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COMMUNITY SCALE WATER MANAGMENT PATTERNS IN TRANSYLVANIA

13th EUROPEAN SEMINAR ON GEOGRAPHY OF WATER

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Contents

Preface

Dear participants, readers

By publishing this handbook, Babes-Bolyai University of Cluj and Cholnoky Jeno Geographical Association contributes significantly to the success of 13th European Seminar on Geography of Water held in Cluj between 4 and 15th of July, 2010. In this way the tradition of publishing the materials of the seminars remains alive.

The 3 main topics were:

Water management (Fresh water resources for drinking purposes. Managing solutions at different scales)

Mineral water (Use of mineral waters as traditional baths. Is there a sustainable solution? Drinking mineral waters. Bottled or free in situ use?)

Groundwater (Are there any solutions for saving the self-polluted groundwater resources in Transylvanian villages?)

The schedule and organizing patterns of the 13th Seminar were unconventional too, because a lot of knowledge has been transferred on site, during the field trip to Szeklerland.

Beside the 32 participants several local professionals and organizers contributed to the better understanding of the Transylvanian diversity.

This handbook tries to link together all the contents of the presentations, both from the classroom and the field trip too.

On behalf of the young and enthusiastic organizing team we would like to express our hope that the 13. European Seminar on Geography of Water lived up to the expectations of all participants.

Dear reader, please feel invited to discover the water related diversity of Transylvania through this handbook.

Zoltán Pál and Boglárka Czellecz

Transylvania, location of the 13th European Seminar on Geography of Water

Transylvania is a known name of a territory by many people, but except the Dracula –legend very few of them have any information about it.

Thinking about Transylvania, there are two significant ways of interpretation: the cultural one and the geographical one.

Transylvania, with its Hungarian and Saxon historical background is a place where many nations are living together: Romanian, Hungarian, Gypsy, Saxon, Ukrainian, Serbian people. Cluj-Napoca and Timisoara are the two biggest settlements of Transylvania and also the main cultural and scientific centers.

On the other hand Transylvania is a well defined geographical unit encircled by the Romanian Carpathian range and the Apuseni Mountains.

The Mountain ridges around Transylvania are divided in three main units, the Eastern Carpathians, the Southern Carpathians and the Apuseni Mountains. In the Eastern Carpathians we find three relatively parallel structural units, a volcanic one, a crystalline one and a flysch zone. We need to emphasize that as the southern element of the volcanic range, the Ciomadu Mountain contains in its crater the Saint Anne Lake that is the only one crater lake in Central and Eastern Europe. Thanks to the Quaternary volcanism in the western side of the Eastern Carpathians there are numerous mineral water appearing and gas upwelling.

In the Southern Carpathians there are characteristic the Mesozoic rocks of the inner crystalline zone. Here we have the highest mountain peaks of Romania: Moldoveanu peak – 2544 m, Negoiu peak – 2535 m.

The Apuseni Mountains are also divided on the grounds of two structural elements into the Northern and Southern Apuseni.

The Transylvanian Basin is a semi-circular basin that is approximate 150 km wide and 200 km long. It has formed as a result of the continuous sinking at the end of the Cretaceous Age, while the neighboring Carpathian mountain-chain rose. In the basin’s foundation/base we have sediments deposited from Mid-Miocene to Pliocene with the thickness of 2.5 - 4 km.

As an inside lane of the basin appears the Badenian salt-belt that can be seen on the surface in the Sovata-Praid region too.

Transylvania is characterized by a dense hydrography, rivers derive mostly from the Eastern Carpathians and the Apuseni Mountains. The main rivers of the region are the Olt River, Mures River, Târnava River, Someș River and Crișul River which all are tributaries of the Danube.

Transylvania’s climate is temperate-continental with oceanic influences from West and continental impacts from North-East. The mean annual temperature is 7-8°C. Because of the variety of the relief and surface in the inner basins of the Carpathian range occurs very often the phenomenon of temperature inversion (example: Ciuc Basin in the Eastern Carpathians).

Transylvania has a yearly precipitation amount of 600-700 mm.

During the field trips of the 13th European Seminar on Geography of Water we have visited one of Transylvania’s eastern regions, the land of Sekler people and one of Transylvania’s central regions, some settlements from the Niraj valley.

Sekler people had the frontier-defender role in the time of the historical Hungary. Even nowadays in Seklerland lives the most of the Hungarian minority from Romania.

Sekler spa resorts based on mineral water treatments were very popular in all Hungary during the 19th century and in the beginning of the 20th century.

On the first day of our field trip that was dedicated for the mineral waters we have visited three traditional spas, respectively the location of the old spas: Băile Seiche, Băile Chirui, and Băile Selters.

The first night of the field trip we have spent in Mădăraș and Racu, two sekler villages in the Ciuc Basin.

The second day, dedicated for the water management and groundwater contamination topic, we have spent in Mădăraș - Racu area.

On the third day, dedicated for the water management and mineral water topic, first we have visited the accumulation lake of Frumoasa village. The main part of the day was spent on Ciomadu – Bálványos area; besides the Saint Anne Crater Lake we were fully encircled by sulphurous and fuzzy mineral waters bubbling out from the ground.

The third night we have spent in Praid, a village where an international tourism has built up in the last years profiting from the salt appearances of the region, the salt mine and salty swimming pools.

On the 4th day of the field trip we have visited the salt canyon and the salt mine.

On July 12, 2010 (the 5th day of the field trip) we have visited the very famous Corund for its hand-made ceramics. Our targets were some of the locations of the Mineral Water Educational Trail of Corund, where we have seen Calcium and Magnesium rich mineral waters and their deposits, like aragonite.

Sovata is also an international touristic center. People are attracted by the salty Ursu Lake that is recommended in case of gynecological problems and also for other treatments.

On the last field trip day we have focused on sustainable water management topic in the settlements of Niraj valley.

During the 13th European Seminar on Geography of water the mineral water topic was the most accentuated one. We consider the mineral waters a very valuable resource of Seklerland and Transylvania too, that deserves to be shown in their natural medium for a large public.

On behalf of the organizing team we hope that this unusual trip-like summer course helped the participants to understand and appreciate the water diversity in Transylvania

Boglárka Czellecz

I.
Community Scale Water Management Patterns in Transylvania, Lectures

I.1. Water Management topic

Community based wetland restoration projects in the Niraj River Basin

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Abstract

This study was started in order to evaluate the causes of the ecological degradation of the Niraj River and the possibilities of the ecological reconstruction. The Niraj River as many rivers in Romania and in Europe it was heavily regularized and most of the wetlands disappeared. The Niraj River is a typical Carpathian River suitable for studying the possibilities for ecological reconstruction of similar rivers. In our study we are focusing to the involvement of the local community in the restoration of the wetlands and in the realization of different ecological reconstruction works. In the Niraj River basin were realized restoration works in the floodplain area of the river and ecological reconstruction works along the tributaries. In all these works the involvement of the local stakeholders (local authorities and opinion leaders of the local community) is essential, finally the local community will be the beneficiary of these works, which are important for the sustainable development of the communities in the river basin.

Key words: integrated water management, wetland restoration, ecological reconstruction, Niraj River

Introduction

In the last period there are dramatic changes concerning the hydro-morphology of the Niraj river and these changes are the main causes of the reduction of the surface of the wetlands and the ecological degradation. The particularity of the Niraj River is that we have all three types of water bodies according to the classification of the WFD. Upstream from Miercurea Nirajului we have natural surface water, downstream to Miercurea Nirajului we have heavily modified water body and the Vetca channel is an artificial water body.

The restoration of the wetlands can be successful with the involvement of the local actors, including local authorities In order to establish a good action plan for ecological reconstruction of the Niraj River it was evaluated the actual status and were analyzed in detail the cases of the degradation of the ecological status of the Niraj River.

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Characterization of the studied area

Climatic data

The Niraj River catchment basin is divided in two different parts: mountainous and hilly with an annual average temperature of 8,5°C at Miercurea Niajului. The climate is continental-temperate. The annual average rainfall is situated between 650–1200 mm having a difference between the mountain zone and the lower part, and the evapotranspiration is situated between approx. 600 mm at the low altitude and 450 mm in the mountainous zone.

Morphology

The Niraj River is a left tributary of the Mures River. The source of the Niraj River is in the Gurghiu Mountains of volcanic origin (1776 m high) at 1300 m asl. The river is 79 km long and the river mouth is situated at Vidrasau at 300 m asl. The difference in height between the source and the river mouth is about 1000 m. The catchment basin is 625 km2 large and the average altitude is 512 m asl. [1]. The average density of the hydrological network is 1,25 km/km^2 and from this the percentage of the permanent network is only 20%, so 0,25 km/km^2.

Hydrology

The Niraj River from its spring to Eremitu is a rapid river and its alluvium consists of coarse gravel. In this part of the Niraj River there is a high gradient. Between Eremitu and Miercurea Nirajului the high slope is maintained enough that the alluvia still consist of coarse gravel and sand. This part of the river is called Nirajul Mare and at Miercurea Nirajului the Niraj River joins the Nirajul Mic. The main characteristics of the run-off in the Niraj catchment basin is the concentration of the flow in the mountainous and hilly area at the Nirajul Mare until Miercurea Nirajlui as well as the concentration of the outflow downstream to the confluence with Nirajul Mic. Downstream Miercurea Nirajului (in the middle and lower part of the basin) the bottom of the valley becomes 1,6 km wide and from here the river has meanders. This broad valley persists (in some sectors it is 2 km large) which is unusually large for a river with such a small water output (average 3,6 m^3/s). It is characteristic that in the case of floods the water output is much higher than the annual average (the maximum water output was 330 m^3/s in May 14, 1970). Thanks to the fine lime particles carried by the tributaries, the water of the river has a yellow color. Due to this color the Niraj River received the popular epithet "blond". The valley has an asymmetric character, several tributaries flow into the valley on its left side. The tributaries from both sides are almost perpendicular to the main watercourse. Most of the tributaries are coming from the left side of the valley. These tributaries bring large quantity of lime which at all times pushes the minor riverbed to the right side of the valley and contribute to the choking of the riverbed [2]. To collect the water from these tributaries on the left side of the Niraj valley flood plain more than 300 years ago a channel was created by the local inhabitants [3]. The channel is named Vecke (Vetca) and is approx. 22 km long. Currently this channel begins in Nirajul Mic (at Miercurea Nirajului) and flows to meet the Niraj River at Cinta village. At the commune Gheorghe Doja the valley enlarges like a fan towards the Mures River valley where its gradient decreases even more. There are bigger meanders until the river mouth, which is situated at the village Vidrasau, approx. 17 km downstream to Tg. Mures. Alongside the entire inferior part of the river the flow is quiet and downstream Gheorghe Doja there is strong silt up of the river bed due to the reduced slope.

Pedology

In the Niraj River catchment basin the soil diversity is high. In the upper part there are mainly lithomorphic soils (andosol, vertisol), on the floodplain there are mainly hydromorphic soils. In the catchments area most frequently there are argillic soils, but there are also mollic soils and cambic soils.

Population and land use

In this area there are situated 64 communities with 38.900 inhabitants. The Niraj River basin traditionally has been one of the most populated areas of Transylvania. The Niraj River catchment basin is entirely situated in Mures County. Due to the lime rich nutrients the soil of flood plain is very suitable for the production of vegetables, this part of the Niraj River valley being named the "Carrot Country". Due to the Vecke channel a very specific way of production in the Niraj valley was employed, water management was linked with the production structure of vegetables in the fertile lime. From documents we know, that the Vecke channel was part of a production system which reflected a remarkable conception for that time and the Vecke was not as simple of a water channel as it is now. This production system used the nutrient rich sediment carried by the river during the floods on the right side of the valley for the production of vegetables and to also reduce/stop potential damages caused by large water outputs. Villages are situated on the right side of the valley and in the relatively long valleys of the tributaries, on the left side there are also villages (e.g. Lutson creek, Dorman creek). The structure of the villages shows that in the past the central part of the valley (the meanly 1 km large part situated between the Niraj River and Vecke channel) was considered a flood plain and the production structure was adapted to this situation. This farming system, beside the mentioned vegetable production, included fruit and animal farming. This specific form of production made possible for the Niraj valley to have, as it has historically, one of the highest population densities in Transylvania, which increased the pressure on the ecological system and increased the nitrate pollution of ground water. Unfortunately with the increasing cereal production (mainly during the socialist period) the former agricultural practices where no longer employed. Part of the Niraj River (79 km long) was "regularized": for example, the segment between Miercurea Nirajului and Cinta was shorted by 30%. The dams created to prevent the floods were situated near the river (100 m) and do not follow the existing meanders, reducing the flooded area to 7% of the original size.

Watermills existed along the Niraj river in each village (some villages had more than one). According to information from the local people were existing about 70 watermills along the river. In the village Grausor still exists the evacuation channel and the former building of the watermill. To ensure access to water for the mills, small dams which prevented the erosion process and maintained the water of the river at a permanent level were constructed. Due to this fact, the ground water and the living river were in permanent contact with one another, ensuring good water quality for the population of the villages. The small natural dams improved the water quality of the springs and wells, allowing the farmers to reap the benefits. In the 50's the watermills were demolished and the dams were abandoned [4].

Due to recent river course regulation works, the gravel from the bottom of the river has been moved and now we can find only fine sand and lime in the river bed. This newer composition has caused serious changes in the hydromorfological characteristics of the river and has caused severe erosion. The consequences of the erosion process are visible now even in Vargata village (10 km upstream from the regularized segment) where the houses built on the once "safe" side of the river are now in danger. These changes have made it less possible to maintain the landscape of the Niraj valley, where the flood area was characteristically the site of growing vegetables, orchards and pastures and the upper part was occupied by forests.

Restoration works

Restoration of the wetlands from the floodplain of the river

The catchment area of the Niraj River traditionally it was rich in wetlands. On the first military survey map (1763–1785), [5] we can see on the middle part of the catchment area between Galesti and Pasareni, large wetlands (see Fig. 1.). We can see also that the river has many meanders.

Fig. 1. Middle part of the Niraj valley

In the period 1950–70 were executed regularization works, many meanders were cut and the Vetca channel it was enlarged, now taking over 43% of the water from the catchment area downstream of Miercurea Nirajului. These works were executed in order to transform the wetland in arable land and to produce crops. It is mentioned (Sustainable Development Strategy of the Niraj Microregion, 2002) that the expectations concerning the crops production weren't fulfilled even by using big quantities of nutrients. According to the new tendencies in the water management and requirements of the WFD [6] we consider that instead of using „end of pipe" solutions we have use the principle „lets the rivers to flow free". Another important principle used is „the river and drainage system should be considered in its context" [7]. These solutions are perfectly possible and beneficiary for the ecosystem and as well for the community.

Fig. 2. Restored meander in Galesti

Together with the local community were started restoration works. One important restoration work was realized in Galesti village (see Fig. 2.) where the mayor of the community took the initiative and were restored 800 m of meanders, which were abandoned before and cute from the river.

Ecological reconstruction of the tributaries

The Niraj River has 29 (in present for the most part indirect) tributaries, most of them in our days are not permanent. In the past the whole catchment area was rich in water but in our days it is dramatically changed. According to our researches now there are 6 important wetlands along the tributaries. Were identified wetlands on the upper sector and as well on the middle sector (see Fig. 3. and Fig. 4.).

Fig. 3. Natural pond at the upper sector

Fig. 4. Natural pond at the middle sector

During the restoration works along the tributaries are recommended to realize bottom weirs mainly along the non permanent tributaries using different technologies. These bottom weirs have different functions: ensure the protection against the erosion, improving the quality of the water by oxygenation due to the small waterfalls, improve the habitat for the aquatic fauna, and improve the landscape. In the valley of the Dorman creek, tributary from the middle part of the Niraj River, the environmental organization Focus Eco Center from Tg. Mures realized several restoration works, using different technologies (see Fig. 5., Fig. 6. and Fig. 7.). These restoration works were realized with the support of local community.

Fig. 5. Bottom weirs with falling water in the Dorman creek valley

Fig. 6. Bottom weirs from wood in the Dorman creek valley

Fig. 7. Bottom weirs from stones in the Dorman creek valley

The restoration of the wetlands along the tributaries is an important point of the ecological reconstruction strategy. Focus Eco Center realized also two small wetland restoration works in the Niraj River catchment basin (see Fig. 8. and Fig. 9.). These wetlands are improving the local micro clime; they are serving as tourism destinations, and have role in the regulation of the water regime and increase the level of the water table. The restoration of these wetlands is recommended to be realized with the involvement of the local inhabitants.

Fig. 9. Restored wetland in Dorman creek valley

We expect that our researches and the pilot projects realized in the Niraj river basin will serve as model for further wetland restoration and ecological reconstruction works in Romania.

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The hydrotechnical improvement of Somesul Mic upper drainage basin (Transylvania–Romania) between efficiency and risk

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Abstract

The four reservoirs arranged in cascade on Someşul Cald valley, which cumulate a capacity of over 450 million m^3 perform multiple functions: the production of electric energy, water supply, protection against extreme water events, flow regulation etc. In the near Basin of Someşul Rece River that has only a few catchments constructed to transfer a limited portion of the flow towards the axis of Someşul Cald, were frequently recorded extreme water events with most severe effects for the residents. Therefore, some flash-floods with exceeding probability between 50 and 20%, produced after the hydro-technical improvement of the studied space, have destroyed many households, houses and lands found, either in the ownership of state or in private property.

Keywords: reservoir, intake, underground adduction, hydro-economic profile, flash-flood

Introduction

The favourable natural conditions of Someşul Mic upper basin represented the basis for a wide hydrotechnical improvement which put forward part of the potential existing in the area [1]. In the first stage (1968–1980) had been finished the most important reservoirs, two on Someşul Cald and one on Somesul Mic. The first reservoir brought into service was Gilau in 1972, followed by Tarnita in 1973 and Fantanele in 1976. In the first stage also had started the works for the intakes and diversions of the hydrographical basins of Iara and Somesul Rece, one of them were brought into use (Somesul Rece II) (Fig. 1.).

In the second stage (1980–1990) were brought into use the intakes and diversions; the improvement of Someşul Cald was also finished in 1983, with Someşul Cald reservoir commissining. The main axis are

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Iara-Fantanele; the conduit of this intakes system has a total length of 21 km, out of which: 4.7 km between Iara and Soimul, 4.9 km between Soimul and Negruta, 4 km between Negruta and Somesul Rece I, 3.7 km between Somesul Rece I and Racatau intakes and the same between Racatau and Fantanele reservoir [2]. Out of the eight existing catchments on this axis, one is supplied with reservoir (Somesul Rece I). The others are smaller as the construction size, and supplied with a Tyrol-type water catchment system.

The second water capture and underground feed pipe component is Someşul Rece II (Tarniţa Channel – Fig. 1.). This component aimes to increase the water flow in Tarniţa reservoir lake and also downstream of this point, after collecting the water which drains the areas of interbasinal space of the Someşul Rece situated downstream of the aforementioned dams.

The capacities of system reservoirs

The five reservoirs of Somesul Mic upper basin have a total volume (333.62 million m^3) representing 72.0% of the total accumulation volume in the Somes River basin (462.32 million m^3). They sum up a water surface area of 1200 ha, approximately 1% of the total surface of hydroenergetic accumulations of Romania [1]. The total useful volume of the intakes represents 202.19 million m3, enough reserve for water supply and the rest of it for the electrical energy production (Table 1).

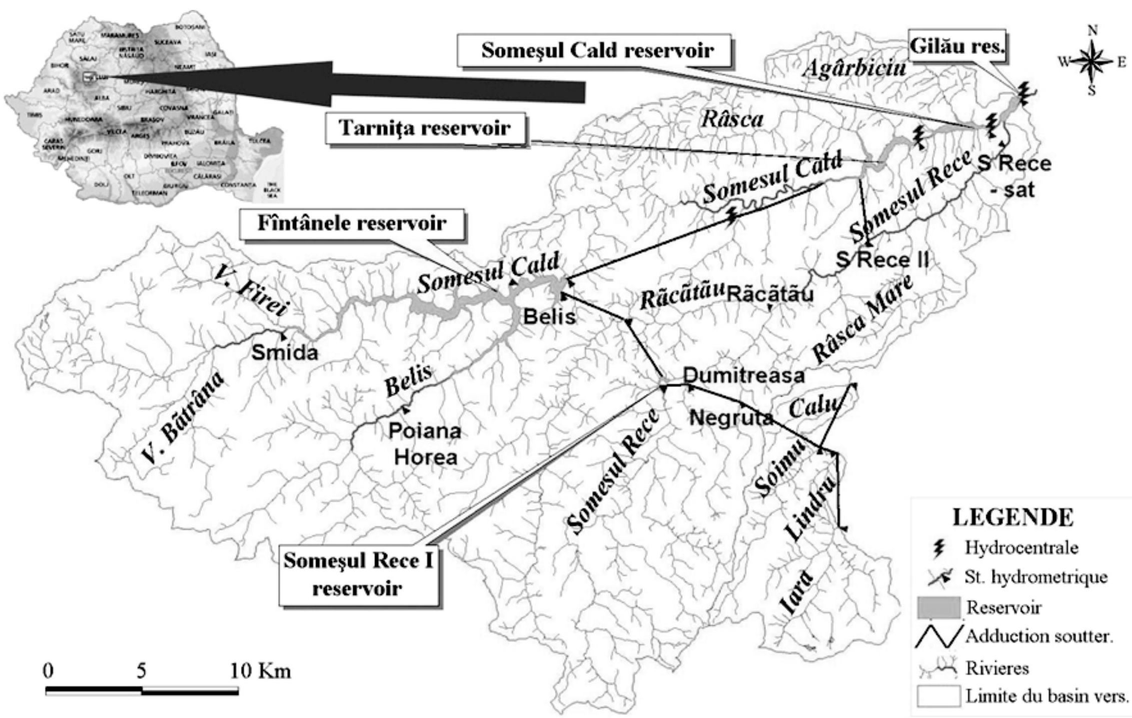

Fig. 1. Hydrotechnical and hydrometric network of Somesul Mic upper basin

Table 1. Characteristic volumes of the reservoirs in Somesul Mic upper basin, after the last bathymetric mapping

Nr.	Lake / Year of mapping	Characteristic volumes (mil. m^3)					
		Total	Gross	Attenuation	Useful	Reserve	Dead
1	Fântânele / 2000	244.69	207.59	37	186.93	10.17	10.5
2	Tarniţa / 2001	75.25	68.08	6.9	13.79	39.08	5.62
3	Someşu Cald / 1993	8.45	6.45	1.99	0.86	3.41	2.18
4	Gilău / 2005	3.56	2.45	1.12	0.61	1.4	0.44
5	Someşul Rece I / project	1.67	1.34	0.33	0.98	-	-

Through the attenuate volume of over 47 million m^3, the retentions in the Somesul Cald Valley can store the freshets generated by the torrential rain falls, eliminating thus the risk of inundation of the settlements placed downstream, along the major riverbed of Somesul Mic course. The influence in the flow regime is increasing directly proportional to the increase in the attenuate volume affiliated to every flooding rate. Therefore, only Fantanele reservoir can retain an important water quantity (37 million m^3), equal to a volume of a flood with a 5% probability formed on its two tributaries, Somesul Cald and Belis to which is added the limited flow rate of Iara-Fantanele underground connection pipes, and the water drainage from the slopes. It is worth mentioning that this retention lake is rarely maintained at its highest level, equal with the one associated with the overflow weir, allowing an increase up to three times of the available slice attenuate volume [1].

The catching- and adduction capacities of the system

Iara-Fantanele underground connection pipe that is headed for Fantanele Lake is sized to provide a water volume of 5.87 m^3/s for an average yearly flow. This amount comes from the Iara upper basin (1.78 m^3/s) and from the upper basin of the Somesul Rece River (4.09 m^3/s). The multiyear average flow rate transported by the conduit of the other reservoir - Somesul Rece II (of 3 km) is 0.800 m^3/s.

Summing up the multiyear average flow rate of Iara-Fantanele with the one of Someşul Cald underground feed pipe (6.81 m^3/s) in Fantanele dam section, a tributary flow rate of 12.68 m^3/s is obtained in the reservoirs system. In Tarnita reservoir, the average multiannual flow rate is of 14.99 m^3/s, part of it from Somesul Cald river flow in Tarnita dam section (8.32 m^3/s). The rest represents the flow of Somesul Rece in the section of Somesul Rece II caption – 4.89 m^3/s (4.09 m^3/s of the basin corresponding to the first intake and 0.800 m^3/s of the inter-basin corresponding to the second intake), as well as the multiannual average flow rate caught in the upper basin of Iara – 1.78 m^3/s.

The main functions of the improvement

The functions of the basin reservoirs are multiple, often common for the four lakes – for example the energetic functions. There are also specific functions for each reservoir, according to the aim it was built for.

Fantanele Reservoir has a complex function:

- energetic, meaning electrical power production in Mărişelu underground power station;
- adjustment in multiyear and yearly regime of water flow rates on Somesul Cald course;
- retaining of the flash-floods waves on Someşul Cald;

Tarnita Reservoir has also a complex function:

- energetic, electrical power production in the plant placed at the bottom of the dam;
- yearly adjustment of Somesul Cald water flow rates;
- retaining of the flash-flood waves originated in the corresponding basins.

Somesul Cald reservoir is a buffer lake between Tarnita and Gilau; its functions are also important, naming:

- electrical power production in the power plant placed at the bottom of the dam;
- restoring the water flows evacuated from Tarnita hydroelectric power plant;
- alluvial deposits dislodge for Agârbiciu outlet; in fact this function was one of the most important, the reason of this reservoir designing, just to retain the high plugging rhythm of Gilău reservoir, placed immediately downstream;
- the function of floods retaining is poorly represented due to the low characteristic volume intended for it.

Gilau Reservoir, although the smallest, it has a complex function, wich lays in the intended aim:

- water supply for an important settlement and economic operators network situated downstream: Cluj-Napoca municipality and the industrial plants within it, Capus and Aghireşu minning areas, Apahida community and other settlements in Somesul Mic valley, “AgroFlip” S.A. Bontida unit, Gherla and in the future Dej municipality;
- compensation of water flows variations which are evacuated by the upstream top hydroelectric power plants;
- energetic, electrical power production in the power plant placed at the bottom of the dam;
- the function of floods retention is limited due to the specific low characteristic volume.

Somesul Rece II reservoirs and those of the accumulations previously presented, have as basic function water caption and transfer through the underground connection pipes system from one basin to another, in order to use these undrainable resources in the most efficiently way.

Somesul Rece I Reservoir is a collector of connection pipe from the Iara basin and Somesul Rece, draining the water towards Fantanele reservoir; it is present even the floods retention function but limited by the low volume of this reservoir.

The reservoirs as water supply resources

The need of surface resources for water supply for the settlements in the area emerged in 1960 when the industry had developed at lot, especially in Cluj-Napoca municipality. This determined considerable growth of water need for the industrial processes and for the settlements created (Fig. 2.).

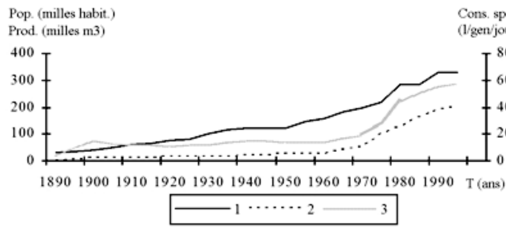

Fig. 2. Population evolution, water production and the specific gross consumption in Cluj-Napoca municipality; 1. The population; 2. Water production; 3. Specific gross water consumption (according to S.C. SOMES S.A., Cluj)

The water treatment plant that uses the water of Gilau reservoir was brought into use in 1973 at a capacity of 60,000 m^3/day (0.694 m^3/s). Nowadays, the daily average flow rate treated is of 2.2 m^3/s (190,000 m^3/day); when the lake water turbidity is high (during freshets) it diminishes to half.

Two pipes with diameters of Ø = 1,000 mm and Ø = 1,400 mm emerge from the water treatment plant, each of 16.5 km long transporting the water by gravitation means to the downstream settlements. The average gradient of the pipes are I = 0.0021 and the drainage speed is 1.6 m/s.

The main distribution network is made of the aforementioned pipes which supply Cluj-Napoca municipality to which is added a tube having Ø = 600 mm and 58 km long which supplies Gherla municipality and a number of nine country settlements placed downstream of Cluj-Napoca. In this year, Dej municipality is intended for connection and

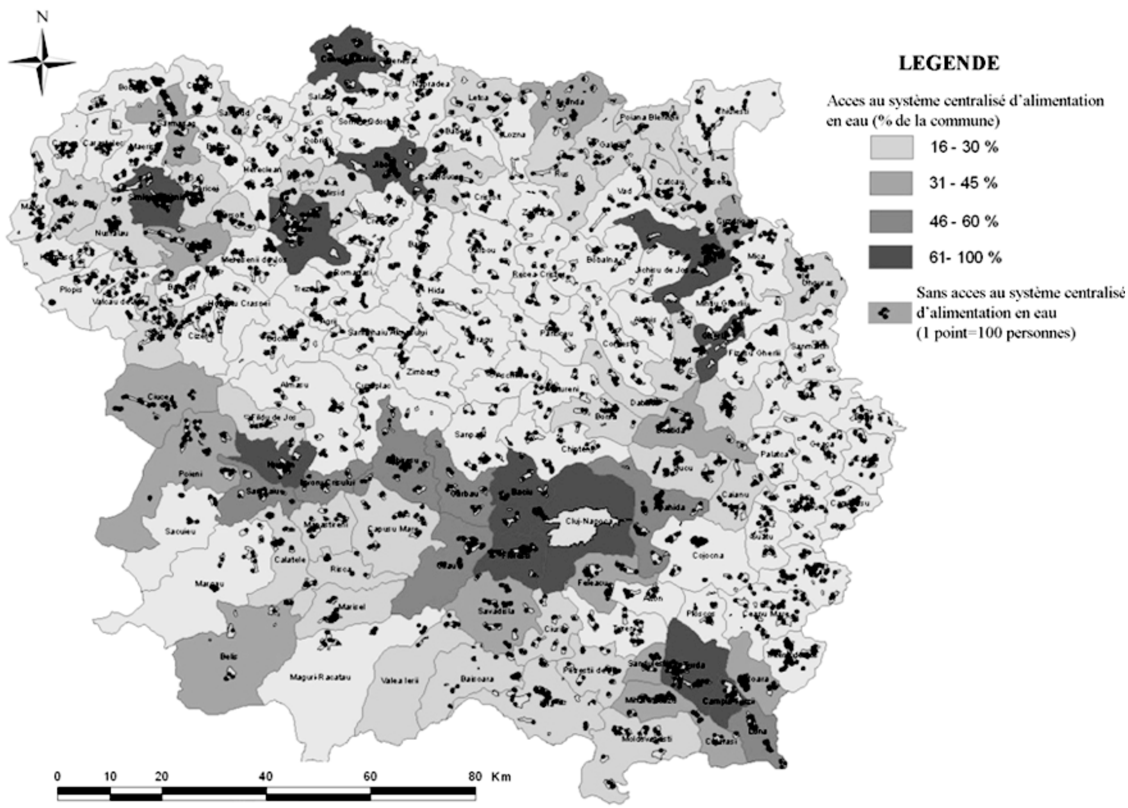

Fig. 3. The regional strategy for water supply services – Cluj and Salaj Counties (Croitoru et al., 2010)

other 11 country settlements, most of them situated nearby Somesul Mic valley and in the next two years the neighbouring Salaj County.

Besides the population in the aforementioned places, Gilau water treatment plant supplies water for more economic operators: E.M. Aghires, the industry of Cluj-Napoca municipality, S.C. „AgroFlip" S.A. Bontida, the industry of Gherla municipality etc.

The hydro-energetic function of the improvement

Within the upper basin of Somesul Mic, hydroelectric power plants are built along the big reservoirs (Mariselu/Fantanele, Tarnita/Tarnita, Somesul Cald/Somesul Cald and Gilau I/Gilau). All the four units are top hydroelectric power plants and their functioning is coordinated by the Main Dispatcher of S.C. „Hidroelectrica". The last three are surface hydroelectric power plants with a lower fall and power, situated at the bottom of reservoirs. Mariselu underground hydroelectric power plant has medium power and a high fall (Table 2.) placed 40 m under the level of Lesu creek, upstream the confluence with Somesul Cald.

The hydro-energetic improved sector is found between 995.4 m and 410.5 m levels with a total high of fall of 584.9 m. The flow rate corresponding to the hydrological regime of the improvement is around 60 m3/s, meaning a gross power of 283.3 MW.

Electrical power production is determined by the functioning regime of the hydroelectrical power plants. As top units they achieve system energy supplementing in peak consumption periods.

Mariselu hydroelectrical power plant, due to its capacity is distinguished because of its electrical power production. Therefore, the total production obtained from its commissioning until the end of 1998 (10,016.167 GWh) from all four hydro-electical power plants, 7,756.97 GWh (77%)

Table 2. The technical parameters of the top hydroelectrial power plants along the main reservoirs of Somesul Mic upper basin (according to S.C. HIDROELECTRICA S.A. – Cluj branch)

Denomination of the unit		Mărişelu	Tarniţa	Someşul Cald	Gilău I
Type		Underground	Surface	Surface	Surface
Hydro-aggregates		3, Francis	2, Francis	1, Kaplan	1, Kaplan 2, E OS
Net fall (m)	Maximum	433	81,4	21,9	14,1
	Minimum	390	66,0	19,9	12,1
Installed power (MW)		220	45	12	6,3
Installed flow (m^3/s)		60	70	70	60
Electrical power production/average year (GWh)		390	80	19,4	11,6
Average time of functioning	(hours)	1773	1778	1617	1841
	(%)	20,2	20,3	18,4	21,0

correspond to Mariselu hydroelectical power plant, 1,794.41 GWh (18 %) correspond to Tarnita hydroelectrical power plant, 266.62 GWh (3%) to Somesul Cald and 198.167 GWh (2%) to Gilau I hydroelectrical power plant. The electrical power production in an average year varies from 390 GWh, as the case of Mariselu hydroelectrical power plant to 11.6 GWh corresponding to Gilau I unit (Table 2.).

As arranged in cascade, the hydro-electrical power plants function usually in tandem. Tarnita unit functioning determines most of the cases the starting up the others two downstream (Somesul Cald and Gilau I). This thing produces due to the reduced useful volumes of the two reservoirs (Table 1.), which cannot ensure water storage coming from Tarnita reservoir, and shall be under the necessity to freely spill it through discharge opening. The hydraulical agent would be so wasted, and the investments in the system of flow supplementation on Somesul Cald through intakes and diversions would become useless.

Tarnita reservoir has a much more useful volume, and so the possibility to store a higher quantity of water. Due to this fact, Mariselu hydroelectrical power plant functioning doesn’t imply the immediate functioning of the other three downstream. As a matter of fact, the higher capacities of the bigger reservoirs offer the possibility of yearly regulation/control of the discharge on Somesul Mic River (Fantanele, Tarnita) as well as the multiannual control (Fantanele).

As concerning the variation of the electrical power production of the four hydroelectrical power plant analysed, from the beginning of their functioning, it is observed that it is faithfully following the turbine flow rates variation (Fig. 4.).

