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GROUNDWATER QUALITY AND PROTECTION IN THE SLOVAK REPUBLIC

JAKOŚĆ I OCHRONA WÓD PODZIEMNYCH W REPUBLICE SŁOWACKIEJ

Za źródła zaopatrzenia w wodę uznaje się podziemne i powierzchniowe zbiorniki wodne w użyciu lub na etapie planowania. Wykorzystywana woda ze zidentyfikowanego źródła powinna spełniać odpowiednie wymogi jakościowe i wynikające z tego wymogi jakości w zależności od celu użycia. Obecnie w Republice Słowackiej ponad 86% podziemnych źródeł zaopatrzenia w wodę jest w użyciu do celów pitnych. Pozostała woda jest pobierana z ośmiu zbiorników (ok. 4000l/s) i rzek. Ochrona źródeł wody powinna być postrzegana zintegrowana ochrona jakości i ilości wód podziemnych i powierzechniowych, wliczając w to naturalne źródła lecznicze i wody mineralne. W tym celu, zgodnie z aktualną legislacją, stosuje się wskazane obszary ochronne a organiczonym wykorzystaniem agrarnym i innym . Poniższa praca omawia problemy związane z ochroną jakości ilości wód.

1. Groundwater Quantity

In Slovakia there are identified 101 groundwater bodies, including 16 groundwater bodies in quaternary sediments, 59 groundwater bodies in pre-quaternary rocks and 26 groundwater bodies of geothermal water (geothermal structures). Out of this number, six groundwater bodies were identified as transboundary groundwater bodies between Slovakia and Hungary. 31 water bodies were identified as groundwater bodies related to water and terrestrial ecosystems where 16 groundwater bodies are found in quaternary sediments and 15 in pre-quaternary rock structures. The overview of ground water bodies in river basin districts of the Slovak Republic is shown in Table 1. Available amounts of ground water in Slovakia are in Figure 1.

Tab. 1 Overview of the number and area of groundwater bodies in river basin districts [21]

Tab. 1. Przegląd ilości i obszaru zbiorników wodnych w oszarze doliny rzecznej.

RBD	Groundwater bodies					
	In quaternary sediments		In pre-quaternary sediments		Geothermal structures	
	Number	Area (km^2)	Number	Area (km^2)	Number	Area (km^2)
Danube	15	10 226,04	56	47 105,28	25	14 811,70
Vistula	1	420,76	3	1 970,86	1	2 790,99
Total	**16**	**10 646,80**	**59**	**49 076,14**	**26**	**17 602,69**

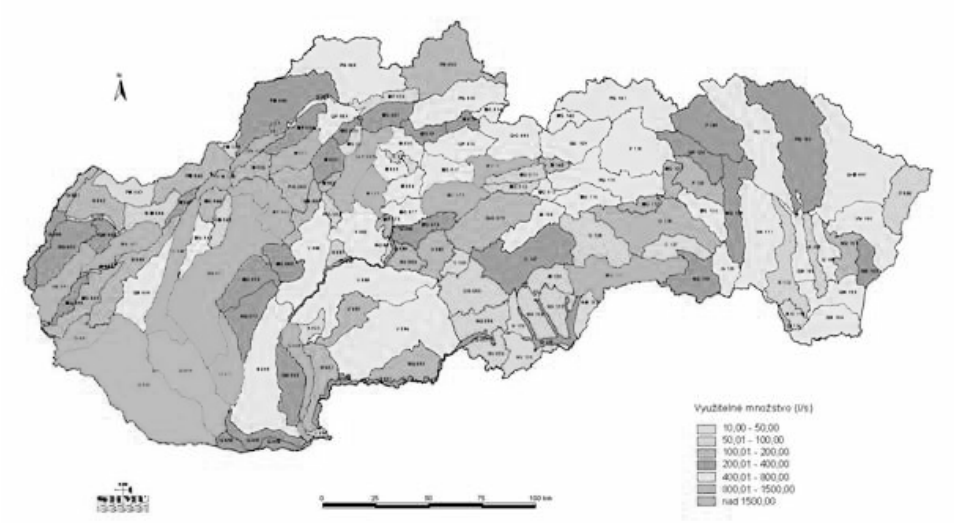

Fig. 1 Available groundwater resources in the Slovak Republic [22]

Rys.1. Dostępne źródła podziemne w Republice Słowackiej

Source: SHMÚ

by: Ľubica Koreňová, Slovak Environmental Agency, lubica.korenova@sazp.sk

The territory of Slovakia is divided into 141 hydrogeological regions. Regarding the existence of individual hydro-geological structures, the spatial distribution of available amounts is not balanced. The most significant areas are coarse grained gravel sands of the Danube River and the Danube Lowland where as much as 35% of available amounts can be found on the territory covering 3,5% of the total area. The second significant region is the Carpathian core mountains, namely their limestone and dolomite parts with

fissure-carst permeability. There are 25% of available amounts on the territory covering 18% of the total area. The third most important collector is represented by sediments of large rivers with 24% of available amounts on the area covering 22%. In these three types of regions covering 44% of the Slovak territory there are 84% of available amounts of ground water.

