, the amount or portion of precipitation evaporates from forest canopy after a precipitation event. In the same ecological conditions, interception values may differ substantially between forest types (Table 1) due to mentioned stand parameters.

Table 8. Various interception measurements in literature.

<i>Stand types</i>	<i>Reference</i>	<i>Interception as the percentage of precipitation</i>
oak coppice	Balçı, 1958	16.1
spruce	Penman, 1963	26
beech	Penman, 1963	8
beech	Çepel, 1965	17.4
oak	Çepel, 1965	20
pine	Çepel, 1965	31.1
oak-hornbeam mixed coppice	Özyuvacı, 1976	15.3
black pine	Özhan, 1982	28.3
oak	Özhan, 1982	15.6
oak-hornbeam mixed coppice	Özhan, 1982	13.8

As seen from Table 1, even the recorded values are quite variable, coniferous species apparently cause almost two times more interception loss compared to broadleaved ones. In brief, 10 to 30 percent of annual precipitation returns back to atmosphere via interception, which is not a minor amount in dry, semi-dry regions.

Transpiration, on the other hand is a major component of evapotranspiration (ET). Transpiration values of various stand types are given in Table 2.

Table 9. Transpiration values of some stand types.

<i>Stand properties</i>	<i>Transpiration (mm)</i>	<i>Annual precipitation (mm)</i>
Pine, age 60 (Molchanow, 1963)	200	550
Oak, age 60	352	523
Spruce, age 60	300	580
Quaking aspen	220	500
Ash, age 60	228	500
Mixed forest (Çepel, 1988)	290	771
Pine-Larix	300	861
Eucalyptus	1200	760
Acacia	2500	760

When transpiration values are added into interception loss- although quite variable with respect to tree species, forest structure, and climate - a substantial amount of water is consumed by some forests. Therefore forest type and stand dynamics are important features of forest lands in water production watersheds. To determine the best management methods to supply optimum amount of water, a substantial effort have been paid via watershed experimentation particularly in North America. Serengil et al. (2007a) and Serengil et al. (2007b) reviewed these studies and compiled some widely accepted statements on hydrologic impacts of forestry treatments. These are;

- I. Cutting timber causes an increase in water yield, and normally its regrowth decreases (Hibbert, 1967; Bosch and Hewlett, 1982),
- II. The duration of the increase in water yield is strongly related to the amount of cutting with the highest increase in the first year (Hornbeck et al., 1993; Stednick, 1996; Sahin and Hall, 1996),
- III. Different harvesting methods sometimes cause contradicting results in different ecological conditions (Vertessy, 1999; Vertessy, 2000; Brown et al., 2005),

- IV. The response to treatment is highly variable and, for the most part, unpredictable (Hibbert, 1967),
- V. Streamflow response to the treatment depends on both the mean annual precipitation of the watershed and on the precipitation for the year under treatment (Bosch and Hewlett, 1982),
- VI. Infiltration and evapotranspiration (ET) play a key role in determining what happens to the flow regime after treatment (Bruijnzeel, 1988),
- VII. Changes in annual water yield from forest cover reductions of less than 20 % of the watershed could not be detected statistically by streamflow measurements (Bosch and Hewlett, 1982; Stednick, 1996). The threshold for small catchments is suggested as 15 % by MacDonald and Stednick (2003).

In this treatment term many silvicultural forestry applications can be included in addition to cutting. These are;

- species conversion,
- prescribed burning,
- applications of chemicals to kill vegetation,
- forest road construction,
- conversion to grass or agriculture or vice versa,
- afforestation.

Cutting treatments on the other hand can be classified as selective, partial, clearcuts and stripcuts.

#### 2.4. Antropogenic stressors to affect forest and water resources

Population growth, urbanization (Table 10), and migration are in the source of human pressure on natural resources around large cities. Urbanization and sprawl cause overutilization of water resources and brings the idea of water transfer with pipelines particularly in case of Istanbul.

Tablo 10. Changes in urban and total population of Turkey (updated from TKB, 2005).

Year	1927	%	1970	%	1983	%	2004	%	2007	%
Total population	13 648 270	-	35 605 176	-	47 864 000	-	67 803 927	-	70 586 256	-
Rural population	10 342 391	75.8	21 914 075	61.5	24 251 000	50.7	23 797 653	35.1	20 838 397	29.5
Urban	3 305 879	24.2	13 691 101	38.5	23 613 000	49.3	44 006 274	64.9	49 747 859	70.5

population								
Urban areas (ha)	-	-	569 400	0.73	894 153	1.2	2 806 153	3.4

Erosion and sedimentation together with desertification is probably the most significant problem of water and land resources of Turkey. More than 80 percent of the land area of the country is subject to land degradation and erosion (Table 11). This makes non-point pollution a significant point of concern compared to European countries.

