CURRENT LEVEL OF UTILIZATION OF WATER AND LAND RESOURCES OF TURKEY

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Abstract: Turkey is a country located between Europe and Asia and has a surface area of 779 452 km^2 including the lakes. Anatolia is a high plateau rising progressively towards the East. Turkey has a variety of climates, changing from the temperate climate of the Black Sea region, to the continental climate of the interior, then to the Mediterranean climate of the Aegean and Coastal Mediterranean regions.

The arithmetical average of the annual precipitation is 642.6 mm and it corresponds to 501.0 km^3 of total water volume. The figures for the surface water potential of Turkey can be stated as runoff volume 186.05 km^3, runoff coefficient 37 %, the consumable water volume 95,0 km^3, and actual consumed volume 32.9 km^3, and for underground water annual exploitable ground water potential of Turkey is 12.3 km^3, the ground water volume allocated is 9.1 km^3 and the real consumed amount is 6.0 km ^{3}. Turkey has been divided into 26 river drainage basins to study the water and land resources as extensively as possible. Out of 77,945,200 ha total surface area, 28,054,310 ha is agricultural land, 21,505,112 is pasture and grazing land and 1,159,161 ha water surface 23,228,060 ha is forest and 3,998,557 ha is classified as other lands etc.

Turkey can irrigate only 4,648,082 ha of the total irrigable area of 25,753,586 ha out of 28,054,310 ha of agricultural land at present. With the conditions at present it is possible to irrigate 8,500,000 ha area economically, that means it is necessary to built the infrastructure needed to irrigate the rest; 4,851,918 ha of irrigable The energy production of Turkey for the year 1998 is given as 42,229 GWh as hydropower and 68 788 GWh as thermic and 111 022 GWh as total. In connection with the development of water resources in Turkey, with 3 589 small size projects a total of 270 857 ha area was protected from floods.

The total municipal water need of Turkey is estimated as 5.7 billion m^3. According to 1997 census, Turkey has about 62 865 574 inhabitants, and the population density is about 82 persons per km^2, and about 35 % of this population lives in the countryside. Demand for irrigation water supply, and this has a great influence of the redistribution of the population. During the years of 90's another important parameter affecting the population density was the internal migration from rural areas to big cities. The average birth rate is about 22 in thousands and the annual increase of total population is 15 %.

Keywords: Turkey, Water Resources, Land Resources.

DIE VORHANDENE ZUSTAND DER WASSERWIRTSCHAFT UND DER LANDWIRTSCHAFT DER TURKEI

Zusammenfassung: Die Türkei, die zwischen Europa und Asien liegt, hat eine Oberfläche von 779 452 km^2. Die Anatolie ist ein Tale, das eine Steigung besitzt. Die Türkei hat sehr unterschiedliches Klima, das in den Schwarzen Meer-, Mittelmeer-, Agäisches Meer- und Mittelanatolien- Regionen Veränderungen zeigt.

Durchschnittliches Jahresmittel des Regens der Türkei beträgt 642.6 mm. Das bedeutet ein Wasservolumen von 501.0 km^3. Die Potential des Oberflächeswassers der Türkei beträgt ausgedrückt als oberflächliches Wasservolumen 186.05 km^3. Abflusskoeffizient ist 0.37. Das gebrauchtliche Wassermenge beträgt 95.0 km^3. Davon 25.9 km^3 ist erreichbar. Die jährliche Grundwasserpotantiel beträgt 12.3 km^3, und davon 9.1 km^3 ist erreichbar. Das gebrauchliche Grundwassermenge ist 6.0 km^3. Die Türkei besteht von 26 Einzugsgebiete. Ausser 77,945,200 ha hat die Türkei eine Ackerlandfläche von 28,054,310 ha, eine Weide von 21,505,112 ha, eine Wasserfläche von 1,159,161 ha, und ein Waldgebiet von 23,228,060 ha. Eine Oberfläche von 3,998,557 ha ist undefiniert.

