Annals of the Academy of Romanian Scientists
Series on **Engineering Sciences**
ISSN 2066-8570 Volume **3**, Number **1/2011**

GENERAL CONSIDERATIONS REGARDING THE IMPACT OF THE VIDRARU LAKE HYDRO FACILITIES ON THE ENVIRONMENT

Remus PRAVALIE[1]

Rezumat. *În articol, după prezentarea parametrilor morfometrici, a condiţiilor fizico-geografice iniţiale ale bazinului hidrografic în care este situat lacul de acumulare Vidraru de pe Argeş, se analizează succint impactul acestuia asupra mediului riveran şi regional.*

Abstract. *After presenting the morphometric parameters and the initial physical-geographical conditions of the drainage basin where the Vidraru Reservoir is located, on the bank of the Argeş River, this article briefly analyses the impact of the basin on the riverine and regional environment.*

Keywords: *Vidraru Reservoir, impact, environment, analysis*

1. General Considerations

The first studies on the region where the Vidraru Reservoir is located, i.e. Făgăraş Mountains, were conducted by the French geographer, Emmanuel de Martonne, in the 19th century, when he made his first remarks on the Southern Carpathians (or the *Transylvanian Alps*, as he called them) and, consequently, on the Făgăraş Mountains.

Later on, after 1950, remarkable studies on the Făgăraş Mountains have been published by Gh. Niculescu (in 1959 and 1961), E. Nedelcu (in 1959, 1962, and 1966), M. Florea (in 1998), etc. Studies on glacial lakes, reservoirs and the Vidraru Reservoir have been conducted by P. Gâştescu (in 1971, 1996 and 2003), I. Pişota (in 1972), I. Ujvari (in 1972), and Al. Nedelea (in 2006).

The Vidraru Reservoir is located in the Southern Carpathians, in Făgăraş Mountains. A major surface of the Reservoir is located in the Loviştea Basin, in a graben, in the east side. The lake dam has the following geographical coordinates: 45°22' N and 24° 37' E (fig. 1.).

The lake covers an area of 870 ha, and has a total water volume of about 473 million m³, and a normal level of retention volume of 469 million m³ **[12]**, and the dam has a height of 166 meters.

The dam construction began in 1960 and was completed in 1966. At that time (in 1967), the Vidraru Dam was, by height, the fifth arch dam in Europe and the ninth in the world **[9]**. The dam is a double-arched concrete construction with a length of 307 meters, and a base width of 25 meters and a crown width of 6 meters.

[1]Student, III, Faculty of Geography, University of Bucharest, Romania, pravalie_remus@yahoo.com.