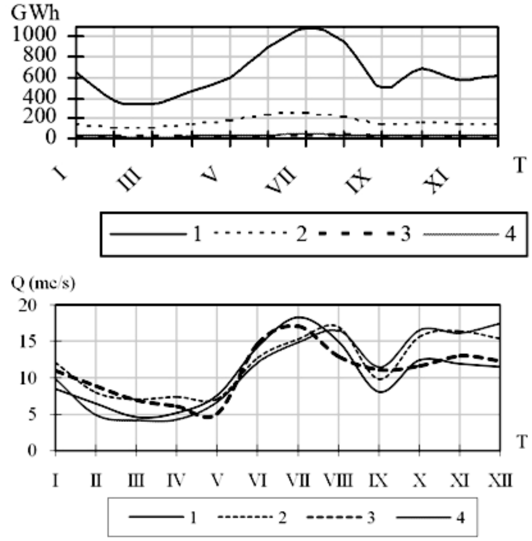

Fig. 4. The average multiyear, monthly electrical power production and the variation of the multiyear, monthly average turbine flow rates at Somesul Cald hydroelectrical power plants. 1. Mariselu; 2. Tarnita; 3. Somesul Cald; 4. Gilau

The lowest electrical power quantity at all hydroelectrical power plants was produced at the end of the winter and the beginning of the spring (February and March).

This range corresponds with the one of air temperature growing, when the energy demand is decreasing, as well as with the range favourable to hydraulic agent storing, the affluent flow rates in the reservoirs are significant in this period.

The maximum electrical power quantity, in annual profile, is produced between May - September following the run-off of high water quantities stored in the lakes during the high waters of the spring and the freshets. This situation is faithfully presented also by the multiannual monthly average turbine flow rates variation in hydroelectric power plants.

The function of floods retaining

In the last decades, marked by hydrometric activity in the mentioned area, more such events took place, among them the most significant were those at the end of 1970s, 1975s, 1981s, 1991s, 1995s, 1997s and 1998s etc. The most significant occurred at the end of the spring (May) but also at the beginning of the summer time (June) or the winter time, the latter two with devastating effects on local plan (December). In December 1995 flood, the diffluent flow rate of Fantanele reservoir was null during the event action; the freshet volume was totally retained in the lake, it was nearly to the Minimum Exploitation Level. The volume increase in the lake was spectacular from 15 millions m^3 to 90 million m^3 (Fig. 5a.)

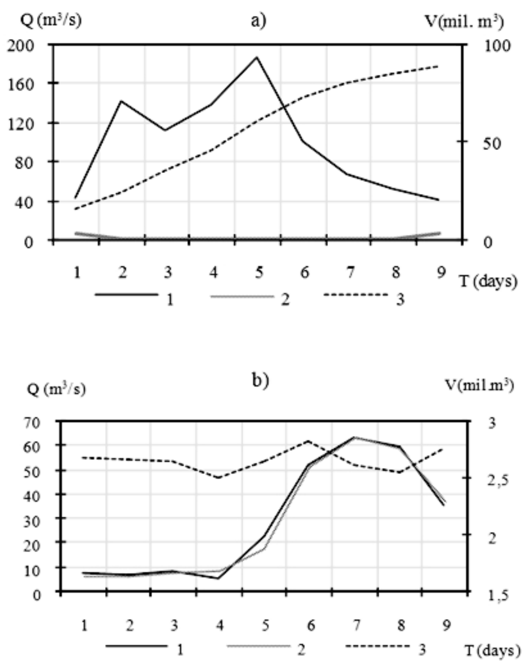

Fig. 5. The influence of Fantanele and Gilau reservoirs over the flood of 23rd of December 1995 – 2nd of January 1996. 1. Affluent discharge. 2. Diffluent discharge. 3. Volume oscillation in lakes

The time passed in the after improvement period, proved the fact that the adduction pipes and water intakes don't represent a good protection against floods for the downstream settlements. The average 5 m^3/s captured in Somesul Rece basin and not even the maximum of 20 m^3/s cannot significantly reduce the flood hazard, when maximum flow rates of floods occur with overflowing probabilities situated below 10%.

The discharge value of December 1995 flash-flood generated in this area passed without retention in Gilau reservoir due to the limited capacities of the intakes to catch the flow rate and the insignificant attenuation volume of the reservoir (Fig. 5b.). Even worse, the water level of the Somesul Rece overflowed by 70 cm beyond the canopy of the dam at the accumulation-intake Somesul Rece I, and the spreading of the afferent discharge downstream towards the villages of Maguri-Racatau and Somesul Rece produced hazards and damages almost unique in the local history (Fig. 6.).

The experience of December 1995 flash-flood was hard to forget by the inhabitants of Maguri-Racatau, for those living in Somesul Rece valley, as well as those for downstream of the intakes and for those living in Somesul Rece village. Several minutes after the water spilled over the canopy of Somesul Rece I dam, the water was 70 cm, several buildings of Maguri-Racatau were destroyed (including the school), the road cracked in more locations and the annexes of the flooded cottages in the river's valley were carried away downstream with the fast-moving foamy waters. By the village of Somesul Rece village the flood was alleviated in the riverbed up to 20%, but still created several damages.

The 1997 and 1998 flash-floods had a lesser impact over the basin and according to their management, both were retained; in

1997s flash-flood, the spillway was deviated in time, at the moment of overflowing producing.

Fig. 6. Problems created by December 1995 floods in the valley of Somesul Rece; 1. Damaged road downstream of Maguri-Racatau; 2. Somesul Rece II intake plugged; 3. House driven by water

In order to complete the aforementioned information in Table 3. are presented the maximum flow rates, the date of the events, the security and discharge coefficients studied of the flash-floods produced in the upper basin of Somesul Mic.

If on both rivers, Somesul Cald and Somesul Rece, equipped with reservoirs and intakes with underground adduction pipes, the effect of floods were different after finishing the hydrotechnical system on Somesul Mic Corridor. A considerable improvement of the social and economic impacts of the flash-floods and the reduction of the areas affected flooding and the damage problems can be noticed (Fig. 7.).

The largest land surfaces were affected in 1970–1981 (more than three quarters of the total). Once the last dam was brought into use (the one of Somesul Cald – 1983 reservoir) the flooding frequency on these lands decreased, based both on the absence of significant floods but especially their on their mitigation into accumulations.

From the technical point of view, the maximum tributary flow rates into Fantanele and Tarnita lake decrease after mitigation to 211–217 m^3/s for 1% insurance value, to 495-511 m^3/s for 0.1% and to 827-862 m^3/s for 0.01% ± 0,20 insurance value (according to National Administration „Romanian Waters" -Administration Somes-Tisa Water Basin and S.C. Hidroelectrica S.A. - Cluj Branch).

In case of Fantanele reservoir, the flash-floods volumes (mil. m^3) with different insurance for the total time of 100 hours and the increasing time of 24 hours have the following values: 16.3 for 10% safety, 20.9–5%, 24.5–3%, 31.5–1%, 70.8–0.1% and 108.7–0.01%.

Through the retaining capacities of the lakes, the maximum tributary discharges can be reduced up to 55% for the 1% insurance value and up to 64% for the 0.01% insurance

Table 3. Maximum flow rates, overflowing probabilities and the discharge coefficients of some flash-floods in the upper basin of Somesul Mic (according to Administratia Bazinala de Apa Somes-Tisa, Cluj)

No.	Hydrometric station	1970			1995				1997				1998			
		Q max	Date	P (%)	Q max	Date	P (%)	η	Q max	Date	P (%)	η	Q max	Date	P (%)	η
1	Smida	-	-	-	108	24th of Dec.	4	1.29*	49.1	9th of May	44	0.95	36.9	19th of June	52	0.59
2	Poiana Horea	-	-	-	36.1	27th of Dec.	42	0.79	19.2	9th of May	72	0.84	11	19th of June	89	0.60
3	Racatau	16.4	8th of Aug	82	56.5	27th of Dec.	24		21.6	9th of May	70	0.93	18.5	19th of June	78	0.47
4	Somesul Rece village	-	-	-	98	27th of Dec.	20	0.22	32	9th of May	62	0.30	57	19th of June	46	0.25
5	Cluj-Napoca	191	11th of June	14	170	27th of Dec.	21	0.08	79.5	9th of May	91	0.26	169	19th of June	21	0.02

* the over unit value of the leakage coefficient is due to the pre-existence of a consistent snow cover

value in the case of Fantanele reservoir, while, in the case of Tarnita, the reduction of maximum discharges is achieved up to 80% for the 1% insurance value and up to 91% for the 0.01% insurance value. Somesul Cald, Gilau and Somesul Rece I lakes, due to their low capacities, cannot retain the flash-floods flow rates.

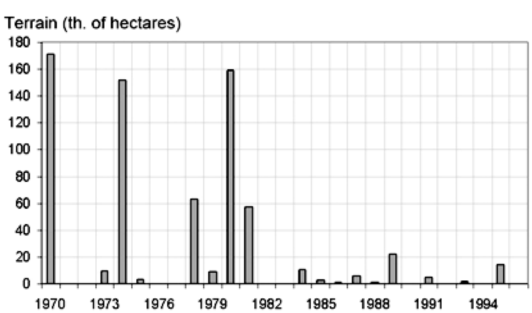

Fig. 7. Land surfaces on Somesul Mic Corridor affected by the floods produced in the same hydrographic basin (1970-1996)

Conclusions

The reservoirs are the only viable solution according to the aforementioned and the experience assimilated in the applied hydrology, as to protect the social, economic and natural environment, the floods and the effects they generate. All the intervention works over the water courses and the corresponding basins are proven less efficient if they are not completed with a hydrotechnical improvement, including reservoirs and control capacities for the flash-flood waves.

The difference in the development of events in the equipped basins and those inadequately equipped is more than obvious. Somesul Mic Basin is not an exception. It's observed a quasi-total control along Somesul Cald axis, where the population has forgotten what means the flash-floods effect and a limited control of intakes capacities on Somesul Rece axis where the flash-floods with overflowing probabilities under 10% are making ravages.

Acknowledgements – We want to thank Directia Apelor „Somes-Tisa" and within to Statia Hidrologica Cluj (Cluj Hydrological Station), Serviciului Hidrologic (Hydrological Service), Serviciului de Aparare Impotriva Inundatiilor (Floods Defense Office), then S.C. Hidroelectrica S.A. – Cluj Branch and all the partners who contributed to this paper drawing up.

We want to thank also „Babes-Bolyai" University, Faculty of Geography, for the technical and logistic support granted.

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I.2. Groundwater Contamination topic

Groundwater quality in Covasna County

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Abstract

The subject of our paper is to present the main suggestions of the European Framework Directive for the nitrate threshold values. We intend to present from the Olt River Basin Management Plan the nitrate polluted groundwater bodies in Covasna County, and we will show the map of nitrate concentration from a study realized in 2009 together with Zoltan Pal, and the results of nitrate levels in monitored wells from the Covasna Water Management System.

Keywords: European Framework Directive, nitrate map

Legal Background

The most important international groundwater law is the Water Framework Directiv (60/2000/EC). [1] According to the Water Framework Directive, the member states were obliged to reach good groundwater chemical and quantitative status until 2015. To achieve this criteria each member state was obliged to establish threshold values for pollutants. "The threshold values should be set at the most appropriate scale (national level, river basin district level, or groundwater body level)"[2]. The threshold levels according ECC 2000/60 for the nitrate is 50 mg/l. The high concentration of nitrate in drinking water could cause the methaemoglobinaemia illness. Methaemoglobinaemia is caused by the decreased ability of blood to carry vital oxygen around the body [3].

Groundwater quality

According to the Olt River Basin Management Plan the threshold value for the nitrate level is 50 mg/l. The quality in the ROOT02 groundwater table is intensive polluted with nitrate (Tab.1.) and for this reason the Olt Branches had an exception from the Water Framework Directive (60/2000/EC), and must reach a good quality indicator until 2027 [4].

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Table 1. Polluted water bodies in Covasna County

	Agri-cultural	Plought land	Source of nitrat	
Parish	ha	ha	Present	Historical
Borosneu Mare	4897	3232	*	
Cernat	6290	4378		*
Dobarlau	1551	293	*	
Uzon	8581	5992		*

Nitrate levels in monitored wells

The groundwater table is permanently monitored by the Covasna Water Management System through 28 wells; samples are collected two times in a year at spring and in the fall. The nitrate concentration is heavy influenced by the geographical location of the wells. We can observe strong relation between the nitrate level and the distance from the settlement and the distance of plough land and the main creek or river.

Relation between nitrate level and settlement distance

The Talisoara F1 well is in the village, and the F2 is out of village; we can observe that the concentration of the nitrate is high inside of the village, and low outside the village (Fig. 1.).

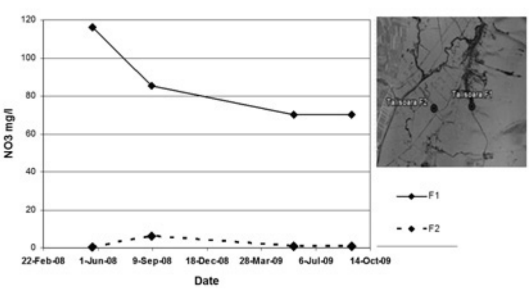

Fig. 1. Relation between nitrate level and settlement distance

Relation between nitrate level and plough land distance from a river

The Martineni F6 well is far from a river and the concentration of a nitrate is higher, as in the Martineni F4 well (Fig. 2.).

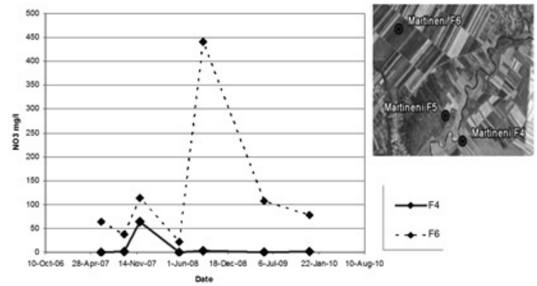

Fig. 2. Relation between nitrate level and plough land distance from river

The nitrate concentration map of Covasna County

In 2009 together with Zoltan Pal we made the first map of the nitrate concentration in Covasna County (Fig. 3.). We can see that almost in each settlement the nitrate level is above the permitted threshold values.

Conclusions

In the majority of the cases the water quality did not meet the Water Framework Directive regulations for the nitrate concentration.

As a possible solution for the high nitrate level could be the sewage system installation.

Acknowledgement – We would like to thank for the Covasna Water Management System, who helped us with the national datasets and for the useful assistance to Zoltan Pal.

Fig. 3. Nitrate concentration map of Covasna County

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Settling Lake and groundwater interrelation, and groundwater quality measurements on Csikrakos

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Abstract

The subject of our paper is the Csikrakos Gravel Pit Lake/Settling Lake and what effects it has on its environment, especially on groundwater. After numerous onsite measurements, lots of paperwork, and calculations we completed the first bathymetric map and 3D Image of the lake, identified underground water flow direction and its correlation with the lake. From the groundwater quality measurements we revealed causes of groundwater contamination(s) in the village/township, its consequences, and presented potential solutions. Through the course of the measurements we determined the following groundwater quality parameters: nitrate, conductivity, total dissolved solids, salinity, pH, and temperature. Our paper attempts to point out the value of the groundwater, which is in danger, and also points out what led to the current situation.

Keywords: settling lake, groundwater table, groundwater flow, groundwater quality, contamination

Introduction

The main motive of our choice of topic was to learn about our place of residence. First, we wanted to measure the depth of the settling lake that lies near our village, Csikrakos. Then, we analyzed the interrelation between the lake and the groundwater table, and the groundwater flow direction. By knowing the direction of groundwater flow, we could map out the land area that recharges the village's public water supply and thereby took corresponding steps to ensure, as much as possible in the rural area, land use activities in the recharge area will not pose as great threat to the quality of the groundwater as it did before.

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Location of the studied area

Csikrakos lies in the northern part of the middle Ciuc basin, about 12 km from the township of Csikszereda. The boundaries of the basin are: in west the Harghita volcanic mountains range, in east the Ciucului Mountains, on the north and south there is only a conventional border. Due to its convenient location in the basin one of the most important gravel washers of the county was opened in 1973. Over time the gravel mine and washer moved higher ground, leaving a large pit in the ground that filled up and formed the lake from the Rakos stream, and as we found out later based on our study, by the accumulation of the groundwater. Today it is known as the Csikrakos settling lake.

Measurements of the lake

To carry out the measurements we used a handmade raft built from wire mesh, plastic bottle, and boards, we also used compass, theodolite, measuring tape, and foot ruler.

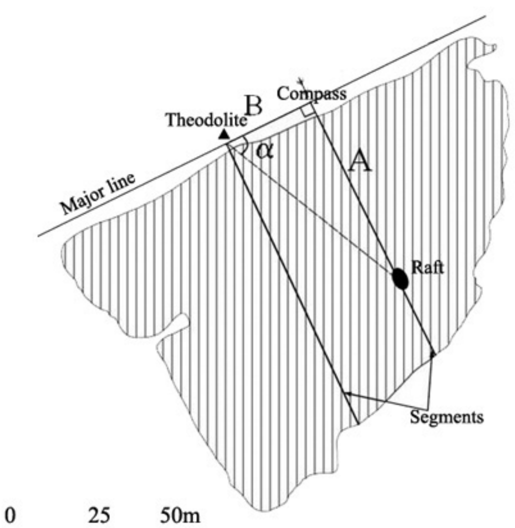

Fig. 1. Strategy for depth determination

Our first step was to define a major line in the north-western part of the lake, which closed a 63 degree angle with the magnetic north and then we carried out measurements along perpendicular segments to the major line with 45 meter intervals. In order to eliminate mistakes one person made sure that the raft was moving on the predefined segment with a compass, another person located the measuring points in regard to the major line with a theodolite, and a third person, who was on the raft, measured the debt of the lake . In this manner measurements in 135 locations were taken on the lake (Fig. 1.). Using the following formulas, Eq. (1)-(2), we determined the distance between the raft and the predefined major line.

$$tg\alpha = \frac{A}{B} \qquad (1)$$

$$A = B * tg\alpha \qquad (2)$$

From these measurements and calculations we determined the morphometric data of the lake:

- Length: 251 m
- Max width: 173 m
- Median depth: 1.88 m
- Max depth: 4.15 m
- Wet periphery: 772 m
- Area: 26000 m^2, more than 2.5 hectares
- Volume: 49068 m^3

Then, using the Surfer software we completed the first bathymetric map (Fig. 2.) and the first 3D image (Fig. 3.) of the lake.

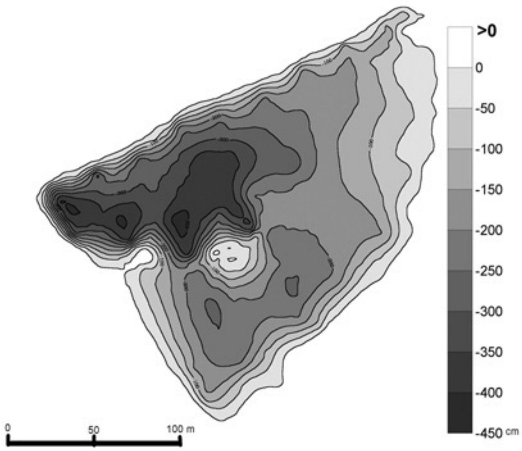

Fig. 2. Bathimetric map of the lake

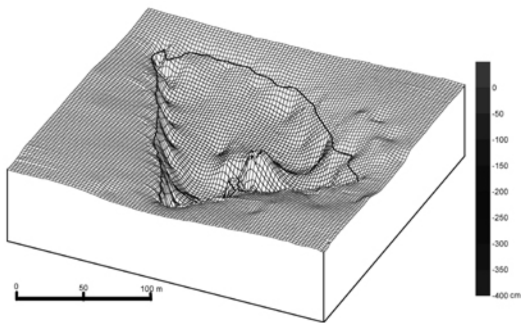

Fig. 3. 3D image of the lake

Groundwater table and groundwater flow direction

One important question we wanted to answer was, if there is any connection between the lake and the groundwater table. We asked people if they have observed any differences in their wells after the formation of the lake. The common answer was that water level in the wells after the formation of the lake dropped two-three meters in general. Another important task was to determine the direction of the groundwater-flow. To find the groundwater flow direction we used graphical method by comparing water levels depths in the wells to the sea level [1].

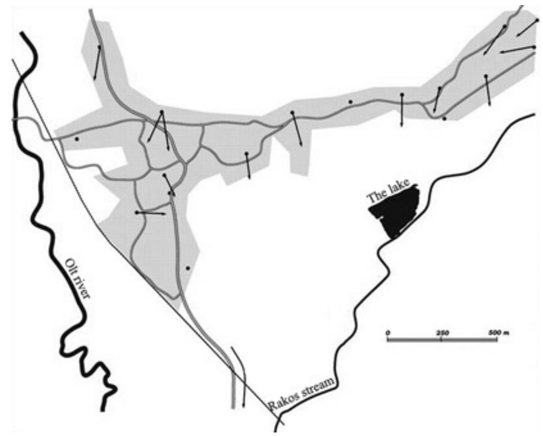

Fig. 4. Map of the groundwater flow direction

As a result we found that the groundwater flows toward the lake and the Rakos stream (Fig. 4.).

Quality of groundwater

Because there is no running water in our village it is very important to know the quality of the groundwater. From water samples from the wells we measured the following parameters: nitrate, conductivity, total dissolved solids, salinity, pH and temperature. More attention was paid to the nitrate concentration which was in general above the maximum limit. High nitrate level in drinking water causes hemoglobinaemia, and children under two years of age are at the highest risk. On this picture, (Fig. 5.) you can see the map of the nitrate concentration.

The permitted level of the nitrate is 50 mg/l. We observed that where the nitrate concentrations were high, the TDS and the conductivity were high as well. After significant precipitations the water quality became even worst.

Fig. 5. Nitrate concentration map (autumn)

Conclusions

Based on our study we came to the conclusion, that there is an existing connection between the lake, and the groundwater table, and the general ground-water flow is toward the lake. In the majority of the cases the water quality did not meet the EU drinking water regulations and nitrate contamination comes from poorly managed man-made sources.

As a possible solution for the high nitrate level could be the sewage system installation or the deeper groundwater usage.

Acknowledgements – We would like to thank the people, who helped us on the field measurements and provided us with useful assistance: to Zoltan Pal, Biborka Fodor, Botond Hegyeli, Erzsebet Fogarasi, and Laszlo Potyo.

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Workshop report - Groundwater contamination in the rural areas of Transylvania

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Group leader: Zoltán PÁL

Abstract

In the recent decades the development of agriculture and industry and the high rate of population growth resulted in an increased consumption of water. But nowadays, besides quantitative water scarcity, we have to face with qualitative water scarcity too. In Transylvania the quality of water is mostly endangered by nitrate contamination, and especially groundwater is exposed to this pollution source. Research of nitrate contamination in groundwater is very important in Eastern Europe. The reason for this is while interest about the risks of using nitrate polluted water is increasing among the population, authorities do not show any interest in solving the problem.

Keywords: quality of groundwater and drinking water, nitrate contamination

Present situation in Transylvania and nitrate pollutions

Transylvania is part of Romania, which is located in Eastern Europe, and is one of the largest in that region. 47% of the country`s land is covered with natural and semi-natural ecosystems, and has one of the largest areas of undisturbed forests in Europe. The total population of it is 22,246,862 people, 45% of them is living in rural areas. Recent studies show that some of these areas have a high rate of groundwater contamination. In Transylvania the reasons for that can be numerous, such as the domination of agriculture, large

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amount of animal stock and the resulting manure hips and animal wastes and last but not least, that 62% of the Romanian villages do not have sewage collector systems or much of the households are not connected to it. Several studies proved that the most common type of contaminant in the wells of these settlements is nitrate, but knowledge about spatial distribution and source of nitrate in groundwater is incomplete.

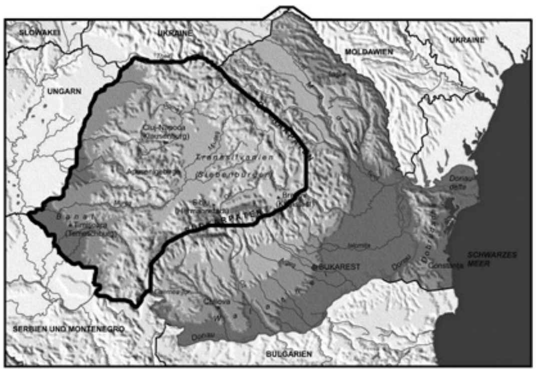

Fig. 1. Location of Transylvania

Nitrate as the most common contaminant – origin and effects

Nitrates are polyatomic-ions and are the salts of nitric-acids. Their molecular formulas consist of one Nitrogen atom in the centre and three identical Oxygen atoms in a trigonal arrangement. It is a toxic substance for humans, and can contribute to several diseases like cancers of the digestive and excretory systems, also inhibits intrauterine development and can result in miscarriage. But one of the most common and well known effects of it is methemoglobinaemia. In this case nitrate oxidizes the iron atoms in hemoglobin from ferrous (Fe2+) to ferric (Fe3+) iron, thus making it unable to carry oxygen. This causes a lack of oxygen in tissue organs and can be recognized by the blue color on the skin of different body parts especially on the fingers, ears, mouth and nose.

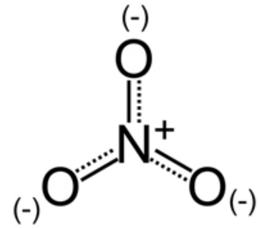

Fig. 2. Molecular formula of nitrate

Fig. 3. One of the symptoms of methemoglobinemia

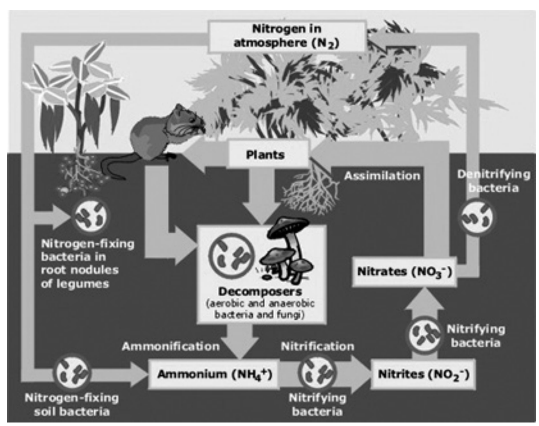

Fig. 4. Nitrogen cycle

How can nitrate get into the ground?

Nitrates are naturally occurring ions, which can get into the soil by the biological oxidation of ammonia first into nitrites and than by the further oxidation to nitrates. This is the only form directly available for plants. This transformation process is carried out by different species of bacteria. The first step is usually done by Nitrosomonas and Nitrosococcus species, while in the second case by the genus Nitrobacter. In normal circumstances there is a balance between net losses and net gains, but if additional nitrate gets into the soil it can be leached into the groundwater.

The source of this extra amount of nitrogen can be numerous. It can result from agricultural activities if fertilizers are used improperly and exceed the necessary amount. In this case plants are unable to use up all the nitrates present in the soil, so it is leached out by percolating water and accumulated in the phreatic zone. Communal wastes, spillages or the lack of sewage systems are other great contributors of nitrate pollution, together with manure heaps and animal wastes.

The key factors of this situation and the results of a study

The most common source – communal wastes

In Romania 77% of the groundwater is contaminated with nitrates, and the main cause of this pollution is of communal origin. The most important sources are associated with the improper storage of liquid and solid wastes. In many rural areas there is no sewer system so people use septic systems, or household wastes (blackwater, greywater) enter into the environment. Other sources are the manure heaps resulting from animal husbandry. Usually in villages these materials are lied down on the ground and no roof protects them from the weather, so organic materials can be washed out during rains.

Fig. 5. Manure hip in a Transylvanian household

Sunlight also helps the degradation of organic substances. In several Transylvanian villages tap water and sewage system are completely missing or only tap water system is installed. This results in a higher rate of water consumption and of course an increase in the amount of waste waters.

The results of a study

The study taken by Zoltan Pal and his group proved that in villages, contamination of ground water with nitrates depends on the amount of livestock, the street structure and house density of the villages and the distribution of communal pollution sources. To come to this conclusion they examined three settlements – Fule, Bardoc and Olasztelek – located along River Kormos. In these settlements besides the fact that the sewer lines are installed and houses are continuously connected to it, most inhabitants use water from their own wells. Resulting from their geographical location it was also possible to demonstrate that there is no connection between the direction of river flow and the concentration of nitrates, moreover the conductivity and concentration decreases down by the river (see Fig. 7. 8. 9. 10.). From these facts we can conclude that this groundwater contamination is a regional phenomena and is the result of local, communal pollution, thus neither of the settlements are responsible for the pollution of the others' water.

Possible solutions

As being one of the most important sources of drinking water the protection of groundwater is a very important issue. People who depend on it should also be protected and informed about the quality of their water, and the actions they should take in order to keep their water clean. In our work we tried to figure out some possible solutions in order to solve or mitigate the problem in Transylvania.

Establishment of groundwater monitoing system

First of all the different organizations, like Health Protection Inspectorate or Environmental Guard, should take the first steps by establishing a groundwater monitoring system. The aim of this system is to estimate the area affected by pollution, the volume of the contamination and the total population affected by this problem. Another task would be to install groundwater sampling points near and inside the villages, because now the sampling wells of authorities are located far from the sources of the nitrate contamination so that it can't be recognized. This action should be the basis of all the other solving projects.

Development of drinking water and sewage system

This action requires the proper use of European funds (Phare) in order to build up an integrated system of tap and sewage. The governments should somehow ensure subsidence to those locals who chose to connect to the network, so later more and more households decide the same way. Taking this action they should focus on the most affected regions and villages, and those members of the population – children and elder people – who are more vulnerable. For these inhabitants an alternative source of water should be provided until the problem is solved.

Regulation

Of course the success of such programs and measures greatly depend on the regulations. Regulations are needed in more levels:

- on a national level, where the adaption of the European Nitrate Directive has to be kept
- on a regional level, where strict regulations should be introduced in order to keep constructions under control
- on a local level where subsidies should be given for good practice both in agriculture and in household productions.

Decontamination

Probably decontamination of the already polluted water is one of the most difficult and complex task. Authorities should improve sewage system, the old, big farms and farming methods. Private animal keepers should build a shelter for manure hips, thus inhibiting the percolation of organic substances into the ground. Also new systems can be installed such as heating with dried excrement and the use of biomass in agriculture. This biowaste and green-compost has lower nitrogen content and can be more efficient in the improvement of soil quality.

Education

In order to understand how these systems should work and why these actions are needed, different trainings and education have to be applied both for authorities, governments and to everyday people. An important aspect is to educate all layers of the population from children to elderly people, and the authorities who are responsible for the execution of different measures, actions. During these trainings, lessons, different models and visual aids have to be applied together with theoretical teachings.

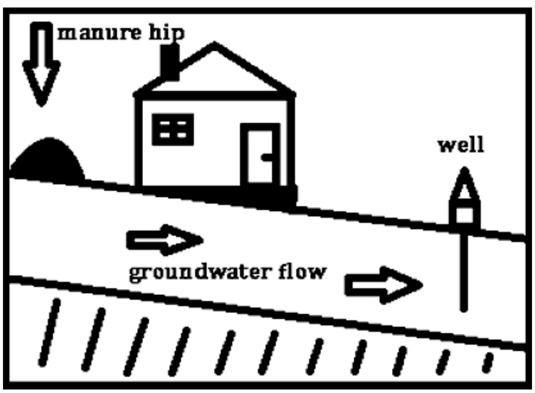

Fig. 6. Model of a typical household for educational purposes

Must be shown the effects of over-fertilizations, health problems, how to keep animals properly; in education, of course, the identity of the lecturer, teacher is also important. We think, both local - who know the situation of the given region - and a foreign - who know the possible solutions and has the experience to solve such problems - experts are needed. In addition different tools can be used to make it more successful for example websites, camps for younger generations, contests and summer schools for the youth.

Control, audit

After all we should not forget about the control and audit of these investments and projects. In this case local and foreign conductors are needed as well, who oversee the constructions, fulfillment of projects and fee systems.

Conclusion

Being an important source of drinking water, raw material for agricultural use and part of the hydrological cycle, the preservation and protection of ground-water's quality is of vital importance. Continuous monitoring, the education of inhabitants how to take care of their water sources are required in order to maintain quality. Moreover, by the up-to-date information about phreatic water of wells, the sometimes even fatal diseases resulting from the contamination of the groundwater, like cancer, can be avoidable.

