Summary Report to EU on monitoring programmes in the Danube River Basin District designed under Article 8 – Part II.

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Status report: Towards the development of groundwater monitoring in the Danube River Basin

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1. Introduction

The development of the “Transnational Monitoring Network” (TNMN) of the ICPDR within the last 15 years was exclusively focussing on surface waters. Hence, this network as well as the monitoring and reporting procedures are already well established.

However, the transnational monitoring activities focussed on groundwater in the Danube River Basin District started in February 2002, and were triggered by the Water Framework Directive aiming at elaborating

- criteria for the identification of transboundary groundwater bodies of basin-wide importance and,
- guidelines for characterising these GW-bodies (common templates).

Finally 11 transboundary GW-bodies were identified as being of basin-wide importance and they were characterised in the “WFD Roof Report 2004”. Monitoring of these selected GW-bodies is now an integral part of the TNMN.

At the end of 2005, it was decided to establish the Task Group Groundwater (GW TG) under the Monitoring and Assessment EG. During 2006, GW TG elaborated the strategy “Towards the development of monitoring of groundwater in the Danube River Basin”. The strategy and the current state of implementation are described in this report. First, general principles in line with the monitoring requirements of the WFD were elaborated which should be implemented in future. Second, the current state of GW-monitoring in the respective GW-bodies is described and third, the future need for further harmonisation to improve the joint monitoring efforts and data collection are outlined.

The monitoring principles are fully in line with Article 8 and Annex V of the WFD and closely following the respective Common Implementation Strategy (CIS) guidance document, which establishes the requirements for the monitoring of groundwater status. Monitoring information from groundwater is required for:

- Providing a reliable assessment of quantitative status of all groundwater bodies or groups of bodies; (Member States must provide maps illustrating the quantitative status of all groundwater bodies or groups of bodies using the colour-coding scheme set out in the Directive);
- Estimating the direction and rate of flow in groundwater bodies that cross Member States boundaries;
- Supplementing and validating the impact assessment procedure;
- Use in the assessment of long term trends both as a result of changes in natural conditions and through anthropogenic activity;
- Establishing the chemical status of all groundwater bodies or groups of bodies determined to be at risk. (Member States must provide maps illustrating the chemical status of all groundwater bodies or groups of bodies using the colour-coding scheme set out in the Directive.);

- Establishing the presence of significant and sustained upwards trends in the concentrations of pollutants. (Member States must indicate on the maps of chemical status using a black-dot, those groundwater bodies in which there is a significant upward trend); and,
- Assessing the reversal of such trends in the concentration of pollutants in groundwater (Member States must indicate on the maps of chemical status using a blue-dot, those groundwater bodies in which a significant upward trend has been reversed).

Since the joint groundwater activities within the ICPDR/TNMN are in an initial implementation phase, further efforts for the harmonisation of monitoring are still needed. Main emphasis is to be put on:

- Development of conceptual models of GW-bodies.
- Development of harmonised monitoring networks.
- Establishing of criteria for the selection of parameters

Finally, monitoring results reported to ICPDR will be the basis for the development of a joint programme of measures within the Danube River Basin Management Plan.

The general monitoring strategy within the ICPDR/TNMN is described in the Summary Report to EU on monitoring programmes in the Danube River Basin District designed under Article 8 – Part I. Due to the different stage of development of basin-wide monitoring of surface waters and groundwaters, the report on groundwater was decided to be presented as a separate status report.

2. Monitoring Principles

The monitoring programmes must provide the information necessary to assess whether the WFD environmental objectives will be achieved. This means that a clear understanding of the environmental conditions required for the achievement of the objectives, and of how these could be affected by human activities, is essential for the design of effective monitoring programmes. The monitoring programmes should therefore be designed on the basis of the results of the Article 5 characterisation and risk assessment procedure and the conceptual model/understanding of the groundwater system in which the general scheme of ‘recharge-pathway-discharge’ is known. Detail and importance of such models is already laid down in relevant CIS guidance [1]. Conceptual models/understanding are simplified representations, or working descriptions, of the hydrogeological system being investigated. Their development underpins much of the work carried out as part of the characterisation process. As the amount of, and confidence in, the available environmental information increases, the accuracy and complexity of the model improves, so that they become more effective and reliable descriptions of the system.

