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The condition of the river water at the Polish-Ukrainian border

Abstract: *The Subcarpathian voivodeship a very interesting natural region, covering the south-east area of the country border with Ukraine and Slovakia. It is characterized by a very diverse land relief which has got tight links with its geological structure. One may notice here basic morphological forms: from the vast plains in the northern region of the province and elevations in the mid part, to the Roztocze Grab at the north-eastern points and the Foothills of Przemyśl, Dynów, Strzyżów and the Carpathian range in the south.Such considerable differentiation of the land relief influences the structure of the morphological forms and course passageways, and the course of river network and its energy potential.*

The land relief and the geological structure.

The area of the Podkarpackie Province comprises so called physical-geographical units whose isolation and classification regulations for the countries in Europe were determined at the International Geographical Congress in London in 1964.

The new physiographic division called physical-geographical regionalization, taking into consideration a decimal classification, became widespread in the country due to, first thing, the publication by J.Kondracki (2002).

The spatial arrangement of the Podkarpackie Province constitutes of , as a whole or partially, three provinces, i.e. Polish Uplands, Western Carpathians with Podkarpacie and Eastern Carpathians, and five sub-provinces, which are the Lublin-Lvov Upland, Northern Podkarpacie, Outer Western Carpathians, Eastern Podkarpacie and Eastern Beskids. In the north-eastern part of the region (Narol and Horyniec municipality) Mesozoic rocks cover Paleozoic works making it the element of the bank aquifer. The area of Sandomierz Basin is filled by so called Podkarpackie cavity, built from the quaternary works of the thickness reaching several meters. The whole southern Podkarpackie stretch is covered by the nappy of the Carpathian flysch, i.e. alternately defaulting slates and sandstones coming from the Alpine orogeny in the Tertiary.

An outstanding morphological unit coming from the Tertiary are, in the Podkarpackie province, the Outer Western and Eastern Carpathians. The

conventionnal border between these mountain ranges is the San and Osława valley, and the Lupkowska Pass. Both the outer Western Carpathians and Eastern are built from sandstones, conglomerates and slates which together are given the name flysch.

Surface water

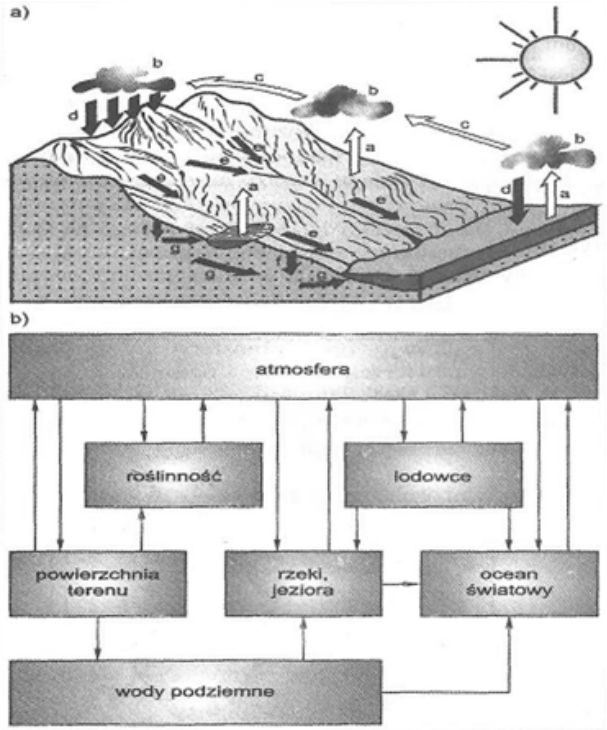
Surface water is part of the hydrosphere which is the water cover of the earth. The driving power of the change in the hydrosphere is the thermal energy of the sun which causes the evaporation process and the process of lifting water molecules up to the atmosphere. Atmospheric changes lead to the cloud formation, and from them to the rainfall. The closed cycle of water circulation in nature is presented by drawing no 1.

