# A General Review of Groundwater Potential in the Seyhan and Ceyhan River Basins

**Mahmut CETIN**[1] **Kazım TULUCU**[2]

[1,2]*Department of Agricultural Structures and Irrigation, Faculty of Agriculture, University of Çukurova, 01330 Balcali-Adana, Turkey*
*e-mail:* [1]mcet64@mail.cu.edu.tr , [2]ktulucu@cu.edu.tr

**Abstract**

The aim of this study was to introduce Seyhan and Ceyhan river basins of Turkey, to try to find out what kind of information archived is available regarding groundwater quality and quantity, and to expose groundwater components of the basins. It is concluded that Seyhan and Ceyhan river basins are rich in groundwater and surface water resources as well as agricultural land, that neither long term nor short term groundwater quality and quantity data are available and/or accessible, that the degree and severity of groundwater pollution is not known. Along the Mediterranean sea salt water intrusion and salinisation of soil resources could be a severe problem not known yet.

## 1. Introduction

The flow regime of Turkish rivers is irregular due to varying geographical situation and topography. Therefore, river basins show different characteristics from each other in terms of climatic conditions, irrigable land, surface water and groundwater potential etc. The varied climate means that the flow of many rivers changes dramatically throughout the year (DSI, 1999), with the bulk of the water resulting from the melting snows of spring. On the other hand, many of the rivers have created extensive delta plains, of remarkable groundwater resource for domestic, industrial and agricultural uses.

Many organizations make information on groundwater available to the public through groundwater investigations. The public consists of individuals who use water as well as those who are concerned with exploration, development of supplies, distribution, and chemical quality. By information is meant: (1) raw data, such as observations on groundwater levels; (2) interpretations such as on quantity, distribution, sources of replenishment, and discharge in areas of concern; and (3) knowledge of fundamental principles and relationships (Walton, 1970). It is necessary to keep track of groundwater withdrawals, to inventory storage, and, in places of need, to know the physical facts concerning the volume of groundwater in storage, its occurrence, replenishment, relation to adjoining surface water bodies, and its state of contamination, if any (USBR, 1995). Different institutions are responsible for the development of groundwater resources in the real world. However, General Directorate of State Hydraulic Works (DSI) is the only legal institution responsible for the development and allocation of groundwater resources and any other groundwater issues mentioned above, in Turkey. Very limited information on the quality and quantity of groundwater basins of Turkey could be found in the archives of DSI.

The objectives of this study are to introduce Seyhan and Ceyhan river basins of Turkey, to try to find out what kind of information archived is available regarding groundwater quality and quantity, and to expose groundwater components of the basins.

## 2. Description of the Basins

Location of the study area in Turkey and some geographical characteristics of the basins are given in Fig. 1 and Table 1, respectively. The basins in question are located in the southern part of Turkey and discharge their surface and subsurface waters into the Mediterranean sea (Fig. 1). The main agricultural land have formed in the down stream parts of the basins and, typically, these plains suffer from poor drainage conditions and salinity problems.

As seen in Table 1, both Seyhan and Ceyhan river basin has almost the same amount of irrigable land consisting of 2.76 % of Turkey's potential, individually. Although the area of Ceyhan river basin is 7.49 % larger than that of Seyhan basin,

