

Strategic Steps to Adapt to Climate Change in Seyhan River Basin



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Abbreviations

DEMP	Prime Ministry Disaster and Emergency Management Presidency (<i>AFAD</i>)
GDA	General Directorate of Aforestation (<i>AGM</i>)
GDEM	General Directorate of Environmental Management
GDF	General Directorate of Forestry (<i>OGM</i>)
EIA	Environmental Impact Assessment
IPCC	Intergovernmental Panel on Climate Change
LA	Local Authorities
MARA	Ministry of Agriculture and Rural Affairs
MDG-F	Millennium Development Goals Achievement Fund
MEU	Ministry of Environment and Urbanization
MFAL	Ministry of Food Agriculture and Livestock
MFWW	Ministry of Forestry and Water Works
MoEF	Ministry of Environment and Forestry
MoNE	Ministry of National Education
NGO	Non-Governmental Organizations
SEPA	Special Environmental Protection Agency
SHW	General Directorate for State Hydraulic Works (<i>DSİ</i>)
SMS	General Directorate of Meteorology (<i>DMI</i>)
TAKEP	Agricultural Drought Action Plan
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Frame Convention on Climate Change

Adaptation to the Impacts of Climate Change in Turkey and River Basin Scale

Turkey, a part of Mediterranean Europe's south zone, is amongst the high sensitivity regions of climate change according to the predictions obtained during the scientific studies conducted within the scope of United Nations Framework Convention on Climate Change (UNFCCC). "In Turkey's First National Communication to UNFCCC"¹, rising summer temperatures, decrease in the amount of winter precipitation of western cities, loss of surface water, more frequent droughts, land degradation, coastal erosion and floods were reported as the impacts of current climate change. This situation created a negative impact especially on water availability for food production and rural development. It is predicted that these impacts will gradually become more severe.²

In the Detailed Stocktaking Report of First National Communication; increasing drought risk, reduced amount of water per person, flood and inundation risks induced by heavy precipitation, desertification, degradation in various ecosystems and loss of biodiversity have been stated among the impacts and vulnerability Turkey is facing.³ In the same report, it has been stated that Turkey is in need of a detailed and national vulnerability analysis which deals with the impacts of climate change (Hydroelectricity production capacity, increased need for energy, necessary investments for water supply and storage, tourism and forests, etc.)

Various studies which have been conducted so far to be able to eliminate these deficiencies show that water resources and agriculture sector are two areas which will be affected by the climate change most. In fact, policies and legal, organizational and financial needs concerning adaptation to the impacts of climate change have been recently started to be discussed. When current policies and practices concerning climate change are assessed, it is seen that adaptation activities are still on "soft adaptation" phase⁴. Lack of awareness and financial capacity has been observed on regional / basin level where these policies will be implemented.

¹ January 2007.

² For example, it is predicted that 50 % of surface waters of Gediz and Büyük Menderes Basins will disappear until the end of this century and that there will be dramatic water shortage in agricultural, domestic and industrial water use.

³ December 2009.

⁴ "Soft" adaptation: "Soft" adaptation precautions focus on building knowledge and capacity, policy and strategy determination and organizational regulations (soft adaptation).

"Hard" adaptation: "Hard" adaptation precautions focus on utilization of specific technologies and precautions including capital assets as seawalls and reinforced buildings (hard adaptation).



Nonetheless, when the fact that climate change will have different impacts on different regions is taken into consideration, it is known that neither policies nor scientific studies are adequate in Turkey's scale. The basic need in climate change adaptation is to identify vulnerabilities at the local level and this also reveals the importance of scientific approaches in climate change. For this, local level strategies and policies of Turkey concerning climate future should be "basin" and "sub-basin" based.⁵

Among prerequisites for basin based adaptation to the impacts of climate change, basin modeling (temperature changes in winter, winter precipitation, increase in temperature etc.), conducting climate projections, development and integration of data information systems, development of ecosystem monitoring systems and development of human resources in the academy, research institutions and in public sector can be listed. Besides, for economic sectors dependent on climate (agriculture, energy, water, tourism, fishery), a regional level focus is of need. Therefore, to what extent people's livelihoods are affected by climate will be demonstrated.

It is clearly stated in all scientific reports that the most important impact of climate change will be concerning water cycle. In Turkey, situated in a semi-arid geography, this situation necessitates efficient use of water, development of river and creeks for the ecosystem, sustainability and safety of flow of river and creeks and efficient management of water potential. The fact that river flows are the leading processes to be affected by the changes in precipitation and temperature the most show that climate change will cause significant changes in the water potentials of water basins.

This situation points out to a number of needs such as examining the vulnerability of water resources systems to climate change so as to ensure agricultural safety in water basins and reviewing the adaptability of strategic products in water basins to climate change⁶. Besides, it is also known that changes in water potential will create significant problems regarding sustainability of the supply of dam storages for drinking water, irrigation water and water for energy purposes. In this respect, it is of great importance to plan economical and social benefits obtained from water resources in basins and sectoral needs with an integrated point of view by taking the impacts of climate change into account and to increase in line with climate change.

⁵ For example, studies conducted in the Seyhan River Basin show that the vulnerability in Seyhan River Basin is different on some areas; hence more importance should be attached to these regions.

⁶ For example, wheat has been a very strategic product in Seyhan River Basin for many years and in current circumstances, it is produced widely on watery and dry conditions.

Today, the implementations conducted for management of water resources in 25 river basins show that new projections which take the impacts of climate change on water resources into account are needed for healthy identification of the water potential in basins and determination of sectoral water needs in the future.

Within this frame, traditional policies regarding water resources management are being reassessed; potentials and planning of surface and ground water resources in basins and in sub-basins, reservoir operation policies, irrigation water need, amounts of water storage, water transfer applications between basins⁷, precipitation-flow relations, flood risk planning are reviewed by taking climate risks into account. It is also on the agenda to review with this respect.

When national policies concerning adaptation to the impacts of climate change on basin scale are examined; it is seen in SHW's Strategy Plan (2010 – 2014) that; *“One of the main objectives is to determine and implement sustainable water management policies in river basins in an attempt to develop underground and ground water resources and ensure the multipurpose utilization of them”*. In these implementations which aim at maintaining and improving the water quality and water amount in basins, adaptation to climate change is also taken into account and the following activities are conducted in 25 basins:

- To carry out studies in pilot basin scale by determining the impacts of climate change on the quality and amount of climate change and develop implantation suggestions, and
- Developing adaptation policies and implementation suggestions in accordance with possible climate change scenarios.

Since water cycle has vector characteristic for almost all sectors dependant on climate; agricultural sector which has the largest water need in Turkey is one of the key sectors in climate change adaptation. Although Turkey has a limited water budget, it aims to increase its agricultural water use from 29.6 million m³ to 72 billion m³ in other words, to increase it 143% until 2030. This increase should be carefully assessed in a proper way for regions all over the country and especially for Seyhan River Basin where the agriculture sector is predominant by taking the impacts of climate change into account.

The agricultural drought dimension in water basins stemming from climate change in Turkey has prior importance⁸. Reduction in agricultural production because of agricultural drought, in the future due to the population growth increasing demand for food will be more significant hence combating against agricultural drought will have prominent importance. Protection of land resources, sustaining ecological balance, development of plants resistant to drought and minimizing hydrological drought⁹ for adaptation to the impacts of climate change will enable to reduce the negative social and economic impacts of drought. This situation is important to meet the increased food demand in future. Strategies and policies concerning agricultural drought in Turkey have been implemented since 2008 and the impacts of climate change are taken into consideration in this frame.

In the “Turkey Strategy for Combating Agricultural Drought and Action Plan” carried out by Ministry of Food, Agriculture and Livestock; a number of goals and actions are determined in an attempt to prevent the pressure of climate change impacts on water resources in Turkey. These precautions should also be taken into account in the activities conducted to fight against drought on province scale¹⁰.

⁷ For example, SHW has planning studies concerning elimination of water deficiencies in Develi Valley and Sultansazlığı by transferring water from Seyhan River Basin and Zamanti River Basin to Develi River Basin.

⁸ Agricultural Drought: It can be defined as the absence of sufficient amount of water in soil so as to meet the needs of plants.

⁹ Hydrological drought: This type of drought occurs when natural waters' level such as underground waters, lakes and reservoirs go below the statistical average. These circumstances can occur even on average precipitation conditions if the water consumption rises of reservoirs reduces.

¹⁰ In order to combat against drought, “Provincial Drought Action Plan” has been prepared in every province by taking each province's own dynamics and special circumstances into consideration. Besides, “Provincial Agricultural Drought Crises Centers” have been founded in cities.