From the total number of fall, part of it evaporates again from the surface of lands to the atmosphere, part of it flows down the surface enabling the surface outflow as the rivers to the water reservoirs, part of it percolates to the ground and penetrates the underground water making possible the underground outflow towards various natural reservoirs, such as: springs, swamps, rivers and lakes. Also, part of the water fall is absorbed by plants which in the process of transpiration give it back to the atmosphere. The considerable amount of water fall as snow, ice sheets and mountain glaciers is trapped on the land surface, and at the same time temporarily excluded from the circulation. In the hydrological cycle, as shown in the drawing no 1, one can distinguish atmospheric and land phase. The atmospheric phase involves the process of evaporating the water from the water surfaces and ground water, transporting it in the atmosphere, and consequently condensation and atmospheric fall as a liquid and solid form. In turn, the land phase involves the surface outflow, infiltration and underground outflow.

In the process of safe functioning of organic life, including human and socio-economic ones, freshwater resources in the hydrosphere have unquestionable importance. From the total capacity of freshwater in the globe, glaciers and permanent snow caps constitute as much as 68,7%, and underground water 30,1%. In turn, lakes and rivers constitute merely 0,27% from the total capacity of freshwater in the earth. Rivers have always accompanied humans and their economic environment. River water is now indispensable in proper functioning of households and in the development of human economic activity. Hence, there is a considerable rise in urban areas along river valleys, which is noticeable in the processes of urbanisation and industrialisation, and in the development of commerce and service. To meet the settlement needs, especially with regard to huge agglomerations or industrial

centres, it is necessary to supply enormous amounts of water for the consumption, hygiene purposes and production processes.

River routes play an important civilization role because of their use for energy purposes, i.e. clean energy production also called unconventional. High costs of the hydro energy investments cause a barrier while implementing such developments, which, however, with time prove worthy in the economic, technological and ecological dimension.



Drawing no 1. Hydrological cycle scheme.

a) atmospheric phase: a- evaporation b,c -transfer of steam in the atmosphere and its condensation; land phase: d-atmospheric fall, e-surface outflow, f- percolation, g- underground outflow;

b) water circulation in a large cycle scheme

Source: E. Bajkiewicz- Grabowska, Z. Mikulski: Hydrologia ogólna. PWN. Warszawa 2006.

The energy potential of Carpathian rivers of the presented area is very

significant, but its industrial use is essentially limited to the San River, where there are two hydroelectric power plants, i.e. in Solina and Myczkowce.

The Podkarpackie Province lies almost entirely in the basin of the Vistula River, which occupies the largest area of the San basin . This river is the longest and final Carpathian tributary of the Vistula, in terms of length (443 km) it is the sixth river in the country.

The San River, on the background of all the Carpathian tributaries of the Vistula, has got the largest catchment, which is 16861 square km, of which 85.3% is within Polish borders. Along with an inclination of the Polish territory in the north-west, the San River, like the other rivers of our country, presents asymmetries in their basins.

The left-hand tributaries, except for the longest, i.e. the Wisłok River, are short rivers of a small catchment, while the right-hand tributaries are long and dehydrate significant areas, including some areas of Ukraine. The situation is presented in a spatial arrangement, figure 1.

The sources of the San River are located on the territory of Ukraine, on the eastern slope of Piniaszkowy (961 m a.s.l) in the area of the Użocki Pass. Between Sanok and Przemysl, the San River is a mountain - lowland river in character with an average decrease in 1 % and in its further length, it is a lowland river with a fall of 0.35 ‰ up to 0.25 %.

The San River joins the Vistula River at 378th km of its course, in the area of Sandomierz. Although the Vistula River is shorter than the San above the confluence of these rivers ,it has, through numerous mountain tributaries, more than twice as much the flow, which qualifies it as the main river.The longest tributary of the San River is the Wisłok River whose source is located on the north-eastern slope of Kanasiówki (831 m a.s.l) in the Low Beskid, and the mouth is in the Dębno village in the district of Lezajsk. The right-bank tributaries constitute a much bigger basin, among them: the Rivers Wiar, Wisznia, Szkło, Lubaczówka and one of the cleanest and most attractive rivers in the country-Tanew.

