What we know about *drinking water*

in the Slovak Republic

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INTRODUCTION

Water is a basic substance related to the origin and development of life on the Earth. Water is necessary for many physiological functions in the human body and it is irreplaceable in personal hygiene of human beings (washing, cleaning, recreation and sports), it has also extraordinary function in creation of acceptable microclimatic conditions.

Drinking water is most important for human health, being a most important segment of the food chain. High quality and clean drinking water is irreplaceable element of drinking regime. The determining criteria are linked to its quality and amount (it has to fulfil physiological requirements of the organism, to support health - not to harm it).

In the Slovak Republic (SR) the drinking water is defined by the Act No. 355/2007 Coll. on the protection, support and development of public health, as amended by later regulations and SR Government Regulation No. 354/2006 Coll. pursuing the requirements for water intended for human consumption. According to this Act, **drinking water is defined as water in its original conditions or after treatment intended for drinking, cooking, preparation of meals or other household purposes, regardless to its origin or whether it was supplied from water system, tank or as water in consumer package, as well as water used in food industry for production, processing, preservation or purchase of products or other substances intended for human consumption.**

Water quality is assessed from physical, chemical, microbiological and biological point of view. Health safety is the most important criterion. **Drinking water must be safe for human health**, i.e. its short term nor long term use must not threat human health and it must also have acceptable sensorial properties perceived by senses.

LEGAL FRAMEWORK OF THE DRINKING WATER ISSUES

National level

The basic legal documents dealing with drinking water issues **in the sector of Ministry of Health** are as follows:

- **Act No. 355/2007 Coll. on protection, support and development of public health, amending certain acts,** as amended, defining drinking water, setting out competencies and roles of public health authorities in the health sector as well as other sectors dealing with drinking water issues, setting out the obligations for monitoring the drinking water quality in the spot of user to the public health authorities, to perform state health surveillance and to impose measures for improvement of shortcomings.
- **SR Government Regulation No. 354/2006 Coll., setting out requirements for water intended for human consumption** defining basic terms such as public and individual supply, requirements for drinking water quality and obligations of drinking water producers and suppliers, parameters of water quality, range, frequency and criteria of drinking water quality control, as well as requirements for application for approval of derogation.
- **Ministry of Health of the Slovak Republic Regulation No. 550/2007 Coll. on details and requirements for products intended for contact with drinking water,** being implementation document to the Act No. 355/2007 Coll.. It covers the issues of requirements for composition, treatment and labelling of products intended for contact with drinking water in more detail. It also sets out the evaluation and interpretation method of migration test.

The following legal documents are in place **under the sector of Ministry of Environment** for drinking water issues:

- **Act No. 364/2004 Coll. on waters, amending Slovak Parliament Act No. 372/1990 Coll. on violations, as amended,** being the basic legal act regulating the general water protection. In relation to drinking water it defines water sources, their protection zones and it sets out handling with water.
- **Act No. 442/2002 Coll. on public water supply systems and public sewage systems, amending Act No. 276/2001 Coll. on regulation of network industries, as amended**, pursuing establishment, development and operation of public water supply systems and specialised skills of the operator. It also sets out rights and duties of public water supply systems owners and operators, as well as competencies of state authorities in the sector of public water supply systems.
- **Ministry of Environment of the Slovak Republic Regulation No. 636/2004 Coll.**, setting out the requirements for raw water quality and for monitoring of water quality in the public supplies and public sewage systems.
- **Ministry of Environment Regulation of the Slovak Republic No. 684/2006 Coll.**, setting out the details of technical requirements of proposal, project documentation and construction of public water supply systems and public sewage systems.

European level in relation to Slovak Republic

Drinking water quality requirements applicable for all EU member states are defined in the **Council Directive 98/83/EC on water quality intended for human consumption.** The drinking water quality standards of this Directive are based on the recommendations of WHO. The Directive is aimed at human health protection against adverse effects of any water contamination by ensurance of its cleanliness and purity.

The member states are obliged to transpose the Directive into their national legislation, while they can incorporate additional parameters for monitoring and also they can set out more stringent limit values. However, they can not set out less stringent limit values, as the health protection should be kept at the same level throughout whole EU.

Directive 98/83/EC is implemented in SR by **the SR Government Regulation No. 354/2006 Coll.**, setting out the requirements for water intended for human consumption. **When compared to the Directive, this Regulation contains additional parameters** monitored in drinking water in SR. E.g. calcium and magnesium are comprised, their presence in drinking water is recommended by WHO. SR Government Regulation No. 354/2006 Coll. contains additional 29 drinking water quality parameters, as follows: culturable microorganisms at 37 °C, colourless flagellates, living organisms (except colourless flagellates), filamentous bacteria (except iron and manganese bacteria), microscopically identifiable micromycetes, lifeless organisms, iron and manganese bacteria, abioseston, silver, dichlorobenzenes, monochlorbenzene, styrene, tetrachloromethane, toluene, xylenes, bromodichloromethane, 2,4-dichlorophenol, chlordioxide, chlorites, chloroform, ozone, 2,4,6-trichlorophenol, absorbance, total dissolved solids, temperature, zinc, magnesium, calcium, pooled concentration of calcium and magnesium. **When compared to the EU standards, 6 parameters have more stringent limits in SR as defined by the Directive:** boron, cadmium, copper, cyanides, chlorides and pH.

PROTOCOL ON WATER AND HEALTH

SR ratified **Protocol on Water and Health**, elaborated in relation to the **UN/ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes** dated 1992, in order to support and improve water use. The Protocol provisions apply in SR to surface waters and groundwaters, closed water bodies, bathing waters, waters for drinking water supplies and hygienic waters. The Protocol is **aimed** at health support and protection on each level of decision in the national as well as international context, and on each level by better water exploitation, improved water management, protection of water ecosystems as well as by prevention, control and decreased frequency of water related diseases, in compliance with protocol objectives in SR.

Document Protocol on Water and Health to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes dated 1992 - National Objectives of SR, adopted by SR Government sets out in 2007 the objectives appearing as the most important ones for water protection and solution of certain actual problems related to water in SR.

