

Kankal, Murat; Nacar, Sinan; Uzlu, Ergun

Article

Status of hydropower and water resources in the Southeastern Anatolia Project (GAP) of Turkey

Energy Reports

Provided in Cooperation with:

Elsevier

Suggested Citation: Kankal, Murat; Nacar, Sinan; Uzlu, Ergun (2016) : Status of hydropower and water resources in the Southeastern Anatolia Project (GAP) of Turkey, Energy Reports, ISSN 2352-4847, Elsevier, Amsterdam, Vol. 2, pp. 123-128, <https://doi.org/10.1016/j.egy.2016.05.003>

This Version is available at:

<https://hdl.handle.net/10419/187851>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

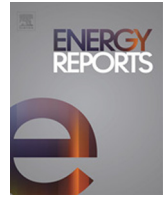
Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>



Status of hydropower and water resources in the Southeastern Anatolia Project (GAP) of Turkey



Murat Kankal*, Sinan Nacar, Ergun Uzlu

Karadeniz Technical University, Faculty of Engineering, Department of Civil Engineering, 61080 Trabzon, Turkey

ARTICLE INFO

Article history:

Received 3 February 2016

Received in revised form

8 May 2016

Accepted 12 May 2016

Available online 1 June 2016

Keywords:

Euphrates–Tigris Basin

Hydropower

Irrigation

Southern Anatolia Project

ABSTRACT

This study focuses on the water resources development of the Southeastern Anatolia Project (GAP) in Turkey. The Euphrates and Tigris Rivers, located in the GAP, have the largest flow volume of 16.9% and 11.4% of Turkey's average annually runoff (186 billion m³), respectively. While the Euphrates represents over 19.4% of the national gross hydropower potential (433 GWh/year), the Tigris correspond to 11.2% of this potential. 20,523 GWh/year of hydropower potential in the GAP is in operation. When all projects of the GAP in planning are completed, the total hydropower potential reaches a level of 27,419 GWh/year. This value corresponds to 10.9% of the annual electric energy production of Turkey in 2014 (251.96 GWh). There is also irrigable land of 1.06 million ha in the GAP, and now roughly 33.7%, 357,241 ha, of which have been irrigated.

© 2016 The Authors. Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Even though water being a renewable natural resource is regarded among the non-consumable natural resources on a global scale, it is consumable resource on a local scale in terms of being usable. Water constitutes approximately one-eight hundredth of the Earth's weight and covers 71% of the Earth's surface, however, the usable amount of fresh water being vital for human and plant life is very limited. Moreover, distribution of fresh water resources is also not well-balanced depending upon geographical and climatological conditions. Fresh water resources have could not meet the demand for the water as a result of the rapid increase in the world population in company with the rapid increase in demand for the water as well as excessive pollution. Together with the regional variability and quality differences related to the fresh water resources in addition to all these, transnational and inland problems have seriously arisen as regards to the usage of this vital resource (Sen et al., 2002).

The effects on global and environmental air quality of pollutants released into the atmosphere from fossil fuels in power plants provide strong arguments for the development of renewable energy resources. Clean, domestic and renewable energy is commonly accepted as the key for future life, not only for Turkey but also for the world. The consumption of conventional fossil

energy resources (coal, petroleum and natural gas) on one hand results in serious environmental pollution problems, and on the other hand faces with the danger of exhaustion. In order to have a sustainable development in Turkey, it must be enhanced the efficiency of the conventional energy generation and increased the proportion of renewable energy sources in the total energy budget (Akpınar et al., 2008).

The demand for energy and particularly for electricity is growing rapidly in Turkey in parallel to the social and economic development of the country. The main indigenous energy resources are limited to hydro, mainly in the eastern part of the country, and lignite to a great extent as there are no big oil and gas reserves in Turkey. All of crude oil, natural gas and high quality coal have been almost imported. It has a large potential for renewable energies (Yukseket al., 2006). Turkey's energy demand is met through thermal power plant consuming coal, gas, fuel oil and geothermal energy, wind energy and hydropower. Because Turkey does not own any nuclear power plant yet, the installation of first nuclear power plant with a capacity of 1000 MW is on the schedule as a plan of the near future (Yukseket al., 2015).

