PART 3
TRANSBOUNDARY GROUNDWATERS

SECTION II

Transboundary Groundwaters in South-Eastern Europe

Chapter 1

SCALE AND SCOPE

SCALE AND SCOPE OF TRANSBOUNDARY GROUNDWATERS IN SOUTH-EASTERN EUROPE

This regional assessment covers transboundary groundwaters shared by two or more of the following countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, Moldova, Montenegro, Romania, Serbia, Slovenia, The former Yugoslav Republic of Macedonia and Turkey. Some transboundary groundwaters in the region have been identified and known for a considerable time and were noted by the earlier UNECE inventory and the inventory by the International Network of Water-Environment Centers for the Balkans (INWEB). However, South-Eastern Europe (SEE) has seen major conflict and political change in the last fifteen years. Aquifers and groundwaters that for many years were located within a single country are now shared between new countries. Thus, while the previous UNECE inventory recorded 23 transboundary aquifers in the region and INWEB reported 47, the present assessment covers 51. The requirement of the Water Framework Directive (WFD) to identify and characterise groundwater bodies as a basis for their integration into river basin management plans has helped to stimulate interest in and knowledge of potential transboundary groundwaters in the region. While this applies particularly to EU member States, it is also significantly influencing the work of those institutions responsible for groundwater in candidate countries and others in EU neighbours.

The assessment has not taken a fixed view as to the minimum size of groundwater to be included; small aquifers can provide a locally critical resource. Thus, some of the 51 groundwaters covered by this assessment are included because one country considers them important even though the neighbouring country does not and may not even recognise them as transboundary groundwaters. In addition, some 10 - 15 further potential transboundary groundwaters in the region, including some previously identified by the INWEB inventory, are not included in the assessment because of their very small size and/or because both neighbouring countries considered them either to be unimportant or not actually transboundary. It is also quite possible for a geological formation which is an aquifer to be crossed by national borders in two different situations where transboundary groundwater flow is hydraulically unlikely. The first occurs where the national border coincides with a major watershed and the hydraulic gradient and hence groundwater flow is strongly away from the border into both countries. The second occurs where an extensive alluvial aquifer stretches each side of a major river (such as the Danube) which forms the national political border and also provides such a dominant hydraulic barrier that transboundary groundwater flow is unlikely. In such cases, a "boundary" rather than transboundary groundwater has been recognised, and several have been excluded on this basis at the request of the countries concerned. However, modification of groundwater flow patterns by human activities and the greater hydrogeological knowledge gained from WFD characterisation means these situations should be kept under review and reconsidered in future assessments.

Transboundary groundwater resources play a significant role in SEE. The physical environment of the region – the geology, topography and major catchments – is such as to promote the occurrence of productive aquifers. These aquifers are mainly of two distinctive main types – the limestones and dolomites of the karstic type area of the Dinaric coast and its mountainous hinterland, and the alluvial sedimentary sequences of the Danube basin, mainly those associated with the Danube River itself and its larger tributaries. In some locations, the alluvial sediments overlie and are in hydraulic contact with the karstic limestones, or comprise relatively thin aquifers of river or lake sediments overlying ancient metamorphic rocks as, for example, between Greece and The former Yugoslav Republic of Macedonia.

The karstic aquifers tend to have recharge zones in mountainous areas on the national borders so that groundwater flow is from the border region towards each country (type 1) or have recharge dominantly in one country and flow into the neighbouring country (type 2). This means that, in general, they are not densely populated in the recharge areas, and have rather few pressures from human activities, and some of them cover only a few tens or hundreds of square kilometres (see table below). Many are characterized by very large discharges from major springs such as the Blue Eye Spring in Albania (18.5 m^3/s), and the Lista Spring in Greece (1.5 m^3/s), both issuing from Mali Gjere/ Mourgana aquifer; and the St. Naum Spring in The former Yugoslav Republic of Macedonia (7.5 m^3/s) and the Tushemisht Spring in Albania (2.5 m^3/s), both issuing in the Prespa and Ohrid Lakes groundwater system.