National objectives of the Protocol on Water and Health for SR:

- increased proportion of public high quality water supply users,
- improved situation in the sector of waste water treatment and release,
- implementation of Water Framework Directive,
- improved quality and health safety of drinking water; solving the problem of exceeded limits for nitrates in public supplies till 2011,
- implemented effective measures for prevention of water related diseases; monitoring of appearance of infectious and non-infectious water related diseases till 2012,
- implemented new information system on public supply,
- implemented new information system on quality of bathing waters in natural as well as artificial swimming sites,
- published manual for owners of individual water sources; public awareness campaign for water, with emphasis to private wells owners,
- cooperation with NGOs, water companies and municipalities in water issues.

Ministry of Health SR is responsible for meeting these objectives, in cooperation with Ministry of Environment SR.

DRINKING WATER SOURCES IN SLOVAKIA

Both, groundwaters and surface waters are used for drinking water preparation in SR. **Groundwater is the best quality drinking water source**, as it is less exposed to negative impacts of pollution as surface water, therefore it is less demanding treatment for drinking purposes. SR has rich sources of groundwater, however, they are unevenly spread throughout SR territory that results in their inaccessibility in certain SR regions. In Bratislava, Trnava and Nitra regions solely groundwater sources are used for abstraction for drinking water supplies. Both, groundwater as well as surface water sources are used in the rest of SR regions.

- Groundwater forms 82.2 % of drinking water sources in SR.
- Surface water forms 17.8 % of drinking water sources in SR.

Slovakia has the richest natural groundwater source in the Central Europe - Žitný ostrov, reservoir of static groundwater with accumulation of more than 15 thous. m^3 of relatively high quality water with capacity 24.8 $m^3.s^{-1}$. With average specific consumption 107 $l.s^{-1}$ (situation as of 2007), more than 16 mill. of inhabitants could be supplied from this drinking water source. 2 415 $l.s^{-1}$ is used from this capacity of Žitný ostrov at present, 1 234 $l.s^{-1}$ for water supply systems.

DRINKING WATER SUPPLIES FOR INHABITANTS OF SLOVAK REPUBLIC IN 2008

The extent of drinking water supply to the inhabitants is one of the most important measures for human health protection, and it also characterises the living standard of the particular country. Many human diseases are related to the drinking water quality as drinking water can act as infectious disease vector. Water comprises to human population health also by its chemical composition, chemical contamination may cause acute damage to the organism or induction of chronical disease after long term intake of increased concentrations of chemical substances in drinking water.

We distinguish the following supplies according to the way of water supply:

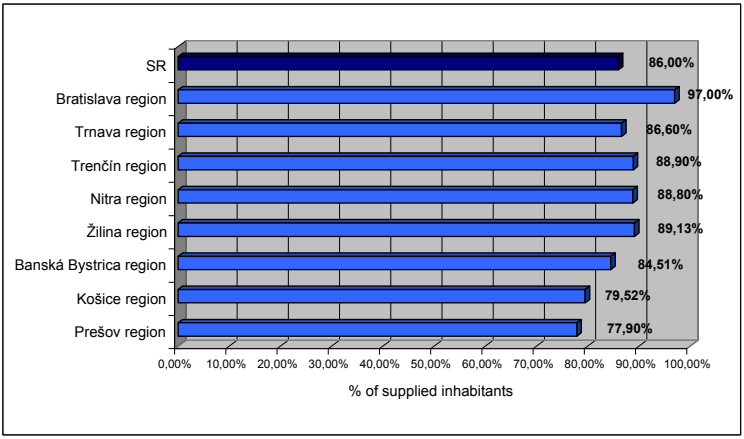
- **public supply** – drinking water supply from public water supply system or water source giving water to at least 50 persons,
- **individual supply** – drinking water supply from a single source with daily production less that 10 m^3 of drinking water, or from the source giving water to less than 50 persons.

Public supply

Public water supply system is defined in the Act No. 442/2002 Coll., as amended, as a group of buildings and facilities serving for public needs and allowing for water supply for public and other bodies. Public water supply can be **local** (supply giving water to users for a single uptake site), **group** (supply giving water to users from several uptake sites), or **long-distance.**

Public water supply systems feed app. 86 % of SR inhabitants. Figure 1 shows the differences between the individual regions. The highest percentage of public supplies is in region Bratislava (97 %), the lowest in region Prešov (77.9 %).

Figure 1: Proportion of inhabitants receiving drinking water from public water supply systems in SR according to regions (situation as of December 31, 2008)



Source: Public Health Institute - Annual Report 2008

Water supply to the inhabitants form a part of water management policy of SR. **Concept of Water Management Policy till 2015** adopted by SR Government in February 2006 is the basic document for its implementation. Development Plan for public water supply systems and public sewage systems for the SR territory in the field of public drinking water supplies and in the field of collection and treatment of municipal waste waters till years 2010 and 2015 was elaborated according to this Concept.

Individual supplies

App. 14 % of SR inhabitants use **individual** sources, i.e. water from their own water wells.

80 – 85 % of water sources for the individual supplies do not comply with hygienic requirements, and they pose permanent risk of health damage, or the water has unacceptable sensorial properties. Exceeding of limit values for indicators of faecal pollution, nitrates, nitrites, ammonia and iron belong to most frequent problems. Low technical status of wells, their insufficient depth and inappropriate disposal of waste water in their vicinity impact also the water quality in the individual water sources. The risk of infectious diseases is higher mostly during flood periods or in the case of sewage system failure.

Saving of financial resources is the main reason of development and usage of individual sources (water wells). First, it is necessary to consider whether the site of the water well is used for agricultural purposes (increased nitrate concentration is risky mainly for shallow wells), or whether it is often flooded (floods being the most frequent reason of water well deterioration). After construction of the well, also operational costs should be considered (pump operation, electrical energy consumption, chlorination or other sanitation means, water quality analyses).