Table 1: Integrated management of water resources in water basins to adapt to climate change (TAKEP)

SCOPE: Integrated management of water resources in water basins to adapt to climate change				
OBJECTIVE	Planning of works aiming to develop water resources on basin base with an integrated approach and with a flexible way so as to meet the needs of changing consumption demands.			
ACTIONS	Starting and end dates	Outputs and Success Indicators	Responsible/Coordinator Organization¹¹	Related Organizations¹²
Action 1: Preparation of Integrated River Basin Management Plans in line with ecosystem services and impacts of climate change	2012-2020	Adaptation to climate in water resources management	MoEF, SHW	MARA, LA, GDF, SHW, GDEM
Action 2: Taking the impacts of climate change in the current and planned "Action Plans for Basin Protection" and "Maps of Protection Areas" and conducting necessary revision.	2012-2020	More efficiently protected basin	MoEF	SEPA
Action 3: Acceleration to erosion and sedimentation control projects in all basins starting with dam and puddle basins	2012-2020	Increasing efficient water storage facilities	SHW	GDA, Metropolitan Municipalities, GDF
Action 4: Prevention of illegal use of underground waters in basins and raising awareness on this issue	2012-sürekli	Awareness raising activities, protection of water resources	SHW	MARA, MoNE, LA, NGOs

When considered from the point of public institutionalism, it has always been the responsibility and duty of General Directorate of State Hydraulic Works to carry out such services as infrastructure, dams, hydroelectric centrals, irrigation, supplying of drinking, potable and industry water and integrated management of water resources on basin basis.¹³

In the public administration system in Turkey renewed as of 2011; Apart from SHW, General Directorate of Forestry (GDF), affiliated to the Ministry of Forestry and Water Works and some other main service units of this Ministry has been assigned important duties and responsibilities concerning water quality and water amount management.

GDF has the following duties concerning development of soil and basin;

- To obtain quality and maximum amount of water in water basins, to prevent erosion, to control floods, avalanche and inundation, to carry out necessary actions and works or have them done foreseen in the main integrated basin development/reclamation plan in cooperation with related units in order to maintain the soil, water and plant balance;
- To implement integrated basin development/reclamation projects, to monitor and assess the investments stated in the plan, report the relevant information of project to the relevant units and have them done when necessary.¹⁴

Almost all of the duties of "General Directorate of Water Management", one of the service units of Ministry of Forestry and Water Works are directly related to water resources management in basins. These duties are stated below:¹⁵

¹¹ Organization shown on the table belongs to public administration structure applied before June 2011.

¹² Organization shown on the table belongs to public administration structure applied before June 2011.

¹³ Founded in 1954, General Directorate of State Hydraulic Works has been working under Ministry of Forestry and Water Works since July 2011 by "Decree Law on the Organization and Duties of Ministry of Forestry and Water Works" (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and numbered 27984).

¹⁴ Decree Law on the Organization and Duties of Ministry of Forestry and Water Works" (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and numbered 27984, Article 30).

¹⁵ Decree Law on the Organization and Duties of Ministry of Forestry and Water Works" (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and numbered 27984, Article 9).

- To determine policies concerning protection, improvement and utilization of water resources
- To ensure the coordination of water management on national and international level
- To prepare river basin management plans on basin scale in an attempt to protect and improve the ecological and chemical quality of aquatic environment by taking protection-utilization balance of water resource including coastal waters¹⁶ into consideration, to have them prepared, to conduct legislation studies on integrated river basin management
- To determine precautions regarding prevention of contamination on river basin with the coordination of related organizations and institutions, to assess and to update these precautions and to monitor the implementations
- To determine the objectives, the principles and the standards of receiving environment concerning protection of quality and amount of surface and underground waters in coordination with the related organizations and institutions
- To determine strategies and policies concerning floods, to prepare related legislation and flood management plan
- To carry out necessary coordination concerning water resources allocation on sectoral basis in line with river basin management plans
- To pursue processes arising from international conventions and other legislations concerning protection and management of water resources, to carry out duties regarding transboundary waters and bordering waters with the coordination of related organizations
- To develop a national water information system with a data base

“General Directorate for Combating Against Desertification and Erosion”, one of the service units of Ministry of Forestry and Water Works, has responsibilities for developing plans for water basins on national and international level and for determining policies and strategies.¹⁷

Besides, one of the main duties of Ministry of Environment and Urbanization¹⁸, established on July 2011 is stated as follows; *“To determine principles and policies for protection and improvement of environment and for prevention of environmental pollution, to develop standards and scales, to prepare programmes; to organize and develop trainings, researches, projects, basin protection plans and contamination maps, to determine and to monitor application principles for these and to carry out all the related tasks and duties concerning climate change”*. This Ministry is the principal responsible organization in combating against climate change.¹⁹

General Directorate of Spatial Planning, General Directorate of Environmental Management, General Directorate of Environmental Impact Assessment, Authorization and Inspection, main service units of Ministry of Environment and Urbanization, have managerial and physical planning duties concerning water management on local and regional level and basin scale.

General Directorate of Environmental Management of Ministry of Environment and Urbanization has the following duties regarding protection of water resources; *“To protect underground and ground waters, seas and land, to determine objectives, principles and contaminants with a view to prevent or eliminate pollution, to determine method and principles regarding removal and control of pollution, to carry out emergency response plans and to have them executed”*.²⁰

General Directorate of Environmental Impact Assessment, Authorization and Inspection of Ministry of Environment and Urbanization has the following duties regarding protection of water resources; *“To protect underground and surface waters, seas and land, to determine objectives, principles and contaminants with a view to prevent or eliminate pollution, to be prepared against contamination of underground and surface waters, seas and land, to take necessary precautions with a view to raise the intervention and combat capacity and have them taken;*

¹⁶ As one of the provisions of EU Water Frame Directive, Turkey shall prepare a river basin management plan.

¹⁷ Decree Law on the Organization and Duties of Ministry of Forestry and Water Works” (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and No. 27984, Article 7).

¹⁸ Decree Law on the Organization and Duties of Ministry of Forestry and Water Works” (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and No. 27984).

¹⁹ Decree Law on the Organization and Duties of Ministry of Forestry and Water Works” (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and No. 27984, Article 2 / b)

²⁰ Decree Law on the Organization and Duties of Ministry of Forestry and Water Works” (Decree Law No: KHK/645, Official Journal dated 4 July 2011 and No. 27984, Article 8)

*to determine appropriate technologies for the protection of environment and to determine the qualification of facilities to be founded for this purpose and to take necessary precautions in this frame and to have them taken”.*²¹

The Ministry of Environment and Urbanization, the General Directorate of Spatial Planning is entrusted with the duties *“to determine the procedures and guidelines related to preparation of all kinds of physical spatial development plans and environmental management plans in all scales, including environmental management plans at regional and basin levels; and to prepare environmental management plans at regional or basin level; and to have them prepared; and to approve them and, to ensure that those plans are applied and monitored”.*²²

With “the Waste Water Treatment Action Plan (2008-2012)” which has been prepared in country-wide basis by the Ministry of Environment and Urbanization; also the infrastructure conditions, which exist in the provinces where 25 basins and sub-basins are located, have been evaluated; and thus, the action plans, which are related to waste water treatment, have been prepared. In those planning; it has been aimed that the ratio of the population (to whom services are rendered by waste water treatment plants) to the total municipal population reaches 73% in the year 2010 and reaches 80% in the year 2012 throughout Turkey.

In order to achieve those targets; activities have been started in order to plan waste water treatment plants according to water basins; and, within this framework, “Basin Conservation Action Plans”, which are based on waste water treatment targets, have been started to be prepared in 25 hydrological basins²³. In those plans; water potentials and water pollution situations of the basins are analyzed as agricultural, domestic (household) and industry originated pollutants; and the pressures on existing protected areas have been determined; and investment and renewal needs (for the future) for the waste water treatment plants located in the basins are determined.

Basin Conservation Action Plans include short, medium and long term actions for each basins related to environmental information systems and agricultural pollution management, forestation, erosion, pasture improvement works, rural, urban and industrial waste waster infrastructure management and management of water resources (potential inventory, river reclamation, flow and water quality monitoring, structuring in management - such as establishment of Basin Water Agency - etc.). In addition, the mentioned “Water Protection Action Plans” are considered as a significant starting point for “the River Basin Management Plans”, which are required to be prepared within the scope of the EU Water Framework Directive.

As the responsibilities in the field of water management have been allocated to many Ministries and to their subdivisions within the context of adaptation to climate change; the need for coordination among those institutions has significantly become a part of the current issue. In legal grounds, the fact that the Ministry of Forestry and Water Works is authorized for integrated management of water resources and for the issues relevant to climate change and water resources which directly interact with each other; and that the Ministry of Environment and Urbanization is authorized for the adaptation to the impacts of climate change, confirm the mentioned complicated structure. When the authority of the other public institutions relevant to the climate change (the Prime Ministry Disaster and Emergency Management Presidency, the Ministry of Food, Agriculture and Livestock, etc.) are also taken into consideration as well as those of the mentioned two Ministries, it is inevitable that this circumstance will cause complexity in both determination of central policies and in local/regional implementations.

In summary; the needs, which come to the forefront in terms of taking the impacts of the climate change in Turkey into consideration in water basins level, become prominent particularly in terms of finding a solution for the institutional complexity. Determination of the water potentials and consumptions in all the basins throughout Turkey, modeling the impacts of the climate change on the water resources; and determination of adaptation needs and costs under various scenarios and thus, reflection of water resources planning to a long term are equally important.

²¹ The Decree Law on the Organization and Duties of the Ministry of Environment and Urbanization (Decree No: KHK/644, the Official Gazette No bis 27984 and dated July 4th, 2011, the Article 9)

²² The Decree Law on the Organization and Duties of the Ministry of Environment and Urbanization (Decree No: KHK/644, the Official Gazette No bis 27984 and dated July 4th, 2011, the Article 7).