In contrast, the alluvial aquifers are, by their very nature, more often in the lowland parts of the major river basins, spread on both sides of the river, which may itself form the national boundary (type 3). They are often of greater areal extent and several are of sufficient size to satisfy the area criterion of 4000 km^2 for inclusion in the ICPDR assessment.[1] They are more densely populated and the activities in the river valley often impose greater water demands and provide greater pressures on both quantity and quality of the underlying groundwater. The conceptual hydrogeolgical models for both main aquifer types indicate that the degree of connection of groundwater flow to surface waters is an important consideration for their integrated management, and the assessment confirms these strong linkages for many of the transboundary groundwaters.

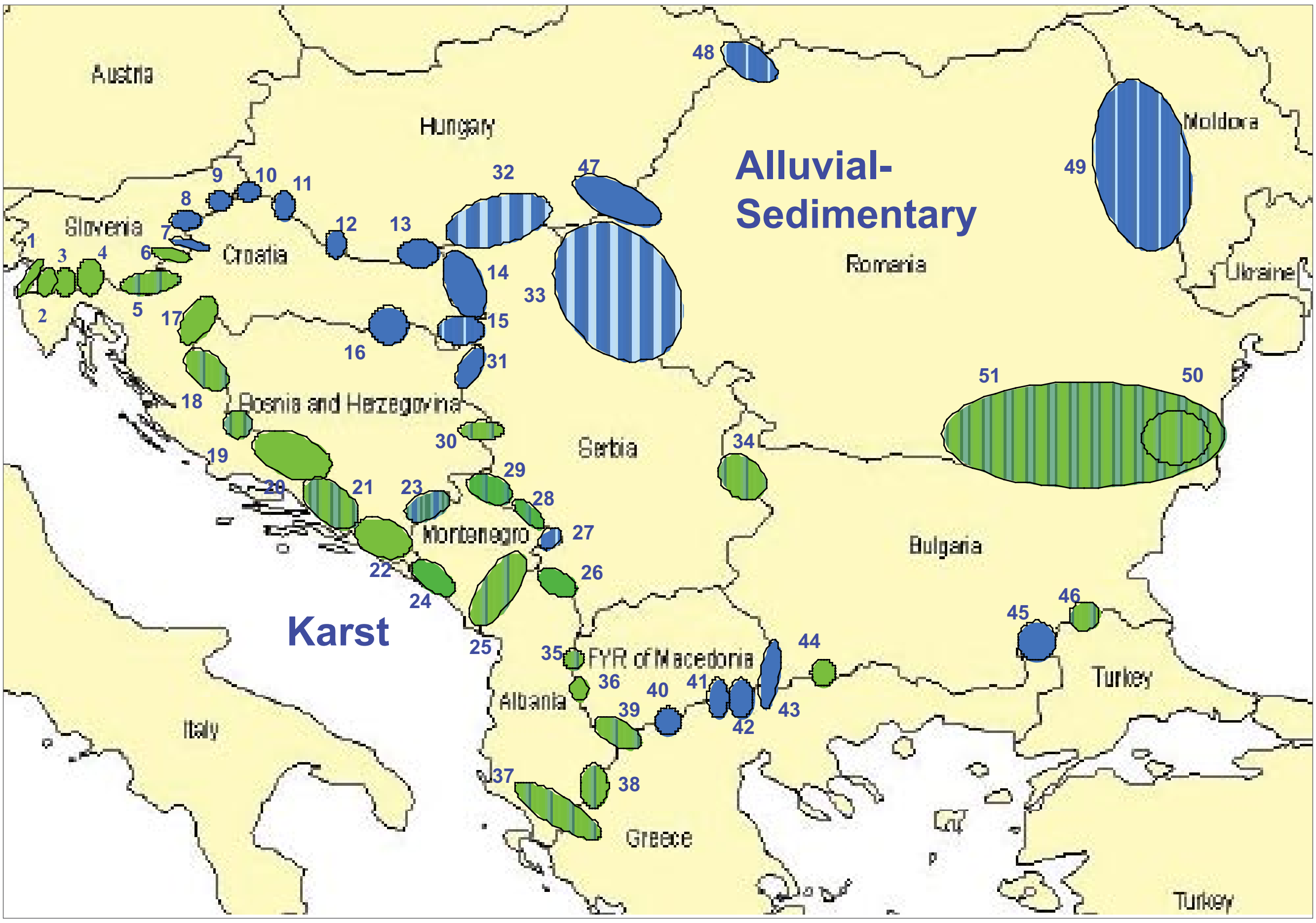
[1] ICPDR, 2005. The Danube River Basin District - River basin characteristics, impact of human activities and economic analysis required under Article 5, Annex II and Annex III, and inventory of protected areas required under Article 6, Annex IV of the European Union (EU) Water Framework Directive (2000/60/EC), Part A – Basin-wide overview. International Commission for the Protection of the Danube River, Vienna, 18 March 2005. This publication is also referred to as: "Danube Basin Analysis (WFD Roof Report 2004)".

