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CORRELATION OF THE RELIEF CONDITIONS, HYDROGRAPHIC NETWORK FEATURES AND HUMAN INTERVENTIONS WITHIN THE BLAHNIŢA RIVER BASIN (SOUTHWESTERN ROMANIA)

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Abstract: Significance of rivers within plains is increasing nowadays as hydrographic network has become one of the most important strategic axes. The objective of the present study is to highlight the evolution of the Blahniţa River and the adjacent hydrographic network (in relation to the hydrostatic level of the groundwater aquifer) in the context of current modeling (natural and anthropogenic) of the entire river basin. The results are a step forward towards understanding the degree of anthropogenic transformation of a hydrographic network. The digital data obtained from the analysis of the cartographic documents contributed to the identification of hydrographic network along the considered period (1978-2020) with the presentation on four stages of the evolution under the anthropogenic interventions such as: construction of the irrigation system, drainage of the ponds, regularization and earth dams along the Blahnița River and channalization of the Blahniţa course. The geomorphological analysis of the relief conditions was based on the study of the hypsometry variation at the level of the entire hydrographic basin, especially along the watercourse. In this sense, the results highlight the importance of slope for surface flowing: the slope of the Blahniţa river basin presents values of 4 to $2^{o}/_{oo}$ to the confluence with Orevița and values from 1.8 to $0.06^{o}/_{oo}$ to the exit from the plain to the Danube Floodplain. The importance of this research consists in rising a red flag on former wetlands that have been dried up, which are currently undervalued and which may be true ecosystems for sustaining habitats in the future.

Keywords: hydrographic network, landscape conditions, geomorphological changes, human interventions, digital cartographic data

1. INTRODUCTION

The hydrographic basin, a spatial mapping unit, is understood as a system, as well as an integrative functional unit for the analysis of geomorphological dynamics (Rădoane 2002, Silveira et al., 2017). Small rivers, generally due to low flows, are extremely sensitive to anthropogenic needs in their river basin. Any human intervention, even seemingly insignificant, in the main current of the river can affect the entire downstream course (***http//www.eco-tiras org/books).

One of the most important methods used to evaluate the changes of the hydrographic network in a receiving basin (rivers, lakes, ponds) is the study of topographic maps made in successive stages (Haase et al., 2009, Swetnam 2007). When studying the historical changes of watercourses, it is necessary to record, in addition to the study of maps, the information obtained from the citizens of the riparian localities (Demek et al., 2011, Havlíček & Chrudina 2013). The long-term development of watercourses has been studied on the basis of successive topographic maps in several European countries such as: Romania (Ichim & Rădoane 1990, Perșoiu & Rădoane 2011, Armaș et al., 2013), Poland (Pieńkowski 2003), France (Passy et al., 2012). Such considerations support the understanding that morphometric and geomorphological cartography contribute relevant information to territorial and environmental management. Further, the concepts of classic geo-morphology on the energy of topography, the structure of river basins and their linkage to modern tectonics can be verified using a large body of statistical data to obtain a further development, based on introducing digital terrain models and new algorithms for their processing (Gartsman & Galanin 2011, Lai et al., 2016, Rădoane et al., 2017). The researchers should give priority to restoration at a regional scale, which corresponds to the objectives of River Basin Management Plans for the interval beyond 2021 (Ioana-Toroimac et al., 2017). A study on the entire river basin in the plain in which the detection of geomorphological aspects is part of the environmental management system is beneficial for the continuous development of human communities and for land use (Băloiu 1980, Ricca & Guagliardi 2015, Dóka et al., 2019).

Based on the literature presented and on the field research carried out between 2018 and 2020, the study aims at analyzing the current situation in the evolution of the Blahniţa river basin in Blahniţa Plain, underlining the relationship between anthropogenic interventions and current geomorphological processes. The research covers the period 1978-2020 and its main objectives concern the human interventions on the Blahnita river basin (regularization of the Blahnita course, drainage of wetlands and expansion of agriculture, cuts of forest areas that fix the sand dunes) and their pressures on the environment (changing landscape features, accelerating geomorphological processes, lowering the groundwater level, soil erosion and reactivation of the sand dunes).

The contribution of this study and its results consists in the real help provided to the scientific community and the regional authorities in drawing up a sustainable management concerning thehuman activities and the natural conditions in Southwestern Romania.