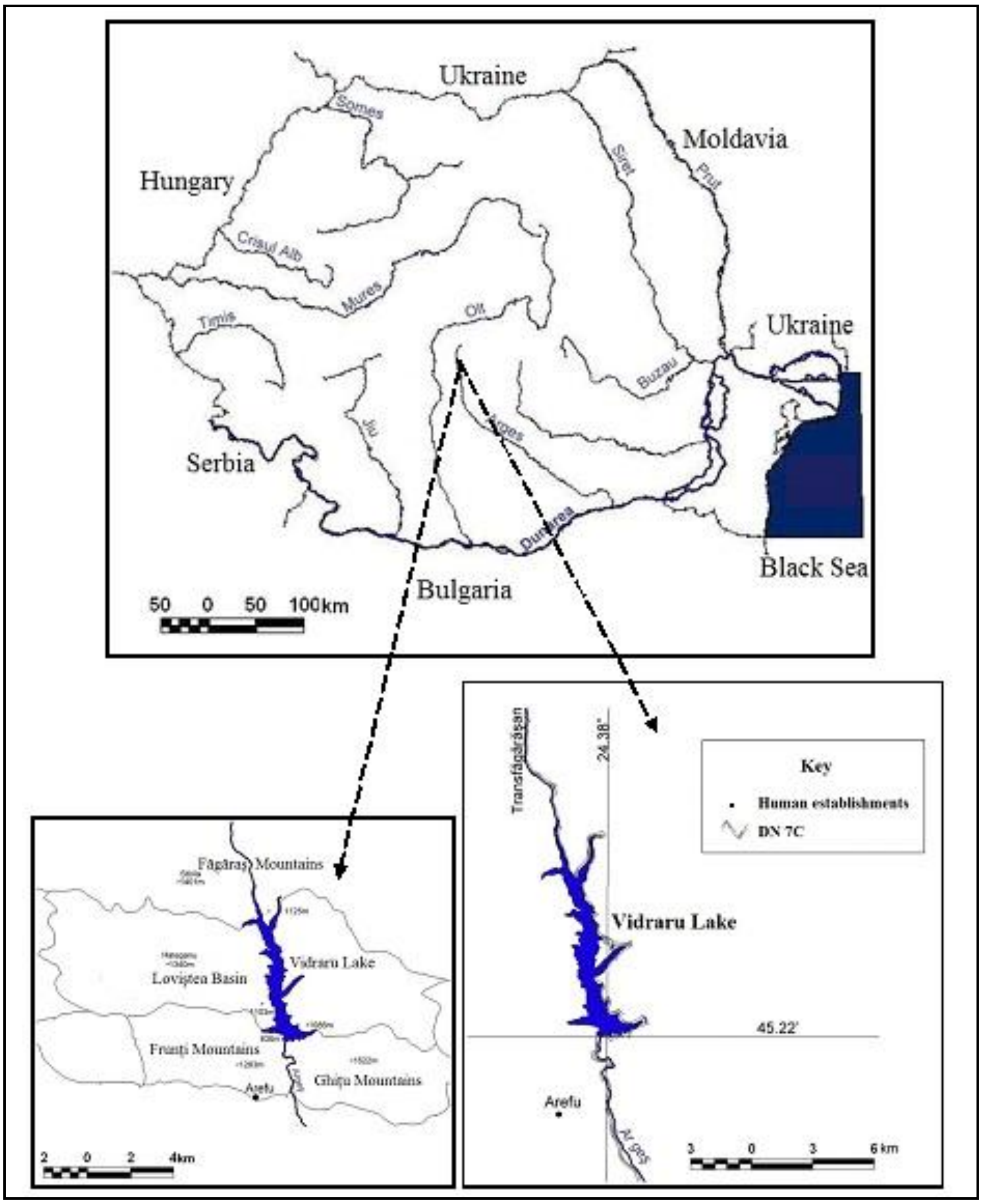

Fig. 1. Vidraru dam lake location (*Source*: Cadastral Map For Romanian Waters, 1992; Spatial data sets www geo-spatial.org).

Along with the dam, the hydroelectric power plant in Cetăţuia or Corbeni-Argeş was built as the first underground hydroelectric power plant in Romania located to a depth of 104 meters below the Argeş riverbed. It has a total usable power of 220 MW.

The water passing through the hydroelectric turbines flows into the Oesti Lake, downstream from it **[2]**.

The Vidraru Lake, together with the lakes on the bank of the Dâmboviţa River (e.g. Pecineagu, Sătic), is part of the Bucharest water supply system **[11]**.

2. Physical-geographical characteristics

In terms of ***lithology***, the Vidraru Dam is built mostly on crystalline rocks, namely gneiss (the Cozia gneisses), paragneiss, and hard rocks, that are resistant and water-repellent.

By its geographical position, the **terrain** of the drainage basin of the Vidraru Lake is characteristic of the high mountain area (Moldoveanu Peak, 8,346 ft., and Negoiu Peak, 6,713 ft.), with a crystalline structure affected by the quaternary glaciation that left glacial cirques at the top source of those two tributaries, Capra and Buda, harbouring the homonymous glacial lakes **[6]**.

The lake basin is mostly based on Loviştea Depression, in its eastern extension, where the heights are below 4,921 ft. (Lăcşor Peak, 4,829 ft., Haţeganu Peak, 4,396 ft.), and the lower part is located on the southern alignment of the Făgăraş Massif (Ghiţu Peak, 5,321 ft., in the east, and Frunţi Peak, 5,032 ft., in the west) **[10]** (fig. 2.).

