# Water Use for Agriculture in Priority Rivers Basins

# CONTENTS

# 1 IWMI PROJECTIONS FOR EUROPE AND CENTRAL ASIA

Using the IWMI base scenario (Molden 2000) described in Section 1 (see 2.2 Water supply and demand), the regional projections for Europe and Central Asia are presented here, followed by an assessment of the Great Konya Basin. Projections for future water demand in Turkey are given at the end of this chapter (Table 3.1).

**Table 1.1 IWMI projections for Europe and Central Asia**

| Factor | Units | 1995 value | 2025 projection | Annual growth 1995–2025 |
|---|---|---|---|---|
| Population | million | 386 | 401 | 0.1 |
| Cereal demand | m mt | 220 | 236 | 0.2 |
| Cereal production | | | | |
| - Total | m mt | 199 | 244 | 0.7 |
| - Irrigated | m mt | 19 | 26 | 1.1 |
| - Rain-fed | m mt | 180 | 218 | 0.6 |
| Growth in total irrigated area | m ha | 25 | 29 | 0.5 |
| Primary water supply | $km^3$ | 210 | 221 | 0.2 |
| PWS, % of PUWR | % | 8 | 9 | |
| Water diversion | | | | |
| - Total | $km^3$ | 324 | 361 | 0.4 |
| - Irrigation | $km^3$ | 199 | 216 | 0.3 |
| - Domestic | $km^3$ | 33 | 42 | 0.8 |
| - Industrial | $km^3$ | 93 | 104 | 0.4 |
| Water-scarcity level | No water scarcity (Total PWS <60% of PUWR, and total growth in PWS >25% | | | |

Source: Molden 2000
m mt = million metric tonnes
m ha = million hectares

The major conclusions of IWMI for Europe and Central Asia are:

- The region is projected to have a small production surplus in 2025 (3% of total demand) from a substantial production deficit in 1995 (10% of the 1995 demand)
- The region is not water scarce.

Issues of importance for the region are:

- Most parts of the region fall in the category of high potential areas
- There is a substantial contribution from rain-fed agriculture to total production
- Productivity improvements through supplemental irrigation in marginal rain-fed lands
- Opportunities for groundwater development
- Deterioration of water quality.

# 2 THE GREAT KONYA BASIN

The Great Konya Basin is one of several closed basins on the Central Anatolian Plateau, which itself lies in a closed basin. Several rivers flow into it from all sides apart from the north, resulting in lakes and marshes in the central lower parts. It is located at latitude 37ºN and between longitudes 33º and 35ºE. Formerly a lake, the central part of the basin is flat and consists of several plains, separated by elevations (plateaus) in the terrain. The most important areas are the **Konya, Hotamış, Karapınar, Eregli and Karaman plains. In the south the basin is bordered by** the Toros range and in the north by the Pontic mountains.

The Konya Basin is a structural basin filled with sediments from different geological periods. Most of these sediments come from the surrounding mountains, but there are also some volcanic deposits. In some places these sediments can be as deep as 400m.

The provincial capital of Konya and the towns of Karapinar, Bor, Eregli and Karaman are situated in the basin.

**Figure 2.1 Position of the Central Anatolian Plateau and the Great Konya Basin**


Source: de Meester 1971

## 2.1 Climate and water resources

The Konya Basin is one of the driest areas of Turkey and is classified as semi-arid, with cold moist winters and hot dry summers. Evaporation exceeds total precipitation by 1,000–1,500mm. A negative water balance would be the natural condition, but as a result of water transfers into the basin there exists a positive water balance, which results in flooding of the areas around the lakes.

The average temperature ranges from 0ºC in winter to 22ºC in summer. Minimum and maximum temperatures can reach -25ºC and 32ºC respectively. The length of the frost-free period (about 165 days) is critical for the decision on which crops to cultivate; it is too short a period for growing rice, cotton, and citrus fruits.

Rainfall distribution shows large variations over the years, as well as during the year. Some areas have more rainfall owing to topographical conditions, but even here distribution is irregular. Winter snow thaws rapidly in spring and releases large amounts of water, which cause erosion and mud-flows on the slopes and substantial flooding near the centre of the basin. Annual surface water and groundwater potentials are estimated at 2.5km$^3$ and 1.7km$^3$ respectively. Although it has not yet been proven, it is expected that losses occur from drainage through the calcareous layers in the subsoil.

According to IWMI Working Paper No.32 *Water for Rural Development*, the following developments (Table 2.1) may be expected in Turkey as a whole, resulting in an overall 94 per cent growth in primary water supply in the period 1995–2025. However, how these developments will be reflected in the Konya Basin cannot be concluded from these data.