2. STUDY AREA

The Blahniţa River Basin is located in the southwestern part of Romania. It has an area of 555 km^2 (Atlas of the Romanian Water Cadastre) and it covers a large part of the northern half of Blahnița Plain with extension in Bălăciţa Piedmont. Blahnița Plain is a low plain divided into two units approximately equal in area and altitude: Jiana Plain and Punghina Plain (Coteț 1957), both arranged, as two scales, on an NV-SE slope.

In Jiana Plain, the Blahnita River Basin covers 330 km^2 (representing 85% of its surface) and is characterized by erosion in the most advanced stage (Boengiu et al., 2010). The catchment is delimited by the slope of Punghina Plain in the southeast and south, by the Getic Piedmont in the east and north and by the Danube Floodplain in southwest (Fig. 1). In order to better understand the evolution of the Blahnita River and its basin, we have to briefly analyze the evolution of Jiana Plain.

Figure 1. Study area: the Blahniţa river basin in the Blahniţa Plain

Jiana Plain was shaped by the Danube River, which dug its eight terraces in the southwest of the Getic Piedmont, as it gradually descended to the south (Coteț 1957, Mihăilescu et al., 1969, Niculescu & Sencu, 1969). The peculiarity of Jiana Plain consists in the fact that the Danube River, at the level of the fourth terrace on which it is located, made a reverse advance in a loop to the northeast, destroying the upper terraces, during a flood (Boengiu 2008, Răducă et al., 2019). This event generated high shores both east, north-east to the piedmont and south east-south to the higher plain of Punghina.

The Blahnița River flows from the Getic Piedmont to Jiana Plain, where it significantly expands its river basin. The two sectors, the piedmont and the plain, have totally different morphological and hydrological characteristics (Boengiu 2008). From the piedmont, near Rogova, Blahnița River descends in the plain where initially it formed a sedimentary cone. Also, from the piedmont, its most important tributary, Orevița, descends to Vânju Mare, which made a sedimentary cone as well. At present they are united in an extended glacis from Rogova to Vânju Mare. In the plain sector, the Blahnița River has a continuous course, with successive meanders forming in some places ponds and lakes over time. To explain the flow of the Blahnița River in the plain, at first converging to the east, according to the inclination of the layers, we mention that they underwent a rise in the Neotectonic phase Pasadena from the Middle-Upper Pleistocene, which continues today, with 2 mm/year, in the west of the Jiana Plain, according to the map of the recent crustal movements

(Mihăilescu et al., 1969, Boengiu 2008). Meeting harder Pliocene clayey rocks, the Blahnița River changed its course to the south, obsessively on the structure, a sector in which the vertical erosion of the ridge continued until the anthropogenic intervention on the course. Although these characteristics of the Blahnița river basin, affect the life of the riparian communities, they did not generate concerns for general studies, which would allow the management of the river throughout it.

The Blahnița River (56 km length - Atlas of the Romanian Water Cadastre) and its main tributaries from Jiana Plain, the Orevița and the Valea lui Stan, are allochthonous, springing from Bălăcița Piedmont. The river basin of the Blahnița, overlaid on Jiana Plain, is asymmetrical, having the main development on the right side. In the plain sector there are no conditions for the appearance of springs, so Blahniţa has a single right tributary (the Jiana stream).

The relief conditions (average drainage slope in the plain sector is $1.68^{o}/_{oo}$, $3.42^{o}/_{oo}$ in the northern Rogova - Bucura sector and $1.1^{o}/_{oo}$ in the N. Bălcescu - Balta Rotunda sector) confirm the fact that intervention, however small, at one point of the main course may affect the entire course downstream.

3. MATERIALS AND METHOD

The study of the evolution of the Blahnița river basin is based on the interpretation of cartographic materials, the extraction of digital data and the field validation of the obtained results. For the study of the temporal evolution of the river, the following were used: Topographic map sc. 1/25,000 from 1979, Hydrogeological map sc.1/100,000 from 1981, Topographic map sc.1/50,000, from 1991 (.ecw file).

In the study of the current situation of the Blahnița River, we used satellite images provided through the Google Earth program and data obtained from field measurements (GPS South S82-T) on the land modeling stage, the course of the Blahnița River (course sections in the riverbed natural and landscaped areas) and the condition of the canals and the extension or restriction of ponds/wetlands in its river basin.