Table 11. Areal coverage and intensity of erosion in Turkey (Topraksu, 1978)

Degree of erosion	Intensity	Area (ha)	Rate (%)
Water erosion			
1	No erosion	5 166 627	6.64
2	Slight	5 611 892	7.22
3	Moderate	15 592 750	20.04
4	Intensive	28 334 933	36.42
5	Very intensive	17 366 463	22.32
	Bare parent material	2 930 933	3.77
Wind erosion			
		506 309	0.65

The Ministry of Environment and Forestry initiated a forestation action plan of 5 years started in 2008. Forestation, rehabilitation, erosion control, and rangeland restoration activities are planned for an area of 2 300 000 ha in this context

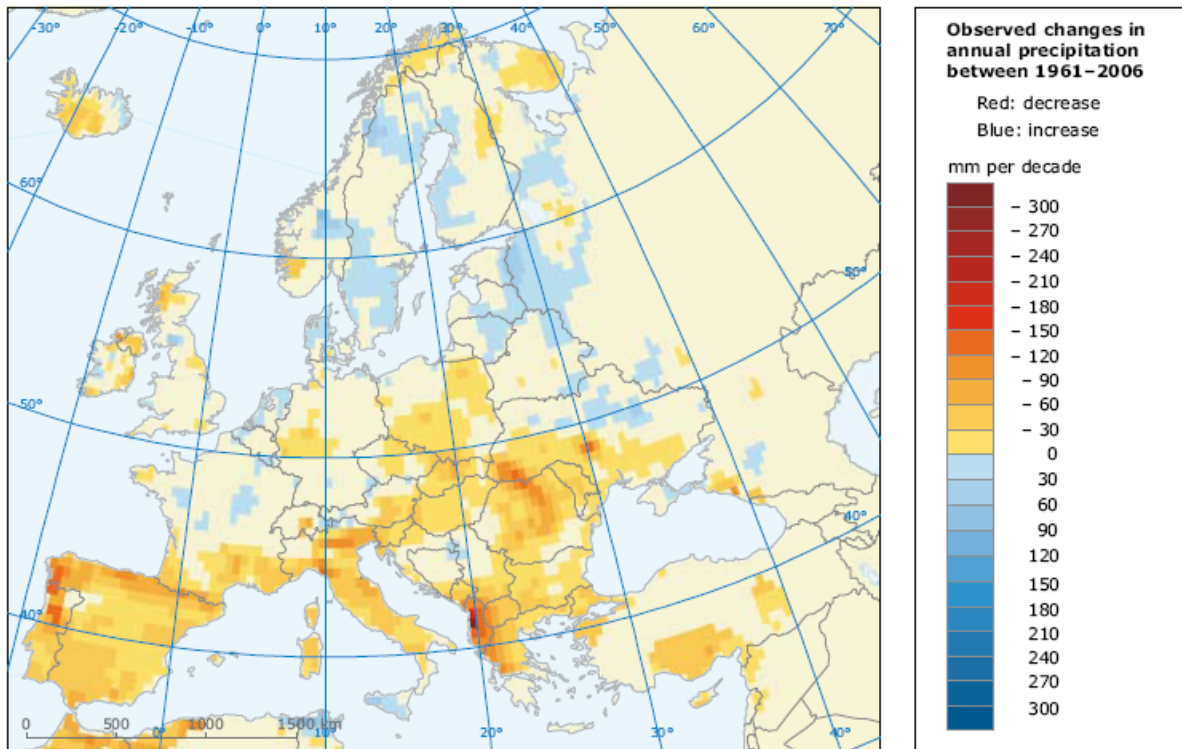
(<http://www.agaclandirmaseferberligi.gov.tr/EylemPlani.aspx>).



Figure 5. Afforestation Works to rehabilitate degraded cedar via seeding in Mersin (2006).

Climate change and projected drought is another major threat to water, soil and forest resources of Turkey. Drought stimulates desertification and in turn affects natural resources of the country and also living conditions of people. Studies revealed that a precipitation decrease is evident in some parts of Turkey since the second part of last century (Figure 6) and simulations suggest that an increase in the extent and severity in drought conditions is expected during this century (Figure 7).

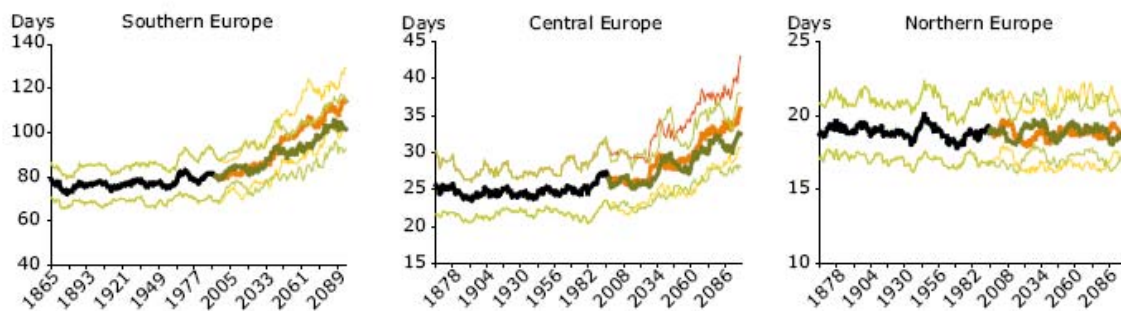
This year a bill on Turkey's adoption of participation in the Kyoto Protocol has been approved by the Turkish Parliament on February 5. This was a relatively late action but revealed Turkey's will and intention to contribute the global efforts to combat climate change. The UN Convention to Combat Desertification was adopted in 1998 four years after opened to signature.



**Source:** The data come from two projects: ENSEMBLES (<http://www.ensembles-eu.org>) and ECA&D (<http://eca.knmi.nl>).

Figure 6. Observed changes in annual precipitation 1961–2006 (EEA, 2009).

Increasing pressures of water scarcity and drought indicate the need for a more sustainable approach to water resource management. Forestry will definitely take part in developing sustainable and efficient water resources management policies.