**Table 2.1 Water demand forecast for Turkey**

| IWMI characteristics | Units | 1995 | 2025 | Annual growth (%) |
|---|---|---|---|---|
| Population | million | 61.3 | 83.5 | 1.0 |
| Total cereal consumption | m mt | 29.8 | 40.3 | 1.0 |
| Cereal production | m mt | 29.7 | 40.2 | 1.0 |
| Irrigated cereal area | m ha | 0.69 | 1.18 | 1.8 |
| Rain-fed cereal area | m ha | 14.04 | 14.10 | 0.0 |
| Total cereal area | m ha | 14.74 | 15.27 | 0.1 |
| Net irrigated area | m ha | 4.2 | 6.6 | 1.5 |
| Gross irrigated area | m ha | 4.6 | 7.9 | 1.8 |
| Primary irrigation supply | km$^3$ | 21.5 | 35.2 | 64 |
| Total water withdrawals | km$^3$ | 51.42 | 92.85 | 2.0 |
| Total primary water supply | km$^3$ | 27.0 | 52.3 | Total growth |
| Total PWS as % of PUWR | % | 21.0 | 40.6 | 94 |
| Scarcity level | Economic | | | |

Source: Molden 2000
m mt = million metric tonnes
m ha = million hectares

### *2.1.1 Water courses*

Compared to other basins, the Great Konya Basin has only a few water courses. The river with the largest catchment area is the Çarsamba river (7,650km$^2$). Other water courses are the Meram, May, Çamurluk, Ayran, Zanopa, and Bor Rivers. They are generally seasonal and dry up in summer.

Çarsamba River

In the past, the stream used to discharge the overflow of Lake Beysehir to the Konya plain. However, during the first stage of the Konya-Çumra Plain Irrigation Scheme, the stream was turned into a canal to transport water for storage to Lake Sugla and Apa Dam Reservoir. In summer it transfers water from these reservoirs to the Çumra plain for irrigation purposes. The water hosts economically important species such as carp, pike, perch, and crayfish. Average flow is 2.6m$^3$/s.

### *2.1.2 Lakes*

The Great Konya Basin is home to the third-largest lake in Turkey from the point of view of surface area, Lake Beysehir, lying the western part of the basin. Many small crater lakes can be found in the basin as well, but are used only for recreational purposes.

Tuz Gölü
After Van Lake, this is Turkey's second-largest lake, lying at an altitude of around 910m and spreading out over a very level area. In winter, the surface reaches up to 150,000ha, whereas it practically dries up in summer, becoming a salty waterbody of 2,000ha. In summer, salt deposits on the shores can reach a thickness of 20–30cm. The major water source feeding the lake is the Konya Drain Pipe, constructed in 1974, which provides a hydrological link between Tuz Gölü and the Konya Basin, although it is not part of it geographically. The lake was declared a Specially Protected Area in 2000 and was categorized as a first degree wetland. Salt is produced in the salinas on its western shores.

Beysehir Gölü
A tectonic lake shaped by karst formations, the lake is fed by water coming from the western Toros mountains. Reaching a height of 1,121m above sea level, it has a surface area of 656km$^2$ and a depth of 10m at its deepest point. This is Turkey's largest freshwater lake. Apart from the Deliçay and Bademli streams, the lake is fed mainly by groundwater. There are numerous islets on the west side of the lake.

Water from the lake probably drains to the Mediterranean Sea through calcareous layers in the subsoil. Manavgat River, which flows into the Mediterranean Sea, is fed by Dumanli springs, **which today lie under the Oymap ınar Dam. It is argued that a good proportion of the discharge** of the Dumanli springs comes from Beysehir Lake. In addition to its function as a water reservoir for irrigation in the Çumra Plain, the lake is used for transportation, generates a lot of wetland products and derived handicrafts, and has scenic and wildlife values.

The gates that regulate the outflow from the lake to the Çarsamba River are closed from September to May. Runoff water downstream from the lake is collected in Lake Sugla through a network of drainage canals. Excess water from Çarsamba River is stored in the Apa Dam and used for irrigation in summer.

Sugla Gölü
This is a lake shaped by intense karst formations. In its natural condition it used to store the overflow from Beysehir Lake. However, in the 20th century, it was linked to the Çarsamba through many canals and became a natural reservoir. Its average surface area is 125km$^2$, altitude 1,094m and depth 10m at its deepest point. The numerous subterranean rivers in the south, thought to drain water to the Mediterranean Sea, have been sealed in an effort to decrease water losses in the basin. Land developed through the construction of surface drainage canals has been dedicated to agriculture.

