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Groundwater governance in transboundary aquifers: A case study from Greece-Bulgaria

Управление на подземните води в трансграничните водоносни хоризонти: казус Гърция-България

Konstantinos Voudouris[1], Elpida Kolokytha[2], Panagiota Venetsanou[1], Nerantzis Kazakis[1]
Константинос Вудурис[1], Елпида Колокита[2], Панайота Венецану[1], Неранцис Казакис[1]

[1] Aristotle University, Department of Geology, Laboratory of Engineering Geology and Hydrogeology, Thessaloniki, Greece; E-mail: kvoudour@geo.auth.gr
[2] Aristotle University of Thessaloniki, Dept. of Civil Engineering, Thessaloniki, Greece; E-mail: lpcol@civil.auth.gr

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Transboundary aquifers

During the last decades there was an enormous increasing in boreholes construction for urban water supply, irrigation and industrial processing. For this reason, groundwater became a key resource supporting human well-being and socioeconomic development. Many aquifers in the world are transboundary extending over two or more countries and are characterized by variable direction of groundwater flow according to the pumping pattern. The modernization of processes to manage demand and distribution of groundwater resources of transboundary aquifers is a specific target today. High interdependency and uncertainty, climate change implications, political oppositions and geopolitical setting together with the absence of effective institutional legal machinery for settling riparian disputes form the complex problem of transboundary river basins. Hopefully the cases of water cooperation are far more often than those of conflict.

This work depicts the transboundary aquifer systems along the boundaries between Greece and Bulgaria. A set of indicators for the sustainable transboundary aquifer management, and governance is proposed and discussed.

Groundwater governance – indicators

Groundwater traditionally is considered a national matter, but in the case of transboundary aquifers the need for international cooperation on groundwater is increasingly recognized nowadays. This is due to the following reasons (Vaessen, Brentführer, 2015):

1) Groundwater is characterized by (Seward, Xu, 2019) high subtractability (one person’s use subtracts from another person’s use) and low excludability (it is difficult to exclude additional users).

2) Groundwater resources are recharged in one country but are discharged and exploited in another.

3) Groundwater development and exploitation in one country has (or could have) significant implications and adverse impact in the riparian country.

4) Some ecosystems in one country depend on groundwater influx from another country.

5) Land-use changes and groundwater development planned in one country affect groundwater resources (quantity or quality) in neighboring countries.

6) Groundwater is a significant resource in drought and flood management for one or more of the sharing countries.

Groundwater governance is the process by which groundwater resources are managed through the application of policies which promote among others aquifer protection, participation and transparency. It is the art of coordinating administrative actions and decision making between and among different jurisdictional levels (Saunier, Meganck, 2007). Groundwater governance including exchange of information, transparent and sustainable management is a precondition and of utmost importance for water security and water supply. There is a distinction between groundwater management and groundwater governance (Seward, Xu, 2019). The first includes hydrogeologists determining rules about groundwater availability and water managers implementing these rules. In contrast, the governance takes into account the concerns of scientists, policy makers and users of a groundwater resource. So, water governance refers not only to the technological solutions

of water supply but also to how water resources are managed, in terms of optimizing the use of existing supplies as well as balancing the social, ecological and economic impacts of new sources (Hoogester, Wester, 2015).

It is pointed out that in the Mediterranean region, the climate changes have put groundwater under anthropogenic pressures (overexploitation, changes of land uses, construction of dams, pollution from agriculture and wastewaters). In addition, groundwater is a key natural resource for the achievement of the UN Sustainable Agenda for 2030, focusing on management and reduction of water stress (SDG target 6.4) and implementing integrated water resources management (SDG target 6.5). Difficulties that arise in the management and governance of transboundary catchments can be due to the lack of: political will for cooperation, understanding among decision makers, scientists, water professionals, stakeholders, and effective exchange of data, technology transfers and information

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention, 1992) and the Convention on the Law of the Non-Navigational Uses of International Watercourses (Watercourses Convention, 1997) are the two legal documents which support and reinforce transboundary cooperation.

The following proposed criteria should be included in groundwater governance research (Table 1):

Table 1. Proposed criteria for the evaluation of groundwater governance (after Seward, Xu, 2019, with modifications)

s. n.	Criteria	Context
1	Hydrogeological maps	existence of aquifer and identification of groundwater
2	Aquifer delineation and characterization	type of aquifer, covering area
3	Groundwater level monitoring	to establish resource and exploitation status
4	Groundwater quality monitoring	for determining quality degradation risk
5	Pollution pressures	inventory of pollution sources, land uses
6	Aquifer vulnerability assessment	application of a suitable method to assess the vulnerability to external pollution
7	Safe yield estimation	the rate at which groundwater can be withdrawn without causing undesirable adverse effects
8	Groundwater abstractions via boreholes	groundwater budget of the aquifer
9	Public participation	effective in control of exploitation and pollution
10	Coordination with agricultural development	ensuring water safe and efficiency
11	Land use control	prohibition or restriction to reduce the risk
12	Groundwater use rights	compensation, penalties, motivations to conserve and protect groundwater resources
13	Groundwater management action plan	measures and actions