In der Türkei ist ausser der Ackerlandfläche von 28 054 310 ha eine Oberfläche von 25,753,586 ha günstig zu bewässern. Davon wird zur Zeit nur 4,648,082 ha bewässert. Unter heutigen Umständen ist 8,500,000 ha ökonomisch, zu bewässern. Das bedeutet, dass Infrastruktur gebaut sein muss, um die restliche Fläche von 4,851,918 ha zu bewässern. Die gesammte Energieproduktion für Jahr 1998 beträgt in der Türkei 42,229 GWh als Wasserkraft, 68788 Gwh als Thermik, und 111,022 GWh als totale Summe. Nach der Wasserwirtschaftentwicklung der Türkei und mit dem fertiggestellten 3589 kleinen Projekten wird eine Fläche von 270,857ha gegen Überschwemmungen geschützt.

Die totale Summe des Wasserversorgungsbedarfs der Türkei wird 5.7 Billion m^3 geschätzt. Nach der Volkszählung im 1997 hat die Türkei 62,865,574 Einwohner. Die Dichte der Einwohner ist 82 Menschen pro km^2. Die Einwohner, deren Rate bei 35 Prozent liegt, leben auf dem Land. Der Bedarf nach der Bewässerung und dem Trinkwasser hat ziemliche Einwirkungen über die Wanderung der Einwohner. Ein anderer Faktor, der die Dichte der Einwohner beeinflusst, ist die Umziehung von dem Land zur grossen Städten in den neunzigen Jahren. Die Geburtsrate liegt ungefähr bei 2.2 Prozent.
***Betreffendewörter*:** Die Türkei, Wasserwirtschaft, Landwirtschaft

1. Introduction

Turkey is a country located between Europe and Asia and has a surface area of 779 452 km^2 including the lakes. The European part (Thrace) which is 23 764 km^2 and the Asian part (Anatolia) which covers 755 688 km^2 are separated by Istanbul Bogazi; Bosphorous, the Marmara Sea and the Canakkale Bogazi (Dardanelles). Anatolia is a high plateau rising progressively towards the East In the North the Eastern Black Sea mountain chain runs parallel to the Black Sea, in the south the Tourus mountains sweep down almost to the narrow fertile coastal plain along the sea. The total coastline of Turkey is about 8340 km.

1.1. Climate

Turkey has a variety of climates, changing from the temperate climate of the Black Sea region to the continental climate of the interior, then to the Mediterranean climate of the Aegean and coastal Mediterranean regions.

1.2. Precipitation

Areal distribution of precipitation differs very much from one region to another. The minimum annual precipitation total was recorded in 1933 at Himmetdede, Kayseri located in central Anatolian Plato as 63.3 mm and the maximum precipitation recorded as 4043.3 mm at Rize on Black Sea coast. The arithmetical average of the annual precipitation is 642.6 mm. There are seven geographical regions in Turkey (Figure 1), and the average annual precipitation totals for the regions are given as at Mediterranean region 750.7 mm, for Eastern Anatolia 611.2, for Central Anatolia 388.8, for Black sea region 816.5, for Marmara 640.6, for Aegean region 672.2 and for Southeastern region 609.8 mm.

1.3. Population

According to 1997 census, Turkey has about 62,865,574 inhabitants, the population density is about 82 persons/km^2 and about 35 % of this population lives in the countryside. Table 1 shows the distribution of the urban and rural population distributions of Turkey since 1960. As could be seen from the table there has been a great demand for irrigation water supply, and this has a great influence of the redistribution of the population. During the years of 90's another important parameter affecting the population density was the internal migration from rural areas to big cities. The average birth rate is about 22 in thousands. There are various parameters affecting the distribution of the population but a close relation between the density and the climate in different regions of Turkey can easily be observed. The major cities are Istanbul, Ankara (the capital), Izmir, Adana, Antalya and Bursa.