The climate is influenced and determined by the movement of air masses, altitude and configuration of the terrain, but also by the existence of the Vidraru Lake that determines a topoclimate characterized by moderate temperatures, high humidity and a local air circulation in the form of local mountain – valley winds.

The average annual temperature is 6.0^{o}C, the lowest value being recorded in January (-2.4^{o}C), and the highest in July (16.1^{o}C).

Thus, the winter months (December, January and February) show temperatures below 0^{o}C. *The average annual depth of precipitation* is 770 mm.

The average annual wind speed is 0.9 m/s, the highest one being in March (1.2 m/s) and the lowest one in December (0.6 m/s). *The number of days with snow cover* is 101, with a maximum in January (27 days), followed by February (24 days), March (17 days) and fewer days in April, November and December, and the largest thickness is recorded in January and February, i.e. 15 to 20 cm **[13]**.

The lake-related ***hydrographic network*** is represented by two main tributaries: Buda (22.6 km) and Capra (20 km) that interflow in the upper part of the lake with the top source in the homonymous glacial lakes **[8]**.

Other tributaries of the lake are Cumpăna, Valea lui Stan, Oticul, Valea cu Peşti.

The vegetation is represented by levels: *the alpine level* (the pastures), *the subalpine level* (the scrubs), *the boreal level* (spruce forests), *and the nemoral level* (deciduous-beech and beech forests mixed with coniferous forests).

Although some of the forest vegetation out of the lake drainage basin has been reduced, especially on the contiguous slopes, because of the many holiday constructions, it still has a protective role against the scour and filling process.

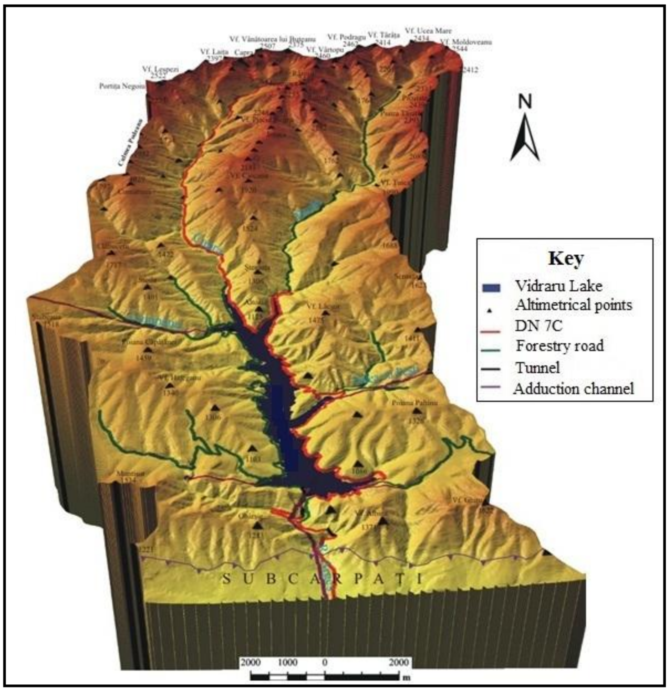

Fig. 2. 3D geographic and hydrographic map for Vidraru dam lake (*Source*: Nedelea, 2006).

3. The Impact of the Lake on the Environment

The emergence of the Vidraru Lake and Dam led to changes to all environmental components, from terrain to soil and biogeographical changes.

As concerns the ***terrain***, by the emergence of the lake, the first slope processes have been the lacustrine abrasion processes due to water level variations depending on the timing of the turbine flow rate. Also, in the upper part of the lake, one can detect the processes of filling/alluviation and the formation of submerged mini-deltas **[3, 4, 5]**.

Because of the emergence of the lake, a ***lacustrine topoclimate*** appeared and is characterized by changes in the rainfall regime, diurnal and seasonal with thermal inversions. Also, another consequence due to topoclimate is the frequent formation of fog layers at certain times of the year.

Changes in the ***hydrography*** can be seen mainly by abstraction/adduction necessary to supplement the tributary flow. The main abstractions were taken from the following rivers: Râul Doamnei, Cernat, Vâlsan, Topolog; thereby the water drainage basin expands from 286 km² to 716 km² and the average tributary flow from 19.7 m^3/s to 22.3 m^3/s **[1]**.