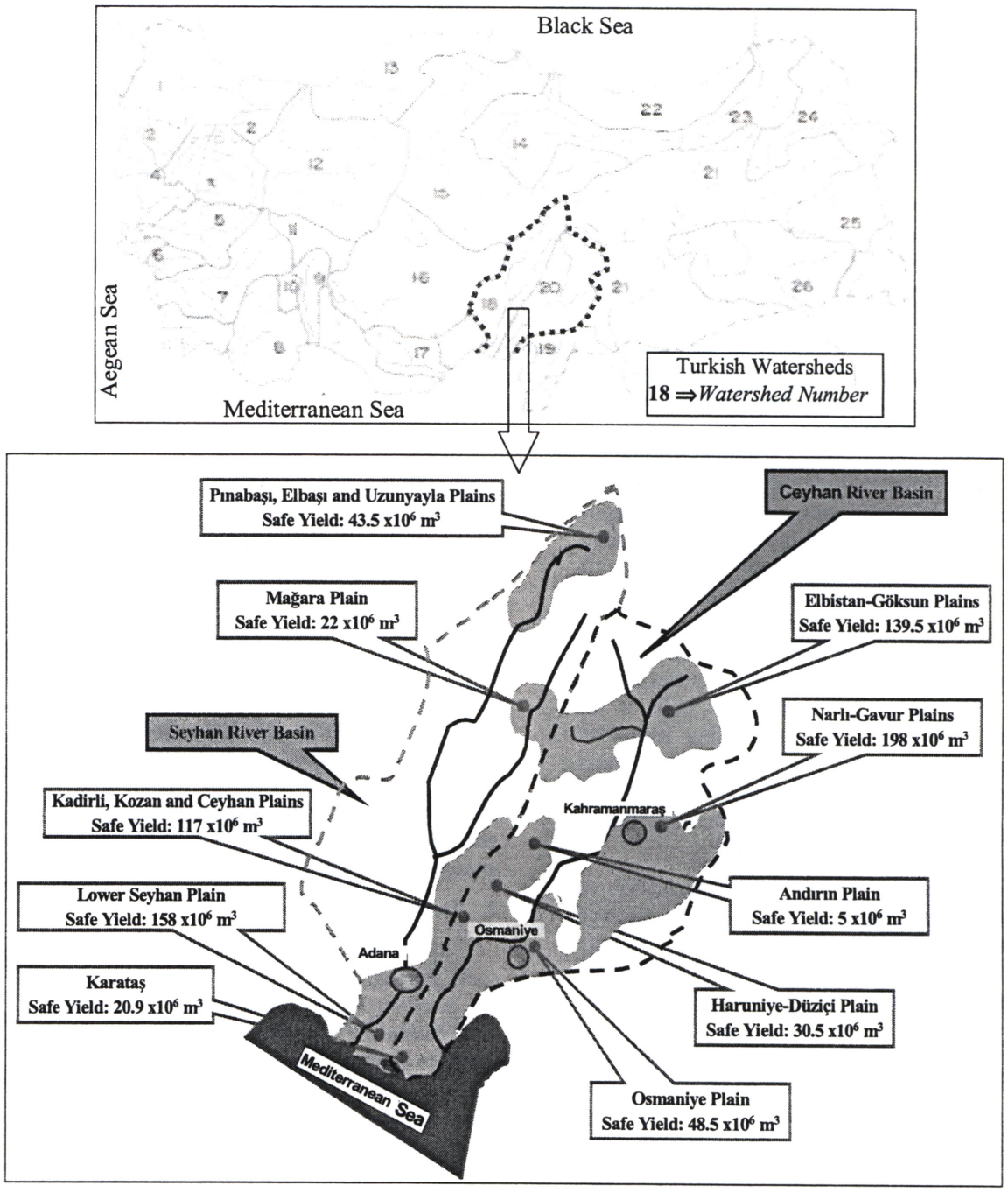


***Fig. 1.*** *Location of the Seyhan and Ceyhan River Basins in Turkey and Their Groundwater Potential*

its surface water potential is 10.36 % less than that of Seyhan river basin. Groundwater inventory studies, at the reconnaissance, planning and detailed stages, conducted by DSI show that annual groundwater potential of Seyhan and Ceyhan river basins is about 224 $km^3$ and 326 $km^3$, respectively. In a general sense, no detailed information is available on groundwater level changes (Cetin, 1990), groundwater quality such as existing pollution situation and future trends in the basins.

***Table 1.*** *Geographical Characteristics of the River Basins*

| **Geographic Characteristics** | **SEYHAN** | **CEYHAN** |
|---|---|---|
| Latitude | 36°30'- 39°15' | 36°33'-38°44' |
| Longitude | 34°45'-37°00' | 35°15'-37°43' |
| Basin total area $km^2$ | 20 450 | 21 982 |
| Surface water potential ($10^9$ $m^3$) | 8.010 | 7.180 |
| Irrigable land (ha) | 714 014 (2.76 %) | 713 670 (2.76 %) |
| Groundwater potential ($10^9$ $m^3$) | 224 | 326 |
| River's regime | Irregular | Irregular |

## 3. Methodology

To determine groundwater input and output parameters, and change in the groundwater reservoir, the following procedure was followed. The groundwater components of the hydrologic cycle used in estimating a groundwater budget are summarized in the equation (de Ridder and Boonstra, 1994; Walton, 1970).

$$I - O = \Delta S \qquad (1)$$

where:

I = Recharge to the aquifer

O = Discharge from the aquifer

ΔS = Change in storage in the aquifer

## 4. Results and Discussion

Elbistan-Goksun, Narli-Gavur, Kadirli-Kozan-Ceyhan, Haruniye and Osmaniye plains covering remarkable large areas suitable for irrigated agriculture have important groundwater resources in the Ceyhan basin and archived documentation showed that their safe yield was around 139.5, 198.0, 117.0, 30.5 and 48.5 **M** $m^3$ per year, respectively (Fig. 1). In some plains of the basin, farmers are still using groundwater resources for mainly irrigation, industrial and domestic purposes. On the other hand, Pinarbasi-Elbasi-Uzunyayla, and Lower Seyhan Plains are also rich in groundwater resources in the Seyhan basin and their safe yield is about 43.5 and 158.0 **M** $m^3$ per year, respectively (Fig. 1).