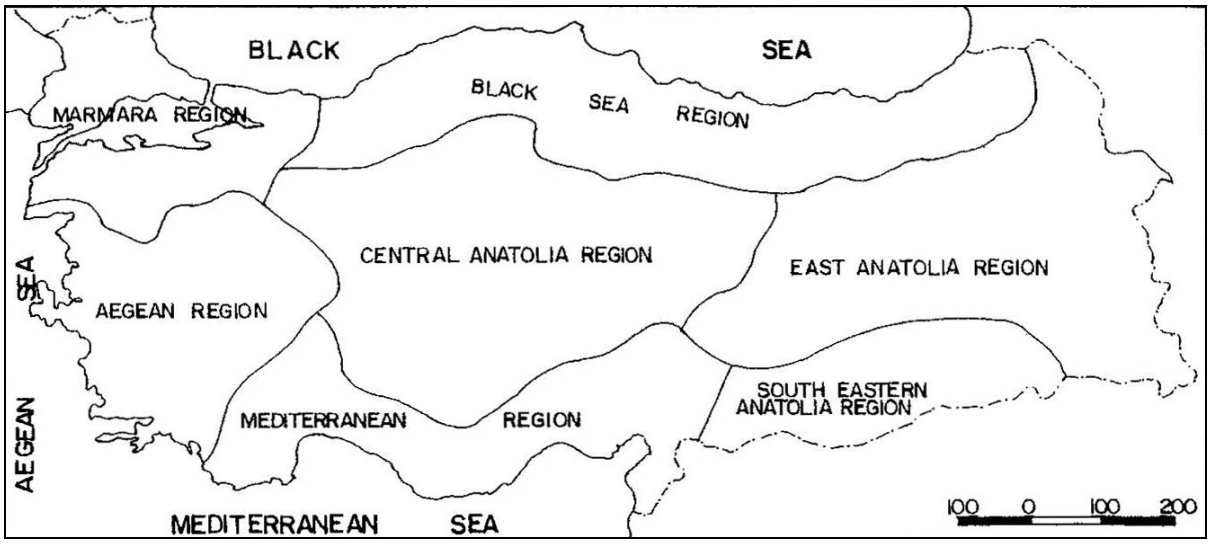

Figure 1: The geographical districts of Turkey

Table 1: Urban and rural population distributions of Turkey between 1965 and 1997 (DSI, 1999)

Urban Population			Rural Population		
Year	Population	%	Population	%	Total
1965	10 805 817	34.4	20 585 604	65.6	31 391 421
1970	13 691 101	38.5	21 914 075	61.5	35 605 176
1975	16 869 068	41.8	23 478 651	58.2	40 347 719
1980	19 645 007	43.9	25 091 950	56.1	44 736 957
1985	26 865 757	53.0	23 798 701	47.0	50 664 458
1990	33 326 351	59.0	23 146 684	41.0	56 473 035
1997	40 882 357	65.0	21 983 217	35.0	62 865 574

About 34.96 % of the population is between the ages of 0-14, 60.68 % is at the age group of 15-65, about 4.28 % is over 65 years old and the rest 0.08 % is not known. About one third of the population is very young and they are not actually the active work force, this is a big difference from the developed countries. Since the number of jobs available is less than the demand, in agriculture, forestry and fishing sectors more than the real number of working is observes and actually this is a secret or covered or undefined unemployment and the rate of unemployment in other sectors is rather high. The gross national income per capita is a measure of the economic situation in the country and the distribution of the gross national income differs from one sector to another .The figures for Agriculture, Industry and Service sectors are given in Table 2 for the years of 1994 and 1998.

Table 2. The distribution gross national income in different sectors (DSI, 1999)

Sectors	1994		1998	
	Million (TL)	Share (%)	Million (TL)	Share (%)
Agriculture	572 671	14.8	8 809 971	16.5
Industry	992 554	25.5	11 186 215	20.9
Service	2 322 678	59.7	33 522 146	62.6
Total	3 887 903	100.0	15 064 361	100.0

2. Water Resources

The mean annual precipitation of 642.6 mm corresponds to 501.0 km^3 of total water volume. The figures for the surface water potential of Turkey can be stated as runoff volume 186.05 km^3, runoff coefficient 37 %, the consumable water volume 95.0 km^3, and actual consumed volume 32.9 km^3, and for underground water annual exploitable ground water potential of Turkey is 12.3 km^3, the ground water volume allocated is 9.1 km^3 and the real consumed amount is 6.0 Km^3.

In order to give some idea about the water resources potentials of some countries and also provide the possibility to compare the percentages of the utilization of water resources of Turkey with those countries and neighbors is given in Table 3.