Çavusçu (Ilgin) Gölü
The Directorate of State Hydraulic Works (DSI) converted this lake into a natural reservoir. Its altitude is 1,026m with an average surface of 900ha and a depth of around 6m. Because the surrounding area is very level, its surface area can reach up to 2,800ha in flood season. Its marshy nature and many reedbeds make it an important bird refuge.

Hotamis Gölü
Located south of the centre of the basin, this lake used to have a very large surface area. However, the land around the lake was drained for farming and the lake converted into a reservoir for irrigation water. Formerly it held most of the reedbeds in the basin. Salinization of the surrounding land is an increasing problem.

## 2.2 Irrigation development

The Konya-Çumra project was the country's first irrigation scheme. Constructed in 1907, it has been taken in and out of operation many times as a consequence of insufficient drainage, floods and salinization, problems aggravated by the fact that most of the irrigation canals in the basin are unlined. The project is cited as a case study in the introductions of many publications on drainage and land reclamation, emphasizing the importance of adequate drainage. However, despite efforts, many canals in the project area remain unlined.

### *2.2.1 Important water use projects in the Konya Basin*

Konya Province Public Water Supply Project
Projections for Konya Province indicate that water demand for domestic and industrial purposes will increase from 77 million $m^3$ in 1995 to 130 million $m^3$ in 2015. Some 37.8 million $m^3$ of this increase will be supplied by the Altinapa Dam close to the province, while the rest will have to be drawn from groundwater. The project was scheduled for completion in 2002. Another component of this project is the construction of sediment trapping structures on the streams in order to reduce suspended matter inflow into the dam and ensure a longer life span for the dam.

Eregli 2nd-3rd Phase Irrigation Project
This project aims to irrigate 42,225ha of the Eregli Plain with a combination of waters from the Ivriz Dam and groundwater. The irrigation canals constructed in 1960 collapsed as a result of the high gypsum content of the soils, for which reason the irrigation scheme requires rehabilitation. Reconstruction of the canals is proposed every year, however the same problem will keep occurring if the canals remain unlined.

Ilgin 2nd Phase Irrigation Project
In addition to the Atlanti Irrigation scheme (12,092ha) on Ilgin Plain, the Ilgin Pump Irrigation scheme (5,547ha) started in 1992 using water supplied from Çavusçu Lake. However, the water taken from Çavusçu is not sufficient for the total area, and the Ilgin 2nd phase project aims at meeting 10 million $m^3$ of the rest of the demand (total 29.3 million $m^3$/year) from groundwater resources.

Karaman Ayranci Project
**Although Ayranc ı Dam was initially planned to supply irrigation water for an area of 5,438ha,** more land has been brought under irrigation over time, and supplies can no longer meet the demand. Furthermore, since the dam was built in a karst region, considerable amount of seepage was found to take place. Presently, the transfer of groundwater from the Hisilayik Cave is under investigation.

Konya Çumra 3rd Phase Irrigation Project
Owing to the shortage of water supplies in the Konya Basin, a transfer of 130 million $m^3$/year from the Gembos basin (south of Beysehir Lake) to Beysehir Lake was proposed under the Çumra 2nd Phase Irrigation Project. This has still to be completed. However, this transfer will not

be sufficient and a further annual transfer of 414 million $m^3$ of water is scheduled from the upper Göksu basin (which drains into Mediterranean Sea), facilitated by three dams and the 14km long, 4m diameter Mavi Tunnel. This will permit irrigation of an additional 223,410ha and the generation of 147Gwh of electricity. The project has not yet started owing to a lack of funds.

Nowadays, the water level of Beysehir Lake is at the minimum level for irrigation purposes (water head 1,121m). Whereas the average water withdrawal from the lake used to be 300–350 million $m^3$, only 93 million $m^3$ could be taken in 2001. Taking into account current consumption trends and the gap in supplies, it is clear that even with the water transferred from Gembos basin there will not be enough to meet water requirements in full.

Esmekaya Project

This project aims at irrigation of 5,668ha of land by utilizing water from the Esmekaya marshes. The project, which started in 1996, was stopped from time to time through legal injunctions as the Esmekaya marshes have the status of 1st Degree SIT from the Ministry of Culture. However, construction was resumed in 2000. The scheme's main technical drawbacks are that the water drawn from the marshes will not meet the requirements of the proposed irrigation scheme, there is no suitable outlet for drainage water, and a considerable amount of leakage from the dam could occur as a result of limestone beds in the area.