The Euphrates and Tigris, located in the GAP, are the two principal branches of the transboundary river basin, joining each other 70 km north of Bassorah in Iraq, to form the Shatt-al-arab, and discharging 100 km thereafter into the Gulf. The total water potential of the Euphrates subbasin is 37 km³/y; Turkey provides 32 km³/y, i.e., about 85% of this potential from less than 30% of the total drainage area. The total water potential of the Tigris subbasin is 57 km³/y; Turkey provides 24 km³/y, i.e., about 40%

* Corresponding author. Tel.: +90 462 377 2632; fax: +90 462 377 2606.

E-mail addresses: mkankal@ktu.edu.tr, mkankal06@gmail.com (M. Kankal).

of this potential from less than 25% of the total drainage area. Hence, Turkey provides about 60% of the total water potential of Euphrates–Tigris basin from 25% of the entire drainage area. Water scarcity in the Middle-East in general, water allocation claims of the riparian states in particular, enhanced by international geopolitical and energy issues from states and organizations outside the region, make the Euphrates–Tigris basin one of the foremost conflict focus of the world (Öziş and Özdemir, 2009).

The number of the multinational river basins being transboundary and/or boundary on the Earth is over 200, and these basins comprise almost 50% of the Earth's land. Serious problems can be arisen among the countries as for benefiting from these waters (Sen et al., 2002). Ever-increasing demand for the water in addition to the differences related to regional and climatological conditions in the water variability have raised the importance of transboundary waters further.

The aim of the current study is to evaluate the historical development of the project, the water resources and hydropower status of the Southeastern Anatolia Project (GAP). The importance of water and development is presented in Section 2. In Section 3, the development of water resources in the GAP is analyzed and finally, the conclusions are presented in Section 4.

2. Water and development

Today, around 3800 km³ of fresh water is withdrawn annually from the world's lakes, rivers and aquifers. This is twice the volume extracted 50 years ago. A growing population and a rising level of economic activity both increase human demand for water and water-related services. Development, technological change, income distribution and life-styles all affect the level of water demand (The Report of the World Commission on Dams, 2000).

The world population has reached 6.8 billion with 5.6 billion (82%) living in the less developed regions. It is projected to reach 9.1 billion by 2050. Most of this growth will be in developing countries, where population is projected more than to double, from 835 million inhabitants in 2009 to 1.7 billion in 2050 (Stephenson et al., 2010). One third of the countries in water stressed region of the world are expected to face severe water shortages this century. By 2025 there will approximately 6.5 times as many people—a total of 3.5 billion living in water stressed countries (Narasaiah, 2006).

Despite the massive investment in water resource management and particularly in dams, billions of children, women and men in rural areas lack access to the most basic water and sanitation services. Although problems of access are worst in rural areas, rapid urbanization is also increasing the demand for water-related services. In 1998, 43% of the world's population lived in urban areas. If current trends persist, that figure could reach 60% by the year 2030 and over 70% by 2050. Most of this growth will take place in developing countries where an estimated 25%–50% of urban inhabitants live in impoverished slums and squatter settlements. Lack of access to water in both rural and urban areas is not just a question of supply. It is partly due to inequitable access to existing supplies (The Report of the World Commission on Dams, 2000; Akpinar and Kaygusuz, 2012).

3. The Southeastern Anatolia Project (GAP)

The GAP Project became one of the most ambitious regional development projects in the country by encompassing not only hydropower and irrigation infrastructure development as originally planned, but also all related sectors including industry, transportation, rural and urban infrastructure, environmental protection and social sectors in the region. Since GAP was planned as a multi-sector integrated regional development project, an integrated approach was essential to achieve its targets and

objectives. It was thus understood that construction of energy and irrigation infrastructure, past and future, would contribute to economic growth, social development and environmental change. All these changes would, in turn, have discernible impacts on different parts of the region and would need to be managed with a view to achieving the sustainability of the GAP Project and improving the quality of life for the local population (Altinbilek and Tortajada, 2012).