Natural water resources in the territory of Slovakia are 146,7 $m^3.s^{-1}$ on average, where documented available resources and groundwater reserves represent 52%. The total available groundwater resources of 78 671 $l.s^{-1}$ [Table 2] were registered in 2010. This value represents an increase by 115 l/s (0.15%) compared to 2009.

Tab. 2. Development of available groundwater resources according to the categories l.s-1 [22]

Tab. 2. Przedstawienie dostępnych podziemnych źródeł wodnych zgodnie z kategoriami l.s -1

	Approved $l.s^{-1}$	Not approved $l.s^{-1}$	Total $l.s^{-1}$
1995	37 289,4	36 591,6	73 881,0
2000	40 792,2	34 966,3	75 758,5
2001	41 527,2	34 560,7	76 087,9
2003	42 473,3	33 725,1	76 198,4
2005	45 408,9	31 390,3	76 799,2
2007	45 149,7	31 681,0	76 830,8
2008	45 824,2	31 255,3	77 079,5
2009	47 568,6	30 988,2	78 556,8
2010	47 724,9	30 946,7	78 671,7

The total available amount of groundwater of Slovakia is the sum of resources and reserves approved by the Hydrology Commission for assessing and approving final reports including calculations of the amounts of water and geothermal energy. These amounts are determined on the basis of documented amounts from hydrological research. Ground water resources and reserves approved by the Commission for Classification of Groundwater Amounts are classified into the categories A, B, C1 and C2. Resources and supplies not approved by the Commission are divided into the categories I, II and III. Special category is represented by the amounts determined through an expert estimate based on the analogy in case the supporting documents and data covering some parts of the regions are missing. The division of available amounts into categories depends on qualitative parameters and limit values.

The basic assessment unit of groundwater management balance is a hydrogeological region divided further into sub-regions and units. Hydrogeological region is the hydrological compact area with similar hydrogeological properties, type of water and circulation of groundwater. Slovakia is divided into 141 hydrogeological regions [22].

2. Groundwater Quality

Groundwater quality in Slovakia is affected by several factors. Many of the factors are dated back to the past concerning mainly pollution by oil products, nitrates, nitrites, etc. At present, the following factors have an effect on groundwater quality:

- Organic pollution of surface water,
- Nutrient pollution of surface water, eutrophication risk
- Pollution of groundwater by priority substances and chemicals relevant to Slovakia,
- Hydromorphological changes in water bodies,
- Deterioration of groundwater quantity ,
- Pollution of groundwater in relation to protection against harmful effects of water,
- Protection against extreme hydrological events,
- Horizontal problems.

In 2010, groundwater quality was monitored in 26 important water management regions (especially in alluvial deposits, Mesozoic and neovolcanic complexes) at the sites of the Slovak Hydrometeorological Institute's Network, including wells and springs used or not used for water abstraction. [3]. The monitoring network consists of 1716 sites with monitoring frequency (mostly of two times a year) set under the Decree of the Ministry of Environment 636/2004 establishing the requirements for raw water quality.

The groundwater of the "Žitný ostrov" (Rye Island) region forms separate part of groundwater quality monitoring in four regions with frequency of 2 up to 12 times a year [2].

Previous monitoring has proved that there is a problem with unfavourable oxidation-reduction network in Slovakia. In 2010, the groundwater quality was monitored at 46 monitoring sites frequently indicating the higher concentrations of Fe, Mn and nitrates.

The pollution caused by organic substances indicated by frequent exceeding of limit values for concentrations of nonpolar extractable substances (NELuv) and phenols remains the same as in previous years.

The dominant character of land use in monitored areas results in relatively frequent higher concentrations of oxidized and reduced forms of nitrogen in waters.

For the trace elements, higher concentrations were mostly observed in the nitrate concentrations, but together with other parameters they have only local character.

The following groundwater quality parameters measured in situ in the region of "Žitný ostrov" almost at all measuring sites did not meet the limit concentrations: dissolved oxygen, in some objects also water temperature (33 measurements), conductivity (9 measurements) and pH (3 measurements). The following parameters had higher concentrations according to basic physical-chemical analysis: iron, manganese, ammonium ions, nitrites, nitrates, chlorides, chemical consumption of oxygen with permanganate and fluoranthene as well as phenols and NELuv.