Sugla Reservoir

In 1996, a study was conducted to transform Lake Sugla into a natural reservoir to store water for the Çumra projects and to prevent floods in the lower Konya Basin. The project was due for completion in 2002. In 1998, the central pumping station at the lake was finalized and each year 100–150 million $m^3$ of water, previously thought to flow towards the Mediterranean Sea, is now directed towards the Konya Plain.

Konya Çumra 2nd Phase Project

This project comprises several sub-projects, including the diversion of Gembos basin waters, improving groundwater levels, renewal of tertiary canals, rehabilitation of Gevrekli Irrigation Scheme, rehabilitation of the Apa Dam, renewal of the Alakova groundwater irrigation scheme, re-routing of electricity, communication and natural gas lines on the Beysehir-Sugla-Apa canal, and renewal of three pumping stations on the disposal canal.

**Aksaray Ulu ırmak 2nd Phase and Yesilova-Yesiltepe Irrigation and Drainage Canals** Rehabilitation

**This project also comprises several sub-projects, such as renewal of canals within the Ulu ırmak** irrigation area, concrete lining of earthen canals, and drilling additional wells in order to meet shortages in the water supply (9.5 million $m^3$/yr).

A comparison between the stored water volumes in 2001 and the average of the last ten years for different reservoirs is presented in Table 2.2. The reasons for the overall decrease are: reduced rainfall, the karst nature of the lake beds which increase seepage, reduced infiltration as a result of a paucity of natural vegetation, long distances between irrigation water transfer points, and high demands for irrigation water as a result of ineffective infrastructure, drainage and high leaching requirements to wash out salts from the root zone.

In 1974, the Konya Drain Pipe was built to transfer excess water from the Konya Plain to the Tuz Gölü Plain, where the water would evaporate. The pipe has a carrying capacity of 25$m^3$/s. However, the Konya Municipality later connected the city sewage water discharge to the pipe

through the Keçili Canal, and some farmers close to the pipe use this drainage water for irrigation.

**Table 2.2 Status of water reservoirs in the Konya Basin (February 2001)**

| | **Total storage volume** (million $m^3$) | **Stored volume in February 2001** (million $m^3$) | **Ten-year average stored volume** (million $m^3$) |
|---|---|---|---|
| Apa Dam | 171.6 | 102.1 | 59.9 |
| Beysehir Lake | 5,571.7 | 3,377.8 | 3,774.6 |
| May Dam | 42.7 | 7.5 | 12.7 |
| Altinapa Dam | 28.6 | 7.9 | 15.4 |
| Sille Dam | 2.5 | 0.8 | 1.4 |
| Çavusçu Lake | 178.0 | 63.3 | 80.9 |
| Ivriz Dam | 83.0 | 25.1 | 39.7 |
| Ayranci Dam | 30.9 | 2.3 | 2.3 |
| Gödet Dam | 158.0 | 20.0 | 32.3 |
| Mamasin Dam | 154.6 | 34.1 | 57.5 |
| Gebere Dam | 2.4 | 0.6 | 0.7 |

### *2.2.2 Institutional environment*

The Directorate of State Hydraulic Works (DSI) and Directorate of Village Affairs (KHGM) are the two government institutions responsible for carrying out irrigation projects. The DSI was established as a legal entity in 1954 and placed under the aegis of the Ministry of Public Works and Settlement. It is responsible for the planning, design, construction, and operation of water resources development for various purposes such as irrigation, flood control, swamp reclamation, hydropower development, navigation, and water supply to cities with over 100,000 inhabitants. The KHGM carries out the development of soil and water resources in four districts in the region. Table 2.5 summarizes their projects in the Konya Basin.

The General Directorate of Rural Services (GDRS) was established in 1984 by incorporating the soil conservation and irrigation organization, the rural settlement organization, and the rural roads, water and electricity organization into one body. It is responsible for the development of small-scale irrigation schemes and small reservoirs, rural roads, and water supply to rural areas. It is also responsible for land consolidation and the on-farm development of all irrigation projects, including the projects developed by DSI. It was formerly located under the Ministry of Agriculture and Rural Affairs, but now falls under the Prime Minister's Office.

While DSI focuses on large-scale water development projects, KHGM is responsible for smaller water resources development projects, as well as land and water development projects. Some projects are developed jointly by the two agencies. However, the figures given by the two directorates show enormous discrepancies. For example, while KHGM claims to have developed irrigation projects covering an area of 242,221ha, DSI's records show this number to be 35,180ha. Another complication is that DSI does not have the authority for land consolidation. DSI is the only authorized agency for development of groundwater water resources, whereas the line is fuzzy when is comes to surface water.

