A NEW APPROACH FOR GROUNDWATER MANAGEMENT IN TURKEY
A groundwater management plan according to EU Groundwater directive (80/68/EEC) and Water Framework directive (2000/60/EC)

F.J.L. Vliegenthart
Hydrogeologist and project manager, Grontmij Nederland bv, PO Box 119, 3990 DC Houten, The Netherlands, frank.vliegenthart@grontmij.nl

A.H. Sargin
Branch head, DSI Genel Mudurlugu, Geotechnical Services and Groundwater Department, 06100 Yücepe, Ankara, Turkey, ahmetss@dsi.gov.tr

A. Gorkmen
Hydrogeologist, DSI Genel Mudurlugu, Geotechnical Services and Groundwater Department, 06100 Yücepe, Ankara, Turkey, agorkmen@dsi.gov.tr

M.S. Dogdu
Hydrogeologist, DSI Genel Mudurlugu, Geotechnical Services and Groundwater Department, 06100 Yücepe, Ankara, Turkey, mufitd@dsi.gov.tr

ABSTRACT

The Turkish-Dutch project ‘Strengthening the capacity of sustainable groundwater management in Turkey’ assists the Turkish government with the implementation of the EU Groundwater directive and the Water Framework Directive (groundwater aspects). In the implementation of EU directives three main aspects can be distinguished: juridical, institutional and technical aspects. The project combines these into an integrated approach. In the juridical part of the project gaps are analyzed between EU directives and existing Turkish (water) legislation. Based on this analysis, a work plan for transposition is proposed. The institutional part of the project prepares recommendations how to deal with the new requirements in groundwater management. An advice will be presented to improve current responsibilities and make clear distinctions in tasks for the involved organizations. Both juridical and institutional aspects are tested in a pilot groundwater management plan. For the Groundwater Management Plan (GMP) a pilot area (Küçük Menderes) was chosen for the implementation and testing of the new directives. This basin was selected because of its relatively small size and the availability of data. One of the main problems in the area is the depletion of the groundwater level due to overexploitation and the lack of precipitation. The project does not seek for short term solutions but performs a thorough analysis of the groundwater system and describes this into the GMP. One of the outcomes of the project is a set of measures and their effects on the groundwater
INTRODUCTION

Groundwater is a major source of drinking water and irrigation water in Turkey. In Turkey at present 55% of the current groundwater resources are allocated for irrigation purposes and 45% for drinking water and industrial purposes. Groundwater is especially used in areas where the usage of surface water is not possible or not convenient. For example; İzmir, Elazığ, Antalya, Kahramanmaraş, Konya, and Diyarbakır are the cities being supplied by means of groundwater resources.

Because of fast social and economic developments there is a growing need for the exploitation of groundwater resources. Groundwater investigations have been carried out since 1956, under responsibility of General Directorate of State Hydraulic Works (DSI). The growing demand for and usage of groundwater urges the development of an adequate legislative framework and management structure, focused on sustainable use of groundwater.

Water related activities are centrally planned in Turkey. The government sets out its economic and development priorities at national level in Five Year Development Plans (FYDP). These are developed by the State Planning Organization (falling under the Prime Ministry), in co-operation with experts from all sectors. Planned targets in these FYDPs are binding for the public sector.

In the seventh FYDP (1996 - 2000) one of the objectives, specifically with regard to groundwater resources was stated as: “Drawing up of a special law which includes institutional reorganization concerning planning, management and conservation of groundwater and surface water resources for the purpose of rational utilization in different sectors and elimination of disorganization in the existing legislation. In the eight FYDP, also an integrated planning approach and harmonization among involved institutions have been strongly emphasized.

This article describes backgrounds and first conclusions of the project including institutional, juridical and technical issues to full-fill the recommendations of the FYDP.

OBJECTIVE AND SETUP OF STUDY

The study is working on the integrated approach and harmonization of institutions as mentioned in the FYDP. The study aims to contribute to the accession of Turkey to the European Union. In particular, the study aims to assist Turkey in the transposition and implementation of directive 80/68/EEC (Groundwater Directive),

directive 2000/60/EC (groundwater sections of Water Framework Directive) and (as far as possible) the upcoming new Groundwater Directive.