Natural ground waters are the most important resources of drinking water in Slovakia. They represent one of the basic components of ecosystems. They are used in industry and agriculture. Therefore, it is very important to know their quality within the monitoring of groundwater regime.

In addition to quantitative characteristics, the objective of groundwater monitoring is also focused on:

- assessment of the current state of groundwater quality
- description of ground water quality trends
- providing water management authorities and other entities with basic data
- for decision making process
- application of results to research and expertise activities

Systematic groundwater monitoring within the frame of the National Monitoring Programme has been running since 1982. At the present time, 26 significant water management regions are monitored (alluvial deposits, Mesozoic and neovolcanic complexes). The pre-quaternary structures were included in monitoring programme to meet the requirements for gathering information on water quality development in regions without considerable anthropogenic effects [8].

In 2010, 1716 objects were monitored - 208 wells of the SHMI basic network, 36 used and 19 not used wells (exploration wells), 47 used and 23 unused springs. In 2010, the groundwater samples were taken only one time in the autumn.

The results of laboratory analyses were evaluated according to the Decree of the Ministry of Health of the Slovak Republic No. 354/2006. Coll. on requirements for drinking water and control of drinking water quality by comparing the measured and limit values for all analysed parameters [5]. The results are annually published in the "Groundwater Quality in Slovakia" Yearbook. In 2010, the values of acceptable concentration (the highest acceptable concentration) were more often exceeded by the following parameters: Mn (151 times), total Fe (131 times), absorbance (111 times) and E. coli (121 times) from the total number of 1716 measurements.

The unfavourable oxidation-reduction conditions indicated by frequently present higher concentrations of Fe, Mn and NH4+ pose currently the most significant problem within the groundwater quality assessment process.

As in previous years, the pollution by organic substances indicated by frequent exceeding of the nonpolar extractable substance limit concentrations (NELuv and chemical consumption of oxygen with permanganate) still prevails. In some monitored regions the number of exceeded NELuv concentrations has increased compared to previous periods.

The dominant character of land use in monitored areas results in relatively frequent higher concentrations of oxidized and reduced forms of nitrogen in water (nitrites times and nitrates - 14 times). As far as trace elements are considered, the higher concentrations were measured most frequently for As (19 times), Al (13 times), Ni (1 times), Pb (1 time) and Hg (1 time). The pollution by specific organic substance has only local character.

Monitored groundwater quality parameters according to the regions are shown in table 3.

Tab. 3. Monitored groundwater quality parameters according to the regions

Tab. 3. Monitorowane parametry jakości wód według obszarów

Region	Number of sampling sites	Number of samples	Number of analyses	Analyses over the limit under the Regulation. 354/2006	% of over the limit analyses	Number of categorized monitored raw water sampling sites			
						A1	A2a	A2b	A3
Bratislava	155	299	17413	201	1.15	142	6	0	7
							Mn, Fe		nitrates
Trnava	154	538	19787	415	2.10	120	11	14	9
							Mn,turbidity, Fe	absorbance ammonium ions, Mn,turbidity, Fe	absorbance, ammonium ions, Mn, ChSK-Mn, sulphates, turbidity, Fe
Trenčin	258	506	18327	485	2.65	246	11	1	0
							E. coli, coliform b.	E. coli, absorbance colour, ChSK-Mn, tubidity	
Nitra	74	154	4251	75	1.76	67	6	0	1
							Mn, turbidity, Fe		nitrates
Žilina	386	502	15687	842	5.37	370	15	0	1
							E. coli, coliform bacteria		nitrates
Banská Bystrica	287	454	16840	812	4.82	237	39	6	5
							E.coli, coliform b., absorbance, Mn, Fe	E.coli, coliform b., absorbance, colour, COD-Mn turbidity, Fe	E.coli, coliform b, nitrates, absorbance, colour, turbidity
Prešov	242	575	16109	1015	6.30	214	24	3	1
							E. coli, coliform bacteria, absorbance, Mn, Fe	E. coli, colif. b., Mn,Fe	absorbance, Mn, colour, COD-Mn, Fe
Košice	160	318	8099	459	5.67	122	26	6	6
							E.coli, coliform bacteria, Mn	Absorbance, ammonium ions, colour, Mn, turbidity,Fe	Absorbance, ammonium ions,colour, Mn, turbidity, Fe
Total	1716	3346	116513	4304	3.69	1518	138	30	30

2.1. Selection of appropriate water resource for drinking water abstraction

When selecting a water supply resource it is important, besides water quality, to assess available capacity, quality protection and potential risk of pollution of the resource.

