SAKARYA RIVER BASIN

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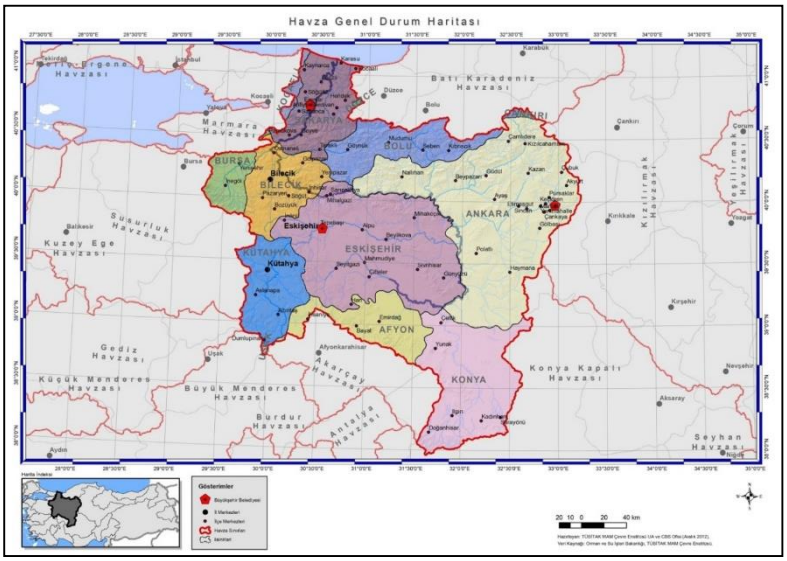
Sakarya River Basin, located in the northwest of the Anatolian Peninsula; It is surrounded by Susurluk in the west, Akarçay and Konya Closed Basins in the South, Kızılırmak and Western Black Sea Basins in the east. Bolu Mountains (2,499 m) in the north of the basin, which includes some parts of the Marmara, Aegean, Black Sea and Central Anatolia Regions, İdris Mountain (1,992 m), Elmadağ (1,761 m) and Haymana Plateau in the east, Emir Mountain (2,307 m) in the south, Murat Mountain (2,309 m), Bayat and Cihanbeyli Plateaus, and Domaniç Mountain (1,845 m) and Uludağ (2,543 m) to the west. The basin resembles a rectangle with its long axis in the west-east direction.



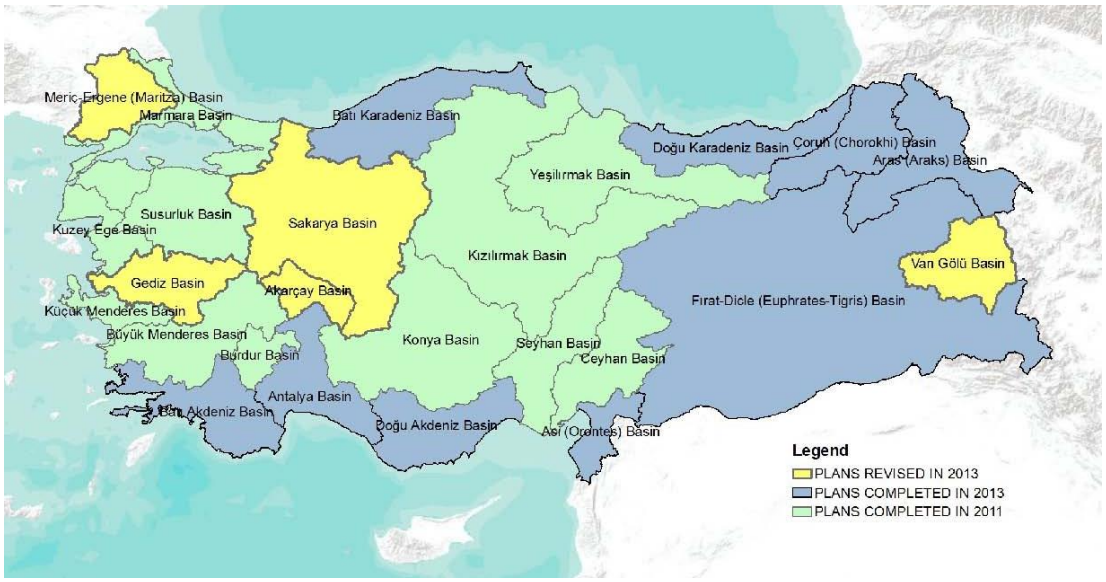
The drainage area of the Sakarya River is 58,160 km^2, and its total length, including its tributaries, is 720 km, considering that some of its springs have dried up. The average height of the basin, which covers approximately 7% of Turkey's surface area, is 508 m. Eskişehir, Sakarya, Bilecik, Ankara, Bolu, Kütahya Afyonkarahisar, Konya, Bursa and Kocaeli provinces are located within the Sakarya Basin. The spatial information of the provinces within the borders of the basin is given in the table below.