The Tanew River flows from the Great Division (392 m), the largest monadnock on the East Roztocze and flows in the border provinces of Lublin and Podkarpacie which are unique on a national scale thresholds, called rapids.

This river breaks through the edge zone of the Roztocze with an effective breakthrough with falls in the bottom of the trough which local residents commonly call "noises" (Fedan, Makieła, 2007, p. 293).

The Wiar River flows from the Jureczkowa village in the municipality of Ustrzyki Dolne and flows through the scenic Przemyskie Foothills, partly

through the territory of Ukraine, to escape to the San River above Przemysl. The Wisznia, Szkło and Lubaczówka Rivers have their origins in the territory of Ukraine. The Wisznia River flows from the area of Gródek Jagielloński on the Sańsko-Dnieprzański Plateau and flows into the San River in the area of Radymno. The Szkło River begins to run in the spa resort of the same name, and flows into the San River in the village Wysocko near Radymno.

The Lubaczówka River flows from the village of Zawadów lying on the East Roztocze. Up to the national border, it is called the Zawadówka River and flows into the San River in the village Manasterz in the municipality of Wiązownica.

Figure 1. Hydrographic distribution of the Podkarpackie province.

Source: WIOS Rzeszów. The condition of the environment in 2010. Rzeszów 2010

The south-east patch of the Podkarpackie province is drained by the Dniester River's basin system, which discharges water into the catchment of the Black Sea area. This is done through the Strwiąż River, flowing from Ustrzyki Dolne which directs its waters to the east of the Dniester River.

An important feature of the river basin in the level of water and its annual distribution of flows. In the mountainous and hilly areas, the San River catchment has a small dirt retention which results from the high inclination of the slopes and a fairly low permeability of rocks.

In this regard, the improvement of the retention occurs in the lower mountainous areas, especially in the lower part of the river catchment, where the pulp layers of permeable Quaternary remnants.

Therefore, the water level of the San River and the other rivers of the Carpathians rapidly react to heavy rainfall in the mountains, which occurs mainly in spring and summer. According to Z. Mikulski (2006, p.39) the fluctuations in water levels in the San River before the construction of the Solina and Myczkowce dams reached up to 7 meters.

The snow caps in the mountains remain longer on the surface, and the process of melting due to climate stages takes place at different times, without causing rapid runoff into river troughs .

However, in the Sandomierz Basin, the melting process covers extensive areas immediately, and yet frozen soil makes it difficult for the water to soak into the ground and feed the underground retention. As a result, great mass of melt water flowing into rivers causes slow, but prolonged flood.

These thaws occur most frequently in March and April, but there are also in January and February. A number of foothill tributaries of the San River such as: the Wisznia River, the Szkło River, the Lubaczówka River and the Tanew River take a lot of water then.

The lowest water levels of the San River can be observed mostly in the summer and autumn months (September, October), when the amount of rainfall is reduced, and in winter when there is snow cover and the ground is frozen.

The water level in the river depends on the flow rate and the capacity of the river bed. The flow characteristic of the San River increase down the river and are as follows: in Przemyśl - 51.7 m^3/s, in Jarosław -72m^3/s and Radomyśl - 133m^3/s. The highest flows in the upper reaches of the San (Lesko) are observed from March to May and are caused by the melting of the snow, the maximum occurs in April.

Another river defining hydrographic space in the Podkarpackie region is the catchment of the Wisłoka River (17% of the province). The average tide of the Wisłoka River in its upper part in the Low Beskid is 3m3 / s, but in the lower part around Mielec it rises to 34.5 m^3/s.