The methodology consisted in raising important landmarks in the coordinates of topographic maps (Mariani et al., 1995, Pătru-Stupariu et al., 2011, Grzywna & Nieścioruk 2016) that were processed in the Global Mapper program and by GIS techniques (Papastergiadou et al., 2008, Plasztan et al., 2018). The CORINE Land Cover, SRTM (1-arc-second Resolution, STRM Plus V3) and DEM databases were also used. Images inserted in the text have been processed or adjusted in the Adobe Photoshop CS6 and Corel PHOTO-PAINT 2019 image editing programs. Finally, for the four stages of the evolution of the Blahniţa River (1979-1981, 1992, 2002 and 2018-2020) maps of the surface hydrographic network were drawn up. Because groundwater comes in some places in contact with the river, influencing each other, data on the depth of the piezometric level measured in existing hydro-observation boreholes (boreholes that are part of the national network) were used in the analysis. The aim is to draw up a map of the depth of the groundwater level, in the plain basin of the Blahnița River. The field observations from 2018-2020 allowed the validation of the statistical results and their correlation with the geomorphological particularities and the effects of the interventions.

4. RESULTS AND DISSCUSIONS

4.1. Geomorphological modeling

In the Blahniţa river basin in Blahniţa Plain there are a series of geomorphological processes determined by the local geographical factors. The geomorphological analysis of Jiana Plain, which the Blahniţa river basin overlays, highlights the existence of four sectors (Fig. 2) with specific aspects.

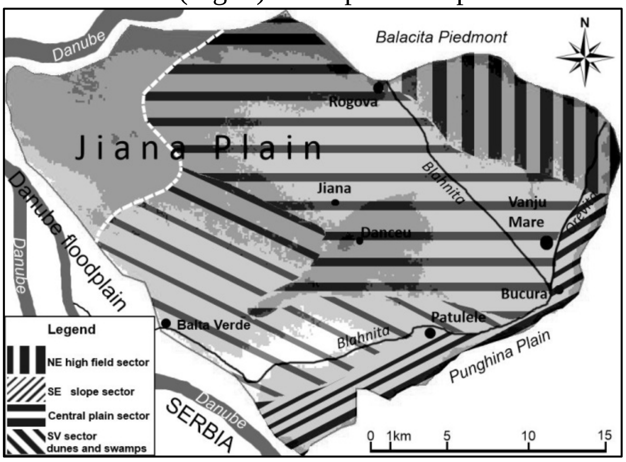

Figure 2. Geomorphological features of the Blahniţa river basin

The northeastern or the high field sector lays between Rogova and Vânju Mare and is presented as a slope to piedmont. This high field is shaped up as a glacis built from the union of the sedimentary cones made by the Blahnița and Orevița rivers at the exit from the piedmont (Coteț, 1957, Boengiu, 2008) (Fig. 3). The average altitude of the glacis decreases from 120 m at the limit with the piedmont to 75 m in the plain, characterized by typical processes of water erosion on the high terraces of the Danube (runoffs, ditches, gullies, ravines and small landslides) (Boengiu et al., 2010), which become more and more visible towards the contact with the piedmont and more faded towards the plain.

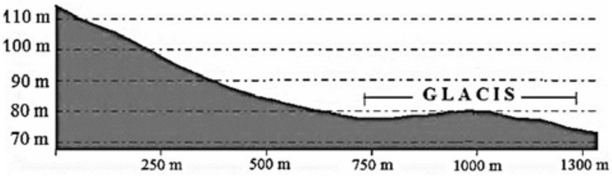

Figure 3. Glacis section from Rogova and Vânju Mare

The southeastern sector presents geomorphological processes characteristic of the accentuated slopes, along the coast of Punghina Plain, in the east of Oreviţa and south of Blahniţa. It is characterized by decreases of altitudes from 170-120 m at top line of the ridge Vânju Mare - Pătulele to 80 - 70 m at the foot line of the coast. The front of the coast is interrupted by numerous torrential valleys, several gullies and ravines (Fig. 4), as well as by stabilized and active landslides (Fig. 5, a, b), more numerous in the northern half.

Figure 4. Ravine near N.Bălcescu (Răducă – April 2020)

The central sector of the Blahnița river basin has the largest surface and shows the fewest manifestations of geomorphological processes. This is the most fertile area of Jiana Plain, completely covered by agricultural crops. Rivers and ponds were dammed and canaled. A specific feature is the erosion witness Jiana, oriented in the northeast-southwest direction, which has undergone a rain-wind modeling with partial erosion. The altimetry is between 102 m in the southern extremity called Capu Dealului and 114.6 m in the trigonometric point Jiana, in the north (Fig. 6). Compared to the plain, the difference in altitude is 30-50 m in the south to 30-40 m in the north. Both slopes of the erosion witness are parasitized by elongated dunes, oriented northwest - southeast, almost entirely stabilized with linear acacia forests.