For the purpose of the study, three working groups have been created to work on all relevant aspects:

- A Juridical Working Group, dealing with transposition of EU legislation;
- An Institutional Working Group, dealing with institutional structure of groundwater management;
- A Technical Working Group, dealing with the pilot groundwater management plan.

The working groups are composed of employees of the counterpart, the beneficiary and the project team. The Juridical and Institutional Working Group consisted of people from national level, while the Technical Working Group consisted of people from national level and regional level.

Figure 1 shows the relation between the Working Groups. Questions to the other Working Groups were posed, which would be put on the agenda for the other Working Groups. Answers were provided before the next round. On necessary occasions joint meetings were organized. In this way a swift and smooth process of exchange of information was secured which has lead to good results in the project.

![Figure 1. Interaction and relation between working groups](image)

INSTITUTIONAL AND JURIDICAL ASPECTS

General

The integrated approach to groundwater resources management provides a framework for linking policy dialogue, legislation, structural reforms, use of economic instruments, technical interventions, environmental management and social concerns at a variety of levels.
The institutional and juridical frameworks in water management are considered as a key determinant. They are part and parcel of each other. It is clear that the more coherent they are the better solution we achieve.

In Turkey, water related activities are centrally planned. Water resources management is described in the Five Year Development Plan, specifying the general principles and priorities of the implementation of medium and long term economic, technical, environmental social and cultural policies.

Institutional framework has three levels. These are decision maker, executive level and end users.

The Prime Ministry, related Ministries and State Planning Organization are the decision maker.

Governmental institutions take place in executive level. They have a two-tiered organization. Its top management level is the General Directorate office in Ankara. General Directorate has several department offices. The second management level consists of the Regional Directorates or Provincial Directorates throughout the country.

There are both governmental and non-governmental organizations at the user level for the operation and maintenance of the projects. In terms of irrigation, Water User Association, Groundwater Irrigation Cooperatives, Public Irrigation and individual person are the main users.

Involved organizations in water management

Similar to other countries several line ministries are involved in the harmonization and implementation of environmental legislation in Turkey. Below is an overview of all organizations involved in groundwater and groundwater management:

- Development Plans are prepared by the State Planning Organization.
- DSI, as a competent water authority, is the main organization responsible for water resources management. All water resources are managed in accordance with Law No. 6200. DSI was nominated for preparing of water law which was intended in the content of seventh FYDP.
- The Ministry of Environment and Forestry was established for environmental protection, prevention of environmental pollution and taking required measures in accordance with the Law No. 4856.
- General Directorate of Electrical Power Resources Survey and Development Administration (EIEI) is responsible for surveys on electric power and for rational use of it.
- Special Provincial Administrations works for under the auspices of Governorships (Law No. 5302). The responsibilities of SPA related to groundwater issues include supplying potable water to rural communities by drilling the
groundwater wells, foundation of irrigation cooperatives, designing irrigation projects to individual farmer irrigations and construction of irrigation channel for irrigation cooperatives.

- The Bank of Provinces, an affiliated institution of the Ministry of Public Works and Settlements, is responsible for urban planning, public works and drinking water supply for municipalities in accordance with the Law No.4759 on Bank of Provinces.

- Metropolitan Municipalities have their own power in accordance with Law No. 5216 on Metropolitan Municipalities. This law is valid for the territorial border of Metropolitan Municipalities. They should ensure the protection of water basins in harmony with the principle of sustainable development.

- Law No. 2560 on Establishment and Duties of General Directorate of Istanbul Water and Sewage Administration gives authority to Istanbul Water and Sewage Administration. Responsibilities of water and sewage administrations (within the border of all metropolitan municipalities) are to take legal, technical and administrative measures for prevention of groundwater pollution and decreasing of groundwater quantity.

- The Ministry of Agriculture and Rural Affairs is responsible for making investigations and preparation projects to protect and improve the resources of soil, water, plants, animals and fisheries as well as products, control of wastewater discharges and receiving environment in fish production areas, monitoring of nitrates parameter in freshwater and groundwater in accordance with The Decree-Law No. 441.

- The Ministry of Health is responsible for determining the quality standards of drinking water and water for consumption, monitoring of these standards and making legislation concerning these areas.

- Ministry of Finance is empowered for allocation of water belonging to the State to municipality.

- The Ministry of Foreign Affairs is involved in all transboundary water related issues.

