WATER INTERFERENCES: DEFINITION, LOCATION, NATURE OF PROCESS AND INDUCED EFFECTS WITH APPLICATIONS IN ROMANIA (I)

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Abstract. - Water Interferences: definition, location, nature of process and induced effects with applications in Romania. In the first part of the paper defines the interference term retention, location and origin of the water that interferes and generates a special category of hazards fluid. Next, have been identified, analyzed and detailed localized, depending on their nature (physical, chemical and mechanical) phenomena and processes underlying this category of hazards fluid and environment effects that induce the different environments in Romania (continental, marine and coastal). Territorial analysis and interference effects they induce in the end allowed the work to delimit affected areas similar to Romania this category waterborne hazards. Regionalization of interference phenomena and processes can be based on several criteria (duration, intensity, frequency and number of types of harmful interference researched area). Based on the latter criterion stated several areas were defined as the number of types of interference and their expressions are identical. Finally, three categories were defined by the number of interferences, regions that affect different (high, medium and low), hence the chance character product: complex, intermediate and low. Of conclusions resulting set theme, originality and the need to study this class of integrated hydrological hazards.

Key words: interferences, physical processes, chemical nature processes, effects

1. The definition for water interference and origin of interfering waters

Water interference represents a phenomenon of inter connection of two water masses with distinct characteristics (physical, chemical, mechanical and dynamic), that join into some point of the propagation environment. Interference

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phenomenon takes place in the marine environment near the coast (beaches, deltas, estuaries, lagoons, mangroves) and in deep waters, but also in the continental environments (surface and underground) (Sorocovschi, 2002, 2010, 2011, Grecu, 2009, Keller, Blodgett, 2008, Bălteanu, Şerban, 2005, Bryant, 2005, Ayala, Cantos, 2002, Dauphine, Rosa, 2002). The localization of interference phenomenon can be absolute (well determined) or relative (more uncertain) and it can be made related with urban and rural areas, with roads or different activities (primary, secondary and tertiary). Also, the localization can be exact, diffuse or random. Its manifestation can be: gradual (the most frequent), linear or in a network (rarely). There are many types for the diffusion of water interferences phenomena: linear, through contamination and irregular. The last type generates numerous disasters, because disorder is caused by many inseparable causes and has multiple effects.

The origin of interfering waters can be natural or artificial. The artificial ones are represented by the mining waters that came from ore mines (nonferrous deposits, gold-silver deposits, radioactive deposits), and from mineral fuels exploitation (oil, natural gas, coal) or their processing. The mining waters are able to influence the chemical composition and the toxically gas content of the waters they interfere with, through the substances and gases they contain (H_2S, CO_2) (Anbumozhi, 2005). The waters from rivers located in areas where building materials and some raw materials are exploited, contain a high level of suspended load, brought by waters running through excavation areas.

Water interferences have, as any other natural hazard, many particularities that make very important to know all the risk phenomena research phase (identification, perception, analyze, evaluation, monitoring, forecast, warning and protection).

An important particularity of the water interference phenomenon is the complexity in space and time. It is connected especially with the big number of factors that interfere with phenomenon's evolution and with the diversity of components nature (physical, economical, financial and socio-cultural). Its complexity is determined not only by the components diversity, but also by their interactions. The analyzing of phenomenon's spatial complexity must take into account various aspects: localization and distribution, shape, dimension, diffusion and density. The characteristics of water interference phenomena can be defined through a set of spatial (placing, location, repartition, distance, affected area), temporal (length, frequency, periodicity, cyclical, trend, persistence), quantitative (volume, weight, mass), qualitative (shape, manifestation, density), dynamic (direction, intensity, velocity, rhythm, dispersion, diffusion), energetically (potential, impact and conservation energies, magnitude) attributes.

2.The nature and location water interference induced processes

The processes that follow the interference phenomenon can have a physical, chemical, mechanical or environmental nature as presented in figure 1 (Sorocovschi, 2006). Each type of process and phenomenon has many attributes that increases the apparition of water interferences (Chiaburu, Dulgheru, 2010).