3.1. Historical development of the GAP

The investigations commenced in the Euphrates River in 1936 by directives of Mustafa Kemal Atatürk, the founder of Turkish Republic. Keban and Kemaliye flow monitoring stations on the Euphrates River and Diyarbakır flow monitoring station on the Tigris River were established in 1935 and 1936, respectively, by the EIE, General Directorate of Electrical Power Resources Survey and Development Administration, founded in 1935 and flow monitoring data was began to collect for making use of in the coming years. As result of crash survey studies together with the foundation of the General Directorate State Hydraulics Works in 1954, "Basin Preliminary Survey Reports" involving whole basin were prepared as from major basins.

Keban Dam, founded in 1966 and put into service in 1974, was one of the most important plants by generating hydroelectric energy of 6 TWh/yr with an installed capacity of 1330 MW. The Lower Euphrates Preliminary Survey Report was published by DSİ in 1967. In Tigris Basin Preliminary Survey Report published by DSİ in 1971, 20 dams with several dimensions, irrigation of 190,000 ha land, and hydroelectric energy generation of 3.9 TWh/yr together with 19 HEPPs having a total installed capacity of 770 MW were anticipated.

DSİ combined the development plans for the Lower Euphrates Basin with the West and Middle Tigris Basins for the first time under the name of "Southeastern Anatolia Project" in 1980. Within the frame of this project, irrigation of 1125,000 ha land and hydroelectric energy generation of 20.1 TWh/yr together with a total installed capacity of 5304 MW were anticipated in the Lower Euphrates. Feasibility report for Birecik and Karkamış dams and HEPPs defined as Border Euphrates Projects was prepared in 1984 and later final projects were designed for Birecik Dam.

In brief, the studies qualified as the Lower Euphrates Project, which is shaped as the Lower Euphrates Planning at first, were called as Water and Soil Resources Development Project in the Euphrates–Tigris Basin and named as the Southeastern Anatolia Project, GAP in short, by adding the Tigris Basin later on.

The foremost milestone of the Southeastern Anatolia Project is the GAP Action Plan prepared in 2008. This action plan was declared on May 27, 2008 in Diyarbakır and the investments were boosted. The aim of the GAP Action Plan comprising the years from 2008 to 2012 was to involve an area of 1058,000 ha to be irrigated, the projects within the scope of GAP were allocated great fund from the budget and so fund problem was eliminated for the irrigation projects. The historical development of the GAP is given in Fig. 1 (DSİ, 2015).

3.2. The status of hydropower and water resources in the GAP

The GAP was initially undertaken as a programme to develop water and land resources of the region and consequently planned as a package comprising 13 projects envisaging irrigation schemes and hydraulic power plants in the basins of the Euphrates and the Tigris. As a whole, the package included 22 dams, 19 hydraulic power plants and irrigation covering an area of 1.8 million ha (Yüksel, 2015). These dams planned on the main branches of the Euphrates and Tigris Rivers are shown in Figs. 2 and 3. It is seen