**Legislation**

For groundwater management the EU Water Framework Directive and the EU Groundwater Directive are important, both need implementation in Turkish legislation. Relevant present Turkish legislation is the Turkish groundwater law and the Turkish Environmental Law. Some backgrounds and details are described under this section of the article.

As for legislation in the water sector, the Turkish Constitution is the basic legislation. It covers that water resources are the natural wealth of the country and should be used for the benefit of the citizen. Within this content, Turkish Civil Code grouped water resources into two categories as common water and private water.
Except some springs located on the private land, the development of water resources is under the responsibility of State. Unfortunately, there is no “Water Law” describing all water issues. Development of surface water has been carried out by organic laws of the water related organizations. DSI is the primary institution authorized to manage water resources. All water resources are managed in accordance with Law No. 6200 on the Organization and Duties of DSI.

Organic law of Water and Sewage Administration gives some responsibility to metropolitan municipalities. That’s why conflicts can arise between DSI and Water and Sewage Administrations. Also, with the aim of achieving decentralization, General Directorate of Rural Service (GDRS) was abolished. Besides, its regional branches (SPA-Local Authority of Rural Service) go on performing the duties. Supplying potable water to rural communities by drilling the groundwater wells is one of the main duties. Unfortunately it does not get license to provide groundwater according to its organization Law. Because groundwater management is carried out by organic law of organizations, there are overlapping subjects related to responsibilities on groundwater issues.

**Turkish Groundwater Law**

Only, management of groundwater resources has been regulated by Law on Groundwater, which followed by DSI on behalf of the State. It was brought into force in 1960. According to the Law, groundwater is under the control and ownership of the State.

Any research, allocation, utilization, protection and registration of groundwater are the main characteristics of the Law. Within the framework of the Groundwater Law, whenever and wherever each person intends to construct a water structure in order to provide groundwater (such as drilling well, excavating galleries or tunnels, etc.), they should get license from DSI (Except SPA).

Besides, in accordance with the aims indicated in the Law on Groundwater; Regulation on Groundwater and Technical By-law on Groundwater were prepared in order to apply the Law efficiently. Technical By-law covers technical details.

**Turkish Environmental Law**

Besides, the first governmental action related to qualitative assessment of water resources is “Environmental Law” in 1983. Afterwards, it was amended. The Law on Environment covers three main ideas. These are as follows; the general principles for environmental protection and prevention of pollution, the measures and prohibitions related to environmental protection and imposition of administrative penalty to
polluters deteriorating the quality of groundwater. “Polluter pays” is the main principle. In accordance with the targets defined in Law on Environment, By-law on Water Pollution Control was prepared.

While groundwater directive (80/68/EEC) provides discharge into groundwater, even if waste water is treated, it is not allowed direct or indirect discharge into groundwater according to Turkish Environmental Law.

**EU Groundwater Directive (80/68/EEC)**

The Groundwater Directive was prepared for the protection of groundwater against pollution caused by certain dangerous substances. This Directive provides a protection framework by preventing the direct discharge of high priority pollutants (List I) and subjecting the discharge of other pollutants (List II). For these issues, prior investigation and an authorization procedure are necessary on a case-by-case basis. Also, monitoring is required only for specific cases and is not generally required for all groundwater bodies.

Article 17 of the WFD includes the strategies to prevent and control pollution of groundwater. Within this context, the European Parliament and the Council shall adopt specific measures to prevent and control groundwater pollution by defining criteria on good chemical status and on quality trends.

The directive has not been transposed into Turkish Legislation yet.


A framework for the Community action in the field of water policy, the EU Water Framework Directive (WFD) was finally adopted by EU member states. The WFD is the most substantial piece of water legislation ever produced by the European Commission, and will provide the major driver for achieving sustainable management of water in the EU Member States for many years to come. It requires that all inland and coastal waters within defined river basin districts must reach at least good status by 2015 and defines how this should be achieved through the establishment of environmental objectives and ecological targets for surface waters. The result will be a healthy water environment achieved by taking account of environmental, economic and social considerations.