Slovak Technical Standard **STN 75 5115: Water management - Wells for individual water supply** are in place for location and technical status of water wells. This standard sets out precisely the conditions for ensuring high water quality from the well, from the site selection according to the hydrogeological assessment in the non-polluted area, it sets out the shortest acceptable distance from the potential pollution sources (septic tank, sewage line, stall, laystall etc.), construction of well, technology, adjustment of well vicinity, control and disinfecting of wells.

FROM SOURCE TO CONSUMER

Groundwater or surface water serves as drinking water sources in Slovakia. As regards the groundwater, mainly source capacity is investigated, but also its quality and location. Groundwater obviously meets the legislative requirements and they do not need extensive treatment - normally the water is only disinfected. Treatment of surface water from rivers, streams and water dams is unavoidable. Water with unacceptable properties is processed in treatment plants where mainly microbiological and biological contamination is removed, and also iron, manganese, occasionally antimony and arsenic. Water companies operating public water supply systems are obliged to ensure investigation of water quality sampled from the source during its treatment, accumulation and transport to the user, in compliance with Ministry of Environment SR Regulation No. 636/2004 Coll. and SR Government Regulation No. 354/2006 Coll., requesting health safety of drinking water.

Health safety of drinking water is reached by its **disinfection.** Pathogenic organisms are removed during the disinfection of raw water before they reach the distribution network. Disinfection is the latest phase of water treatment. **Chlorination** is the most frequent technique of disinfection in SR and it is performed by elementary chlorine (gas) or by its compounds (sodium hypochlorite, calcium hypochlorite, chlordioxide). In addition to chemical methods also physical disinfection is used - **UV radiation** being the most frequent one.

DRINKING WATER QUALITY CONTROL IN SLOVAK REPUBLIC

The owners of public water systems or their operators ensure raw water quality control in the source and water quality control in the distribution network. Water companies, municipalities or other legal bodies and persons can operate public water systems if they have license for public water system of appropriate category. In the case of identification of exceeded limit values of parameters that are defined by limit or highest acceptable limit value the operator is obliged to inform immediately the corresponding regional public health authority. The extent, number and frequency of water quality control depend on the volume of supplied water and number of supplied inhabitants.

Drinking water quality in SR is monitored by Public Health Authority of the Slovak Republic (PHA SR) **and 36 Regional Public Health Authorities** (RPHA) in their competency in the framework of performance of state health surveillance and drinking water quality in the spot of end user, as a part of specialised roles of public health bodies. The actual legal documents set up also additional roles of public health authorities in the field of drinking water such as issuing of instructions for removal of identified shortcomings, measures for disease prevention, issuing and cancelling of derogations, fining of costs and penalties.

Monitoring is performed by employees of departments for environmental hygiene and health of all regional authorities in compliance with the national legislation, and with EU criteria defined for evaluation of drinking water data. Monitoring is performed permanently, and the sampling sites are selected in locations or buildings where the water flows out for a regular human consumption. The drinking water sampling plan is designed in order to identify drinking water quality on each public supply consumption site by sampling and following laboratory analysis. Moreover, the authorities investigate also drinking water quality **by checking the results of operational control performed by the public supply operators.** Operational Control Programme is delivered by the operators for approval to the corresponding regional public health authority on a yearly basis. These bodies are obliged to monitor and to ensure quality of supplied drinking water in the source as well as in the distribution system - mainly water companies and municipalities.

Drinking water quality control and water health safety check is performed by a set of 82 **water quality criteria** that represent **physical, chemical, biological and microbiological** water properties. Drinking water quality parameters are defined by SR Government Regulation No. 354/2006 Coll. pursuing requirements for water intended for human consumption, and water quality control for water intended for human consumption. **Limit values of water quality criteria are distinguished to recommended value, indicative value, limit value and highest acceptable limit value.** Exceeding of the highest acceptable limit values can cause the most serious health impacts and such exceeding exclude exploitation of this water for drinking purposes.

In addition to the **full scale water analysis**, also **minimal analysis**, i.e. measurement of 28 water quality parameters (see Table 1) is performed in order to control and to gain regular information on stability of water source as well as effectiveness of water treatment, mainly disinfection (when applicable), on biological quality and sensorial properties of drinking water. This minimal analysis is performed also after extraordinary sampling, after start of operation of new segments of water system, when the water supply was interrupted for more than 24 hours, and also before seasonal exploitation of public water supply system or water source intended for public supply.

Table 1: List of parameters of minimal drinking water analysis

No.	Parameter	No.	Parameter
1.	Escherichia coli	**15.**	Colour
2.	Coliform bacteria	**16.**	Nitrates
3.	Enterococci (faecal streptococci)	**17.**	Nitrites
4.	Culturable microorganisms at 22 °C	**18.**	Aluminium
5.	Culturable microorganisms at 37 °C	**19.**	Free chlorine
6.	Colourless flagellates	**20.**	Chemical oxygen demand (Mn)
7.	Living organisms (except colourless flagellates)	**21.**	Taste
8.	Filamentous bacteria (except iron and manganese bacteria)	**22.**	Conductivity
9.	Iron and manganese bacteria	**23.**	Manganese
10.	Micromycetes	**24.**	Odour
11.	Lifeless organisms	**25.**	Water reaction
12.	Abioseston	**26.**	Turbidity
13.	Clostridium perfringens	**27.**	Iron
14.	Ammonium ions	**28.**	Temperature

Drinking water quality reflects its origin, but also maintenance during the way "to the tap". The control by selected parameters should ensure complex information on water quality and on potential positive or negative effect to human health.

CHARACTERISTICS OF SELECTED DRINKING WATER QUALITY PARAMETERS

Presence of ***coliform bacteria*** indicates faecal contamination originating from digestive system of homoiothermic animals and humans. However, they can also appear in soil, plants and surface water. They indicate week protection of the water source, shortcomings in water treatment and its health security and distribution, or secondary contamination. In case of their presence also the risk of transfer of other potentially pathogenic and pathogenic microorganisms. Absence of coliform bacteria in drinking water for public supply in min. 100 ml is required (limit value). In drinking water for individual supply the absence of coliform bacteria in minimum 10 ml is required (limit value).