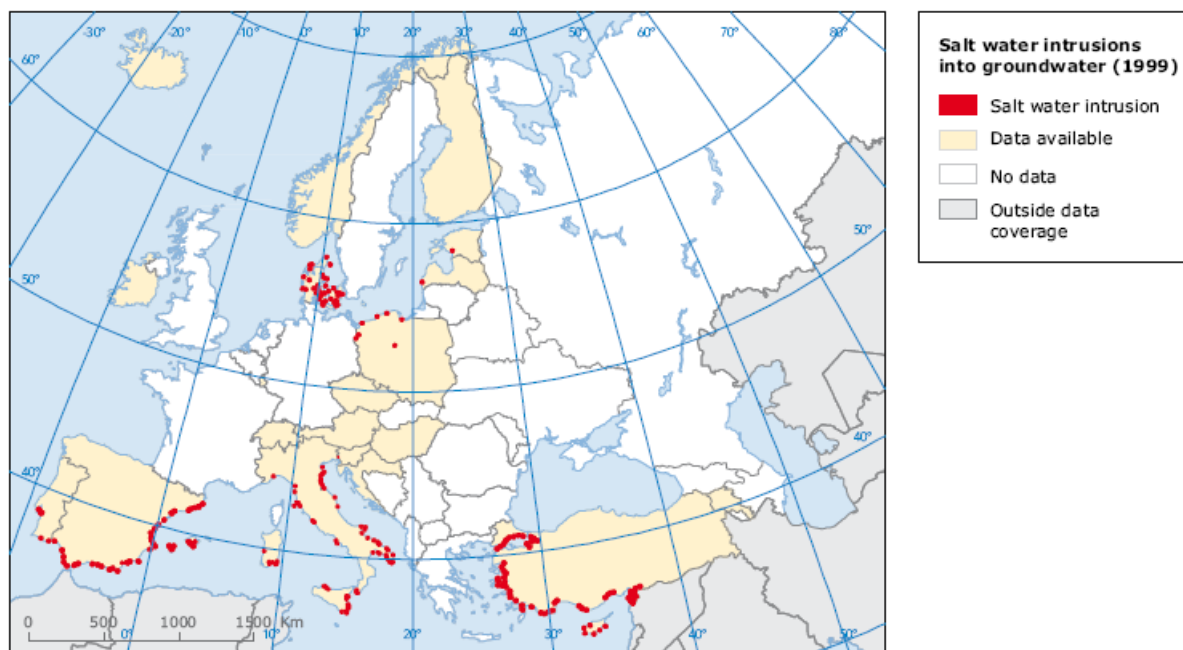
**Source:** Sillmann and Roeckner, 2008.

Figure 7. Simulated land average maximum number of consecutive dry days for different European regions (1860–2100) (EEA, 2009).

A significant anthropogenic impact observed mostly in Mediterranean region is excessive water abstraction. This can affect terrestrial ecosystems, leading to the drying out of woodland, forests, heathland, dunes and fens, making them less suitable for characteristic plant and animal life.

Excessive groundwater abstraction in coastal regions may cause the freshwater level to lower and seawater to flow into the aquifer — a process known as saline intrusion. This diminishes the quality of the aquifer and prevents the subsequent use of the groundwater.

Large areas of the Mediterranean coastline in Turkey have been affected by saline intrusion driven by abstraction of water for agriculture and public water supply, with demand for the latter being markedly increased by tourism.



Source: EEA, 2007.

Figure 8. Saltwater intrusions into groundwater in Europe (1999)(EEA, 2009)

### 3. Forest and Water Management in Turkey

#### 3.1. Legislation on forest and water management in Turkey

##### 3.1.1. Forest Management

In Turkey, all forests are under the control and supervision of the State regardless of their type of ownership. Therefore the State plays a dominant role in forest management. “State forest ownership and management” principle governs the ownership and management of the forests being

accepted as public property. In fact, State forests in Turkey cover more than 99% of all forests therein as to the distribution according to ownership.

Forests in Turkey are protected by Constitution. The article 169 of the Turkish Constitution deals with the protection and improvement of forests and emphasizes State ownership and management of forests. Accordingly; *“The State enacts necessary laws and takes necessary measures for protection of forest and for extension of forest areas..... Whole forests are under the care and the supervision of the State..... **State forests are administrated and exploited by the State** according to Law. These Forests cannot be owned by accusatory prescription and cannot be the subject of the right of servitude except for public benefit...”*

According to the Forest Law numbered 6831 in force; according to their ownership and management types, forests are divided into three classes by the Forest Law. State forests, forests owned by public legal entities and private forests

Forests with property rights belonging to Treasury, and the management rights and protection responsibilities belonging to General Directorate of Forestry are called state forests. The articles 26 to 40 of the Forest Law numbered 6831 deals with the topic of management of these forests.

According to Article 40 of forest law numbered 6831, *“any kind of work in state forests should be done by General Directorate of Forestry (OGM)”*. However, this article also permits OGM to contract some work such as afforestation, nursery production, forest inventory and planning, road construction to private companies. Again according to Article 40, during the contracting period, people living in forest villages have priorities in some works as harvesting, amelioration, and seedling production and for this reason. This contract never means to transfer protection and exploitation powers to private companies or forest villagers as the Article 169 of the Constitution definitely prohibits such a transfer of responsibility.