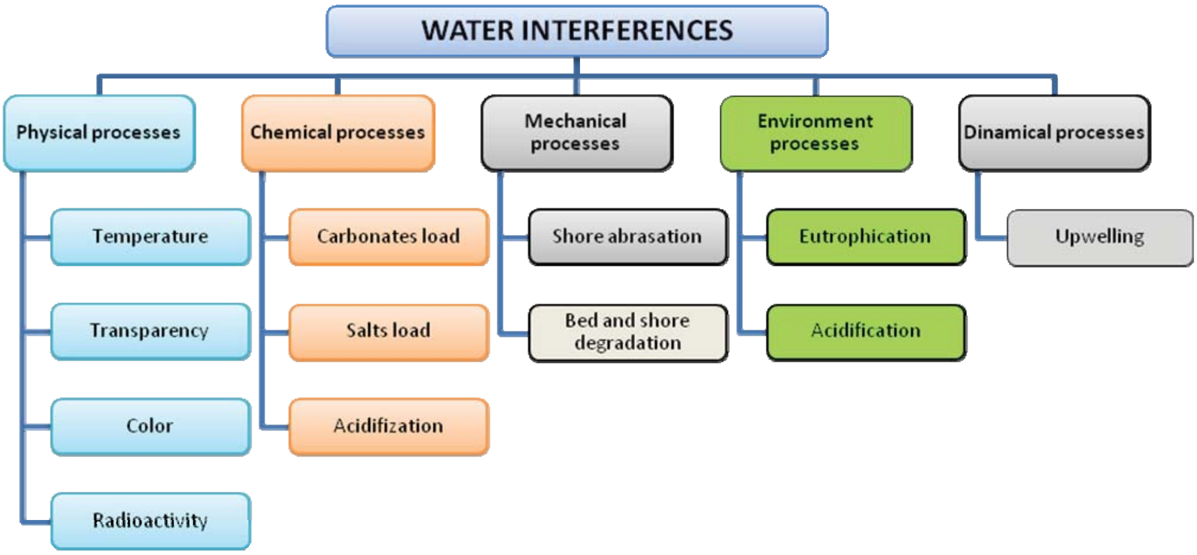

Figure 1. The classification of water interferences by processes nature

2.1. Physical processes

Physical processes refer to the modifications determined by water characteristics, such as temperature, transparency, color and radioactivity.
The spilling of high volumes of warm water that come from water plant cooling towers makes the downstream waters to have higher annual temperatures than average values and a very short or no ice formations period (Table 1).

Thereby, an example is the Târnava Mică River that downstream the Sângeorgiu de Pădure water plant (in its working time) where has been recorded a water temperature with 2°C higher than the one from the upstream section, Sărățeni (8.3 °C). Similar situations appeared on Jilț downstream the Turceni water plant.
River and lake water temperatures highly depend on the drainage basin's climatic zone and on the tributaries water temperature. For example, the Danube's annual average water temperature is *smaller* in the upper section upstream Passau, because of the input with cool waters from the northern side of the Alps (Riss, Iller, Günz, Mindel, Lech, Issar and Inn). This phenomenon is more obvious in summer time, when water input is higher.

Table 1. Water temperature and ice formations period on different river sections downstream of the water plants cooling towers (1951-1980).

River	Hydrometric station	Annual average water temperature	Total days with ice formation / year
Târnava Mică	Târnăveni	10,7	37
Jil□	Turceni	11,1	43

A similar phenomenon appears in springtime on Olt River from Făgăraş Depression, when numerous tributaries come from the northern side of the Făgăraş Mountains bring a high volume of cool water determined by the melting of snow by the foehn wind (*The Snow Eater* or *The Shepherd*).

The thermal interference appears even in the underground domain. Such an example is the thermal waters from Câmpia de Vest (Western Plain), that have their source at depths with very high temperatures (40 – 60 °C), that interfere when they reach the surface with low and medium depth underground waters.

The thermal marine interferences are very frequent and are very complex phenomena, with areal and local *nature.* The local nature appears in the case of hydro fronts that separate water masses thermal and salt characteristics.

If there is a high salinity vertically homogeneous layer at the water surface, the thermal interference phenomenon cannot be present. This is the case for the salt lakes in Transylvania Depression where is present the *heliotherm* phenomenon (Sovata, Cojocna, Sic, Ocna Mureş, Turda, Ocna Sibiului, Ocna Dej lakes).

The physical interferences determine transparency, turbidity and color modifications that appear especially at confluence points, river mouths or mining areas (open-cast or underground mining).

Water's turbidity is connected to the supplementary input of alluvial load that comes from slope's surface in times of excessive rainfalls, or through washing of loose materials by meteoric waters.

The chromatic modifications can be also induced by the human factor, downstream of many water constructions, especially industrial and urban ones. The transparence and color of river water can be strongly modified by the input of waters that come from mining areas (base metals, precious metals, fossil fuels and building materials). The waters of Arieş River, for example, change their color to yellowish after the confluence with Abrud River (Fig. 2).