**Table 2.3 Irrigation and drainage data for Turkey**

| **Irrigation potential** | **1993** | **8,500,000ha** |
|---|---|---|
| **Irrigation** | | |
| 1 Area equipped for irrigation | 1994 | 4,070,746ha |
| - surface irrigation | 1993 | 3,806,511ha |
| - sprinkler irrigation | 1993 | 263,849ha |
| - micro-irrigation | 1993 | 386ha |
| % of area irrigated from groundwater | 1994 | 16.5% |
| % of area irrigated from surface water | 1994 | 83.5% |
| % of equipped area actually irrigated | 1994 | 74.0% |
| 2 Spate irrigation | | |
| 3 Equipped wetland and inland valley bottoms | 1994 | 115,164ha |
| **Total water managed area (1+2+3)** | | 4,185,910ha |
| - as % of cultivated area | | 20% |
| - increase over the last 10 years | | |
| - power irrigated area as % of total area | | 5.3% |
| **Full or partial control schemes** | | |
| Large schemes >1,000ha | | 1,805,390ha |
| Medium schemes | | |
| Small schemes <1,000ha | | 2,265,356ha |
| Total number of households in irrigation | | |
| **Irrigated crops** | | |
| Total irrigated grain production | 2002 | 1,328,000ha |
| As % of total grain production | 2002 | 10% |
| Harvested crops under irrigation | | |
| - wheat | 2002 | 1,004,000ha |
| - cotton | 2002 | 728,000ha |
| - sugarbeet | 2002 | 334,000ha |
| - vegetables | 2002 | 327,000ha |
| - fruittrees | 2002 | 169,000ha |
| **Drainage environment** | | |
| Drained area | 1994 | 3,143,000ha |
| As % of cultivated area | | 15% |
| Flood protected area | 1994 | 799,000ha |
| Area salinized by irrigation | | |

Source: FAO 1997a

The regional directorate of DSI is located in Konya (Aksehir and Tuzlukçu districts fall in the Akarçay basin), Aksaray, Nigde, and Karaman provinces. The 26 rainfall and 17 rainfall and evaporation observation points in the area, in addition to those of the governmental meteorological agency, show the importance attached to the Konya Basin by DSI. By the end of 1998, there were 98 flow and lake measurement and 27 water quality control stations in the basin. The stations also measure snowfall. Also by the end of 1998, DSI had installed 1,034 wells. However, because of the decline in groundwater levels, water quality and discharge rate, well construction has slowed in recent years.

**Table 2.4 Output of DSI interventions in the Konya Basin**

| | |
|---|---|
| Irrigated area | 426,439ha |
| Drained area | 1,600ha |
| Power supply | 32.1MW |
| Drinking water | 37.8 million $m^3$ |

Turkey leads the world in passing management of irrigation schemes to irrigation cooperatives, a process started in the 1990s. To date, DSI has turned over the management of 37 small-scale irrigation projects, covering 165,368ha, to municipalities, cooperatives and villages. Two hundred and sixty-one cooperatives use groundwater for irrigation of 157,915ha. And of over 600

irrigation schemes now managed by water users associations in Turkey, 12 covering an area of 150,030ha are in operation in the Konya Basin.

In 2001, of 45 projects turned over to different institutions by DSI's IVth Regional Headquarters, 96,632ha of a total of 170,338ha were actually irrigated (an irrigation intensity of 56.7%). A further 2,135ha of land will be handed over after the completion of four projects in 2003.

There are only two irrigation projects operated by DSI itself, totalling an area of 4,940ha.

**Table 2.5 KHGM's projects within the Konya Basin, 2002**

| | **No. of projects** | **Area** (ha) |
|---|---|---|
| Irrigation from reservoirs | 97 | 7,650 |
| Surface irrigation | 598 | 148,210 |
| Groundwater irrigation | 400 | 86,361 |
| Soil conservation | 82 | 29,347 |
| Field development | 76 | 144,593 |
| Drainage and soil restoration | 46 | 9,498 |
| Land consolidation | | 116,415 |
| No. of active water users associations | | 407 |

## 2.3 Agriculture

### *2.3.1 Soils*

A significant proportion of the Great Konya Basin is classified as agricultural land (48%). Cereals are cultivated on 37 per cent of this land on a rotational basis (Table 2.6).

All of the soils of the basin have a high percentage of fine earth carbonates. This is caused mainly by the calcareous nature of the parent material, which is derived from the surrounding limestone uplands. Due to the semi-arid climate, no part of the soil is entirely decalcified; the pH is never less than 7. Secondary carbonate enrichment is common as a result of lateral or upward transport of bicarbonate-rich groundwater (de Meester 1970).