**GROUNDWATER MANAGEMENT PLAN**

Harmonization and implementation of the Groundwater Directive and Water Framework Directive is worked out in practice by implementing a pilot project at regional level with the aim of developing a Groundwater Management Plan. This
enhances the knowledge and experience, both on institutional and technical level, with the actual implementation of European groundwater legislation and in that this might also contribute to further harmonization and implementation of this groundwater legislation. In the development of a groundwater management plan, certain legal and institutional issues will become clear. On the other hand, legal interpretations will have practical implications on the field scale. By regarding all three aspects holistically a solid groundwater management plan is developed.

In the Water Framework Directive it is described that so called River Basin Management Plans (RBMP) needs to be prepared. Annex VII of the Water Framework Directive describes the contents of these plans related to surface water and groundwater. In a groundwater management plan similar aspects are described but such a plan focuses mainly on groundwater management.

Following steps, of which some will be explained in more detail in this article, are required in the development of a Groundwater Management Plan (GMP):

1. Characteristics of the groundwater bodies
2. Summary of significant pressure and impact of human activity
3. Identification and mapping of protected areas
4. Map of monitoring networks
5. List of environmental objectives
6. Summary of economic analysis
7. Summary of programme of measures
8. Register of more detailed programmes including summary
9. Summary of public information and consultation measures
10. List of competent authorities
11. Contact points and procedures for obtaining background info and comments from the public

Selection of Pilot area

A GMP should be developed on the basis of the outlines of a River Basin. Groundwater bodies should be inside or have direct relations with (preferably) a single River Basin. A groundwater body outside of a (sub) River Basin cannot be fully evaluated according to above mentioned steps. For instances: there is risk that a pressure (groundwater abstraction) in upstream area is affecting a groundwater body in downstream area. The situation in this downstream groundwater body can (most likely) not be improved with measures inside this downstream groundwater body. Measures are probably necessary in the upstream area too and therefore it is necessary to include the whole groundwater basin (or river basin) and not a single sub basin (see figure 2 for a schematized figure of this situation).
With this knowledge the search for a suitable pilot area started. In the selection of the area we also included following criteria:

- The area should be representative for groundwater in Turkey;
  - both water quantity and quality (nitrate, pesticides, heavy metals) issues should be present;
  - different pollution sources;
  - significant impacts / problems;
  - complex enough to deal with all aspects;
- Availability of data and local groundwater knowledge;
- A connection with surface water is preferred (link with WFD).

All criteria were found in the river basin of the Küçük Menderes in the southwestern part of Turkey. Besides mentioned criteria, for the purpose of the study, this area had the benefit of being relatively small compared to most of the other river basins. The process itself is important in this study, not the very detailed issues themselves. For that reason a smaller area was preferred. Figure 3 shows the location of the Küçük Menderes river basin.
Küçük Menderes river basin

For the Küçük Menderes river basin a Groundwater Management Plan is developed. As already mentioned the steps in the plan itself are important. This Groundwater Management Plan is the very first one to be developed in Turkey and therefore this plan will act as an example for the other river basins in Turkey.

Küçük Menderes River Basin has a drainage area of 3502 km² and extends from east to west. The basin is surrounded by several mountains and ridges between 600 and 2159 m above sea level. The lowest regions in the basin are plain areas. The altitude of the plains increases from west to east.

The Küçük Menderes River basin has the typical Aegean (Mediterranean type) climate characteristics. Summer seasons are hot and dry, winter seasons mild and rainy. Precipitation type is generally convective but at sea shore and high elevations of inner land it is orographic. The regional average annual precipitation of the basin is 730.2 mm/year according to long-term data. The average air temperature of the basin is 16.6 °C. The average monthly air temperature varies from 7.1 °C in January to 27.5 °C in July. The annual evaporation value for the basin has been calculated as 1517 mm (Yazıcıgil, 2000).

Figure 3. Turkey and the Küçük Menderes River basin
The main stream in the basin is the Küçük Menderes River and its tributaries which are Fertek, Uladı, Ilica, Değirmen, Aktas, Rahmalar, Prinçi, Yuvalı, Çeriköz-kayası, Eğridere, Birgi, Çevlik and Keles streams. The annual mean discharge of the river at the Selçuk gauging station, having a catchment area of 3255 km², is 11.45 m³/sec. Long period (1953-2004) flow data of Küçük Menderes River are given in Figure 4. Küçük Menderes River begins to flow from east of the basin at the altitude of 220 m in Kiraz Sub-basin. After that, the river flows from north to south in Kiraz Sub-basin until the altitude of 170 m in Beydağ County. From this point, Küçük Menderes River flows approximately in east-west direction and passes through Ödemiş Plain and reaches Torbalı County in the east at 20 m altitude. The river turns towards the north-south direction and arrives at Selçuk Plain (5 m altitude) by passing Belevi passageway (neck). It completes the flow in the Aegean Sea. Total surface flow length of Küçük Menderes River is 114 km. The other streams and creeks in the basin are ephemeral.