²³ In the first stage; 25 hydrological basins in the geography of Turkey have been scored by taking into consideration of drinking water resources, conserved areas, pollutant resources and water quality in the basins. In line with this prioritization, it has been decided that conservation action plans are prepared for the first 11 basins, among which also the Seyhan River Basin is contained. Preparation of those plans has been undertaken by the TUBITAK Marmara Research Center, the Environmental Institute.

2

The Need for a Climate Change Adaptation Strategy in the Seyhan River Basin

The Seyhan River Basin²⁴, which is the second largest basin after the Nile in the East Mediterranean, is located in the Mediterranean Basin, which is regarded by the Intergovernmental Panel on Climate Change (IPCC) as one of the regions that will be affected in the highest level by the climate change throughout the world. The basin hosts the most fertile and productive agricultural lands of Turkey and of Europe. In terms of geographical structure, the Seyhan River Basin consists of high steppes, mountainous areas, transition zones, low planes and the Cukurova Delta. The basin, which is one of the richest regions in the world also in terms of biodiversity, offers the people in the region various agricultural possibilities as dry farming, irrigated farming and livestock.

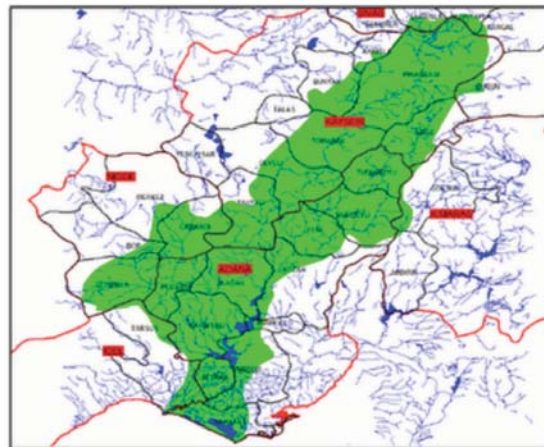


Figure 1: The Map of the Seyhan River Basin

The catchment area of the Seyhan River Basin is approximately 20,731 km²; and the part, which is up to the Seyhan Dam, is defined as Upper Seyhan. The part, which is defined as the Lower Seyhan River Basin and remains at the river mouth of the dam, consists of the Tarsus and Yuregir plains.

²⁴ The basin covers: Adana, Kayseri, Nigde, Sivas, Icel and Kahramanmaraş.

Intensive agricultural activities are carried out in the Lower Seyhan River Basin, as it is located in Cukurova where the most fertile and productive lands of Turkey are located. In addition to the agricultural pollution; domestic and industrial waste waters are discharged to both the Seyhan River and to the drainage canals from many points in the Adana Province and around thereof, which are located right at the river mouth of the Seyhan Dam.

2.1 Climate Change in the Seyhan River Basin

Due to the altitude variations; various climates are dominant in the Seyhan River Basin. While winters are warm and rainy and summers are arid and hot in the lower parts of the basin, which are nearest to the sea; the climate changes with the altitude in the upper parts of the basin and, continental climate is observed in those parts.

The basin, which reaches the Central Anatolia from the coast, covers three different regions in terms of climate. The summers are hot and arid and the winters are warm and rainy in the coastal regions consisting of Cukurova and the (mountain) foots nearby. The region, which reaches Pinarbasi from Ulukisla and to the more northern parts, reflects the characteristics of the Central Anatolia. The summers are hot and arid and the winters are cold and rainy. However, continental climate is dominant in Kayseri.

According to the preparatory works carried out by the IPCC; the Mediterranean Region, in which also the Seyhan River is located, has been determined as the most sensitive and the most indefensible region to global warming.

In the Figure 2; the 30-year average winter P-E (precipitation- evaporation) changes in the Seyhan River Basin and around thereof are shown in accordance with the A2 simulation of the two global climate models (ECHAM5 and CCSM).²⁵

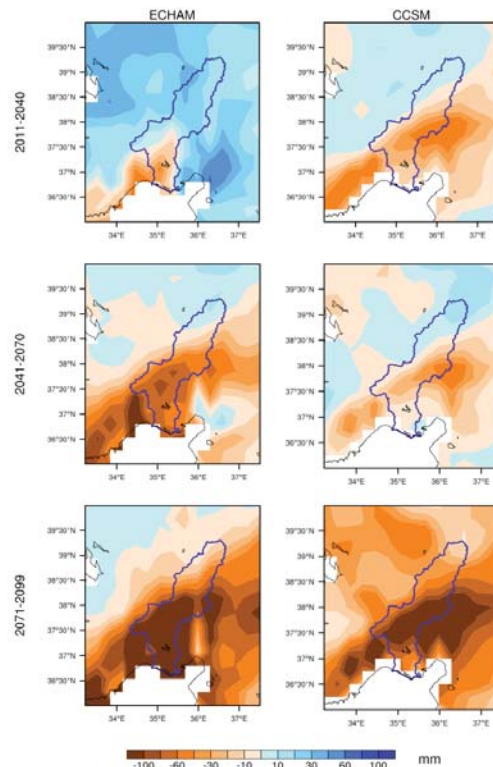


Figure 2: The 30-year average winter precipitation- evaporation changes in the Seyhan River Basin and around thereof in accordance with the A2 simulation of the two global climate models (ECHAM5 and CCSM)

²⁵ The changes indicate the differences from the reference period (1961-1990) (<http://agora.itu.edu.tr/>).

In order to analyze the relationship between the climate and the agricultural systems in Turkey; a research project, “Impact of Climate Changes on Agricultural Production System in Arid Areas” (“ICCAP”)²⁶, has been carried out with the cooperation of the Research Institute for Humanities and Nature (RIHN, Japan), the Scientific and Technological Research Council of Turkey (TUBITAK) and the Cukurova University, and this study has been concluded in March 2007. In this project, the arid and semi-arid areas in the southern coast of the Mediterranean in Turkey, including the Seyhan River Basin, have been selected as the case study areas. The other scientific grounds of choosing the Seyhan River Basin in the project are listed below:

- Due to Atlantic anomalies, Hadley circulations and west winds; it is under the impact of streams and, the Mediterranean Region is a sensitive area in terms of global warming;
- The basin is a significant food production area for Turkey and for the Europe and, livestock and meadow-pasture activities are performed in a widespread manner in the upper parts of the basin;
- A very strategic product, wheat, has a very long history in the basin and; wheat is produced in wet and dry conditions in a widespread manner;
- The Seyhan River has national characteristics and, the entire basin is located within the national boundaries.

The project has been realized by the research teams that have worked on the topics such as Hydrology and Water Resources, Irrigation-Drainage, Vegetative Productivity, Vegetation and Agricultural Economics. The topics such as climatology, meteorology, surface and underground waters hydrology, irrigation engineering, agronomy, product physiology, agrology, forestry, livestock and anthropology were contained in the studies that have been dealt with within the scope of the project.²⁷

The study entitled “For the Agricultural Safety in the Seyhan River Basin, A Research on the Sensitivity of Water Resources Systems Against Climate Changes”, has been conducted within the scope of the Hydrology and Water Resources Group and has been carried out for prediction of the impacts of the climate change, that will occur resulting from the global warming, on the water resources in Turkey. Within this scope; the parameters, which control reactions of the water resources systems against such changes, have been defined; and thus, it has been ensured that their sensitiveness are put forth exclusively for the Seyhan River Basin. For this purpose, with dispersed parameter deterministic hydrological models, which apply in the scale of the basin, have been used. The assumptions, on which the model relies, should be interpreted as projections for the future.



²⁶ The ICCAP cooperation consisted of approximately forty researchers, including the graduate students (in the Japanese team) from fifteen universities and research institutes in Japan and, of the researchers (approximately in the same number) in the Turkish team from five universities, and of Israeli researchers and of the public bodies within the framework of the contact point duties in Turkey, in particular, the Adana Cukurova University.

²⁷ The Republic of Turkey, Climate Change First National Communication, January 2007 (Within the scope of the United Nations Framework Convention on Climate Change)



Within the scope of this project; a modeling study, in which the General Circulation Model (GCMs) and the Basin hydrological model outputs have been reduced to the Basin scale, has been conducted. In this study; the SRES (the Special Report on Emission Scenarios), A2 scenario has been selected, and thus, calculations have been made under two methods named as MRI and CCSR; and it is predicted that the temperature will increase as $+2^{\circ}\text{C}$ and the precipitation will decrease as -159 mm^{28} according to the MRI, and that the temperature will increase as $+2.7^{\circ}\text{C}$ and the precipitation will decrease as -161 mm according to the CCSR.

It has been stated that the decrease in the precipitations in January, April, October, November and December will be more than those in the other months; and that, for the flow observation station no 1818, the monthly average flows will decrease remarkably, compared to the current situation, and that the decrease in April, May and June will be more than those in the other months; and that the monthly peak flow will be observed prior to the present one.

Also a study, which covers the topics such as the flow rate, the water drawn (that has occurred), water supply and water demand in rivers and is related to their impacts on the water resources system, has been conducted. In this study, assessments have been carried out by generating scenarios according to the conditions where the investments are less, compared to the land and water uses (the Scenario 1) and according to the conditions where the investments are dense (the Scenario 2). The ratio between the water drawn (that has occurred in rivers) and the current flow indicates the water stress.