**Table 2.6 Land use in the Konya Basin**

| **Land type** | **Type of land use** | **Area** (ha) |
|---|---|---|
| Agricultural land | a) Rain-fed agriculture (fallow) | 2,042,383 |
| | b) Rain-fed agriculture (non-fallow) | 8,473 |
| | c) Irrigated agriculture | 274,818 |
| | d) Vineyards | 40,745 |
| | **Total** | **2,366,419** |
| Grassland and pastures | a) Grassland | 156,782 |
| | b) Pasture | 1,720,628 |
| | **Total** | **1,877,410** |
| Forest and heathland | Forest | 454,077 |
| | Heathland | 176,276 |
| | **Total** | **630,353** |

Apart from highly fertile soils, the basin contains salty soils, brackish soils, soils with high lime content, and organic soils. Because of the unique combination of the high diversity of soils and their topography, the basin has been a focus for local and European researchers, and serves as an open-air museum and laboratory. Some examples of soil related issues include:

- **The most severe wind erosion in Turkey: Konya-Karapınar**
- The most severe boron problems: in Bor
- Exploitation of peat for domestic fuel purposes: near Eregli-Aksaray road
- Degradation of gypsiferous soils as a result of irrigation: around Eregli
- Irrigation with lime-water: around Eskil
- Threat of soil-related diseases to public health: Aksaray

### *2.3.2 Land use*

Three types of land use can be distinguished in the Konya Basin: rangelands, dry arable, and irrigated arable land. The rangelands are owned by the Turkish government and grazed communally. Conversion of rangeland to dry arable land is common, but as yield potential is low this contributes little to food production.

Dry farming

Rainfall in the Konya Basin is often not enough to grow an annual crop, for which reason water conservation practices are implemented. After harvest, the land is kept under stubble and ploughed the following spring to break the soil structure and control weed growth. No crop is planted and in autumn the ground is harrowed and sown with winter wheat. In this way the crop is able to use soil moisture accumulated over a period of two years and stands a better chance of reaching maturity. Due to the high risks involved, fertilizer inputs are very low.

Irrigated farming

As in dry farming, wheat is the major crop, followed by sugarbeet, fruit trees (apples and pears), melons and lucerne. Fallowing is practised in some areas to restore natural soil fertility, as very little manure and/or fertilizers are available. Sugarbeet is grown under a contract with a factory in Konya, which supplies fertilizers and has an extension service. Table 2.7 shows that the Konya Basin receives 36mm of rainfall during the summer months, and that depending on the crop, irrigation water requirements may vary between 350 and 1,200mm.

Winter wheat is only irrigated once in spring, while other crops will receive water throughout the summer.

**Table 2.7 Range of crop water requirements in the Konya Basin**

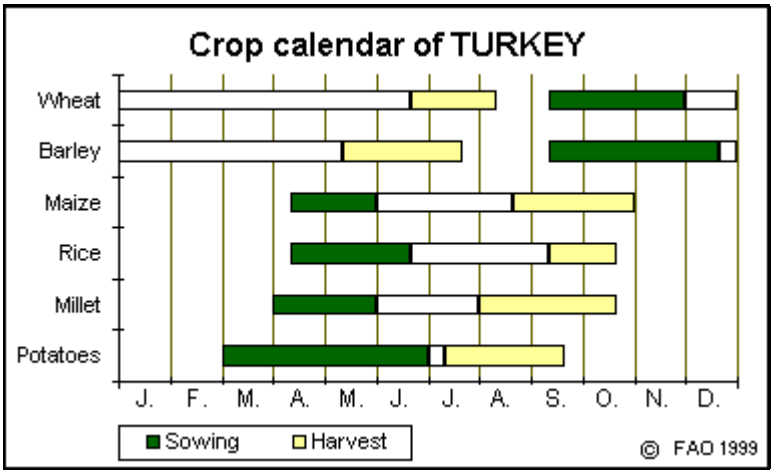
| **Altitude** (m) | **Average annual rainfall** (mm) | **Growing season** (days) | **Summer rainfall** (mm) | **Crop water requirements** (mm) |
|---|---|---|---|---|
| 1,028 | 325.8 | 180 | 36.3 | 350–1,200 |