The sector of sands and interdune ponds stretches over a large area in the southwestern part of Blahniţa River Basin in Blahniţa Plain (Fig. 2). It is a tabular area divided in a northern part with fixed dunes with some small interdune lakes and a southern part where permanent stagnant waters in a swampy area are located. The entire south and west part of the Blahniţa river basin is characterized by an accentuated dynamics and modeling of the sands under the influence of the wind. The altitude of the plain decreases from northeast to southwest from 90-115 m in Jiana area to 45-60 m in Blahnița low plain, at Balta Verde.

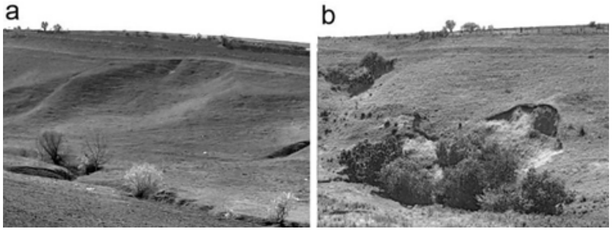

Figure 5.a) Stabilized landslide;
b) Active landslide north of Viaşu (Răducă – July 2020)

4.2. Drainage regime conditions

In order to understand the degree of anthropogenic transformations of the drainage network, knowledge on its natural changes is required. From the Getic Piedmont, the Blahnița River enters Jiana Plain at Rogova, at the confluence with its tributary, the Poroinița stream. Crossing the glacis mentioned above, it reaches the plain where it flows east to the confluence with the second important tributary, the Orevița then to the south towards its confluence with the Danube River.

Google Earth images, the CORINE Land Cover database (EEA, 2018), SRTM (1-arc-second Resolution, STRM Plus V3), and field measurements (GPS South S82-T) were used to highlight the slopes of the Blahniţa valley in its flow through Jiana Plain. Thus, the elevations of the riverbed were raised in the accessible points. They indicate that of the Blahnița River flows down on the steepest slope of 4.27‰ at Hotărani, its slope decreases to 2.57% at the confluence with Orevița tributary. From this point southwards to the Danube Floodplain the slope is below 2‰. In the central sector, Nicolae Bălcescu - Pătulele, the slope decreases from 0.24‰ to 0.06‰ (Table 1, Fig. 7).

The flow of the Blahnița River is insignificant, given its length, the number of tributaries (one) and the crossing of a plain region. The river network is poorly developed, and is largely influenced by the restrictive climatic conditions (Marinică & Marinică 2014, Vlăduț & Licurici 2020).

From Table 2 it results that the multiannual flow measured at Pătulele hydrological station (Qo) is 0.50 m^3/s. The maximum monthly flow (QL max) was 7.25 m^3/s, recorded in March (year 2006), quite a small value compared to the maximum multiannual flow (reference), which is 14.47 m^3/s. The percentage drainage registered high values in March and April (11.2% and 11.4% respectively), confirming the typology of the rain-snow drainage regime of the Blahniţa River (Table 3). Those features rank the study area among the Oltenia poorest catchment areas in terms of water resources, considering the surface runoff.