[1] Guidance Document No. 15: Groundwater Monitoring – WG C Groundwater (2006);

Guidance Document No. 3: Analysis of Impacts and Pressures – Working Group 2.1 IMPRESS (2003)

Guidance Document No. 7: Monitoring under the Water Framework Directive – WG 2.7 Monitoring (2003);

The conceptual model will represent the current understanding of the groundwater system based on the knowledge of its natural characteristics (e.g. the aquifer type, three-dimensional structure, dynamics and boundary conditions), perceived pressures and knowledge of impacts.

Considering the principles described in the guidance documents should allow for the establishment of a monitoring network which is representative for the groundwater body in order to establish a coherent and comprehensive overview of water status within each river basin district. The amount of monitoring required (number of points and sampling frequency) will be proportional to the difficulty in (a) judging the status of the groundwater body, (b) the presence of adverse trends, and (c) the implications of errors in such judgements, in particular with regard to setting up programmes of measures.

The design of a monitoring network should take into account the three-dimensional nature of the groundwater system and both, spatial and temporal variability, especially when determining the location of monitoring sites and the selection of appropriate monitoring site types. The network should have a spatial and temporal density which considers the natural characteristics of the groundwater body (conceptual understanding) and the pollution risks, to help focus monitoring activities in areas where significant pressures combined with higher vulnerability exist.

In order to contribute to a three-dimensional representative monitoring network an advanced conceptual understanding of hydrogeological characteristics and pressures is essential, especially where there is evidence of significant vertical variation in the aquifer characteristics and stratification of groundwater quality.

2.1. Chemical Monitoring

Groundwater monitoring programmes are required to provide a coherent and comprehensive overview of water status within each river basin, to detect the presence of long-term anthropogenically induced trends in pollutant concentrations and ensure compliance with Protected Area objectives.

A groundwater body will be at good chemical status if the following criteria are satisfied:

- *General water quality:* The concentrations of pollutants should not exceed the quality standards applicable under other relevant Community legislation in accordance with Art. 17;
- *Impacts on ecosystems:* The concentration of pollutants should not be such as would result in failure to achieve the environmental objectives specified under Article 4 for associated surface waters nor any significant diminution of the ecological or chemical quality of such bodies nor in any significant damage to terrestrial ecosystems which depend directly on the groundwater body;
- *Saline intrusion:* The concentrations of pollutants should not exhibit the effects of saline or other intrusions as measured by changes in conductivity.

The WFD requires both surveillance and operational programmes to be established to provide the information needed to support the assessment of chemical status and identification and monitoring of pollutant trends.

2.1.1. Surveillance monitoring

The confidence in the Annex II of the WFD risk assessment will be variable depending on the confidence in the conceptual model/understanding of the groundwater system.

Surveillance monitoring shall be carried out in order to:

- supplement and validate the impact assessment procedure,
- provide information for use in the assessment of long term trends both as a result of changes in natural conditions and through anthropogenic activity.

2.1.2. Operational monitoring

Operational monitoring shall be undertaken in the periods between surveillance monitoring programmes in order to:

- establish the chemical status of all groundwater bodies or groups of bodies determined as being at risk,
- establish the presence of any long term anthropogenically induced upward trend in the concentration of any pollutant.

2.2. Quantity Monitoring

A quantitative monitoring network is required to assist in characterisation, to determine the quantitative status of groundwater bodies, to support the chemical status assessment and trend analysis and to support the design and evaluation of the programme of measures.

A groundwater body will be at good quantitative status if:

- the available groundwater resource is not exceeded by the long-term annual average rate of abstraction; and
- the groundwater levels and flows are sufficient to meet environmental objectives for associated surface waters and groundwater dependent terrestrial ecosystems; and
- anthropogenic alterations to flow direction resulting from level change does not cause saline or other intrusion.

As with other networks, the monitoring design should be based on a conceptual understanding of the groundwater system and the pressures. The key elements of the quantitative conceptual understanding will be:

- assessments of recharge and water balance; and/or
- existing groundwater level or discharge assessments and relevant information on the risks for groundwater dependent surface waters and groundwater dependent terrestrial ecosystems;
- the degree of interaction between groundwater and related surface and terrestrial ecosystems where this interaction is important and could potentially cause the surface water body status to be affected.