Table 3. Water Resources Potentials and water utilization ratios of some countries

Country	Water Resources Potential (km^3)	Water Per capita (1991) (m^3)	Year	Consumption (km^3)		
				Domestic	Industry	Agriculture
USA	2 478	9 870	1985	56.0	215.0	196.0
Canada	2 901	108 505	1986	5.0	34.0	3.0
Bulgaria	205	22 735	1980	2.0	5.0	7.0
Egypt	58	1 082	1980	4.0	3.0	49.0
Spain	111	2 826	1985	4.0	11.0	30.0
Romania	208	8 898	1980	2.0	8.0	15.0
Portugal	66	6 423	1980	2.0	4.0	5.0
Japain	574	4 623	1980	18.0	36.0	54.0
Holland	90	5 981	1985	2.0	7.0	5.0
Italy	187	3 244	1980	8.0	16.0	34.0
Belgich	13	1 268	1980	1.0	7.0	1.0
Finland	113	22 654	1980	0.8	3.0	0.2
French	185	3 268	1985	8.0	24.0	8.0
Germany	195	2 455	1983	9.0	34.0	7.0
Greece	59	5 869	1980	2.0	2.0	4.0
Thailand	169	2 993	1987	4	3.0	25.0
Turkey	186	2 889	1999	5.7	4.0	29.2
England	120	2 084	1980	7	20.0	1.0
Swiss	50	7 484	1985	1	2.8	0.2
Moracco	30	1 167	1985	0.7	0.3	10.0
Norway	413	97 062	1980	0.8	2.1	0.1
Chine	2 800	2 466	1980	52	28.0	380.0
Sweden	180	20 972	1980	1.2	2.4	0.4
Polland	56	1 477	1980	3	10.0	4.0
Israel	2	428	1986	0.5	0.5	1.0
Austria	92	12 121	1980	1	2.7	0.3
Check	90	5 736	1980	1.5	4.0	0.5
Brazile	6 950	45 329	1987	15	6.0	14.0
Bangladesh	2 357	19 855	1987	2.8	0.2	20.0

Turkey has been divided into 26 river drainage basins to study the water and resources as extensively as possible (Figure 2). The water resources potential of each basin is given in Table 4. It is possible to get information on the population, surface area (drainage area), mean annual precipitation total in mm the specific discharge in l/sec/km^2, volume of annual runoff total in m^3 for each basin from the table. The land resources of each basin are given as total plain area, potential value of irrigable plain area, and the actual irrigated area totals.