1936		The investigations commenced in the Euphrates River by command of Atatürk, the founder of Turkish Republic.	1992		The Atatürk Dam began electric energy generation.
1938		The geological and topographical surveys were commenced and flow monitoring stations were established in the Keban strait.	1994		Surface irrigation was begun in the Harran Plain through Şanlıurfa Irrigation Tunnels.
1954		The State Hydraulics Works was founded.	1997		Kıralkızı and Dicle dams began filling.
1961–1971		The Euphrates Planning Directorship established in 1961 published “The Euphrates Basin Reconnaissance Survey Report” in 1964. “The Lower Euphrates Project Preliminary Survey Report” completed in 1967 was followed by “The Lower Euphrates Feasibility Report” prepared in 1970. “The Tigris Basin Preliminary Survey Report” was published in 1971.	1998		Batman Dam began filling.
1966		Construction of the Keban Dam was started.	1999		Construction of Karkamış Dam and HEPP was completed.
1974		The Keban Dam put into operation and so it will provide regulated water for the downstream GAP dams.	2000		Construction of Birecik Dam and HEPP was completed.
1976		Construction of the Karakaya Dam was started.	2007		Construction of the Ilisu Dam and HEPP was started.
1980		The Lower Euphrates and Tigris Projects were combined under the name of GAP.	2008		GAP Action Plan put into practice.
1981		Construction of the Atatürk Dam's diversion tunnels and Şanlıurfa Irrigation tunnels were started.			The Lower Mardin Main Channel was put out to tender.
1987		The Karakaya Dam began electric energy generation.			Suruç Project Main Transmission Channel was put out to tender.
1990		The Atatürk Dam began filling.			Kıralkızı-Dicle Gravity Main Channel was put out to tender.
			2009		Construction of the Upper Harran Main Channel was completed.
			2011		Construction of the Silvan Dam was started.
			2012		It was come to an end in the construction of the Lower Mardin Main Channel and Kıralkızı-Dicle Gravity Main Channel.

Fig. 1. Historical development of the GAP (DSİ, 2015).

that these dams are in operation except for Ilisu and Cizre dams. With the preparation of GAP Master Plan in 1989, the project transformed into an integrated regional development effort also covering such diverse fields as rural and urban infrastructure, housing, transportation, communication, agricultural and industrial development, tourism, education and health (Republic of Turkey, 2013b).

The hydroelectric power generated as a part of the GAP has a place in Turkey (Table 1). The electricity production from the GAP was 16.9 TWh in 2013. This production corresponds to 28.5% of total hydroelectric power production in the same year. In 2004, the hydroelectric power generation from the GAP was 22.4 TWh that constitutes 14.9% of total production in Turkey while this generation occurred as 7.0% of total production in 2013. The major

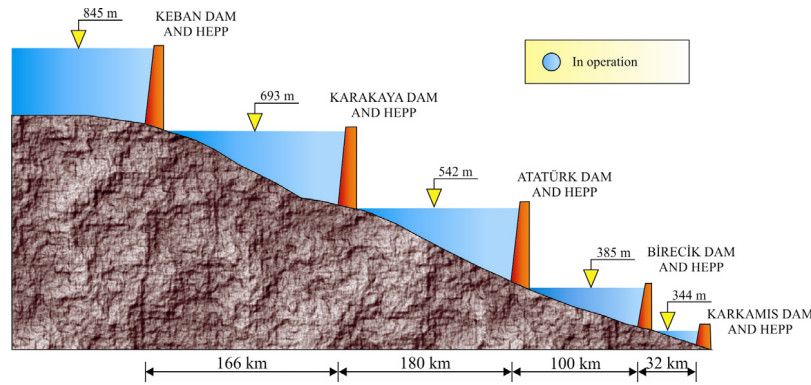


Fig. 2. The dams in the Euphrates River (DSİ, 2015).

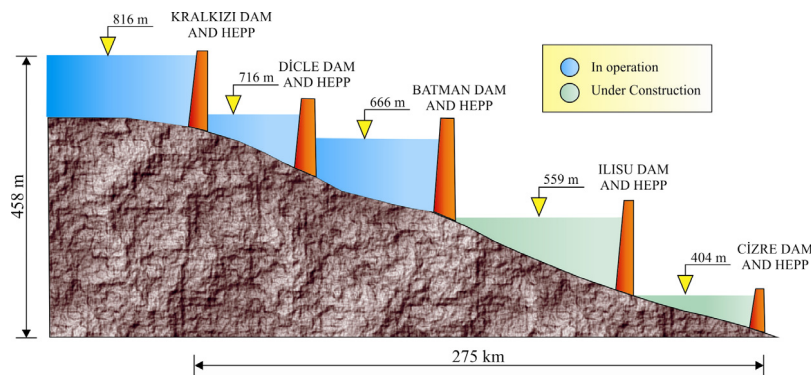


Fig. 3. The dams in the Tigris River (DSİ, 2015).