Escherichia coli (E.C.) - according to WHO the only correct indicator of faecal contamination, being exclusively of intestinal origin and it appears in faeces. It indicates mainly actual faecal pollution, and its presence in drinking water shows serious shortcomings in water source protection, in treatment and health safety of drinking water.
Absence of Escherichia coli in drinking water for public supply in minimum 100 ml is required (highest acceptable limit value). In drinking water for individual supply the absence of Escherichia coli in minimum 10 ml is required (highest acceptable limit value).

Enterococci indicate faecal pollution and general pollution, as well as potential appearance of other potentially pathogenic microorganisms. They indicate actual faecal pollution as they die quickly out of the intestinal system. They cause urinary system infections, myocardium inflammations and intestinal infections. Resistance to antibiotics can cause survival of enterococci in hospital environment.

Presence of enterococci in drinking water shows insufficient protection of water source and shortcomings in treatment and health safety of drinking water. As well as for the other indicators of faecal pollution, absence of enterococci in drinking water for public supply in minimum 100 ml is required (highest acceptable limit value), in drinking water for individual supply the absence in minimum 10 ml is required.

Culturable microorganisms at 22 indicate general water pollution, the optimal bacterial growth is under temperature 22 °C. Their number inform on general bacterial water contamination, the increased number indicates penetration of surrounding pollution or failure of water treatment or disinfection.
Limit value for public supplies is 200 CFU/ml and for individual supplies 500 CFU/ml.

Culturable microorganisms at 37 °C indicate general water pollution. Their temperature optimum for growth is at 37 °C, proving relation to homoiothermic organisms, therefore they have higher hygienical importance as the parameter cultivable microorganisms at 22 °C.
Limit value for public supplies is 20 CFU/ml and for individual supplies 100 CFU/ml.

Iron (Fe) is a paramater without health importance, but it impacts negatively sensorial water properties and it may cause yellow to rust colour or bitter taste. Even low Fe^{2+} concentrations in water can cause increased growth of iron bacteria that clog pipelines and cause smell during their decomposition. Increased iron presence in water is obviously followed by manganese.
Limit value for iron content in drinking water 0.2 mg/l was set out due to impact to sensorial water properties (colour) when the concentration is increased. When iron is appearing naturally, tolerable limit is 0.5 mg/l.
Natural presence of iron in drinking water does not present any health risk for human organism.

Manganese (Mn) similarly as iron is a paramater without health importance, but it impacts negatively sensorial water properties and it may cause brown-black colour or bitter taste. Manganese also penetrates to water by leaching from soils, sediments and certain necrotised parts of plant bodies. Waste water can act as artificial sources, e.g. from ore processing and metallurgy. In addition to sensorial properties, the increased manganese content can result in overgrowth of manganese bacteria and following clogging of water pipelines.
Limit value for its concentration is 0.05 mg/l, in case of natural appearance from geological sublayers without impacting sensorial properties it is 0.2 mg/l.
Natural presence of manganese iron in drinking water does not present any health risk for human organism.

Calcium (Ca) belongs to categories of parameters presence of which is desirable in water. It forms bone and teeth tissue. It is needed for transmission of neural excitation in muscles, and it is also unavoidable in the blood precipitation.
Recommended value is > 30 mg/l. The regulation for drinking water further recommends the value for pooled concentration with magnesium ***(Ca plus Mg)*** 1.1 – 5.0 mmol/l.

Magnesium (Mg) belongs also to the category of parameters presence of which is desirable in water. It forms a component of bones. It is needed for transmission of neural excitation. Increased concentration is expressed by inappetence, diarrhoea to unconsciousness and death. It facilitates mineralisation of organic substances from lifeless organisms, contributing to self-purification processes in water. Magnesium appears in waters bound in insoluble carbonates or soluble hydrogencarbonates together with calcium compounds. It importantly influences neutralisation water capacity and water pH. It forms an essential component of chlorophyll and cell organelle.
Its presence in drinking water is defined by recommended value 10.0 to 30.0 mg/l and limit value 125 mg/l. Regulation for drinking water furthermore recommends the pooled value with calcium ***(Ca plus Mg)*** 1.1 – 5.0 mmol/l.

Calcium and magnesium are leached into waters from limestone and dolomites, or occasionally from waste waters from facilities processing calcium hydroxide. Calcium and magnesium determine the ***overall water hardness***, having preventive impact in induction of heart-vascular diseases. Calcium content in water, and also magnesium to less extent, have antitoxic function and they inhibit absorption of certain toxic elements and their transfer from intestinal system to blood.
Also additional elements can contribute to water hardness: aluminium, manganese, zinc, barium, strontium, iron. High concentration of these elements in drinking water is desirable, however, in technological waters it causes creation of encrustations ("water stone"). Mostly for technological reasons several scales of water hardness was proposed (e.g. very soft - soft - moderately hard - hard - very hard). It is difficult to define optimal concentration of magnesium and calcium in drinking water, moreover, the heath requirements must not correspond to the technological ones. Undesirable effects of increased water hardness are as follows: creation of encrustations in boiling vessels, hot water distribution pipelines, water heaters and boilers and increased consumption of washing powders.

Water hardness is in general understood as sum of calcium and manganese concentration in water.

Water hardness recalculations – the following formulas are used for recalculations of water hardness:

- 1 mmol/l = 5.6 °dH
- 1 °dH = 0.1783 mmol/l

Recommended drinking water hardness - SR Government Regulation No. 354/2006 Coll. sets out recommended drinking water calcium and magnesium concentration 1.1 to 5 mmol/l (i.e. water hardness between 6.16 and 28 °dH).