Acknowledgements - This work was supported by Zoltan Pal, teacher assistant, Babes-Bolyai University of Cluj, Faculty of Geography; Babes-Bolyai University of Cluj, Faculty of Geography, Cluj Napoca, Romania; Cholnoky Jeno Geographical Society

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Appendix

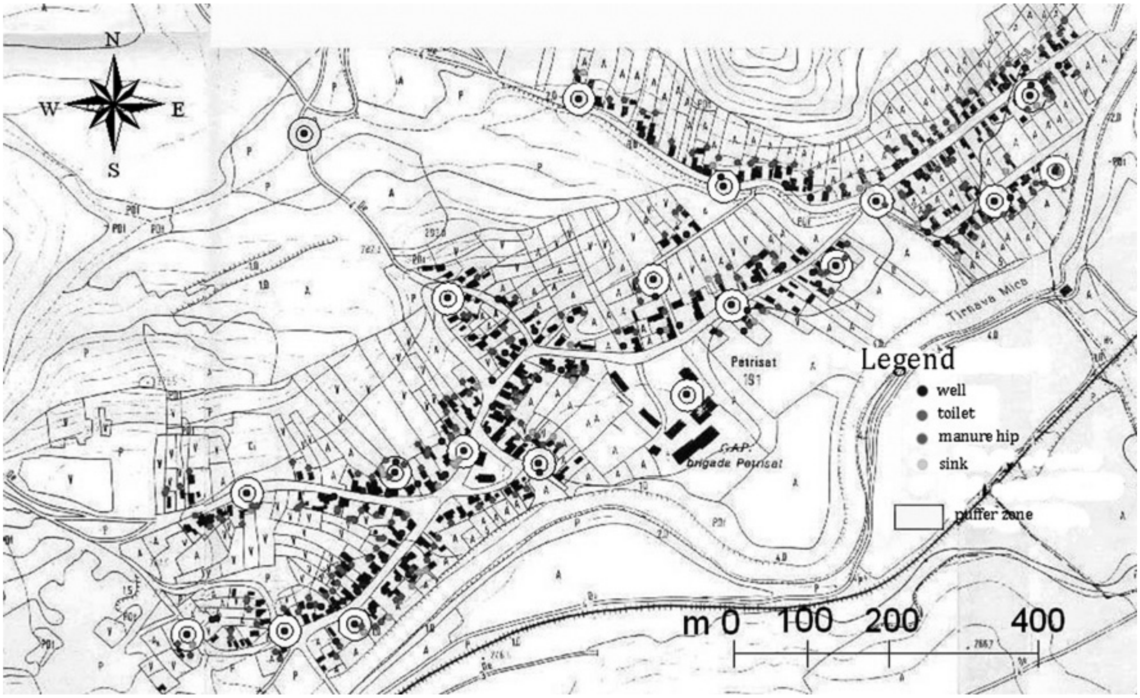

Fig. 7. Location of wells, toilets, manure hips and sinks in a village (edited by V. NEMES on the basis of Z. Pál 2007)

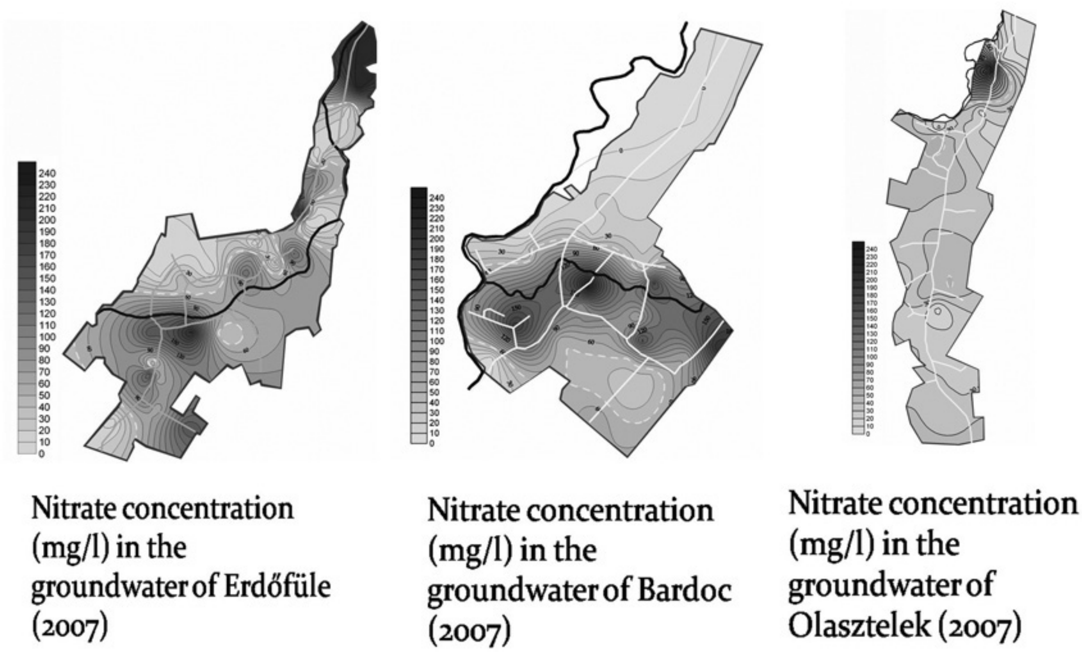

Fig. 8. Nitrate concentration in the groundwater of the three studied settlements (edited by V. NEMES on the basis of Z. Pal 2007)

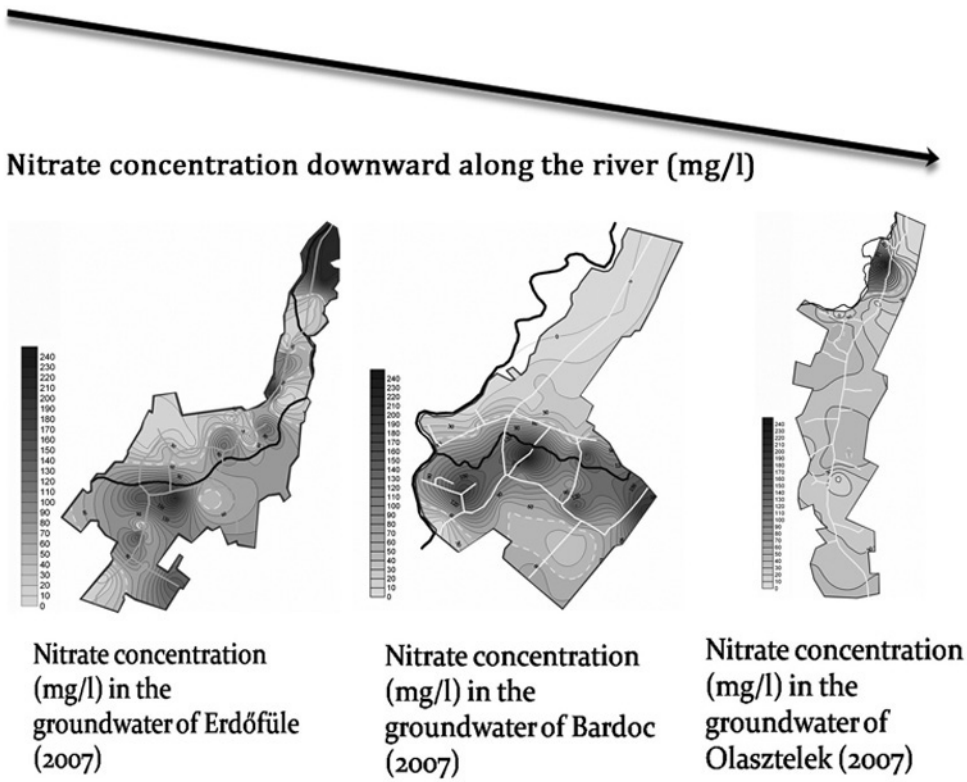

Fig. 9. Nitrate concentration downward along the River Kormos (edited by V. NEMES on the basis of Z.Pál 2007)

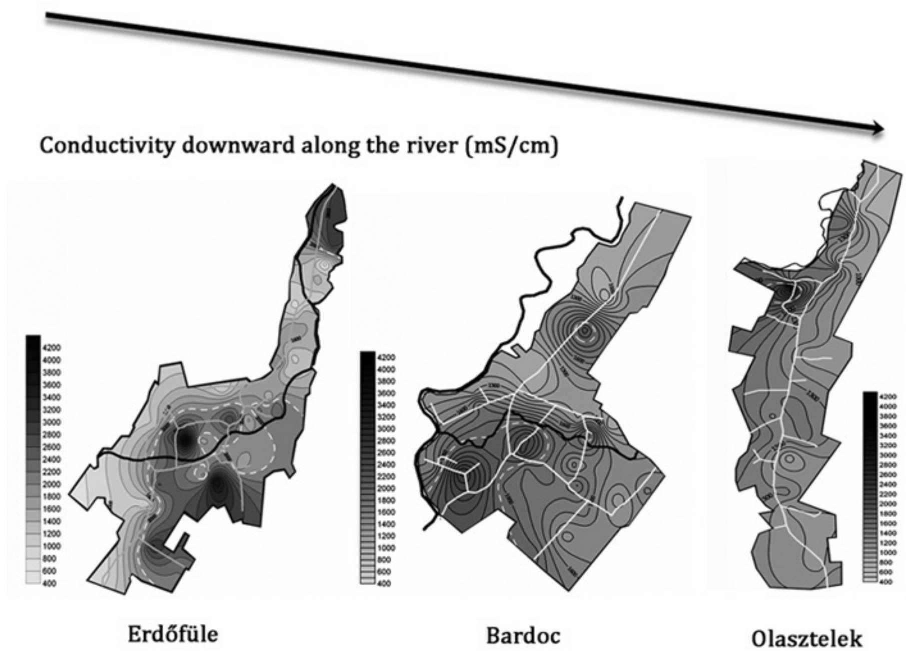

Fig. 10. Conductivity downward along the River Kormos (edited by V. NEMES on the basis of Z.Pal 2007)

I.3. Mineral Water topic

The Mineral Water Database of the East Carpathians

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Abstract

Mineral waters represent an important natural resource in our country. They've been studied since the late 18th Century, when important data appeared about their origin, therapeutic effect, geological background. The idea of a Mineral Water Database from the East Carpathians first came in the year 2006, when a research group from the Cholnoky Jenő Geographical Society was established. We (teachers and students as well) proposed to make a database, based on literature and field data. Since 2006 we managed to collect data from several regions of the East Carpathians and we made progress in sharing information on the internet.

Key words: mineral water, database, map, internet, East Carpathians

Introduction

"Geographical data shall be made available for access and view free of charge by citizens and other users, with delivery, downloading and re-use on harmonized terms and conditions" [1].

Following the concept of free information sharing the idea of a Mineral Water Database from the East Carpathians first came in the year 2006, when a research group from the Cholnoky Jenő Geographical Society was established. We (teachers and students as well) proposed to make such a database, based on literature and field data. Since 2006 we managed to collect data from several regions of the East Carpathians. Then we thought about sharing the information we gathered with the public, so that everyone who's interested in mineral waters should find data on the internet. That is why we thought that a web-based database would be the proper solution, which follows the open source standards and implements web-based geoinformation systems.

Mineral waters

Mineral waters of different types are present in the East Carpathians due to the geological variety and post-volcanic phenomena. By the time mineral waters also became an important natural resource (drinking water and bathing).

The first studies on mineral waters were made in the late 18th Century by Mátyus István, Fridvalszky János, Lucas Wagner, and Heinrich Johann Crantz. These studies

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represent important descriptions in Latin, German and Hungarian about mineral waters' therapeutic effect on human health [2].

During the 19th Century studies appeared on the chemical composition and origin of mineral waters. Authors like András Gergelyffy, István Boleman, Vilmos Hankó, Fronius Friedrich, Carl Ludvig Sigmund wrote the first definitions on mineral water [2].

At the beginning of the 20th Century water exploitation became the focus of mineral water research. New methods were introduced and improved to increase water discharge, such as hidrogeological drillings. Mineral water was bottled, and distributed to the whole country. At this time a mineral water was defined according to its chemical composition. As a result, according to the Directive of Bad Neuheim from 1911 water was considered "mineral" if it's TDS (total dissolved solids) value reached 1000 mg/l [2].

Nowadays the research and study of mineral waters continues with the focus on water consumption and therapeutic effects. Directives appeared on the quality (chemical analysis, microbiological purity), marketing (labeling and packaging) and exploitation of mineral waters.

Even though our country has a great potential in mineral water supply, there is lack of homogenous digital data and information. There is an important necessity for a mineral water database in order to collect, assemble data and information and to store them properly.

Methods used in creating a Mineral Water Database

In the Mineral Water Database data is collected from literature and from field as well. There are several steps according to which data about a specific mineral water spring is collected and processed till it reaches the final position in the database:

Preliminary study of literature

The study of literature is necessary in order to locate the most important mineral water springs, and to collect information about their geological origin, chemistry, benefic effect on human health. This information is used when field data is collected.

Collecting maps, descriptions, pictures about mineral springs

It is important to collect information of how these mineral water springs looked like in old times, information which we can gather from old maps, pictures, descriptions, photos. Old maps are digitizes if necessary and georeferenced into WGS84. We also collect recent topographic, geological, hydrological maps, which are also georeferenced. In the database we use the WGS84 DATUM, UTM projection and coordinates are shown in decimal degrees.

Field trip measurements

The field trip data collection focus on position, detailed description about the current environmental state of the spring, and chemical analysis.

We register the spring's geographical position with a GPS, then we take measurements on water's chemical composition (temperature, pH, electrical conductivity, total dissolved solids, salinity, dissolved oxygen, Ca, Mg, Fe, NO2, NO3, PO4), when possible we also take samples for laboratory analysis. The environmental state refers to the mineral springs' maintenance, ownership and environmental risks.

Register the data on a mineral water data sheet

To ease data collection and make everything understandable we made a mineral water data sheet, in which we register in situ data. The mineral water data sheet is annexed.

Data processing

First data was stored in Microsoft Excel tables, so that basic statistical analysis was also possible. The rows represent the mineral waters. The columns represented the measured parameters and descriptions. Each mineral water spring has a unique code, which was created following the example of the Romania's Water Cadastre. In the water cadastre each catchment has an unique code. The code of each mineral water spring contains the code of the catchment and a number which represents the distance from the river/creek mouth, like: VIII-69.2(1), where the VIII-69.2 means the code of the catchment and the (1) means the spring.

In the columns data about geographic position (UTM coordinates), altitude, descriptions, general information about region, name, administrative unit, origin, sate, form, infrastructure, maintenance, ownership, environmental risks and chemical measurements are stored.

Excel files are not part of a database, even though query is also possible. For a Mineral Water Database we also need to represent data on maps and to share information. Making a shape file with attribute data would be just a solution to create new maps, but information would be strictly stored in desktop GIS.

In order to share information we thought that WebGIS would be the proper solution. For WebGIS we need specific infrastructure which is only partially possible at this moment, considering our resources. So with compromises we reached to make a database where: we do not have our own server, instead we use a domain of a server. The spatial database we use is of open source, MySQL.

For representing data on map Google Maps was a solution which is also open source. Query is possible through MySQL and php language. Unfortunately we cannot use the custom WebGIS applications like WMF or WFS, and query is not possible through a GIS application.

The website www.borviz.org

The Mineral Water Database differs from the custom WebGIS infrastructure. The custom infrastructure, application server, database, map-server is only possible when we have a server of or own. We could use a custom WebGIS infrastructure on a private PC, but that would only as a demo for a future project.

Instead of a server we use a domain name in a shared web hosting service (from Satu Mare).

Why borviz.org?

The word "borviz" means carbonated mineral water, in Hungarian. The word is used all over the East Carpathians were such mineral waters exist. "Borviz" The term also appared in the names of some localities, like Borsec, Bilbor, Borcut.

"org" is a top level domain name, and first it was ment to be used by non-profit organizations. We consider our database free, open source and non-profit and that is why we chose the .org domain.

The database engine is the MySQL which also supports spatial data, so coordinates can be stored, layers can be created using the MySQL spatial data and geometries. The choice was MySQL because it is open source, extensive, fast, easy to customize and the most popular in web-based GIS.

It is also important to notice, that when we will be able to have our own server, the changes we will make will not affect the data already stored in this database, MySQL will be easy to configure into a new infrastructure.

Fig. 1. Main page of www.borviz.org website

Above we can see the main page of the website (Fig. 1.). The site contains the main page with an introduction to the database. We can navigate from the main page to other pages like "search", "mineral waters", "contact", "edit" and "sing in".

The "search" navigates us to the page where queries are possible. The "mineral waters" page navigates us to the mineral water data sheet where we can find information about each spring, and we can locate them on Google Map. This is possible through Googlemaps Api and JavaScript. Through the "Edit" we can introduce new data into the database. This is only possible when we have signed in as a user.

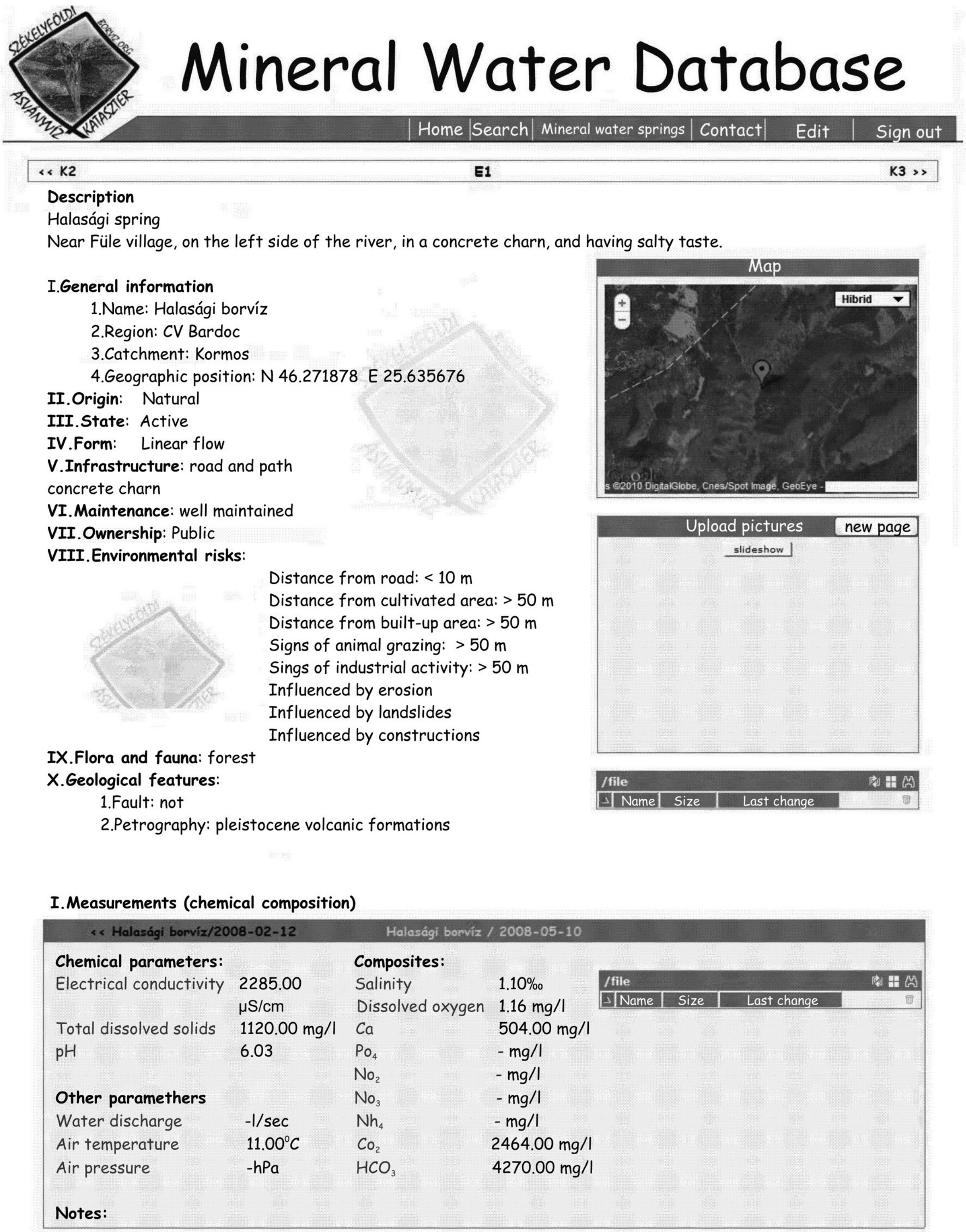
Below we can see the mineral water data sheet (Fig. 2). On the top there is the code which is unique for each spring and which helps us doing queries. Then according to the data form presented in the previous chapters there is information about each mineral spring's geographic position (coordinates), general information, origin, state, form, infrastructure, maintenance and environmental risks. A separate table is for the chemical parameters of the mineral springs. It is possible to introduce several measurements to one spring so that we can find out changes in time in chemical composition.

The mineral water springs can be seen on a Google Earth map with satellite, topographical and hibrid view (Fig. 3). This is possible through the Googlemaps Api which substitutes the Mapserver and Geoserver from a custom WebGIS infrastructure. Googlemaps Api does not work by its own: the http interface is realized by PHP which takes data from the MySQL database and prepares the coordinates for Goolemaps Api.

Then the JavaScript from the users' computer shows the requested map with the mineral water spings on it. Googlemaps Api uses the following steps to show the requested map: inicializates the map (size, zoom, type), requests the map and then as a last step it puts the layer with the springs on the map. Googlemaps API works with layers as well as other GIS applications.

If we click on one bubble we can see the name and code of the mineral spring. It is possible to zoom and pan on the map.

Query is possible in the Mineral Water Database through the MySQL database and PHP-JavaScript operations. The request



Mineral Water Database

| Home | Search | Mineral water springs | Contact | Edit | Sign out

<< K2 E1 K3 >>

Description
Halasági spring
Near Füle village, on the left side of the river, in a concrete charn, and having salty taste.

I. General information
1. Name: Halasági borvíz
2. Region: CV Bardoc
3. Catchment: Kormos
4. Geographic position: N 46.271878 E 25.635676

II. Origin: Natural
III. State: Active
IV. Form: Linear flow
V. Infrastructure: road and path
concrete charn
VI. Maintenance: well maintained
VII. Ownership: Public
VIII. Environmental risks:
Distance from road: < 10 m
Distance from cultivated area: > 50 m
Distance from built-up area: > 50 m
Signs of animal grazing: > 50 m
Sings of industrial activity: > 50 m
Influenced by erosion
Influenced by landslides
Influenced by constructions
IX. Flora and fauna: forest
X. Geological features:
1. Fault: not
2. Petrography: pleistocene volcanic formations

Map
Hibrid
s ©2010 DigitalGlobe, Cnes/Spot Image, GeoEye -

Upload pictures new page
slideshow

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Name | Size | Last change

I. Measurements (chemical composition)

<< Halasági borvíz/2008-02-12 Halasági borvíz / 2008-05-10

Chemical parameters:		Composites:	
Electrical conductivity	2285.00 µS/cm	Salinity	1.10‰
		Dissolved oxygen	1.16 mg/l
Total dissolved solids	1120.00 mg/l	Ca	504.00 mg/l
pH	6.03	Po_4	- mg/l
		No_2	- mg/l
Other paramethers		No_3	- mg/l
Water discharge	-l/sec	Nh_4	- mg/l
Air temperature	11.00°C	Co_2	2464.00 mg/l
Air pressure	-hPa	HCO_3	4270.00 mg/l

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Notes:

Fig. 2. Mineral water data form, as seen on the website

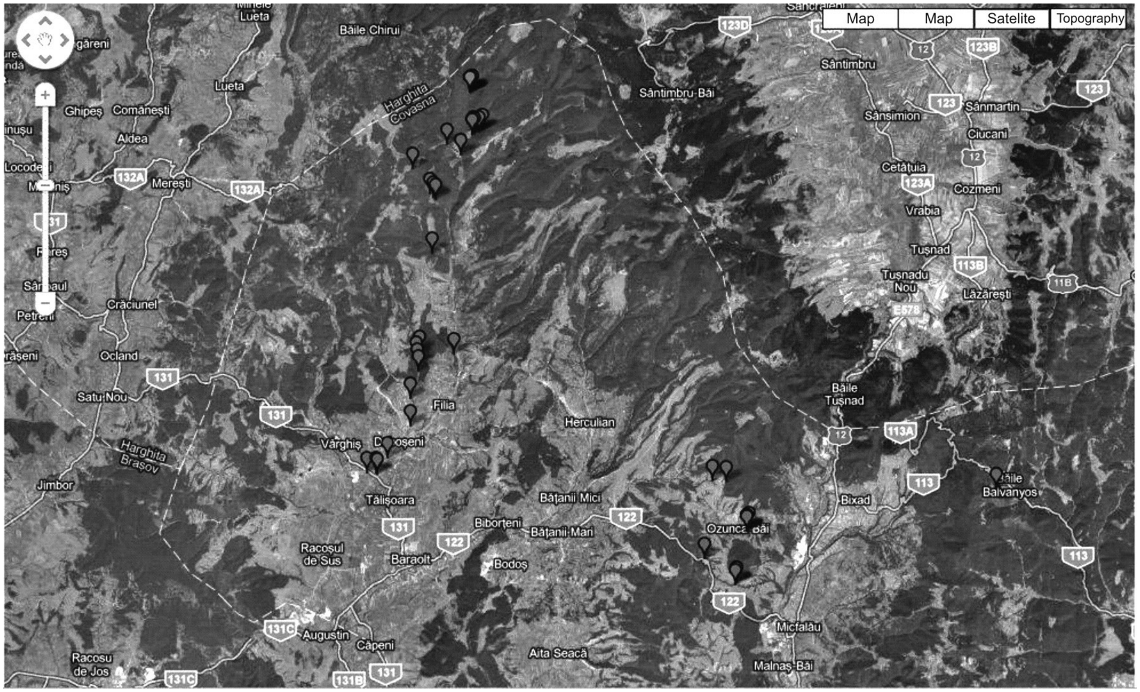

Fig. 3. Mineral water springs on hybrid (satellite and topography) map

(SELECT id, name, description, g_long, g_lat FROM springs WHERE name LIKE "E1") is sent to the MySQL database. The results are sent to GooglemapsApi and query result is shown on the map.

Query is possible through logical expressions like ≤, ≥, <, >, =. Query is done after chemical measurements (electrical conductivity, total dissolved solids, pH, temperature, Ca, Mg, Fe, CO_2, HCO_3), after environmental data os even after unique code and also multiple query is possible.

The result is shown separately, where the specific parameters after which we made the query are listed, and results can also be seen on the map.

The possibility of doing query is the most important part of the Mineral Water Database. With the help of the Internet, people will be able to find the springs they are interested in. In the future we plan to realize queries on the therapeutic effect of mineral waters (drinking and spa) so that people would be able to find the proper mineral water for their problems. With the help of the database the most valuable mineral water springs will be detected and shown on the map. People will be also able to locate the closest spring to their home, which is also benefic for their health.

Data introduction in the database is possible through the "edit" page. Editing is possible only if one is signed in as a user and has its own id and password for it. The admin rights are for privileged people who have the right to make changes and do data uploads in the database. Through this we can introduce data directly into the MySQL database.

Data can be introduced manually, but also by converting excel files into MySQL tables, or even shape files (with point, lines, polygons) can be added.

Data introduction is optimized in such a way that it is almost like we filled a field mineral water data sheet. It is also possible to upload pictures about the mineral water springs which can be seen separately in a slideshow. On each picture the date of the shot is also mentioned so that you can compare the environmental evolution of the spring by the time.

In the measurements part we can introduce data about the spring's chemical composition. In this part we plan to introduce other parameters too, like Fe, Mg, Cl, oxygen isotopes if possible and also microbiological data which reflects the water's purity (important if we consider that the water from these spring is used for drinking). We can see that the database is mainly user-friendly and easy to handle. Data introduction is realized through clicks and fills. Additional notes (information about special taste, other observations) can be added as a text in a separate field.

Conclusions

The Mineral Water Database of the East Carpathians is a transition between a traditional website and a WebGIS. Unfortunately we couldn't follow the custom WebGIS infrastructure (lack of resources), but still we've reached to have and share data and information about mineral waters using a website and a spatial database.

In this database one can find information about the geographic position, chemical composition and environmental condition of mineral water springs. Detailed descriptions and photos are also available. Data was collected from literature and from field measurements.

In the database query and multiple queries are possible using several parameters. It is possible to find mineral springs according to their therapeutic effect.

Mineral waters can be seen on satellite, topographic, hybrid maps.

For now we have data for almost 400 mineral water springs from Covasna and Harghita County which are not included in the database yet. In the future in the project we plan to extend through the whole East Carpathians, to have every mineral spring in our database.

Acknowledgements – We would like to express our special thanks to Csaba Csíki-Józsa for programming, and the Cholnoky Jenő Geographical Association for supporting this research.

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Mineral Water Nature Trail at Corund

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Abstract

Corund and its surroundings are very rich in mineral water. This variety is caused by the fact that this region is a contact zone between the Gurghiu Mountains volcanic plateau and the Transylvanian Basin. Because of this, here can be found salty, carbonate, ferruginous, carbon dioxide, hydrogen sulfide mineral water. Seeing this diversity we decided to plan a mineral water nature trail. Its course starts from Corund`s south-eastern entrance, the length is 7.1 km along which the visitors can see 10 spots. Important springs: Diovapai, Szolo-Mali, Cseredombi.

Keywords: mineral water, nature trail, Corund, salty water, ferruginous water, fizzy water, spring deposits

Introduction

The Mineral Water Database of Seklerland Research Group, which functions within the Babes-Bolyai University and the Cholnoky Jenő Geographical Society, has as its main objective to create a database, where all the mineral water occurrences from Transylvania can be found.

During our work, we are trying to map and analyze all the mineral water occurrences, which we find with the help of previous documentations and of the locals. Besides we are concerned about the usage, presentation and promotion of the mineral water. That is how the idea of the mineral water nature trail was born which would present the variety of mineral water from Corund area.

Corund and its surroundings

Corund is the most popular settlement from Salt Region (Sovidek or Regiunea Sarii). It is located 26 km north-west from Odorheiu Secuiesc, along the 13A main road, at the southern part of the Corund-basin. Administratively the following villages belong to Corund: Atia, Calonda, Valea lui Pavel and Fantana Brazilor.

The natural borders of the village are Firtos Mountain and Kadacsmezo from West, from North are Holloko and Solyomko, from East: Csillag Mountain, Szolomal, Les Mountain and from South: Kalondateto, Horvasmezo, Egettvesz, Vapa, Sarok, Fugevar and Hazanezo [1].

From geographical point of view the area of the village can be separated in two

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parts: the Eastern part, which belongs to the volcanic plateau of the Gurghiu Mountains and the Western part, this one belongs to the Hills of Tarnave [2].

Orbán Balázs, Transylvania`s greatest traveler said „From 800 Transylvanian mineral water 129 springs up in the area of Praid." Here belongs the area of Corund and Ocna de Sus too [3].

In order to understand the occurrence of so many different types of mineral water, it is important to write about the geology of the area.

The Badenian salt-belt, which lies in the Sovata-Praid-Corund region, plays an important role in this area [2]. The origin of the salty water can be explained by the occurrence of the salt-accumulations. In the case of Corund, a part of the salty springs do not get their salinity from the salt plugs, but from the upper Mediterranean and Sarmatian salty clays [4].

The Corund-basin is filled with Pannonian clay, clay marl, conglomerate and its frame; the mountains are in fact the pyroclastics of the Neogene volcanic plateau. In the northern part of the village we can find post-volcanic activities, like gas eruptions and mineral water having diverse composition [2].

Materials and methods

On our fieldtrips we use a data sheet, which has been previously developed by the Mineral Water Database of Seklerland Research Group. To determine the geographical position of the springs we use handheld Garmin GPS Map 60. For the precision of our data, we are doing measurements right at the place where the water springs up. We measure the air temperature and the temperature of the water, the runoff, the conductivity, the amount of total dissolved solids, the pH of the water, the Ca and Mg content, dissolved CO2, HCO_3 content. In case of communal pollution we also measure the content of NO_2, NO_3, NH_4 or phosphates. The data sheet contains information about the denominations, geographical position, accessibility, origin, functioning. It also contains information about its appearance, maintenance, environmental vulnerability, about the nearby flora and fauna, and about the geology of the place.

We also measure the discharge. We use a scaled measuring cup and stopwatch. We measure repeatedly the time while the water filled the measuring cup. We calculate an average value.

In order to do our measurements, we use portable instruments, like Thermo Orion 5 star portable multiparameter with electrodes, Merk Reflex 10 plus reflectometer, Nitrachek nitrate meter, traditional thermometer, Garmin GPS and tape measure.

Thematic Mineral Water Nature Trail at Corund

Our measurements proved the mineral water variety of the region, so we decided to make here a nature trail. These kinds of trails can be touristic attractions, but also educational tools too.

The nature trails are shorter paths, which are connecting natural points of interest. Along these trails, the visitors can meet important natural or historical objects, with the help of some guidebooks or explanation marks, panels [5].

The route of this nature trail starts from Corund`s south-eastern entrance, from the Diovapai mineral water. Along the 7.1 km length path the visitors will have the opportunity to get acquainted with mineral waters by stopping at the below mentioned 10 spots. Tourists will find information about mineral waters on the information panels placed in every location, which present the spring properties, healing properties, chemical composition. In some cases the history of the spring is displayed too. The route is marked by tourist signs, the level difference is 132 m and it can be explored in about 2-3 hours.

Our natural trail was planned principally to children, but it can be useful for adults too. Further on we present briefly the points of interest along this educational trail.

Diovapai mineral water

In this location we can see the spring called Diovapai. The locals call it only as Dio-spring, conform Tófalvi Zoltan`s (a writer born at Corund) work "Corund Bath" [6].

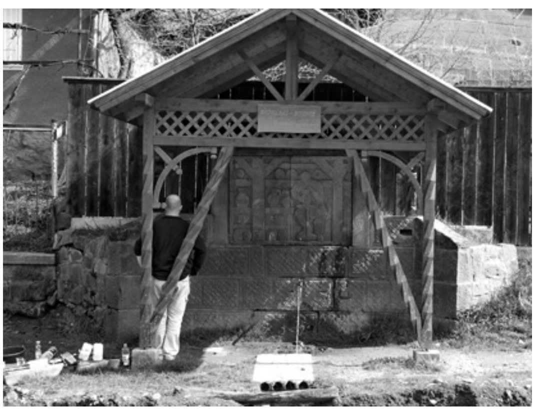

Fig. 1. Diovapai mineral water (Foto: Bán Barna)

It is located in the eastern part of the village. It comes to the surface from the right side of the 13A road as we arrive from Odorheiu Secuiesc, at the altitude of 610 m above sea level. For the exact definition of the location, we use the geographical coordinates, like the Diovapai spring it is located at the intersection of the 46°28'00'' northern latitude and 25°12'00'' eastern longitude.

The spring has a natural origin and it is actively functioning, it also made a ferruginous deposit, called limonite. The water contains carbon dioxide and iron. The water has a kind of "petroleum" taste due to the presence of the hydro-carbons, which are dissolved in the water.

The spring is maintained, it is protected with a wooden construction with roof. The water is coming from a carved stone through a 25 cm long tube, having 3 cm in diameter.

During the usage, there were discovered its therapeutic effects too. The consumption of the water is indicated in the following cases: anaemia, cardiac and circulatory disorders, cardiomyopathy, hypertension, gastro-enteritis and intestinal insufficiency [7].

At present Corund Commune is the owner of the spring. Because of the traffic, industrial activities and the animal breeding the environmental vulnerability of the spring is very high. The pollutants (exhaust gases and combustion products, animal faeces etc.) caused by these factors can easily filtrate in the ground and in the mineral water.

Szolomali (Szolosvolgyi, Szolopataki) mineral water

This spring has many different names: the local people are using the Szolomali name, Szolosvolgyi, from the work of Tofalvi Zoltan, or Szolopataki Spring, mentioned by Ambrus Lajos in his book about Corund`s history [6, 7]. It springs in the Szolomali orchard, owned by the Unitarian Church [2]. The exact location of this spring is: 46°28'00'' northern latitude, 25°11'00'' eastern longitude. It is also important to know the altitude too, which in this case it is 638 m above sea level.

Fig. 2. Szolomali mineral water (Foto: Bán Barna)

The spring has natural origin, with active functioning. From the chemical composition point of view this spring is carbonated, softly chlorous, magnesium, calcium, fizzy water [6]. We can find here the limonite too, such as at the Diovapai spring.

Its churn is made from concrete, its diameter is 80 cm, it is 170 cm deep and it has a cap. A wooden-made panel shows the name and the type of the spring and some elements, which are dissolved in the water. This spring is used and also maintained, but its functioning is influenced and endangered by the erosion of the stream nearby.

III^rd^ location

The third sight is located at the intersection of the 46°29’21’’ northern latitude and 25°10’34’’ eastern longitude, on 586 m above sea level.

Here we can observe the constructions made by the springs. Actually these spring deposits are variously tinted carbonate formations, which were accumulated by salty-fizzy springs. Their origin is due to the rising salty-fizzy water, which dissolves from the sedimentary rock the calcium-carbonate and deposits it on the surface.

The presence of the carbon-dioxide is due to the post volcanic activity. The carbon-dioxide intensifies the acidity of water, and in this way helps the dissolution of the calcium-carbonate then on the surface it contributes to the formation of the spring deposits.

The aragonites and the different types of spring cone deposits are forming due to the above-mentioned processes.

IV^th^ location

Here is the most eastern occurrence of the spring deposits, which location is defined by the 46°29’52’’ northern latitude and 25°10’43’’ eastern longitude, on 612 m (average value) above sea level.

Here the sediments of two salty springs are coating the andesitic rocks. Both springs have natural origins, active functioning and runoff. Their water flows over the deposits in the direction of the stream and gathers in surface cavities. The landscape reminds us to the Pamukkale from Turkey, the deposits have a staired structure, with little basins containing water.

Due to the fact that the springs are reaching backward to the surface, in dry weather they don`t feed these basins with water. As a consequence, these basins are exposed to the destruction of the erosion.

Cseredombi mineral water

This spring has more names: Cseredombi mineral water, Elisabeth-spring, Fingoborviz and Szejkesviz, as it is showed by Ambrus Lajos [7].

The spring is located in the fields of Corund, near to the confine of the village, in Praid`s direction. Its exact geo-graphical position is in the intersection of the 46°29’34’’ northern latitude and the 25°10’38’’ eastern longitude, on 600 m high above sea level.

It is a ferruginous, salty mineral water. This spring is well used; we can see this from the wood construction which is protecting

Fig. 3. Bugyogo spring group

the spring and the beaten path which also refers to the popularity of the spring. The water comes into a concrete churn which is 1.4 m deep, and its inner diameter is 52 cm. The usage of the water is indicated in case of gastric problems [7].