Provinces	***Area of the Province (Ha)***	***Part of the Province in The Basin (Ha)***	***Ratio of the Part in The Basin to the Total Province Area (%)***	***Distribution of the Basin to the Provinces (%)***
Ankara	2.561.500	1.784.520	69,7%	28,2%
Eskişehir	1.373.843	1.373.843	100,0%	21,7%
Konya	4.082.400	814.102	19,9%	12,9%
Sakarya	450.472	450.472	100,0%	7,1%
Bolu	1.071.600	449.854	42,0%	7,1%
Kütahya	1.211.900	425.450	35,1%	6,7%
Bilecik	418.100	406.348	97,2%	6,4%
Afyonkarahisar	1.453.200	380.975	26,2%	6,0%
Bursa	1.108.700	188.216	17,0%	3,0%
Kocaeli	363.500	34.546	9,5%	0,5%

RIVER BASIN PROTECTION ACTION PLANS

Türkiye prepared River Basin Protection Action Plans (RBPAP) for all 25 river basins in order to reduce pollution and protect and improve basins by defining short, medium and long-term measures with participation of all stakeholders in 2013. Main aim for these plans were determination of the pressure and effects caused by the urban, industrial, agricultural, economic, ...etc. activities and the amount, characteristics and pollution status of the existing surface, underground and coastal waters in basins; having a detailed basin scale examination of the amount and potential use of the existing water resources and pollution sources/loads; preparation of water quality maps; determination of environmental infrastructure status.

Meanwhile, Basin Management Committees were also formed and the implementation of the measures determined by the RBPAPs began to be followed since 2013.



Short, medium and long term measures for The Doğu Akdeniz River Basin can be grouped as below: The implementation of the following actions is monitored within the scope of the Basin Protection Action Plan.

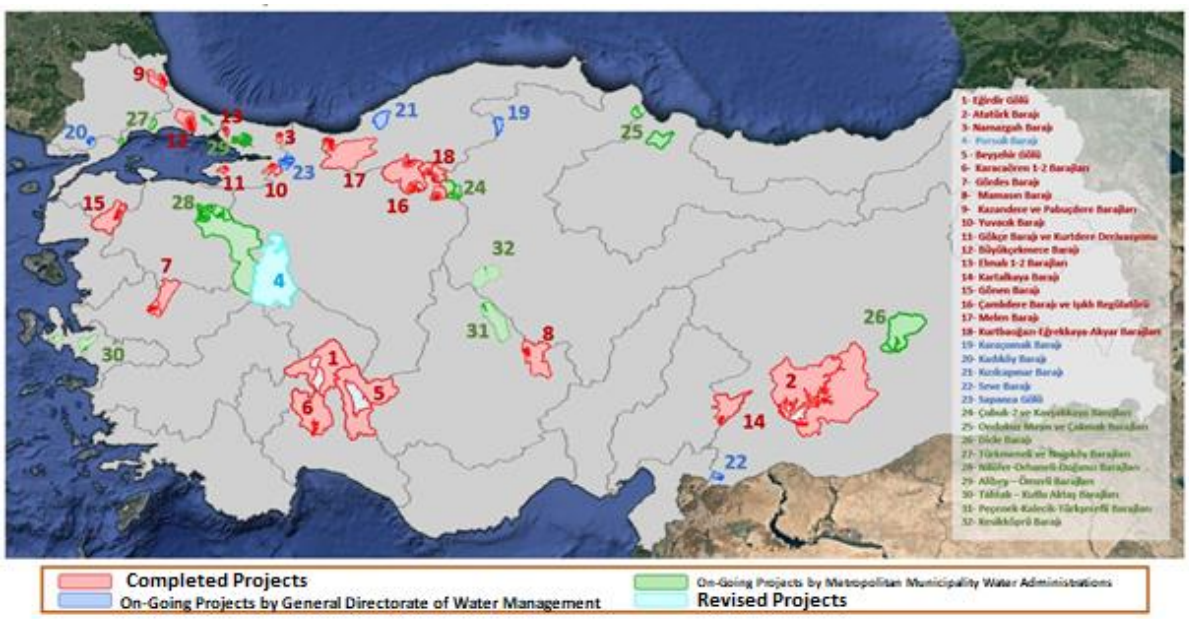
1. Urban Wastewater Management 2. Industrial Wastewater Management 3. Urban Waste Management 4. Non-Point Source Pollution Management 5. Forestation, Erosion and Sedimantation Control 6. Sewage Sludge Management 7. Conservation Studies for Drinking Water Basins 8. Flood Management	9. Drought Management 10. Monitoring, Inventory and Water Information System Studies 11. Water Investments 12. Water Re-use 13. Impacts of Climate Change on Water Resources 14. Sectoral Allocation Plans 15. Planning for Hotspots