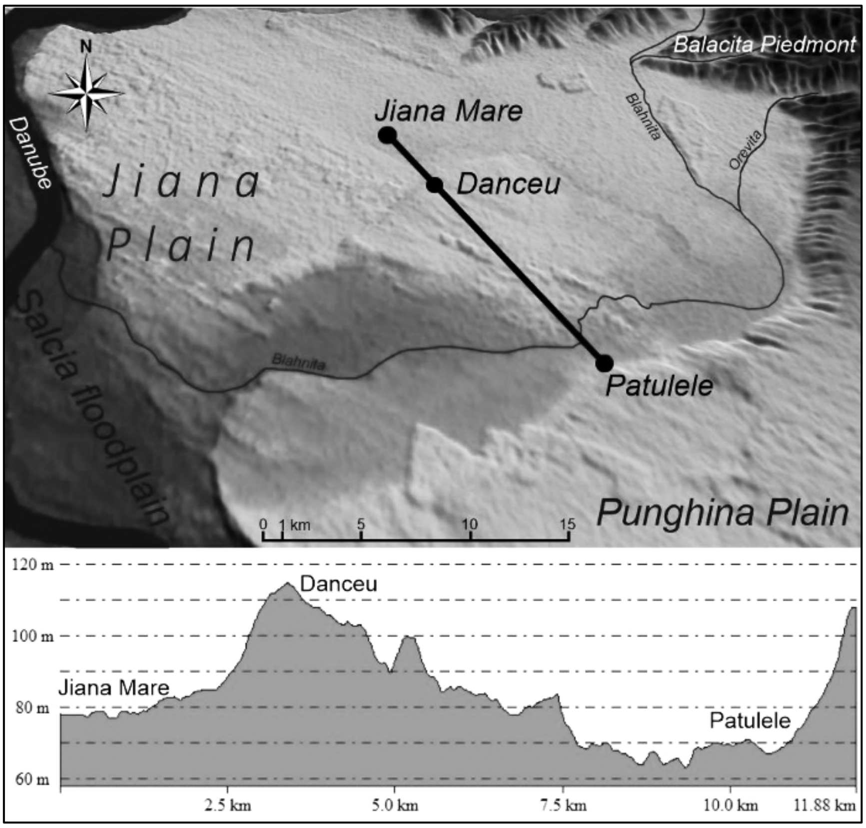

Figure 6. Section over the witness of erosion from Jiana Mare to Pătulele

Table 1. Data on the Blahniţa river channel slope

Measurement point / Thalweg altitude (m)		Distance between (km)	Measurement point / Thalweg altitude (m)	Slope (⁰/₀₀)
I Rogova Bridge / 105.5		5.26	II Hotărani Bridge / 83	4.27
II Hotărani Bridge / 83		3.30	III Confluence with Oreviţa / 74.5	2.57
III Confluence with Oreviţa / 74.5		2.78	IV N.Bălcescu Bridge / 71.5	1.07
IV N.Bălcescu Bridge / 71.5		4.55	V Pătulele Entrance / 70.2	0.24
V Pătulele Entrance / 70.2		5.00	VI Pătulele Bridge / 70.1	0.06
VI Pătulele Bridge / 70.1		3.50	VII Pătulele Exit / 63.5	1.85
VII Pătulele Exit / 63.5		2.16	VIII Dănceu Bridge / 57.5	2.77
VIII Dănceu Bridge / 57.5		5.18	IX Swamp Rotunda Bridge / 53	0.86
IX Swamp Rotunda Bridge / 53		6.44	X Balta Verde Bridge / 43.5	1.47
X Balta Verde Bridge / 43.5		0.42	XI Danube Floodplain / 39.1	10.3

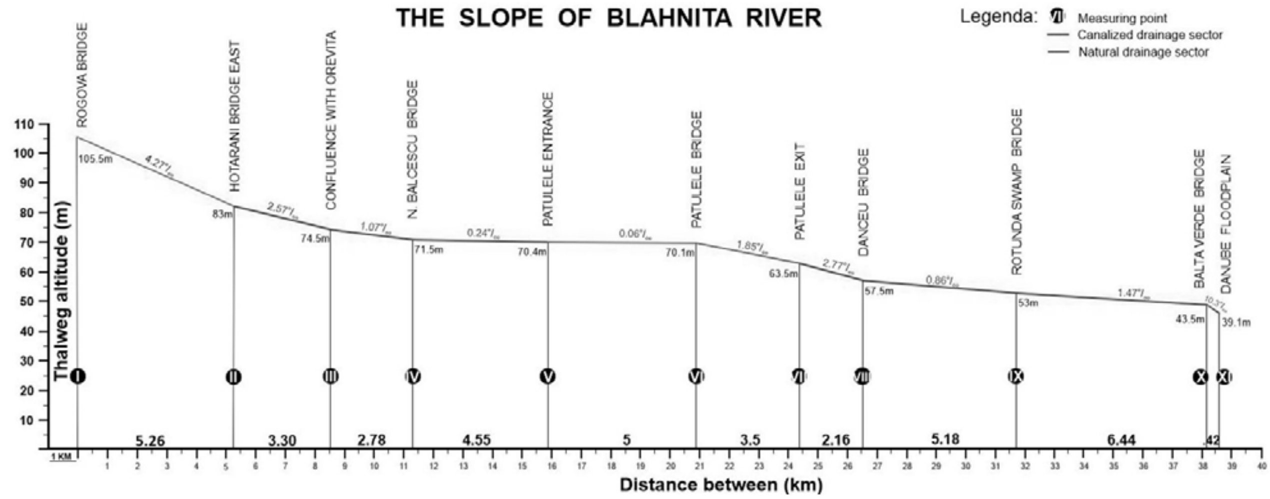

Figure 7. Longitudinal profile of the Blahnita River in Jiana Plain

Table 2. Maximum monthly flow in the Blahnița River at Pătulele hydrometric station*