If there are considered several water resources, it will be important also to assess technology to be used in treatment process [tab. 4], means of water distribution and costs. There is defined minimum number of raw water samplings per year and the types of analyses within the raw water quality monitoring. These monitoring processes are identified based on the volumes of abstracted water (m^3/day) and the number population supplied with water. The methods for determining water quality parameter are defined as well [18].

Tab. 4. Categories of the standard methods of surface water and ground water treatment [18]

Tab. 4. Kategorie standardowych metod oczyszczania wód podziemnych i powierzchniowych [18]

Category	Water treatment[1])
A1	Only disinfection or simple physical treatment plus disinfection; Rapid filtration or CO2 addition and disinfection; for groundwater – CO2 or gas compounds removal by aeration, or possibly water saturation by oxygen and disinfection.
A2[2])	Physical and chemical treatment + disinfection, e.g. coagulation filtration, slow biological filtration, infiltration, coagulation, flocculation, sedimentation, filtration and disinfection; for groundwater – Fe and Mn removal with 1-stage and 2-stage sludge separation;
A3	Intensive physical and chemical treatment, advanced treatment and disinfection, e.g. break point chlorination, coagulation, flocculation, sedimentation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination), possibly combination of physical-chemical and biological treatment methods and disinfection.

Notes:
1) Other methods of water treatment are added based on technological complexity and treatment efficiency
2) Concerning the assessment of treatment efficiency, this category is divided into the following subcategories:
- A2a) treatment with single-stage sludge separation,
- A2b) treatment with two-stage sludge separation.

For the categories of standard methods of surface and ground water treatment (table 4), there exist recommended values and limit values of raw water quality parameters for each category of raw water quality. These parameters (total of 40) are divided into the following categories:

A – Microbiological and biological parameters - 4 parameters (EC, KB, EK, ZO)
B – Physical and chemical parameters
  - Organic – 12 parameters (Sb, As, F, Cu, Pb, etc.)
  - Inorganic – 3 parameters (TOC, PeS, PAU)
C – Parameters potentially affecting sensory quality of water - 17 parameters (COD, Mn, Fe, Ph, etc.)
D – Radiological parameters - 3 parameters (α, β, radon)

3. Water Resources Protection

3.1. Protection of Water Quantity

The major objective of water utilities is to maximize usage of the water resource [9]. In the period between 2009 and 2011, the impact of environmentally uncontrolled exploitation of water-deficit regions was highly adverse, ultimately resulting in the depletion of ground water resources by using the accumulated reserves. As a consequence, water managers, in addition to qualitative water resource protection, began to pay closer attention to quantitative protection, i.e. protection of the volume of water reserves.

The protection of water resources in Slovakia is considered as an integrated protection of groundwater and surface water quality and quantity, including springs and mineral waters. Quantitative protection is based on accumulation ability and management of particular region with respect to abstracted or pumped water. This is the reason why the limit for surface water use is determined by so-called "ecological limit" (MW_{eko}) which has no effect on a habitat in river basin.

The quantitative protection of the yield of groundwater resource was introduced in 1993.

At the same time, the Methodology establishing ecological limits for utilization of ground water resource was developed and applied to the General Protection and Reasonable Water Use. The methodology defines how to establish usable volumes of ground water resources while ensuring sustainable development of the land by defining general ecological limits for the entire catchment – a hydrogeological zone or hydrogeological structure, as well as local ecological limits for particular sources that are being used (springs and wells). Previous experience shows a decrease in the volume of continuously used springs Q_{min} and wells Q_{rec} of 15–20% and 20–30%, respectively.

Qualitative protection plays significant role in water resource quality protection. The pollution comes from population, industry and agriculture through various types of contamination. Legislation determines obligations and responsibilities for wastewater discharge and manipulation with chemicals in order to avoid deterioration of surface and ground water resources.

3.2. Protection of Water Quality

One of the key roles of water protection in terms of water quality is to resolve the problems relating to sources of pollution. Pollution sources, which have an adverse effect on water quality, are broken down into two categories based on the type and severity of their impact: point sources of pollution and diffuse sources of pollution.

The most significant point sources of pollution are wastewater discharges from industrial and agricultural facilities and from residences. Even though the volume of discharged wastewater has been declining since 1990, in order to ensure active water quality protection, the portion of population connected to the sewerage system has to be increased and measures relating to wastewater treatment have to be taken.

Legally, the polluter is responsible for drainage water and sewerage treatment and obliged to monitor the quantity and quality of discharged wastewater. The validity of monitoring results depends on the precision of the sampling procedure and the level of expertise of laboratories providing wastewater analyses.