Hill of the Village

One interesting feature of this site is that here has been functioned for a while the old aragonite mine, which has a long history. The first location of the mining was at the place called Old mine, which place is now very rundown. The signs of the former extraction are still on the smashed stones.

The mining continued on the place called Hill of the Village, its marks are the almost vertical walls and layers of deposits, which are not covered [7].

The water gathered in the little pool goes down under the surface. It flows along the constructions made by the extractions from the water and along the detritus, which is a result of the former mining. After a while, the water comes out and appears again on the surface. It is like a disappearing stream. Similar phenomena occur mainly in carstic areas.

This location has many different names: Palfy Spring (the upcoming mineral water), Hill of Soorhaz, Mennykoves csigadomb, Kolugas [7]. It's located in the north-west side of the village, 170 m east from the main road. The altitude of the location is 556 m above sea level, its GPS coordinates are: N 462952 or 46°29'52'' northern latitude and E 251004 or 25°10'04'' eastern longitude.

Laposlik

Laposlik is the northernmost spring-cone, which can be found in Corund. Its exact location by GPS coordinates is: N 460900, E 250900, or 46°29'00'' northern latitude and 25°09'00'' eastern longitude. Because we are not talking about just one point, but about an area, its altitude is given as average, which is 535 m above sea level.

The spring-cone was created by a group of 4 springs called Bugyogo [7]. All of them have natural origin and active function, their water gathers in cavities, and then flows away.

Thick deposits indicate the presence of the warmish salty-fizzy mineral water. These deposits can be yellowish because of the iron and other pollutants.

It is easy to access it, it can be reached directly from the road 13A, is located 180 m southeast from the intersection to Atia village.

Beside the spring deposits we can find fossilized animals and plants too. The plants and animals (leaves, reptiles, insects) which fell in the water become coated with a thin carbonate stratum, this way they are preserved for more time.

The salt fountain of Arcio

The Salt fountain of Arcio, or Arcso, arises on the right bank of the Corund creek, 200 m south from the junction to Atia village. This pit has saline, lukewarm, ferruginous, fizzy, bicarbonate, magnesium water [2, 6].

Its location on the Earth`s surface can be described with coordinates: N 46°39'53'', E 25°09' 55'', its elevation is 506 m.

This spring was the salted spring of the former Corund Spa; it springs in the „salt house". The regulations about using the spring water traces back to the reign of Maria-Theresa (1717–1780), Austrian empress: people from Corund were allowed to take salty water on Wednesdays, and those from Atia were allowed to access the salt spring on Saturdays. This salt water was then boiled and vaporized and the remaining salt was later sold in the neighboring villages. The salt water was used in the household activities too, for making pickles and for processing pork, this habit is still in use [7]. The spring water is used nowadays also for industrial purposes: there is taken away weekly at least 2700 liters of salty water to the nearest milk processing factory.

The spring streams into a timber house, into a so-called salt-shed, which is actually a basin-like container, a trustee of the local people is maintaining continuously this construction. From here water can be taken out by those who can open the special locker of the salt-shed. The spring has a daily discharge about 400 liters [7].

Conclusions

The Mineral Water Database of Seklerland Research Group`s mineral water nature trail is unique, because it refers only to mineral water and as far as we know, in the vicinity this one is the only trail of this kind. This trailer can be used for open air education and for touristic purposes too.

While visiting the trail, people can see salty, carbonate, ferruginous, carbon dioxide, and hydrogen sulfide mineral waters. These formed here because of the geological characteristics of the region: here meets the Gurghiu Mountains volcanic plateau and the Transylvanian Basin, which is formed by sedimentary rocks.

This variety of mineral water is shown at 10 spots. The route of the trail is 7,1 km long, the level difference is 132 m and it can be visited in 2-3 hours.

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The CO_2 driven Lobogo mineral water in Baile Chirui, Romania

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Abstract

The operation cycle of a mineral water spring, the Lobogo well, formed as a result of a hydrogeologic drilling is presented. The drilling bears the code H503, operates periodically and has a geysering nature. We have performed five sets of measurements to register the physical and the chemical parameters, to get closer to the functioning of this mineral water. The full operation cycle of the spring is approx. 51 hours. The first indicator that emphasizes the geysering nature is the electric conductivity, whith an amplitude of 20% before turning to another phase.

Keywords: mineral water, hydrogeologic drill, geysering well, operation cycle, out bursting, CO_2, electric conductivity

Introduction

The name of Kiruly (the Hungarian name of Chirui) first appeared in 1623 in the protocol of litigation as Kireoly [1]. Not only the area, but also its mineral waters were known. Their exploitation as spas began in the 18th century, when the Transylvanian lords were coming here for recreation and treatment. Already from the 1850's a "simple cold watered bathing pool made of board" was known as the Lobogo spa [1]. During the communist era it operated as a "pioneer" camp for students. Currently is part of the Public Property of Lueta, and the camp is decaying, while its buildings are left unused.

Nowadays the Lobogo well (code: H503) is a 150 m deep drilling made in 1999 during a research project that focused on mineral and thermal water resources in Chirui, Vlahita and Homorod Bai area. The water of the well is included in a 1.40 x 0.8 m concrete casing, with an 11 cm diameter pipe and a length above the surface of 32 cm.

As the drilling was made, the water bubbling out of it had the following characteristics: discharge: 5 l/s; temperature of the water: 18°C; pH: 6.5; CO2 content: 1460 mg/l; HCO_3 content: 1891 mg/l [2].

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The data mentioned here will be important if we make comparison between the data from 1999 and from 2009.

This mineral water has an interesting way of functioning, that we consider a periodical one, outbursting periods are followed by inactive periods (without any watre above the surface).

Geological overview

Baile Chirui is located on the volcanic plateau on the Western slope of the Harghita Mountains, part of the Eastern Carpathians. The plateau was formed as a result of the eruptions in the Pleistocene. These eruptions are part of the Neogene-Quaternary volcanism of the Carpathian-Pannonic region, which began in the Western part around 21 million years ago.

Two segments can be distinguished in the Carpathian range: the one between Polonina (UKR) and Gutin (RO) Mountains, which took place between 14 and 9 million years ago, and the youngest part, between the Calimani Mountains and the Southern-Harghita that took place between 11 and 0.1 million years ago [3].

The volcanic plateau pertaining to the Harghita Mountains mainly consists of pyroclastites, epiclastites rock and predominantly andesite lava. After the eruption, due to external, erosive effects, during the displacement of the volcanic rock debris are formed. They are present in every layer and have a significant quantity [4]. The thickness of the layer of volcanic sediments is 100 to 650 m [5].

In the Vlahita-Chirui area andesite volcanoclastic rocks can be found, and the andesite appears with hornblende and pyroxene. In the area of Baile Chirui smaller dyke masses are inlayed in the composition of pyroxene-andesite [6].

The Lobogo well is 150 m deep and provides information about several different geologic layers. Thus we can find there pyroxene andesites and andesite agglomerates, grey marl, calcite sandstone and coherent clayey marl on the base of the well.

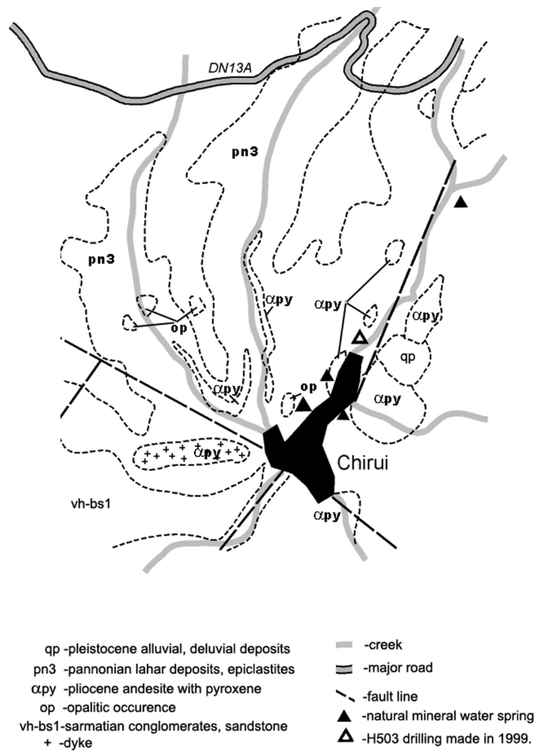

Fig. 1. Distribution of the deposits in Chirui [2]

In the case of the underground waters the condition for the creation of a water-bearing layer is that under the permeable layer a non-permeable layer to exist. If high pressure is associated with such a condition, by opening the layers (e.g. drilling) the water will break to the surface as a geysering well [7].

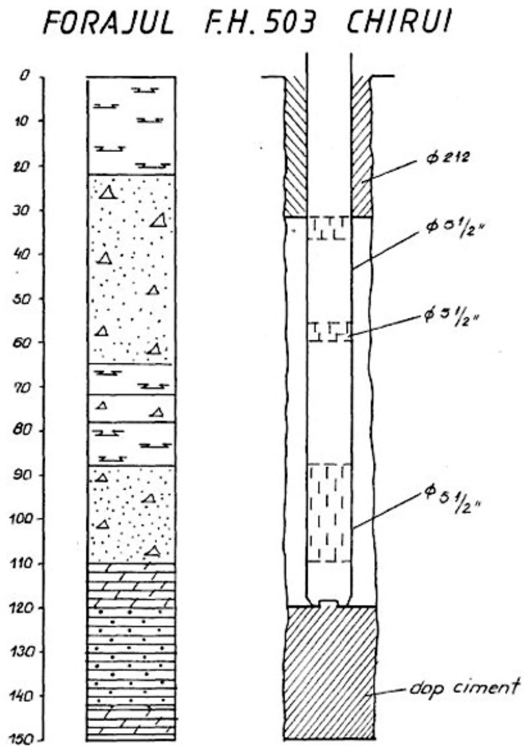

Fig. 2. The cross-section of the $H_5 0_3$ well [2]

Data and method

We assume that between the two action types of the geysering well the water becomes saturated in gases, mostly CO_2. In order to study this issue we started a sequence of measurements, which is still on-going. Thus far we have observed six times the drilling, as well as its operation and the water parameters. We performed our measurements with handheld devices: air thermometer, air pressure tester (SILVA), Thermo multi-parameter gauge with several electrodes, used for measuring the water temperature, its electric conductivity, total dissolved solids (TDS), and the pH. We also used traditional laboratory methods (titration) for ascertaining the CO_2 - and HCO_3 content. Flow rate measurements and water jumping high were also made. The added value of these observations resides in the fact that they were performed on an hourly basis.

Results and discussion

The aim of our field observations was to demonstrate the periodical behaviour in the mineral water functioning, and to try to explain the main influencing factors of the system. These observations had in line 14, 27, 29, 24, 67 hours duration. Each time we have detected or the positive or the negative (outbursting or decline) move of the well's water. Last time, during 67 hours of observation and measurements both of the well's actions were measured.

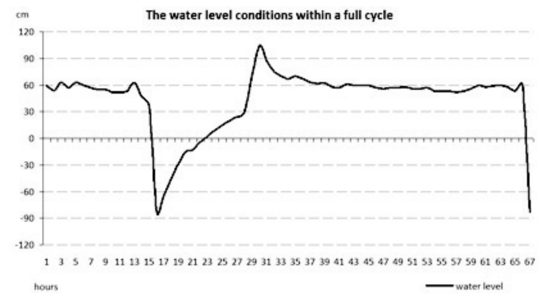

Fig. 3. The water level during March 12–15, 2009

Fig. 3. was drawn based on the measurements performed in March 2009, when we managed to follow the entire cycle with hourly resolution. If we further develop on the idea of periodicity we have observed that in this case the period of time between the drop and the outburst is also 13 hours. Generally, for the deeper wells, saturation time – time needed to get all water layers of the well saturated with dissolved CO_2 – is from about 10 hours (most unfavourable case) up to several months and more [8].

The other result of the measurements is that since there is a full cycle involved, that is two drops and the changes occurring between them, including the outburst, we can determine the duration of the cycle, as well as the time period between the outburst and the drop. The latter is 38 hours. The results observed here could be useful in the future for determining the approximate position of the water level.

The same results were found during the previous observations regarding to the time passed between a drop and an outbursing or an outbursing and a drop, that confirms the periodical character of the well's functioning.

The movement of the water is in relation with the conductivity, and we illustrated this observation in Fig. 4.

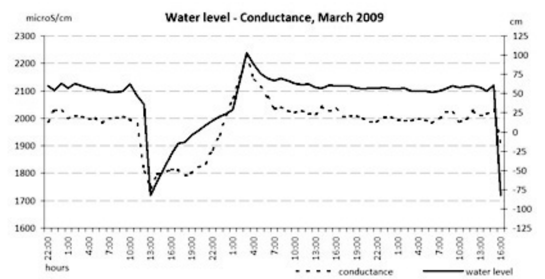

Fig. 4. The correlation between water movement and electric conductivity during a full cycle

When we performed the measurements in November 2007 it was the first time we saw an outburst and a drop. We used this occasion to determine the difference between the conductivity values of the two conditions. As a result, in November 2007 we obtained 20%, which is the same value as Pándi (2006) [9] mentioned (no official reference). Based on the cycle we observed in March 2009 we obtained a slightly different result. If we follow the sequence of events, the conductivity variance between the drop and the outburst is 19%, which is very close to the above-mentioned 20%. We think that this difference can be considered negligible in the case of naturally driven events.

In Fig. 4., apart from the fact that the two curves run also side by side, we can notice that the variance of the conductivity values precedes the changes occurring in the water movement, i.e. we could say that the change of conductivity indicates the evolution of the water movement.

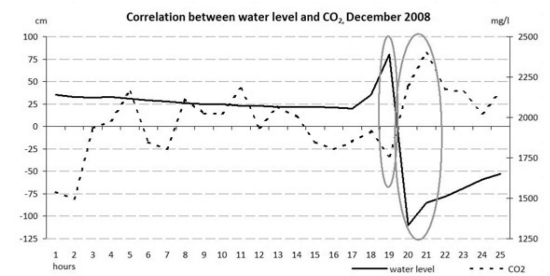

Fig. 5. Behaviour of the dissolved CO_2 vs. water movement

Fig. 5. illustrates the correlation between the water level and CO_2. These two variables show contrasting change around the so-called turning points: first the value of CO_2 changes and then the water height. Consequently the figure suggests that when the water jumps to a higher level before dropping, CO_2 shows lower values, while in the following condition, when the water is deep in the pipe, the CO_2 values increase.

Summary and conclusions

Above we presented the parameters, which play an important role in the operation of the Lobogo-well. We also need to analyze the water temperature and flow rate data and add to the above mentioned results. Based on the measurements performed so far, we can state the following:

- The periodic geysering operation of the Lobogo-well does not depend on the weather
- The full operation cycle of the spring is approx. 51 hours (38 hours in the outbursting phase, 13 hours saturation

– dormant – phase) and may depend on the height of the pipe above surface

- The change in electric conductivity indicates the approach of the out-bursting phase. The maximum relative water level at burst out is +180 cm at certain pipe height above surface
- Prior to the drop a brief positive water level increase can be observed
- The drop is a sudden process; it only lasts for a few seconds. The minimum relative water level is –130cm
- CO_2 is probably one of the most important driver of the processes that generate the outburst and the drop

To complete the research of the Lobogo well in Baile Chirui we also have to focus on the water layers and pressure conditions deep down. Measurements of gas flow rate and concentration are required to draw further conclusions.

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II. Participants articles

Ecohydromorphological Survey of Streams in Rural Areas

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Abstract

Taking into account European standards, determination of the ecological status of river ecosystems is based on an integration of hydromorphological, hydrochemical and hydrobiological evaluations of channel and riparian zone indicators. Complex ecological assessment is aimed at assessing the impact of human activities on natural sources, and at using the results as management measures [19], for example, such as a restoration measure proposal in order to achieve a "good ecological status" in the sense of WFD requirements and targets. The objective of this study is to verify whether application of hydromorphological survey is suited to identify reaches where restoration would be useful, and subsequently to use the outputs gained as a basis for suggesting specific restoration measures. The study evaluates the ecohydrological status of the study stream Slubice River based on application of an ecomorphological survey method of the river habitat quality – EcoRivHab [8, 10, 11] and the hydroecological monitoring method – HEM [6, 7], and subsequent comparative analysis of their outputs, considering that the methods differ in the way of evaluation, definition of the mapped zones, and also in the number of evaluated parameters.

Keywords: hydromorphology, ecohydromorphological assessment of the stream, EcoRivHab, HEM, restoration, Slubice River

Introduction

During the last two centuries in particular, the increasing level of the use of rivers and their modification in order to allow for navigation and anti-flood measures or drainage of waterlogged flood plains and canalization of channels to remove water from landscape as quickly as possible, together with its concurrent maximum utilization level, caused that ecological nature and functionality gradually disappeared from river flood plains. The rise of utilization, regulation and other forms of river modifications called for the need of understanding ecological impacts on a wide spectrum of river habitat changes [18]. From the 90ies of the 20th century, efforts have been thus rising to design complex evaluation methods of the overall, so called ecohydrological status of rivers – hydrochemical, hydrobiological

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and hydromorphological indicators of the channel and riparian belt [9, 11]. These indicators including evaluation of anthropogenic transformation of the river network jointly define ecological integrity of every aquatic system, and their evaluation is necessary for the management, sustainable development and protection of water bodies.

An essential precondition of any potential evaluation is the need to define the so called reference status to be used as a comparative element [8, 9, 11]. The reference or potential natural status is defined as a relatively undamaged water ecosystem, not affect by anthropogenic activity. The aim of ecohydrological evaluation thus consists in assessing the level of anthropogenic impact of the river compared to the reference status [9, 11, 19].

Numerous methods have been developed and are currently used in Europe, focused on biological evaluation as a rule, based on an effort of European Union membership countries to develop a standardization form of the mapping methods that would be applicable in a larger than only regional scale. However, the authors [14] point out at the importance of hydromorphological and geomorphological characteristics for examination of spatial interactions between the abiotic environment and biological data. Mc Ginnity et al. (2005, in [21]) provides a summary of 28 different evaluation methods used predominantly in Europe and the US, but also in Africa, Australia, and in New Zealand. However, according to [1], only 4 of these national methods satisfy the ecohydrological status evaluation rules in the WFD context: The River Habitat Survey (RHS; Raven et al., 1997, 1998); French "Systeme d'Evaluation de la Qualite du Milieu Physique" (SEQ Physique; Agences de l'Eau & Ministere de l'Environnement, 1998); German "Gewasserstrukturgutekatierung" for small to medium-sized rivers (LAWA – Field Survey; LAWA, 2000); and the Austrian national method "Okomorphologische Gewasserbewertung" (Muhar et al., 1996, 1998; Werth, 1987).

In terms of output quality, field survey has been the preferred foundation for hydromorphological evaluation of river habitats. Maps and aerial images document only significant morphological defects of the river bed [21]. The authors [9, 11, 18] emphasize the need to deal in a greater extent also with the riparian zone, inundation area, and the development of the entire river basin, as part of ecohydromorphological research.

River Modifications in the Czech Republic

The current modification rate of the river network in the Czech Republic is high, similarly as in the majority of advanced European countries – 28.4% (MZP CR, 2000 in [8]). It is the result of landscape modifications that started as early as in the Middle Ages, however, those performed especially during several last centuries.

The changed social situation in the Czech Republic after 1989 meant an interruption of water management technical modifications and agricultural ameliorations that had been in progress then, and it evoked an effort of changing the current development of water management and the achieved unsatisfactory condition of water bodies. The interest in water management restorations gained real support in 1992 when the government approved the grant programme called River Restoration Programme. River ecosystem restorations are focused mainly on the renewal or enhancement of characteristics and functions of near natural water bodies, they remove the consequences of unsuitable technical adaptations, unsuitable ways of land use, or unfavourable processes caused by other human interventions [13].

The aim of this study was to verify the suitability of hydromorphological survey application in order to identify reaches where restoration would be suitable, and subsequently to use the outputs obtained as a foundation for formulating a proposal of specific restoration measures.

Applied Methods and Data Sources

Two ecohydrological evaluation approaches most important in the Czech Republic were applied in the study basin of Slubice River in order to determine the ecohydrological status of the river: The method of ecomorphological eva-luation of the river habitat quality – Ecohydromorphological River Habitat – EcoRivHab [8, 10, 12] and Hydroecological Monitoring – HEM [6, 7]. Both methods are based on the field survey completed with utilization of distance data, and they satisfy WFD criteria [22] as well as those of CSN EN 14614 [3]; they exhibit a number of common features, but also important differences. Their greatest difference is the principle of evaluation, definition of the mapped zones, and the number of the mapped parameters (Table 1.). Outputs of both methods were subsequently compared in order to determine any differences in the overall evaluated status, and to see whether the methods are suitable to be applied in identification of problem reaches suitable for restoration.

Within the framework of both methods, the evaluated river was divided in reaches of heterogeneous lengths and of homogeneous nature based on indicators of the ground plan course of the river, nature of riparian zone and flood plain use, and the nature of the river bed modification. Monitoring is related to the entire water ecosystem. EcoRivHab method defines 3 mapped ecomorphological zones: (1) Channel; (2) Riparian belt; and (3) Flood plain, while the method HEM defines 4 mapped zones: (1) Channel and route; (2) Bottom; (3) Banks and inundation area; and (4) Flow and the hydrological regime. It is evaluated using a five-point scale where 1 is the best value.

The method EcoRivHab assigns the same weights to all parameters, while 3 values of group parameters are thus derived from the 31 evaluated parameters by calculating arithmetic means of the scores; the groups represent individual ecomorphological zones whose arithmetic mean determines the overall ecomorphological class. The overall ecomorphological status (ES) of the river is characterized by 5 quality classes – the so called ecomorphological classes, which determine to what extent the river has been affected by anthropogenic activity. ES I – Natural or near natural status; ES II – Slightly changed; ES III – Moderately changed; ES IV – Strongly changed; ES V – Completely changed [8, 10, 11].

In terms of the method HEM, each of the 17 evaluated parameters has a different weight assigned. The weighted mean are preset in a way to emphasize the impact of indicators which are crucial for the hydromorphological situation of the river. Thus at first, the partial hydromorphological quality is calculated for each of the 4 mapped zones using the weighted mean. The resulting hydromorphological quality of the reach is then calculated as arithmetic mean of the partial values calculated for individual zones. Classification of the hydromorphological status (HS) consists in assigning the calculated value of the reach's hydromorphological quality to one of 5 HS classes: HS 1 – Very good; HS 2 – Good; HS 3 – Average; HS 4 – Poor; HS 5 – Destroyed. Hydromorphological status of the river corresponds to the reference conditions if very good HS has been achieved in the given reach, and at the same time, if none of the evaluated indicators reaches a worse value than 2 [6, 7].

The summary of essential characteristics of the methods is provided in Table 1. Thematic maps of individual ecomorphological zones and the map of the summary ecomorphological/hydromorpho-logical status are the result.

Table 1. Basic characteristic of applied hydromorphological assessment methods

Method	EcoRivHab	HEM
Number of parameters	31	17
Monitorized zone	3:channel: ripariant belt, flood plain	4: channel, bottom, banks and inundation area, flow and hydrological regime
Length of reaces	heterogenous	heterogenous
principle of assessment/ ponit assessment	field mapping, comparison contemporary state with local reference state/5	field mapping, contemporary state/5
Number of classes	5	5
Summary state	arithmetic average	weighted average
Data demands -water quality -outflow variability	 yes no	 no anual mean, day mean

Repeated field monitoring in the study basin of Slubice River was used as the basic data source. All results were interpreted in the form of thematic maps in GIS environment, while the digital layers ZABAGED 1:10,000 and aerial images were used as the foundation. Based on the field survey, Land Cover of the basin (Fig. 1.) was determined using the foundation of aerial images. Discharge was measured in 6 selected profiles of the basin using a current meter, and water quality was observed, as well. Maps of the Imperial Imprints of the Stable Cadastre of Bohemia in the scale 1:2,880 were used to evaluate changes in the river route, which capture the landscape status of the study area between the years 1838 and 1839.

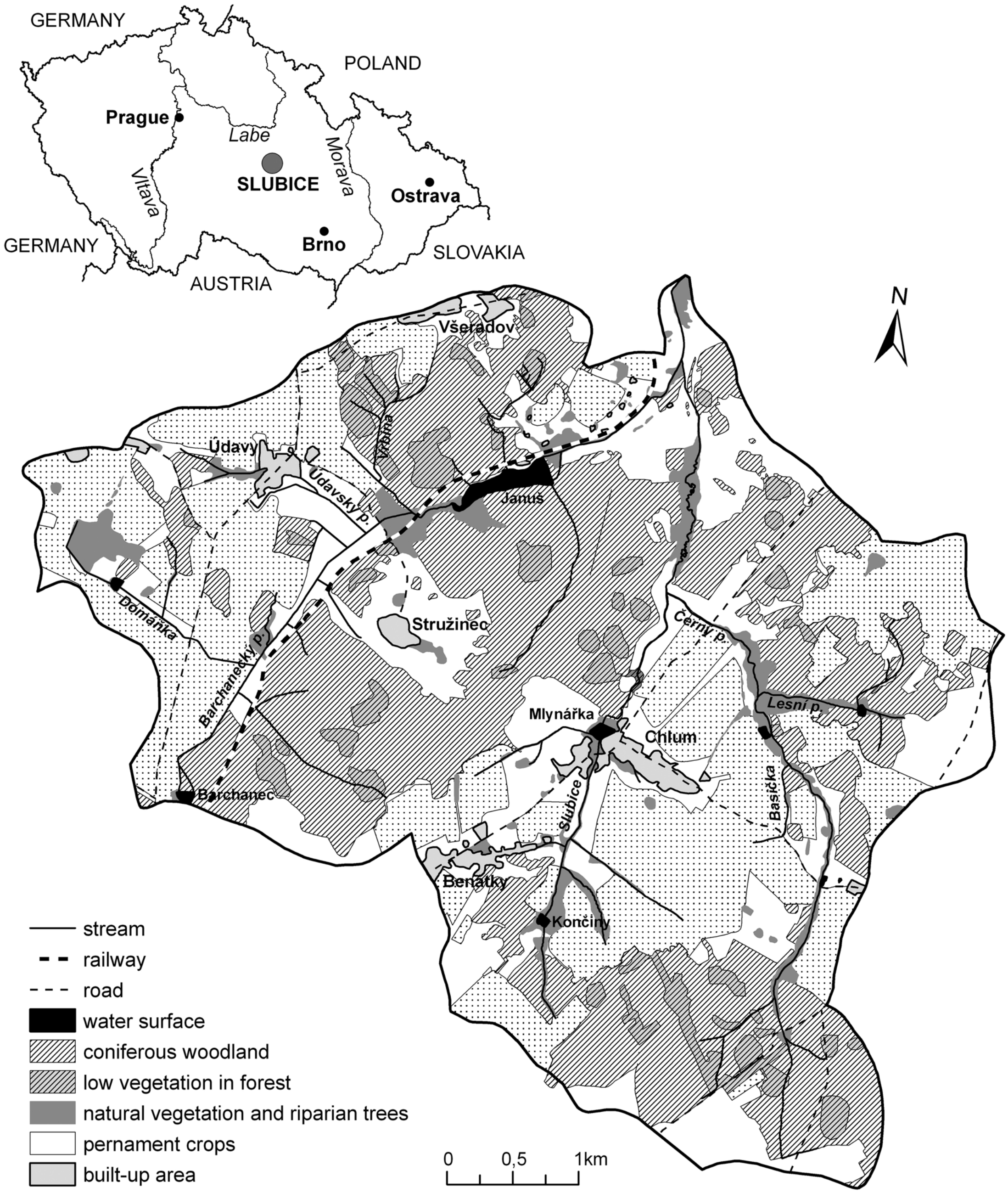

Fig. 1. Location and Land Cover in 2009 of studied area Slubice River basin

Study Area

The study area is found in the central part of the Czech Republic (Fig. 1.), in the Elbe River basin and at the northern edge of the Czech-Moravian Highlands, in the altitudes of 540–683 m above sea level. Slubice River is a left-sided tributary of Chrudimka River at the river km 78.48 (Chrudimka River is a left-sided tributary of Elbe River). The basin area is 29.21 km^2. Slubice is 6.75 km long and its average long-term yearly discharge is Qa = 0.32 m^3/s. The whole basin forms part of Protected Landscape Areas (91% in Zďarske vrchy PLA; 9% in Zelezne hory PLA). In spite of that, the river basin as a whole exhibits considerable anthropogenic influence, especially due to agricultural activities, and only a few reaches of the rivers remained natural. Although 51.5% of the basin area is covered with forests, which is a value that markedly exceeds the Czech average (33%), they are spruce monocultures almost in all cases. Despite the local climatic conditions (average annual temperature 6°C; average annual precipitation total 879 mm) and inclination of the terrain, arable land represents 29.2% of the river basin area, while meadows and pastures amount only to 16.7% (Fig. 1.). 35% of the basin area was drained and 49.8% of the total length of 32.8 km monitored rivers were modified (artificially reinforced) during the 2nd half of the 20th century as part of agriculture intensification. There are only 741 permanent residents in the Slubice River basin and no industrial production is found here. It follows from the water quality evaluation and the major negative impacts on the water ecosystem development include runoffs caused by agricultural land erosion, and water contamination associated with waste water discharge.

Results

Ecohydromorphological Status Evaluation Based on EcoRivHab and HEM Methods

EcoRivHab method application indicated a relatively higher adaptation rate of the river network in Slubice River; on the contrary, it provided a relatively good status of riparian zone, but severe transformation of the flood plain (more than 50% evaluated as ES IV and V). Moderately changed status markedly predominates in the whole ecomorphological status of the river; ES III was determined for 54.7% of the total river length (Fig. 2.). Poor condition of the zone channel and river route (54.7% classified as HS 4) was determined based on the method HEM. On the other hand, the zone banks and inundation zone and the zone flow and hydrological regime are found in a relatively good condition according to HEM, with more than 70% of the river evaluated as HS 1 and 2 (zone 3 and 4, Fig. 3.). The summary hydromorphological status of Slubice River was evaluated as average, which represents 49.5% of the river length (Fig. 2.); it can be found in agriculturally utilized areas with straightened and stabilized river beds. Good HS (20.2%) was determined for those reaches whose beds were not artificially reinforced, although their routes were changed, and a reach where restoration processes have been initiated with a success. Very good HS (25.7%) represents reaches with near natural habitat, which can be denoted as reference reaches of the river in terms of the survey for the purpose of EcoRivHab method.

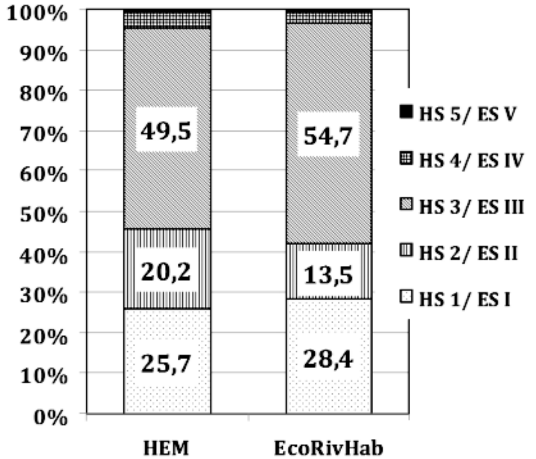

Fig. 2. Comparison of outputs obtained by application of HEM and EcoRivHab methods

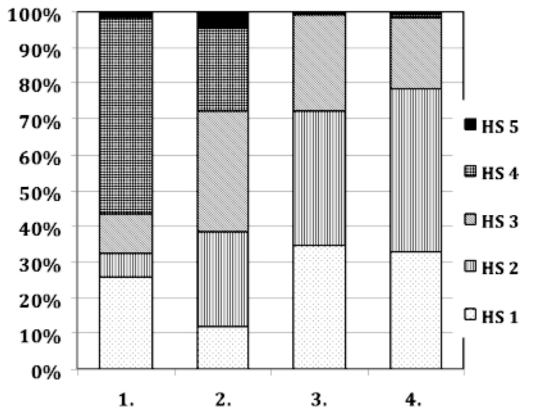

Fig. 3. Hydromorpholohical state in particular zones in Slubice River basin by the HEM method

Comparative Analysis of Survey Outputs

In spite of considerable similarity of both ecohydromorphological methods, the results exhibit certain differences. An essential difference between the methods consists in a different evaluation principle; EcoRivHab compares individual evaluated parameters to a predetermined reference status, while HEM evaluates the current status of the parameters. Deviations in the summary evaluation are caused by different definition and extent of individual surveyed zones. EcoRivHab determines 3 surveyed zones, emphasizing the riparian zone and flood plain, which are defined as 2 separate zones; the channel is evaluated as a single zone, while it incorporates the flow characteristics, hydrological regime, vegetation and technical adaptation of the banks. Riparian zone and flood plain of the river exhibit a good conditions, thus they improve the summary evaluation of the ecomorphological status of the river where the channel zone is affected by anthropogenic activity. HEM defines 4 surveyed zones; besides the channel and river route zone, separate zones are represented also by the bottom, flow and hydrological regime. The banks and inundation area, including the riparian zone, are evaluated in a complex manner as a single zone, which moreover includes also the parameter of modification rate of the banks. HEM thus greatly emphasizes the channel whose status is reflected to a decisive extent in the summary evaluation, while the riparian zone and flood plain are suppressed. Banks are viewed as a part of the riparian zone, not as a part of the channel. Thus the methods are not comparable in terms of evaluation of partial zones, and large differences can be found in the results between zones within the methods (Fig. 3.); however, the methods do not differ in principle concerning the evaluation of the summary hydromorphological (HEM) and ecomorphological (EcoRivHab) status of the river (Fig. 2.). It follows from Fig. 2. that HEM is more rigorous when it comes to segment assignment to the very good / natural status class, indeed; on the hand, EcoRivHab can be seen as more rigorous in the category of good / slightly changed status. It thus cannot be clearly determined which of the methods provides worse evaluation of Slubice River.

Differences in the summary ecomorphological/hydromorphological status are manifested in 5 evaluated reaches (see Fig. 4.). 3 reaches in total were evaluated better by 1 class by HEM than their corresponding reaches under EcoRivHab evaluation; their evaluation was worse precisely due to the emphasis laid by EcoRivHab on riparian zone and flood plain use. On the contrary, 2 reaches were evaluated as worse by HEM than by EcoRivHab. Again, this difference is given by the fact of zone definitions as described above, where good-quality flood plain and the riparian zone evaluated by HEM are suppressed while the channel is emphasized. As for the bloated reach SLU022, HEM evaluation is lower even by 2 classes. According to EcoRivHab, the riparian zone and flood plain of the reach SLU022 exhibit a near natural status, and the summary status is evaluated by EcoRivHab as that with a mild effect of anthropogenic activity (ES II); however, the channel has been modified, the bottom shows no structures, the banks are solidified with logs, and the hydrological regime is affected by bloating (due to the pond dam), thus in general, HEM evaluates the reach in the poor status (HS 4). The different evaluation of the short reach below Mlynářka Pond dam is given only by different definition of this reach for both methods.