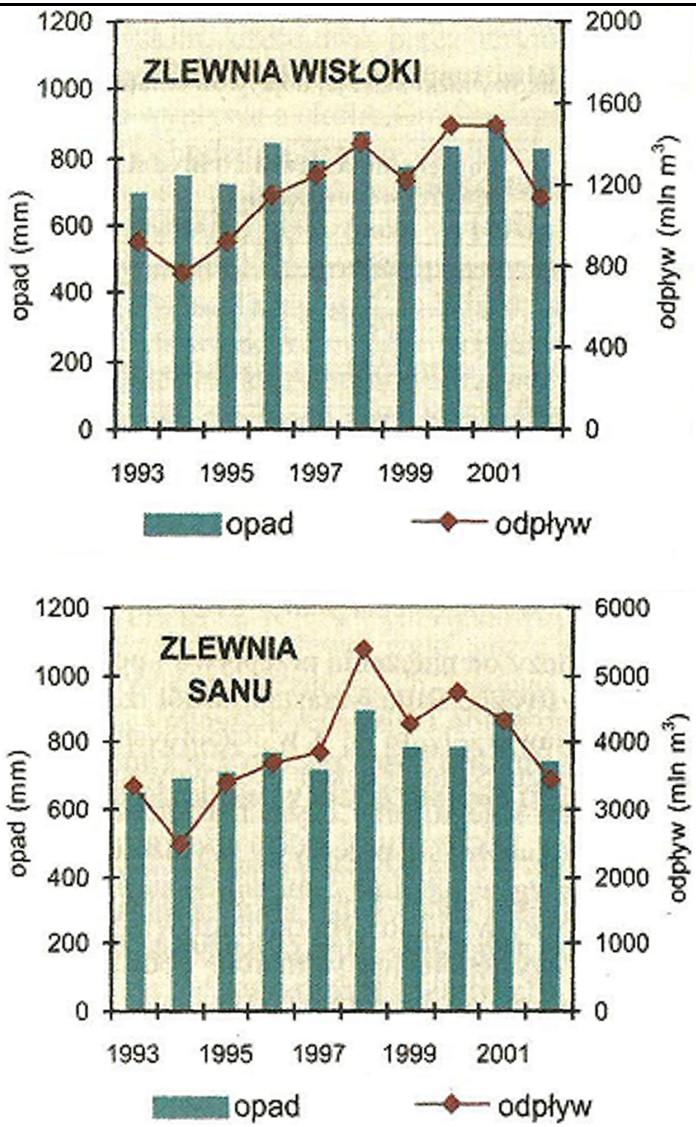


Figure 1. Water fall and runoff in the basin of the Wisłoka and Sanu Rivers 1993-2002.

Source: The condition of the environment in the Podkarpackie province of in 2003. Library of Environmental Monitoring. Rzeszow, 2004.

The values of runoff in the basin of the Wisłoka River are less diverse than in the basin of the San River and range from 18.4 l/s-km2 (Wisłoka-Krempna) to 6.7 1/s-km^2 (Wielopolka-Brzeźnica), and are therefore the result of different physiographic and climatic conditions.

Similarly to the San River, in so called wet years the annual water flow in the Wisłoka River is much higher than the average of several years, while in the years of low levels of rainfall this flow is lower than the average from the long-term. In Figure 1 we have shown the relation between the amount of rain and outflow in the analyzed rivers.

Along the river courses from the streams to the main rivers of the Podkarpacie, the urban settlement network has been located, for which the water was essential for the process of localization.

At the San River and the Wisłok River there are 19 cities, including the ones that are significant for the urbanization and economic processes, such as Lesko, Sanok, Przemysl, Jaroslaw, Nisko and Stalowa Wola and Krosno, Strzyżów and Rzeszow. In turn, along the Wisłok River five cities are located, including such prominent for the socio-economic growth as Jaslo, Dębica and Mielec.

In addition to the basic function as a water source, rivers are a very good source of green electricity production, for which there is systematically increasing demand from users such as households, institutions, local governments, operators, service providers and transport.

3.The quality of water in rivers.

The cleanness of river water has measurable meaning for consumers gathered in the settlement along the river valleys, as well as for many industries, especially the pharmaceutical and food industries, as well as for the water organic world.