The development of a quantitative monitoring network can be iterative; data collected from new monitoring points being used to enhance and refine the conceptual model used to locate each monitoring point in the groundwater body as a whole and the operation of the quantitative monitoring programme.

Implementation of a numerical groundwater model or a hydrological model integrating groundwater and surface water are useful tools in compiling and interpreting quantitative monitoring data and identifying resources and ecosystems at risk. Furthermore, the uncertainty estimates that can be obtained with a numerical model can help identify parts of a groundwater body where additional data points will add most to the description of groundwater quantity and flow.

2.3. Site selection

The selection process should be based on three main factors:

- the conceptual model(s) including assessment of the hydrological, hydrogeological and hydrochemical characteristics of the body of groundwater including characteristic travel times, distribution of different types of land uses (e.g. settlement, industry, forest, pasture/farm land), pathway susceptibility, receptor sensitivity and existing quality data;
- assessment of risk and the level of confidence in the assessment; including the distribution of key pressures and;
- practical considerations relating to the suitability of individual sampling points. Sites need to be easily accessed, secure and be able to provide long-term access agreements.

An effective monitoring network will be one in which the sites are able to monitor for the potential impacts of identified pressures and the evolution of groundwater quality along the flow paths within the body.

Where risk issues relate to specific receptors such as ecosystems, additional sampling points can be focussed in areas that are close to these receptors. In these cases, where the location of pressures (point sources) is well known, sampling points will often be used to help isolate impacts from different pressure types, assess the aerial extent of impacts and determine contaminant fate and transport between the pressure and the receptor. In some cases this may involve the use of multi-level samplers although such installations can be very expensive.

Groups of groundwater bodies where pressures are limited (low or absent): In groups of groundwater bodies that are defined as 'not at risk' and confidence in the risk assessment is high, sampling stations will be required primarily to assess natural background levels and natural trends. Locations should therefore be selected accordingly.

The provisions for the surveillance monitoring require sufficient monitoring sites to be selected for bodies, which cross a Member State boundary (see also chapter 2.7).

2.4. Selection of parameter sets

2.4.1. Chemical Monitoring

The recommended core set of determinants comprises dissolved oxygen, pH-value, electrical conductivity, nitrate, ammonium, temperature and a set of major and trace ions. Parameters such as temperature and a set of major and trace ions are not formally required by the WFD but may be helpful to validate the Article 5 risk assessment and the conceptual models. Selective determinants (e.g. heavy metals and relevant basic radio nuclides) will be needed for assessing natural background levels.

For the selection of parameters, the provisions of the Groundwater Directive (Directive 2006/118/EC, Annexes I and II) have to be considered.

Additional indicators of anthropogenic contaminants typical of land use activities in the area and with the potential to impact on groundwater will also be required on an infrequent basis to provide additional validation of WFD risk assessments and to check for any new identified pressure.

In addition at all sites monitoring of the water level is recommended in order to describe (and interpret) the 'physical status of the site' and to interpret (seasonal) variations or trends in chemical composition of groundwater.

In addition to the core parameters, selective determinants will need to be monitored at specific locations, or across groundwater bodies, where the risk assessments carried out as part of the characterisation process of groundwater bodies indicate that they are at risk of failing to achieve relevant objectives. Transboundary water bodies shall also be monitored for those parameters, which are relevant for the protection of all of the uses supported by the groundwater flow (see also chapter 2.7).

The selection of parameters will be made on a case-by-case basis and be influenced by WFD characterisation work supplemented, where necessary, by other information including existing water quality data and local knowledge. The chemical monitoring suites must be reviewed on a regular basis to ensure that they provide representative information and data on groundwater quality and fully support the risk assessment process.

Broad land use/cover categories can be used as a basis for initial determinant selection. A careful analysis of the types of land use/cover and the nature and approximate amounts of chemicals being used should be made in cooperation with competent local bodies and be used for the identification of potential determinants. Further targeting and optimisation of determinant sets should be based on information from the characterisation process.