Discussion

Based on the application of both ecomorphological methods taking into account the use of the outputs, it can be said that EcoRivHab provides complex and detailed, high-quality evaluation of the river ecomorphological status, emphasizing the quality of a wider riparian belt; thus the monitoring results can be used e.g. as a foundation for preparing a restoration study. While EcoRivHab can be applied to selected rivers and/or in selected areas (for example, a PLA or on the contrary, in areas severely affected by anthropogenic activity), HEM seems to provide a considerably generalized evaluation suitable for overall monitoring of hydromorphological characteristics of stream order. Their different principle of evaluation is an essential difference between the methods. While EcoRivHab compares individual evaluated parameters to a predetermined reference status, HEM evaluates only the current status of the parameters. Furthermore, HEM does not consider the difference between the upper and lower river and does not consider in any way the size of the river surveyed. On the contrary, EcoRivHab involves the difference of the upper, middle and lower course by performing the comparison to a reference status for the given evaluated reach during the evaluation (reference statuses defined separately for the upper, middle and lower course), thereby capturing the river development and size. Deviations in the general evaluation are caused by different definitions and extent of individual zones surveyed. HEM points out at the importance of the channel, while EcoRivHab seeks to emphasize the value of functional riparian belt and flood plain or to describe its non-functionality. Good-quality flood plain and riparian zone are thus suppressed in HEM evaluations, emphasizing the channel.

Although the overall ecohydromorphological status of the river differs between evaluations of both methods in 19% of the total river length, as a rule, these are deviations of 1 class, and it can be thus said that in spite of the differing way of defining the mapped zones and the different number of evaluated parameters, the results of both used methods provide a comparable informative value – average / moderately changed status was assigned to 49.5% vs. 54.7% (HEM vs. EcoRivHab) of the river;

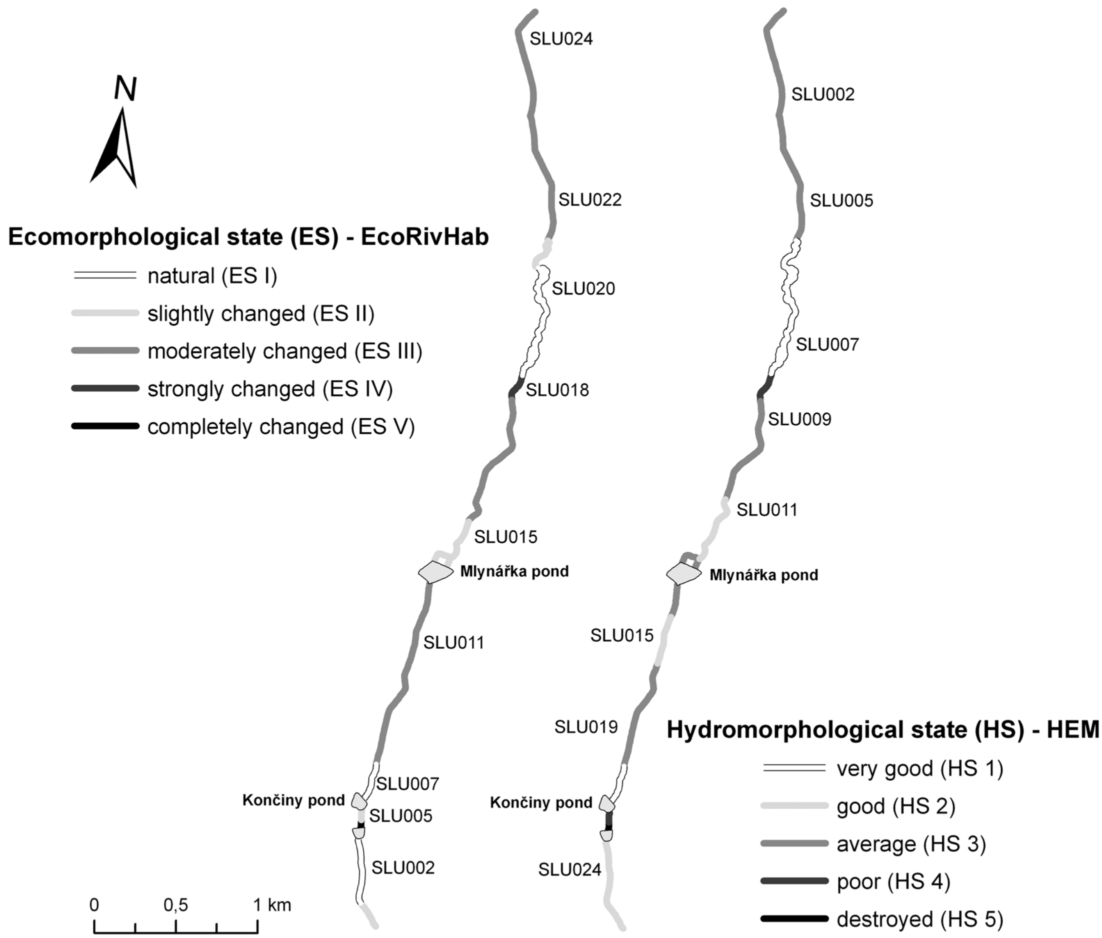

Fig. 4. Ecohydromorphological state of the Slubice River: comparison outputs obtained by application of HEM and EcoRivHab methods

very good/natural status was assigned to 25.7% vs. 28.4% (HEM vs. EcoRivHab) of the river. As clearly illustrated by Fig. 4., it is apparent that corresponding reaches differ by 1 class max. (except one short reach) in the summary evaluation. Both of the applied methods can thus be used to identify localities suitable for restoration. The choice of the localities suitable for implementation of restoration measures then stem from the fundamental assumption that any restoration is most suitable where the highest improvement of the status can be obtained; we should thus revitalize the reaches showing the worst ecomorphological (hydromorphological) status at first. Not considering reaches where pipes are installed in order to make fields accessible, bloated reaches between existing ponds, and the disastrous condition of some dams, 3 reaches found in the lower and middle part of Slubice River seem to be suitable for restoration based on the evaluation by both methods; these reaches were evaluated by both methods most often as those with average / moderately changed status (Fig. 4.).

Conclusions

Application of ecohydromorphological monitoring in the study area was used to evaluate the current river habitat with the aim to identify reaches showing the worst condition where restoration measures would be suitable, and to find near natural reaches that could be used as a source of information for the restoration proposal design.

The Slubice River basin was evaluated by both methods as that with moderate impact by human activity. Modification of the channels (straightening, deepening and reinforcing) showed to be the major problem of Slubice River and also of the entire basin; on the contrary, the riparian belt and inundation area – exhibits functionality and a relatively good condition. Slubice River shows alternating natural reaches and reaches with moderate affection by anthropogenic activity, and is thus a suitable candidate for implementation of restoration measures with the objective to interconnect the natural localities with a new near natural channel.

Compared to the ecomorphological status of other rivers in the Czech Republic determined using EcoRivHab method, the status of rivers in Slubice River basin seems to be considerably better than the ecomorphological status of rivers in urban areas or industrial areas [4, 2], but substantially worse than other basins within PLA [12, 15, 16, 17].

In general, the ecohydromorphological status differs in almost one fifth of the length in the evaluation of individual reaches by both methods; still it can be said that the results of both methods provide similar informative value in the summary evaluation. It was thus confirmed that application of ecohydromorphological monitoring to identify localities suited for restoration is suitable, and the possibility of using the outputs as a foundation for proposing specific restoration measures.

The determination of the real ecohydromorphological status of the river based on field survey not only fulfils WFD requirements, but it also provides an important source of information for the management, and for sustainable development and protection of water bodies formations.

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Bottled Water vs. Piped Water: the Case of Italy

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Abstract

The paper deals with some geographical aspects related to the business of bottled water in Italy. The reasons for a high and increasing demand for bottled water - Italy ranking in the top position in the world - are mainly identified in the customers' distrust in the quality of municipal water and in the driving force of strong advertising campaigns. On the production side, the multifaceted situation regarding withdrawal licenses in the different Italian regions is outlined, stressing the need for more uniform regulations and for higher abstraction fees. A comparison between bottled and piped water, from the viewpoint of quality, price and environmental effects, is also presented, with a final mention to the national campaigns launched by environmental associations to support the use of piped water.

Keywords: Bottled water, piped water, water abstraction regulations, Italy

Introduction

Issues of great relevance stem from such an apparently negligible, everyday choice as drinking either bottled or piped water: economic and environmental outcomes, as well as water governance aspects – just to mention the main ones – are linked to each glass of water that is drunk by numberless consumers. Under this concern an interesting case of study is provided by Italy.

The demand for bottled water

The Italians are the greatest consumers of bottled water in the world. According to recent data related to all EU countries (2009) the Italian people almost double the EU average consumption which is gauged at 104 litres per capita. The steep trend of growth should be considered too, as mineral water consumption in Italy has increased fourfold during the last thirty years (Fig. 1.).

1 – The paper was conceived together by the two authors. Franca Battigelli specifically wrote the paragraphs 1, 4, 5, Andrea Guaran the remaining paragraphs.

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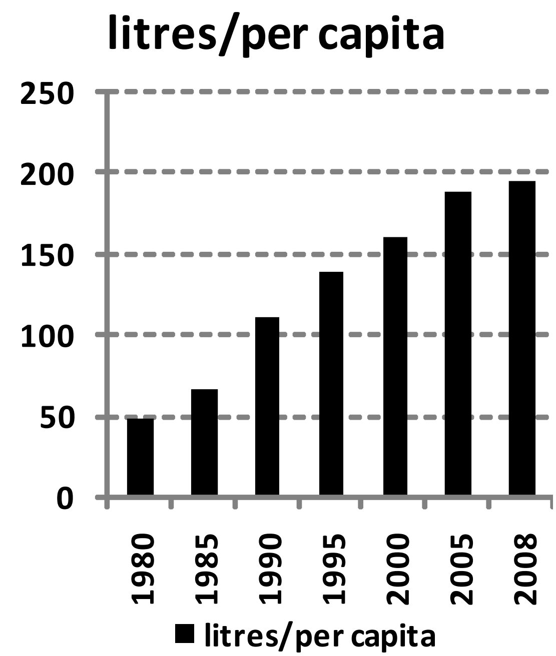

Fig. 1. Bottled water consumption in Italy, 1980–2008 (Source: Legambiente, 2009)

Why do the Italians drink such a large quantity of bottled mineral water, rejecting "the mayor's water" that is available in one's own house, and regardless of the great difference of price? Moreover, why do the Italians buy so much bottled mineral water given that a large percentage of it is natural non-sparkling water (Fig. 2.)?

The reasons for such behaviour lie within two main factors, strictly connected with each other. The first motive is the scarcely reliable quality of public water, particularly in some areas. A great number of Italians think that the water that comes from the tap is not good for drinking due to the bad condition of the pipes and to the need for the addition of necessary but bad smelling chlorine. The other reason concerns the spread of the idea, intensely supported by marketing strategies and by the barrage of media advertising, that bottled water is much better than public water. Also the packaging – convenient plastic bottles and different sizes, half litre for individual use and one and half litre for family use – contributes to driving the demand of bottled water up.

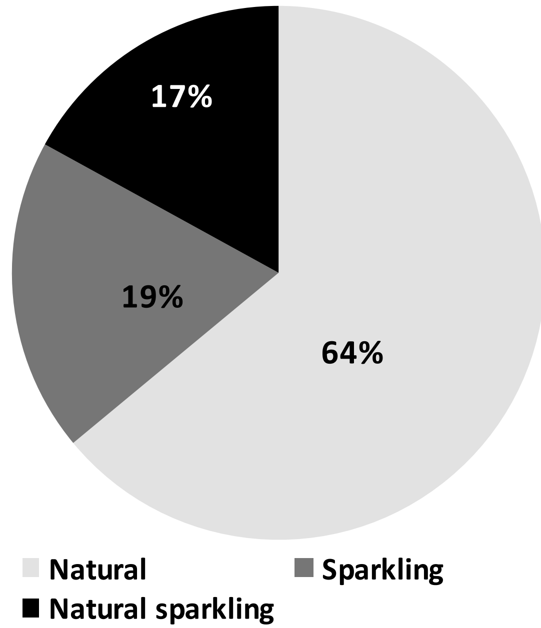

Fig. 2. Typology of mineral water demand (Source: Legambiente, 2010)

Bottled water production: the puzzle of licenses

In 2008 no less than 12.400 m litres of bottled water, commercialized in more than 300 brands by 167 bottling companies, were produced in Italy, resulting in a turnover of 2.3 billion euros. The production is highly concentrated as more than half of the output is the responsibility of four companies, i.e. S. Pellegrino/Nestle, S. Benedetto, Uliveto/ Rocchetta, Ferrarelle. As to the geographical distribution of the bottling companies, 31% are located in Central Italy (Tuscany and Marche at top-ranking), 28% in the South and Islands, the remaining in Northern Italy, with Lumbardy first on the list in Italy with

18 companies that produce 37 water brands [1].

In Italy the mineral water concession politics are lacking in uniformity. As a matter of fact every region has its own concession system, because in the national legislation there isn't any single act that could put in order this delicate matter, which is left to the regional legislative intervention instead. In fact there is only one direction document named Italian regions direction document on natural and spring mineral water matter that was deliberated in 2006 by Regions Conference.

This document, considering that «the value is given neither from the quantity nor from the quality of the water – but from the territory – with the consequence that the water taken out in one region, quality being equal, is much more onerous than in other regions, both for the firms and for the consumers»[5], fixed some parameters. Actually the regions could make a decision and deliberate on this delicate matter, to avoid very different regional situations. In fact a little ground surface, given as a concession to a company, could concern a very large hydro-geological basin, while a big area could offer moderately good water resources to bottle.

According to that there are three models for the concession fee. The first type provides that private water companies pay a fee from 1 to 2,5 € for a bottling water

Table 1. Mineral water concession fees in Italy (Source: Legambiente, 2010)

Fees definition criteria	Regions	Cost (2009)
Surface criterion (€/ha)	Basilicata, Calabria, Campania, Emilia Romagna, Friuli Venezia Giulia, Lazio, Liguria, Lombardia, Marche, Molise, Piemonte, Puglia, Sardegna, Sicilia, Umbria, Valle d'Aosta, Veneto, Trento autonomous district	minimum 5,11€ (in Liguria) maximum 587,68 (in the Veneto plain)
Pumped water (€/m³)	Abruzzo, Lazio, Sicilia, Toscana, Umbria	minimum 0,50€ (in some municipalities of Toscana) maximum 1,04€ (in Sicilia)
Bottled water (€/m³)	Basilicata, Campania, Friuli Venezia Giulia, Lazio, Lombardia, Marche, Piemonte, Valle d'Aosta, Veneto, Trento autonomous district	minimum 0,30€ (in Basilicata and in Campania) maximum 3,00 (in Veneto)
Other criteria and special measures	Abruzzo	a quota defined independently of water quantity use
	Bolzano autonomous district	a capacity quota (€ per l/s)
	Campania, Lazio, Piemonte, Toscana, Trento autonomous district, Veneto	a large discount in case of glass bottle use and/or a company makes use of "a empty to give back"

cubic meter. Another fee model considers not only the bottled water but the whole pumped water, used mostly to bottle but also in production processes. In this case the cubic meter cost is fixed from 0,5 to 2 €. The third typology doesn't calculate the water consumption, but prefers to fix the fee by giving a monetary value to the concession area. The fee should amount to 30 € per hectare at least, not less . A region can revise these parameters every two years, after an in-depth evaluation of market conditions and of the local situation.

Although the rules fixed some reference points, however they were not so strict about the monetary aspect, only a few regions reviewed entirely their legislations before the spring of 2010. Some regions apply old legislative measures; two of them still refer to an act made during the monarchic period (1927).

This confused legislative situation that so aptly is defined as «the far west of the concession fees of the mineral water» [8] allows, referring to the three fees definition criteria, the following fluctuations of the concession costs.

Now we want to resolve the jungle of the mineral water concession fees and underline the question of the not expensive costs of exploitation of a natural resource of vital importance. On average the money that in Italy the companies spend for the concessions weighs lightly on their whole production expenses. In relation to that the regions earn very little from the mineral water exploitation concessions. A general increase of concession fees should be pursued, in order to pay the "right" price for such an important common good as well as to promote more sustainable behaviour for consumers.

Bottled vs. piped water: a comparison

A comparative evaluation of bottled water and piped water can be done from different viewpoints, among which quality, price to the consumer, environmental effects are briefly outlined as follows.

Widespread advertising campaigns always present mineral bottled water as a choice of quality, thanks to its pureness and to low salt content (particularly sodium and chlorine), as is certified by renown laboratories of analysis; positive effects on health (and even on beauty) are alleged to derive from drinking mineral water. On his part, the consumer is usually prone to rely on bottled water as an allegedly necessary alternative to piped water, considered as less pure and with relatively high salt content. This is undeniably true in a number of municipalities in Italy, mainly due to the bad conditions of the water mains; but it is not the general case. Researches carried out by consumers associations in Italian cities prove that in most cases the quality of water taken from the tap ranges from acceptable to very good[2]. In any case, it should be considered that the quality of piped water is constantly monitored and controlled by the

[2] In 2010, out of the more than 8000 municipalities in Italy, around hundred of them in six Italian regions (Lombardy, Trentino-Alto Adige, Tuscany, Campania, Umbria) did not meet the European standard regarding content in arsenic in piped water; anyhow any derogation to the European parameters is no longer admitted after end-2010.
E.g., a quality assessment of water taken from fountains of drinking water in 35 Italian cities is reported in Oroblu, "Altroconsumo", October 2009, pp. 12–19. Parameters related to physical-chemical status, as well as to polluting substances (nitrates, pesticides, metals) have been monitored; as a result, only in one city (Reggio Calabria) water turned out to be very bad in quality, in two cases (Ferrara and Lecce) it was classified as poor, while in most cases (including Rome) the quality of water proved to be from high to very high.

urban water management system and it is always ensured up to the local duct.

Therefore, in most cases drinking bottled water can be basically considered a matter of taste (if any) and of subjection to advertisement rather than of quality, let alone a real need.

Regarding the price to the consumer, piped water taken from the tap costs from € 0.50 to € 1.2 per cubic meter; the average price of (the cheapest) bottled water is € 0.25–0.40 per liter, that is to say up to 600 times higher. Besides, it is interesting to look into the cost structure of bottled water. Only a slight part of the price paid for a bottle of mineral water covers the real cost for the natural resource; also the cost related to the whole process of production is not very high (it accounts for 12–15 cents per bottle), while transportation and distribution costs can charge up to 5 cents. The remaining part of the final market price is earmarked for marketing and advertising expenses and for the profit of the bottling company. As a matter of fact, only a modest part of the price paid by the consumer for a bottle of water covers real production costs.

As to environmental effects, it can firstly be argued that less than one fifth of water bottles that are sold in Italy are made of glass (Fig. 3.), the greatest part being plastic bottles, whose production, distribution and disposal have strong effects on the environment. Bottling 124 m hectoliters of water that are consumed in Italy in one year needs 365.000 tons of PET: this is produced from 690.000 tons of mineral oil (with the emission of 950.000 tons of equivalent CO2, besides SO and CO) and 7,3 m cubic meter of water (www.acquaveritas.it, www.imbrocchiamola.org).

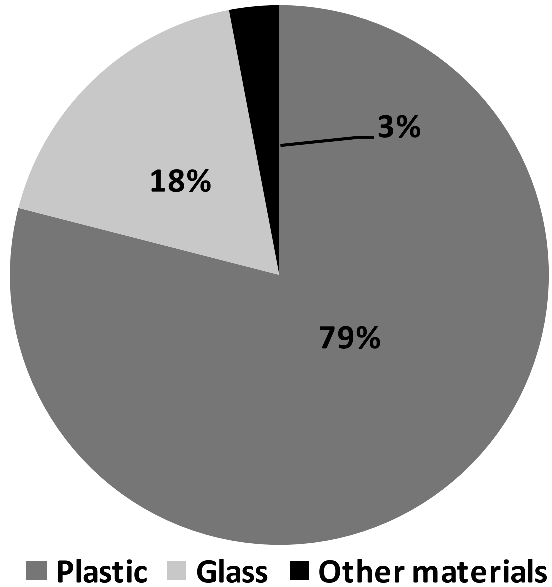

Fig. 3. Water bottles by type of material (Source: Legambiente, 2009)

Also the distribution process implies negative environmental impacts, as bottled water has to travel around Italy for hundreds of kilometers from the factory to the market. While only two out of ten bottles are transported by railway, the major part is transported by trucks, thus contributing to CO_2 and PM10 emissions that increase according to distance. Just an example: some of the most popular brands of mineral water – Ferrarelle and Lete – use to carry bottles for 700–800 km along Italy from the factory located in Caserta, Campania region, to the main market area in Milan-Turin.

Not to speak of bottled water targeted to export: about half a million of bottles are carried to the foreign market, mainly by road transportation.

Last but not least, it must be considered that just one third of used plastic bottles are collected separately, the main part taking the way of dumping grounds or incinerators. The disposal of plastic bottles, that costs in average around 1 € for 100 bottles, is usually at expense of the municipal waste disposal facilities.

On the opposite, it can be said that no one of such environmental impacts derives from piped water taken from the tap.

Conclusion

Habits regarding drinking water have multifaceted effects. From an economic viewpoint the market of bottled water in Italy supports a major sector; this is certainly useful in terms of employment, but, above all, ensures relevant profits to the bottling companies. On the other hand, only slight benefits to the regional governments derive by granting private companies abstraction licenses of a public and so precious resource. Also the environmentally negative impacts generated by the business of bottled water are mainly charged to the public side. That is to say, the profit is to the private, the cost to the public.

In the last years several campaigns in this field have been launched in Italy by environmentalist and citizens associations. Under winning logos like "Let's drink the Mayor's water", citizens are invited to drink piped urban water that is "good, safe, regularly controlled, producing no waste and available in all houses". The aim is to spread correct information about the issue of drinking water in order to promote awareness and sustainable habits among citizens, thus reducing the production of waste and of CO_2 as well as enhancing a true "culture of water".

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Aznalcollar: crisis and environmental recovery strategy chronicles

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Abstract

The Guadiamar River represents the last of the large tributaries that flows into the Guadalquivir River from its right bank and the vertebral column of the Donana National Park which it provides with an important functional connection with Sierra Morena allowing in such a way the wildlife movement. The breakage of the Boliden pond situated near the Guadiamar River and the leak of 6,000,000 m3 of toxic mud in 1998 caused one of the major environmental accidents in the history. Today, the Guadiamar surroundings are protected and have served as an example for creating the Green Corridor as a protection figure and give it new horizons that allow regenerating it as much as possible to a natural state.

Keywords: Guadiamar, Mine Accident, Green Corridor, Eco-innovation corridor

Introduction

"April 25, 1998. Early morning, 3:30 am. An anonymous phone call to the Civil Guard station in Sanlucar la Mayor raises all alarms: the tailings pond failure has just been produced at the Aznalcollar mine. This caused the biggest environmental disaster that had ever happened in Spain and one of the largest disasters in Europe. Here our story begins..." – preface to "Guadiamar: Ciencia, Tecnica y Restauracion. El accidente minero diez anos despues". [1]

The break of the pond that contained pyrite tailings of the mine (one of the major capacity tailings ponds in Spain), property of Boliden-Apirsa, that happened on the Aznalcollar municipal territory on the confluence of the Agrio and Guadiamar Rivers, "caused the spill of more than 6 million m3 of sledge and acidic water with high heavy metal concentration. It provoked an extraordinary flooding and overflow of the Agrio and Guadiamar Rivers at 63 km out of the banks, reaching more than 3 m height at some points and between 500 and 1.000 m out of the floodplains and putting

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the Donana protected area into a dangerous situation" [1]. Ten towns of the basin, at the province of Seville, were affected.

Today the quality of the river's water is much better than it was before the accident. Before the tailings pond failure Guadiamar already was a river contaminated by the mining activity. With the help of the water treatment plant of Aznalcollar all the important towns of the basin can purify their water and the food industries have improved their out of control spilling. The basin's reforestation has been carried in different vegetation models in accordance with the nature being considered as a start of a natural recolonisation process.

Significant signs of the wildlife recovery appeared and the basin was declared as an ecology not existing before the corridor between Donana and Sierra Morena. After all the taken and still pending measures the Guadiamar River came back to life.

The First Large-Scale Project in the Eco-Innovation in Europe

The environmental recovery process of the Guadiamar Basin affected by the mine's spill can undoubtedly be considered the first eco-innovative venture in Spain and in Europe because of the mobilization of the used economic resources as well as the successful and effective combination of science, techniques and public management. The events happened in Aznalcollar represent an example of efforts made by the community in order to convert environmentally destructive situation, as in another case it could be the climate change, into reversible. So in 2008 the exposition called "Guadiamar: Ciencia, Tecnica y Restauracion; el accidente minero 10 anos despues" (Guadiamar: Science, Techniques and Restoration; the mining accident 10 years later) was organized and opened to the public by the Superior Council of Scientific Research. Besides, this exposition inspired an excellent text coordinated by Hector Garrido [1].

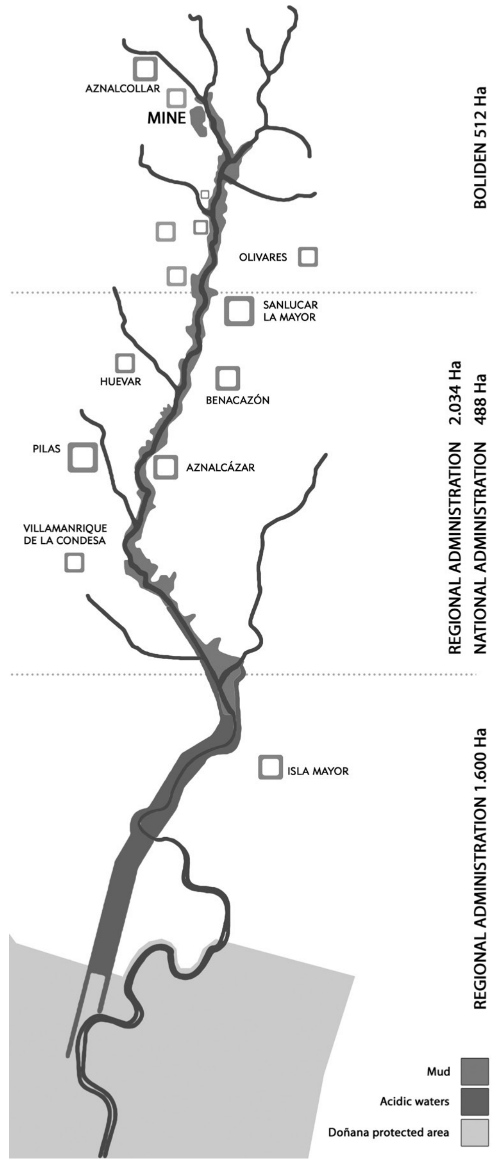

Fig. 1. Sectoring of the Guadiamar River and its lower part affected by the spill in order to undertake cleaning measures. Source: Martinez, F. et al. (2003) [2]

Along with the mission of achievement of the total environmental recovery a restructuring strategy of the productive base of Aznalcollar was designed by the Andalusia Council. The Environmental Activities Park of Andalusia (Parque de Actividades Medioambientales de Andalucia, PAMA) served as a support to the productive mutation from the mining activity to the series of other absolutely different activities based on the sustainability as well as on the microcluster generation as to the recycling technologies. At the same time the technological frontier activities in the field of solar energy are appearing with all their strength. This represents a message to the historical origins of Sanlucar la Mayor which roman name, Lucus Solis, literary means "the forest of the sun".

There is no comparison to a productive mutation process so fast and intensive in the recent economic history of Andalusia (except the early planting agriculture in Almeria). The achievement of changes and its future potentials are so significant that it is reasonable to move the concept of the Green Corridor that was developed during the process of making reversible a natural disaster to the productive sphere [3], such as the Technological Corridor which marks the emergency of all the activities complex related to the eco-innovation.

Unsurpassed Scientific-Technological Effort

In front of a problem with apparently no solution all the scientific and technological potential of the country started working intensively having all the range of means and the unsurpassed in Spain coordination level.

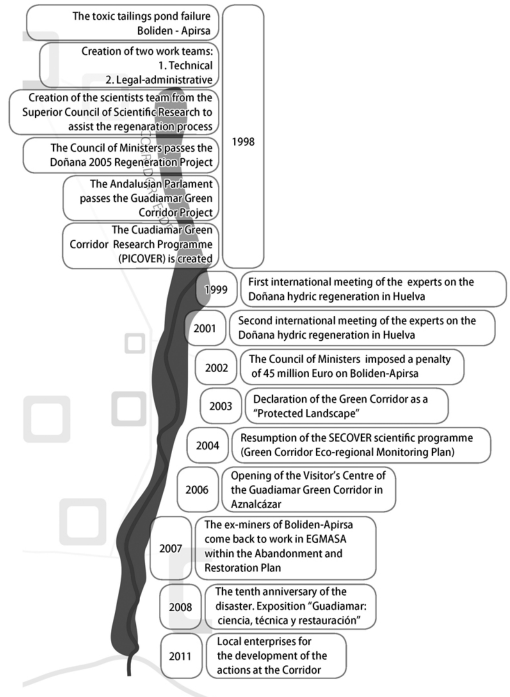

Fig. 2. Chronicle. Source: H. Garrido et al. (2008) [1] and own elaboration

After having completed the first urgent tasks of sludge collecting and water cleaning, in which planning engineers from the Guadalquivir Hydrographical Confederation and scientists from the Superior Council of Scientific Research (CSIC) and different universities of Andalusia cooperated, it was evident that it was necessary to intensify the cooperation of the scientific-technical community. So the research works started and lead to what is known today as the Guadiamar Green Corridor [1 GARRIDO 2008]. First, it was done within the Guadiamar Green Corridor Research Programme (PICOVER, Programa de Investigacion del Corredor Verde del Guadiamar), one of the most important active multidisciplinary research programmes in Spain, incorporating engineering and geotechniques, soil treat-ment and recovery, water treatment, chemistry, biology and ecology, hydrology and mechanisms for the environmental parameters control [4].

In fact, different spin-offs appeared from such a concentration of the technical knowledge as that of the Guadiamar recovery, in such fields as metal characterizing or the edaphological analysis. Being controlled by the Green Corridor Office the Green Corridor Eco-regional Monitoring Plan (SECOVER, Seguimiento Ecorregional del Corredor Verde) was created [5]. There the social-economic dimensions were incorporated and new and more effective forms of citizens' participation were introduced.

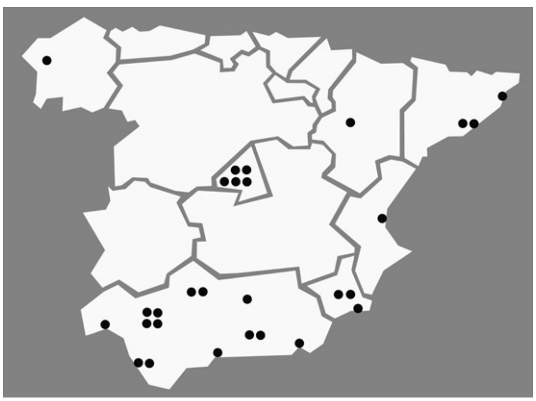

Fig. 3. Centres that took part in the Guadiamar Green Corridor Research Programme [4]

The water as the territory restructurer and the local agents as activators

The European Landscape Convention (ELC) signed in Florence in 2000 considers the landscape as an integrating concept of the relationship between human beings and the nature, a functional concept for a new evaluation on what is known as the life quality. The especially significant landscapes require protection, organization and integrated management as it happens in this case.

The Guadiamar Green Corridor is not just a protected landscape but it is also the connecting element between two symbolic natural spaces of the South of Spain: the Donana natural space on the south (more than 100,000 ha of dunes and marshland, the biosphere reservation) and the Aracena and Picos de Aroche natural park on the north. The axis/ axle of Aznalcollar-Sanlucar la Mayor is basically composed by five categories of environmental and territorial protection some of which are superimposed. Besides providing an area for enjoying free time in the natural environment, the Guadiamar Green Corridor serves as an ecological corridor for the wildlife movement between the protected spaces of Sierra Morena and Donana. Finally, this space's aim is also to guarantee the quality of the water supply in the Donana marshland and the Guadalquivir estuary.

Within the metropolitan context the corridor represents a space for living getting more and more elements of excellence. Among these elements there are the Solar Technology Interpretation Centre (Centro de Interpretacion de las Tecnologias Solares (CITES)), the Guadiamar Green Corridor Interpretation Centre, the centre of attention for visitors to Casa Quemada and the Over Limit active leisure centre. According to the represented local actions there are to mention the Eco-Albergue projects and Las Doblas Environmental Education Centre as the initiatives of this natural space activation.

The Solar Technology Interpretation Centre (from Spanish, CITES) is a popularization facility aligned with the Guadiamar Corridor new productive specialization on the renewable energy. The CITES activity is oriented in two directions: technical-popular segment aimed at schools and education centers, such associations as families and individuals, entrepreneurs

Fig. 4. Albergue Encinares near the Guadiamar Green Corridor

and companies, technology and innovation centers and other institutions related to the solar energy.

Besides, the Project of the Guadiamar Green Corridor Interpretation Centre is promoted in Aznalcollar as the process popularization facility that examines the area regarding the sustainability and the eco-innovation technologies. This facility has a double vision: on one hand, it is aimed at informing about the strong productive mutation experienced by the area and, on the other hand, the Centre is represented as "office of control and information for the visitors".

Abengoa Solar develops the Cortijo Casa Quemada rehabilitation project together with a Solucar platform as a centre of attention for visitors to Casa Quemada. The aim is to manage as well as possible the current and previewed flow of visitors (from schoolchildren to technologists or public managers from all over the world) as each time there is more people interested in technological and industrial tourism.

Over Limit Aventura camp has facilities for practicing paint ball, archery, rock climbing, rappelling, bungee jumping, orientation games, canoeing, mountain bike, balloon walk, quads, 4×4 hiking, survival games or just carriage walks – all this is a part from the rural accommodation.

As for the field of the initiatives of the local agents not belonging to the public administration, one of the main projects that were promoted by the NGO is creating the Eco-Albergue Encinares near the Guadiamar Green Corridor. This will provide young hostellers in groups or individually with the permanent accommodation. This is focused at all the sectors of the population, at all ages. The idea is to connect it to the European Hostels Network responding to the existing among of young people demand of cheap accommodation. On the other hand, it will offer such special services as laboratories, exposition and event halls renting, group and individual accommodation to companies, researchers, etc. This project supposes an important activation mechanism of the river surroundings.

Another main local initiative of this body is creating Las Doblas Environmental Education Centre. It will strengthen the functionality of the Green Corridor on the section corresponding to Sanlucar la Mayor reinforcing the public utility and creating protected spaces for the wildlife. In the centre such activities as courses, seminars, conferences, workshops related to the environment take place. This environmental education means knowledge and environmental values transmitting that make adopt positive attitudes towards the natural and social environment that are reflected in the actions of respect and care towards the biological and cultural biodiversity and that encourage the solidarity, the cooperation and the sustainable development. In such a way, the centre will offer support to participation and investigation processes in the field of environment. The existing constructions will be adopted and there will be used the renewable energy. The project consists of the Visitor Centre, Information Points, Viewpoints, Wildlife Observatories, Paths with Signposts and Nature Classrooms.

This project will benefit by the general population, education centers (teachers, monitoring students, etc.), local authorities (with support to their different environmental activities), researchers (providing special areas for observing and investigating the bird migrations, the richness of the botanical diversity, etc.)