The second ownership type is forests owned by public legal entities. The construction, management, exploitation and protection of these forests are the topic of the articles 45 to 49 of the Forest Law numbered 6831. Although the management and operation of these forests is carried out by the public entity itself, or a contractor of the public legal entity, this management is under the control of the General Directorate of Forestry (OGM).

Private forests are included in the types of ownership stated in the Forest Law . Owner of a private forest shall not use all rights granted by the absolute right of property. As State forests, the State has the right to control and supervise the private forests. According to Article 51 of the Forest Law, *“Private forests are managed and administered in accordance with management plans undertaken*

by their owners and approved by the forestry administration. Obedience to and proper implementation of these plans are controlled by the forestry administration". The management and protection of private forests are undertaken by their owners under the control and supervision of the State by the provisions of the Law numbered 6831.

### **3.1.2. Water Management**

A number of governmental and non-governmental organizations have direct and indirect interest in the development and conservation of water resources in Turkey. Institutional structure consists of three levels; namely, decision making, executive and users level. In decision- making level, Prime Ministry, State Planning Organization and various ministries take place. Governmental organizations under the ministries are at the executive level. Main executive-level organizations responsible for development of water resources are General Directorate of State Hydraulic Works (DSI), General Directorate of Rural Services (GDRS), General Directorate of Bank of Provinces (Iller Bank), General Directorate of Electric Power Resources Survey and Development Administration (EIEI), and Urban water and sewage administrations

DSI, placed under the Ministry of Environment and Forestry, is the major organization responsible for the development and management and preservation of water resources in Turkey. Development, management and conservation of groundwater resources are also exclusively under the responsibility of DSI. Iller Bank's responsibilities include developing urban plans, supplying municipal water, constructing sewerage systems and treatment plants, and providing loans to municipalities for the financing of such projects. EIE is responsible for surveys on electric power and for rational use and conservation of it. EIE works in close coordination with DSI in collecting hydrometric data and development of hydropower. Urban water and sewage administrations in metropolitan municipalities are in charge of such works as constructing, operating, and maintaining water supply and treatment facilities, and are responsible for networks of industrial establishments within the boundaries of metropolitan municipalities. There are a number of monitoring-supervising organizations performing under various legislative arrangements. Among them, the most important ones include The Ministry of Environment and Forestry, The Ministry of Agriculture and Rural Affairs, and The Ministry of Health. The Ministry of Environment and Forestry is responsible, among other things, for setting policies, principles and rules, inspecting activities, coordinating studies, and enhancing public awareness on environmental aspects of water resources (Eroğlu, 2008).

Table 12. The current state water regulations in Turkey (Coşkun, 2003)

<i>Classification</i>	<i>Type</i>	<i>Legislation</i>	<i>Content</i>	<i>Authority</i>
General Waters	High Seas Agreement The Agreement of Sea Law of UN Continental Borderline Code No. 2674	International law regulation Sets nautical mile as 12 miles Sets nautical mile as 6 miles Permission and control of vehicles Water line foundation and water deliveries Sea transportation		Municipalities Municipalities
	Municipalities Act No. 1580	Controlling the soundness of vehicles Using waters for production		Municipalities Administration Ports Ministry of Agriculture Related Ministries* Council of Ministers Ministry of Tourism Marine Force Commandment Coastal Security Commandment
	Seas, Lakes, Rivers Water Crops Law No. 1380	Ali kinds of activities in ports Protection of waters		Coastal Security Commandment General Directorate of State Hydraulic Works Ministry of Environment
	Ports Law No. 618 Encouragement of Tourism Act No. 2634	Ali kinds of protection activities of water Prevention of water pollution Protection and usage of waters		Coastal Security Commandment General Directorate of State Hydraulic Works Ministry of Environment
	Coastal Security Law No. 2692	Protection of waters		
	Environmental Law No. 2872 Organization and duties of the State Hydraulic Works No. 6200 Establishment and duties of Ministry of Environment Government Decree No. 443			
	The Law About Underground Water No. 167	Establishment, usage, and protection of underground waters		General Directorate of State Hydraulic Works, Ministry of Works, Ministry of Industry & Trade, Ministry of Agriculture, Ministry of Forestry General Directorate of İSKİ
	Underground Water Organization and duties of the Water and Sewage Administration of İstanbul (İSKİ) No. 2560 Organization and duties of the Water and Sewage Administration of Ankara (ASKİ) No. The Law About Utilization of Hot and Cold Mineral Waters No. 927	Carry out water works within the limits of municipality Carry out water works within the limits of municipality		General Directorate of ASKİ
	General Hygiene Act. No. 1593	Determination of borders, usage, hygiene control, to receive certain incomes Control and protection of waters		Ministry of Mining, Ministry of Health and Social Assistance Provincial Special Adm., Ministry of Finance Ministry of Health and Social Assistance
	Private Waters	Village Act No. 442	Protection of springs and water throughs in the limits of village Drinking water supply in villages	
The Law About Village Drinking Waters No. 7478		Supply of public needs		Ministry of International Affairs, Ministry of Health and Social Assistance Ministry of Public Works, General Directorate of State Hydraulic Works, Bank of Provinces
Springs and Village Drinking Waters Regulation of the Control of Water Pollution		Prevention of water pollution		
Law About Waters No. 831		Supply of water		
Law about Drinking Water of Garrisons No. 178				

\*Related Ministries term is exactly presented in the law.