The currently operated wastewater treatment plants represent a specific problem, because they are overloaded (both hydraulically and from a load point of view) and the wastewater treatment technology does not comply with legal regulation standards any more.

Protected areas are designated according to the Act No. 184/2002 Coll.:

1. Protected water management areas (PA)
2. Protection zones of water supply resources (PZ)
3. Sensitive areas (SA)
4. Vulnerable areas (VA)
5. Areas containing surface water intended for drinking water abstraction
6. Bathing water areas
7. Areas with water suitable for life and reproduction of indigenous fish species
8. Protected areas and their protection zones under the article 17, Act. No. 543/2002 Coll. on Nature and Landscape Protection

3.3. Protected Water Management Areas

Protected water management areas are defined as areas where surface and ground water is accumulated as a result of favourable natural conditions [tab. 5]. This is why the Government may designate them as the protected water management areas.

All activities in protected water management areas can be planned and performed only if a broad protection of surface and ground water will be assured.

Tab. 5. Protected water management areas in Slovakia [14]

Tab. 5. Obszary chronionego gospodarowania wodą w Słowacji [14]

			Available water resources		
No.	**Geological structure**	**Area (km^2)**	**Surface ($m^3.s^{-1}$)**	**Ground ($m^3.s^{-1}$)**	**Total ($m^3.s^{-1}$)**
1.	Beskydy - Javorníky	1856	184	0.69	2.53
2.	Žitný ostrov	1400	_	18.00	18.00
3.	Nízke Tatry	1290			
	(a) western part	358	_	2.50	2.50
	(b) eastern part	805	2.33	2.43	4.76
4.	Strážovské vrchy	757	_	2.33	2.33
5.	Veľká Fatra	644	0.97	2.98	3.95
6.	Upper river basin of Ipeľ, Rimavica and Slatina	375	1.09	0.11	1.20
7.	Vihorlat	225	0.08	0.43	0.51
8.	Slovak karst	209			
	a) Plešivská planina	57	_	0.55	0.55
	b) Horný vrch	152	_	1.97	1.9
9.	Muránska planina	205	_	1.40	1.40
10.	Upper river basin of Hnilec	108	0.16	1.10	0.26
Total		6942	6.47	33.49	39.96

The protection of water production, occurrence as well as transport and other interests shall be in accordance with requirements set for protected water management areas within the processing of development conceptions and regional planning documentation. Today, there are ten designated protected water management areas in Slovakia covering area of 6 942 sq km that represents 14.16% of the entire Slovak territory.

Basic characterization of designated protected water management areas are listed in Table 6.

3.4. Protection Zones of Water Supply Resources

Protection zones (PZ) of water supply resources are designated by the state water authorities with aim to protect their yield, quality and safety [10, 16]. Protection zones of water supply resources are divided into the protection zone of the 1st degree serving for its protection in direct vicinity of water abstraction points or capture devices (water intake or water collector) and the 2nd degree protection zone serves for the protection of water supply resource against risks coming from more distant sites. For enhanced protection the water authority is allowed to establish also the 3rd degree protection zone (not for underground water).

Tab. 6. Number and areas of protection zones in Slovakia [10]

Tab. 6. Ilości i obszary obszarów chronionych na Słowacji [10]

				Number		Area of protection zones (ha)			
No.	**River basin district**	**Sub-basin**	**Sub-basin areas (km^2)**	**Ground water**	**Surface water**	**Ground water**	**Surface water**	**Total area (km^2)**	**% of basin area**
International Danube river basin									
1.	Danube	Morava	2282 1138	39 31	0 0	13901 7375	0 0	139.0 73.8	6.1 6.5
2.	Váh	Váh incl. Nitra	18769	396	6	205101	44.038	2491.4	13.3
3.	Hron	Hron Ipeľ Slaná	5465 3649 3217	124 49 71	7 1 5	55123 8360 16371	9316 7872 17703	644.4 162.3 340.7	11.8 4.4 10.6
4.	Bodrog	Bodrog	7272	207	15	6760	335272	3420.3	47.0
5.	Hornád	Hornád	4414 858	140 31	1 7	19865 7818	67890 9024	877.6 168.4	19.9 18.6 15.2
International virtual river basin									
1.	Dunajec a Poprad	Dunajec a Poprad	1950	50	13	15606	14023	296.3	15.2
Total (Slovakia):			49014	1138	73	3562,80	5051,39	8614.2	17.6

If conditions in the locality of the 1st degree protection zone provide sufficient protection of water resource yield, quality and safety, further degrees of protection zones will not be designated.