2.4.2. Quantity Monitoring

Recommended parameters for the purposes of quantitative assessment of groundwater include:

- Groundwater levels in boreholes or wells (only this parameter is mentioned in WFD, the other parameters are recommended as supportive);
- Spring flows;
- Flow characteristics and/or stage levels of surface water courses during drought periods (i.e. when the flow component directly related to rainfall can be neglected and discharge is sustained substantially by groundwater);
- Stage levels in significant groundwater dependent wetlands and lakes.
- Optional: water abstraction

2.5. Monitoring frequency

2.5.1. Chemical Monitoring

Monitoring frequency selection will generally be based on the conceptual model and in particular, the characteristics of the aquifer and its susceptibility to pollution pressures. Sampling for operational monitoring must be continued until the groundwater body is determined, with adequate confidence, to be no longer at poor status or at risk of being at poor status and there is adequate data to demonstrate a reversal of trends.

Sampling frequency and sample timing at each monitoring location should furthermore consider:

- Requirements for trend assessment;
- Whether the location is upgradient, directly below, or downgradient of the pressure. Locations directly below a pressure may require more frequent monitoring;
- The level of confidence in Article 5 risk assessments, and changes in the assessments over time;
- Short-term fluctuations in pollutant concentrations, e.g. seasonal effects. Where seasonal and other short-term effects are likely to be encountered, it is essential that sampling frequencies

and timings are adjusted (increased) accordingly and that sampling takes place at the same time(s) each year, or under the same conditions, to enable comparable data for trend assessment, accurate characterisation and status assessment; and

- Land use management patterns, e.g. the period of pesticides or nitrate application. This is especially important for rapid flow system like karstic aquifers and/or shallow groundwater bodies.

2.5.2. Quantity Monitoring

The amount and frequency of monitoring will be determined by the data needed to determine risk and status, and where necessary to support the design and assessment of a programme of measures.

Frequency of monitoring predominantly depends of the characteristics of the water body and the monitoring site respectively. Sites with significant annual variability should be monitored more frequently than sites with only minor variability. In general monthly monitoring will be sufficient for quantity monitoring where variability is low but daily monitoring would be preferred (particularly when measuring flows). The frequency should be revised as knowledge of the aquifer response and behaviour improves and in relation to the significance of any changes in pressures on the groundwater body. This will ensure that a cost-effective programme is maintained.

2.6. Sampling and analysis (including QA/QC)

As the starting point, sampling strategies, sampling techniques, sample treatment, analysis, calculations and reporting should be considered integral parts of the overall monitoring process (monitoring supply chain). This section only provides a brief overview of the key aspects. For more detailed guidance on methods and instructions, the reader is referred to international and national standards, guidelines and textbooks (reference to ISO 5667 series for sampling and to the Chemical Monitoring Activity). For sampling and analysis, validated methods should be used which also address the issue of fitness-for-purpose. Sampling and analysis should be carried out in accordance with published international and national standard methods, unless explicitly justified not to do so due to e.g. the absence of suitable standard methods.

Due to the technical difficulties in accessing groundwater and the rapid changes in chemistry that can take place once the water has been removed from its point of origin, sampling for groundwater monitoring requires careful planning and the selection of the most suitable equipment and methods.

Standard methods for sampling are generally less precise than analytical methods, in part because of the varying field conditions at different sites and the varying purposes of sampling, and in part because the process of standardising sampling is presently less advanced than that for chemical analysis. Therefore, even with national and international standards there is a need of harmonisation of approaches and methods to ensure the comparability and representativeness of sampling.

Sampling methods for groundwater monitoring must take into account the regional and the local conceptual model:

- The hydrogeological conditions (layered aquifer, porous/fissure/fracture flow, permeability etc);
- Physico-chemical properties (volatility of substances, adsorption properties, reactivity etc) of determinants sampled for;
- The type of parameters being measured (chemical, biological, physical) and;
- The characteristics of the sampling point (e.g. well diameter, screen length, depth of sampling, static/flowing).

Unstable parameters such as pH, temperature, conductivity, dissolved oxygen and where necessary, redox potential and turbidity must be measured in the field, as quickly as possible. For this, special calibrated equipment with clear operating instructions and procedures is required.