**3.2. Forest and Water Management Agencies**

**3.2.1. Forestry Agencies**

Forestry services are managed by agencies of Ministry of Environment and Forestry. These are;

- General Directorate of Forestry,
- General Directorate of Forestation and Erosion Control,
- General Directorate of Forest and Village Relations,
- General Directorate of Nature Conservation and National Parks.

The agency that is responsible of the management of forest resources on country scale is General Directorate of Forestry. This General Directorate conducts its activities with a strong management network covering all countryside. Forest Management and Planning Department in this agency is responsible of preparation of forest management plans.

Regional Directories of General Directorate of Forestry are organized other than provincial borders and separated into management directories and forestry enterprises. Forestry engineers are employed in Forestry Enterprises and responsible of all forestry activities in their enterprise boundaries. The management of the forests in these enterprises are based on management plans.

**3.2.2. Agencies Related with Water Resources Management**

Agencies responsible of water issues are central agencies and local organizations. Agencies under Ministry of Environment and Forestry conduct much of the work as central authorities while municipalities are responsible of water works in their regions. However not all municipalities have capacity to manage water resources.

Tablo 13. State agencies in water works and their responsibilities.

Agency		Responsibility
National  (Central government agencies)	Ministry of Foreign Affairs	Transboundary waters and Aarhus, Helsinki, Espo agreements.
	DPT – Directly connected to Prime Ministry	Revision and approval of central government investments related to water resources.

	<p>State Planning Organization)</p> <p>Ministry of Environment and Forestry</p>	<p>Implementation and inspection of environmental legislation. Discharge permission, supervision, wetland management, monitoring, EIA (Environmental Impact Assessment, finance, treatment plant approval, preparation of watershed protection action plans.</p> <p>Monitoring of surface and groundwater, irrigation, potable water, assignment of water resources for irrigation and drinking purposes, water transportation, financial, project development, bidding and construction of treatment plants.</p>
	<p>General Directorate of Provinces – Connected to Ministry of Public Works and Settlement</p>	<p>A directly connected agency to the ministry responsible with the finance, bidding and construction of water resources and treatment plants.</p>
	<p>Ministry of Health</p>	<p>Sanitary regulation related to drinking and swimming water and provides necessary measures related to environmental health.</p>
	<p>Ministry of Agriculture and Rural Works</p>	<p>The duties comes up with Water Products Law, determination of agricultural irrigation demands, water quality monitoring, disposal of stock wastes, financial support to agricultural activities like irrigation.</p>
<p>Local organizations (Ministry of Interior)</p> <p>(General Directorate for Local Authorities)</p>	<p>Water and Sewerage Administrations of Metropolitans</p>	<p>Planning, construction and management of systems.</p> <p>Potable water assignment.</p>
	<p>Water and Sewerage Agencies of Local</p>	<p>Construction and management of systems in</p>

	<p>Authorities</p> <p>Special Provincial Administrations (Ministry of Interior)</p>	<p>municipality borders.</p> <p>Water, sewerage, waste and environmental services outside the municipality borders.</p>
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As seen from Table 12 more than one organization are responsible from water works like quality, allocation, and assignment. Policy making is shared among different ministries which causes lack of coordination in some cases. To establish a more efficient and harmonized water management system a water framework law should be employed otherwise;

- Capacity to conduct monitoring, supervision, and establishing measures continue falling short in case of Province Directories of Environment and Forestry,
- Overlapping of some agencies authorities and responsibilities,
- Problems in setting the policies and strategic measures towards municipality, industry, and agriculture sectors due to insufficient coordination among responsible agencies,
- Lack of integration on management in watershed scale,
- Problems in the application of polluter pays principle and deficiencies and conflicts in financing investments among ministries and agencies (i.e. Special Provincial Administrations, State Hydraulic Works, Ministry of Environment and Forestry, Ministry of Culture and Tourism,
- Problems between state and private sector collaboration in managing treatment plant establishment and management,
- Problems with private engineering consultancy sector,
- Difficulties on updating policies and following treaties related to transboundary water issues,

#### **4. Watershed Management as an Integration Tool**

Managing natural resources in a watershed to meet the demands of people in a sustainable manner is simply watershed management. Integrated management of soil, water, atmosphere, and social attributes is a basic understanding of the concept. This therefore mandates the collaboration between various disciplines related with natural resources and particularly water.

The Water Framework Directive of European Union that obligate the preparation of River Basin Management Plans entered into force in December 2000. It aims to achieve and maintain “good water status”. Toward this end, it emphasizes the ecological dimensions of reducing the chemical pressures to which bodies of surface water are subject, while at the same time requiring that good quantitative status be maintained for groundwater.

The deadline for the preparation of River Basin management plans is 2009 for member states which means that a sufficient time frame will be available starting with the adoption of Water Framework Directive.

Implementation of the Directive is a multi-stage process starting with initial characterization, validation of the results of this characterization by means of measurements, classification of water bodies according to their respective ecological status classes, and implementation of measures that aim to reduce pressures on water bodies and maintain the good status of water resources. Since water bodies span national borders, the Directive requires the Member States to coordinate “all programmes of measures” for whole river basin districts “where use of water may have transboundary effects”.