DRINKING WATER PROTECTION PLANS

The purpose of drinking water protection plans is to determine basin-specific protection areas and principles based on scientific data to improve and sustainably manage the quality and quantity of drinking water sources.

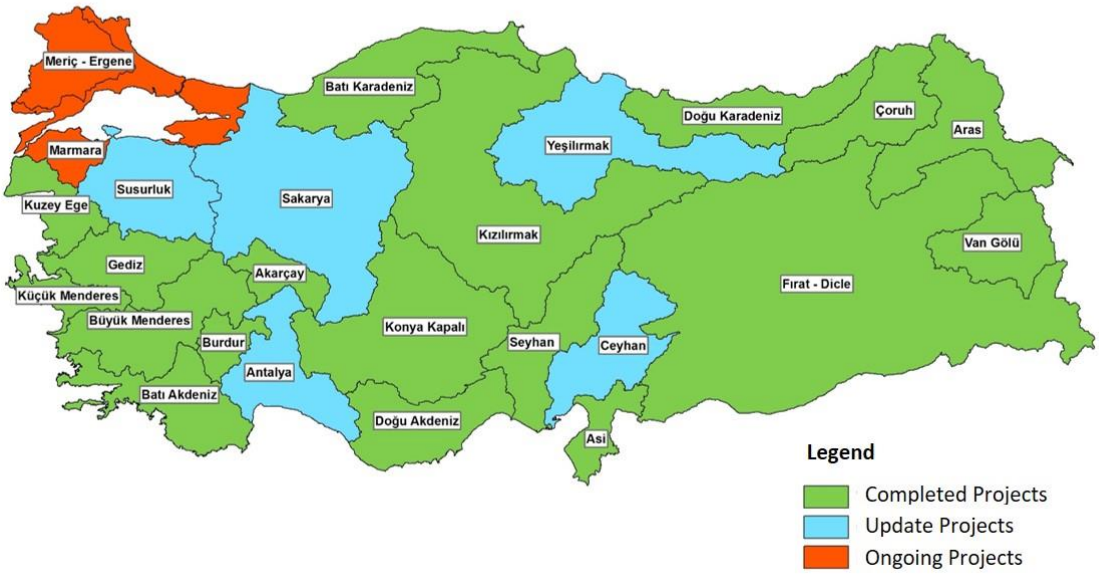
According to the Regulation on the Protection of Drinking-Water Basins:

- Protection plans for surface water sources that provide drinking water to metropolitan municipalities are prepared by the general directorates of water and sewage administrations of metropolitan municipalities in coordination with Ministry;
- Protection plans for surface water sources that provide drinking water to settlements outside of metropolitan municipalities are prepared by Ministry.



FLOOD MANAGEMENT PLAN

The Sakarya Basin Flood Management Plan (FMP) was completed in 2018. The work on updating the plan started in 2021 and will be completed in 2024.