**Table 2.8 Crop water requirements and irrigation frequency of selected crops**

| | Data from literature | | Calculations with CROPWAT* | | | |
|---|---|---|---|---|---|---|
| **Crop** | **No of irrigations** | **CWR** (mm) | **Planting date** | **CWR** (mm) | **Irrigation requirements** (mm) | **No. of irrigations** |
| Wheat | 3 | 466.5 | 1/10 | 370 | 195 | 1 |
| Barley | 3 | 431.3 | | | | |
| Maize | 5 | 621.0 | 15/4 | 640 | 559 | |
| Sorghum | 4 | 590.4 | | 507 | 413 | |
| Potatoes | 4 | 577.5 | 1/3 | 539 | 417 | |
| Sugarbeet | 7 | 858.4 | 15/4 | 799 | 719 | |
| Sunflowers | 5 | 701.5 | | | | |
| Clover | 9 | 1,253.5 | 1/3 | 928 | 795 | |
| Beans | 3 | 505.5 | | | | |
| Melons | 2 | 351.3 | 1/5 | 599 | 535 | |
| Tomatoes | 14 | 778.9 | 1/5 | 749 | 668 | |

*Based on meteorological observations by Konya weather station

**Figure 2.2 Turkey crop calendar**




Source: FAO GIEWS

According to the data from literature (Table 2.8), the irrigation water demands for crops in the basin range from 351mm (for melons) to 1,253mm (for clover). When the crop pattern in the basin is evaluated, and considering that wheat, sugarbeet and tomato production cover about 90 per cent of the irrigated area, the average annual water demand can be assessed as 650mm. DSI's Regional Directorate for Konya estimated the irrigable area at 2,134,915ha. Rounding this figure down to 2 million ha for calculation purposes, it can be concluded that the total crop water requirement in the Great Konya Basin is around 13 billion $m^3$/year. If irrigation operation, conveyance and application efficiencies together are taken at 40 per cent – which is a very optimistic estimate – the demand goes up to 32 billion $m^3$/year. This value is about eight times the actual surface and groundwater potential of the basin (4.2$km^3$), not taking into account water use by other sectors.

Applying these calculations to land currently under irrigation, it follows that annual water requirements in the basin are 13.5 billion $m^3$ (gross) and 5.4 billion $m^3$ (net), and the gap in irrigation water supply is now around 9 billion $m^3$. As a result, irrigation cannot take place in some areas even though infrastructure has been completed, groundwater resources are

overexploited, and low-quality water such as drainage water and sewage water is used for irrigation.

Apart from the water supply problems for irrigation, almost all settlements within the basin encounter problems with drinking water supply. In the past, DSI has explored ways of supplying water to the Konya Basin from distant basins such as Kizilirmak, Seyhan, and Sakarya.

**Table 2.9 Irrigated crop area in Turkey**

| **Irrigated area** (1,000ha) | | **Crop area as % of the total area equipped for irrigation, by month** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | J | F | M | A | M | J | J | A | S | O | N | D |
| Wheat | 1,004 | 24 | 24 | 24 | 24 | 24 | | | | | | 24 | 24 |
| Rice | 58 | | | | | | 1 | 1 | 1 | 1 | 1 | | |
| Maize | 122 | | | | | | 3 | 3 | 3 | 3 | 3 | | |
| Barley | 122 | 3 | 3 | 3 | 3 | | | | | | | | 3 |
| Potatoes | 104 | | | | | | 2 | 2 | 2 | 2 | 2 | | |
| Sugarbeet | 334 | | | | | 8 | 8 | 8 | 8 | 8 | | | |
| Pulses | 121 | | | | | | 3 | 3 | 3 | 3 | | | |
| Vegetables | 327 | | | | | | 8 | 8 | 8 | 8 | | | |
| Citrus | 84 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Fruits | 189 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Oil crops | 100 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Groundnut | 21 | | | | | | 1 | 1 | 1 | 1 | 1 | | |
| Sunflowers | 67 | | | | | | 2 | 2 | 2 | 2 | 2 | | |
| Tobacco | 60 | | | | | | 1 | 1 | 1 | 1 | 1 | | |
| Cotton | 728 | | | | | 17 | 17 | 17 | 17 | 17 | 17 | | |
| Fodder | 35 | 1 | 1 | 1 | 1 | | | | | | | 1 | 1 |
| All irrigated crops | 3,476 | 37 | 37 | 37 | 37 | 58 | 55 | 55 | 55 | 55 | 55 | 51 | 37 |
| Equipped for irrigation | 4,186 | | | | | | | | | | | | |
| Cropping intensity | 83 | | | | | | | | | | | | |

Source: FAO AQUASTAT

**Table 2.10 Agricultural water withdrawal in Turkey**

| | |
|---|---|
| Total Renewable Water Resources (TRWR) | 184km$^3$ |
| Irrigation water requirements | 10.97km$^3$ |
| Water use efficiency percentages | 40% |
| Water withdrawal for agriculture | 27.11km$^3$ |
| Water withdrawal as % of TRWR | 15% |

Source: FAO AQUASTAT

## 2.4 Ecoregions in the Konya Basin

The only WWF Global 200 ecoregion located in the Great Konya River Basin is the Anatolian Freshwater ecoregion, which falls across parts of both Turkey and Syria.