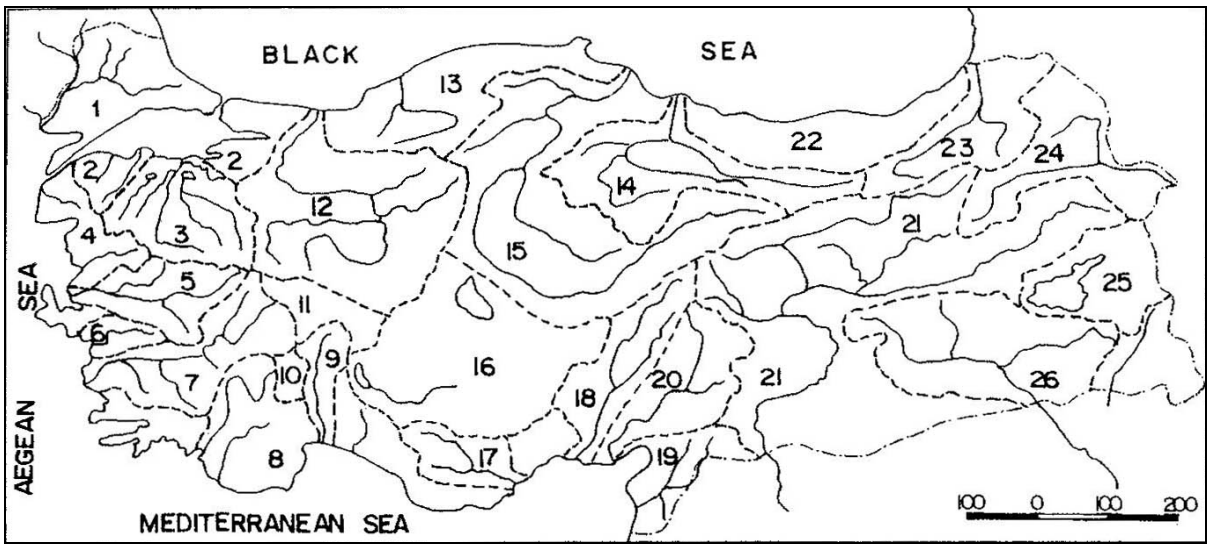

Figure 2: The drainage areas of the river courses of Turkey

If there is no water impoundment structure on the river course, they flow either to neighboring states, like the rivers Coruh, Arpacay and Aras to Russia and Armenia, and the river Sarisu to Iran, the river Tigris to Iraq and the river Euphrates to Syria and then to Iraq or to the internal sea, lakes, and wet lands or marshes (Figure 2). From technical point of view it is hardly possible to utilize from all the surface water volume computed as 186.05 km^3. A substantial part of this volume is released to the neighboring countries according to the International laws of transboundary rivers and this point is taken into consideration in the design stage of the projects. In order to avoid the saltwater intrusion on the coastal plains and deltas, to sustain the existing fauna and flora in the downstream of the reservoirs and also facilitate the river navigation, a certain amount of water should also be released down from any kind of water impoundment and regulating structure.

On the other hand, in some of the drainage basins construction of dams and thus utilization of water for multi purposes cannot be possible due to topographical and geological conditions. Therefore about 91 km^3 of surface waters could not be utilized due to technical and economical reasons. The water which can be utilized for various purposes will be thus 95 km^3 after the construction of all the necessary water structures to regulate the virgin river flow along the water courses. According to results of the reconnaissance studies done for 342 plains and completed in the year of 1969, total volume of the ground water reservoir studied is 9353.8 hm^3 and when the other isolated aquifers are included the total useable volume is 12 km^3 and when added to surface water the total useable water amount of Turkey is 107 km^3. The distribution of the surface area into different types of use are given in Figure 3. In Figure 4 the present situation of economically irrigable lands, the sources of irrigation water, organizational responsible with irrigation of different plots of lands are presented.

Table 4. Water and Land Resources of drainage basins

BASIN				WATER POTANTIALS OF BASIN			IMPOUNDED WATER WITHIN THE BASIN		SOIL RESOURCES OF BASIN	
No	Name	Population (1990)	Area (km^2)	Annual Precipitation (mm)	Flow (km^3)	Discharge ($lt/s/km^2$)	Number of Dams	Impounded Water (hm^3)	Plain Areas (ha)	Irrigable Plain Areas (ha)
1	Meric Ergene	1 056 473	14	604	1.33	2.9	21	1 817	1 095 320	1 077 992
2	Marmara	11 329 437	24	728.7	8.33	11	58	2 894.5	865 704	729 957
3	Susurluk	2 674 579	22	711.6	5.43	7.2	26	3 848	850 046	755 934
4	North Aegean	617 011	10	624.2	2.09	7.4	15	797.0	367 479	316 348
5	Gediz	2 327 897	18	603	1.95	3.6	16	3 565.9	667 207	623 403
6	K.Menderes	1 972 770	6	727.4	1.19	5.3	17	1 697.7	223 437	194 799
7	B.Menderes	1 975 402	24	664.3	3.03	3.9	22	2 739.9	1 04 296	907 383
8	West	890 441	20	875.8	8.93	12.4	25	1 830.0	437 356	406 601
9	Antalya	1 558 219	19	1000.4	11.06	24.2	14	2 858.0	451 224	448 111
10	Burdur Lakes	200 200	6	446.3	0.5	1.8	9	161.7	251 403	249 484
11	Akarcay	665 447	7	451.8	0.49	1.9	3	172	364 411	359 938
12	Sakarya	5 703 375	58	524.7	6.4	3.6	45	6 827.9	2 814 341	2 681 137
13	Western Black Sea	1 892 776	29	811	9.93	10.6	28	2 784	855 008	640 557
14	Yesilirmak	2 290 024	36	496.5	5.8	5.1	44	6 287.9	1 617 206	1 401 213
15	Kizilirmak	3 963 186	78	446.1	6.48	2.6	78	23 774.3	4 049 796	3 761 142
16	Konya Closed	2 430 730	53	416.8	4.52	2.5	25	2 800.8	2 182 762	2 134 915
17	East Mediterrenean	2 051 695	22	745	11.07	15.6	11	10 173.5	438 281	327 790
18	Seyhan	1 695 572	20	624	8.01	12.3	18	6 124.5	764 673	714 014
19	Asi (Orontes)	1 277 313	7	815.6	1.17	3.4	8	1 1086.5	376 240	331 719
20	Ceyhan	1 418 391	21	731.6	7.18	10.7	27	8 229.3	779 792	713 670
21	Euphrates	7 199 119	127	540.1	31.61	8.3	89	112 193.2	4 293 793	4 111 316
22	Eastern Black Sea	2 494 663	24	1198.2	14.9	19.5	41	1 491.6	712 575	350 717
23	Coruh	467 718	19	629.4	6.3	10.1	21	7 467.3	326 220	303 362
24	Aras	889 157	27	432.4	4.63	5.3	20	4 085.2	642 017	641 137
25	Van Lake Closed	1 005 209	19	474.3	2.39	5	7	608.7	436 485	433 319
26	Tigris	2 818 791	57	807.2	21.33	13.1	42	30 630.5	1 148 238	1 137 628
	T O T A L	62 865 574	779	642.6	186.05	209.3	730	246 853.9	28 054 310	25 753 586