Q_0 (m^3/s)	QLmax		Month	QLmax/Q_0	Year
0.501	7.25		March	14.47	2006

*observation period: 1992 – 2018

Table 3. Percent of monthly flows (%) in the Blahnița River at Pătulele hydrometric station*

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	X
8.42	9.34	11.20	11.40	8.70	7.89	6.20	5.59	5.41	7.45	8.07	10.20

*observation period: 1992 – 2018

4.3. Anthropogenic interventions

The anthropogenic changes occurred in the river basin of the Blahnița during the analyzed period consist mainly in the channelization of the river Blahnița and its tributaries, and the drying and drainage of the main lakes or swamps adjacent to the river (Fig. 8-11). The regularization of the Blahnița River was made gradually through an earthen canal, with the walls banked and with earth dams against floods on either side. This canal also played an important role in Crivina - Rogova irrigation system. From the western extremity, the water was raised from the Danube with the help of pumps at the level of the Blahnița and was then gravitationally distributed through a network of secondary canals for crop irrigation. The second system of canals aimed at draining and drying the ponds and swamps in Bucura - N. Bălcescu area, where the groundwater level appears on the surface (Fig. 12).

The evolution of the Blahnița river basin, correlated with hydromorphological pressures, is represented in the four successive stages, as follows:

- In a first stage (1979-1981) the Blahnița River was regularized through a wall earthen canal and with earth protection dams, from Rogova to Bucura where there was a swamp with the same name and having an area of 275 ha - measured on the topographic map from 1979 (TM'79). After passing through Bucura Swamp, the Blahnița headed south through a new swamp, being fed with the water of a former tributary only 12 km long, on the route on which there was a group of linear ponds at that time: Hotărani Swamp (110 ha - TM'79), Băieșului Swamp (180 ha - TM'79), which ends with Bălcescu Swamp (270 ha - TM'79), after the name of the locality on the territory of which it is located. To drain the swampy area, from its southern end, a drainage canal was built on the river route to Ontolea Lake united with Rotunda Lake, in the same way as the one from Rogova to Bucura. After passing through Rotunda - Ontolea Lake (505 ha - TM'79), the river flowed through a new canal with walls banked and marginal earth dams to Balta Verde, where Blahnița enters the Danube Floodplain (Fig. 8). Jiana Swamp (170 ha) was supplied with water coming from the northwest of Hotărani Swamp.

- In the next stage (1992) the Blahnița River was regularized through the mentioned canal, from Rogova to Bucura, where there was a swamp with the same name (with an extension identical to the one from the previous stage). Through Bucura Swamp, Blahnița passed and went southward, also on its natural route, but without the swamp between Bucura and Nicolae Bălcescu, which in the meantime had been drained, where it met the previously built drainage canal which still drains Hotărani and Băieșului swamps. There is no change compared to the previous stage (Fig. 9), from this point to its confluence with the Danube. The only difference is that Ontolea Lake, with a small area, was separated from Rotunda Lake. On that map, there appears a small pond south of Cioroboreni, Sărata Swamp.

- The analysis of the topographic map from 2002, highlights the continuation of the drainage program of the remaining ponds and swamps and the channelization of the Orevița and the Valea lui Stan tributaries, which have their sources in the Getic Piedmont and which caused damage to Vânju Mare and especially to downstream crops. At this stage, Bucura Swamp was drained and Hotărani and Băieșului ponds were drained as well, with the help of an earthen canal (Fig. 10). It should be mentioned that after 1990, the canal irrigation system, in which water was provided by pumping from the Danube, was abandoned, because after the restitution of previously nationalized properties, the system became very expensive and unsustainable for the small landholders. At this time, the entire course of the Blahnița River was channelized. From all of the ponds, only Ontolea and Rotunda still had water surface, the others were still partially swamped, especially in spring.

- The last stage of the analysis is the current one (2018-2020), which is based on current satellite images, corroborated with observations and measurements in the field (Fig. 11). The existing situation, at this stage, presents the Blahnița River channelized from Rogova to the discharge into the Danube, the canal being built next to Rotunda Lake, which is a private property and is arranged for sport fishing. It should also be mentioned that when crossing the northern limit of Pătulele village where the slope is only 0.06‰, the river makes numerous meanders and has its course not channelized, being a place of relaxation for locals and a water source for animals. This sector is included in the protected area for avifauna, Jiana (ROSCI0306) (European Environment Agency, Natura 2000 Network).