It is expressed that, in a region where this ratio exceeds 0.4, there is a high water stress, in other words, that there is an excessive demand for water. It has been predicted that this value, which is less than 0.4, will be between 0.6-0.8 in the future period according to the Scenario 1 and will be between 0.6-1.2 according to the Scenario 2. Based on the amount of water in the dam, it is stated that the future reservoir volume of the Seyhan Dam will be less than the present one and will be empty in some circumstances according to the Scenario 1 and that it will frequently be empty according to the Scenario 2. When the reliability coefficient, which is an

²⁸ A large part of the basin is located in the Mediterranean belt where the average precipitation is 700 mm in winters. Spring and winter precipitations are caught in large intake structures and they are used for irrigation and energy generation.

indicator of the ratio of the water supply to the water demand, is reviewed; it is stated that this is generally 1 and it is stated that it shows that dam's water supply meets the demand and that, in the future, according to the Scenario 1, the reliability changes from 1 towards 0.9 in MRI and from 1 towards 0.8 in CCSR and that, according to the Scenario 2, the reliability changes from 1 towards 0.7 in MRI and from 1 towards 0.5 in CCSR.

Based on those results, it is predicted that, in the basin, and with the impact of the global warming on the decrease in the flows, the water drawing ratio will increase in accordance with the flow, and that, in the future, according to the Scenario 1, in the water resources system, it will be possible for the water supply to meet the demand, and that, however, according to the Scenario 2, the increase in the global warming and in the water demands in the upper basin will cause water shortage.

According to the results of the modeling study that has been conducted; it has been determined that significant decreases will occur also in the underground water potential in the Seyhan River Basin. In the Adana Plain, the underground water resources are affected significantly by the climate changes. The decrease, which will occur in feeding the underground water in the Upper Seyhan River Basin, has also direct impact on the underground water flow that occurs in the north, in the Adana Plain. Similarly, a decrease is observed also in terms of the feeding arising from the precipitation that falls on the plain.

On the other hand; as more waters will be drawn in order to meet the need for irrigation, significant decreases occur in the underground water level. It is understood from the changes in the underground water budget components calculated by the model that the Adana Plain aquifers and underground water resources are highly sensitive to the climate changes. The sensitivity of the system substantially arises from the decrease that occurs in feeding (with inflows) to the Adana Plain aquifers.

The decrease, which occurs in the underground water level, causes the fact that inflow of salt water moves forward gradually to the plain aquifers in the plain. The system's underground water model puts forth that the length of the salt water inflow is sensitive to the decrease in the underground water level. The projections show that, in the future, an increase, which will occur in the ratio of 50% in drawing underground water by means of wells, will cause the fact that the salt water wedge will move forward up to 10 km inwards the land at the end of the year 2080. A decrease in storage will naturally cause degradation also in the underground water quality. In the coastal parts of the Adana Plain; the salinity of the underground water may reach 25% of the sea salinity.

In summary, according to the results of all those scientific studies²⁹; it is predicted that, in the Seyhan River Basin, in the year 2070, the air temperature will increase as 2-3.5°C and the precipitations will decrease as 25-35%, and the snows on the mountains will melt earlier and the irrigation water will become less and the agricultural product pattern in the basin has to change and the dry and irrigated farming areas will be affected and the pressure on use of the underground waters will increase and a pollution risk will occur; and that, in the coastal regions, salty sea water will flow into underground waters up to 10 km inwards.

2.2 Seyhan Basin Conservation Action Plan

The Seyhan Basin Conservation Action Plan has been prepared by TUBITAK-MAM Environmental Institute, and it covers the period of 2011-2040 as short, medium and long terms. In direct relation to the adaptation to the climate change; in the Seyhan Basin Action Plan, it has, in short term (2010-2015), been aimed *“to conserve and improve the surface water resources; to increase the dam reservoir capacities in order to enhance the resistance of the settlements in the basin to the impacts of climate change and drought and, to develop alternative solutions that include also production of freshwater from brackish and salt waters (sea water) and water transfers between basins”*.

²⁹ The studies of the Cukurova University, TUBITAK, RIHN-Japan and SHW (the General Directorate of State Hydraulic Works)

In the Plan; the fundamental topics to be dealt with have been determined as waste water management, solid and hazardous waste management, diffuse source pollution management and control (agricultural pollution management, management of the pollution arising from livestock activities), forestation, erosion control and pasture improvement works, water resources management, the solutions to be found for hot spots (the Catalan Dam Basin, the Dipsiz Lagoon; Hydroelectric Power Plants in the basin, which are in construction and planning phase; the Lower Seyhan River Basin and others) and establishment of the basin environmental information system. Many activities, planned within the scope of those fields, indirectly support the adaptation to the impacts of the climate change.

In addition, Environmental Management Plan³⁰ studies are carried out in both the provinces located in the basin and in the regional scale, as physical planning activities in the Seyhan Basin. The Environmental Management Plans, the main purposes of which are,

- to determine policies and strategies for establishment of the protection-utilization balance,
 - to prevent non-planned urbanization and industrialization and thus, to direct urban and rural developments properly,
 - to prevent use of agricultural lands out of purpose,
 - to conserve sensitive areas (coasts, forests, drinking and utility water basins, and natural, cultural and historical values, etc.) and,
 - to generate policies, strategies and land use decisions to be taken as basis for subscale plans,
- have been prepared/are prepared in the basin; in Adana³¹ and Kayseri³² in “provincial” level; in Nigde³³ and in Kayseri³⁴ in “regional” level.

2.3 Community-Based Adaptation to Climate Change in the Seyhan River Basin Grants Programme (United Nations Joint Programme)

One of the most significant components of the “United Nations Joint Programme on Enhancing the Capacity of Turkey to Adapt to Climate Change”, which has been implemented between the years 2008 and 2011 in the coordination of the Ministry of Environment and Urbanization, is to develop sample applications regarding adaptation to climate change in the Seyhan River Basin. The vulnerability studies on the climate changes have been conducted for the region within the scope of the Joint Programme and have been dealt with in basin scale in a participatory process; and probable measures have been determined with respect to the adaptation to climate change. Those measures, which are in conformity with the conditions in the region, have constituted the primary topics of the grants programme.

A system approach for adaptation to climate change has been applied in the Seyhan River Basin by coupling various expertise from various institutions together; and, within the framework of this approach, the topics, which can be financed within the scope of the Community-Based Adaptation to Climate Change in the Seyhan River Basin Grants Programme have been presented. The topics has been identified as agricultural and food security, water resources and quality, public health, disaster risk management, management of basins and coastal areas, management of natural resources and infrastructure. Within this scope; 18 projects³⁵ in various themes such as water and natural resource management, enhancement of the agricultural productivity, food

³⁰ Environmental Management Plan (EP): is an upper scale plan, which constitutes a whole with the plan provisions and with the explanatory report on the plan and is prepared in the scale of 1/50.000 or 1/100.000 in basin basis and determines the general land use decisions, policies and strategies on the issues such as agriculture, tourism, housing, industry, transportation...etc and is prepared by taking development plans and regional plans (if any) as basis in order to ensure rational use of natural resources and enables consideration of financial decisions and ecological decisions together with each other in conformity with the balance growth and continuous development purposes.

³¹ The Adana Province Environmental Plan in the scale of 1/100.000 (2009)

³² The Kayseri Environmental Plan in the scale of 1/50.000 (it has been prepared by the Kayseri Metropolitan Municipality, 2005).

³³ The Kirsehir, Nevsehir, Nigde, Aksaray Planning Region Environmental Plan in the scale of 1/100.000 (2008)

³⁴ The Yozgat-Sivas-Kayseri Planning Region Environmental Plan in the scale of 1/100.000 (it is prepared by the Governorate of Kayseri, 2011).

³⁵ 12 of those 18 projects have been implemented in Adana, 4 of those 18 projects have been implemented in Kayseri, and 2 of those 18 projects have been implemented in Nigde.

security, determination of disaster risks, forestry, use of alternative irrigation techniques, conservation of ecosystem services, fishery, livestock; rise in the sea level, public health and creation of awareness, each of which aims to contribute to achievement of the Millennium Development Goals threatened by the changing climate conditions, have been supported.

With the mentioned projects in which researches have been conducted relevant to the impacts of the community-based adaptation approach and the climate change in the basin on the environmental and socio-economic systems; it has been aimed to build capacity and create awareness with respect to adaptation to climate change in the long term.