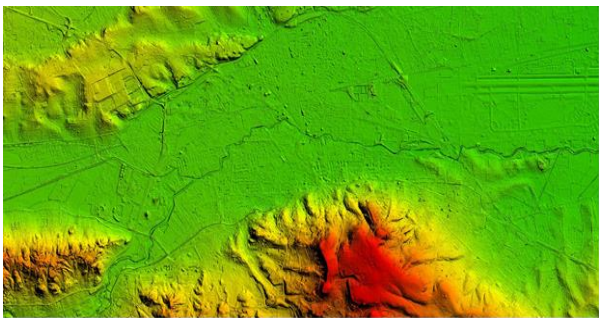


Flood Hazard and Flood Risk maps are generated within the scope of Sakarya River Basin Flood Management Plan. The necessary measures to be taken to prevent risks before, during, and after floods have been determined using these maps, as have the responsible institutions and the time of implementation of the measures.

To mitigate the effects of potential flood events in the Sakarya Basin, 104 measures have been identified under the following groups of mitigation measures within the scope of the Flood Management Plan.

- Stream-bed regulation
- Improvement of transition structures
- Cleaning of stream beds
- Improvement of walls
- Improvement of roads
- Flood protection wall
- Improvement of monitoring capacity
- Flood Storage and Offset Embankment
- Education/ Informing/ Raising Awareness
- Data-Information Collection/ Production

- Upper basin measures
- Flood forecasting and early warning system



Mitigation measures determined within the scope of the plan are still being tracked via the Flood and Drought Plans Tracking Web Application in 2019 and the National Water Information System (USBS) in 2020.

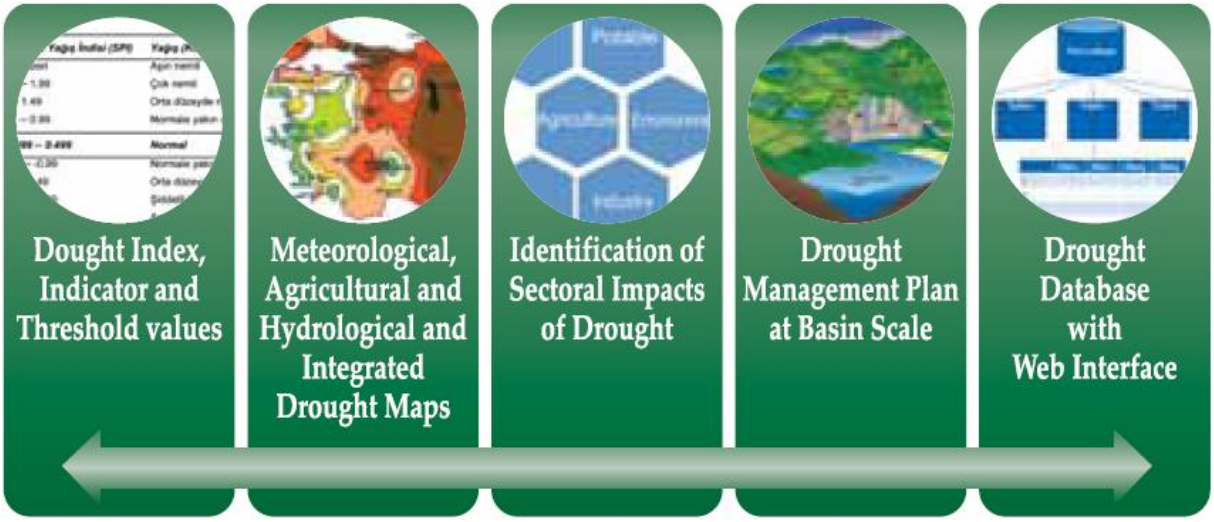
DROUGHT MANAGEMENT PLAN

Drought Management Plans (DMPs) are being prepared at the basin level for all of the water user sectors, including agriculture, in order to minimize the negative effects of possible drought risks and be prepared for drought. The aim of DMPs is to mitigate and prevent the negative impacts of possible droughts by determining the measures to be taken during water scarcity and the measures to be taken before, during, and after the drought periods in order to solve the drought problem as quickly as possible. Drought analyses, climatic and hydrological studies, sectoral vulnerability analyses, and drought maps are used to plan and direct studies such as recovery and intervention.