Table 1

Electric energy production comparison between the GAP and Turkey (TEIAS, 2015; Republic of Turkey, 2013d).

Year	Turkey				GAP hydraulic (TWh)	GAP/Turkey	
	Thermal (TWh)	Hydraulic (TWh)	Wind and Geothermal (TWh)	Total (TWh)		Hydraulic (%)	Total (%)
2003	105.1	35.3	0.15	140.6	15.3	43.34	10.9
2004	104.5	46.1	0.15	150.7	22.4	48.59	14.9
2005	122.2	39.6	0.15	161.9	18.7	47.22	11.6
2006	131.8	44.2	0.22	176.2	21.4	48.42	12.1
2007	155.2	35.9	0.51	191.6	18.2	50.70	9.5
2008	164.1	33.3	1.01	198.4	15.6	48.30	7.9
2009	156.9	36.0	1.93	194.8	12.1	33.6	6.2
2010	155.8	51.8	3.58	211.2	17.5	33.8	8.3
2011	171.6	52.3	5.42	229.3	17.3	33.1	7.5
2012	174.9	57.9	6.76	239.5	19.2	33.2	8.0
2013	171.8	59.4	8.92	240.2	16.9	28.5	7.0

reason related to this drop is that Turkey is a developing country, and thus the demand for the electric energy is increasing. Even if all energy projects under construction or in planning in the GAP region are put into practice, the coverage ratio of the GAP for Turkey's electric power demand will show downward tendency over the long run. Besides, the hydropower installed capacity in the other part of the Turkey has rapidly increased thanks to private sector. Therefore, share of the hydroelectric power generation from the GAP in the total hydroelectric generation in Turkey decreased in the last five years.

The progress of the Dams and HEPPs in the GAP region is presented in Fig. 4 according to the project level. There are 19 HEPPs that have an installed capacity of 7528 MW in the GAP region, and in which annual energy generation of 27,419 GWh occurs. The current status of these HEPPs is given Table 2 according to the project phase. There are 11 HEPPs, which have an installed capacity of 5356 MW and generate an annual electric energy of 20,174 GWh in total, located on the Euphrates River, and the rest,

which have an installed capacity of 2172 MW and generate an annual electric energy of 7245 GWh in total, on the Tigris River. As of installed capacity of the HEPPs in the GAP region, 73.9%, 5566 MW, of which is in operation, 19.5%, 1466 MW, is under construction, and the rest, 496 MW, in planning.

The HEPPs, namely Karakaya, Atatürk, Kralkızı, Dicle, Batman, Birecik, Karkamış, Şanlıurfa, Çağçağ and Erkenek, have generated an electric energy of 392.1 TWh, actual cash value of which is 23.5 billion US dollar, from the first operation year to the end of 2013 (Republic of Turkey, 2013d).

An irrigable area of 1.8 million ha is planned to be irrigated by DSI in the GAP region. At the first stage, economically irrigable area of 1.06 million ha is foreseen to be completed (DSI, 2013). Total 357,241 ha land, 310,212 of which on the Euphrates Basin and the rest on the Tigris Basin, was involved to be irrigated by the end of 2013 (Table 3). An area of 1319,031 ha has been in project phase and planning stage while the construction of the irrigation network in an area of 120,198 ha has been in progress. The status of

Table 2
The status of hydropower potential in GAP (DSI, 2015; Republic of Turkey, 2013c).