Designated protected zones serve simultaneously specific regulations. According to 2010 data there are about 1138 PZ groundwater resources in Slovakia. A single PZ, especially the 2nd degree PZ, may comprise several water resources, e.g. the entire spring line or group of wells, etc.

In Slovakia there are 73 protection zones designated for the need of surface water abstraction for drinking purposes, 8 of which are designated for the abstraction from water supply reservoirs and 65 for the direct water abstraction from surface streams that are mostly situated in the East Slovakia Region.

In Slovakia there are 73 PZ intended for surface drinking water abstraction, of which 8 are related to abstraction from water supply reservoirs and 65 PZ are designated to direct abstraction from surface streams that are situated mostly in the Eastern Slovakia Region.

The above-mentioned data indicate high percentage of the area covered by protection zones in Slovakia – 17.6% (table 6 and table 7). It is important to note that the areas of protection zones of some water supply resources arte often overlapping. Therefore, the area of 17.6 % does not represent the total area of protection zones in Slovakia, but it is a sum of all individual protection zone areas without mutual overlapping. After consideration of the zone overlapping, the area of all protection zones covers 3 113 sq km in total, i.e. 6.36% of the Slovak territory.

Tab. 7. Overview of water supply resources and protection zones [21]

Tab. 7. Przegląd źródeł zaopatrzenia w wodę i obszarów ochronnych [21]

Sub-basin	Number of water supply resources		Number of protection zones of water supply resources		Area of protection zones (ha)	
	Ground water	Surface water	Ground water	Surface water	Ground water	Surface water
Morava	90	0	31	0	13 865	0
Danube	77	0	29	0	6 030	0
Váh	760	5	447	14	211 671	19 436
Hron	274	7	173	7	56 917	9 542
Ipeľ	55	1	70	1	15 648	8 400
Slaná	62	5	76	6	13 789	13 762
Bodva	3	1	30	7	12 146	10 416
Hornád	152	4	124	18	19 324	72 693
Bodrog	215	11	230	17	7 082	339 459
Danube Basin District	1 688	34	1 210	70	356 472	473 708
Vistula Basin District	46	9	59	11	15 580	15 925
Total (Slovakia)	1 734	43	1 269	81	372 052	489 633

3.5. Sensitive Areas

Sensitive areas are surface water bodies, water quality of which is or can be threatened by increased nutrient concentrations; which are or can be used as water supply resources as well as water bodies requiring a higher level of discharged wastewater treatment with regard to advanced water protection interests. The entire territory of Slovakia has been declared as a sensitive area.

3.6. Vulnerable Areas

Vulnerable zones under the Water Act are agriculturally used areas where rainfall water flows into a surface water or infiltrates to groundwater resources in which the nitrate concentration is higher that 50 $mg.l^{-1}$ or can be exceeded in the near future. Land agriculturally used in particular cadastral territories listed in the Governmental

Regulation has been designated as vulnerable zone. In particular, it relates to all lowland areas of Slovakia, alluvial plains of larger rivers as well as lower situated valleys with agricultural land.

Identification of sensitive and vulnerable areas is reassessed every 4 years under the coordination of the Ministry of Environment of the Slovak Republic.

The Regulation will accept the possibility not to declare the 3rd or even 2nd degree PZ of water supply resource, if there is other type of area protection (e.g. vulnerable area). In practice it means that such protection can substitute the function of the 3rd degree PZ and in specific cases even the 2nd degree PZ.

3.7. Surface Water Resources Intended for Drinking Water Abstraction

Water supply streams and their catchments can be considered as protected areas with surface water intended for drinking water abstraction under the Decree No. 211/2005 Coll. setting the list of important water management rivers and water supply streams [6]. There are 102 identified water supply streams in Slovakia. According to Article 7 of the Water Act water supply streams are water supply resources of surface water [1]. Ground water supply resources are groundwater bodies used for drinking water abstraction or groundwater bodies supplying more than 50 people or allowing water abstraction in average of more than 10 m^3 a day in natural status or after treatment.

3.8. Implementation of Protected Areas in the Slovak Republic

The European System of Protected Areas – NATURA 2000 is applied for protection of animal and plant species of Slovakia. It is confirmed under the Act 543/2002 Coll. on Nature and Landscape Protection.

NATURA 2000 is a system of the EU member states protecting the most rare and endangered plant and animal species as well as natural habitants and through this preserving biological diversity throughout the European Union.

The system of NATURA 2000 consists of the two types of protected areas:

- Special Protection Areas
- Special Areas of Conservation

The national system of protected areas is developed in compliance with the Act 543/2002 Coll. on Nature and Landscape Protection. It divides the Slovak territory into five levels of protection. The higher level of protection is established the wider range of measures is applied. The areas not included in any protection category are classified into the first level of protection under the act mentioned above.