The groundwater components of the hydrological cycle could be hardly determined for the Haruniye, Osmaniye and Lower Seyhan plains. The results were given in Fig. 2. Because no sufficient information was available for the other plains, we failed to prepare groundwater budget for those plains.

Hydrogeological investigation reports were prepared just for Haruniye and Osmaniye plains (DSI, 1974; DSI, 1975) by DSI. DSI (1974) shows that 10 exploration wells, varying depths between 175 and 225 meters, were constructed in the Haruniye plain, that change in storage in the aquifer (Eq. 1) is approximately 43.6 **M** $m^3$ and safe yield is around 30.5 **M** $m^3$ per year. Sabunsuyu, of the average yearly water capacity of 123.6 **M** $m^3$, is the main surface water for the plain and recharges the unconfined aquifer system. However, present discharge, ET and underground flow component of the aquifer system are not known and needs researching (Fig. 2a). Additionally, Existing and future groundwater quality issues are questionable.

The aquifer system in the Osmaniye plain is unconfined. For the exploratory purposes, 17 deep groundwater wells varying depths between 25 and 206 meters were established by DSI (1975). Kalecik, Karacay, Hamis and yarpuz creeks, having total capacity of 502.1 **M** $m^3$/year, are main surface waters, discharging 60.5 **M** $m^3$/year into the unconfined aquifer system, in the Osmaniye plain. The safe yield of the aquifer system is around 48.5 **M** $m^3$ per year, on average, and all groundwater budget