Pursuant to Annex VII of the Water Framework Directive a river basin management plan contains the following elements (WFD, 2000):

- a general description of the river basin district, i.e. of surface waters and groundwater,
- a summary of significant pressures and impact of human activity on the status of surface water and groundwater,
- identification and mapping of protected areas,
- maps of the monitoring networks for the bodies of surface water, bodies of groundwater and protected areas,
- a list of environmental objectives for the waters,
- a summary of the economic analysis of water use,
- a summary of all measures and programmes of measures,
- a register of any more detailed programmes and management plans for the river basin district dealing with particular sub-basins, sectors, issues or water types, together with a summary of their contents,
- a summary of the public information and consultation measures taken, their results and the changes to the plan made as a consequence,
- a list of the competent authorities, and the contact points and procedures for obtaining the background documentation and information

The management plan must be regularly (at least every six years) adjusted and updated every six years at the latest. During the preparation of River Basin Management Plans and in the implementation phase Forestry Agencies particularly Regional Directorates of General Directorate of Forestry should take part as a competent authority.

Some initial studies and projects have been implemented to determine the situation in Turkey to adopt River Basin Management Plans. There is a need for an adapted basin management framework for Turkey. For more information on this subject please refer to TUSIAD (2008), Dalkılıç and Harmancıoğlu (2008), Grontmij (2003), DPT (2007), and Efeoğlu (2008)

Watershed rehabilitation works that have been realized so far can mitigate adoption of watershed management concept. They in 1950s were introduced with the aim of decreasing the damages of floods and overflows and thereby providing safety for current dams.

First implementations in the upper watersheds were reduction of soil erosion, facilities and afforestation works regulating water flow regime.

In the meanwhile, various supports were provided to the watershed local communities by conservation of natural vegetation cover and regulating grazing at rangelands. Preventions for increasing isolation in the houses were developed in order to decrease wood consumption.

Forest Organisation realised many projects all over Turkey aimed at soil conservation and erosion control and these projects are continued.

Since the watershed activities are in the scope and duty of many state organisations and it is important to include local community and nongovernmental organisations for a sustainable natural resource management.

The following are some of the significant Rehabilitation Projects that have been realized in Turkey;

- Eastern Anatolia Watershed Rehabilitation Project
- Anatolia Watershed Rehabilitation Project
- Çoruh Watershed Rehabilitation Project Master Plan Works
- Middle East Watershed Monitoring and Evaluation Project
- Çakıt Watershed (Adana) Rehabilitation Project

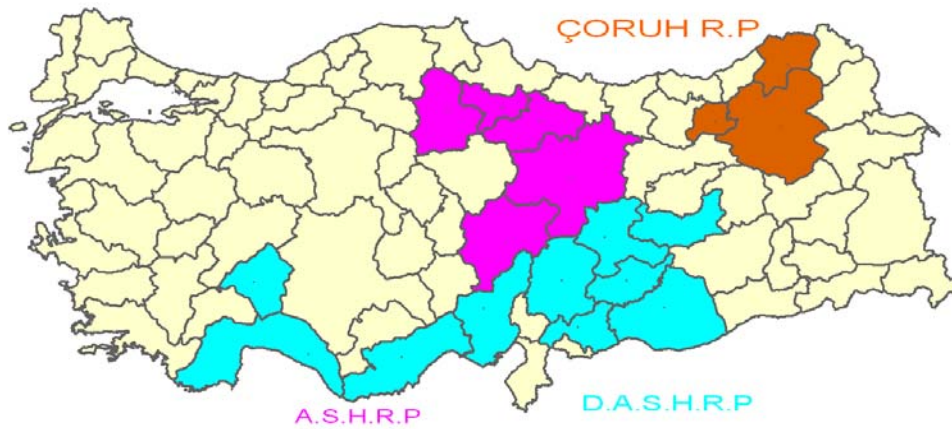


Figure 9. Realized watershed rehabilitation Works in Turkey.

*Main Principles of the Projects were;*

- To stop natural resource erosion. These projects are not rural development projects. Rural districts are supported in order to reduce the pressure on natural resources.
- Participation of local community and nongovernmental organisations is essential as well as related state agencies. Participation is sought in decision-making, implementation and project finance.

*Common Aims of the Projects were;*

- Conservation, rehabilitation and management of natural resources (forest, soil and water)
- Integration of conservation, rehabilitation and management of natural resource activities through income raising activities
- Developing human resources
- Sustainability and generalising

*Eastern Anatolia Watershed Rehabilitation Project:*

This project aimed at rehabilitation of natural resources at the upper watersheds.

Natural resource conservation and rehabilitation was targeted and in order to reach this target, income raising activities to increase the living standard of local community as well as training the local people for natural resource preservation and sustainable management activities and capacity building activities for the agencies were also continued.

#### *Anatolia Watershed Rehabilitation Project:*

The watershed as a whole was taken into consideration and implemented in the selected micro-catchments. Integration of preservation and rehabilitation of natural resources with income raising activities were aimed. Different from the first project; In sustainable watershed management, decreasing the pollution in surface and underground waters deriving from animal related activities and manure and pesticide used in agricultural activities; thereby decreasing the drainage of nutrients into seas were aimed.

Monitoring water pollution, supporting organic farming activities, spreading these activities all around the country and providing support in implementation of EU Nitrate Directive are also targeted.

#### *Çoruh River Rehabilitation Project:*

It is similar to the previous projects in a different part of the country with different characteristics; apart from the aforementioned activities, extending and supporting the solar energy system, which is a renewable energy source, was targeted in order to reduce consumption of fossil fuel.

Furthermore; functional planning for forestlands, national park and hunting-wildlife improvements, eco-tourism planning and development are also included.