In particular, it concerns the following categories of protection areas and protection levels:

- Protected Landscape Area (protection level 2)
- National Park (protection level 3) and its protection zone (protection level 2)
- Protected Range (protection level 3 to 5)
- Nature Monument and National Nature Monument (protection level 4-5)
- Protected Landscape Element (protection level 2 to 5)

At the present time there is designated 23 large protected areas in Slovakia comprising 9 National Parks and 14 Protected Landscape Areas covering an area of 1 113 565 ha including protection zones. The number of small protected areas is 1101 inclusive of 385 Natural Reserves, 239 Nature Monuments, 60 National Nature Monuments and 189 protected Ranges covering the total area of 111 062 ha including their protection zones.

3.9. Special Type of Protection Areas – Wetlands

There are 13 wetlands of international importance included in the List of Wetlands of International Importance, i.e. Ramsar sites covering an area of 39 337 ha (other four sites with area of 1 007 ha are proposed for the List of Wetlands of International Importance.)

- 72 wetlands of national importance
- 179 wetlands of regional importance
- 1050 wetlands of local importance

3.10. Pecuniary Damages/Loss

In connection with pecuniary damages compensation in protected areas due to limited economic activities it is important to distinguish between protected areas designated under the Act 543/2002 Coll. on Nature and Landscape Protection and protected areas designated under the Act 364/2004 Coll. [1].

3.10.1. Future concept of water policy in the Slovak Republic

Development and sustainable use of water resources
Groundwater resources [22]

- detailed hydrogeological survey aimed at passive regions in accordance with the requirements for development of public water supply systems;
- based on the results of available groundwater resources reassessment and by taking into account the impact of climate change to prepare a policy for the protection and reasonable use of resources with the goal to achieve good status of groundwater;
- to prepare proposals for the use of small water resources for the purpose of local drinking water supply based on the hydrogeological survey;
- more effective use of groundwater and surface water interaction;
- to reassess unsuitable resources or resources being at risk or remove them from the water supply system and to prepare other water resources with sufficient capacity;
- to develop integrated system of environmentally friendly management of water resources, including water ecosystems;
- to prepare wetland protection plans;
- to assure sufficient water resources covering the future demand;
- to provide adequate administration of all water courses in the territory of Slovakia, including streams without administration.

Groundwater quality protection:

- to increase protection of water supply resources by protection zones in order to reduce the level of water treatment required for drinking water production;
- not to permit abstraction where the conditions set for the sanitary protection zones cannot be met;
- to apply regular checks of groundwater quality also in the water resources not used for water abstraction.
- to resolve the issues of compensation for property loss by adequate financial backing regarding protected water supply areas and sanitary protection zones.

Groundwater quantity protection:

- to develop programmes of measures aimed at pollution prevention;
- to develop a new methodology for pricing the quantity of groundwater taking into account ecological protection and the methodology for balancing groundwater resources;
- to reassess the available quantities of groundwater for drinking purposes in terms of sustainable development and taking into account the impact of climate change on hydrological catchments.

Diffuse pollution of surface water and ground water resources

- to limit the diffuse pollution mainly from agriculture, and to implement measures to reduce water erosion;
- to update on a regular basis the database of the Ministry of Environment SR with basic data on all sources of pollution in Slovakia, water quality and water resources, and to prepare maps based on collected data;
- to use economic tools to limit diffuse sources of pollution, mainly from agriculture.

In order to achieve the objectives of water planning process in river basins pursuant to the Water Act it is important to develop the river basin management plans, the Water Plan of Slovakia and the programmes of measures for achieving environmental objectives.

The Plan defines environmental objectives and establishes the programmes of measures according to analyses of the present status of surface water and ground water resources and assessment of the impact of anthropogenic activities on water resources and financial resources [22].

3.10.2. Trends

A time-spatial imbalance between available water resources and water demands still remains in Slovakia. Despite continuing overall decrease in use of water resources in Slovakia due to economic conditions, the supply of population with drinking water from public water supply systems experiences constant growth in the regions with insufficient water resources. Shortage of water resources is also caused by reducing natural resources and supplies as a consequence of global climate changes, quality deterioration, intensive anthropogenic activities, environmentally inappropriate and excessive use of water resources in some regions and localities.

River basin management plans and programmes of measures are administrative tools to address significant water management issues (referred to as SWMI). Identified SWMIs are therefore a key pillar of river basin management plans and programmes of measures. Measures in the programmes of measures are proposed to eliminate SWMIs and to achieve the objective [22].