Similarly, sample treatment such as preservation or filtration of water samples must be done in the field without aeration and as rapidly as possible in order to avoid changes in the distribution between dissolved and particulate phases within the sample.
New analytical methods and parameters should be applied to the monitoring programmes to improve the quality of monitoring and to deliver efficiencies. For those emerging analytical methods and new parameters, standard methods may not yet be available. In those cases, 'in-house' validated methods are required and their application must be documented accordingly and the performance of new methods regularly evaluated.

2.7. Transboundary aspects

With respect to groundwater the Directive requests information on the chemical and quantitative status of groundwater. Specific provisions concern those bodies of groundwater, which cross the boundary between two or more Member States.

The WFD Roof Reports of the ICPDR identify the following groundwaters to be relevant on the basin-wide scale:

- Transboundary groundwater bodies with an area of more than 4000 km² or
- smaller transboundary groundwater bodies if they are of great importance based on agreed criteria

(see also Map 2 in the Summary Report to EU on monitoring programmes in the Danube River Basin District designed under Article 8 – Part I).

There are a number of large groundwater bodies or groups of groundwater bodies that have been identified to be of importance on the basin-wide scale.

With the view of establishing a basin wide coherent monitoring approach, bilateral agreements should be reached on both monitoring strategies (i.e. sampling procedures, network design etc.), and principles, which require coordination of conceptual, model development, the exchange of data and QA and QC aspects (in line with the requirements of Article 13(2) WFD).

The provisions for the surveillance monitoring require:

- Sufficient monitoring sites to be selected for bodies which cross a Member State boundary;
- Transboundary groundwater bodies to be monitored for those parameters, which are relevant for the protection of all uses, supported by the groundwater flow.

The surveillance monitoring programme will also be useful for defining natural background and characteristics within the groundwater body. This will enable future changes in conditions to be assessed, reference data to be acquired and typologies to be investigated. This information will be useful for characterising transboundary water bodies and as a basis for European-wide reporting.

Transboundary water bodies shall be monitored for those parameters, which are relevant for the protection of all of the uses supported by the groundwater flow.

The quantitative monitoring network shall be designed so as to provide a reliable assessment of the quantitative status of all groundwater bodies or groups of bodies of basin-wide importance including assessment of the available groundwater resource. Member States shall provide a map or maps showing the groundwater monitoring network in the river basin management plan. For groundwater bodies within which groundwater flows across a Member State boundary, is has to be assured that sufficient monitoring points are provided to estimate the direction and rate of groundwater flow across the Member State boundary. Sufficient frequency of measurement to estimate the direction and rate of groundwater flow across the Member State boundary shall be ensured.

2.8. Reporting to EC and ICPDR

According to Art. 15(2) WFD EU Member States shall submit summary reports of the monitoring programmes designed under Article 8 undertaken for the purposes of the first river basin management plan within three months of their completion. The monitoring programmes must be operational by the end of 2006.

The procedure for reporting is outlined in the Strategic Paper (full title: Development of the Danube River Basin District Management Plan - Strategy for coordination in a large international river basin, ICPDR DOC 101). On the level of sampling sites the templates comprise for example information on the type of monitoring (quantity or quality, operational or surveillance monitoring), screen-range, well / spring and use of site.

All data reported to ICPDR will be integrated in the ICPDR databases. The major tool for this purpose will be the Danube GIS as soon as it is ready for integration of such data. The interoperability with the European Information System on Water (WISE) is foreseen through the work of the GIS EG of the ICPDR. The flow of groundwater data to the ICPDR databases will be specified in future.

3. Monitoring of Groundwater in the Danube River Basin - Summary

3.1. Monitoring strategies and network design

The network design is based on already existing national monitoring programmes which were in some cases still under adaptation to the requirements of the Art. 8 WFD. The report represents the state of information of August 2006. There is still a need of further development and harmonisation of the monitoring programs.

To design the network different characteristics of the groundwater body have been used by the countries to select the appropriate sites. First of all the aquifer characterisation (porous, karst and fissured, confined and unconfined groundwater) has been taken into consideration. Another criterion was the depth of the groundwater body since deep groundwater bodies are more difficult and costly accessible than shallow groundwater bodies. For deep groundwater bodies the flexibility in the design of the monitoring network is very limited. One monitoring network is partly dependent on existing boreholes owned by private companies. The flow direction was also taken into consideration by some countries. The detailed description of the country specific approaches of the monitoring network design for each groundwater body can be found in Annex 1.