Havzası Kuraklık Yönetim Planı Hazırlanması çalışmalarına 2021 yılında başlanmış olup 2023 yılında tamamlanması planlanmaktadır.

Sakarya Basin DMP is started at 2021 and expected to complete by 2023.

Studies During the Preparation of Drought Management Plans:

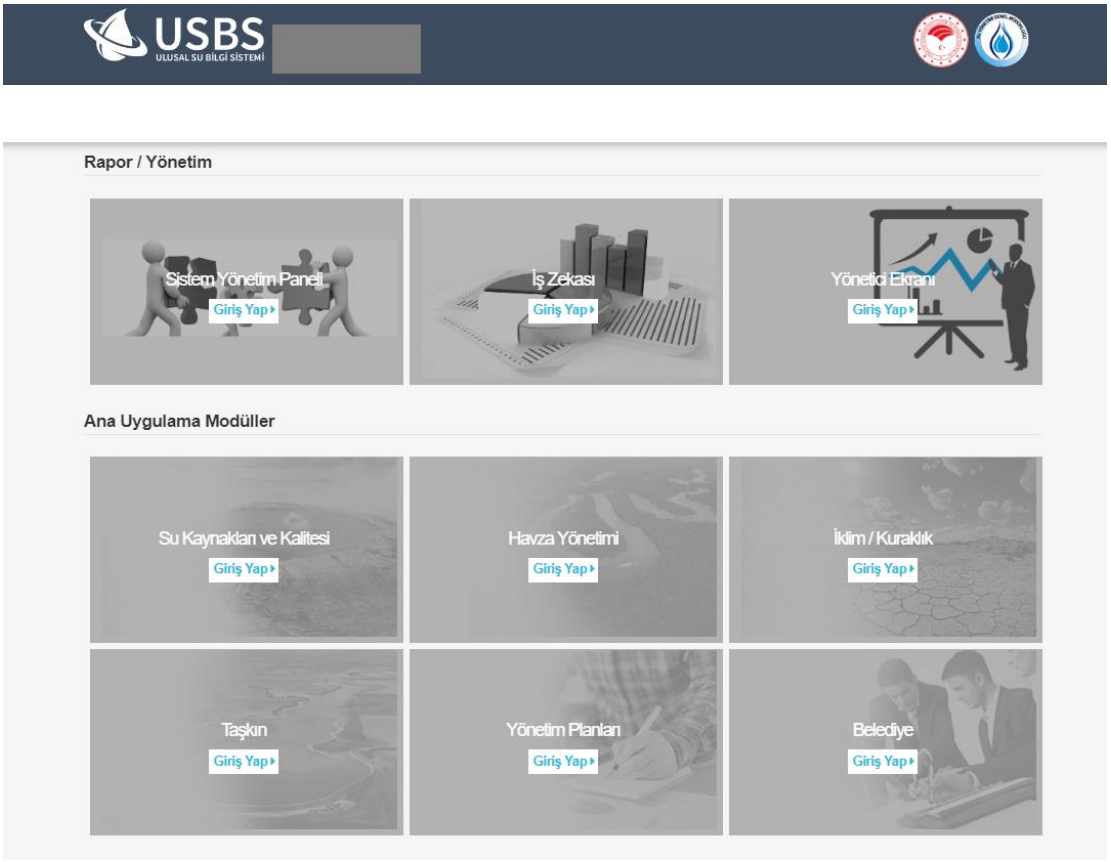


In order to minimize the negative effects of possible future droughts on the basins, the measures that will ensure the transition of the basin from drought crisis management to risk management, from the modernization of irrigation systems to the treatment and use of wastewater, will be determined in detail in the Drought Management Plans.

MONITORING, INVENTORY and WATER INFORMATION SYSTEM

Actions that are taken about water quality and quantity as follows:

- To acquire the data that has been produced for various purposes by different organizations,
- To enhance the quality of data,
- To prevent the repetitive production of data,
- To enhance the accessibility of data,
- To determine and complete the missing/incomplete data,
- To set and apply a watershed-scale and sustainable monitoring system.