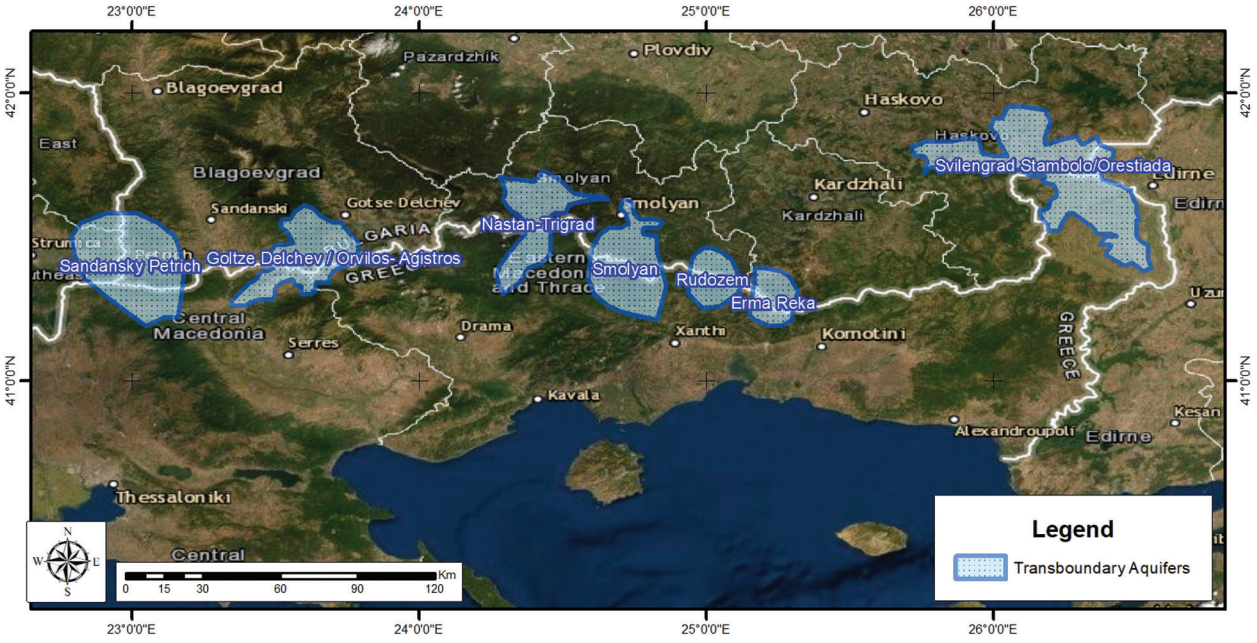

Fig. 1. Transboundary aquifer systems between Greece and Bulgaria (www.inweb.gr with modifications)

Table 2. Transboundary aquifer systems between Greece and Bulgaria (www.inweb.gr)

s. n.	Name	ID	Type	Area (km^2)	Geology	Water use
1	Sandansky Petrich*	50	fissured	764	gneiss	Domestic, irrigation, thermal springs
2	Gotze Delchev/ Orvilos- Agistros	51	karst	200	marbles	No direct uses
3	Nastan-Trigrad	52	karst	203	marbles	No direct uses
4	Smolyan	53	fissured	94	granite	No direct uses
5	Rudozem	54	mixed	80	marbles, gneiss	No direct uses
6	Erma Reka	55	fissured	40	marbles	No direct uses
7	Svilengrad Stambolo/ Orestiada**	56	alluvial	672	sand, gravels	90% for irrigation and 10% for drinking water supply

* Greece-Bulgaria-North Macedonia, ** Greece-Bulgaria-Turkey

hydrogeological maps, aquifer delineation, groundwater level and groundwater quality monitoring, pollution pressures and aquifer vulnerability assessment to external pollution, safe yield estimation, groundwater abstractions via boreholes, public participation, coordination with agricultural development, land use control, groundwater use rights, and existence of groundwater management plan.

Transboundary aquifer systems between Greece and Bulgaria[1]

According to the UNESCO Chair/International Network of Water-Environment Centres for the Balkans (INWEB, www.inweb.gr) there are seven (7) transboundary aquifers (Fig. 1). The general characteristics of these aquifers are shown in Table 2. Three aquifers are karstic developed in marbles, three aquifers are developed in fissured rocks and one is mixed (marbles, gneiss). All these types are vulnerable to external pollution and highly dynamic and heterogeneous with complex hydrological processes. The hydrogeological behaviour of these rocks is controlled by tectonic deformation, which favors infiltration of rainfall. The aquifer systems discharge also through springs. One aquifer (Svilengrad-Stambolo-Orestiada) is developed in quaternary sediments and is systematically pumped for irrigation purposes. Groundwater natural recharge occurs via infiltration through rivers (Arda, Evros/ Maritsa) and despite the exploitation the groundwater levels show stability (good quantity status).

There is no systematic record of quantity and quality data of the aforementioned aquifers in the two countries. According to the Ministry of Environment and Energy of Greece (Special Secretariat for Water, Update of River Basin Management Plans, Water District of East Macedonia and Thrace, 2017) all the aquifers in Greek part are in good groundwater quality and quantity status, underlining the important role of them to supply water for domestic use. The rational and sustainable management of transboundary aquifers requires the necessity of mutual cooperation between Greece and Bulgaria for conflict resolution. A shift is needed from a dialogue mostly focused on the *rights* a country feels has, to the *needs* – namely what is actually required to achieve its goals on the long run. For this purpose data (hydrogeological, climatic, water quality data, land uses, groundwater abstractions, etc.) from each transboundary aquifer systems should be collected and evaluated. Furthermore, integrated risk analysis and multi-criteria decision analysis should be applied as an additional managerial tool (Ganoulis, 2008; Ganoulis et al., 2010).

[1] *Ed. note*: there is considerable information about the territory of Bulgaria dating back to 1985. The latest information on cross-border underground water bodies is summarized on the GEOSCIENCES for 2015 and 2017 and Geologica Balcanica:

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