The existence of associated drinking water protected areas or ecosystems (aquatic and/or terrestrial) are considered in national monitoring programs.

The different approaches of groundwater body delineation and characterisation and the different national implementation time plans to adapt the monitoring network to the requirements of the WFD lead to an irregular distribution of the monitoring points in a transboundary groundwater body (see Table 1). For the comparison of the density of the monitoring stations in a transboundary groundwater body it is important to remember that most of them comprise an area larger than 4000 km² and national groundwater bodies with different aquifer characteristics. The density of the monitoring networks for both quantity and chemical monitoring is presented on the two overview maps attached to this report.

Table 1: Number of monitoring stations and density per groundwater body

Trans-boundary GWB	Country	Area [km²]	CHEMICAL			QUANTITY			Associated to	
			Sites	km²/ site	Number of sites bilaterally agreed for data exchange	Sites	km²/ site	Number of sites bilaterally agreed for data exchange	Drinking water protected areas	Eco-systems
1 Deep Thermal	DE	4250	4	1063		5	850			
	AT	1650	4	413		1	1650			
	Σ	**5900**	**8**	**738**		**6**	**983**			
2 Upper Jurassic – Lower Cretaceous	BG	15476	16	967		23	673			
	RO	11427	13	879		13	879			
	Σ	**26903**	**29**	**928**		**36**	**747**			
3 Sarmatian – Pontian	RO	11964	35	342		35	342			
	MD	9662								
	Σ	**21626**								
4 Sarmatian	RO	2178	7	311		7	311			
	BG	4178	7	597		7	597			
	Σ	**6356**	**14**	**467**		**14**	**467**			
5 Mures/Maros	RO	2710	56	48	5	56	48	5		
	HU	4319	144	30		118	37		134	3
	Σ	**7029**	**200**	**35**		**174**	**40**	**5**	**134**	**3**
6 Somes/Szamos	RO	1440	44	33	3	44	33	3		
	HU	976	34	29		23	42		18	2
	Σ	**2416**	**78**	**31**		**67**	**36**	**3**	**18**	**2**
7 Upper Pannonian – Lower Pleistocene /Dunav / Duna-Tisza köze deli r.	RO	11408	40	285		40	285			
	RS	17200	21	819		48	358			
	HU	9546	204	47		248	38		136	10
	Σ	**38154**	**265**	**144**		**336**	**114**		**136**	**10**
8 Podunajska	SK	2211	63	35		283	8			
	HU	1160	55	21		97	12		61	15

Basin, Zitny Ostrov / Szigetköz, Hanság-Rábca	**Σ**	**3371**	**118**	**29**		**380**	**9**		**61**	**15**
9 Bodrog	SK	1466	30	49		102	14			
	HU	1300	18	72		25	52		11	3
	Σ	**2766**	**48**	**58**		**127**	**22**		**11**	**3**
10 Slovensky kras /Aggtelek-hsg.	SK	598	4	150		35	17		11	
	HU	471	12	14		13	36		11	9
	Σ	**1069**	**16**	**67**		**48**	**22**		**22**	**9**
11 Komarnanska Vysoka Kryha / Dunántúli-khgs. Északi r.	SK	563	0			0				
	HU	3038	16	190		43	71		28	9
	Σ	**3601**								

Most countries provided a detailed list of parameters for the chemical surveillance monitoring. The parameters for the operational monitoring are not explicitly mentioned. Since there was no agreed list of parameters, which could be used as reference, the parameters were listed according to national standards. Therefore only the parameters obligatory for the surveillance monitoring program were compared and additionally temperature, general information about further parameters and the operational monitoring program. In Table 2 an overview over these parameters in the monitoring programmes and the monitoring frequency is given. To compare the complete range of parameters a more structured list is needed.

The list of parameters for the quantity monitoring program is much more limited. The frequency for the measurement of the quality parameters varies between the countries and also within some countries.