Fig. 5. Las Doblas Environmental Education Centre

Conclusions

During some period of time we have been witnessing a so-called divorce between the economy and the ecology. The values of the natural resources presented by the physiocrats of the 18th century were forgotten. In order to prove the original interest towards the physical resources and their relation with the economical activities the classic work of Adam Smith published in 1776 and entitled "An Inquiry into the Nature and Causes of the Wealth of Nations" [6] is also to be mentioned. There have been recently some thoughts about the idea of recovering the natural resources within the current capitalistic economical context. However, in many cases there can be found only a banal ecological vocabulary connected with the green politics: everything is eco-friendly and everything is sustainable [7].

The case briefly presented here corresponds totally to the great part of the explained in the previous paragraph. The Guadiamar River was not respected as it deserved and, as a consequence, it produced an almost irreversible disaster in many aspects. However, this natural catastrophe has served for starting to value the Guadiamar new potentials through the original and interesting initiatives explained in this work.

Finally, further on the public administration, the role of the local agents is to be emphasized. Their initiative is fundamental for creating projects that add value, protect and unite the territory.

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A river basin GIS: from landscape analysis to a new framework for Ledra river (North-eastern Italy)

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Abstract

Ledra River is a Tagliamento left feeder that rises by a composite system of water resurgences to the north east of Friuli. The river basin is a particular area where water is strongly related with both naturals and anthropic aspects. It involves eight municipalities. Looking also at the "water frame directive" (2000/60/EU) in 2007 these authorities created an experimental advisory body with the aim of monitoring, studying and homogenizing the management of the river: the "Consulta del fiume Ledra". Looking at the landscape as an indicator of sustainable development, knowledge of landscape becomes an important topic for the Consulta. But the landscape legislative situation of the basin is very complicated because of the large number of actors working in the area [1]. To simplify the situation we use the software Map Info to create two databases: a hydrographical one and a database of protected areas. With the support of this database we work in particular on the modification of the buffer zone limits and a homogenization of the different municipalities rules with the landscape regulation. This work highlights the fragmented landscape management of the river basin and the necessity of a functional reorganization to preserve the river's values considering it both from a hydrographical and ecological point of view.

Keywords: landscape, river basin, water management

Introduction

Water is beyond a shadow of a doubt our most important resource, representing the basis of life. The management of a river basin is a complex due because the basins were once split among different administrative areas. Recently the UE spread a directive [2] in order to organize this pattern, but the harmonization with the local administrative levels is hard to obtain. May the utilization of GIS instruments help achieve this hard work? I would like to present a local sample so as to show the places where the GIS analysis could be useful not only for studying the area but also to harmonize the actual law.

Ledra River is the last left big feeder of Tagliamento, the main river of the Friuli Venezia Giulia region, in north east of Italy. The river basin (101 km^2) is located in the north of the Friuli region, surrounded by the

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Prealps to the north and the morainic ridge line to the south. The largest and lowest part of the basin actually called "Campo of Gemona-Osoppo" was once a glacial lake. It was then filled-up by Tagliamento tributaries' sediments, but water is still there. Now the impermeable soil of morainic hills cause the emersion of Tagliamento underground water: these springs create the Ledra River. Due to the fact that Ledra River basin is one of the most rainy places in Italy (average 2800 mm/year), this area is very rich in rainwater and so water comes also for Ledra from two mountain streams: Orvenco and Vegliato [3]. Thanks to a drawing system, Ledra River basin gives fresh water and irrigation water (Ledra channel) to all of the northern parts of the region. This is the reason why Ledra water is a very important resource. At the same time, Ledra River basin counts the highest density of population and the strongest human impact of Tagliamento catchment area. In the basin there is also one of the biggest industrial zones of the region [4]. These two elements cause pollution problems.

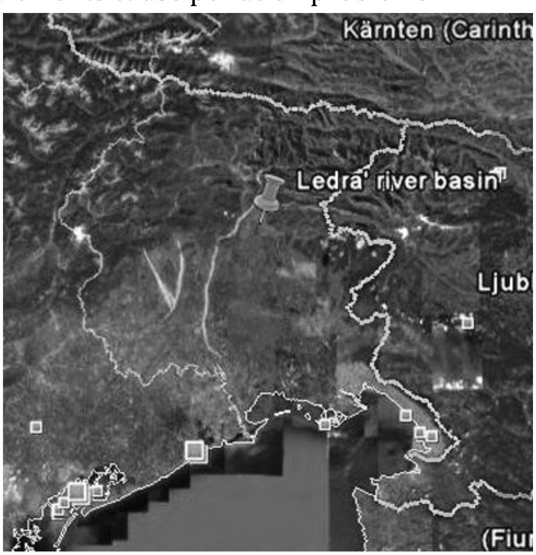

Fig. 1. Ledra River basin (from Google maps)

The "Consulta" of river basin

The management of the area would turn out to be very difficult if one keeps into account that it involves eight municipalities. In 2007 these municipalities, looking at water frame directive [2], created an advisory body: "The Consulta di bacino del fiume Ledra", with the aim of studying, monitoring and managing the river basin. This project about a voluntary aggregation of the municipalities through which the river flows, also involves other stakeholders. In fact it is composed by a scientific committee involving some experts from the Universities of Udine and Trieste and a political committee that involves some local politicians. Looking at the landscape as an indicator of sustainable development [5], it becomes an important topic for the Consulta. In 2008–2009 I created a GIS system of the whole river basin including different information for my graduation thesis. The most useful ones were: a hydrographic database, a landscape mosaic and levels about landscape management. Through this data I could analyze the problems of internal and external coherence of the whole river basin.

The actual rivers regulation in Italy

In a second charge for the Consulta, in 2010, I tried to implement these analyses by creating a new framework for the closest areas to the river (less than 150 km for each side of the river).

The actual regulation in these areas is mainly composed by two different rules:

- RD 25/07/1904 n. 523, "Polizia delle acque pubbliche" that concerns the maintenance of quantity and quality of water resources but also has great influences on landscape. It must be applied to all hydrographic elements (4 and 10 meters from each side of the river) [6].

- „Codice dei Beni culturali” [7, 8]: related to the protection of the river landscapes (150 m from each side). Applied only to hydrographic elements included in the “Registro delle acque pubbliche” [9].

Thus, we have to consider two different areas with different rules in each municipality. In fact not all the hydrographic elements are included in the protection. On Fig. 2. you can see the overlap of the buffer zone considering only the elements included in the register and the one considering the hydrographic database realized by the use of GIS in the previous study. Dotted areas are those that are excluded from the protection. In this situation, the rules come mainly from the municipalities’ regulatory plans, so we have different situations in each municipality.

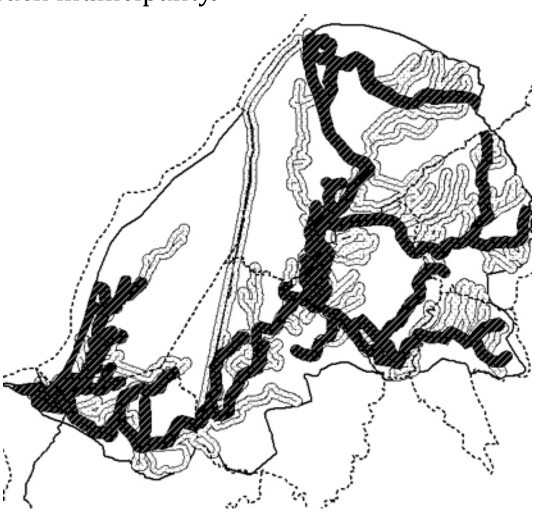

Fig. 2. Comparison between the actual buffer zone (hyphenated black) and the areas that are excluded from the protection (dotted white) inside Ledra River basin (black line) splitted into the different municipalities (hyphened line)

Fig. 3. Aerial photography from “Virtual earth” with overlap some of the elements related with landscape management: strong line = hydrography, gridded areas = permanent pasture, hyphened area = actual Buffer zone, hyphened line = limits of the buffer zone considering new database

Another problem is the delimitation of the buffer zone of the 150 m. The limits have no coherence with other elements of landscape protection like stable pasture while the regional law, 29. April 2005, n°9 obliged to make an inventory of stable pasture of the region to preserve the local biologic diversity [10]. They also split other signs in landscape like roads, agricultural units and vegetation (Fig. 3.), that could be considered like a possible landscape screen.

The new regulation project

The situation looks very complicated. The main purpose of my work was a harmonization on three levels:

1. Included elements
2. Law of different Municipalities
3. Buffer zone delimitation

Included elements

The first step was the updating of the hydrographic elements using the new hydrographic database and field inspection. The principal variation was, according to WFD, the inclusion of artificial elements, like Ledra channel.

Law of the different Municipalities

The rules from the municipalities' regulatory plans (PRGC) were compared with a scheme. Then with a critical synthesis were linked to obtain a unique rule.

Fig. 4. Final situation after the harmonization of the limits (aerial photo from Google Maps), strong line = hydrography, hyphened area = new buffer zone

Buffer zone delimitation

The limits were reshaped in GIS world considering and including:

1. PRGC division
2. Agricultural units
3. Roads and railway
4. Vegetation
5. Other natural and anthropic elements

After a control of the evidence by direct inspection of the whole river basin there was a definitive reshaping of the limits in GIS world.

Procedure

The product was submitted first to the scientific committee of the Consulta to have suggestions from different technical points of view and then to the local politicians to obtain the passage.

Conclusion

With this work we verify the possibility of using the GIS applications to simplify and harmonize the landscape management of the rivers. We also give coherence at the actual regulation with Water Frame Directive and European Landscape Convention.

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Private or public water management: the Irisacqua case study

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Abstract

The paper deals with the very important and crucial issue, at least in Italy, about the water services management. The recent legislative measure, in November 2009, produced a lively debate at the political level and in the public opinion. The act application could threat the principle of the drinking water public management and so it seems a conclusive step to the water management privatization process. The Irisacqua experience, a wholly publicly owned company that manage the integrated water system in the Goritian district, in Friuli Venezia Giulia region (North-East of Italy), exemplifies an enough efficient water managing reality that could be strongly reorganized or forced to disappear.

Keywords: water management, water services legislation, Irisacqua

Water: a common good

The recent promulgation in Italy of the public services management decree (Act No. 166, November 2009) emphasizes the delicate question about public or private water system management. After this legislative measure, Italians organised some movements to prevent that this decree would be put in practice. The main questions are: Is the public service better than the private or the opposite? Is it a realistic belief that a private management could be more efficient, both from the administrative point of view and the reduction of water losses?

In the last years the main international organisations have recognized the water resource as a common good, for this reason everybody must benefit from it. All the world citizens should have the opportunity to use at least 40/50 litres of drinking water every day. So which management, private or public, can assure a real respect of water as a common good? Which of them can grant the drinking water admittance to all social strata, included the low income households, considering a proportionate differentiation of the water rates?

The Act No. 166 provides the gradual dissolution of the public water management.

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Table 1. Water services: a look at the Italian and Friuli Venezia Giulia regional legislation

Legislative measure	Main characteristics
until 1994	The political responsibility and the management were entrusted to the municipalities, through municipal companies or consortia of several municipalities.
Act No. 142, 1990 – Local autonomies system	It ratifies the possibility, for the municipalities, to create special public companies, joint-stock companies, to manage the services.
Act No. 36, January 1994 - Rules on Water Resources	Every region has to identify the Optimal Territorial Areas (ATO). Establishment of the ATO Authority (AATO) that plans organizes and controls. Development of a framework plan for the management of water services. The possible legal forms to manage the water services are: wholly public control, joint ventures or wholly private. Application of the principle of Integrated Water System: unified management of drinking water distribution, sanitation and sewage. Introduction to the principle that the water is an economic good.
Water Framework Directive (2000/60/EC)	Introduction to the principle “Full cost recovery”. It imposes that the invested capital has to be rewarded through the charges, for all water uses.
Legislative Decree No. 267, Aug. 2000 – Text of the laws on local boards	It defined the fundamental rules, concerning the associated exercise of functions and strategic value services. In particular, they indicate which are the possible forms of management and the methods of charging.
Regional Act No. 13, July 2005 - Organisation of integrated water and identification of ATO	Friuli V.G., last in Italy, adopts the national legislation (1994), as required. Identification of four areas that reproduces exactly the political-administrative division (the districts in the region are four). In the Friuli V.G. region only the ATO Authority of Gorizia area had established itself fast enough and by that date they were preparing the area Plan.
Legislative Decree No. 152, April 2006 - Environmental Regulations	It reiterates the existing legislation: - specifying the characteristics of the Integrated Water System; - underlining the fundamental role of the ATO Authority; - clarifying the management forms and procedures for entrusting the management of water (Art. No. 150). This legislative measure means that the water management is changed. It starts the progressive annulment of the in house administration modality.
Act No. 166, November 2009 – Urgent measures for the implementation of Community obligations ...	The provision of water services management concerns: - groups and private companies, through competitive procedures; - joint ventures, public and private, with a private sharing of not less than 40%; - in house, entirely public, only in special cases.
Referendum campaign (from 24th April to 4th July 2010)	Three questions: - to attempt to stop the privatization of water; - to promote forms of public control and management of water services; - to prevent anyone from making profit on water.
Referendum institutional course	Only two of the three petitions have been accepted by the Constitutional Court, the first and the third.
Act No. 42, March 2010 – Urgent measures regarding municipalities and regions	It provides for the Optimal Territorial Areas (ATO) suppression and to transfer its competences to the political district. This measure decides to abolish the ATO, a public body, even if it actually at last could become operative.

Why do we have to dissolve in house companies even if they are a good example to follow? As a matter of fact in Italy there are several in house companies, entirely public, controlled by municipalities and which work only in their own territorial jurisdictions.

Now we think it right to present a brief resume of national and regional legislation about water management (Table 1.) in order to set a background scheme, useful to deal with our case study.

Irisacqua: case study

We have pointed out above that Friuli Venezia Giulia region has been divided in four Optimal Territorial Areas (ATO), each ATO corresponding to one district of the region. In particular the Eastern Goritian ATO (ORGO) was founded in 1999.

Fig. 1. ATO Gorizia district

Several reasons concurred in the choice of the Goritian management of the integrated water system as a case study. The principle motive is its efficiency, not only in the service that Irisacqua Ltd offers but also in the fast adaptation to the regional act of 2005. Somehow it is like the Irisacqua Company had anticipated the act and at the beginning of 2006 it was ready to undertake its work.

Table 2. Irisacqua data [2]

Users data	
Gorizia district population	181.000
of which residents	142.500 (83%)
Domestic users	51.500
Not domestic users	8.100
Population served by drinking water system	177.500 (98%)
Technical data	
Water reservoir age	37 year on average
Drinking water network age	30 year on average
Sewer line system age	43 year on average
Waste water treatment plant	26 year on average
Water availability per capita	480 l/pop/year
Drinking water network efficiency (delivered water/supplied water)	50,3% 50,3%
Drinkableness tests	> 250 per year

The water service of the district of Gorizia is managed by a single operator since 2003 (Table 2.). That year the three municipal multi-utility companies that had attended this service until then (together with gas and electric energy services), merged thus creating the joint stock Company IRIS. The mono-utility Irisacqua Ltd was founded on 29th December 2005 in Gorizia in order to respect the legislation and to be recognized as an in house operator. Irisacqua is a non-profit public company that joins all the 25 municipalities of the Goritian district (including Grado, which had until 2006 his own traditionally accepted municipal management, due to its particular condition of seaside resort).

Fig. 2-3. Details of Water pumping Mt. Calvario Gorizia station and Waste water treatment plant of Bistrigna (Staranzano) (Source: Irisacqua Ltd)

Water management policies

According to the Act No. 36 of 5 January 1994, and the Friuli Venezia Giulia regional act no. 13 of 23 June 2005, the "Eastern Goritian" AATO and Irisacqua Ltd stipulated a contract that granted the company the management of the integrated water service of the district for a 30 year period, beginning from 1st January 2006. Thus Irisacqua Ltd took over the duty to carry out the tasks included in the area Plan. The priority among the works to do was established by the ATO Authority: first of all they needed to extend the sewer connections from the 70% to the 95%. Secondly they had to conform to the waste water treatment plants that did not respect the standards since the approval of the legislative decree 101/99 which contained dispositions about the water conservation.

For what concerns the aqueducts, Irisacqua Ltd has to face two main problems, partly connected. Firstly, the company has to substitute the fibro-cement pipes which are very fragile and risks to leak water and increase the losses of the water system. As a matter of fact, according to the Legambiente data of 2008, the department of Gorizia has got one of the higher percentages of losses of water (that is the difference percent between the water supplied and the water used for residential, commercial or other authorized purposes). In order to understand the reasons of these data, we have to point out some technical data presented in the Table 2. In particular, we can note the old age of the water reservoir, the drinking water network, the sewer line system and the waste water treatment plant. Since the abundance of water and its high quality (and the consequent low level of treatments needed to make it drinkable) the water losses are considered an ethical more than an economic problem (the economic loss is of 5 cent/m^3).

As established in the area Plan, the price of the service is fixed by the ATO Authority, with the particular intention of supporting low consumption and discouraging the waste of water. A brief analysis of the different tariffs presented in the Table 3. could help us to explain how this strategy is carried on. The main distinction is made between standard (up to 180 m^3/year) and high consumption (over 180 m^3/year). Both categories present the same fixed rate but vary for the cost of each liter consumed. The users are divided in different categories: families up to 4 members, large families (over 4 members), domestic use subsidized, non-resident users, different uses, public

Table 3. Differentiation of drinking water rates [2]

Standard consumption	Irisacqua (consumption)	Irisacqua (fixed share)	Irisacqua (100 mc)
Family up to 4 components (from 73 to 180 mc/year)	0,542	45,37	99,57
Large family (more than 5 components) (from 73 to 180 mc/year)	0,542	45,37	99,57
Domestic use subsidized (from 73 to 180 mc/year)	0,433	4,54	47,84
Non-resident users (from 73 to 180 mc/year)	0,542	68,05	122,25
Different uses (up to 180 mc/year)	0,813	45,37	126,67
Public uses (up to 180 mc/year)	0,542	45,37	99,57
Big users (more than 5.000 mc/year)	0,795	1134,23	
High consumption	Irisacqua (consumption)	Irisacqua (fixed share)	Irisacqua (300 mc)
Family up to 4 components (over 180 mc/year)	1,355	45,37	451,87
Large family (more than 5 components) (over 180 mc/year)	0,813	45,37	289,27
Domestic use subsidized (over 180 mc/year)	1,084	4,54	329,74
Non-resident users (over 180 mc/year)	1,355	68,05	474,55
Different uses (over 180 mc/year)	2,439	45,37	777,07
Public uses (over 180 mc/year)	1,355	45,37	451,87

uses. For what concerns the standard consumption, we can note that the tariff for the families, the non-residents and public uses is the same but non-residents have to pay a higher fixed share. Domestic use subsidized is characterized by a reasonable fixed share and of the lowest cost of consumption. The high consumption of course is more expensive but there are interesting changes in the tariffs. Large families pay a cheap tariff while in this case the domestic use subsidized is penalized. In both cases the tariffs for different uses are the most expensive (Fig. 4-5.). Finally there is the category of big users, those who consume more than 5000 mc/year: they have to pay a high fixed share but the tariff for the consumption is lower than all the

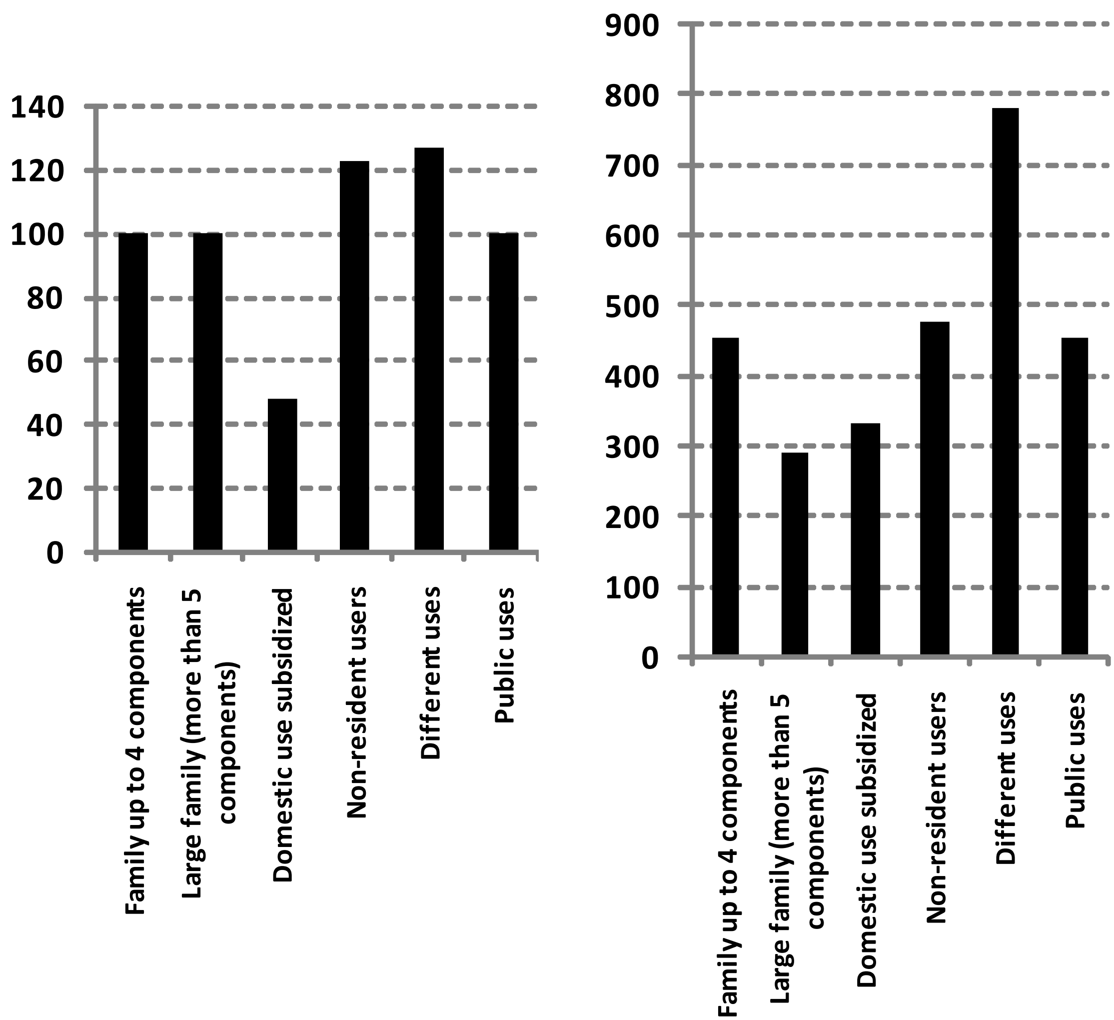

Fig. 5. Irisacqua: prices (€) for 100 mc and 300 mc per year (Source: Irisacqua data)

tariffs for high consumption. It is necessary to remember that the natural wear of the water-meters year after year causes the underestimation of water consumption of about 12%. However Irisacqua has promoted a campaign for the sensitization to the importance of water saving.

The conduct of the company and the results achieved till now allows considering Irisacqua Ltd a model of "progressive" public management of water. As a matter of fact, it respects most of the universal principles of "Water as a common good", that we are going to analyze. The attention for people is expressed on different levels. First of all Irisacqua grants everybody the admittance to the water service, not excluding the low income households. It is obvious that the customers are the main focus of attention: for this reason the company is ready to satisfy its clients' needs, granting a good water quality, established by frequent controls and by ICIM 9001 and IQNet certifications and in general promoting the transparency in the conduct. Moreover Irisacqua takes care of its staff's health (e.g. examining noise and electromagnetic risks). The company is engaged in project of international co-operation like those of sustainable water management in countries where water lacks (e.g. in Burkina and Bosnia-Herzegovina). From this we can note that the care of the environment is as important as the care of people and is realized respecting the Kyoto Protocol, getting rid of asbestos, preventing noise pollution and involving the clients in limiting the waste of water.

To conclude it is necessary to explain what would happen to in house companies like Irisacqua if the Act No. 42 came into force. The legislation admits the existence of in house companies but imposes on them the necessity of restarting their activity according to the disposition of the act. In this way Irisacqua would lose all the advantages that it had acquired since its foundation.

Irisacqua activity evaluation

We think we can resume the main distinctive features of Irisacqua water policy resorting to a Swot analysis. So into strong points we can enumerate with priority the awareness of the importance of the efficient and careful public water management of a common good. Moreover, another important factor to think of positively is a steady investment policy to reduce the water distribution network leaks, to increase the sewer system and to renew the waste water treatment plants, planning the construction of only four plants (but bigger than the present ones). Another very interesting point, especially for its ethical value, is the decision to diversify the water rates to reach two aims: to help indigents and to repay for low consumption, at the same time deterring from the waste of water.

About the opportunities, the main interventions that the Irisacqua company could intensify and plan with more accuracy are the educational campaign on the water uses, addressed to citizens and to schools, and the promoting projects of international co-operation on water aspects. Also the studies on the whole water management system to promote sustainable policies, for instance to recycle the purified waste water (now only 0,07%), must be more significant and probably they must require further projecting and financial engagements.

Obviously there are also some weak points which draw the Goritian situation to another national water structures and water management systems. So the water distribution network in the district of Gorizia is very old, 30 years on average, and inefficient, with 51% of water losses. It's important to remember that the 12% of the district population is without sewage-linking system and also the waste water treatment plants are small and in bad conditions.

At last we would underline some threats that could make not easy the Irisacqua water policy. First, it is not to forget the agricultural negative impacts on the water quality, considering the dangerous and prejudicial to the health chemical products infiltrations. These products are used in particular in the plane lands of the district. We have to add into the threats also the unsustainable water management system that involve a high use of a good quality water in order to satisfy the raising water demand. Finally, we name the risk relating to the new national act about "privatisation" of water service management. It could put in crisis the present best practises that the "Eastern Goritian" AATO and Irisacqua are promoting in favour of the Goritian district population and economic activities.

Conclusions

The Irisacqua case study, on which we have lingered, is only a significant example, in its complex, of a positive water management modality, even if the critical aspects aren't absent. This and other realities of water companies that operate on the national territory, characterized by the fact that are wholly publicly owned, run the risk of disappear, so giving the private market the opportunity to expand. This situation would have not a negative value if it didn't involve the threats, due to the violent entrance of the "at all costs" profit logic that the privatization has.

It's necessary for the water resources to be considered and emphasized indeed « [...] as a public common good and as a public service not commercial, against the today's trend to the water commercial speculation» [3].

[1] Both authors worked together on the research. Lara Burigo specifically wrote the paragraphs Irisacqua: case study, Water management policies. Andrea Guaran wrote the remaining paragraphs.

[2] All the data (2008) are found on the Irisacqua documents.

[3] Comitato Italiano per il Contratto Mondiale sull'acqua (edited by), Manifesto italiano per un governo pubblico dell'acqua, Milano, 2005, p. 9.

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The regime of Harmas-Koros River between 1907–2006

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Abstract

Before the river regulations and the drainage of the marshland the decisive part of the Hungarian Plain was a real water world. With the river regulations, 459 kilometres from the Koros Rivers have been cut away. The width of the active floodplain turned to be very narrow: with a fence of parallel barrages 150 thousand hectares active floodplain was trimmed to 11,500 hectares. The flood risk (spring, summer) hasn't been stopped so far nowadays it is still threatening the settlements. During high water or flood, the rivers carry multiple amount of water comparing to their medium water amount [1]. During my explorations I analysed the changes of the low and the high water level with mathematical methods on two water stations by Harmas-Koros – Kunszentmarton, Gyoma – looking through over a 100 years time interval (1907–2006). I would like to find answers, which have been the most often low and high water level periods in the last 100 years at the water station Gyoma and Kunszentmarton.

Keywords: river, low water level, high water level

Introduction

Hungary has lot of surface water, but important part of these take its source out of national borders. This country and the studied area is located one of the deepest part of Carpathian Basin, extensive areas of the territory of Hungary are highly exposed to flood hazard. Majority of river discharge is collected by runoff from the mountain ranges (the Alps, Carpathians) encircling the steadily subsiding Hungarian plains. Danube and Drava have transported the three-quarters of surface water, the fourth quarter have carried by Tisza which catchment's area is the half part of Hungary. Koros Rivers (it means Fekete-, Feher-, Kettos-, Sebes-, Harmas-Koros) is belonging to Tisza River drainage basin that is the second main watercourse in the country (Fig. 1.). The Koros catchment's area is 27,537 km^2 but 53% is in Romania, just 47% in Hungary.

Since the second part of 19th century (1886), in Hungary, there has been measured systematically the day-water level of all meaningful river on the water stations. The data have published in the Hydrographical Yearbook annually. The water level report was necessary because of the floods estimate, the flood control,

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the water traffic and the opportunity of the water energy. The zero point – from the real water level is measured – is not in the riverbed. In this case, it could happen, on summertime, under a long dry period subside the water levels below zero.

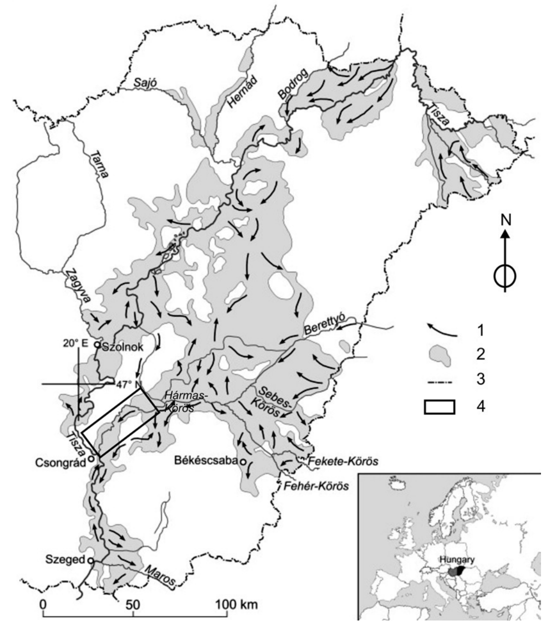

Fig. 1. Waterlogged areas in the Tisza valley before the water regulation [2] 1 = outlet of water from the river channel and direction of currents; 2= inundated areas; 3 = national border; 4= studied area

Methods

Low and a high water level database were made for the time interval between 1907 and 2006 with two water stations, in case of analyzing the regime of Harmas-Koros River. By the side of Kunszentmarton (46°84'N and 20°27'E, the water station zero point = 76,13 m Baltic Sea) since 1859, by the side of Gyoma (46°94'N and 20°84', the water station zero point = 78,66 m Baltic Sea) since 1873 have collected hydrographical data. The water station chose zero point before the river control, after the low water level of 1855 [3], but it was changed in 1888.

Conclusions

The low water level happened in wintertime (57%) in Gyoma (first water station). In the research-period was the low water level −116 cm on 3rd August 1930. In 100 years period only 12 times were above zero (1965, 1966, 1977, 1981, 1988, 1992, 1996, 1998, 1999, 2002, 2004, 2005), based on the annual lowest water level (Fig. 2.).

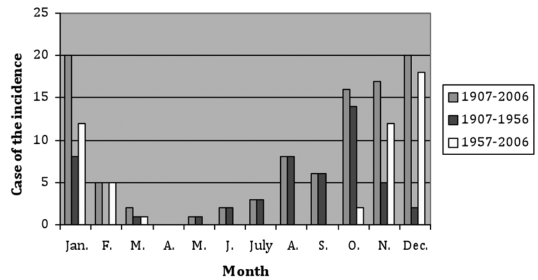

Fig. 2. Monthly evolution of low water level in Gyoma (1907–2006) (From data of Hydrographical Yearbook, edited by Babak K. 2009)

The high water level had happened the first five month of the year (Fig. 3.). The smallest high water level was 365 cm on 9th of July 1990; the biggest high water level was 918 cm on 14th of June, 1970. The biggest difference in a year was 943 cm in 1919.

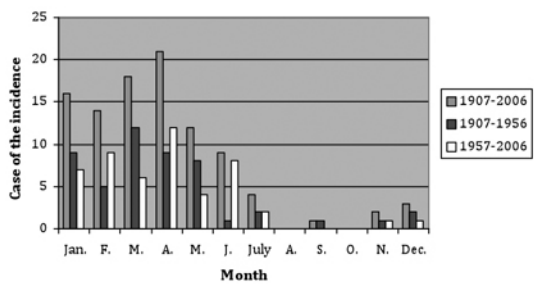

Fig. 3. Monthly evolution of high water level in Gyoma (1907–2006) (From data of Hydrographical Yearbook, edited by Babak K. 2009)

We were researched the high water level after the flood prevention preparedness too. In 100 years period, 30 times were below 550 cm and 5 times were above 850 cm, based on the annual highest water level (Fig. 4.).

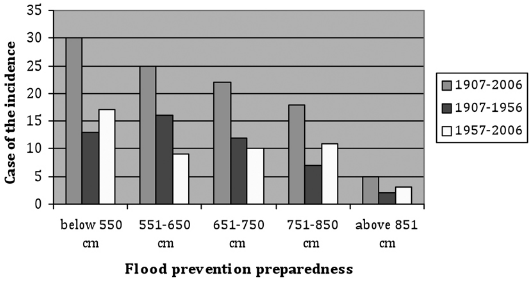

Fig. 4. The high water levels after flood prevention preparedness in monthly evolution in Gyoma (1907–2006) (From data of Hydrographical Yearbook, edited by Babak K. 2009)

In Kunszentmarton (second water station) the low water level happened many times in wintertime (69%). In the research-period was the low water level −240 cm on 24th of August 1946 (Fig. 5.). In 100 years period, only 4 times were above zero (1913, 1915, 1943, 1948). The high water levels happened in January, March, April, May (Fig. 6.).

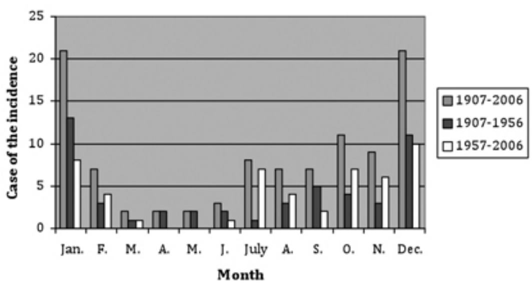

Fig. 5. Monthly evolution of low water level in Kunszentmarton (1907–2006) (From data of Hydrographical Yearbook, edited by Babak K. 2009)

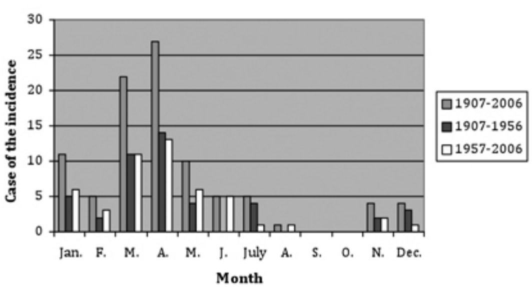

Fig. 6. Monthly evolution of high water level in Kunszentmarton (1907–2006) (From data of Hydrographical Yearbook, edited by Babak K. 2009)

The smallest high water level was 280 cm on 5th of March in 1990; the biggest high water level was 1041 cm on 21st of April in 2006. The biggest difference in a year was 1134 cm in 2006. The high water level was studied after the flood prevention preparedness, as well. In 100 years period, 22 times were bellow 550 cm and 10 were above 850 cm (Fig. 7.).