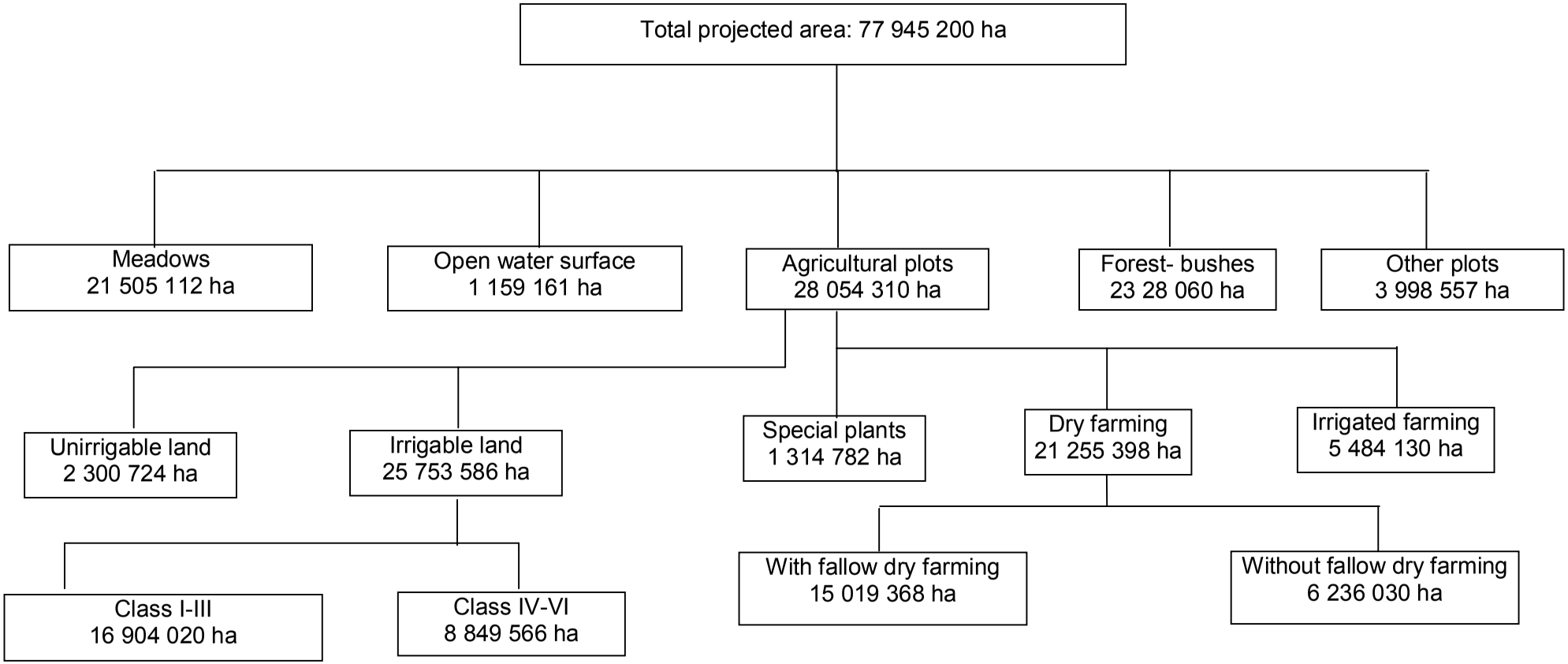

Figure 3: The distribution of the surface area into different types of using land