Transboundary groundwaters in SEE					
No[1]	Aquifer Name	Countries	Area 1 (km²)	Area 2 (km²)	Notes
1	Secovlje-Dragonja/Istra	Croatia - Slovenia	20	99	These four are all parts of the Istra groundwater system
2	Mirna/Istra	Slovenia → Croatia	...	214	
3	Opatija/Istra	Slovenia → Croatia	...	302	
4	Rijeka/Istra	Slovenia → Croatia	...	460	
5	Cerknica/Kupa	Slovenia → Croatia	238	137	
6	Radovic-Metlika/Zumberak	Slovenia → Croatia	27	158	
7	Bregana-Obrezje/Sava-Samobor	Slovenia → Croatia	4	54	
8	Sutla/Bizeljsko	Croatia → Slovenia	12	180	
9	Ormoz-Sredisce ob Drava/ Drava-Varazdin	Slovenia → Croatia	27	768	
10	Dolinsko-Ravensko/Mura	Slovenia – Croatia	449	-	
11	Mura	Hungary – Croatia	300	-	
12	Drava/Drava West	Croatia → Hungary	262	97	
13	Drava East/Baranja	Hungary → Croatia	607	955	
14	SW Backa/Dunav	Serbia - Croatia	2672	-	
15	Srem -West Srem/Sava	Serbia - Croatia	627	-	
16	Posavina I/Sava	Bosnia and Herzegovina → Croatia	250	396	
17	Kupa	Croatia – Bosnia and Herzegovina	452	...	
18	Una/Plesevica	Croatia → Bosnia and Herzegovina	1,592	108	
19	Krka	Bosnia and Herzegovina → Croatia	85	414	
20	Glamocko/Cetina	Bosnia and Herzegovina → Croatia	2,650	587	
21	Neretva right	Bosnia and Herzegovina → Croatia	2,120	862	
22	Trebisnjica/Neretva left	Bosnia and Herzegovina → Croatia	>2,000	242	
23	Bileko lake	Bosnia and Herzegovina - Montenegro	>1,000	...	
24	Dinaric littoral (west coast)	Montenegro – Croatia	200	-	
25	Skadar/Shkodra Lake	Montenegro - Albania	200	450	
26	Beli Drim/Drini Bardhe	Serbia → Albania	1,000	170	
27	Metohija	Montenegro - Serbia	...	1,000	
28	Pester	Montenegro- Serbia	...	407	
29	Lim	Montenegro - Serbia	...	6-800	
30	Tara massif	Serbia → Bosnia and Herzegovina	211	<100	
31	Macva-Semberija	Serbia - Bosnia and Herzegovina	967	>250	
32	Danube –Tisza /NE Backa	Hungary → Serbia	9,545	4,020	