The most important factors affecting the quality of water in rivers are the consequences of industrial processes, agri-food processing and natural factors, i.e. hydrological conditions and the ability of self-purification of river water.

The quality of water in rivers is also influenced by weather conditions, particularly low water levels and very high air and water temperatures occurring during the summer , and high insolation. Such conditions cause deterioration of biological and chemical water, especially in rivers receiving significant amounts of urban waste water.

Among the examined quality indicators, mostly microbiological indicators determined the result of the general classification of water, i.e. the number of coli forms and fecal coli form bacteria (The condition of the environment/2006, p. 56). Moreover, the level of quality was affected by the nitrogen content, aluminum, phosphate and salt.

The deterioration of water quality in rivers usually occurs after the adoption of

wastewater from large urban and industrial areas, or the adoption of polluted water flowing from watercourses.

An important factor in evaluating the suitability of water in rivers is the fish appearing in them. Studies have shown that water quality requirements specified for the most demanding fish such as whitefish and carp were met only on the San and Wołosaty Rivers in front of a dam in Solina.

The waters rated as useful for living for the carp fish are only in the upper reaches of the San, Wisłok and Wisłoka Rivers. In other rivers, there live fish of a lower species. This situation is illustrated by the spatial arrangement Fig. 2.

Fig 2. The suitability of water for fish habitat.

In the Podkarpackie province more than half the amount of water taken during the year to meet the consumption needs of the population, is covered with river water resources. The main suppliers of water consumption are three rivers: Wisłok (42%), San (32%) and Wisłok (26%). Taking into account the spatial arrangement of the measuring points assessing the purity of river waters (fig.3), it is noted that the rivers in the southern part of the province in areas with a high forestation and a low concentration of anthropogenic streams, are characterized by good and satisfactory quality. On the other hand, with the increase in the share of built-up areas in the catchment and agricultural land, there is a decrease of water quality in rivers, especially in rivers that are receivers of municipal and industrial wastewater. Therefore, river waters of the fourth and fifth grade prevail in the central and northern area of the province.

The research conducted in 2007 testing the quality of river water in the Podkarpackie showed that 47% is of the fourth grade, 30% in class III and 19% of the fifth grade, and only 4% is the water of the second grade. There wasn't found a very good water quality, which belongs to Class I (The condition of the environment 2007 p 47). Figure 3. General classification of water quality in rivers.

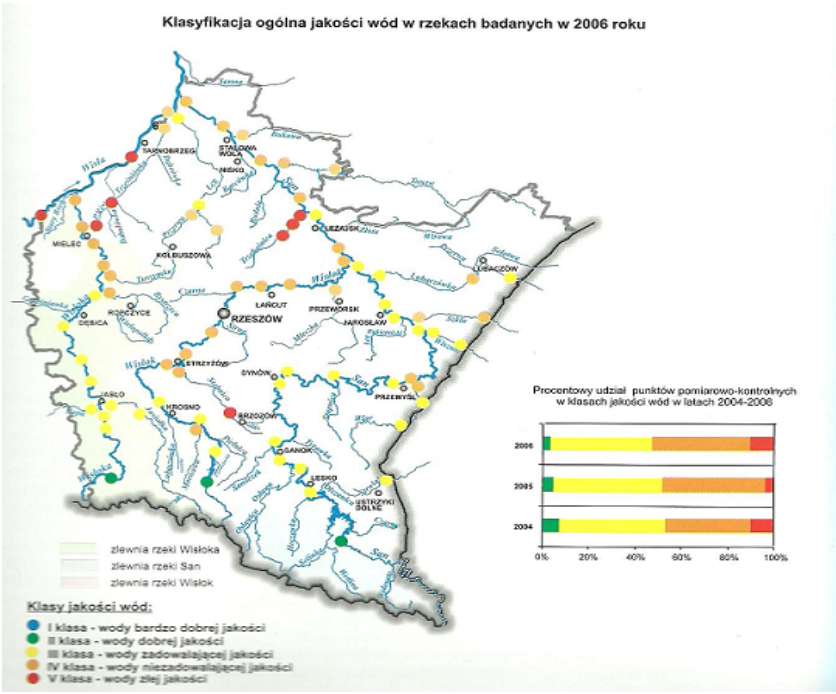


Fig 3. General classification of water quality in rivers.