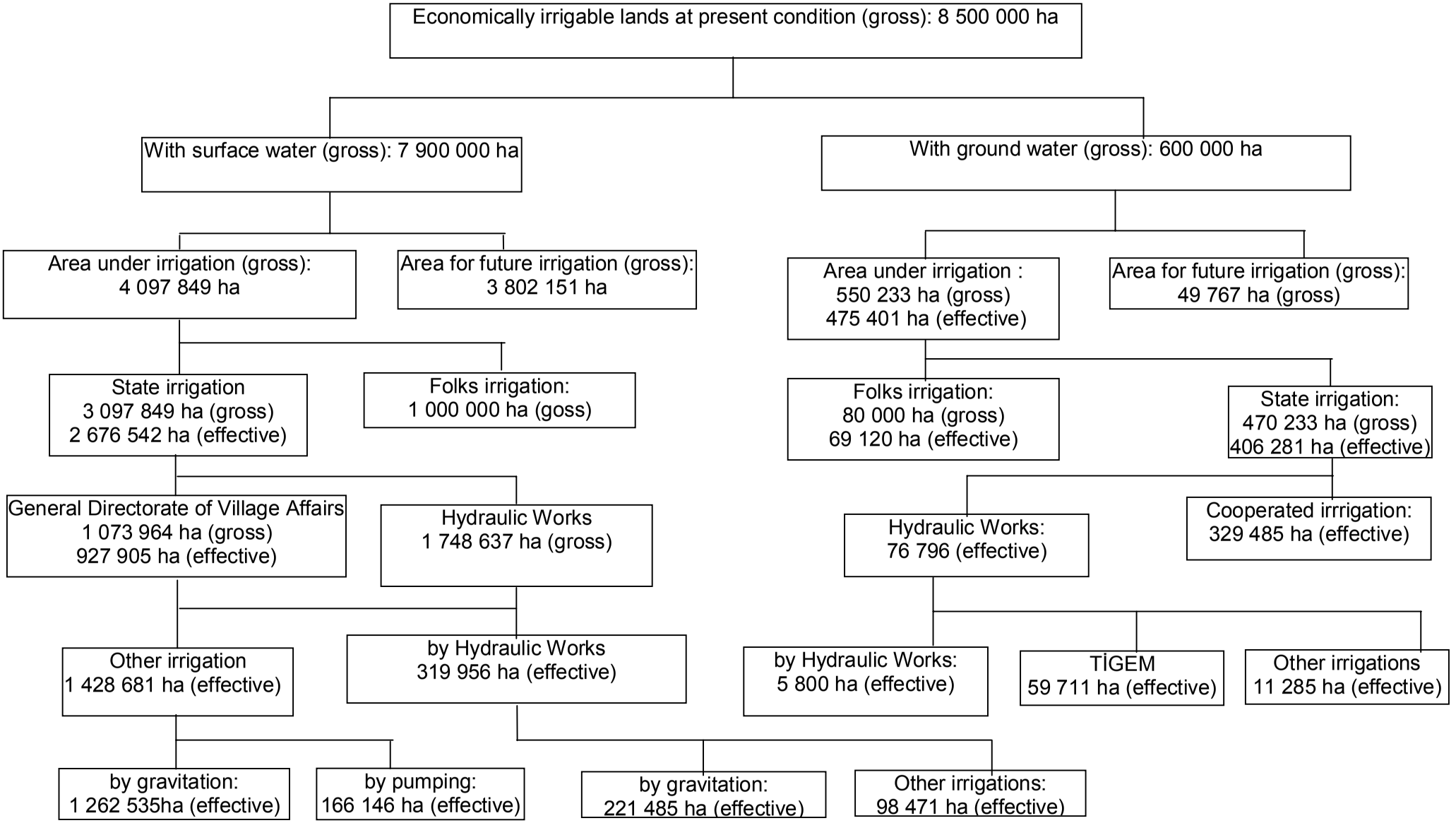

Figure 4: The present situation of economically irrigable lands

3. Present level of water utilization and power production in Turkey

The electric energy produced by Turkey is enough at present for the need of the country. For example in the year 1998, the total amount of electric energy produced was 111 022 GWh of which 42 229 GWh is from Hydropower and 68 788 GWh is from thermic sources, and the amount of energy consumed in the same year was 87 705 GWh and unit consumption was 1382 kWh per capita, and compared to some countries (Table 5) this figure is rather small. As could be seen from the table, in developed countries the unit energy consumed is above 4000 kWh and for example in Norway it is 23 712 kWh.