The piloting activities have been conducted for decreasing the vulnerability to climate change and of the removal of the incomplete issues with respect to the fundamental topics such as agriculture, water management, food security, risk management for disasters such as forest fires, floods, and drought caused by climate change, management of coastal regions, management of natural resources and ecosystem services, risks relevant to infectious diseases, climate risks in terms of gender, the impacts of climate change on livelihoods, and management of the information and data on the impacts of climate change.³⁶

In the Table 2; the projects, which are supported within the scope of the Grants Programme, and the institutions, which carry out those projects, are shown:

³⁶ <http://www.iklim.mdgf-tr.org>

Table 2: The projects that are supported within the scope of the Community-Based Adaptation to Climate Change in the Seyhan River Basin Grants Programme

	Topic of the Project	Project Owner/Province
1	Adaptation of the Animal Production and Environmental Activities to Global Warming in Seyhan River Basin	Cukurova University, Faculty of Agriculture, the Department of Animal Science (Adana)
2	Developing Farmers' Capacity to Adapt to Irrigation and Energy Restriction	Union of Village Services of Sarız District Governorate (Kayseri)
3	Identification of Surface Water Resources Potential and Flood Risks Within the Perspective of Developing Water Resources Management Policies in Seyhan River Basin Within the Framework of Adaptation to Climate Change	VI. Regional Directorate of State Hydraulic Works (Adana)
4	Good Agriculture, Healthy Society	Adana Commodity Exchange (Adana)
5	Establishing, Supporting and Developing the Adaptation Capacity of the People of Yuregir Against Climate Change	Yuregir Municipality (Adana)
6	The Development of Good Agricultural Techniques for Sustainability of the Natural Resources in Catalan Potable Water Basin	Adana Provincial Directorate of Agriculture (Adana)
7	Climate Scouts	The Adana Branch of the Ecological Agriculture Organization Association (Adana)
8	Raising the Awareness of Farmers for Risks Encountered in Agricultural Production Relevant to Climate Change in Kayseri Province	Kayseri Provincial Directorate of Agriculture (Kayseri)
9	Observing the Changes of Reproductive Seasons of Fishes Depending on the Climate Change and Modifying of Fisheries Management	Cukurova University, Faculty of Fisheries (Adana)
10	Designing and Establishing a Local Global Climate Change Monitoring and Prediction Social Collaboration Network and an Internet Based Global Climate Change Geographical Monitoring and Prediction Decision Support System in Adana and Niğde Provinces	Adana Provincial Directorate of Environment and Forestry (Adana)
11	Screening and Saving of Local Vegetables for their Resistance to Drought and Salinity	Cukurova University, Faculty of Agriculture, the Department of Horticulture (Adana)
12	Project for Poor Farmers and Women Living in Seyhan River Basin to Breed Saanen Dairy Goats	Central Anatolia, Fighting Drought and Ecological Life Association
13	Transmitted Diseases Observation and Control System	Cukurova University, Tropical Diseases Research and Application Center (Adana)
14	Adaptation of Forest Ecosystems and Forestry to Climate Change in Seyhan Basin: Ecosystem Services (Social), Biodiversity (Environmental) and Forest Products (Economic)	Adana Regional Directorate of Forestry (Adana)
15	Adaptation and Mitigation of the Effects of Sea Level Rise Related to Global Climate Change in Seyhan Delta	Bird Researc Society Adana Branch (Adana)
16	Raising Awareness Level of Rural People in the Subject of Possible Effects of Climate Change in Kayseri Province	Kayseri and Villages Training and Solidarity Association (Kayseri)
17	Savings By Using New Technologies in Irrigation in Pınarbaşı Province	Karabogaz, Kilicmehmet, Buyukpotuklu Irrigation Union (Kayseri)
18	Come on Girls! Let's Take Pictures!	Genc Doga Association (Nigde)

Furthermore; within the scope of the “United Nations Joint Programme on Enhancing the Capacity of Turkey to Adapt to Climate Change”; studies on clean production and eco-efficiency in industry have been continued in the provinces located in the Seyhan Basin; and, within this framework, pilot implementations on increasing water efficiency have been carried out in three different industrial sectors. Those implementations, which aim at adaptation to the impacts of the climate change by reducing consumption of water used as a raw material by the industry or by achieving savings in energy and in chemicals and by reducing the CO₂ emissions, have been realized in the food and beverages sector in Adana and Kayseri and in the metal processing and machinery sector in Nigde and in the chemistry sector in Adana. Improvements have occurred in the production process and in the product quality, the process times have shortened in the industries, savings have been achieved in the labor force, maintenance-repair costs have reduced and waste water treatment costs have reduced, as the auxiliary gains of those piloting.





Towards a Climate Change Adaptation Strategy in the Seyhan River Basin

All the studies, which have been conducted in order to adapt to the climate change in the Seyhan River Basin, basically aim at enhancement of the management capacity of the climate change risks in the basin. The need for development of a local climate change adaptation strategy in the Seyhan River Basin ensures that the adaptation to climate change approach is included into the planning activities in the basin in the manner that the local/regional institutions and all other relevant stakeholders increase their capacities in line with the experiences that have been gained in the past. Those strategies are relevant to the sectors and vulnerability areas determined in the basin.

The outputs of the “community-based” projects³⁷, which have been realized for adaptation to the impacts of climate change in the Seyhan River Basin, are the first and constitute a model in Turkey in terms of determining the impacts and priorities of the climate change in local level. All those studies, which have been conducted for adaptation to climate change in the Seyhan River Basin, are remarkable as a model in terms of both reflecting the needs in local level to “the National Climate Change Adaptation Strategy and Action Plan” and providing guidance to other basins.

Furthermore, those activities in the basin become important; as new legal and institutional needs have become a part of the current issue (because of those activities) in the light of the international commitments (UN, EU and others) of Turkey relevant to combating the climate change. In addition, significant steps have been taken with respect to raising awareness of the people of the region in terms of combating climate change and with respect to collection of local information.

The activities, which have been conducted in the basin for adaptation to climate change, have sometimes pointed at urgent or new opportunities where threats and opportunities intersect with each other and, have sometimes shown that there may be more economical applications and that it will be beneficial to scale-up in the project activities, and that it can be implemented by improvements and, that the projects can be implemented even in the same type.

³⁷ The projects, which are supported within the framework of the “The United Nations Community-Based Adaptation to Climate Change in the Seyhan River Basin Programme”



In order to determine properly the sectors and areas affected by climate change in the basin; the basic need was to become aware of and to measure the impacts. At this point, *the combined impacts* between/among the sectors depending on climate are of importance. However, the combined impacts of the climate change are not taken into consideration adequately due to the insufficiency of the policies and applications in Turkey.

For example; the change in the land use relevant to food productions, which arises from land degradation and from the changes in the erosion patterns in the basin, are not contained in the food security policies. Moreover, currently, there is no viewpoint that continuously monitors and reviews the impact of the rise in the waters and seas on fish stocks and on migration of the fish. In addition, studies such as “*measure impact*” of the soil loss (arising from climate change) on tourism sector are not performed, and those impacts are not measured.

When Seyhan River Basin is compared to the other basins in Turkey, there is still no comprehensive model existing which is run by using various scenarios on basin level despite current and ongoing researches on more advanced levels. Lack of data collection networks and meteorological stations³⁸ hinders establishing a concrete connection with the outputs of the models, thus a large number of comprehensive models are needed. There is still a crucial need for such models, scientific works enriched with these models and projections (need for drought projection index, for example). In order to meet these needs, it is required to generate meaningful statistics and information in basin scale with appropriate criterion.

Within the scope of vulnerability analysis performed in Seyhan River Basin, it was confirmed that water problems related to climate changes and the effects of these problems on the basin are the primary issues.³⁹ Vulnerability areas and general needs identified in the basin are as following:

³⁸ There is a need for meteorological stations nationwide and in basins, in rural areas and in areas where ecosystem services are extensive in order to identify the effects of the climate properly.

³⁹ United Nations Joint Programme on Enhancing the Capacity of Turkey to Adapt to Climate Change, Community-Based Adaptation to Climate Change in the Seyhan River Basin Grants Programme, “Synthesis Report on System Approach Working Group Meeting”, February 2009 (Generated by Dr. Deniz Koca).

Water Resources: To develop strategies for adaptation and sustainable water management (surface and ground water), to ensure real balance of supply and demand by identifying the needs in different sectors (drinking, industrial and irrigation water), to ensure the efficient use of water resources and minimizing the pressure that sudden changes in basin scale (drought and flood) create on water quality, to improve dams (drinking water/ industrial water supply, irrigation, hydroelectric energy, flood control dams), to establish irrigation and drainage systems, to develop water supply and water treatment plants;

To include analyses to be performed for water resource management in basin scale and current and planned administration policies into the national and regional policies in climate change adaptation process and to support decision-making mechanisms in this manner;

Agriculture and Food Security: To assess the water provided for agricultural irrigation in basin scale (water-saving in agriculture sector), to identify water resources foreseen to be provided for agricultural purposes in the context of climate change and to deal with agriculture and food security in this framework;

Natural Disaster Risk Management: Uncertainties arising from climate change trigger disasters that are about to happen suddenly (particularly drought in basins). In this respect, to finalize and prepare the distribution of authority and work among institutions in a manner of ensuring the balance of water management and administration policies and planning, risks arising out of disasters (flood control and prediction for the future) with an optimal system/mechanisms⁴⁰;

Natural Resources Management: To determine and to plan water resources that feed wetlands, to ensure the management and sustainability of ecosystem services in the basin through taking measures (reservoir structures, etc.) within the scope of water supply that wetland may need, to control erosion and sedimentation in all basins, particularly basins of dams and ponds;

Public Health: To research the effects of excessive weather events in Seyhan River Basin on human health, to strengthen the institutional infrastructure in order to avoid virus, bacteria, etc. that will increase with the pollution of city water because of drought;

With the purpose of materializing vulnerability analyses more that are carried out with a general approach, it is required to identify and to measure these effects and to perform projections by building comprehensive models in the basin in other climate dependent sectors, particularly water resources and agriculture sectors. This means more data, more information and more scientific research.

In the current situation, there is need for joint and complementary solutions for the future in order to adapt to the climate change in Seyhan River Basin, in the vulnerability areas of the basin. As a result of the lessons learned and experiences obtained in this process, it was considered as useful to ground the framework of a regional strategy for adaptation to the climate change in Seyhan River Basin on three main points. They are as following:

1. Policy: It is required to develop new strategies and policies about planning and implementing national policies (agriculture, rural development, regional development, health, tourism, etc.) efficiently for adaptation to climate change in basin level, and therefore to strengthen governance, coordination, monitoring and assessing capacities

⁴⁰ "Adana Province Global Warming Strategy Report" was prepared as an activity of "Impact of Climate Changes on Agricultural Production System in Arid Areas in Seyhan River Basin (ICCAP)" and this Report was shared by General Directorate of State Hydraulic Works (SHW) with Adana "Local Wetland Committee".