We can find other examples in Romania, Crişul Alb River (White Criş) and Crişul Negru River (Black Criş). Their names are associated with the water's color determined by the load with suspensions that come from upstream areas with mines precious and non-ferrous minerals (Bătinaş, 2010).

a b

Figure 2. The modification of river water color: a) confluence of Valea Şesei River with Arieş River; b) Valea Seliştei River downstream the mud-setting pond Valea Seliştei (Bătinaş, 2010

Another type of interference is the suspension load. The high quantity if suspensions can determine the transparency and the color of water.
For example, several streams in northwest Transylvanian Depression (Almaş and Agrij) and those crossing the Curvature Sub-Carpathians are carrying a huge amount of silt in suspension; thus they get a yellowish color in spring with very little transparency. Instead, the streams that are draining wetlands or swamps are getting a black color. Clogging is a physical process consisting of solid particles deposit in surface and underground waters. Most lakes are heavily clogged as a result of massive deforestation occurred lately in their catchment areas. Degree of contamination depends on the size of the lake basin, the volume of water stored, the position they occupy accumulation in the basin, profile posed the balance between two reservoirs etc. (Gâştescu, 2006).

Clogging lakes entails a series of negative effects such as their invading vegetation in portions where silt is near the surface, leading to the restriction of water surface, with all known consequences. The most significant negative effect of clogging is the reducing of water quality in the lake. Another example is the Jiu River that has a dark color determined by the suspension load that comes from the coal mining area of Petroşani Depression.

Water's radioactivity is determined by presence of radon or small quantities of radioactive solvable salts (uranium, thorium, potassium). The radioactivity is smaller in running waters because of the water's dynamic. The origin of high radioactivity of mineral springs (Herculane - Seven Springs, Sângeorz Spa - springs 5 and 4, Geoagiu - Healing Spring etc.) was correlated with the presence of granitic rocks, schists penetrated by veins of pegmatite, igneous rocks (rhyolites, dacite), which waters wash them during their journey. On the national level were outlined areas where radioactive waters are frequent. They are located in areas of predominantly acidic igneous rocks: Cerna Mountains, Southern Carpathians between Jiu and Lotru, Gilău Mountains, Bihor Mountains, Măcin Mountains (Socolescu, et all., 1975).

2.2. Chemical nature processes

Many water interferences trigger chemical processes generated by natural and also human influenced factors.

Although water interferences have negative effects such as water pollution, we can talk about "natural pollution" (although it's a misnomer), in places where it is produced by natural interferences caused by the mobility of natural process contamination. This kind of interferences appear in various conditions: when *waters are crossing a soluble rocks area* (sulphates, radioactive rocks etc.), that determines surface or underground waters contamination; when *waters are crossing an erosion area,* that triggers a pollution with solid particles, especially when they are contaminated with various chemical fertilizers, or when there appear long time suspension fines (shale or clay); when *there appears an abundant aquatically vegetation* (fixed or floating), especially in low speed water flow rivers and lakes, triggering pollution phenomena that vary in time according to vegetation periods; when *river bank vegetation* produces pollution through leaves or plant falling (Heise 2003).

River water chemistry is induced by river bed substratum characteristics and influenced by hydrological, climatic and morphological particularities of drainage areas. Rivers that cross a karstic area usually have a carbonate character (Arieşul Mare River at Scărişoara and Arieş River at Câmpeni, Gârda Seacă or Valea Morilor at Huda lui Păpară - from Arieş drainage basin, Roşia Brook at Pocola, Holod River at Holod and Peştera Brook at Vadu Crişului – Crişurilor drainage basin) (Sorocovschi, Şerban, 2008, Cigher and al, 2010, Marin, 2002). Instead, rivers crossing an opencast or near surface salt area from eastern Transylvania Depression (Târnava Mică River, Sărat Brook) and from Moldavian Sub Carpathians (Trotuş River) and Curvature Sub-Carpathians (Râmnic River), have a chlorinated character (Table 2).

Table. 2. Hydrochemical type of river waters influenced by karst and salt from diapir area.