Also, by building the dam, changes have taken place concerning the local base level; the dam represents a human-determined threshold, resulting in a new upstream and downstream local base level, plus the modification of scour/filling processes **[2]**. Adjacent valleys were turned into bays by being flooded (e.g. Cumpăna, Valea Călugăriţei, Valea cu Peşti, etc).

The original water balance also changes; after the lake emerged, new elements have been introduced to both inputs (adductions) and outputs (increased evaporation at the lake surface; the presence of the turbine flow rate) (fig. 3.).

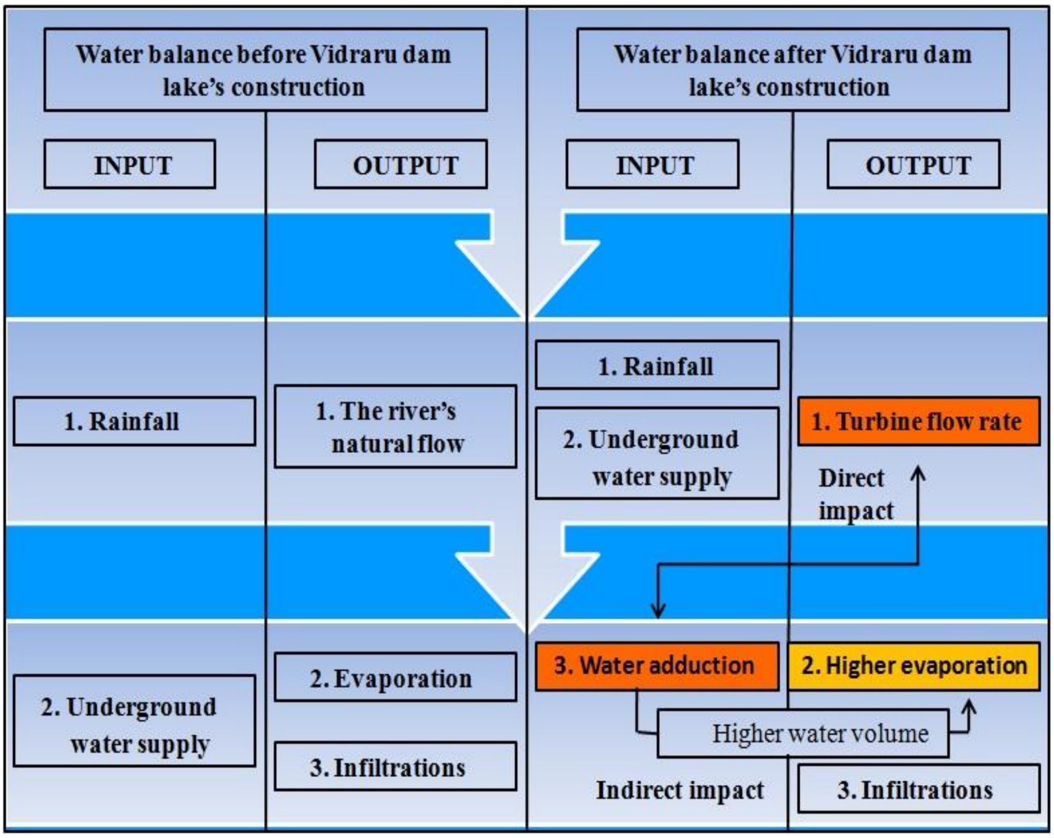

Fig. 3. Water balance changes after Vidraru dam lake's construction.

Another impact on the environment is the clearance of the standing stock of forests that was made due to the construction of the dam and the Transfagarasan Road that led to the emergence of adverse effects, such as water flowing, surface erosion, streaming, appearance of avalanche couloirs, landslides in the drainage basin and within the extent of the lake (reactivation of the processes of the surface and linear erosion, especially on steep banks, resulting in gullies, ravines, torrential bodies) **[7]**.

Except for these direct changes, ***the vegetation*** has also suffered indirect changes. Thus, due to the great volume of excavations and heavy vehicles driving on those two roads bordering the lake, changes occurred in the soil profile, land subsidence, and also a slowdown in the growth processes of forest species.