In order to regulate the existing river system of Turkey it is planned to build 730 dams, but it is noted that in detailed studies on the drainage basins this number may change. When the construction of these dams are completed 7 254 454 ha area will be irrigated, 704 868 ha land will be protected from floods, 130 326 ha land will be drained and dried to be used for farming, 9 856,3 hm^3 domestic water supply will be available for the water distribution network of the cities, and 123 040 GWh energy will be produced by 485 hydropower plants with an installed capacity of 34 728,7 MW. Besides these benefits, water, regulation and flood control projects in smaller scale and the ground water development projects will bring extra prosperity to Turkish people. At present only 5,7 Km^3 of domestic water and 33,2 km^3 of the industrial and irrigation water can be utilized the rest big portion could not be developed.

4. Land utilization in Turkey

Out of 77 945 200 ha total surface area, 28 054 310 ha is agricultural land, 21 505 112 is pasture and grazing land and 1 159 161 ha water surface 23 228 060 ha is forest and 3 998 557 ha is classified as other lands etc. The detailed land use in Turkey is given in Figures 3-4.

Turkey can irrigate only 4 648 082 ha of the total irrigable area of 25 753 586 ha out of 28 054 310 ha of agricultural land at present. With the conditions at present it is possible to irrigate 8 500 000 ha area economically, that means it is necessary to built the infrastructure needed to irrigate the rest; 3 851 918 ha of irrigable land.

4 097 849 ha of land is irrigated by surface water resources of which 1 000 000 ha is irrigated by the irrigation networks realized by local farmers and 2 728 499 ha by the state projects (2 023 885 ha by DSI and the rest 1 073 964 ha by General Directorate of Village Affairs KHGM) and 550 233 ha is irrigated by ground water resources of which 470 233 ha from state wells and 80 000 ha from the wells of the local people.

In developing the irrigable 8.5 million ha of land for the full utilization of the people, it is necessary to keep the following points in mind:

-use the soil according to their capability
-the ownership of the small parcels should be rescheduled
-soil erosion in the upstream of the watershed should be prevented
-irrigation should be realized by state
-investments for irrigation projects should have priority
-production planning is necessary according to the availability of suitable climatological conditions and soil conditions, and cash.
-education of the farmers is to be realized
-a coordination is to be set among the ministries and related state organizations

5. Methodology in planning the utilization of water and land resources of Turkey

Since 1963 Turkey being as a democratic country, started the national development process according to five year plans, the seventh five year plan started in 1999 and the future projections covers the period of 1996-2000 (DSİ, 1999) set forward by State Planning.

Table 5: The birth rates, size of the land, installed capacities, energy productions and energy consumptions in Turkey and some other countries

Countries	Birth Rate (%)	Surface Area 1000 km^2 (km^2)	Total Installed Capacity (GW)	Total Energy Production (TWh)	Consumption	
					Total Amount (TWh)	Annual KWh per capita
Turkey	1.5	780	21.3	94.9	74.2	1 183
Greece	0.6	132	9.1	42.4	37.2	3 574
Spain	0.1	506	46.8	174.4	151.5	3 859
Italy	-0.2	301	68.3	244.5	246.0	4 280
France	0.5	552	109.5	513.1	384.2	6 580
Germany	0.6	357	114.1	555.3	479.7	5 856
Japan	0.3	378	209.3	1 012.1	901.3	7 161
U S A	1.0	9 364	783.5	3 667.8	3 221.3	12 015
Norway	0.6	324	27.8	104.81	103.8	23 712

(*) From Bulletin of Electric Energy Statistics for Europe 1995 -1996

Organization balances the investment in different sectors. In water and land resources utilization, sustainable development concept is closely followed. Especially water and land resources integrated development projects on national and transboundary rivers are to be properly done.

6. Conclusions

Turkey, due to its location in one of the most strategically sensitive region of the world, pays more attention to utilization of water and land resources. In planning, design and construction of new projects, sustainable development concept is followed very closely. Multi purpose multi unit development projects both on national and transboundary rivers with neighbours get more attention and integrated river basin development concept considering water, land, ecological and environmental impacts, population increase, increase in irrigated agriculture and industrial development need to better quality water, in utilized.

7. Reference

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