Name of project	Installed capacity (MW)	Energy production (GWh)	Project level	First operation year
Karakaya Dam and HEPP	1800	7,354	In operation	1987
Atatürk Dam and HEPP	2450	8,900	In operation	1993
Birecik Dam and HEPP	672	2,516	In operation	2000
Karkamış Dam and HEPP	180	652	In operation	1999
Şanlıurfa Dam and HEPP	50	124	In operation	2005
Büyükçay Dam and HEPP & irrigation	30	84	Master plan ready	
Koçali Dam and HEPP & irrigation	39	187	Master plan ready	
Sırımtaş Dam and HEPP	26	87	Under construction	
Kahta Dam and HEPP	75	171	Master plan ready	
Fatopaşa HEPP	22	47	Master plan ready	
Erkenek HEPP	12	52	In operation	2010
Euphrates basin (Total)	5356	20,174		
Dicle Dam and HEPP	110	296	In operation	1999
Kralkızı Dam and HEPP	94	146	In operation	1998
Batman Dam and HEPP	198	483	In operation	2003
İlisu Dam and HEPP	1200	3,833	Under construction	
Cizre Dam and HEPP	240	1,208	Final design report ready	
Silvan Dam and HEPP	150	623	Under construction	
Kayser Dam and HEPP	90	341	Master plan ready	
Garzan Dam and HEPP	90	315	Under construction	
Tigris basin (Total)	2172	7,245		
General total	7528	27,419		

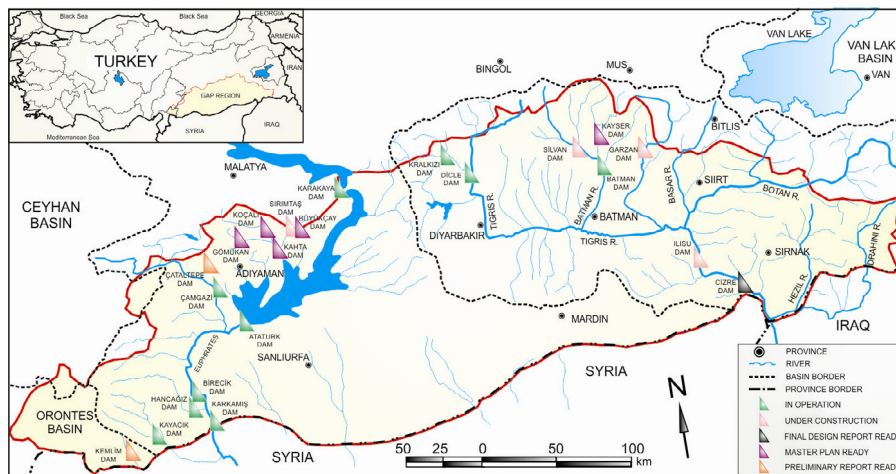


Fig. 4. The dams and HEPPs in the GAP (Republic of Turkey, 2013a).

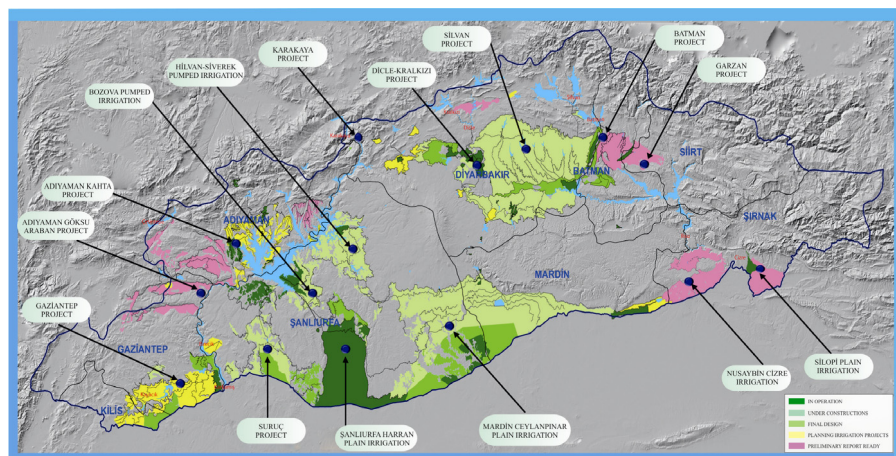


Fig. 5. The status of irrigation in the GAP (The Report of the World Commission on Dams, 2000).