There is no surface water storage facility in the basin. Beydağ Dam, which is planned to function by the end of 2009, will be used for irrigation purposes. Beydağ Dam is located in the eastern part of the basin in Beydağ County. Additional dams (3 in total) are planned but still under review and further study.
Although the groundwater bodies (GWB) in the area are derived according to the available lithological data, GWB as defined in the WFD is not a classical hydrogeological unit; rather, it is a reporting unit used for purposes of water management plans such as assessing the status of groundwater, monitoring the qualitative and quantitative impacts of water abstraction, establishing environmental objectives, implementing the necessary measures and assessing their effectiveness through monitoring. A generalized geological map of KMRB is given in Figure 5.

Figure 5. Groundwater bodies in Küçük Menderes River Basin

According to that map and the groundwater body definition in the Water Framework Directive, two main GWBs were derived in KMRB: Alluvial fill deposits (GWB-I) and the marbles of the Menderes Massive (GWB-II).

The alluvial fill deposits or GWB–I constitute the main aquifer and cover almost the entire plain area. The alluvial deposits are generally composed of complex alternations of gravel, sand, silt and clay materials. These deposits form the main aquifer in Kiraz, Ödemiş-Tire, Bavyırı-Torbali, Tire-Belevi and Selçuk Plains. The thickness of these deposits reaches as much as 200-250 m in Bavyırı-Torbali and Ödemiş-Tire Plains. The average specific capacities and yields of hundreds of wells drilled by DSI and İller Bank in this unit are 2.0 l/sec/m and 28 l/sec, respectively. The average hydraulic conductivity (K) of the unit is 5.6 m/day. The Neogene units, which are characterized by a sedimentary sequence grading from clastic to limestones, and acidic volcanics, can be considered with in the alluvial fills defined above due to similar hydraulic characteristics.
Marbles, constituting the upper part of the metamorphic sequence (Menderes
Massive), can be considered as the second GWB in the basin. They have secondary
porosity and permeability produced by the presence of fractures and solution cav-
ities. As a result they show productive aquifer characteristics, specifically in the west-
ern part of the basin. There are only a few wells drilled in that body compared to the
first system. According to those data, the average specific capacity and yield values
are 18 l/sec/m and 43 l/sec, respectively. The average hydraulic conductivity (K) is 52
m/day. However, these values may not be representative as there are only a few
wells drilled in that body and due to the complexity of karstification. Hence, in order
to make a reliable groundwater management plan, it is essential to make additional
investigations on the GWBs defined above (especially on marbles).

Pressures

Related to water quantity the main pressures in the area are the amount of
groundwater wells, the total abstraction of groundwater, lack of precipitation and
primitive irrigation systems. Groundwater is used for drinking water, industry and
irrigation purposes. The amount of installed wells has rapidly increased from the
1980's due to growth of population and lack of precipitation. Compared to the offi-
cial situation, in practice, the situation is even worse due to a large amount of non-
registered or illegal wells. The amount of non-registered wells is unknown.

The groundwater levels in the area have been lowered especially in the last 20-25
years. The reasons of the groundwater level changes can be divided in seasonal fluc-
tuations and long term fluctuations. Seasonal fluctuations of the groundwater level
depend on the abstraction of groundwater during irrigation periods and variation of
the seasonal precipitation. The irrigation period in the area is between April and
October. The groundwater levels recover at the end of the irrigation period under
natural conditions. But these natural conditions have been deteriorated by human
activities (especially excessive pumpage after 1985s) and the effect of prevailing dry
period after 1980s.