Water hardness scale

Level	Hardness degree [mmol/l]	Hardness degree [°dH]
very soft	< 0.69	< 3.89
soft	0.7 – 1.25	3.9 – 7
moderately hard	1.26 – 2.5	7.01 – 14
hard	2.51 – 3.75	14.01 – 21
very hard	> 3.76	> 21.01

[°dH] = German degree

Nitrates (NO_3^-) form natural component of waters in small amounts. Exceeding of their limit together with ***nitrites (NO_2^-)*** signalises excess use of fertilisers and leaks of waste waters from septic tanks and farms. Nitrates are reduced in intestinal system by activity of certain bacteria to more toxic nitrites that cause transformation of haemoglobine to methaemoglobine after absorption to blood, leading to decreased concentration of haemoglobine able to transfer oxygen. Risk of methaemoglobinemia is higher in suckling babies up to age of 3 months. Oxygen lack is manifested in the first phase by cyanosis and blue lips, and it can lead in more serious cases to asphyxia, failure of brain functions and insufficiency of basic vital functions. Nitrates react in stomach with amines and other nitrogen substances from foodstuffs resulting in carcinogenic N-nitroso compounds.
Highest acceptable limit value for nitrates in drinking water was set out to 50 mg/l, according to indirect toxic effects of nitrates to human organism, mainly to babies under 6 months of age. Highest acceptable limit value for nitrites is in drinking water is 0.5 mg/l.
Ministry of Agriculture SR and Ministry of Environment SR Decree No. 608/9/2004, setting out the Catch of SR Food Code regarding natural mineral water, spring water and packed drinking water defines the highest acceptable limit value for nitrates to 10 mg/l and for nitrites to 0.1 mg/l for water suitable for preparation of food for babies under 6 months of age.

Water reaction (pH) expresses the concentration of hydrogen ions and it can fluctuate between 0 and 14. In the chemically clean water it has neutral value pH = 7 and the concentration of ions is balanced. Most of fresh water organisms accommodate water reaction around pH 7. The range is much broader in the natural waters, from pH 3 in acid peatland waters up to pH 11 in waters with extensive photosynthesis. It is important mainly in influencing the procedure of degradation of salts in water, as well as toxicity of certain substances. Water with low pH can have aggressive effect to the material of pipelines, resulting in increased concentrations of iron or copper, and higher water reaction can also diminish the effectiveness of disinfection.
Drinking water reaction should lie between 6.5 and 8.5.

Chemical oxygen demand - permanganate (COD_{Mn}) serves for estimation of organic pollution. It can naturally originate from leachates of organically rich soils, degradation of animal and plant bodies directly in the well, or artificially when it can signalise leaking of toxic substances - pesticides or fertilisers.
Limit value is set out to 3.0 mg/l.

Ammonium ions (NH_4^+) after exceeding the limit value can indicate faecal pollution, but they can also originate from the geological background. They can also serve as indicator of insufficient disinfection and in combination with increased nitrite concentration and increased content of organic substances COD_{Mn} they indicate of actual contamination by animal-originating waste and prove accidental pollution.
Limit value for this parameter is set out to 0.5 mg/l.

Free chlorine - drinking water supplied to consumers must be secured by disinfection from the health protection point of view. Application of chlorine for drinking water disinfection is considered worldwide as one of the most effective technologies of health security of water, as well as prevention of appearance and spread of diseases. Chlorination is the most frequent disinfection methods also in SR, regardless whether chlorine in elementary form is used or application of its compounds.
Health impact concerns are not reliable since the hygienic criteria, concentration limits and professional approach of drinking water supplier and operator are met. Limit values are set out according to the long term investigation of chlorinated drinking water consumption impact to population health that did not confirm any negative influences to human health.
Limit value for chlorine is 0.3 mg/l and this value is related to free chlorine concentration after treatment. Minimal required concentration in the distribution network is 0.05 mg/l.

WATER RELATED HEALTH RISKS

Drinking water can act as **infection disease vector** in case of microbiological contamination. Water can spread mainly agents of intestinal infections as **typhoid fever, bacterial dysentery, cholera, anthrax, leptospiroses, viral hepatitis A, enteroviroses, and parasitic** and other diseases. The most frequent waterborn diseases in SR conditions are (mainly in persons living under lower hygienic standards) **bacilar dysentery, infectious hepatitis A,** certain **animal-transmitted diseases** and other **diarrhoea diseases.** The risk of those diseases is higher during flood periods or in cases of sewage failures. Recent case of waterborn disease outbreak was identified in Jaslovské Bohunice where **gastroenteritis** was manifested in more than 100 persons. Non-professional link of distribution system of irrigation water and drinking water was the reason of this epidemy rather than insufficient disinfection performed by the water company. This is only one example of low understanding of people having long term impacts in practice.

Increased concentrations of chemical substances in drinking water pose an additional risk that can result in acute organism harm, or in case of long term intake also induction of chronical diseases. **Increased concentrations of nitrates** in drinking water originating from individual sources are in question in Slovakia potentially causing methaemoglobinemia in suckling babies.

Drinking water is also a source of important trace elements (Li, Zn, Co, Cu, Sn, Mn, Cr and others) **that are desirable or even essential for human organism. Calcium and magnesium** (that contribute to water hardness) have irreplaceable importance in relation to cardiovascular diseases. **Fluorine** concentration in drinking water is limited and intake of this element from drinking water in recommended amounts is important from the health point of view for proper development of bones and teeth. Long term intake of drinking water without these elements pose also a health risk.

Health risk is also caused by intake of water containing **heavy metals** (mercury, lead, arsenic and cyanides being specifically toxic), **pesticides and oil substances**, N-nitro-compounds (carcinogenicity), polychlorinated biphenyls, terphenyls, polycyclic aromatic hydrocarbons (carcinogens). Risk appears also after chlorination of organic compounds of humine character - trihalomethanes, tetrachloromethane, dichloromethane, bromoform that have low toxicity, but they increase uptake of metal compounds.

Decreased consumption and demand for drinking water from public sources is evident from available data during recent years. **Water consumption is below so called hygienic minimum** in several regions of Slovakia (this level differ in individual countries fluctuating between 80 to 100 l per inhabitant per day). This decreased demand can be caused by increased exploitation of water from individual sources for household purposes, purchase of packed water and other types of drinks, as well as the ambition of inhabitants to decrease the costs of public water consumption. The households with unfavourable socio-economic situation the citizens reduce also water consumption for personal hygiene - having also potential adverse effect to their health.