Geology	River	Hydro-metric station	Cations (mg/l)			Anions (mg/l)		
			Ca	Mg	Na+K	SO_4	Cl	HCO_3
Limestone	Arieş	Scărişoara	24,6	6,54	4,43	17,82	7,02	85,47
	Arieş	Mihoieşti	22,3	5,42	3,1	10,47	5,02	88,65
	Gârda Seacă	Upstream Arieş	51,8	5,2	1,15	5,3	1,0	173,2
	Huda lui Păpară	Downstream	51,2	5,76	4,88	11,47	4,5	172,6
Salt	Târnava Mică	Sărăţeni	25,2	10,1	181.0	11.33	286.0	80
	Târnava Mică	Târnăveni	61,6	20,2	227,3	22,46	346,0	229
	Trotuş	Rădeana	50	2,4	380	51,2	550	164,7
	Râmnicu Sărat	Tătaru	120	3,6	850	467	1120	110

Diapir areas influence the underground or surface water chemistry and quality through direct leaching of salt deposits caused by infiltration waters, and through ground-water supplies, through river bed deepening into salt deposits, through washing of salt efflorescence by torrents flowing into the river (Figure 3). The acidification of natural waters is connected with the drainage of swamp areas or, respectively, suphuric areas that have human influences, that triggers the decrease of natural waters pH (Bătinaş, 2012).

Figure 3. Water interferences determined by salt massives and salt eflorescences washing on Praid – Valea Corundului Canyon area (Bătinaş, 2012).

Such an example is represented by the mining areas from Arieş Basin (Baia de Arieş, Roşia Montană and Roşia Poieni), Crişul Alb Basin (Gura Barza) and those from superior Crişul Negru Basin (upstream Beiuş). Therefore, in the proximity of the mine waters mouth, the pH is very low, waters having a strong acid composition (Table 3).

Table 3. The values of pH and heavy metals concentration in waters from the proximity of mining areas from Arieş Basin (1993-1998), Crişul Alb Bazin (1994-1998) and Crişul Negru Basin (2001-2007) – in mg/l

Sampling point	Suspen-sions	Fixed residue	Iron	Man-ganese	Cop-per	Lead	Zinc	Cad-miu	pH
Roşia Montană	171,999	778,503	10,138	6,108	1,191	0,010	0,928	0,011	5,597
Roşia Poieni	167,211	1590,636	32,795	2,841	10,356	0,027	4,883	0,024	4,544
Baia de Arieş	368.162	628.019	1.799	nd	0.224	0.077	0.767	nd	7.038
Baia de Criş	48,942	301,675	0,199	0,190	Nd	nd	0,021	nd	7,762
Upstream Beiuş	407,001	254,102	nd	nd	0,067	0,016	0,235	nd	8,84

Together with the sulphuric compounds, high concentrations of heavy metals ions (copper, lead, zinc, cadmium) are discharged into the waters, affecting the aquatic biotope, till the complete disappearance of species. The Abrud River sector between Gura Roşiei and the confluence with Arieş River presents the phenomenon known as „ecological devastation” (Bătinaş, 2010).

Natural processes can temporarily change the values of parameters used for river water interpretation, but most of the negative water interference are induced by human activities which create pollution phenomena’s (Smith, Petley, 2009). Pollution sources are very diverse and often cause significant changes in water quality characteristics, negatively influencing their usability for human needs.

In Romania there is a great variety of pollution sources, the most relevant being the followingones:

- Oil and phenolic compounds from refineries and petroleum products transportation pipes polluting the groundwater aquifer of alluvial cone-Teleajen Prahova;
- Fertilizers and agricultural chemicals (nitrogen compounds, phosphates, pesticides, etc.) that are found either in the big manufacturers of such substances (Tg. Mureş, Arad, Craiova, Râmnicu-Vâlcea, Roznov, etc.) or in agricultural areas, where there is an additional pollution due to incorrect administration of these products;
- Materials from industrial processes occur in areas surrounding large former industrial sites (Victoria, Făgăraş, Codlea, Tohanu Vechi, Bod, Işalnita Craiova, etc.);
- Household products and products of livestock activity (organic matter, nitrogen compounds, bacteria, etc.), occur in groundwater in the area of several cities (Piteşti, Oradea, Bucharest, Cluj, Suceava, etc.); and in large livestock (Palota, Cefa, Halciu, Bonțida, Poiana Mărului, Băbeni, etc.).
- Heavy metals are found in groundwater near the mines, the ore preparation plants or waste dumps (Baia Mare, Copşa Mică, Mediaş, Târnăveni, Piteşti, Roşia Poieni, etc.).

As a result of these interferences, water bodies of national hydrographic network are defined by all five quality classes, as settled by the European Framework Directive 60/2000 on Water. Most watercourses that drain mentioned areas are included in the last class, unsatisfactory. This is best shown in Figure 4.

A frequent chemical process is the acidification of continental and marine waters, which occurs on a naturally or artificial way. Natural acidification processes are determined by the presence of allogenic compounds capable of producing certain reactions that can change water or soil pH. For example oligotrophic rivers that drain wetlands (rich in colloidal humic acids) have an acid reaction.