The amount of groundwater potential based on equilibrium conditions as of
1967 is about 127*10^6 m³ (for GWB-I). At present the amount allocated for irrigation is
57*10^6 m³, for drinking water and industrial use 37.2 *10^6 m³ and for private irriga-
tions 60*10^6 m³. The total amount allocated is about 154.2*10^6 m³ which is an over-
exploitation of 27.2*10^6 m (21%). These numbers do not include any corrections for
non-registered or illegal wells. If non-registered wells are also considered, it is obvi-
ous that the difference between operational groundwater reserve and allocation
amount will be bigger and long-term fluctuations will be much more effective in the
basin which will cause the lowering of the groundwater table as shown in Figure 6.
The Water Framework Directive includes a set of criteria to see whether or not a groundwater body is in good or bad status. These criteria need to be used to compare the current and future situation of the groundwater body status. Definition of the quantitative status of a groundwater body is good, if:

- The level of groundwater in the groundwater body is such that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction;
- Accordingly, the level of groundwater is not subject to anthropogenic alterations such as would result in:
  - failure to achieve the environmental objectives for associated surface waters,
  - any significant diminution in the status of such waters,
  - any significant damage to terrestrial ecosystems which depend directly on the groundwater body,
- Alterations to flow direction resulting from level changes may occur temporarily, or continuously in a spatially limited area, but such reversals do not cause saltwater or other intrusion, and do not indicate a sustained and clearly identified anthropogenically induced trend in flow direction likely to result in such intrusions.
CONCLUSIONS

The first criterion is the most relevant for GWB-I in the Küçük Menderes River Basin. Main conclusion from figure 6 (and related text) is that groundwater at present is over abstracted, primitive irrigation systems are used and the amount of precipitation is low. Too much groundwater is used compared to the natural recharge and conditions. According to the Water Framework Directive this situation is not accepted. To see if any changes in groundwater abstraction can be expected in the future additional research is done on:

- Irrigation systems and water saving technologies;
- Population density (densely populated areas exert greater pressure than areas with only few inhabitants per square kilometer, everything else equal);
- Characteristics of water services (basically drinking water supply, sewerage, wastewater treatment, number and proportion of persons connected to water services) are another important indicator of the pressures water bodies are exposed to;
- Macro-economic indicators (GDP, employment, income);
- Economic relevant sectors such as agriculture (total crop/irrigated area), livestock (amount of energy, fertilizers and pesticides used) and tourism (development in visitors in summer/winter);
- Education of the people (especially farmer)

Based on these developments it is expected that demand (for drinking water, industrial use and irrigation) will not reduce in the near future till 2015 (preliminary conclusion) but it is clear that rise of water use should be expected. An important development (baseline scenario) is the construction of the Beydağ Dam. It is expected this dam will be finished by 2009. From that period, less groundwater will be abstracted in the upstream area of the River Basin. It is expected farmers will use this water instead of groundwater while the abstraction of groundwater will be more expensive (energy costs) compared to the water from the reservoir. But, as most likely less groundwater will be used, also less recharge will be possible in the (local) mountainous area within the watersheds.

It is mentioned in Yazıcıgil (2000)’s study, what the effect will be realized when Beydağ Dam will be fully operational. In that situation groundwater is still needed for industry, drinking water and irrigation in such amount it still increases the safe yield (pumpage=total recharge) and the sustainable yield (long term pumpage and recharge). Similar calculations are done for the future situation after construction of 3 more additional dams. In that case it is expected the safe yield will not be increased anymore but the sustainable yield will still. Due to this, groundwater levels and the groundwater body will still not recover into “good status” according the Water Framework Directive in terms of quantitative status.
For that reason additional measures will be needed. These measures are part of this study and are still not completed. An important measure in this could be the pricing of water. It is mentioned in the Water Framework Directive and under discussion in Turkey. But also inspections, enforcement, irrigation techniques, water conservation, abstraction from other groundwater bodies (especially GWB-2) are important measures and instruments for further study.

Similar issues are relevant for some part of Turkey. For that reason we think this study is important into the approach toward Europe and the implementation of the Water Framework Directive and the Groundwater Directive. Concept of the groundwater management plan need to be used in the future.

At the same time institutional and juridical restructuring might be needed too. This study will give suggestions on those aspects. A new perspective on the existing Institutional Framework should be implemented. Afterwards, enforcement, monitoring and inspection system in accordance with the Water Framework Directive should be established to achieve sustainable goals.

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