4. Conclusion

The monitoring of qualitative parameters of water resources has a long-standing tradition in Slovakia. The current legal regulations define parameters and features of quality monitoring as well as the number of analyses within relevant monitoring periods. The above results indicate that the quality of our water resources becomes slightly better. However, there exist some water resources with water unsuitable for long-term drinking water abstraction. It is important to note that individual components of landscape protection shall be integrated within the approach to the landscape protection.

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Bibliography

[1] Act no. 364/2004 Coll. of May 13, 2004 on waters and amendments to the Act of the National no. 372/1990 Coll. On offences as amended by later regulations (water Act).

[2] Božíková J, Mikita M (2005) "Žitný ostrov" region and use of its drinking water resources potential, Project and Construction, I.,Vol. 1, No 2, Bratislava, The Slovak Chamber of Civil Engineers,pp. 8–11, ISSN 1336 – 6327.

[3] Decree no. 29/2005 of the Ministry of Environment of the Slovak Republic of the February, 2005 on details for identification of water supply protection zones and measures for water protection.

[4] Decree no. 100/2005 of the Ministry of Environment of the Slovak Republic determining the details on handling of hazardous substances, on requirements of emergency plan and managing enormous water quality deterioration.

[5] Decree of the Ministry of Heath No 126/2006 Coll. Drinking water quality.

[6] Decree no. 211/2005 of the Ministry of Environment of the Slovak Republic establishing the list of significant water management rivers and water supply streams.

[7] Decree no. 221/2005 of the Ministry of Environment of the Slovak Republic determining the details on identification, assessment and monitoring of surface water and groundwater, on water resources inventory and water balance.

[8] Decree no. 457/2005 of the Ministry of Environment of the Slovak Republic determining the details on requirements of hydraulic structure operating regulations.

[9] Hanzel V, Melioris L. Groundwater of Slovakia – its share of population supply. Groundwater SAH 2(96):5–11.

[10] Kriš J (1996) Water and life (Regulation of the Government of the Slovak Republic no. 249/2003 of June 26, 203 designating sensitive and vulnerable areas). Vodohospodársky spravodajca XXXIX:4–5.

[11] Report on Water Management in the Slovak Republic (2010) (Green Report) The Ministry of Environment SR, Bratislava, 2010.

[12] Report on the State of Environment in the Slovak Republic, the Ministry of Environment SR, Bratislava 2010.

[13] Regulation of the Government of the Slovak Republic no. 296/2005 establishing requirements for surface water quality and quantity, limit values of wastewater and specific water pollution parameters.

[14] Regulation of the Government of the Slovak Republic no. 249/2003 of June 26, 2003, designating sensitive and vulnerable areas.

[15] Slovak technical standard (STS 75 7221) surface water quality classification.

[16] Tóthová K, Mahríková I (2006) Securite of water supply and sewerage systems in Slovakia – present state. Security of water supply systems: From source to tap. The NATO programme for security through science. NATO security through science series – C: Environmental security. Springler, pp 155–167. ISBN 1-4020-4563-8, ISSN 1871-4668.

[17] Kriš, J., Faško, M. and Škultétyová, I.: Water resources and their protection in Slovak Republic. In: Environment. Survival and Sustainability. Abstracts: International conference. Nicosia- Northern Cyprus, 24.2.2007. Nicosia, Near East University, 2007. ISBN 978- 975-8359-41-7. S. p. 612.

[18] Vyhláška Ministerstva životného prostredia Slovenskej republiky č. 636/2004 Z.z., ktorou sa ustanovujú požiadavky na kvalitu surovej vody a na sledovanie kvality vody vo verejných vodovodoch

[19] Čiháková, I., Slavíčková, K., Ježková, B., Horký F.: Rizika při zásobování pitnou vodou od zdroje ke spotřebiteli - Hodnocení stavu objektů na jímání podzemní vody, Voda Zlín, 2012

[20] Slavíčková, K. , Čiháková, I., Ježková, B., Horký, F.: Hodnocení stavu a bezpečnosti vodárenských objektu, Aqua 13.6 2012, Trenčín.

[21] Vodný plán Slovenska, Implementácia rámcovej smernice o vode 2000/60 a Rady z 23 októbra 2000, ktorou sa stanovuje rámec pôsobnosti pre opatrenia společenstva v oblasti vodného hospodárstva, Ministerstvo životného prostredia Slovenskej republiky, 2009.

[22] http://www1.enviroportal.sk/indikatory/detail.php?kategoria=2&id_indikator=478#1

[23] Vyhláška MŽP SR č. 24/2003 Z. z., ktorou sa vykonáva zákon č. 543/2002 Z. z. o ochrane prírody a krajiny