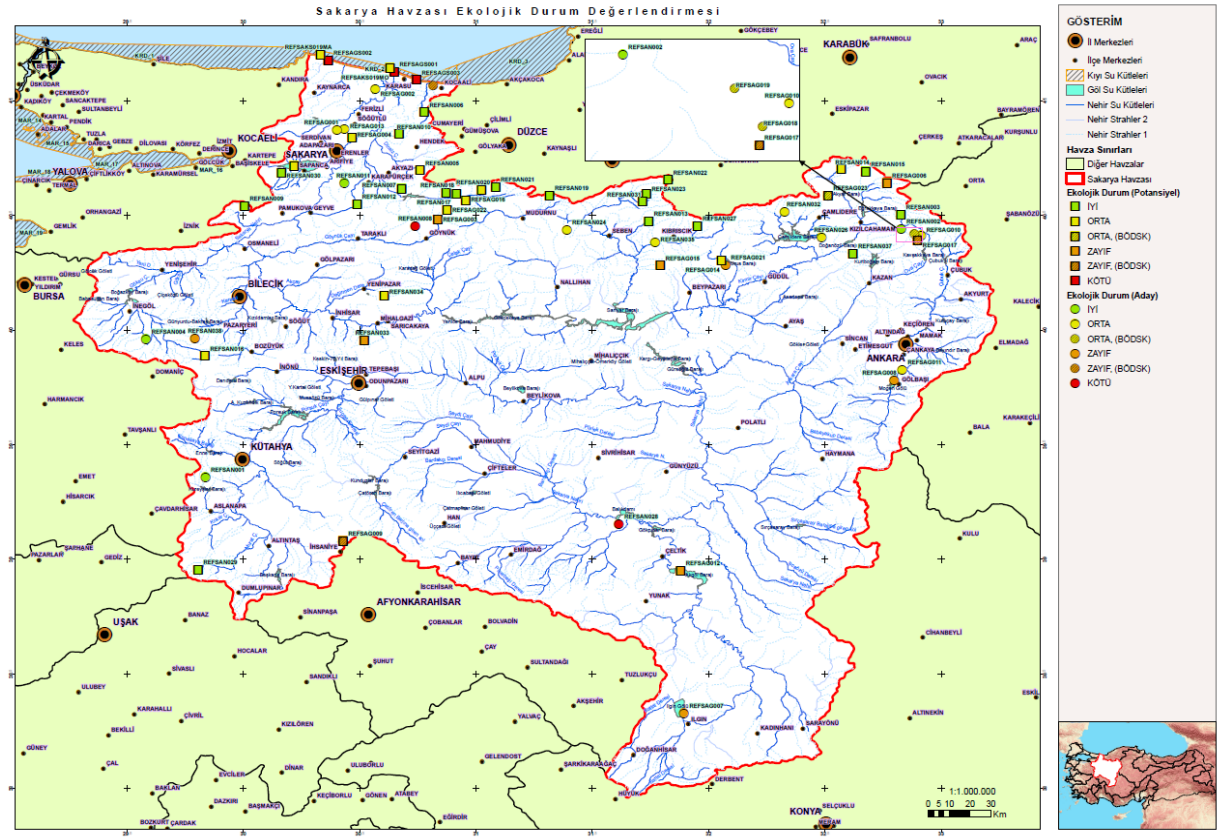
Graphical User Interface of National Water Information System (TRNWIS)

For the purpose of ecological-based assessment of water quality; biological, physicochemical, and hydromorphological monitoring studies were conducted in 25 basins across the country as part of the Project for the Establishment of a Reference Monitoring Network in Türkiye to identify natural and/or near-natural reference (unpolluted) sites that were not or minimally impacted by anthropogenic activities, and pristine water sources were identified.

Within the scope of the study, monitoring studies were carried out in a total of 64 locations in the Sakarya River Basin, including 36 rivers, 23 lakes (17 natural, 6 heavily modified), 3 transitional waters, and 2 coastal waters, and 52 reference (unpolluted) water sources were identified. In addition, the ecological status of the monitored water bodies in the Sakarya River Basin was determined as a result of the monitoring activities.