The fauna has also changed because the downstream-upstream migration of fish species (trout) was blocked. Another cause is the endangered biodiversity. The sculpin-perch (Romanichthys valsanicola), a relict fish that grows into the Vâlsan River is an example of this.

Because of the Vâlsan River capture in the Vidraru hydro facilities and because of the reduced flow, this fish is now considered an endangered species and is protected in a section of the Vâlsan River within the range of a spa area, named Brădet.

The construction of the Vidraru hydropower system also provided many benefits, such as fewer numbers of floods.

An example is the flood in the summer of 1941, when a part of the Corbeni village, located at the entrance of the Argeş Gorges, was destroyed.

Another benefit of the Vidraru hydro facilities was related to the restoration of the agrarian areas, based on the downstream hydro facilities, of about 10,000 ha out of the Argeş Basin, and the creation of the possibility of developing new industries in Curtea de Argeş, and especially, in Piteşti.

Energy industry development and the emergence of a major water reservoir used in case of drought are other important benefits that the Vidraru hydro facilities offer.

Landscape changes that have occurred by building the hydroelectric power plant, the existence of some historical monuments of great importance in the region, such as the Poienari Citadel, the appearance of the Vidraru Lake and the construction of the Transfagarasan Road that runs over the crown of the dam attract many tourists every year.

The development of tourism also triggered the appearance of guesthouses, which have a negative impact on the environment in the sense that some of them lack septic tanks; therefore the surrounding water is polluted with human waste.

It is necessary to carefully monitor the quality of the water in this sector, especially since the Vidraru Lake is part of the Bucharest water supply system.

All of these changes that have an impact on the environment as a consequence of the appearance of the Vidraru Reservoir can be described by grouping them into three categories, namely: physical-geographical changes, biological changes, and socio-economic changes (fig. 4.)