In the third generation Watershed Rehabilitation Projects that are conducted, integrated water management is included within the projects since the need for water resources increases along with conservation and improvement of natural resources.

The following subjects are featured: prevention of pollution deriving from industrial and domestic wastes, water production, management and operation of upper watershed forests in line with water production, planning product range according to current water bodies, etc.

#### *Çakıt Watershed (Adana) Rehabilitation Project*

The watershed that used to cause torrents, debris flow, and flooding was rehabilitated with a set of control measures including check dams, terraces and afforestations. The sedimentation problem has also been taken under control. The return periods of extreme flows have been extended with the measures taken.

## 5. Introducing Hydrologic Objective into Forest Management Plans

The major problem of introducing water production objective into forest management plans is the very limited amount of data and information on water producing functions of forests in Turkey. The ecosystem services of Forests have been prioritized recently. The decision to embed functional values into management plans by General Directorate of Forestry goes back to 1997. After a series of preparations, preparation of functional forest management plans has been initiated since 2006. The functional values of forests have been determined as;

- Wood and non-wood products
- Nature conservation
- Erosion control
- HYDROLOGIC
- Aesthetics
- Ecotourism and recreation
- Climate regulation
- Public health
- National defence
- Scientific

A total of 27 percent of forests in Turkey are assigned for erosion control and water production. The share of social, economic and ecologic functions are given below (Figure 10)

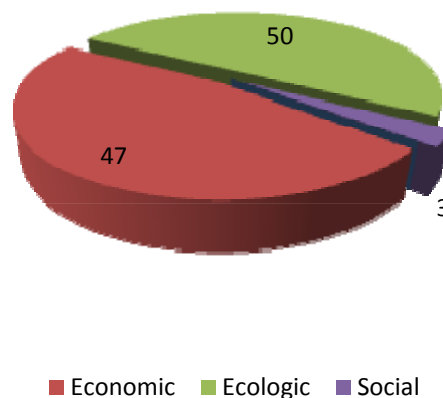


Figure 10. Social, economic, and ecologic functions of forests in Turkey (OGM, 2009).

Assigning a hydrologic function brings a specific set of silvicultural approach. Hydrologic function conflicts with erosion control function in some cases. A single storey forest cover is preferred in hydrologic function but an abundant biomass over the forest floor can result in a thicker litter layer

which supports erosion prevention. Some of the silvicultural measures towards increasing water yield are;

- Maintaining a single storey, loose crown structure to decrease interception,
- A multi-storey and dense forest structure can be preferred where quality and regime is more important and yield is not a concern,
- Mixed stands can be preferred to enable both hydrologic and erosion control functions,
- Clearcutting larger than 3 ha should be avoided.

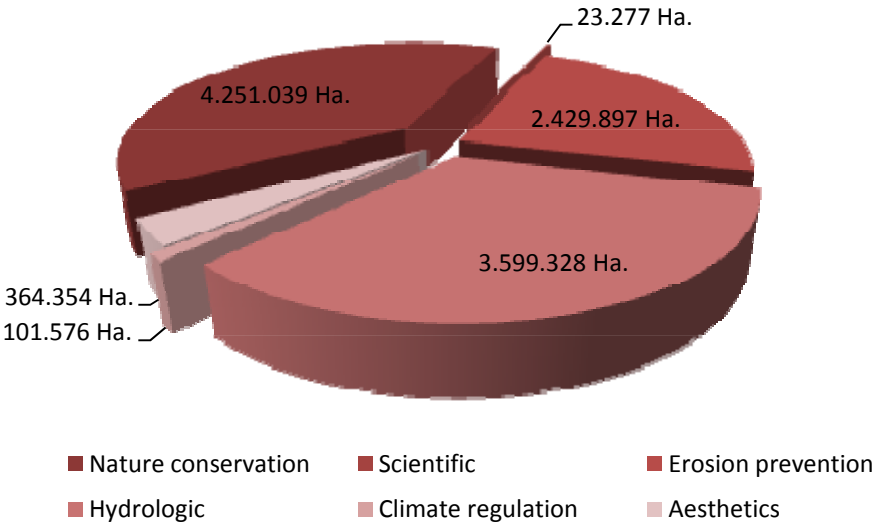


Figure 11. Ecologic functions of forests in Turkey (OGM, 2009).

To give a brief explanation related to local applications of functional planning towards hydrologic function Laçın Forestry Enterprise Management Plan and functional units maps are given (Figure 12). An application procedure of water production function into forest management with a stepwise approach was also suggested by Serengil and Ok (2007).