RECOMMENDATION FOR OWNERS OF WATER WELLS

Water quality of wells is investigated by the public health authorities, however, owners should take care of water quality and status of wells as such. This issue in relation to the tendency to spare financial sources often leads to slight water assessment - water looks clean, we can drink it. According to the experiences many owners of water wells did not ask anytime for water analysis and they underestimate the risks resulting from such water. Health problems need not to express immediately but after several years.

In the case of acceptable results the quality of water from well depends on potential pollution sources in its vicinity. Dump sites, dung-pits, silage pits and any other pollution sources should not be located in its vicinity that can cause leakage of pollutants to the well. Also ensurance of close surrounding is important in order to avoid well pollution by e.g. rain water run off from the surface. As any other construction also water well needs regular control and maintenance, especially control after e.g. flood periods or other accidental situations.

Quality of water in the exploited well should be checked at least on a yearly basis. When the well is improperly located or when it is not sufficiently protected the user is in a risk of water related disease.

If the water well is impacted by flood event it can be used as a drinking water source only after its clean up and disinfection and check of water quality by laboratory analysis.

Procedure for sanitation of individual water well

Mechanical clean up including disinfection is performed always under presence of three persons as regards of potential first aid to the person working directly in the well. Working safety principles should be followed, together with application of personal protection tools.

1. Wells can be cleaned up after subsidy of flood water. Impurities, mud sediments and organic residues should be removed in the distance minimum 10 m.
2. Outer walls of the well should be carefully mechanically cleaned including the covering and pumping technology (by means of brush or strong water stream).
3. Whole well volume is pumped out and the pumped water is directed to waste or to safe distance from the well.
4. Before entering the well presence of toxic gases is investigated - the simplest test being immersing of lighted candle. When the flame dies down the well is cleaned only after thorough ventilation of the space (e.g. by tube connected to vacuum cleaner). If it is technically acceptable inner walls and well bottom are cleaned mechanically. Then the walls are rinsed by clean water and the well is again emptied.
5. Inner well walls are rinsed by chlorine based disinfection agent according to the instruction of producer (e.g. SAVO solution). Disinfection can be ineffective when the water is turbid. Disinfection is repeated when necessary and the water is pumped out till the turbidity disappears. Well walls are again rinsed by clean water and water is pumped out.
6. After filling up of well drinking water disinfection agent is applied (depending of well type e.g. SAVO for drinking water, chloramine, Presept) and it should be ensured that water containing disinfectant will rinse whole water system and pass all taps in the house. It is necessary to disnfect also all stench-traps.
7. Until the water quality from the well is measured, water is used solely for service purposes (household cleaning etc.).
8. Laboratory investigation should control the efficiency of sanitation procedure.

DRINKING WATER QUALITY IN THE SLOVAK REPUBLIC

The results of drinking water quality control are processed and published by the public health authorities on a yearly basis in the following documents:

- **Evaluation Reports from monitoring results of drinking water quality supplied to users by public water supply systems in SR.** The reports contain detailed evaluation of results from drinking water quality monitoring from public sources at the site of user on the level of the individual parameters. The archive of Evaluation Reports of the National Reference Centre for Drinking Water (NRC), which issues the summary reports for whole country is available at the web page of Regional Public Health Authority in Košice www.ruvzke.sk since 2008.
- **Annual Reports of Regional Public Health Authorities.** Annual reports evaluate in their individual sections the supplies of drinking water from public sources as well as public wells, quality of water for public use according to the results of monitoring and results of state health surveillance, and on the basis of water quality operational control.

Evaluation Report NRC 2007 shows that **microbiological parameters** are analysed most often. The most important exceeding of limit values was identified in epidemiologically important parameters like **coliform bacteria** (6.2 %), **enterococci** (3.7 %) and **Escherichia coli** (3 %).
The highest exceeding of limit values among the **sensorial parameters** was identified in **temperature** (23.5 %), water **oxygen saturation** (8 %) and **iron** content (8 %). Insufficient disinfection was identified in 25.4 % of total number of laboratory analyses (4 600) in the parameter **free chlorine.**

Nitrates and nitrites belong to the most frequently measured **chemical parameters** in the framework of drinking water quality monitoring. 6 383 laboratory analyses of nitrate content in drinking water samples were performed during 2007. **Nitrate** concentration exceeded the limit values in 0.85 %, mainly in smaller municipal water systems. Among **heavy metals**, presence of antimony and arsenic in drinking water was identified in several Slovakia locations, however, these two elements originate naturally from geological environment.

In the framework of evaluation of all analysed drinking water quality parameters the **limit values were exceeded in 3.2 % of results in 2007.** When solely the parameters with health impact (those which have the limit value defined as the highest acceptable limit value), only 0.3 % of analyses shown their exceeding.

The results shown indicate mainly shortcomings in the protection of water sources, insufficient water disinfection, as well as negative impact of distribution network development to the water quality on site of the user in parameters resulting in sensorial changes.

Table 2: Overview of water quality in public water supply systems according to monitoring results of RPHAs and Public Health Authority of the Slovak Republic for year 2008

Region	Total number of analysed samples		Number of samples exceeding limit value (non-compliant)		Non-compliant samples					
	CHM	AM	Number	%	Phys.-		Microbiol.		Biolog.	
					abs.	%	abs.	%	abs.	%
Bratislava	122	397	75	14.5	56	26.3	35	14.7	5	1.6
Trnava	66	510	80	13.89	59	10.24	23	3.99	5	0.87
Trenčín	176	599	217	28	181*	23.4*	54	7	0	0
Nitra	201	730	92	9.9	72	7.7	24	2.6	0	0
Žilina	181	567	73	9.76	38	5.08	55	7.35	0	0
Banská Bystrica	194	836	317	30.78	154	14.95	187	18.16	56	5.44
Košice	103	684	175	22.24	108	13.72	90	11.44	6	0.76
Prešov	152	753	151	16.7	61	6.7	94	10.4	17	1.8
SR	1195	5076	1180	18.4	548	8.7	562	8.96	89	1.4

Note:

* – increased proportion of non-compliant samples is caused mainly by exceeding of limit value in the physical parameter temperature (exceeding of parameter temperature in 95.6 % out of total number of 181 non-compliant samples in physico-chemical parameters, i.e. 173 samples).
Parameter temperature is recorded in the framework of sampling as accredited parameter, and it does not reach required value 8 - 12 °C according to actual legislation in many sampling sites due to decreased drinking water uptake in the site of consumer and long stay of water in pipelines. However, this is a parameter with only recommended limit value exceeding of which has not direct impact to population health.
Overall non-compliance of the samples does not present the sum of physico-chemical, microbiological and biological non-compliances as one sample can be non-compliant in multiple parameters.