Table 3
The status of irrigation project in Euphrates and Tigris basin of the GAP region (DSI, 2013).

Project (Euphrates basin)	Irrigation area (ha)	In operation (ha)	Under construction (ha)	Master plan ready (ha)	Planning (ha)
1. Karakaya Dam & HEPP	–	–	–	–	–
2. Lower Euphrates Project	691,108	227,264	16,291	276,781	170,772
3. Border Euphrates Project	–	–	–	–	–
4. Suruç-Yaylak Project plain irrigation	113,136	18,322	37,844	56,970	–
5. Adıyaman–Kahta Project	77,839	10,806	–	12,322	54,711
6. Adıyaman–Göksu–Araban Project	70,968	–	–	–	70,968
7. Gaziantep project	140,903	20,545	16,564	100,706	3,088
Total	1093,954	276,937	70,699	446,779	299,539
Individual project	90,072	33,275	2,770	17,777	36,250
Project (Tigris basin)	Irrigation area (ha)	In operation (ha)	Under construction (ha)	Master plan ready (ha)	Planning (ha)
1. Dicle–Kralkızı project	130,159	6,692	17,729	105,738	–
2. Batman project	37,351	10,000	27,351	–	–
3. Batman–Silvan project	245,372	–	–	245,372	–
4. Garzan project	40,365	–	–	–	40,365
5. İlisu Dam & HEPP	–	–	–	–	–
6. Cizre project	121,000	–	–	–	121,000
Total	574,247	16,692	45,080	351,110	161,365
Individual project	36,548	30,337	–	1,861	4,350

irrigation in project phase is shown in Fig. 5. The Lower Euphrates Project with an area of 691,108 ha is the foremost irrigation project and corresponds to 38.5% of all projects. Şanlıurfa Tunnels and Irrigation within the scope of the project constitutes the most part with an irrigation area of 376,000 ha, 161,000 ha of which was involved to be irrigated and corresponds to 45% of total irrigation in operation.

4. Conclusion

In this study, the historical development of the project, water resources and hydropower status of the GAP in Turkey was investigated. The main conclusions that can be drawn in the present study are as follows:

- The Euphrates–Tigris being one of the most important basins is estimated to uphold 28.3% of the total runoff in Turkey.
- In Turkey, The Euphrates and Tigris Rivers constitute 30.6% of the national gross hydropower potential (433 GWh/year).
- GAP involves 19 HEPPs. When these power plants are completed, the electric energy production capacity will reach 27,419 GWh/year that corresponds to 10.9% of the annual electric energy production of Turkey in 2014 (251.96 GWh).
- An irrigable area of 1.8 million ha is planned to be irrigated in the GAP region, but the area to be economically irrigated accounts for about 1 million ha, 357 thousand ha of which in operation, and 120 thousand ha under construction.
- Nowadays, the using and sharing of the water has become significant. Therefore, the water resources in Turkey must be developed right away so that a rapid development process comes out, and foreign dependency in the energy and agriculture can be reduced. It is concluded that the fact that the planning projects in the GAP having a great potential must be completed and put into service right away will make a great contribution to Turkey.

Acknowledgments

This paper is dedicated to the memory of a top researcher, a good person, and a beloved friend, Associate Professor Dr. Murat İhsan KÖMÜRÇÜ of Karadeniz Technical University in Trabzon, Turkey.