Anatolian Freshwater

The ecoregion has diverse freshwater habitats, particularly compared to surrounding drier areas. These include both running-water and lake environments. Historically it supported about 20 species and ten subspecies of endemic fish, many with very local distributions. Lakes are abundant and are important habitat for migrating waterbirds. A number of endemic fish within the ecoregion that are of conservation concern include *Alburnus akili*, two subspecies of *Capoeta*

*capoeta*, *Chondrostoma holmwoodii*, *Leucalburnus kosswigi*, *Phoxinellus anatolicus*, *Phoxinellus egridiri*, and *Aphanius burduricus*. Waterbirds include great bustard (*Otis tarda*), ruddy shelduck (*Tadorna ferrugininea*), and common crane (*Grus grus*).

*General threats:* Habitat loss, excessive water diversions, and pollution are the principle threats to the fish fauna. In particular, pollution from industry, agriculture, and domestic sources has been blamed for declines in several endangered species. Draining of wetlands for malarial control and conversion to agriculture is also reducing the amount of habitat available for aquatic organisms.

# 3 CONCLUSIONS FOR THE GREAT KONYA BASIN

## 3.1 Irrigated agriculture

Since statistical data on current agricultural practices are hard to obtain, 'guesstimates' have to be made to calculate water withdrawal in the Konya Basin. It is felt that the crop water requirement estimates given in section 2.3.2 above (Tables 2.7 and 2.8) are too high and that a more realistic value of irrigation requirements could be obtained by calculating water requirement per crop. This requires an estimate of the surface area of each crop in the irrigation systems.

In *Soils of the Great Konya Basin, Turkey* (de Meester 1970) an estimate was given for the crops grown in the Cumra irrigation area. These were cereals – 70%, sugarbeet and fruit trees – each 10%, and melons and lucerne – each 5%. When evaluating the data presented in Table 2.9 'Irrigated crop area in Turkey', this gives the following results: cereals (wheat, maize and barley) – 36%), sugarbeet – 10%, fruit trees – 5%, vegetables – 10%, and lucerne – 1%. As the climate of the Konya Basin is not suitable for a number of irrigated crops, and the data in Table 2.9 cover Turkey as a whole, for calculation purposes the first set of values will be used in combination with an irrigated area that is estimated to cover between 234,571ha (KHGM) and 426,439ha (DSI).

**Table 3.1 Water consumption for five major crops in the Konya Basin**

| **Crop** | **Area** (ha) (DSI) | **Area** (ha) (KHGM) | **Irrigation requirements** (mm/ha) | **Irrigation efficiency** (%) | **Crop water withdrawal** (million $m^3$) | **Crop water withdrawal** (million $m^3$) |
|---|---|---|---|---|---|---|
| Wheat (cereals) | 298,507.3 | 164,199.7 | 195 | 0.4 | 1,455.2 | 800.5 |
| Sugarbeet | 42,643.9 | 23,457.1 | 719 | 0.4 | 766.5 | 421.6 |
| Fruit trees (grapes) | 42,643.9 | 23,457.1 | 645 | 0.4 | 687.6 | 378.2 |
| Vegetables (tomatoes) | 21,322.0 | 11,728.6 | 668 | 0.4 | 356.1 | 195.9 |
| Lucerne | 21,322.0 | 11,728.6 | 795 | 0.4 | 423.8 | 233.1 |
| **Total** | **426,439.0** | **234,571.0** | | | **3,689.2** | **2,029.3** |

From the above table it follows that the volume of water required for irrigated crops in the Great Konya Basin ranges between 2,209 and 3,684 million $m^3$. Naturally available water amounts to only 4,200 million $m^3$, so the natural water supply situation is critical. To increase the irrigated area, additional water has to be imported from outside the basin, an activity already undertaken on a large scale.

## 3.2 Future water demand

IWMI Working Paper No.32 *Water for Rural Development* was used collect information on the future water situation. The general conclusion for this region is that there will be economic water scarcity – i.e. an increase in primary water supply of over 25 per cent of current levels.

**Table 3.1 Water demand forecast for Turkey**

| | **Irrigated cereal area** (million ha) | **Total water withdrawals** ($km^3$) | **Rain-fed cereal area** (million ha) | **PUWR** ($km^3$) |
|---|---|---|---|---|
| 1995 | 0.69 | 51.42 | 14.04 | 128.57 |
| 2025 | 1.18 | 92.85 | 14.10 | |
| Increase (%) | 1.8 | 80.5 | 0.0 | |

Source: Molden 2000