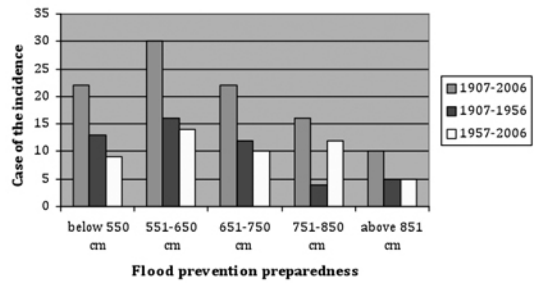

Fig. 7. The high water levels after flood prevention preparedness in monthly evolution in Kunszentmarton (1907–2006) (From data of Hydrographical Yearbook, edited by Babak K. 2009)

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Indicators for Sustainable Use of the Water Resources in Republic of Bulgaria

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Abstract

The water resources of Republic of Bulgaria play and will continue to play a key role in the economic development of the country. Their state is directly related to the ecosystems' services, used by the society. Sustainable exploitation of the water resources in the national economic sectors cannot be accomplished without considering the entireness of the ecosystems and of the services they offer. Therefore, indicators can be successfully used as an instrument, providing environmental information to decision-makers. Considering these, the article aims at examining the European practice in relation to sustainable development of the environment and more concretely of the water resources; and to establish indicators for sustainable use of the water resources on a national level as a basis for identification of the major problems related to water use in the country and draw the future actions for their sustainable exploitation.

Keywords: sustainable water use, environmental indicators, Bulgaria

Introduction and purpose

Water resources and the services of the ecosystems are crutial for the economic development of Republic of Bulgaria. The international experience shows that managing water resources only for the satisfaction of the needs of the population and the economic production, without considering the needs of water for the functioning of ecosystems, can lead to environmental and societal risks. Sustainable exploitation of the water resources can be accomplished only considering the entireness of the ecosystems and of the services they offer.

Indicators can be used as an instrument, providing environmental information to decision-makers. They can turn the achievements of the natural and social sciences into manageable unities, facilitating decision-making. They can enhance measuring and calibration of environmental progress for the aims of the sustainable development. They can ensure early warning and on-time alarming in order to prevent economic, social and environmental damages.

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The article aims at examining the European practice in relation to sustainable development of the environment and more concretely of the water resources; and to establish indicators for sustainable use of the water resources on a national level as a basis for identification of the major problems related to water use in the country and draw the future actions for their sustainable exploitation.

Indicators as an instrument for water management

Evolution of the indicators

Initially the demand for environmental information was closely related to the definition and implementation of environmental policies and their effects on the state of the environment. Over the years, policy priorities evolved, as did demands for reliable, harmonized and easily understandable information, not only from the environmental community but also from other public authorities, businesses, the general public, environmental NGOs and other stakeholders. At the same time, international activities and co-operation on the environment continued to grow.

This has stimulated a number of countries to produce environmental information that is more responsive to policy needs and public information requirements. The aim is to further strengthen countries' capacity to monitor and assess environmental conditions and trends so as to increase their accountability and to evaluate how well they are satisfying their domestic objectives and international commitments. In this context, environmental indicators are cost-effective and valuable tools.

Definitions

Indicator: a parameter, or a value derived from parameters, which points to, provides information about, and describes the state of a phenomenon/ environment/ area, with a significance extending beyond that directly associated with a parameter value.

Index: a set of aggregated or weighted parameters or indicators.

Parameter: a property that is measured or observed.

Functions of environmental indicators

The OECD terminology points to two major functions of indicators:

- they reduce the number of measurements and parameters that normally would be required to give an exact presentation of a situation. As a consequence, the size of an indicator set and the level of detail contained in the set need to be limited. A set with a large number of indicators will tend to clutter the overview it is meant to provide.
- they simplify the communication process by which the results of measurement are provided to the user. Due to this simplification and adaptation to user needs, indicators may not always meet strict scientific demands to demonstrate causal chains. Indicators should therefore be regarded as an expression of „the best knowledge available".

Criteria for selecting indicators

As indicators are used for various purposes, it is necessary to define general criteria for selecting indicators and validating their choice. Three basic criteria used in OECD work are: policy relevance and utility for users, analytical soundness, and measurability. An environmental indicator should: provide a representative picture of environmental conditions, pressures on the environment or society's responses; be simple, easy to interpret and able to show trends over time; be responsive to changes in the environment and related human activities; provide a basis for international comparisons; be either national in scope or applicable to regional environmental issues of national significance; have a threshold or reference value against which to compare it, so that users can assess the significance of the values associated with it; be theoretically well founded in technical and scientific terms; be based on international standards and international consensus about its validity; lend itself to being linked to economic models, forecasting and information systems.

Measurability

Measurability issues such as the quality of underlying data are important in the use of environmental indicators, and must be taken into account to avoid misinterpretation. Measurability and data quality vary greatly among individual indicators. Some indicators are immediately measurable, others need additional efforts before they can be published and used. For example, most indicators of societal responses have a shorter history than indicators of environmental pressures and many indicators of environmental conditions, and some are still in development both conceptually and in terms of data availability.

An important criterion affecting the usefulness and relevance of an indicator is the timeliness of the underlying data. The interval between the period to which data refer and the date when data are released should be as short as is practicable. Current timeliness of environmental data often remains insufficient for policy evaluation or public communication purposes. Unlike some economic data, environmental data lag behind referring to two or three years (or even more) prior to the current year.

The availability of coherent data over longer periods is essential to keep track of earlier policy measures and to monitor changes over time. To date, the consistency and completeness of time series data vary greatly by issue and country, and do often not allow a systematic and meaningful presentation of trends over longer periods.

Coherence or comparability among countries and international harmonization are essential to make data and indicators meaningful for decision making and performance evaluation and for allowing policy-makers to make effective international comparisons. Despite significant progress over the past twenty years, differences remain among countries as well as within countries where different information sources often provide different figures on the same item.

Coherence between environmental and economic information systems is essential to establish links between environmental and economic variables, to analyze environmental pressures exerted by different economic sectors and distinguish government responses from those of the business sector or private households. To date, breaking environmental indicators down at sectoral level remains difficult because of different definitions and classifications used. Further harmonization work and closer links between accounting work and the development of indicators could help to overcome some of these difficulties.

The data required to support the indicator should also be readily available or made available at a reasonable cost/benefit ratio; adequately documented and of known quality; updated at regular intervals in accordance with reliable procedures.

Types of indicators

OECD work on environmental indicators, initiated in 1989, includes several categories of indicators, each corresponding to a specific purpose and framework.

Core environmental indicators (CEI) are designed to help track environmental progress and the factors involved in it, and analyze environmental policies. The OECD Core Set is a set commonly agreed upon by OECD countries for OECD use. It is published regularly. The Core Set, of about 50 indicators, covers issues that reflect the main environmental concerns in OECD countries. It incorporates core indicators derived from sectoral sets and from environmental accounting. Indicators are classified following the PSR model: indicators of environmental pressures, both direct and indirect; indicators of environmental conditions; indicators of society's responses.

Key environmental indicators (KEI) endorsed by OECD Environment Ministers, are a reduced set of core indicators, selected from the OECD Core Set, that serve wider communication purposes. They inform the general public and provide key signals to policymakers.

Sectoral environmental indicators (SEI) are designed to help integrate environmental concerns into sectoral policies. Each set focuses on a specific sector (transport, energy, household consumption, tourism, agriculture). Indicators are classified following an adjusted PSR model reflecting: sectoral trends of environmental significance; their interactions with the environment (including positive and negative effects); and related economic and policy considerations.

Indicators derived from environmental accounting are designed to help integrate environmental concerns into economic and resource management policies. Focus is on: environmental expenditure accounts; physical natural resource accounts, related to sustainable management of natural resources; and physical material flow accounts, related to the efficiency and productivity of material resource use.

Decoupling environmental indicators measure the decoupling of environmental pressure from economic growth. In conjunction with other indicators used in OECD country reviews, they are valuable tools for determining whether countries are on track towards sustainable development. Most DEIs are derived from other indicator sets and further broken down to reflect underlying drivers and structural changes.

Conceptual framework

The system of indicators for sustainable use of the water resources is based on the model Pressure – State – Response, which is widely used in Europe and globally.

Environmental pressures

Environmental pressures describe pressures from human activities exerted on the environment, including natural resources. "Pressures" here cover underlying or indirect pressures (i.e. human activities themselves and trends and patterns of environmental significance) as well as proximate or direct pressures (i.e. the use of resources and the discharge of pollutants and waste materials). Indicators of environmental pressures are closely related to production and consumption patterns; they often reflect emission or resource use intensities, along with related trends and changes over a given period. They can be used to show progress in decoupling economic activities from related environmental pressures, or in meeting national objectives and international commitments (e.g. emission reduction targets).

Environmental conditions

Environmental conditions relate to the quality of the environment and the quality and quantity of natural resources. As such they reflect the ultimate objective of environmental policies. Indicators of environmental conditions are designed to give an overview of the situation (the state) concerning the environment and its development over time. Examples of indicators of environmental conditions are: concentration of pollutants in environmental media, exceedance of critical loads, population exposure to certain levels of pollution or degraded environmental quality and related effects on health, the status of wildlife and ecosystems and of natural resource stocks. In practice, measuring environmental conditions can be difficult or very costly. Therefore, environmental pressures are often measured instead as a substitute.

Societal responses

Societal responses show the extent to which society responds to environmental concerns. They refer to individual and collective actions and reactions, intended to:

- mitigate, adapt to or prevent human-induced negative effects on the environment;
- halt or reverse environmental damage already inflicted;
- preserve and conserve nature and natural resources.

Examples of indicators of societal responses are environmental expenditure, environment-related taxes and subsidies, price structures, market shares of environmentally friendly goods and services, pollution abatement rates, waste recycling rates, enforcement and compliance activities. In practice, indicators mostly relate to abatement and control measures; those showing preventive and integrative measures and actions are more difficult to obtain.

Indicators for analysis on a national level

The measurement of the environmental pressure on the water resources in Bulgaria has been executed through the examination of the following parameters: amount of fresh water abstracted, of which surface and ground water abstracted; amount of fresh water abstracted for the needs of the major economic sectors: agriculture, hunting and forestry (incl. fishing); industry; public water supply; domestic sector; gross domestic product (GDP) by fresh water abstracted.

The state of the environment is related to the quality of the environment and respectively to the quantity and quality of the natural resources. They represent the state of the environment and it's dynamic for a certain period. Practically, the measurement of the environmental state is complex and expensive. Therefore, the pressure on environment is often measured as a substitute. We have measured the environmental state through the quality of the resources it offers to the population. The indicator used to measure the environmental state is the share of the population on water regime.

The societal response to the anthropogenic pressure put on environment represents to what extend the society has managed to relate the environmental problems with its activities. The indicators measuring the societal response are the price of the water services and the expenditure on the restoration and protection of the water resources.

Indicators for environmental pressure

Fresh Water Abstraction means abstraction of natural water having a low salt content. Fresh water abstraction from surface water sources includes the abstraction of water from inland rivers, the Danube, dams, fresh lakes, shaft, kettle, mining, and drainage systems. Fresh water abstraction from ground is abstraction from spring and drilling wells.

The level of the water abstraction depends on natural and socio-economic factors. The resources of fresh water in the country are estimated to be 19 433 million cubic meters or 2 497 cubic meters per capita per year (2004), which is considerably less than the average amount for the EU countries (4000 million cubic meters per capita per year).

The surface fresh waters are the major water source in the country (around 92% for the period 2000 - 2004). The situation is similar to other EU countries (70 – 90 %).

One of the basic indexes for assessment of the potential quantitative water problems is the intensity of water use. The index is measured by the percentage of the annually abstracted waters from the total amount of fresh waters in the country. It is considered that this index should not exceed 20%. According to this, the water abstraction in Bulgaria during the latest ten years is sustainable. The tendency of decrease starts since 1991 (26.8%) and in 2002 decreases down to 11.7%. In 2003 are abstracted 17.2% of the total water resources and in 2004 – 14.9%, which is close to the average level from the EU (14.2%).

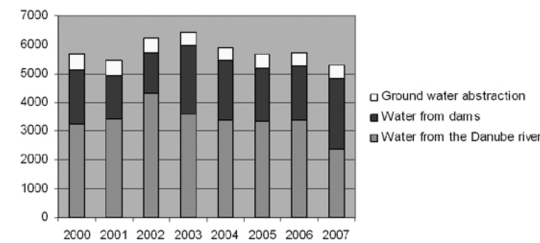

Fig. 1. Fresh water abstraction. Surface and ground water abstraction (Mill. m^3/year)

GDP by Fresh Water Abstracted characterizes the outcome of economic activity and is measured by value added generated by the production of goods and services by the total amount of fresh water abstracted. The juxtaposition of GDP with the abstracted fresh waters shows the effectiveness of water use. Data indicate a stable tendency of increase in the GDP produced by unit of water. The comparison with other European countries shows that Bulgaria is characterized by a high level of abstracted fresh water per capita and lowest GDP per capita. The water resources in Bulgaria increase with about 75% during the years with high water level and decrease nearly three times during the years with low water level. During the years with low water-level all territory of Bulgaria experiences severe water stress – the ratio is 56.5%. As a result of economic development the overexploitation of groundwater and surface water the water stress will be occurred. Therefore the effective water management in Bulgaria requires establishing and implementation of the concrete measures for stress diminution, adaptation and conser-vation of water resources particularly during the periods of dryness.

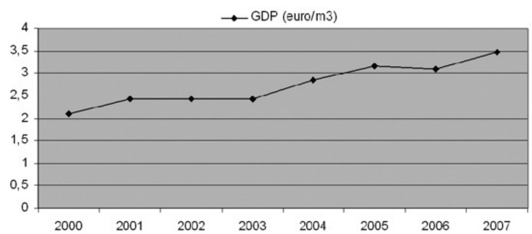

Fig. 2. Gross Domestic Product by Fresh Water Abstraction

Fresh Water Abstracted by Economic Activities shows which economic sectors are the major water consumers and therefore put the most pressure on the natural systems.

About 99% of the fresh water is abstracted for the needs of the public water supply, the agricultural and industrial sector and energy production. The users may be supplied from the public-supply network, from hydromeliorative systems or from private water-supply sources. The tendency of decrease in water use is typical for almost all production sectors.

There has been a sustainable decrease in water abstraction both from surface and ground sources. Water abstracted in 2004 presents 85% of the abstracted in 2000. 15.5% from the total amount were used in the public water-supply sector (2004) (EU 15 – 17%). A trend of decrease has been registered in the industrial sector. The abstracted water in 2004 is 58% of that in 2000. The major water user is the energy production sector. In average 61% of the annually abstracted water has been used for energy production, mostly for cooling purposes. The major part of the cooling water is returned in the surface water; however some of its qualitative characteristics are changed.

The drop is most significant in the agricultural sector and begins since 1992. In 2004 the hydromeliorative systems and other agricultural activities have abstracted twice less water than in 1992. A factor determining this fluctuation is not only the restructuring in the agricultural sector but also the uncertain water-provision during the years.

About 67% of fresh water in 2007 was abstracted by economic units' self-supply and the other part is apportioned almost equally between the suppliers – public water supply (water supply companies – 17%) and hydromeliorative systems (16%). This structure is relatively stable during the years.

The major water consumer from the Industrial sector is the electricity, gas, steam and hot water supply, while the production of transport equipment uses least water. The Industrial sector uses mostly surface water sources. The Agriculture, Hunting and Forestry sector also uses more surface water than ground water. The Public water supply sector uses considerably more ground water sources due to the higher quality of the ground waters in comparison to the surface waters. The Domestic sector uses mostly ground water but its share from the total water consumption is the least. Generally, the anthropogenic pressure on the ground waters is relatively small.

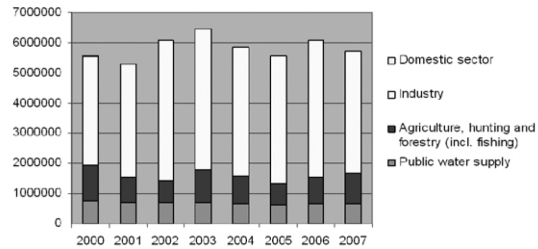

Fig. 3. Fresh Water Abstraction by Economic Activity (Thousand m^3/year)

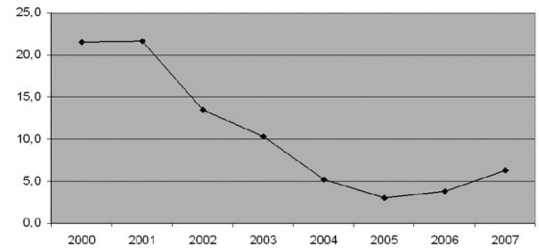

Fig. 4. Population on Water Supply Regime (%)

Indicator for Environmental State

The population connected to public water supply in 2007 is 98.9% of the total Bulgarian population (98.8% in 2003 and 98.7% in 1991). 100% of the urban population is connected to the public water supply and around 97% of the village population.

In 2007 water supply services were performed by 58 water companies, 29 of which were state, 24 – municipal and the rest – private (of local subject or under foreign control). The state companies conduct water supply to 77%, municipal – to 7% and private – 16% of the population.

About 6% of the population was with irregular water supply which was mainly due to reasons of seasonal character. During the drier years the population under water supply regime reached about 21% (2000 and 2001). The total water used by households in 2007 was 100 liters daily per capita. The lowest has been registered in 2002 – 90 l/day/capita.

The urban population uses more water compared to rural population. The drinking water used in the towns amounts to 106 l/day/capita, and in villages – to 89 l/day/capita in 2007. Both in towns and villages the used quantity has increased by about 4 – 5 l/day/capita in comparison to 2006.

Indicators for Societal Response

Often the implementation of economic instruments proves to be efficient in improving the sustainability of water use. According to the principle of management of the water as an economic and social good, the aim of all applications of the water resources must be the recovery of the full costs. As a minimum, at least the full costs of the public water supply must be recovered in order to ensure the sustainability of the investment and the functioning of the supplying enterprise. In many cases, even the minimum can be reached very difficultly, demanding direct subsidies for a couple of years ahead. Also the policies for poverty reduction may be incompatible with the introduction of the full costs recovery in irrigation, for instance.

According to the “polluter pays” principle, taxes can be introduced on waste water. The taxes should cover the external environmental pollution and the water purification expenses. Taxes can be related to the quality and the quantity of the waste water. This instrument should be combined with legal measures for control and monitoring of the polluters and specifically the industrial polluters. The opportunities to reduce water use in the domestic sector are relatively less, keeping in mind that the water use covers mainly the basic human needs. Nevertheless, reductions are possible.

It is difficult to control the amount of water for irrigation, but less water-consuming crops can be introduced instead.

Water Price Dynamic 2000–2007

The price of the water supply has risen by 0.24 BGN for the period 2001–2007, reaching 0.84 BGN in 2007. There are also regional variations in the price, which respectively reflects the water use in the certain regions. Water supply is most expensive in regions where water resources are scarce. Domestic water supply is also overestimated in touristic regions. Water supply is cheapest in the capital, where the consumption is highest and where the population with the highest standard of life lives. Equipping with water-meters and rising the price of water-supply service stimulates water saving. At the same time as lower is the level of consumption as much is the cost price of service. In 2007 per capita consumption in South-West and South Central Bulgaria reaches 110 l/day, at price of 0, 65 BGN per cubic meter, excluding VAT, while in North and South-East Bulgaria 92 l/day/capita, at price of 1, 03 BGN per cubic meter, excluding VAT.

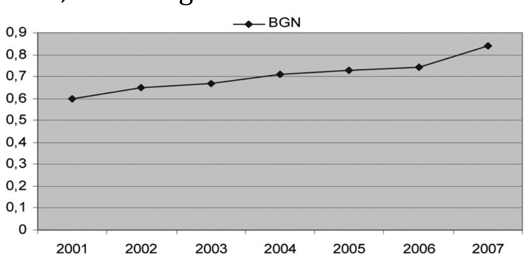

Fig. 5. Water Services Prices (Levs/m^3)

Expenditure on Protection and Restoration of the Water Resources

A condition for achieving sustainable water use is the provision of necessary investments for water-saving technologies, reduction of the loss at water transfer and measures for preventing contamination. Data indicate that expenditure on protection of water resources in 2007 exceeds by 2, 7 times those made in 2000. The highest is the increase of investments – about 6 times.

Any of the economic instruments cannot be introduced efficiently in Bulgaria until the water-supply infrastructure is entirely repaired. The rising of the water-supply prices in order to limit consumption will be effective only if it is justifiable. Both the old and amortized water-supply system and the hydromeliorative systems built in Bulgaria predetermine the significant loss at water transferring. By suppliers' calculations average annually about 1.2 billion cubic meters of water are lost due to leakage and evaporation. The loss at hydromeliorative systems is determined by specifics of the services – type of irrigated crops and customers' location. Due to the availability of open-air irrigation channels the loss also depends on climate factors. In 2007 the loss is estimated at 63% of the water entered the system but in drier years (2003 and 2006) they reach 72%.

At public water supply companies loss is estimated in average 62% of the water entered the water supply network. About 57% of this network has been brought into exploitation before 1970, and its main part (72%) has been built by asbestos-cement pipes.

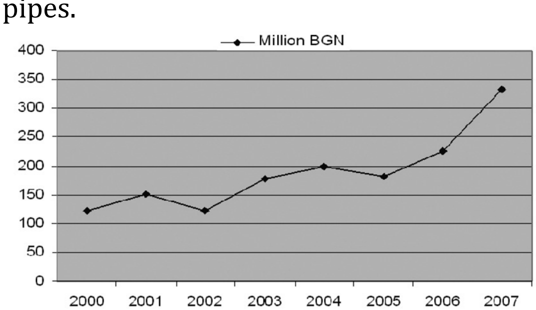

Fig. 6. Expenditure on Protection and Restoration of the Environment

Measurability

The source of the information is the National Statistical Institute Sofia, Bulgaria. The information is collected through conduction of specialized annual statistical monitoring on water. Data has been collected through electronic questionnaires.

The information about the water use is delivered partially by statistical monitoring on the major water-users. The criteria for the scope is the enterprises using more than 36 thousand cubic meters water annually (100 cubic meters daily). Smaller enterprises contribute to the statistics on a voluntary basis.

Conclusions

- The fresh water resources of Bulgaria are considerably less than the average amount for the EU countries.
- The water abstraction in Bulgaria during the latest ten years is sustainable according to the basic indexes for assessment of the intensity of water use.
- The juxtaposition of GDP with the abstracted fresh waters shows the effectiveness of water use. Data indicate a stable tendency of increase in the GDP produced by unit of water.
- The comparison with other European countries shows that Bulgaria is characterized by a high level of abstracted fresh water per capita and lowest GDP per capita.
- The prices of water services constantly rise but water loss due to transportation is still very high. The regional variations in the prices and water loss are very unfavorable for the consumers, considering the discrepancies in water resources availability.
- As a result of economic development the overexploitation of groundwater and surface water the water stress will be occurred. Therefore the effective water management in Bulgaria requires establishing and implementation of the concrete measures for stress diminution, adaptation and conservation of water resources particularly during the periods of dryness.

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Environmental conflicts and sustainable water policies in the Mediterranean Region. The case of Sardinia

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Abstract

Water policies in the Mediterranean region, facing recurrent crises due to increasing demands and decreasing availability, tend to cause serious environmental and social conflicts. The case of Sardinia, analyzed through the examples of the wetlands of Molentargius, the tourist resort of Villasimius and the recent regional policies to face desertification, shows a variety of issues related to the Geography of Water academic research field.

Keywords: wetlands, tourism, desertification, climate change, Mediterranean, Sardinia

1. Introduction

The complex and multifaceted issues linked with water management in arid and semi-arid environments typical of the Mediterranean Region are a very stimulating field of study for Geography of Water.

The widespread environmental and social conflicts related to decreasing water availability and growing demands from different sectors (agriculture, industry, tourism, etc.), linked with topical issues such as sustainable water policies, territorial planning, local development, stakeholder participation and relations between tourism and environmental conservation, form a common feature in many Mediterranean areas, which, at the same time, show a high number of local situations which add to the complexity of this wide territorial system [1-4].

Sardinia provides an interesting case study as a Mediterranean island with chronic water shortages. Its climate is characterized by hot, dry and windy summers and mild and wet winters, with average annual precipitation ranging from 300 mm in the South-Eastern coast to over 1,000 mm in the inner mountains. Inter-annual variability is high and droughts are frequent. The

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possible consequences of climate changes, as well as the innovative territorial policies which have been experimented in the late years, add to the importance of this case study [5].

Being the focus of the 14th IP European Seminar of Geography of Water, in 2011, the Sardinian case will be mainly investigated through the following research aims:

- sustainable water policies and territorial planning;
- key relations among water uses and local development;
- best practices for sustainable use of water resources;
- challenges and responses to climate change;
- importance of stakeholder participation.

In order to develop these issues, analyzing the environmental conflict theme appears to be particularly useful, because it focuses on past, present and possible future uses of water resources taking into account different concerns and solutions, producing long-term results.

In this regard, three themes have been selected and will be briefly presented in this article: the Regional Park of Molentargius - Saline, the tourist town of Villasimius and the policies to face desertification and climate change. These three case studies, exemplifying many key issues of water management in the Mediterranean, will be further analyzed during the 14th IP Seminar, through the contribution of participants from different European universities and local experts and stakeholders.

Environmental conflicts and territorial planning in wetlands: the case of the Regional Park of Molentargius – Saline

The broad definition of „wetlands" adopted by the Ramsar Convention in 1971, encompassing not just marshes and lakes, but also coral reefs, peat forests, temporary pools, underground caves, and many other kinds of water bodies and adjacent riparian and coastal zones, including man-made habitats such as salt flats and fish ponds, well suits the variety of these transition ecosystems in the Mediterranean Region. The long-term interaction between man and these water bodies in the region created complex territorial systems whose future is now seriously threatened.

Only partially used in past times, mainly for fishing, water supply and vegetable material production, wetlands were mostly perceived as dangerous and unhealthy environments, sources of miasma and linked with diseases and epidemics, particularly malaria. Urbanization, land reclamation and water abduction led to a dramatic reduction of wetlands surface all over the region, particularly for coastal ponds, marshes and swamps. Only after the Second World War malaria was finally eradicated from the Mediterranean countries, thus producing a less negative view on ponds, marshes and swamps, but the general recognition of the ecological, cultural, educational, recreational and tourist importance of these areas is even more recent [6, 7].

Sardinia has a great variety of wetlands covering a total surface of over 12,000 hectares, out of a regional surface of 24,090 km2, the remnant of a much greater system which largely shrank during the XIX and XX Centuries [8].

The WWF and LIPU (Lega Italiana Protezione Uccelli) indicate intensive agriculture, hunting, overfishing, exploitation of water resources, organic and chemical pollution, industrial risk, legal and illegal urbanization, tourism growth and abandonment of traditional activities as the main threats to the preservation of wetland ecosystems in the island.

The Sardinian coastal ponds are affected by many forms of pollution that often undermine their trophic status. The abnormal increase in fertilizing substances, mainly coming from areas of intensive agriculture and farming (including cattle and sheep farms), causes severe eutrophication and large-scale mortality of aquatic fauna.

The discharge of chemical pollutants can also cause serious and persistent negative impacts, particularly when heavy metals and organochlorines enter the food chain. The discharge of waste materials from mining activities is another aspect of the problem, as, in many parts of the Island, some rivers and streams currently carry heavy metals drained from abandoned mines into lagoons. Chemical pesticides and wastewater produced by cheese factories and oil mills are also locally serious problems.

Besides agriculture and industry, other serious damages also come from urban landfills, illegal waste dumping sites and untreated wastewater coming from urban areas and tourist resorts in the summer peak season. The lack of knowledge on the natural and cultural importance of wetlands also leads to other destructive actions, such as real estate speculation or car parking at the edge of ponds and lagoons.

The Regional Park of Molentargius - Saline (1,622 ha) was established in 1999 in order to protect a vast coastal pond of international importance (included in the Ramsar Convention and declared Site of Community Importance and Special Protection Area by the European Union) located within the urban area and hinterland of Cagliari, in Southern Sardinia, inhabited by over 300,000 people [9].

The origin of this wetland system dates back to the Pleistocene, when repeated cycles of marine ingression and regression created two strips of sandy alluvial deposits. The innermost, Is Arenas, is a fossil beach that separates the main pond of Bellarosa Maggiore from a swamp that was transformed into salt flats since ancient times. The outer strip, Poetto, is a sandy complex of dunes, now heavily urbanized, which separates the salt flats from the sea (Fig. 1).

Fig. 1. The Regional Park of Molentargius – Saline (source: Wikipedia, modified)

This system of ponds is thus formed by different water bodies, some of which have maintained high biodiversity levels, hosting important species of birds such as flamingos, cormorants, herons, egrets, moorhens etc. Other parts of the system, instead, such as the salt flats and the wetlands bordering the urban area, have been heavily modified by human activities over the centuries and show severe eutrophication and pollution problems, leading, in 1985, to stop salt production because of excessive presence of pollutants.

The evolution of the Molentargius ecosystem is closely linked to the history and development of the urban center and suburbs of Cagliari. With the growth of population and wastewater discharge, the inflow of water exceeded the absorption capacity of the sandy soil, resulting in permanent bodies of water, quite extensive and relatively deep, bordered by reeds and marsh grass. The surface of free water tended to decrease, but, at the same time, this increasingly modified ecosystem produced a number of ecological niches and therefore augmented the biological diversity of the whole complex.

The main problems of the area, directly linked with strong human pressures due to the location of this wetland area within a metropolitan area, include:

1. Eutrophication, with considerable development of secondary vegetation that gradually invaded the bed of the ponds, causing progressive silting.
2. Agricultural settlements in the sandy strip of Is Arenas which have altered the species composition and caused nitrate pollution.
3. Illegal house construction and sand quarries for the extraction of material for building.
4. Drastic changes in the sandy strip of Poetto due to urban and tourist settlements and infrastructures which have largely replaced the sand dunes generating rapid beach erosion.
5. Illegal waste dumps, unauthorized hunting and fishing, presence of stray dogs and recurrent wildfires caused by weak controls.

Since the establishment of the Regional Park, important achievements have been accomplished. These include:

- creation of a Centre for Environmental Education;
- setting of educational footpaths, biking trails and waterways;
- restoration of historic buildings related to the tradition of salt production;
- increased controls to prevent fires, hunting, fishing and waste dumping;
- partial recovery of damaged environments within the area;
- reduction of polluting wastewater inflows;
- participated planning with the involvement of bordering municipalities and environmental associations.

While important results have been recorded, lack of funds still prevents these problems to be definitively solved. Some other conflicts, caused by the presence of illegally built houses and intensive agriculture within the park's boundaries, are less likely to be solved in the forseeable future, because their repression would probably cause protests which the involved municipalities are not currently willing to face. Moreover, the continued development of tourist facilities along the bordering beach will probably still be accompanied by serious phenomena of soil erosion and coastline recession [9].

In the longer term, while the development of ecotourism itself in the park is still negligible, concerns related to the coexistence of tourism and conservation might arise in the future, as already happened in other wetlands (e.g. Camargue and Everglades) where the financial benefits of ecotourism are counterbalanced by its considerable environmental impact.

Sustainable water policies in tourist areas: the case of Villasimius

Villasimius, located in the extreme South-Eastern tip of Sardinia, is the third largest tourist resort in the island and one of the most renowned seaside destinations in Italy. Its territory (58 km2) occupies a series of steep hills that stretch southward into the granite peninsula of Capo Carbonara and several uninhabited islands. The little plain that hosts the town of Villasimius (3,576 inhabitants in 2010) is thus isolated among mountains and sea cliffs and communications with the nearest city (Cagliari, 48 km) have always been rather difficult (Fig. 2.).

Fig. 2. Location of Villasimius (source: GraphicMaps, modified)

This hilly area, sheltered from the relatively humid North-Western Mistral wind, is characterized by semi-arid Mediterranean climate. Precipitation is scarce and very irregular. The meteorological data available for the XX Century seem to show a constant decrease in rainfalls, from an average of 566 mm per year recorded between 1922 and 1991 down to just 220 mm per year between 1992 and 2001. This is the lowest precipitation level in Italy and one of the lowest in the whole of Europe. As in the rest of the Mediterranean region, summers are extremely dry and drought usually lasts from early June to early September. The few rivers and streams show highly irregular flows and are dry for most of the year. A typical Mediterranean scrub covers the whole territory, gradually turning into a thicker and taller forest in the mountains. Frequent wildfires are responsible for its severe deterioration.

Nowadays Villasimius is the main tourist area in the Province of Cagliari and the third largest in Sardinia. The beauty of its location and its relative isolation has turned it into an exclusive resort mainly targeted to middle and high-class vacationers. The latest data available (2005) show how impressive the impact of tourism on the old rural community has been. Villasimius currently has 5,970 beds in 32 hotels and 1,151 beds in 2 campgrounds. About 1/3 are four star hotels. Tourist arrivals in 2005 reached 81,190, which is over 20 times the local population. Overnight stays reached 618,137, with an average length of stay of 7.6 days, longer than the Sardinian and Italian averages. Overnight stays were only 30,194 in 1972 and 286,440 in 1992. Currently, Italian tourists are the vast majority of visitors (85.7% of arrivals, 86.6% of stays), followed by Germans, French and Britons. Occupancy rate is 50.8%. These figures actually hide a strong seasonality, with 83.3% of arrivals and 91.3% of overnight stays concentrated in just four months (June, July, August and September). The month of August, in particular, draws 1/3 of all overnight stays and reaches a striking occupancy rate of 78% [10]. "Informal tourism", mostly based on second homes, is also very important, although it is not recorded in official statistics, and would probably double these figures, as happens in other tourist resorts of Sardinia [11, 12].

In recent years Villasimius has shown significant commitment toward environmental tourism and sustainable development. A large part of its coastline (30 km out of 40), islands included, was transformed into a natural park in 1998 ("Marine Protected Area of Capo Carbonara"). Further steps in this direction include the creation of a local Agenda 21 (2001), the commitment to the Aalborg Charter (Charter of European Cities & Towns Towards Sustainability) and the implementation of EMAS - the Eco-Management and Audit Scheme of the European Union (2009) [13].

Yet, high seasonal concentration of tourist activities and extreme fluctuations of population between winter and summer, together with ongoing tourist urbanization within the municipal borders, put local water resources under considerable stress. Over 1,000,000 overnight stays are concentrated in the warmest and driest months of the year and tourists tend to adopt unsustainable uses of water multiplying their normal consumption. Moreover, the urban lifestyle adopted by the residents (3,600 people) has led to considerable and growing water consumption (110 m^3 per capita in 2000, 187 m3 in 2005), in spite of increasing water prices for drinkable water (€ 1,06 per m^3 in 2000, € 2,12 per m^3 in 2005) [10-12].

The emergence of conflicts related to the difficult allocation of scarce water resources, particularly among tourism, agriculture and civil uses, was particularly dramatic during the severe droughts on the 1980s and 1990s. A partial solution was then found through the connection to the hydraulic network of Southern Sardinia. On the other hand, greater attention was put on wastewater treatment. The sewage network was extended to the entire territory and private wastewater treatment plants were gradually replaced by a unified public plant that is able to serve over 40,000 users at a time. The declining rainfalls of the late 1990s, when water rationing in summertime became normal, led to the building of a very innovative plant for wastewater recycling and reuse. The plant, opened in 1999, is currently able to produce up to 6,000 m^3 per day of clean reclaimed water (70% of total treated wastewater) that is used for the irrigation of agricultural fields (300 ha), tourist facilities (mainly swimming pools and 150 ha of gardens) and reforestation programmes. Farmers pay € 0.15/m^3 for it, while the tourist sector pays € 0.26/m^3. A large amount of drinking water coming from the aqueduct can thus be saved for domestic and civil uses. Irrigation does not have to rely on groundwater anymore, letting the aquifers recover from a severe process of salinization. A small seawater desalination plant (capacity of 1,300 m^3 per day) has also been built but has not been used, yet.