2. Science and Technology: It is needed to benefit from comprehensive scientific studies, R&D activities, trustworthy data and the best technologies as supportive tools for adaptation efforts in order to adapt to the effects of climate change in Seyhan River Basin, to transmit information to each part of the community and to increase R&D capacity in this area.

3. Implementations and Investments: It is needed to strengthen rural infrastructure (as institutional, human resources and financial) and to raise awareness in order to adapt to the climate change in the basin. It is required to monitor implementations for adaptation economically, socially and environmentally in different scales and levels changing from local to center in the basin, in this respect to improve the infrastructure, to identify new infrastructure needs (agricultural irrigation, etc.), to determine new research and data systems, to actualize investments such as alternative technologic investments and early warning systems by prioritizing⁴¹ with the support of financial policies and financial mechanisms/tools (insurance planning, etc.)

⁴¹ Within the scope of activities for management the risks of natural disaster in Seyhan River Basin and with the support of “United Nations Joint Programme on Enhancing the Capacity of Turkey to Adapt to Climate Change, “Pilot Survey for Inundation Early Warning System” in Aşkarpbeyli province of Iskenderun with the cooperation of Regional Directorate of Meteorology of Adana in 2011”

4

Strategic Steps in Climate Change Adaptation in the Seyhan River Basin

Strategic steps and priorities specified to adapt to the climate change in vulnerable areas in Seyhan River Basin are given below in detail.

4.1 Water Resources Management

Change in the water cycle will cause significant changes in the quality and supply of water resources and will affect a number of sectors dependent on climate starting with food production where water has crucial importance.

Impacts such as rise in summer temperatures, reduction in winter precipitation (especially in western cities), loss of surface water, more frequent drought, land degradation, coastal erosion and inundation directly threat water resources.

STRATEGIC STEP 1: To structure climate change effects management mechanism that will support inter-organizational cooperation for Seyhan River Basin with the current organizations and with organizations that will be established

PRIORITIES

1. To enable the qualitative and quantitative management of water resources to be directed and coordinated by General Directorate of State Hydraulic Works, the only general directorate having effective and significant experience in the field and conducting the prediction and monitoring of climate change and improving of infrastructure by this organization
2. To overcome the problems among organizations arising from conflict of authorities concerning the allocation and planning of water resources in basin scale
3. To assess the functions of “General Directorate of Water Resources”, one of the main units of Ministry of Forestry and Water Works, within the body of General Directorate of State Hydraulic Works (SHW) in order to prevent the conflict of authority

4. To restructure SHW which is responsible for water management and which has management experience in the field, to develop its capacity for adaptation to climate change within the frame of inventory, survey, planning, project, construction and administration, to eliminate its technical staff and equipment deficiency
5. To determine a coordinator Regional Directorate amongst Regional Directorates of SHW in the basin will be responsible for conducting activities of water quality, water management, administration works, etc. on basin scale
6. To leave the activation of controlling of water allocation to a functioning unit in Seyhan River Basin (the importance of appropriate allocation inventory should be taken into consideration in water management on basin scale)

STRATEGIC STEP 2: To determine the current and potential effects of climate change on water cycle in Seyhan River Basin and to develop and apply necessary instruments for adaption on the basis of science

PRIORITIES

1. To develop a digital data base on basin and sub-basin scale in accordance with the current scientific and technological level, updating this data base systematically, ensuring its continuation
2. To prepare climate change scenarios of Seyhan River Basin making use of these data
3. To develop and update a basin scaled atmospheric modeling system peculiar to Seyhan River Basin
4. To empower inter-organizational cooperation in obtaining data physical and chemical data of rivers and in data sharing⁴²
5. To prepare administration scenarios based on adaptation to climate change on basin scale
6. To revise Integrated Management Plan of Seyhan River Basin by taking climate change modeling and scenarios into account
7. To integrate all plans regarding management of water resources (development, management and with physical characteristics) by taking climate change modeling and scenarios into consideration
8. To conduct Environmental Impact Analysis (EIA) in the basin by taking “climate effect analysis” into account and monitoring current investments of EIAs within this frame

STRATEGIC STEP 3: To realize the Integrated Basin Management Principles of Seyhan River Basin in a way to direct climate change adaptation strategies

PRIORITIES

1. To conduct soil improvement and water resources management works by updating land data in Seyhan River Basin
2. To plan and manage hydraulic energy resources in accordance with scenarios based on climate change
3. To predict and monitor the effect of climate change on coasts, constructing the infrastructure in the organizational structure, developing infrastructure of legislation on this issue
4. To render agricultural irrigation efficient by taking the effects of climate change into consideration⁴³
5. To plan investments of Hydroelectric Power Plants in vulnerable regions of the basin by taking the risks of climate change into consideration

⁴² Strengthening the cooperation between SHW and EIE (General Directorate of Electrical Power Resources Survey and Development Administration)

⁴³ Sample activity: Scaling of functioning SHW projects, planning, implementation and financing of classic irrigation projects in relation to climate adaptation.



6. To discharge waste water treatment facilities to the most appropriate receiving environment amongst alternatives so as to protect underground and ground waters
7. To construct water storage facilities in the basin
8. To measure surface flows periodically
9. To ensure wise use and management of water resources in the basin through eco-efficiency works in agricultural industry

STRATEGIC STEPS 4: To develop capacity of government agencies and all other stakeholder in Seyhan River Basin in order to ensure efficient implementation of adaptation decisions on water management and to ensure public participation

PRIORITIES

1. To develop technical knowledge, equipment and practice capacity to implement adaptation strategies within the scope of current duties and responsibilities of staff working in public institutions in the basin
2. To train and inform general public on utilization of drinking water and agricultural and industrial water and on efficient use of water
3. To train and inform relevant stakeholders on efficient use of water for urban, agricultural and industrial purposes
4. To conduct capacity building, education and awareness raising activities on utilization and conservation of underground water reserves and ensuring their quality

STRATEGIC STEP 5: To build new and flexible financial resource mechanisms which will realize water management adaptation strategies on basin scale and to support with the help of national and international financial mechanisms

PRIORITIES

1. To increase the number of self-financing implementations for the adaptation of to climate change of water resources in the basin
2. To search international resources
3. To prioritize irrigation investment since at least 74% of water resources are used for irrigation, to eliminate the related problems in this field, to direct financial resources and investments

STRATEGIC STEP 6: To deal with water management in cities situated on Seyhan River Basin towards adaptation to the effects of climate change

PRIORITIES

1. To ensure demand-supply balance within the scope of climate change scenarios of water management in cities situated on the basin
2. To conduct activities which pay attention to the sustainable use of natural resources, conservation of ecological balance, prevention of pollution, performing implementations on water and energy efficiency
3. To find out illegal use of water for increasing water efficiency in cities and taking measures against reducing illegal use rate
4. To increase the number of sewerage and rainwater collecting systems for integrated water management and planning in settlements, reutilization of collected and purified water⁴⁴

⁴⁴ Such as the objective stated in the “National Climate Change Strategy” in effect which aims effective utilization of waste waters in urban green fields.

4.2 Agricultural Production and Food Security

Changes in water cycle, temperature and possible seasonal transitions due to climate change will inevitably affect agricultural sector and hence Seyhan River Basin which is directly controlled by these systems. There will be increases in types and expansion areas of agricultural pests due to the changes in temperature and precipitation. Climate changes foreseen in the basin will affect agricultural production, production lands and livestock, increase in the severity and frequency of extreme weather conditions will increase the risk of decline in crop production. This situation is directly related to food security. The impact of climate change on agricultural sector is fundamental in terms of food security. Because, agriculture is the most privileged sector in the basin in socio-economic perspective and basically responds to the food needs of the population.

STRATEGIC STEP 1: To take measures against drought in agriculture in an attempt to decrease the effects of climate change on agriculture and food security in Seyhan River Basin

PRIORITIES

1. To update Provincial Drought Action Plan in cities situated on the basin
2. To expand metrological monitoring stations and early warning systems in the basin
3. To protect seeds resistant to drought in the basin
4. To protect the plants resistant to drought and salinity
5. To establish a “Drought Research Center” for Seyhan River Basin

STRATEGIC STEP 2: To develop and search scientific data which will demonstrate the potential effects of climate change on agricultural production and food security and which will provide a basis for solution alternatives.

PRIORITIES

1. To make comprehensive assessment of agricultural biodiversity in the basin and animal and plant genotypes resistant to climate change⁴⁵
2. To research production methods which support adaptation to climate change in agricultural production ⁴⁶
3. To update the current agricultural data bases in accordance with the studies on climate change, enabling them to have positional and temporal resolution⁴⁷
4. To share the outputs of activities and results of scientific studies with the related stakeholders⁴⁸
5. To support scientific studies and researches towards adaptation to the effects of climate change in water and land management fields in universities and research centers/research institutions⁴⁹ in Seyhan River Basin
6. To increase the number of laboratories of research institutions conducting studies on current agricultural sector in the basin and have them equipped with necessary instruments
7. To conduct a preliminary research to establish regional agriculture-food techno parks for the cities situated on the basin
8. To determine products which can adapt to the climate change

⁴⁵ Sample action: 1. Extraction of agricultural biodiversity inventories in the basin; 2.Resarch studies on determination of plants resistant to arid and salty fields.