CHM – check monitoring (investigation of quality parameters in the entire range of analysis - 82 parameters)
AM – audit monitoring (investigation of quality parameters in the range of minimum analysis - 28 parameters)

Source: Annual Report of PHA SR, 2008

Derogations for exploitation of water which does not comply with hygienic limits of drinking water quality parameters are issued for chemical parameters listed in Annex 1 part B of the Council Directive 98/83/EC on quality of water intended for human consumption. Maximum limit value set out for the parameters treated by the derogation does not pose any health threat. The validity of exemptions is limited - it must not be longer than three years, and control should be performed by the end of this period in order to investigate drinking water quality. Second derogation can be issued after this period, however, it must be announced to the European Commission.

Doubts on unacceptable quality of water from SR public water supply systems that are spread among lay public are not justified and often exaggerative. They often lead to unjustified purchase of different expensive filtration equipment and their application is acceptable only under certain circumstances and only for short period in some types from the health protection point of view.

Water quality in public water supply systems is ensured by control, but also high quality groundwater reservoirs that serve as water supply for most of SR water supply systems. When citizens want to gain information on "its own water supply system", or when they have a doubt on unacceptable water quality, they can turn to the respective water company (or municipality) or to the respective regional health autority in their region.

Drinking water quality in water supply zones of the Slovak Republic

Drinking water quality evaluation in the EU member states is performed also on the level of so called supply zones according to the European Commission recommendations.

Supply zone is defined as geographically defined area within which water intended for human consumption comes from one or more sources and within which water quality may be considered as being approximately uniform. "Traditional" evaluation and assessment of drinking water quality on the regional (local, district, and region) level was therefore replaced by following of supply zones.

European Commission distinguishes small and large water supply zones.

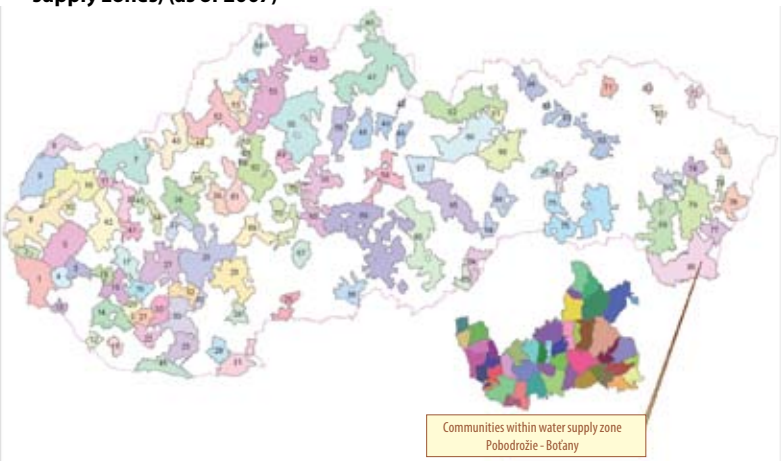
Small water supply zone supplies 50 to 5 000 inhabitants or up to 1 000 m^3/day is supplied to it. Three categories are defined for this type as follows:

1. Supplied zone with supply of 10 - 100 m^3/day (50 - 500 inhabitants)
2. Supplied zone with supply of 100 - 400 m^3/day (500 - 2 000 inhabitants)
3. Supplied zone with supply of 400 - 1 000 m^3 /day (2 000 - 5 000 inhabitants)

More than 5 000 inhabitants are supplied in large water supply zone or the water supply is higher than 1 000 m^3/day.
Supply zones in SR were defined by Water Research Institute in cooperation with regional public health authorities. **1 020 small and 94 large water supply zones are defined in SR at present.**

The number of inhabitants supplied under large water supply zones in SR increased since 2005 when safe drinking water was delivered to 3.69 mil. inhabitants (68.5 %), to 3.72 mil. (69 %) in 2006 and 3.75 mil. (69.4 %) in 2007. It is necessary to add for the completeness of data that the total number of inhabitants supplied by the public systems reached 86.6 % of inhabitants in 2007.

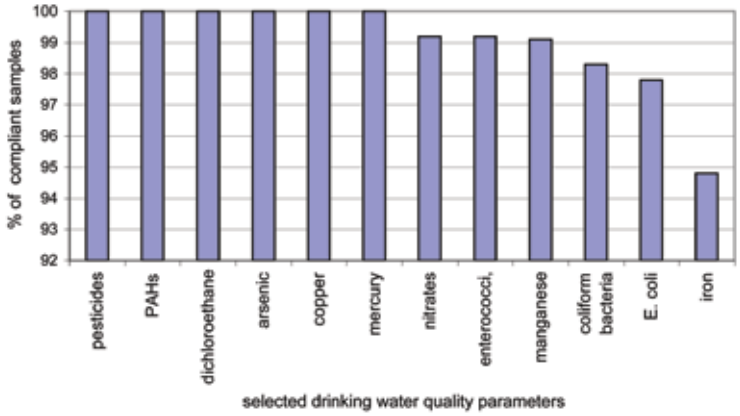
Figure 2: Map of SR water supply zones with more than 5 000 inhabitants (so called large water supply zones) (as of 2007)