The low quality of the tested waters was mainly determined by microbiological contamination, as well as slime and oxygen indices. The presented water quality status requires an effective action. According to the records of the EU Water Framework Directive, Poland is obliged to achieve good ecological and chemical status of groundwater until the year 2015.

Evaluation of the quality of boundary waters of the Podkarpackie province.

A very important ecological action is Polish-Ukrainian border water monitoring conducted under an agreement between the Government of the Republic of Poland and the Government of Ukraine on cooperation in the field of water management in the border waters. In the Podkarpackie province, tests are carried out in the rivers flowing through the Polish-Ukrainian border and these are: The Lubaczówka, Szkło, Wisznia and Wiar Rivers, which are the tributaries of the San River. The border waters are controlled at the measuring points located close to the border, in the range of up to 10 physical- chemical indicators. Studies have demonstrated, that since 2007 the purity of these rivers has been significantly improving because of a drop in water pollution, especially in the Wisznia River.

An acceptable state of contamination is still present in the Szkło River due to the content of sulfates and nitrite nitrogen. On the Ukrainian side, the Szkło river flows through the areas where until the mid-90s of the twentieth century the mining of sulfur was carried out.

High sulfate concentrations in the waters of the Szkło river, persisting for many years, has vividly decreased after the year 2000 to reach the so-called stable level, although it is still higher than the predetermined threshold for border waters.

As shown in Fig. 3, the monitored rivers of the Ukrainian-Polish border are among the so-called class III- water of satisfactory quality, except for the Szkło river having class IV, i.e. unsatisfactory quality. It is expected that the problem of underestimation of water quality of river on the eastern border of the Podkarpacie region will be systematically addressed within a specific period of time.

Abstract

The rivers network is an important part of the Earth's hydrosphere, which protects the living conditions of households, and supports production processes in industry and agriculture. Therefore, the quality of flowing water is essential, which should be protected by its users.

The rivers of the Podkarpackie province correspond mostly to class III and IV of purity (77% of the total), while in the class V there is 19% and class II purity only 4% of the total river water. The most polluted waters are rivers which are by the urban or industrial centers, and 4 trans-border rivers in the eastern region.

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Федан Роман

Стан води в річках на польсько-українському кордоні

Підкарпатське воєводство є дуже цікавим природним регіоном, що охоплює південно-східну область країни на кордоні з Україною та Словаччиною. Воно характеризується дуже різноманітним рельєфом, який тісно зв'язаний з його геологічною будовою. Тут можна помітити всі основні морфологічні форми: від великих рівнинах в північній частині воєводства до височин в середній частині, до хребта Розточчя в північно-східному напрямку і передгір'їв Перемишля, Динова, Стрижова та Карпатських гір на півдні. Така значна диференціація рельєфу впливає на структуру морфологічних форм і, звичайно, структуру водороздолів і напрям течії річок та їх енергетичний потенціал.

Федан Роман

Состояние воды в реках на польско - украинской границе

Подкарпатское воеводство является очень интересным природным регионом, охватывает юго-восточную область страны на границе с Украиной и Словакией. Оно характеризуется очень разнообразным рельефом, который тесно связан с его геологическим строением. Здесь можно заметить все основные морфологические формы: от обширных равнинах в северной части воеводства до высот в средней части, к хребту Расточье в северо-восточном направлении и предгорий Перемышля, Дынова, Стрижова и Карпатских гор на юге. Такая значительная дифференциация рельефа влияет на структуру морфологических форм и, конечно, структуру водоразделов и направление течения рек и их энергетический потенциал.