⁴⁶ Sample Action: 1.Research and demonstration studies on direct planting implementations which protects soil water content; 2. Research and demonstration studies on crop rotation systems to be implemented on arid fields.

⁴⁷ Sample Action: Rendering Seyhan River Basin Land Maps in line with scientific and technological level which is in compliance with numerical and international standards.

⁴⁸ Sample Action: 1.Determination of an institution which will coordinate scientific studies on adaptation in the basin, 2. Creating a network among researched working on the basin.

⁴⁹ Research institutions of public organizations and other.

STRATEGIC STEP 3: To ensure efficiency in agricultural water utilization on Seyhan River Basin

PRIORITIES

1. To update irrigation project's planning activities within the scope of Upper Seyhan River Basin Master Plan⁵⁰
2. To update Seyhan River Flood Control, Prediction and Early Warning Feasibility Survey⁵¹
3. Updating Kayseri Develi 2nd Phase Irrigation Planning Revision and Project Construction Work⁵²
4. To update the support of financial sector for drip irrigation and facility of payment practices⁵³
5. To prioritize the planning, implementation and financing services of effective agricultural irrigation projects of SHW by taking problems concerning classic irrigation into account
6. To grant resource support to Special Provincial Administration by SHW for efficient irrigation investments

STRATEGIC STEP 4: To evaluate the existing legislation and plans aimed at diminishing the impacts of the climate change in the Seyhan River Basin on agricultural production and food security and eliminate the deficiencies regarding implementation

PRIORITIES

1. To eliminate the deficiencies in the legislation on the protection and improvement of forest and pasture areas
2. To revise land inheritance law and introduction of land consolidation
3. To resolve the lack of legislation in terms of implementation of Good Agriculture Practices and Food Waste Management
4. To enforce the Law on Soil Protection and Land Use more effectively.
5. To resolve the lack of legislation governing the duties and responsibilities of local governments and public institutions regarding adaptation to climate change and to add adaptation targets to the strategic plans of the institutions
6. To establish agricultural laboratories on the basis of districts and support the commodity exchanges and NGO's in this respect
7. To prepare Environmental Management Plans on the basis of basins and soil maps
8. To prepare the "Seyhan River Basin Land Use and Capability Map" with a scale of 1/5000; and to harmonize the "Seyhan River Basin Land Use Plan" based on this map with the scientific and technological level which is in conformity with numerical and international standards

⁵⁰ Kayseri (1981-1984).

⁵¹ Seyhan (1993-1994).

⁵² Kayseri (2006-2009).

⁵³ For instance, Ziraat Bank (Agricultural Bank) grants 50% for drip irrigation and offers facilities in payment.

STRATEGIC STEP 5: To specify the impacts of the climate change in the Seyhan River Basin on agricultural production and food security, and to ensure coordination among relevant institutions for adaptation to climate change

PRIORITIES

1. To establish a unit that will ensure coordination among various institutions and organizations in the field of climate change in the basin regarding the sustainability of agricultural production and the provision of food security
2. To ensure coordination among Universities, Research Institutes, Provincial Directorates of Food, Agriculture and Livestock, and farmers
3. To increase the number of joint activities between agricultural industrialists and producers on adaptation to climate change

STRATEGIC STEP 6: To expand sustainable agriculture applications across the Seyhan River Basin in consideration of the impacts of climate change (good agriculture, organic, nature-friendly practices)

PRIORITIES

1. To spread the incentives on Good Agriculture Practices, and diversify the sources of income against the impacts of climate change
2. To ensure international validity of Good Agricultural Practice certification.
3. To promote research and development studies on the species and diversity of vegetables
4. To promote organic agriculture throughout the basin⁵⁴
5. To increase the number of integrated facilities for the safety of humans, food and environment and to develop an audit mechanism.

STRATEGIC STEP 7. To increase the awareness, training and capacity on adaptation to climate change in agricultural activities in the Seyhan River Basin.

PRIORITIES

1. To train agricultural producers and industrialists on the priorities, alternatives, and applications on agricultural adaptation and to increase consciousness
2. To regularize the capacity building activities targeting the technical staff in the relevant public institutions
3. To raise awareness and develop capacity (by means of technology and funding support) of agricultural SME's in the Seyhan River Basin, especially in Lower Seyhan, to refrain from traditional agriculture methods and use climate-sensitive, innovative methods
4. To offer more information to farmers through the Provincial and especially District Directorates on Food, Agriculture and Livestock on issues such as agricultural subsidies, grants, agricultural applications etc.
5. To increasingly continue the dialogue and flow of information among farmers-universities-agricultural institutions
6. To inform the members of the "Provincial Board on Soil Protection" in the basin on adaptation to the impacts of climate change.

⁵⁴ Using no nitrate in organic agriculture applications is a major prevention of the pollution of drinking water sources.

STRATEGIC STEP 8. To create sources of funding from the related public institutions, private sector, national and international sources for the studies on adaptation to the climate change in the agricultural sector in the Seyhan River Basin

PRIORITIES

1. To subsidize especially the projects conducted on the adaptation to climate change in order to create alternative sources of income for farmers, to develop the incentive mechanism
2. To support the marketing capacity of agricultural production practices which take into account adaptation to climate change
3. To provide financial support to the basin by means of project cooperation activities in international organizations
4. To support especially the studies regarding the impacts of climate change on livestock production and adaptation studies will be transferred to the field on the basis of the basin

4.3 Ecosystem Services, Biodiversity and Forestry

Goods and services provided by healthy ecosystems reach people directly or indirectly, which ensures sustainability conditions. For instance, forests not only offer wood, but they also hold the soil, cleans the pollutants that will distort the quality of water before they directly reach the roots in the soil, provide flood control, and regulate water system in the drainage basin. It should not be forgotten that ecosystems such as topsoil areas, wetlands and deep seas, which significantly store carbon also have a direct role in regulating the climate. It is known that climate change will cause to the loss of terrestrial and marine ecosystems as well as biodiversity. This situation will have a major impact on the species, the ecosystems and the services they provide on which the society is dependant. From the climate change adaptation point of view, ecosystem services play a significant role in ensuring the efficiency of a series of sectors starting with the agricultural sector, and in flexibility and risk reduction in the relevant subsectors (such as plant and livestock production, food security, forestry).

STRATEGIC STEP 1: To evaluate and monitor the impact of climate change in the Seyhan River Basin on biodiversity, ecosystems and forests

PRIORITIES

1. To complete and update the basic data regarding the biodiversity in the basin
2. To determine the diversity of species and biological parameters regarding indicator species in inland waters
3. To map the distribution of rare, endemic, endangered and economic species and model the population parameters and the changes therein
4. To constantly monitor the changes in the biodiversity and the diversity of species in inland waters, marine and terrestrial ecosystems



STRATEGIC STEP 2: To integrate issues related to adaptation to climate change in the ecosystem management and conservation plans and practices in the Seyhan River Basin

PRIORITIES

1. To identify the priority areas in terms of biodiversity across the basin, and to prepare action plans tailored for such areas for the prevention of losses
2. To compile an inventory of the non-wood forest products in the basin, and to ensure the economic usage of non-wood forest products that are little affected by climate change (aromatic and medical plants, etc.)
3. To process and make economic use of water products which are in the lower circles of the nutrition chain and have a low economic value
4. To adapt fishing activities to climate change⁵⁵
5. To process and make economic use of off-target species which are in the lower circles of the nutrition chains in marine and inland waters and do not have an economic value
6. To identify the changes in land use caused by the impacts of climate change in forest areas
7. To complete the studies on the integration of the biodiversity layers in the basin with the forest management plans as soon as possible

⁵⁵ Example: To change the dates of hunting prohibitions parallel to the changes in the spawning periods of fish, to allow less hunting of the species whose population in the basin has dropped due to climate change.

STRATEGIC STEP 3: To establish healthy data management in identifying the impacts of climate change on the ecosystem, biodiversity and forestry in the Seyhan River Basin

PRIORITIES

1. To prepare “Seyhan River Basin Biodiversity Data Catalogue”⁵⁶
2. To map endangered and economic species
3. To update and extend the scope of the data on the abiotic environmental factors in the basin
4. To renew/prepare soil maps (to prepare them for lands other than agricultural lands)
5. To monitor the ecosystems in the basin; to collect data on the impacts arising from climate change and human factors which the ecosystem suffer from (types of impacts, impact severity, frequency, etc.), and to quantify the data and share the data with relevant units.
6. To establish meteorology monitoring stations in the forest areas in the basin by the General Directorate of Forestry for the impacts of climate change

STRATEGIC STEP 4: To increase the amount of scientific studies for identification of and adaptation to the impacts of climate change on the ecosystem, biodiversity and forestry in the Seyhan River Basin, and to improve the administrative capacity of relevant institutions in this direction

PRIORITIES

1. To work on high-resolution climate change projections for the healthy determination of the impacts of climate change on biodiversity in the basin
2. To conduct studies on modeling the population changes in and distribution of the rare, endemic and economic species in the basin.
3. To determine and monitor the human-induced impacts on species (pollution, fishing, etc.)
4. To determine the non-climate impacts on biodiversity (to determine the impacts on different ecosystems)
5. To establish an “Institute” in the basin for supporting and coordinating the scientific studies and research on ecosystem and climate
6. To conduct research studies in order to identify and monitor the impacts of climate change in protected areas
7. To conduct research and modeling studies that will demonstrate the current status and potential of the ecosystem services in the basin along with the relation between these services and natural risks/ disasters
8. To conduct scientific research on the transition to forest patterns that will adapt to climate change.
9. To determine the physical and chemical parameters of streams

⁵⁶ Data Catalogue will help determine which data on biodiversity will be obtained from which institution.