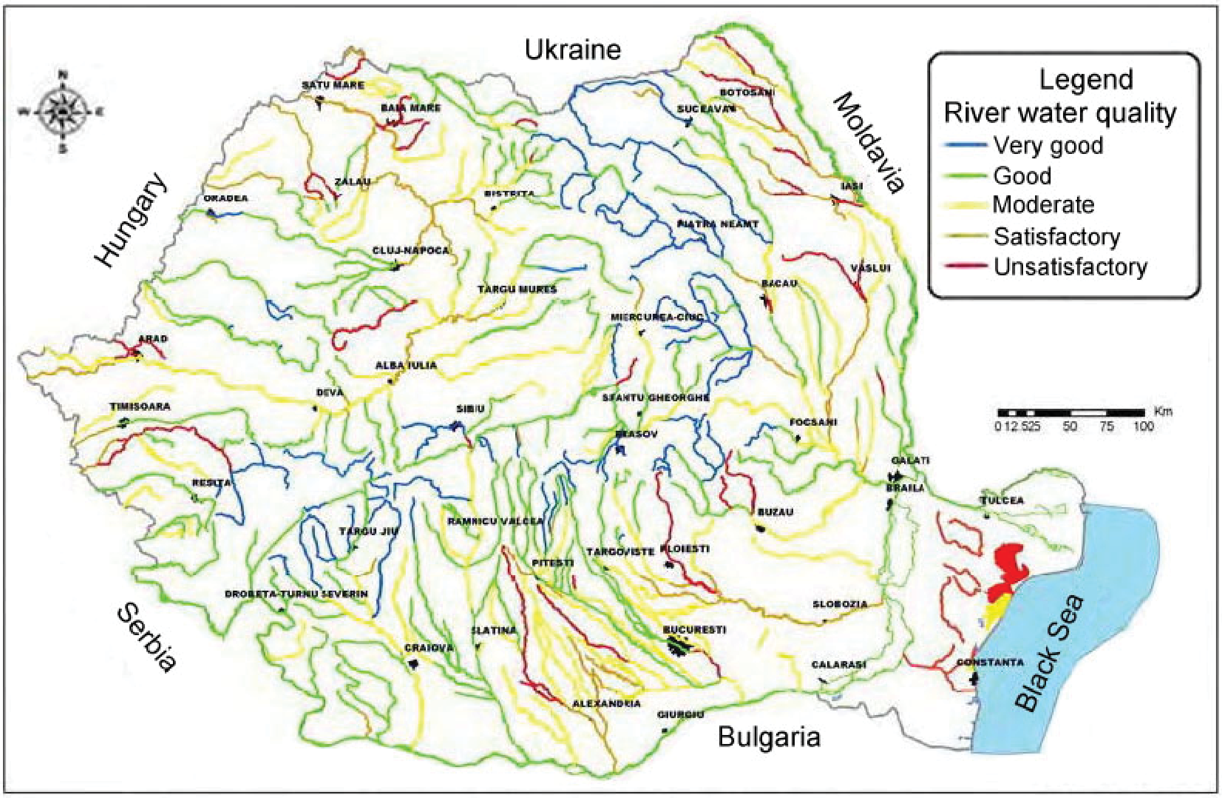

Figure 4. Surface water quality following the EU Water Directive (modified after http://www.mmediu.ro/gospodarirea_apelor/rapoarte_ape.htm)

Thus, the water takes on a yellowish-brown or brown color. In Romania, oligotrophic swamp is known as *tinov* in Moldova and Transylvania *molhaş* in the Apuseni Mountains and mlacă in Maramureş (Pop, 1960).

Areas where there are oligotrophic swamps are widespread in the Eastern Carpathians (Dorna Basin, Lucina-Fundu Moldova, Oaş-Maramures, Călimani, Harghita, etc.), the Southern Carpathians (Sebeş River Basin, Semenic Plateau) and Western Carpathians (upper basin of Someşul Cald, Someşul Rece, Muntele Mare-Dobrinu), an area where wetlands "climb" to 1400-1700 m (Chinan, V., 2010). Presence of peat deposits represented by plant debris in various stages of decomposition, gained influence under water (IMCG, 1992) producing an acid reaction. Thus, the Sphagnum peat is acidic (pH of 3.3 to 4.0) Sphagnum peat with Cyperaceous has pH of 4.0 to 5.5, and the Cyperaceous from 5.5 to 6.6 pH units (Chinan, 2010).

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