At the end of 2020, from the Google Earth satellite images, corroborated with field research, it can be seen that, of all the swamps in the Blahniţa basin, only Ontolea (30 ha) and Rotunda (310 ha) still had water surface, the others were still partially swamped, especially in spring time: Bucura Swamp (2 ha at the confluence with Oreviţa), Hotărani Swamp (3.1 ha between Cioroboreni and Hotărani) and Jiana Swamp (1.4 ha in the north of Jiana Mare).

The hydrostatic level of the groundwater aquifer, with depths lower than one meter, had a significant contribution to the formation of wetlands in the Blahnița river basin (Fig. 12). In the existing hydro-observation drillings, level measurements were made in the summer of 2015-2016 (The Jiu Water Basin Administration data). Analyzing the depth of the groundwater level in the respective boreholes in the Blahniţa river basin, a map was made with hydroisobates that highlights a fairly wide area, where this level is at depths between 0 and 1 m which favors its rise, especially during the rainy periods of the year.

4.4. Results validation

The results of the study obtained from the temporal analysis of the hydrographic network were drawn up on the basis of cartographic documents of the Blahnița river course. Moreover, these results were further correlated with the natural and anthropogenic changes suffered between 1978 and 2020 in the entire river basin.

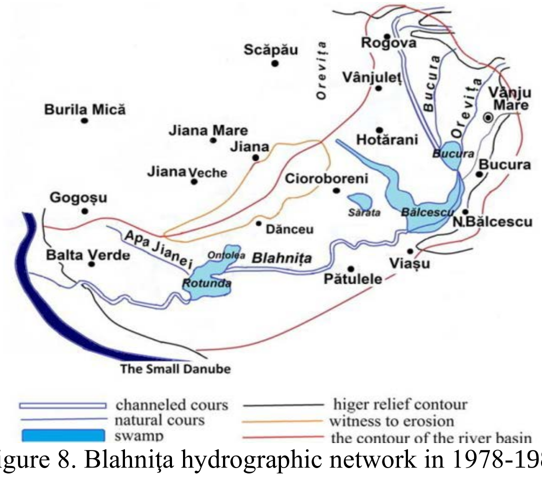

Figure 8. Blahniţa hydrographic network in 1978-1981

First of all, the validation of the results of the cartographic analysis was made by similar studies on the methodology used. The 19th century topographic maps were of much lower geometric quality compared to the early 20th century and modern maps. The maps of the period of the last 50–100 years examine the changes in the hydrographic network and the results show the numeric values illustrating quantitative changes. They are also a step forward towards understanding the degree of anthropogenic transformation of a damage network (Rădoane et al.,