In the scope of monitoring activities, the smallest possible taxonomic level of all biological quality elements was identified and in this context 36 fish, 283 phytobenthos, 511 phytoplankton, 452 macroinvertebrate, 41 macroalgae/angiosperm and 97 macrophyte species were identified in the Sakarya River Basin.

Additionally, for each biological quality element, the Reference Monitoring Network and Reference Monitoring Programs have been established, which include the monitoring stations determined in the reference sites, the parameters to be monitored at these stations, and the monitoring frequencies. In line with these monitoring programs, monitoring activities will be carried out regularly.



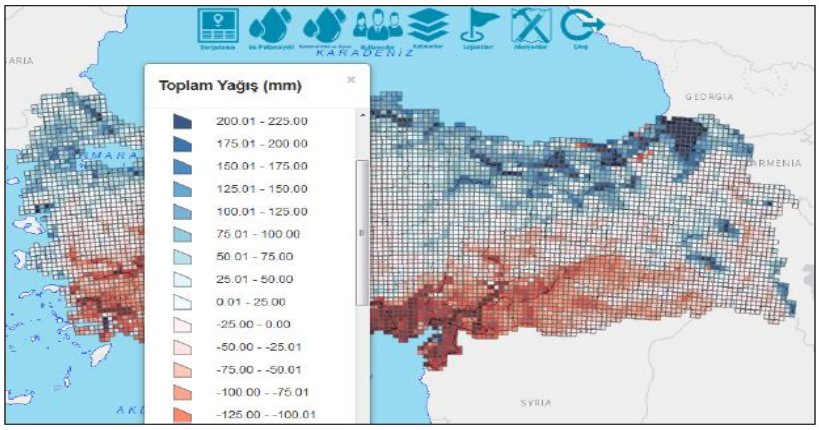
Ecological Status Assessment Results in the Sakarya River Basin

WATER REUSE

In the fight against possible water scarcity in our country in the future, it is necessary to develop practices related to the economical and planned use of existing water resources. One of these strategies, the option of reusing used water, is one of the most important methods of using water sparingly. With the recovery and use of used water, it is planned to reduce the need for existing water resources and to provide significant water savings. In the "Project for the Evaluation of Reuse Alternatives of Used Water", which was prepared specifically for 25 river basins in our country, both the reuse of wastewater treated in wastewater treatment plants and the water returned from agriculture were evaluated. With the evaluation, used water resources and reuse alternatives were determined. Used water resources was determined as waste water treated in wastewater treatment plants, drainage water returning from agriculture, cooling water and rain water.

IMPACTS OF CLIMATE CHANGE

The project on impacts of climate change on water resources was finalized in 2016.



According to the climate change projections made for 2015-2100 period:

It is expected that there will be a continuous increase in average temperatures. It is expected that the average temperature of the basin, which was **11,3ºC** according to 1971-2000 observations, will **increase** by **at least 1,7°C**, **maximum 4,9ºC** in 2071-2100 period. It is expected that temperature increases for this period will predominate in the **northeastern** and **southeastern** parts of the basin.

According to the observations of 1971-2000, the average annual precipitation amount of the reference period of the basin was determined to be **477,8 mm**. According to the results of the projection carried out, there is a **decrease tendency** in the total precipitation compared to the reference period (1971-2000), and it is predicted that the basin will receive **8% less** rainfall compared to the reference period in **2071-2100**. It is expected that rainfall decreases for this period will predominate in the **southwestern and northeastern** parts of the basin.

DSİ (Directorate General for State Hydraulic Works) data were used for hydrological model studies and the mean gross water potential of the basin for the reference period was determined to be **8.592 million ^{3}/year**. With the effect of climate change, it is predicted that in the period **2041-2070**, the gross water potential of the basin could **decrease by 75%**. However, in the same period, it is expected that the annual amount of water available will not meet the total water need, and the **water deficit** will be around **1.175 million m^3/year** level.

As a result of the hydrogeological studies carried out, the hydrogeological reserve of groundwater of the basin was determined to be **377 km^3**. The technically and economically usable amount of this reserve, the possible reserve is calculated to be **200 km^3**. It is estimated that at the end of the century under the effects of the climate change, the hydrogeological reserve of the basin will decrease by **5%** and possible reserve by **10%**.