The huge tourist development of Villasimius still represents a serious challenge for a semi-arid environment. The sector seems to be destined to a steady growth, which forms both a great economic opportunity and a major environmental threat. Water policies and infrastructures are forced to run after increasing water demands and conflicts among residents, tourists, farmers and environmentalists are still possible, also considering the great ecosystemic value of the territory, but this resort proves to have reached relative success in creating a territorial system that is both environmentally and tourist friendly. An example surely valid for many Mediterranean areas, as proven by the role of Villasimius in co-operation projects aiming at spreading best practices to North African countries (currently Tunisia and Morocco, through the CIUDAD programme of the European Union).

Facing climate change and desertification

Decreasing rainfalls and desertification processes have been recorded in many arid and semi-arid environments over the past decades, particularly in the Mediterranean region [14-20]. Due to its climatic characteristics, Sardinia naturally tends to suffer from recurrent and severe water shortages, as well as isolated intense precipitations leading to violent floods [5].

The water supply system of Sardinia is composed of:

- interconnected reservoirs and cross junctions;
- demand centers (civil, agricultural, industrial, hydropower and environment);
- pipes connecting reservoirs and demand centers.

There are 58 reservoirs, with a total current capacity of about 1.9 billions of m^3. The demand centers serve a population of 1.7 million inhabitants, about 180,000 hectares equipped for irrigation and 11 industrial zones. This system, based on the use of surface resources, provides 75% of water resources now used in Sardinia. To a lesser extent groundwater and unconventional water (e.g. recycled water) are used. Water management has been rationalized according to its final uses: one only Authority Basin for the whole island and one public entity providing water to agriculture (through land reclamation consortia), civil uses (through Abbanoa j.s.c.) and industry (through industrial consortia), also collaborating with ENEL j.s.c. for power production.

Climate fluctuations determine continuously changing water balances among available resources and potential needs and conflicts among agriculture, industry, urban dwellers and tourism sector have been and are still common in many parts of the island.

While total water consumption in irrigated agriculture varies year by year according to climatic conditions, normally absorbing between 50% and 60% of total water, and still benefits from extremely low tariffs, domestic uses keep showing long-term growing trends (80 m^3 per capita in 2000, 130 m^3 in 2005), in spite of rising tariffs. Water demand appears to be largely inelastic, so there will be little reaction to an increase of price; water is a normal good so consumption will increase along with income and water rationing measures seem to have no influence on consumption. This is most probably due to the fact that many households have adopted defensive measures to contrast the restrictions imposed (e.g. storage tanks) [21].

Climate change is a variable that might further complicate this situation. The recurrence of both droughts and floods has increased over the second half of the XX Century, as shown by official and independent meteorological records [5, 22, 23]. The lack of reliable information for earlier periods, due to incomplete series and insufficient territorial cover, does not allow proper estimates on the effects of longer-term climatic fluctuations, but, nevertheless, the present tendency is worth in-depth analysis and attentive reflections on possible future socio-economic and environmental impacts.

Average yearly precipitation data in Sardinia recorded three distinct periods:

- a “wet” period, from 1922 to 1974, with an average of 690 mm/year;
- a “transition” period, from 1975 to 1986, with high variability;
- a “dry” period, from 1987 to 2002, with an average of 560 mm/year.

The past 8 years (2002-2010), though, have shown a new growth in precipitation amount, albeit with a high number of violent episodes (e.g. 572.8 mm in only 9 hours on Nov. 12th 1999 in Capoterra, Southern Sardinia).

At the same time, average temperatures showed a tendency to grow, and models elaborated by the Regional Climatic Department forecast a growth of up to +5°C for the current Century [5].

Although local combinations of rainfall and temperature changes can produce varied and unpredictable results, the overall trend is serious enough to have led the Regional Government and the Universities of Cagliari and Sassari to produce extensive research works aiming at understanding how the effects of these possible climate changes might affect the region.

In fact, Sardinia is one of the most studied regions for the phenomena of desertification in Italy. Two main aspects, reduction of precipitation linked with excessive exploitation of water resources, and exceptional intensity of precipitation events, particularly in the Southern and Eastern regions of the island, caused climate change and desertification to become hot topics in the political agenda. Other phenomena tend to contribute to desertification:

- intensive agriculture and nitrate pollution;
- excessive density of cattle and overgrazing;
- infiltration of saltwater in coastal areas, due to excessive groundwater exploitation;
- recurrent wildfires in the summer period;
- consumption of fertile soil caused by urbanization and industrialization;
- pollution caused by abandoned mines.

The Regional Government, through its Environmental Agency (ARPA), thus produced a detailed map (1:100,000), the first and only one in Italy, aiming at monitoring desertification phenomena linking them with possible climate changes and sustainable use of water resources (ESAs methodology, 2009).

The map found 47% of the island’s surface to be at risk. In particular, 7% is already in extremely critical conditions, mainly due to advanced soil erosion and degraded vegetation cover. Critical areas are scattered all over the island, with a concentration in the largest plains of Central-Southern, South-Western and North-Western Sardinia. More detailed analysis, as a pilot project, was done on the Nurra plain, in the North-West, and strictly linked with degradation and loss of water resources caused by wrong agricultural practices. Further evolution of these phenomena could dramatically affect key socio-economic elements such as the distribution of olive and citrus trees plantations [22, 23].

The concept of desertification has evolved over the years, and is defined by the UNCCD (United Nations Convention to Combat Desertification) as „land degradation in arid, semi-arid and dry sub-humid areas, resulting from various causes, including climatic variations and human activities". This definition focuses on soil degradation and would surely require more attention in respect of water resources. Quantitative and qualitative deterioration of water resources, affecting life conditions and development perspectives, is undoubtedly a key indicator of desertification phenomena, seen as bio-productive degradation processes caused by climatic variations and human activities. In the common perception, desertification is generally associated with the image of partial or total lack of water resources. Although considered a key indicator of desertification, degradation of water resources is both a cause and a contributing cause of desertification and an effect of desertification processes, such as soil erosion and deforestation.

Conclusions

This brief overview on some of the main issues related to sustainable water management in the Mediterranean Region, through some examples located in Sardinia, shows the complexity of the challenges and the difficulty of finding long-term solutions to environmental conflicts. The analysis of these issues requires multidisciplinary approaches taking into account natural features, human activities and possible future evolution models. The exchange of best practices and the research contribution of different schools and academic traditions would enrich the ongoing debate on sustainable water management and are particularly fertile fields for Geography of Water. Data management, key-note lectures, meetings, working group sessions, e-learning, technical visits, surveys, stakeholder involvement and field work within the IP European Seminar appear to be able to compound the scientific knowledge of different disciplines, such as environmental sciences, social sciences, economics, etc., and will be extensively used and promoted within the IP Seminar partnership network in order to stimulate systemic and integrated views on natural resources management in different geographical contexts.

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Biodiversity conservation strategies and water conflicts in and around the Yasuní Biosphere Reserve of the Ecuadorean Amazon Region

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Abstract

In a mega diverse country like Ecuador the nature conservation and sustainable development programs are well recognized at National and International level through creating Protected Areas and Biosphere Reserves, defined by International Union for Conservation of Nature (IUCN) and by UNESCO. On the one hand, this Amazonian region is involved in many planning strategies for the sustainable development and the biodiversity conservation, on the other hand the same region is generally considered by the Ecuadorian State to be a remote and a peripheral area to be included in the integration processes of modernization, developing productive activities based on extractive economy and substitutive models of territorialization. Therefore the anthropogenic direct drivers affecting the dynamics of land use which also determine rapid cultural changes of local communities are mainly related both to the oil reservoir exploitation and the expansion of the agricultural frontier in the Amazon territory. The local communities, mainly composed by indigenous people and metice peasants, are local actors taking part in the so-called environmental conflicts, mostly driven by oil exploration and production. In the Amazon territory oil production processes determine chain impacts on the environmental and social systems. The most pervasive socio-environmental impact is oil production water of which miles of barrels per day are released in the environment by the National Oil Company alone. On one side the research project is based on the field work conducted by collecting geographical data and by qualitative investigation and on the other side it is based on the quantitative G.I.S. analysis examining spatial relationships between anthropic activities, land cover, local communities, protected areas and ecosystems. Through the case of study, developed in and around the territory of the Yasuní Biosphere Reserve (UNESCO, 1989), the general objective of the research project is to verify the sustainability development program, focusing on the land use dynamics, to investigate the participative processes of local communities into the territory planning and to project possible scenarios trajectories of environmental conflicts. The specific objective is to quantify the net loss of Tropical Moist Forest habitat expressed by original vegetation cover substituted by anthropic activities along the oil infrastructures in the Yasuní Biosphere Reserve influence and to conduct quantitative land cover analysis on a new oil road.

Keywords: environmental conflicts, Amazon basin, biodiversity conservation, sustainable development, oil production, indigenous people

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Introduction

Nature conservation today is a controversial issue involving different academic research fields (from natural to social sciences), local and international institutions and organizations and, directly or indirectly, local communities.

Nature conservation and sustainable development are concepts even more indivisible and they respond to request arose from the need to take part in the weighty environmental issue and to deploy strategies to preserve biodiversity at each biological organization level combined with human activities sustainable oriented.

While in the ancient past the ecosystem changes have been ruled in the biosphere by extrinsic processes such as tectonic movements or natural climate change, in recent past major changes result primarily from dynamics intrinsic to the life on the Earth, mostly directly connected to human activities. These dynamics are well known as anthropogenic direct drivers; they often act together in complex and synergic ways determining direct and indirect impacts on ecosystems: habitat destruction, habitat fragmentation, overexploitation of natural resources, biodiversity loss, pollution, introduction of alien species and rapid climate change [1].

Biological diversity at multiple scales is fundamental to all ecosystem processes and scientific researches show that between 12% and 52% of species are threatened with extinction related to anthropogenic drivers and across a wide range of taxonomic groups the population size of majority of species is declining [2].

The linkage between biodiversity and human well-being have been expressed by the U.N. Agencies as the “ecosystem services”; in general humanity has always depend on services provided by biosphere and its ecosystems like regulating services, provisioning services, cultural services and supporting services [3].

Within the ecosystem services biodiversity has important intrinsic and extrinsic roles: supporting complex ecosystem dynamics through regulatory, structural and functional roles, cultural role like aesthetical, spiritual and recreational elements of biodiversity and the important provisional roles like supplying food, fresh water, fiber and other goods [4]. The capability of biodiversity to provide goods and services is what mainly give to rural societies in the Developing Countries the possibility for living and guarantying social reproduction.

For terrestrial ecosystems the most important drivers of change in the past 50 years have been land cover/land use dynamics, in particular woodland conversion to crop land.

Human-induced changes in the terrestrial surface have been significant and relevant, especially deforestation, and they have affected the delivery of ecosystem services and determined alteration of biogeochemical and hydrological cycles that control the functioning of the earth system [5].

Deforestation and forest degradation affect 8.5% of the world’s remaining forests, nearly half of which is in South America. Deforestation and forest degradation have been more extensive in the tropics over the past few decades than in the rest of the world [6]. Land cover and land use analysis show two different approach to the issue: land cover refers to the land physical attributes like vegetation status, grassland; whereas land use expresses how land is transformed by human activities like cropping and ranching. Cross analysis of these two approaches allows a whole representation of dynamics interfacing social and environmental system.

If on one hand the majority of international conservation treats and agreements such as the Ramsar Convention on Wetlands (1971), the Convention on Migratory Species, and the CITES (1973) is specifically based on the classic biology conservation paradigm that separates humans from natural environment, on the other hand the Convention on Biological Diversity (CBD) at the Rio de Janeiro Summit (1992) opened space of discussion for developing new strategies of biodiversity conservation throughout the world. Moreover the CBD through the subsequent meetings of the Conference of Parties (COP) and its Subsidiary Body on Scientific, Technical and Technological Advise (SBSTTA) started a new theoretical framework to preserve biological diversity assuming the biodiversity as a multi scalar concept and dealing with its complexity [7]. This issue has moved the focus of the conservation programs from the interest of preserving a single species or a wilderness area to that of protecting biodiversity to all of the organization levels of biological diversity (from genes to landscapes) and at the same time postulating that "the conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population, for which purpose access to and sharing of both genetic resources and technologies are essential" [8].

This new paradigm has an important role also in influencing the conservation strategies and the sustainable development planning at international level promoted by organizations like the IUCN, many United Nation agencies projects, and orienting treats and conventions.

The paradigmatic dichotomy between biodiversity conservation and sustainable development was definitely resolved in the fifth COP meeting (Montreal, 2000) adopting the "ecosystem approach" which considers human societies as integral part of ecosystems and which takes on integrate strategies of management of soil, water systems, biological diversity with its essential processes, functions and interactions between organisms and their environment and between ecosystems themselves. The ecosystem approach assumes also sustainability as a concept to be verified at environmental, economical and socio-cultural levels, involving local communities into the process of decision making in biodiversity use and management. In order to develop a sustainable management of biological resources all the relevant information should be kept in account, including scientific knowledge, indigenous and traditional knowledge, innovations and practical methods [9].

An interesting framework to combine biodiversity conservation priorities and sustainable human activities is the Biosphere Reserve protected area model, instituted by the Man and Biosphere Program (MAB) of UNESCO (1971) and evaluated, tested and implemented several times by the Seville Strategy process (1996, 2002). The MAB research protocol aims to integrate human activities, natural environment protection, scientific research projects in the same area, emphasizing mutual relationships between human beings and nature and recognizing on one side the mankind role to shape landscapes and on the other side to find methods and pathway to use natural resources without environmental degradation. This model is based on the conception of protected area as an open system in which energy and matter may flow in the boundaries systems, in contrast with the classic conservation approach which protects ecosystems isolating them from the surrounding environment [10].

Within these biodiversity conservation models and sustainable use and natural resources management, planned and organized by international institutions like UN agencies and NGOs, also takes place cooperation projects.

A matter of facts the same CBD states that "each Contracting Party shall, as far as possible and as appropriate, cooperate with other Contracting Parties, directly or, where appropriate, through competent international organizations, in respect of areas beyond national jurisdiction and on other matters of mutual interest, for the conservation and sustainable use of biological diversity" [11].

During the long and complex process on nature conservation and sustainable development programs the Millennium Development Goals (MDGs) pro-moted by U.N. is opening chances for international cooperation "recognizing the interdependence between growth, poverty reduction and sustainable development; ensuring environmental sustainability are goals to be achieved by 2015 that respond to the world's main development challenges" [12].

Through the MDGs Achievement Fund managed by the United Nation Development Program (UNDP) a territory planning for conservation and sustainable development of the natural and cultural heritage of the Yasuní Biosphere Reserve (YBR) is taking place in the Amazon region of Ecuador. This program is promoted by the Spanish Government through the Spanish Agency for International Cooperation (AECID) together with UN-Ecuador and locally coordinated by the Energy Ministry, the National Secretary for Development, Provincial institutions and indigenous organizations like CODEMPE. According with the 7th goal of the MDGs this international cooperation project aims to ensure the environmental sustainability of the YBR trying out the complex conflictive arena of different actors carrying out their own interests and attempting to achieve the stakes underlying the Amazon territory [13].

In some cases the conservation strategies employed to preserve ecosystems or to combine environmental sustainability could take to a conflict dimension due to lack of preliminary process of participation and involvement able to allow technical, scientific, juridical, political and economical requests to get consensus and support by local communities. This is the case of local communities excluded by the management and use of a certain territory [14].

Geographical framework and study site

Ecuador is a little country (256.370 km2) located in South America laying on the interception of the Andes mountain range and the Equator Line. The Andes range is an ecosystem "watershed" that splits the country in three different bio-geographical regions: the Costa, the Sierra and the Oriente (the Amazon region) [15]. Due to the exceptional biodiversity richness Ecuador has been included in the Mega Diverse Countries list, placed on top for vertebrate endemism per 1000 Km2 and for absolute number presence of birds, amphibians and butterflies species in the same area unit [16]. Moreover this country presents two areas declared Biodiversity Hotspots due to the high endemism rate (representing at least the 0.5% on global scale) and a high deforestation process (70% net loss of the original forest cover). They are located on the north-western coast and in the northern Amazon region called Tropical Andes [17]. Because of its biodiversity richness and the ecosystems degradation due to the land cover/land use changes Ecuador is involved in many conservation programs promoted by International Union for Conservation of Nature (IUCN), UNESCO, governmental and non-governmental organizations, cooperation agencies and national and international institutions.

The Ecuadorian population (12.5 million inhabitants) is composed by 52% of indigenous groups, 40% of mestizo and 8% of afro-descendant and Spanish origins [18].

The national economy till the 1960–1970 was mainly based on extractive and large-scale agricultural activities linked to rubber, to cacao and to bananas production. The convergence between the crisis of the agro-exporter model and the discovery of huge oil reserves in the Amazon region has inverted the economic and production course, maintaining the frame of reprimarizacion modernizada [19].

The Ecuadorian productive system is now definitely based on extractive and agro-industrial activities oriented to a land use exploitation of non-renewable resources like petroleum and extensive agriculture crops [20].

Even if several agriculture reforms were approved in order to orient migration fluxes into low population density areas and to assign lands to indigenous people and peasants, the agriculture productivity system is based on an unfair distribution of land. Therefore indigenous people, representing the poorest part of the population and distributed in the rural areas of the country, share the same need about the territory issues: the access to land and to the natural resources and land ownership rights [21].

The Ecuadorian oil boom (1970-2000) has led the so called Amazonian colonization which is a multifactor process that pushes further both the agriculture and oil frontier in expanding in the eastern peripheral area of the country [22]. This process is the effort of the Central State actor to plan integration and modernization processes of the most peripheral and wilderness area of Ecuador.

Therefore, the emerging oil industry started to build communication and productive infrastructures such as roads, pipelines, settlements and Central Processing Facilities (CPF). In particular the extensive road network built exclusively to facilitate oil production is the main colonization vector in the Amazon region especially for local communities as well as for indigenous people and mestizo that search new spaces to settle in. Only between 1985 and 1996 oil companies together with the Ecuadorian state have implemented the road network from 1830 to 7250 km, resulting in an increase up to 400% in extension [23]. The oil road network is the main vector of the territorial re-organization that shows the typical territorialization through land cover substitution and stimulating land use changes of non-traditional agriculture practices [24].

Nowadays the ongoing oil production exceeds 400.000 barrels per day and it represents the 46% of exportations and nearly 40% of GDP [25].

In the Amazon territory oil production processes determine chain impacts on the environmental and social systems.

The most pervasive socio-environmental impact is the 217.000 barrels per day of oil production water of which 31.000 barrels per day are released in the environment by Petroecuador Company alone [26].

A common practice for disposing of production waters is scattering them on the soil through toxic pits and through artificial channels into the rivers. The waters contamination in the oil production area is really high so that just between the Napo and Coca river basins, where local communities live, drink and bath, the petroleum hydrocarbons concentration is between 100 and 10.000 times higher than the limits allowed by Environmental Protection Agency (EPA) [27]. More than thirty years of oil exploitation took the whole area into an environmental and health emergency, determining high environmental and social costs on local level [28].

The Amazon region shows very different logics of territory use and organization and often in contrast to each other. By the analysis of the extractive and substitutive activities is possible to draw cartography of territorial actors with their own dynamics disclosing different ways to perceive natural resources [4].

At the moment the territorial dynamics are very complex and sometimes overlapped to each other. Even if it could be a reductive operation it is useful to identify actors and rational logics configuring the territory and taking to the environmental conflict [29]. Therefore, within this territorial system internal and external actors are detachable: on one side local populations, composed by indigenous and mestizo peasants and local institutions; on the other side oil companies and national institutions such as the State and its Ministry of Energy and Environment.

The study site is located within the Amazon Region, called Oriente, which represents about the 50% of the national area. The Oriente contains half of the Ecuadorian forest systems, mainly composed by Moist Tropical Forest (MTF), and represents alone about the 40% of the biodiversity of the country [30]. It includes the Yasuní National Park, the indigenous territory of Wuaorani, a 10 km buffer zone that surrounds the Biosphere Reserve, the rivers basin of Rio Curaray and Rio Napo, the main road infrastructures, cities and human settlements. Using a systemic approach the study site was selected by the relevant territorial processes that modify and set up this complex Amazon territory: the natural boundaries defined by rivers basin, the Yasuní Biosphere Reserve, the oil blocks licensed for petroleum extraction and production.

The extremely dense rivers network of this portion of Amazon Basin is one of the dominant factors both in the geomorphologic and pedogenetic processes and territorialization processes of Amazonian local communities, becoming structuring elements of the geographical space [24]. The Yasuní Biosphere Reserve was instituted by UNESCO in the 1989 and it plays a key role in the conservation programs and territory planning.

The oil blocks are vectors of modernization and integration process in the area and they represent the way of external actors to draw the geography of energetic resources and to use the Amazon territory.

Through the geographical overlapping of these three territorial processes in and around the Yasuní Biosphere Reserve the study site was processed to produce a cartographic output.

Data and methods

The research project is based both on fieldwork activities in Ecuadorian Amazon collecting spatial referenced data, GPS surveying, information by semi-structured interviews to privileged informers and on quantitative investigation about spatial relationship between anthropic activities, ecosystems, indigenous territories and the Yasuní Biosphere Reserve. All the biophysical, ecological, anthropic, socio-economic data acquired in the fieldwork were retried and integrated into the Database Management System (DBMS) in order to manage a powerful data storage geographically and temporally referenced and thematically differentiated.

This variety of geographic and spatial data has been used to conduct quantitative analysis by the Geographical Information Systems (GIS) technology as a tool able to manage different information sheets and maintaining a systemic approach to the territory.

Using satellites and retrieved thematic maps land cover and land use dynamics have been analyzed within the study site focusing on the road network and territorialization processes.

Results and discussion

Diachronic quantitative analysis on anthropic impacts on land cover was conducted by GIS analysis through geo-metric intersection operations between the original vegetation cover before the Amazon colonization process and the substituted remain cover. This analysis was performed in the study site by calculating net loss on each forest systems. Results show that colonization process is much more pervasive in the MTF ecosystems rather then in the area close to the Andes range. Indeed within the study site 4892 km2 is the net loss of original vegetation cover which represents the 85% of the 5819 km2 of substituted area. These results are explained by the colonization process of the Amazon region enlightening by the cartographic superimposition of the substituted cover to the oil activities areas (oil blocks). This case clearly shows relationships between land cover and land use changes: on one side the territory use linked to the energy resource exploitation, on the other side land cover changes producing TMF habitat loss [31]. This is a way to represent territorial dynamics expressed by interfacing human-environment mutual interactions [7].

Considering that the study site is one of the most important deforestation front in the world [32] and assuming that every linear kilometer of road extended in the TMF there is an average loss of 120 ha of forest [33] the territory analysis focus also moves around the new oil roads as potential catalyst of new colonization process in the Amazon region.

Through the Google Earth platform and satellite imagery interpretation method a new oil road close to YBR has been identified. This road was constructed by the Occidental Petroleum Company without any authorization [34]. The GIS analysis and measurement operations indicate a full-run road of 40 Km of which 15 km within the YBR buffer zone. On this sample area there are 44 oil infrastructures of which 6 are inside the Biosphere buffer zone. All the deforested area related to this oil infrastructure is 110 ha of which 60 are inside the buffer zone.

Moreover through the satellite imagery interpretation 27 open toxic pits were identified 6 of which lies within the buffer zone. Also in this case the territorial analysis shows the relationships between oil production and road network giving some physical measurement of what is potentially getting a colonization vector. Every case of road construction in the Amazon region is directly linked to the oil extractive activities and this specific study case reveal the uncontrolled operations of private oil companies in the areas despite international and national laws [31].

Using Landsat ETM+ imagery emphasizing land cover status and using retrieved thematic maps of river basins, oil production systems and local communities geographical analysis have been developed to show different pattern of territorialization.

The quantitative and comparative analysis is conducted on two different territories: the first structured around the Auca Road, the second one around the Curaray River. The Auca territory has been elaborated using the Landsat ETM+ imagery, buffering till the last colonization line at 22 km from the main road axis; the Curaray territory, without paved road, has been buffered using the natural boundaries of the river basin.

The G.I.S. analysis indicates that there are 25 urban settlements, 6 Wuaorani indigenous communities and 4 Quichua-colonos communities in the Auca territory (on 4683 km^2); in contrast there are 12 urban settlements, 13 Wuaorani communities and 22 Quichua-colonos communities in the Curaray territory of 8.204 km^2.

Moreover the comparative analysis gives these results: the Auca territory is 100% covered by oil blocks of which 60% is managed by external actor Petroecuador, 17% by the Keer-McGee company, 8% by the Vintage company and 14% is without oil operator; the Curaray territory instead 68% is without any oil operator, 23.57% managed by the Italian ENI-AGIP company, 7.90 by Keer-McGee and 0.43 by PetroEcuador [31]. The comparative analysis clearly shows two different territory patterns built up to the communication network: on one side the territory is set up around a main road axis, on the other side the territory remains configured on the water ways [29]. The spatial pattern obtained around the main road axis is shown by the forest-nonforest interface modeled by the processes of agriculture colonization; from the main road axis depart orthogonal and parallel processes according to the typical fish-bone pattern [35]. If on one side the modernizing territorial practices are shown by the substitution activities, on the other side the communication ways is mostly overlapped to the dense river network of the Rio Curaray. The comparative analysis also reveals the conflicting logics of territorialization: waters logics versus land logics. Within the Curaray territory social systems organize and reproduce themselves innervating the complex but viable water systems, carrying out territorial practices based on the opportunities offered by soil and the hydrography mediated by the man-space relationship, adapting themselves and the community development to the river basin eco-system [29].

These two different logics of modeling and using the territory witness distinct way of perceiving and representing natural resources and relationship among societies and ecosystems. The confrontation of these different logic of territorial developments are at the roots of socio-environmental conflicts in Amazon basin. The qualitative research on the fieldwork also gives indications about the existent cooperation projects developed in the area. An exemplar signal of participative cooperation is given by the Proyecto Bosques within the European Commission Program called “Red comunitaria e institucional para la conservación del bosque tropicalamazónico” This cooperation project is taking place in the Orellana Province and it involves both local institutions and indigenous-peasant communities. The reforestation plan and the TMF conservation is based on participative processes able to create a local communities network capacitated and organized to preserve forest and to manage sustainably forest resource.

The Solidaridad Internacional ONG pushed for this integrated forest conservation plan since 2005 trying to propose alternative ways for rational use of forest resources and in order to preserve them. The solutions are complex: in the deforested area the NGO propose that families start to reforest with woody species and to maximize alternative cultivations already present in the area like cacao. As far as it was possible to verify within the study site, this could be the way to give roots to the cooperation project by a local bottom-top processes [36].

Walking sustainable horizons research on cooperation and conflict management

Sustainable development is the result of virtuous interactions in social practices including: consumption models, social relations and institutions and environmental systems. This virtuous interaction is facilitated by promoting awareness of the choices of local societies, which are the keystone of sustainability practice. Facing the issue of sustainable development means to take into consideration the interactions among economy, society, environment at first focusing on the manner local society achieves self welfare. This refers to both local resource use and necessary economic exchanges including mobility, with other societies and countries. The way local resources are used is related to our efficient use of them and to the maintenance of environmental conditions (mainly climate and biodiversity) that allowed humans to live and local societies to become rooted in specific places. The necessary economic exchanges relate to critical issues like equity, social justice, because the welfare in a local society is based on a high quantity of external resources [37], [38], [39], [40]. So, the efficient use of local and external resources joined with environmental stewardship is the keystone of sustainable development as approach characterized by three dimensions:

- sustainable development as a local process, the local territory has an important task in creating local and global networks, region are cornerstones of development
- sustainable development as a planned and communication process
- sustainable development as a participated process, the key is empowerment of local stakeholders, the construction of a participated decision-making system and conflict management strategy [41], [42], [43], [44], [45], [46].

Central issues in any decision related to actors, territories, natural resources are power relations and the way to achieve consensus and to deal with conflicts [47].

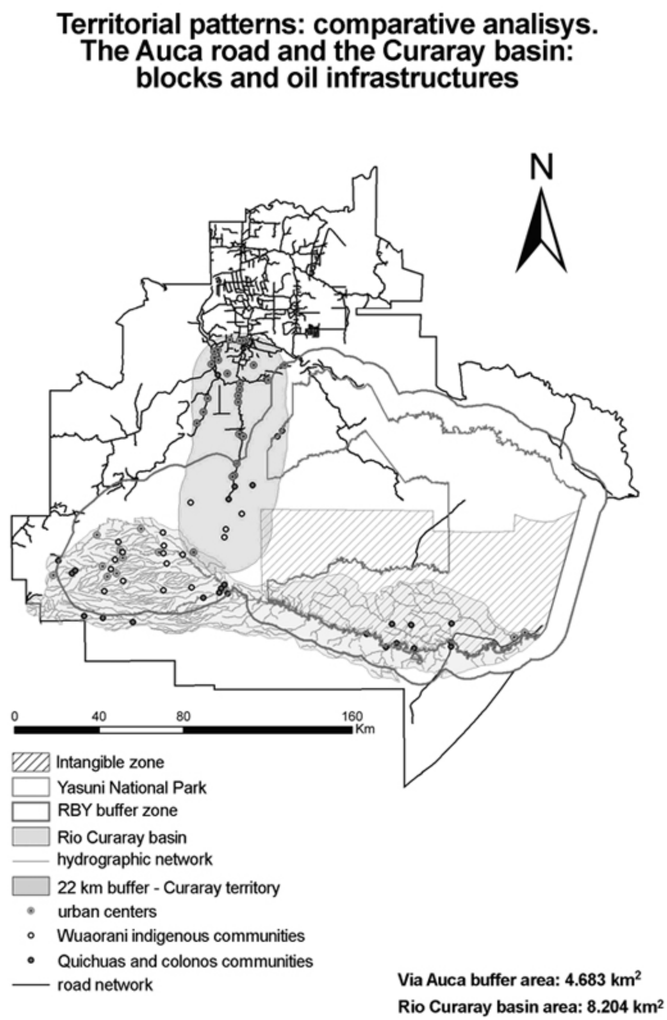
In the practice of territorial decision making any action should be appraised in a wider context than the strictly technical and economical issues of the action or in the sectorial and territorial circle directly involved by the plan or programs (in this case study beyond oil economy). Environmental and territorial issues deal with social and ecological relationships more complex than those apparently influenced from the project or the program. The issues of social equity and environmental carrying capacity are tightly connected [47], [48], [49], [50], [51]. Choices concerning the environment have always more to do with distributive policies; in every project, plan or program at stake is the socio-spatial justice; in the location oil infrastructures the costs are supported by the receiving territory whereas benefits are enjoyed by territories or populations localized far from the place mostly hit (the Nation), often there are no compensation measures. This reasoning does not intend to support the zero hypothesis as the best solution, rather to project or program alternatives which have to be appraised not only in terms on environmental impacts, but also against the socio-spatial implications influencing both the definition of the priorities and the results. In the practice of environmental assessment this issue of socio-spatial justice has been faced foreseeing the consultation of the public after the conclusion of the impact statement.

The social network that interacts with every plan or program foresees four typologies of actors: the proponents, the environmental authority, the directly affected actors and public opinion. If two actors are traditionally in narrow contact during all the phases of the evaluation (proponents and environmental authority), directly affected actors and population have often few opportunities to contribute, so actual "participatory" models consist in the post-consultation phase which results in a dynamic that often threatens to crystallize in the classical decide-announce-defend (DAD) mode.

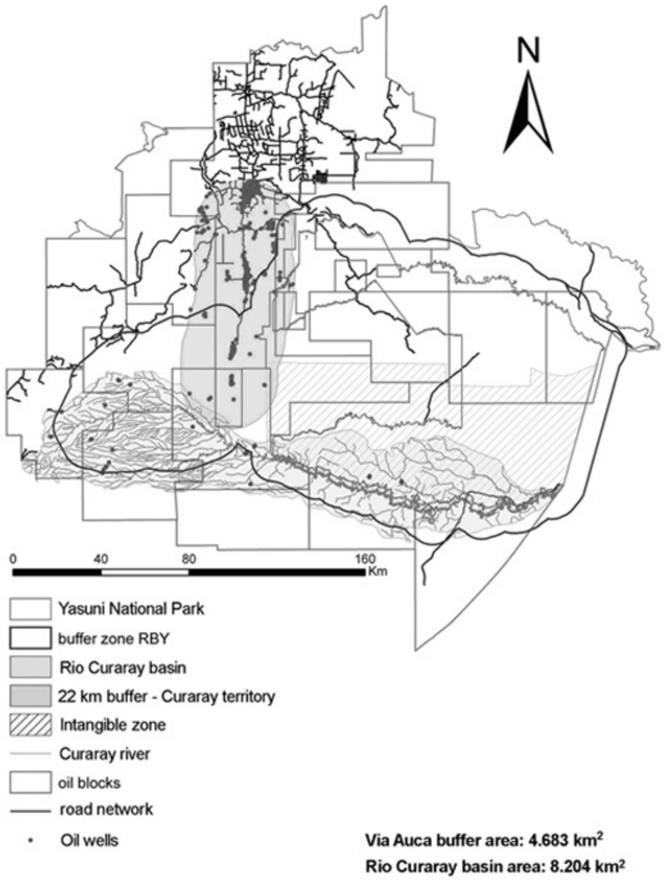
True public participation processes in decision-making are necessary to improve the quality of the decisions made and strategic in order to make them more acceptable and shared within the environmental and territorial policies. Besides this, participation contributes to the growth of environmental consciousness. Citizens and local actors should participate in the construction of environmental policies on the basis of common conditions. 10 of Rio declaration on Environment and Development contains indications concerning public participation on projects, plans, programs and legislative initiatives dealing with environment. The Declaration foresees that the member States assure: the information of the public on each plan, program or they revision, the possibility to express comments and observations before the approval, the guarantee that any observation is take into consideration before the approval. Member States take the necessary actions to identify citizens or the groups participating in decision-making with particular attention to environmental NGO.

After almost two decades of patchy experience of sustainability the need now is to consolidate sustainability practice and to embody sustainability approaches into current individual, public, private, actions. Many communities in the world have produced in these twenty years a wide spectrum of experiences in sustainability including research, business, public administration, civil society, and in different sectors from tourism to farming, from transport to landscape and territorial management. It is time now for a second generation of sustainability projects based not so much in pilot experiences but more on consolidation and diffusion of successful practices. So, research, cooperation, training, education, exchange among partners, monitoring of successful experiences, and a strategic integration among knowledge communication and practices, are the kernels of definitive transition to sustainability horizon.

Sustainability culture should become a diffused aspect of decision making practices and not remain the property of enlightened minorities or a theoretical benchmark far from reality. The land use daily decision making of individuals, firms, public administrations, have to face conditions of complexity and uncertainty. They need a vision of sustainability that will help them to take strategic and adaptive decisions. In this changing context sustainability may not be an optional decision, but is becoming the chosen option. This new decision making paradigm can be easily supported by the wise diffusion and integration of existing experiences and by the acknowledgement of the practices of research and cooperation in educational institutions and in the field of territorial policies.



**Territorial patterns: comparative analisys.
The Auca road and the Curaray basin:
blocks and oil infrastructures**



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