References

- Akpinar, A., Kaygusuz, K., 2012. Regional sustainable water and energy development projects: A case of Southeastern Anatolia Project (GAP) in Turkey. *Renew. Sustain. Energy Rev.* 16, 1146–1156.
- Akpinar, A., Komurcu, M.I., Kankal, M., Ozolcer, I.H., Kaygusuz, K., 2008. Energy situation and renewables in Turkey and environmental effects of energy use. *Renew. Sustain. Energy Rev.* 12, 2013–2039.
- Altınbilek, D., Tortajada, C., 2012. The Atatürk Dam in the Context of the Southeastern Anatolia (GAP) Project. Springer, Berlin.
- DSI, 2013. Water and DSI. General Directorate of State Hydraulic Works, Ankara, Turkey, 2009. http://www2.dsi.gov.tr/english/pdf_files/dsi_in_brief2009.pdf (accessed 03.02.16).
- DSI, 2015. Southeastern Anatolia Project. General Directorate of State Hydraulics Works. <http://www2.dsi.gov.tr/dijital/gap-brosur/files/assets/basic-html/page1.html> (accessed 03.02.16).
- Narasaiah, M.L., 2006. Irrigation Management and Globalization. Discovery Publishing House, India.
- Öziş, Ü., Özdemir, Y., 2009. Turkey's transboundary watercourses and the Euphrates–Tigris basin. In: Karpuzcu, M., Gürol, M.D., Bayer, S. (Eds.), *Transboundary Waters and Turkey*. Gebze Institute of Technology, Gebze, pp. 21–60.
- Republic of Turkey, 2013a. Ministry of Development Southeastern Anatolia Project Regional Development Administration. <http://www.gap.gov.tr/gap-provinces/maps/water-structures#this> (accessed 15.06.13).
- Republic of Turkey, 2013b. Prime Ministry Southeastern Anatolia Project Regional Development Administration, Latest situation on Southeastern Anatolia Project Activities of the GAP Administration 2006, Şanlıurfa, Turkey. http://includes.gap.gov.tr/files/ek-dosyalar_en/about-gap/latest-situation.pdf (accessed 15.06.13).
- Republic of Turkey, 2013c. Prime Ministry Southeastern Anatolia Project Regional Development Administration. GAP'ta son durum, 2012, Şanlıurfa, Turkey (in Turkish). <http://www.gap.gov.tr/file-includes/Gap-Son-Durum-2012.pdf> (accessed 15.06.13).
- Republic of Turkey, 2013d. Prime Ministry Southeastern Anatolia Project Regional Development Administration. Güneydoğu Anadolu Projesi Son Durum Raporu 2013, Şanlıurfa, Turkey (in Turkish). http://www.gap.gov.tr/dosya_ekleri/gap-son_durum/index.html (accessed 15.06.13).
- Sen, Z., Ozis, U., Avci, I., Bilen, O., Zehir, C., Birpınar, M.E., 2002. *Sınır Aşan Sularımız. Su Vakfı Yayınları*, İstanbul, Turkey (in Turkish).
- Stephenson, J., Newman, K., Mayhew, S., 2010. Population dynamics and climate change: what are the links? *J. Public Health* 32, 150–156.
- TEIAS, 2015. Electricity generation and transmission statistics of Turkey. Turkish Electricity Transmission Company. <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2013/istatistik2013.htm> (accessed 03.02.16).
- The Report of the World Commission on Dams, 2000. Dams and Development, a New Framework for Decision-making. Earthscan Publications, London, UK, and Sterling, USA. http://www.internationalrivers.org/files/attached-files/worldcommission_on_dams_final_report.pdf 2016 (accessed 29.01.16).
- Yuksel, I., 2015. South-eastern Anatolia Project (GAP) factor and energy management in Turkey. *Energy Rep.* 1, 151–155.
- Yuksel, I., 2015. Water management for sustainable and clean energy in Turkey. *Energy Rep.* 1, 129–133.
- Yukse, O., Komurcu, M.I., Yuksel, I., Kaygusuz, K., 2006. The role of hydropower in meeting Turkey's electric energy demand. *Energy Policy* 34, 3093–3103.