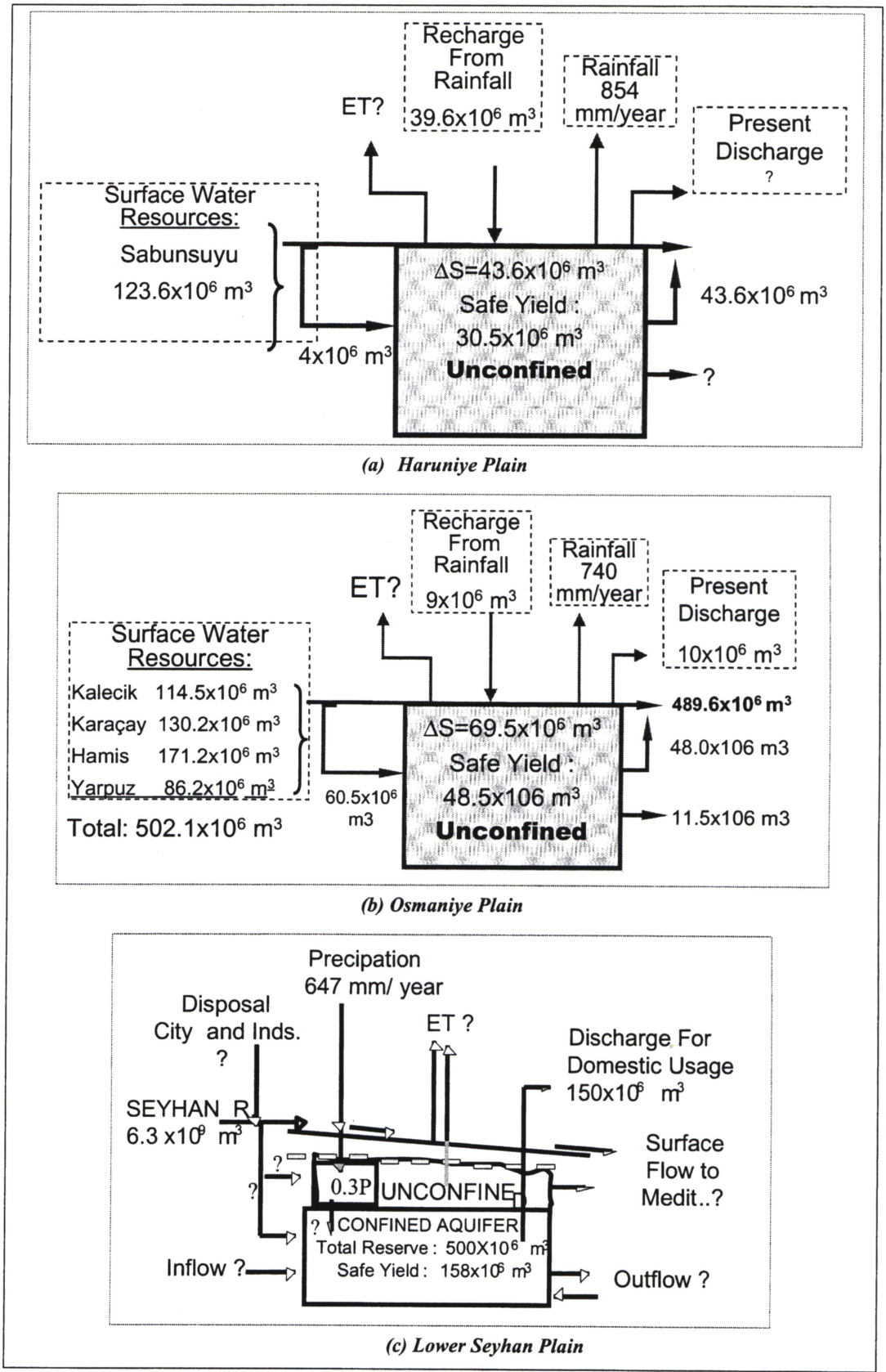


***Fig. 2.*** *Groundwater Budget Components of Eq. 1: (a) Haruniye Plain, (b) Osmaniye Plain and (c) Lower Seyhan Plain*

components, except for ET, are determined to some extend (Fig. 2b). Again, no information is available regarding quality issues such as pollution and pollutants.

Reconnaissance studies show that aquifer system in the Lower Seyhan plain is indeed complex and it is presumably a mixture of confined and unconfined aquifers having the depths from 20 to greater than 60 meters. Therefore, inflow and outflow parameters of the aquifer system are questionable (Fig. 2c). However, some parameters could be defined. In the Lower Seyhan Plain, it was determined that sewage and industrial pollution is a danger for the groundwater resources because of discharging pollutants into the surface water bodies and leakage to groundwater system. Although the situation is alarming, no detailed research has been conducted yet. Detailed research is needed to conclude precisely. Another important subject is that the plain is neighboring the Mediterranean sea. It is likely that saline water intrusion could be a serious problem along the Mediterranean sea when groundwater is dewatered or sea level rises.

## 5. Conclusions

The following conclusions could be drawn from this study:

- ✓ Seyhan and Ceyhan river basins are rich in groundwater and surface water resources as well as agricultural land.
- ✓ Neither long- nor short-term groundwater quality and quantity data are available and/or accessible.
- ✓ Groundwater pollution is such an issue that it is not known existing situation and future trends.
- ✓ Sea water intrusion is another issue along Mediterranean sea and needs detailed researching.

## 6. References


Cetin, M., 1990: A Study on the Existing Conditions of Groundwater of Dortyol-Erzin Plain and their Improvement Possibilities. M.Sc. Thesis, Institute of Applied Sciences, University of Cukurova, Adana, Turkey, (in Turkish with Extended English Summary), 123p.

de Ridder, N. A., and Boonstra, J., (1994): Analysis of Water Balances. In: Ritzema, H. P. (Editor-in-Chief), Drainage Principles and Applications. ILRI Publication 16 (Completely Revised), Wageningen, The Netherlands, Chapter 16.

DSI, 1974: Hydrogeological Investigation Report for Haruniye Plain. Geotechnical Services and Groundwater Division of General Directorate of State Hydraulic Works *(DSI)*, Ankara, Turkey *(in Turkish with Extended English Summary)*, 53p.

DSI, 1975: Hydrogeological Investigation Report for Osmaniye Plain. Geotechnical Services and Groundwater Division of General Directorate of State Hydraulic Works *(DSI)*, Ankara, Turkey *(in Turkish with Extended English Summary)*, 60p.

DSI, 1999: Statistical Bulletin with Maps. General Directorate of State Hydraulic Works *(DSI)*, General Pub. # 991, Group # VIII, Distinctive # 177, DSI Printing Office, Ankara, Turkey *(in Turkish)*.

USBR, 1995: Ground Water Manual. A Water Resources Technical Publication, Second Edition, U. S. Department of the Interior Bureau of Reclamation, U. S. Government Printing Office, Washington, DC, 661p.

Walton, W. C., 1970: Groundwater Resource Evaluation. McGraw-Hill Series in Water resources and Environmental engineering, McGraw-Hill, Inc., New York, 664p.