Transboundary groundwaters in SEE					
No[1]	Aquifer Name	Countries	Area 1 (km²)	Area 2 (km²)	Notes
33	North and South Banat	Romania ⟶ Serbia	11,408	8,556	4231(N) + 4325 (S)
34	Stara Planina/Salasha Montana	Bulgaria ⟶Serbia	87 or 231	785	Includes Vidlic/ Nishava and Tran
35	Korab/Bistra-Stogovo	Albania - The former Yugoslav Republic of Macedonia	140	...	
36	Jablanica/Golobordo	Albania ⟶ The former Yugoslav Republic of Macedonia	370	...	
37	Mali Gjere/Mourgana Mountain	Greece - Albania	200	440	
38	Nemechka/Vjosa-Pogoni	Albania - Greece	550	350	
39	Prespa and Ohrid Lakes	Albania, Greece and The former Yugoslav Republic of Macedonia	750	413	Includes Galicica mountain
40	Pelagonija/Florina	Greece - The former Yugoslav Republic of Macedonia	607	...	
41	Gevgelija/Axios-Vardar	The former Yugoslav Republic of Macedonia ⟶ Greece	...	...	
42	Dojran Lake	Greece - The former Yugoslav Republic of Macedonia	190	92?	
43	Sandansky-Petrich	Greece - The former Yugoslav Republic of Macedonia	764?	...	
44	Orvilos-Agistros/Gotze Delchev	Bulgaria, Greece and The former Yugoslav Republic of Macedonia	200	202?	
45	Svilegrad Stambolo/ Orestiada/Edirne	Greece - Bulgaria	665	600	
46	Topolovgrad massif	Bulgaria, Greece and Turkey	249	...	
47	Maros/Mures alluvial fan	Romania ⟶ Hungary	2,200	4,319	Upper & Lower
48	Samos/Somes alluvial fan	Romania ⟶ Hungary	1,380	976	Upper & Lower
49	Middle Sarmatian - Pontian	Romania ⟶ Moldova	11,964	...	
50	Neogene-Sarmatian	Bulgaria ⟶ Romania	4,450	2,178	
51	U Jurassic - L Cretaceous	Bulgaria ⟶ Romania	15,476	11,427	

Notes: [1] Groundwater numbered on map below.
Direction of flow between countries indicted by arrow where known.
Area 1 is first country, area 2 is second.
Shaded groundwaters are karstic, those with no shading are alluvial sediments.

The locations of the groundwaters covered by this assessment are shown in the map below. From this map, the geographical distinction between the two main aquifer types is clear, and it can be seen that several of the countries of the region have much of their national borders traversed by transboundary groundwaters. Joint assessment, monitoring and management of these groundwaters are, therefore, an important issue for these countries.



Distribution of transboundary groundwaters in the SEE region

GROUNDWATER USE

The assessment immediately confirms the great importance of groundwater in total water usage in SEE. This is not surprising, given the general absence of surface waters in karstic areas and the likely quality constraints for drinking water supply on surface waters in large alluvial basins. Where clear and specific information was provided on water usage, many of the transboundary karstic groundwaters were reported to provide 60% to 80% of total water usage in their respective areas, and some of the Dinaric karstic groundwaters of Bosnia and Herzegovina, Serbia, Croatia, Montenegro and Albania as much as 90% or even 100%. The alluvial groundwaters not surprisingly exhibit a greater range of use relative to surface water, with the proportion of groundwater in total usage varying from only 15-25% for some up to 70% for the important Banat, Backa and Srem Pannonian Basin alluvial groundwaters in Serbia, Croatia and Hungary. This large aquifer sequence provides 100% of drinking water supply to the Vojvodina region of Serbia.

There are also contrasts in the main water uses between the two main aquifer types. In almost all cases where information was provided, drinking water supply is an important function, often comprising more than 50% of the total groundwater use, and generally more dominant for the karstic groundwaters. Irrigated agriculture is widely practised, using 25% to 50% of groundwater, and is more important in the alluvial aquifers. However, perhaps surprisingly, it is reported as significantly greater than 50% only for the Svilengrad alluvial aquifer shared between

Bulgaria, Greece and Turkey, where it may comprise up to 90% of groundwater use. For several of the Dinaric karstic groundwaters, irrigation is important in the narrow coastal plain areas, either directly from groundwater or from rivers and canals receiving major karstic spring discharges.

For many of the alluvial groundwaters, the main uses are comparable on both sides of the border, but in some of the karstic areas there is little or no demand for groundwater in the often mountainous catchments and recharge zones of the up-gradient country because of the sparse populations. This means that, for some, there is a completely different picture for use between the countries sharing the transboundary groundwater. For at least six of the karstic aquifers (three shared by Bosnia and Herzegovina and Croatia, and the others shared by Bosnia and Herzegovina and Montenegro, Albania and The former Yugoslav Republic of Macedonia, and Serbia and Montenegro) the large altitude drops within the karstic systems are used to divert discharging groundwater to generate hydroelectric power. The water is then used again lower down for irrigation and drinking water supply. Other widely reported regional uses include small amounts for industry, livestock production and spas. The strong linkages to rivers and lakes were confirmed, both in alluvial settings and for discharging karstic waters, and the consequent need to protect the ecosystems of these associated surface waters was emphasized.