STRATEGIC STEP 5: To increase the awareness raising activities on climate change and ecosystem in the Seyhan River Basin

PRIORITIES

1. To open a “museum” in order to bring the ecological values and biodiversity of the basin into prominence and keep track of habitat losses
2. To train decision makers on issues related to the link between adaptation to climate change and protection of natural values.
3. To provide the Local Wetland Commissions in the basin with up-to-date information on the impacts of climate change and adaptation
4. To increase the knowledge and equipment capacity of the authorized staff for the monitoring of environmental parameters rather than outsourcing such tasks
5. To raise awareness among forest peasants on the adaptation to the impacts of climate change



4.4 Natural Disaster Risk Management

It is anticipated that there will be an increase in the frequency, severity and spatial distribution across the country of the natural disasters that are sensitive especially to the changes in water cycle, such as drought and floods, depending on climate change. For instance, as the amount of surface flow increases in winter months, additional measures against floods will have to be taken and the infrastructure will have to be improved. Similarly, an increase is foreseen in the severity of rainfalls in some regions. Therefore, the risk of flood will emerge both in the rural and urban areas in such regions, or the existing risk will rise. Forest fires, which is another important dimension of the impacts of climate change, is seen as a risk throughout the year in the Mediterranean Basin, especially in the southern regions; and it is predicted that such increase in the forest fires will lead to the expansion of invasive species, causing forest fires to jump across broader areas.

STRATEGIC STEP 1: To identify the risks emerging from the impacts of climate change in the Seyhan River Basin based on sectors and areas

PRIORITIES

1. To analyze, constantly monitor and update the extents of exposure of water sources, agriculture and food, public health, industrial and urban settlement areas, and sectors to risks and disasters in the Seyhan River Basin
2. To determine priority areas and sectors in the vulnerability analysis (for purposes like establishing early warning systems)
3. To strengthen the capacity of the Provincial Drought Crisis Centers in the provinces across the basin

STRATEGIC STEP 2: To integrate the measures of pre-disaster protection in Seyhan River Basin into all the planning practices, taking the impacts of climate change into consideration

PRIORITIES

1. To revise/ prepare the sector and management plans in the basin (Provincial Agricultural Master Plans, Regional Agricultural Master Plans, River Basin Conservation Action Plan, Regional Environmental Layout Plans, Institutional Strategic Plans of provinces, etc.) in consideration of vulnerability analysis and risks
2. To revise the Agricultural Drought Action Plan, Disaster Risk Reduction Plan, Provincial Emergency Aid Plans so as to include the factors of adaptation to climate change, vulnerability analysis in terms of exposure to disaster, as well as the risks
3. To improve the City Master Plans and Implementation Development Plans in the provinces in the basin so as to support the disaster preparedness of urban settlements⁵⁷

⁵⁷ Example action: More green areas.

STRATEGIC STEP 3: To establish a coordination mechanism among institutions in order to integrate disaster and risk management with the climate change adaptation measures in the Seyhan River Basin

PRIORITIES

1. To prevent the conflict of authority among the local institutions related to disaster and risk management⁵⁸
2. To make the Prime Ministry Disaster and Emergency Management Presidency more active and recognized
3. To organize the National Disaster Risk Reduction Platform of Turkey⁵⁹ on the basis of Seyhan River Basin
4. To share the results of scientific research conducted in the basin on the impacts of climate change with the institutions and/or persons related to natural disasters

STRATEGIC STEP 4: To increase the preparedness capacity of all institutions and sectors for natural disasters and emergency situations arising from climate changes in the Seyhan River Basin

PRIORITIES

1. To set up early warning systems for the priority areas and sectors identified in the vulnerability analysis especially for drought
2. Revision of the infrastructure of settlement areas by local governments and to search for the necessary sources in this respect
3. To revise the flood-resistant infrastructure system in urban areas
4. To organize measures for the protection of forests against fire in consideration of the rising risks
5. To enhance the tools and machinery park of the units that will be assigned duties in natural disasters

STRATEGIC STEP 5: To enable sharing and transferring risks arising from climate change in the Seyhan River Basin

PRIORITIES

1. To conduct planning across the basin in order to increase and extend the government support in agricultural insurance applications via trainings
2. To hold training activities in order to make agricultural insurance more widespread.
3. To extend the scope of Natural Disaster Insurance so that it includes the disasters induced by climate change

⁵⁸ The local institutions of the Prime Ministry Disaster and Emergency Management Presidency are the Provincial Directorates of Disaster and Emergency and Civil Defense Search and Rescue Unit Directorates. Civil Defense Search and Rescue Unit Directorates are granted regional responsibility in 11 provinces (provinces with a high risk of earthquake), and report directly to the center. There are Search and Rescue Teams in the rest of the provinces. The authorities and duties of the Provincial Directorates of Disaster and Emergency and Civil Defense Search and Rescue Unit Directorates are overlapping. The proposal is to reorganize the Civil Defense Search and Rescue Unit Directorates under the Provincial Directorates of Disaster and Emergency (Turkey's National Strategy and Action Plan on Adaptation to Climate Change).

⁵⁹ "Establishment, Duties and Working Principles of the National Disaster Risk Reduction Platform of Turkey" Cabinet Decision (Decision no: 2011/1320, published in the Official Gazette dated 12 February 2011 and numbered 27844).

STRATEGIC STEP 6: To raise awareness in the society on the disasters caused by climate change in the Seyhan River Basin

PRIORITIES

1. To increase the capacity and consciousness of all sectors of society, mostly the vulnerable groups (women, the elderly, etc.)
2. To ensure active participation of NGO's and professional organizations in the awareness-raising activities
3. To conduct training activities in the basin, especially about erosion and fire
4. To include courses such as "impacts of climate change, risks and solutions" in the training curriculum

4.5 Public Health

It is known that the changing climate conditions will also create, or are creating significant impacts on human health even now. Deaths and diseases linked with weather conditions may rise due to the increase in the frequency of extreme climate events. For instance, the elevation in the number of subsequent days that are too warm will directly influence acute health problems especially in elderly people and people suffering from chronic cardiovascular or respiratory diseases. Risk of flood which will increase due to climate change will alter the expansion risks of contagious diseases along with the distribution of such risks in the spatial dimension. It is probable that human mobility will increase via migration and tourism; contagious and/or new disease-inducing microorganisms or vectors will penetrate the environment and find themselves new habitats in the wake of the imminent warming. So, this will create another risk area. Moreover, there is a high possibility of zoonosis (infections and diseases transmitted from animals to humans or vice versa), which may lead to the contagion of serious infectious diseases borne by vermin.

STRATEGIC STEP 1: To study the impacts of extreme weather events on human health in the Seyhan River Basin

PRIORITIES

1. To extend and revise epidemiological risk maps for the whole Seyhan River Basin.
2. To monitor and evaluate the frequency, level and risks of the impact of extreme weather events such as heat waves or drought on human health in the basin
3. To draft genotype-maps of the risk factors in risky regions
4. To establish institutional infrastructure in order to prevent the increase in the viruses and bacteria that will be caused by the pollution of city water due to drought
5. To conduct studies on the prevention of migration, and identification and control of social problems

STRATEGIC STEP 2: To investigate and monitor the epidemic diseases linked with meteorological data and/or climate change in the Seyhan River Basin

PRIORITIES

1. To investigate whether the epidemic diseases in the basin occur due to a natural disaster
2. To determine and prevent any changes that may occur in the microorganisms and vectors that will regain importance, or will emerge for the first time in the region due to climate change, and to eradicate the microorganisms
3. To conduct risk identification studies on the scale of the basin as to which localities the epidemic diseases are mostly observed

STRATEGIC STEP 3: To strengthen the capacity of relevant institutions for the identification of the impacts of extreme weather events and climate change on human health in the Seyhan River Basin, to inform the public, and conduct training activities

PRIORITIES

1. To hold regular meetings for resolving the possible disaster scenarios on human health based on climate change in order to ensure integration among institutions
2. To establish cooperation among Provincial Directorates of Health in the provinces in the basin and conduct joint studies with universities on the identification of impacts of climate change on human health
3. To establish/ arrange early warning systems in the basin so as to include the risks on human health arising from the impacts of climate change
4. To allocate appropriate budget for the research studies and laboratories in the relevant institutions in order to identify the impacts of the climate change in the basin on human health
5. To raise awareness among the society on the diseases that may possibly occur due to climate change and the prevention and control of such diseases starting from elementary school level; to hold continuous training and information meetings
6. To establish / increase the number of clinics for tropical diseases at the State Hospitals in the provinces in the basin⁶⁰



⁶⁰ Tropical diseases are important especially for the health of the people living in tent villages in the basin



Strategic Steps to Adapt to
Climate Change in Seyhan River Basin