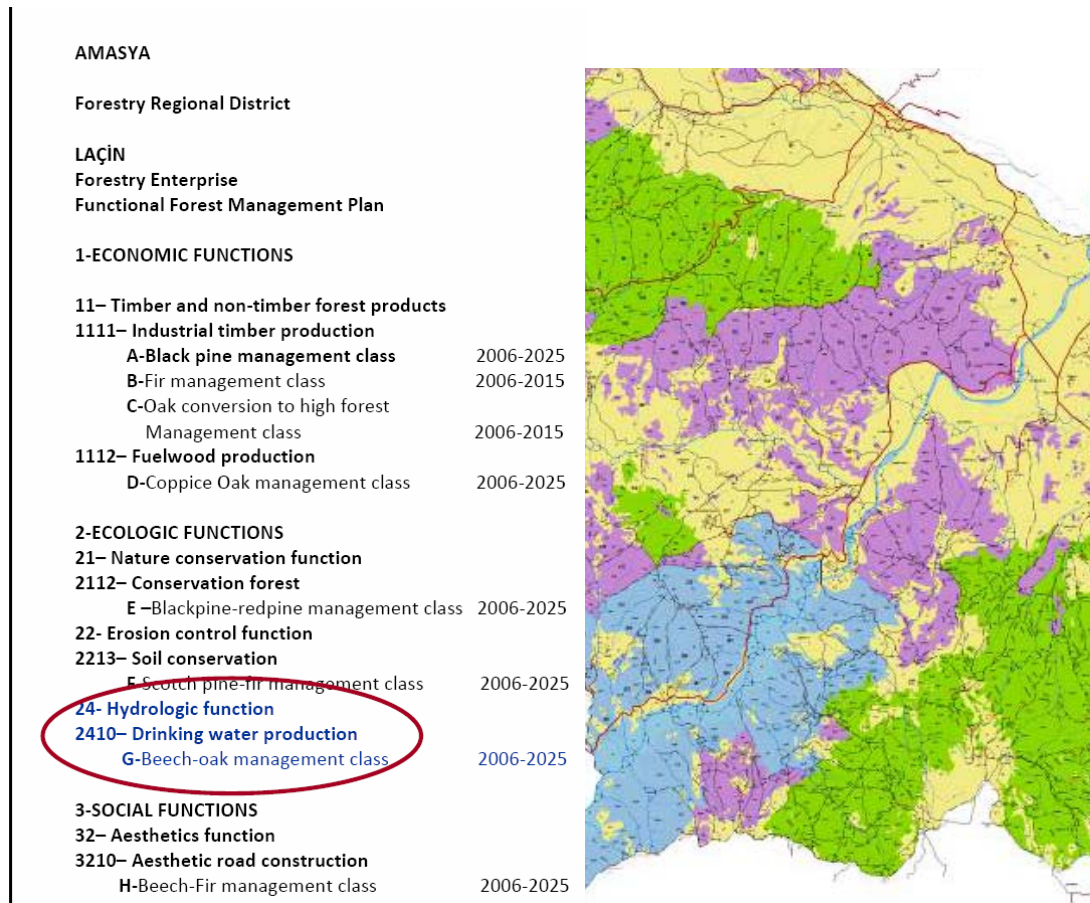


Figure 12. A sample management plan and planning unit map. Colours on the map indicate different functions that took place in the management plan. Blue refers to hydrologic function.

In addition to this; General Directorate of Forestry initiated treatments on 3.6 M ha to give priority to hydrologic function in 2007. These treatments included conversion to deciduous forest from pine. Rehabilitation works have also been implemented by this agency in the last 5 years in the following amounts (ha).

2003: 5 200  
2004: 32 000  
2005: 49 000  
2006: 260 200  
2007: 298 300  
2008: 323 400

## 6. Introducing Forest Management into Basin Management

The most economical and probably only way to meet increasing water demand of population in Turkey seems to be more effective usage of existing resources. Keeping the existing reservoirs clean,

soil erosion and sedimentation in minimum and encouraging people to save water can definitely mitigate water scarcity. But before these measures, watersheds, the water production areas should be managed towards an objective of optimal water production so that an optimal amount, a seasonally uniform and clean production can be ensured.

Erosion and sedimentation is a major problem which threatens the economic life span of hydroelectric power and potential in Turkey. Impaired forests, rangelands, and farmlands and inappropriate actions on these land uses are a primary cause of non-point pollution and sedimentation. Considering the large portion of forests in watersheds, forestry has to be integrated into water resources management.

## **7. Conclusions**

It is an opportunity for Turkey to conduct Forest Service and Water Management under the same Ministry. State agencies responsible of forestation and forest management particularly General Directorate of Forestry and General Directorate of Forestation and Erosion Control have determination to increase collaboration with State Hydraulic Works and make contribution to mitigate water related problems. Watershed scale planning postulates project based strong communication. This situation facilitates a stronger collaboration between agencies to manage water resources more efficient. With the implementation of River Basin Management Plans mandated by Water Framework Directive of the EU a stronger collaboration can be achieved in the near future.

This issue is also mentioned and stressed in macro development plans. In the last development plan (9<sup>th</sup> plan to cover 2007-2013) prepared State Planning Organization, it is emphasized that water resources development efforts should be based on holistic watershed scale, flexible to meet the demands of public, in coordination with water related agencies, ensuring the efficient use of existing resources.

Turkey has a rough topography and therefore high slope conditions. Many anthropogenic stressors including erosion and sedimentation, desertification, climate change, drought, water scarcity, water pollution, salinization of soil and groundwater are threatening land, vegetation, and water resources. The most efficient way of combating these influences is using forest resources as a means of regulation and control. Forestry agencies are working hard to increase the productivity and areal coverage of forest lands. One issue that requires attention is to empower scientific research in the field of forest water relationships, effects of climate change and air pollution, drought and other anthropogenic stressors and environmental impacts of forestry treatments. These research topics require long term ecosystem research which can be provided with the Regional Forestry Research Directorates. Long term eco-hydrological studies are encouraged in these directorates and other

research support agencies of the country and special attention is given to regional and international collaboration.

Recognizing the role of forests in water production a more sophisticated management of forest lands towards hydrologic objective and inclusion of forest management into water resources management would provide a high potential of action to ensure the sustainability of water resources.

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