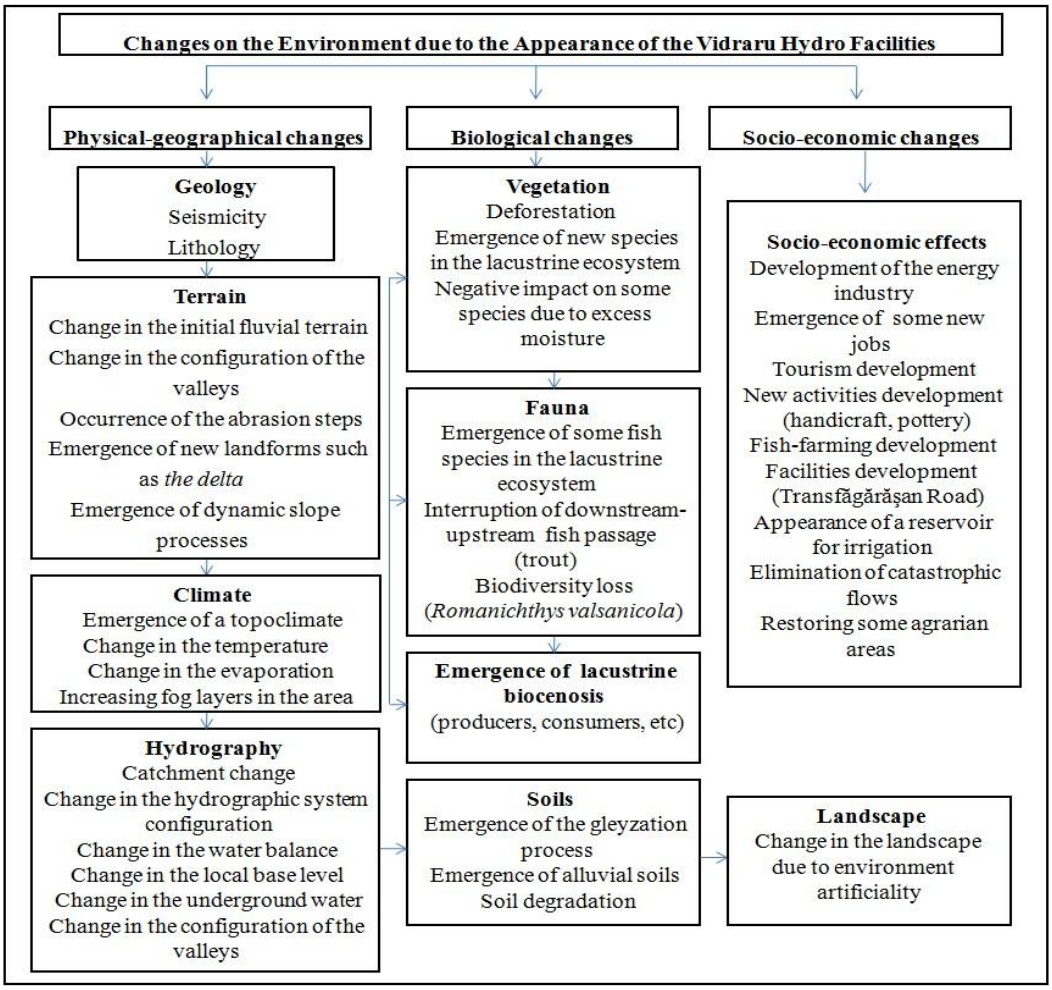

Fig. 4. Main environment changes caused by Vidraru dam lake's establishment
(after P. Gastescu, 2003).

3. Conclusions

Besides its relevance related to energy and water supply, and tourist attraction, the Vidraru hydropower system, one of the most important in Romania, has had several negative consequences on the environment. The Vidraru Lake represents a model/example for identifying and assessing the impact on the riverine environment, but also on the related hydrographic system.

At the same time, the geological, geomorphological, climatic, hydrological, biogeographical and soil-related features that were analysed shape the overall physical-geographical image of the Vidraru hydro facilities. The results that were obtained also promote an overall image of the relevant area and help identify the environmental features in the context of water resources facilities, defining the Vidraru Dam.

R E F E R E N C E S

[1] Bocioacă, M. (1970), *Lacul Vidraru-studiu hidrologic preliminar*, Physical Limnology National Colloquium Paper, Institute of Geography, Bucharest.

[2] Dinoiu, Nicolae (2004), *Lacul de acumulare Vidraru şi rolul său în gestionarea apei Bucureştiului*, Dissertation Paper.

[3] Gâştescu, P. (1971), *Lacurile din România. Limnologie regională*, Romanian Academy Publishing House.

[4] Gâştescu, P., Driga, B. (1996), *Lacul de baraj antropic-un ecosistem lacustru aparte*, Geographical Magazine, vol. II-III, Institute of Geography, Bucharest.

[5] Gâştescu, P., Driga, B., Sandu, Maria (2003), *Lacurile de baraj antropic - între necesitate şi modificări ale mediului*, in volume Risks and Disasters, vol. II, editor V. Sorocovschi, Publishing House of Science Books, Cluj-Napoca.

[6] Nedelcu. E., (1966), *Observații geomorfologice in regiunea lacului de acumulare din bazinul Argeșului superior*, SCGGG (Studies and Research of Geography, Geology and Geophysics), Geography Series, t XIII, no. 1.

[7] Nedelea, Al., (2006), *Valea Argeșului in sectorul montan. Studiu geomorfologic*, Bucharest University Publishing House.

[8] Pişota, I. (1972), *Lacurile glaciare din Carpaţii Meridionali*, Romanian Academy Publishing House.

[9] Pop, Grigore (1996), *România-Geografie hidroenergetică*, Cluj University Publishing House, Cluj Napoca.

[10] Posea, Gr and Badea, L. (1984), *România - unitățile de relief (Regionarea geomorfologică*), Map, Scale 1:750.000, Scientific and Encyclopedic Publishing House, Bucharest.

[11] Stănescu, Viorel Al., (1995), *Hidrologie urbană,* Educational Publishing House, Bucharest.

[12] *** (1992), *Atlasul cadastrului apelor din România, Partea I, II*, Ministry of Environment, Aquaproject SA, Bucharest.

[13] *** (1997), Cumpăna Weather Station, The National Meteorological Administration.

[14] *** www.geo-spatial.org.