Source: Water Research Institute

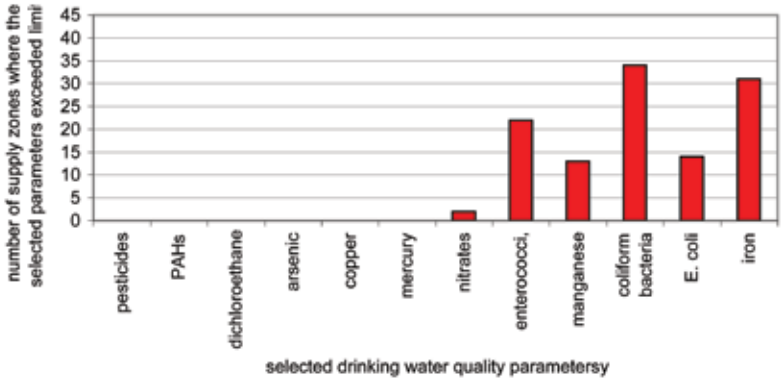
High quality of drinking water was reached in water supply zones with more than 5 000 inhabitants according to the results of drinking water quality investigations performed by public water systems operators and regional public health authorities in 2007. The proportion of compliant samples did not decreased below 94 % (see example on Figure 3) in none of followed parameters. Coliform bacteria was the most frequently exceeded parameter in water supply zones (in 34 supplied zones) and iron (in 31 supplied zones) (see example in Figure 4).

Figure 3: Drinking water quality in SR water supply zones with more than 5 000 inhabitants (as of 2007)



Source: Public Health Authority of the Slovak Republic, Water Research Institute

Figure 4: Number of large water supply zones where the selected parameter exceeded the limit (as of 2007)



Source: Public Health Authority of the Slovak Republic, Water Research Institute

DRINKING WATER QUALITY IN EUROPEAN UNION COUNTRIES

EU member states are obliged to deliver **to the European Commission the report on drinking water quality in the supply zones** where the water supply is in average higher than 1 000 m^3 per day or it serves to more than 5 000 inhabitants. First such report on Slovakia was elaborated in February 2009 for period of years 2005 to 2007. The report was elaborated by Public Health Authority of the Slovak Republic on the basis of monitoring data of each regional public health authority and data submitted by Water Research Institute (data from operational control of water systems operators). The Slovak report is available on web page of Slovak Environmental Agency (www.sazp.sk) and on the central data repository of European Environmental Agency / European Commission (http://cdr.eionet.europa.eu/sk/eu/dwd).

EC assesses fulfilment of the implementation requirements of Council Directive 98/83/EC on the basis of these data for each member state, moreover it evaluates drinking water quality on the European level. **Assessment Reports on drinking water quality in the European Union of European Commission** are publicly available on European Commission web page http://circa.europa.eu/Public/irc/env/drinking_water_rev/library?l=/drinking_synthesis&vm=detailed&sb=Title.

The latest available **Synthesis Report on the Quality of Drinking Water in the Member States of the European Union in the Period 2002 - 2004** reveals that the highest proportion of supplied inhabitants among 17 assessed countries (B, CZ, DK, D, EE, EL, ES, F, IRL, IT, LUX, NL, AT, PT, FIN, S, UK) was in Belgium and The Netherlands where the proportion of supply was around 100 %. In contrary, the lowest percentage of supplied inhabitants was in Estonia, Denmark, Austria and Ireland where the proportion of supplied inhabitants was lower than 70 %.
Most EU countries used groundwater as the dominant **drinking water source**. Surface water form important part of drinking water sources in Ireland, Great Britain, Portugal and Estonia. Several member states exploit also other sources, e.g. sea and rain water or waters from riverbank infiltration. This is a case of e.g. Finland and Germany.
In the water supply zones of EU the most frequently exceeded limits set out by the Council Directive 98/83/EC were for the following **water quality parameters:** coliform bacteria, iron, manganese, turbidity and aluminium. Lower drinking water quality was further caused by microbiological parameters, i.e. E. coli and enterococci. Nitrates and fluorides caused the same for chemical parameters.
Nitrates, fluorides, iron, but mainly arsenic belong to parameters for which the requirements of member states for **exemption for drinking water exploitation when it did not met the hygienic criteria** were applied. Italy asked for highest number of derogations.

Most countries recorded increased values for several parameters during the reported period, but also decreased frequency of non-compliant analyses of certain parameters in contrary. Significant changes in development of drinking water quality were not recorded in e.g. The Netherlands, Great Britain. Improved drinking water quality was recorded in Germany, Spain, Ireland and Portugal.

Next **Synthesis Report on the Quality of Drinking Water in the Member States of the European Union in the Period 2005 - 2007** will be published by European Commission in November 2009.

INFORMATION SYSTEM ON DRINKING WATER

More detailed information on drinking water quality in the individual SR regions are shown on web page http://pitnavoda.enviroportal.sk, where the data from information system on drinking water (or water intended for human consumption) are published. Information system on drinking water is available based on access rights on http://pitnavoda.sazp.sk

Information system on drinking water was developed in the framework of project entitled "Information system on water intended for human consumption" financed by European Union funds (UIBF 2006). Slovak Environmental Agency was the project beneficiary. The project was implemented within the Public Health Authority of the Slovak Republic and Water Research Institute cooperation. Slovak Environmental Agency operates the information system. Public Health Authority of the Slovak Republic operates and submits data to the system. The system contains also selected data also from database of Water Research Institute.

Other interesting links

www.uvzsr.sk
Public Health Authority of the Slovak Republic
www.ruvzke.sk
Regional Public Health Authority in Košice, NRC for drinking water
www.vuvh.sk
Water Reasearch Institute
www.sazp.sk
Slovak Environmental Agency
www.enviro.gov.sk
Ministry of Environment of Slovak Republic
www.enviroportal.sk
Portal of environmental information
water.europa.eu
Water information system for Europe
http://ec.europa.eu/environment/water/water-drink/
European Commission – Directorate General for Environment
http://cdr.eionet.europa.eu/
Central data repository of environmental information of European Environment Agency and European Commission
http://www.eea.europa.eu/themes/water
European Environment Agency
www.who.int
World Health Organisation

Project beneficiary
Slovak Environmental Agency

Project supplier
Dekonta, s. r. o., Bratislava

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