Table 2: Parameters and frequency for the surveillance monitoring program

	AT/DE	**BG**	**RS**	**HU**	**MD**	**RO**	**SK**
Transboundary GWB*	1	2, 4	7	5, 6, 7, 8, 9, 10, 11	3	2, 3, 4, 5, 6, 7	8, 9, 10, 11
CHEMICAL (with estimation of frequency)							
Oxygen	1/a	>1/a	1/a	>1/a[2]		1/a	1/a
pH-value	1/a	>1/a	1/a	>1/a1		1/a	1/a
Electrical conductivity	1/a	>1/a	1/a	>1/a1		1/a	1/a
Nitrate	1/5a[3]	>1/a	1/a	>1/a1		1/a	1/a
Ammonium	1/a	>1/a	1/a	>1/a1		1/a	1/a
Temperature	cont.	>1/a	1/a			1/a	>1/a (selected stations)
Further parameters, e.g. major ions	x	x	x	x		x	x
operational		x		x		x	x
QUANTITY							
GW levels/well head pressure	x	x	x	x		x	x

[2] In the starting year

[3] A yearly program and a five year monitoring program were established.

spring flows		x				x	
Flow characteristics							
Extraction (not obligatory)	x						
Reinjection (not obligatory)	x						

Remarks:

Transboundary GWB: Number of transboundary GWB according to chapter 5 (WFD Roof Report 2004)
>1/a: More than 1 per year
x: Parameter is measured

3.2. Design of the ICPDR groundwater monitoring programme - future reporting

For groundwater monitoring a six-year reporting cycle is foreseen, which is in line with the reporting requirements to the European Commission. This will allow for making any relevant statement on significant changes of groundwater status for the GW-bodies of basin wide importance. A possibility of annual reporting of groundwater status was considered (as a part of future TNMN Yearbooks) but it was pointed out that a slow character of changes in groundwater quality in response to the emerging pressures makes the added value of annual reporting questionable.

Moreover, an informative note on the regular reporting on the groundwater status within the Danube River Basin Management Plan will be included in each TNMN Yearbook to provide public with a complete overview of the ICPDR monitoring activities. The note will be amended by explanation on which GW bodies are of basin-wide importance. In case that any significant changes in status of monitored GW bodies will occur, the GW TG will consider publishing this in the TNMN Yearbook.

Reporting to the ICPDR is foreseen in the following way:

Groundwater quantity

- status/risk information and in case of poor status or risk the particular reason

Groundwater quality

- status/risk/trend information and in case of poor status or risk the particular reason
- aggregated quality data on the level of GW-bodies for selected parameters e.g.
    - conductivity, ammonium, nitrate
    - parameters characterising the GW-body
    - parameters causing risk/poor status

3.3. Conclusions/gaps/uncertainties/recommendations

The main conclusions can be summarised as follows:

- Unlike the Transnational Monitoring Network (TNMN) for surface waters, it is the first time that the data of the monitoring network for the Art. 8 WFD report for the transboundary groundwater bodies are collected and internationally coordinated. For the collection of the data, templates for the textual description of the monitoring strategies and network design per groundwater body and for the collection of information for each monitoring station were prepared and used.

- Differences in the progress of the WFD implementation in the Danubian countries are still apparent in this part of the analysis. Since the monitoring networks are already established according to national requirements a wide spectrum of approaches for the network design was used. Serbia is currently in process of implementing a monitoring program according to the requirements of the WFD which has not yet been established. As a result the density of the monitoring network differs a lot as it can be seen in Table 1.
- The bilateral coordination in the transboundary groundwater bodies has been established but needs further refinements. Especially the frequency and the list of parameters can be more easily adapted than the site selection.
- There is a need of further harmonising the risk assessment. Common conceptual models for each transboundary GW-body (as a whole) need to be developed. The need of further harmonization concerning the delineation of GW-bodies might appear.
- There is a need of a harmonized procedure of status assessment for the whole transboundary GW-bodies.
- It has to be agreed upon the future data flow of groundwater data to the ICPDR.

4. Literature

CIS Guidance Document No. 15: Groundwater Monitoring – WG C Groundwater (2006);

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 EU Water Framework Directive (2000/60/EC). Part A – Basin-wide overview, (WFD Roof Report 2004), 18 March 2005