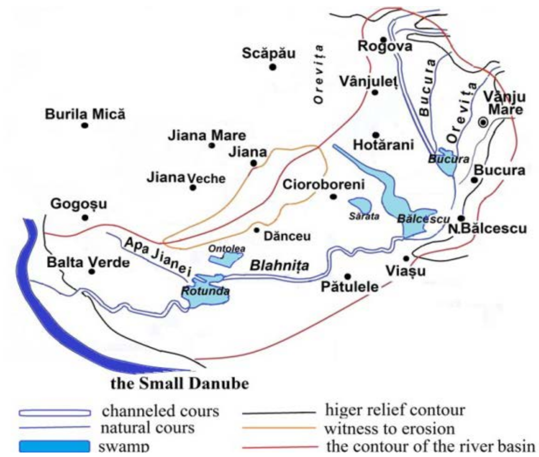

Figure 9. Blahniţa hydrographic network in 1992

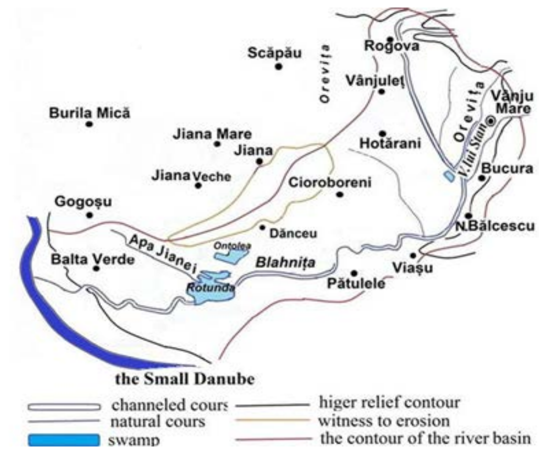

Figure 10. Blahniţa hydrographic network in 2002

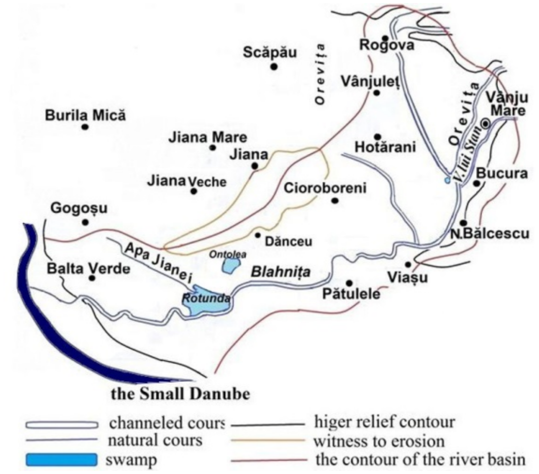

Figure 11. Blahniţa hydrographic network in 2018

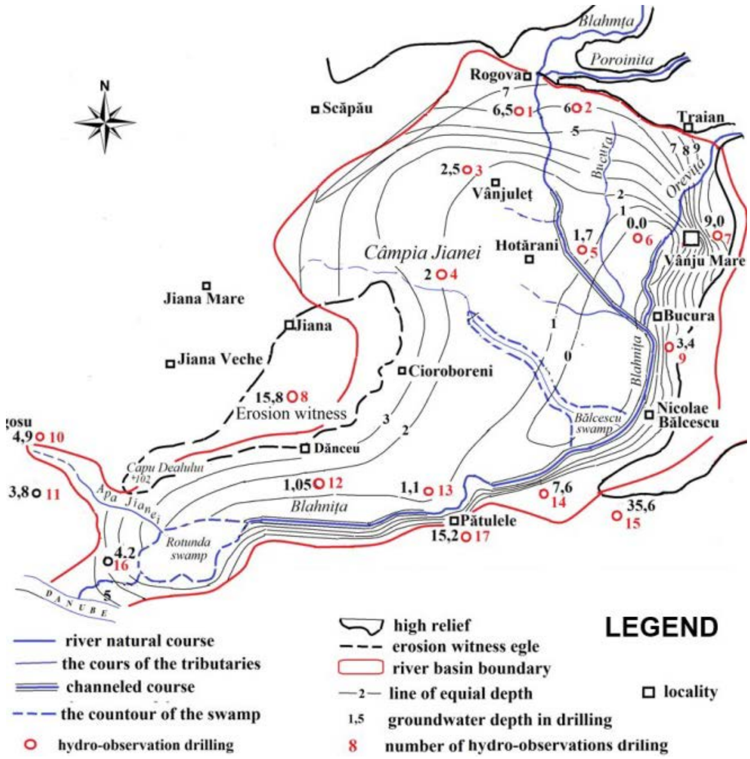

Figure 12. Map of hydroisobate in the Blahnița river basin

2013, Grzywna & Nieścioruk 2016, Pătru-Stupariu et al. 2011).

The changes of the last 40 years have drawn a modern and complex hydrographic network in Bălăcița Plain. The cartographic documents used in the first stages of the analysis of the hydrographic network in the Blahnița basin highlight the hydrotechnical works, and, unlike the satellite images, the discharge of watercourses, swamps and agricultural lands in the Blahnița major riverbed can easily be observed.

Several research studies suggested that changes in land use in southwestern Romania during previous decades can be related to global environmental change and human interventions (Dumitrașcu 2006, Licurici 2011, Prăvălie 2013).

In the Jiana-Pătulele area, based on the comparative analysis between topographic maps, Google Earth satellite images and the CORINE Land Cover database, a reduction of forest areas by 37% (1666 ha) is reported in 2018, compared to 1981.

A case study was carried out at Pătulele on the comparative analysis of topographic map (Topographic map of Romania 1979 made by the Military Topographic Department) and satellite images (Google Earth Pro 04/2020). As we can see, the cut of the mulberry tree forest and the destruction of the silkworm farm led to the appearance of the dunes at Pătulele (Fig.13).

The insufficient forest cover causes significant environmental imbalances in the basin which largely consists of sandy soils that require stabilization through vegetation (Prăvălie et al., 2017). In the Blahnița river basin, the main cause of the reduction of the forest surface is of an anthropogenic nature through the deforestation carried out by the authorized owners.

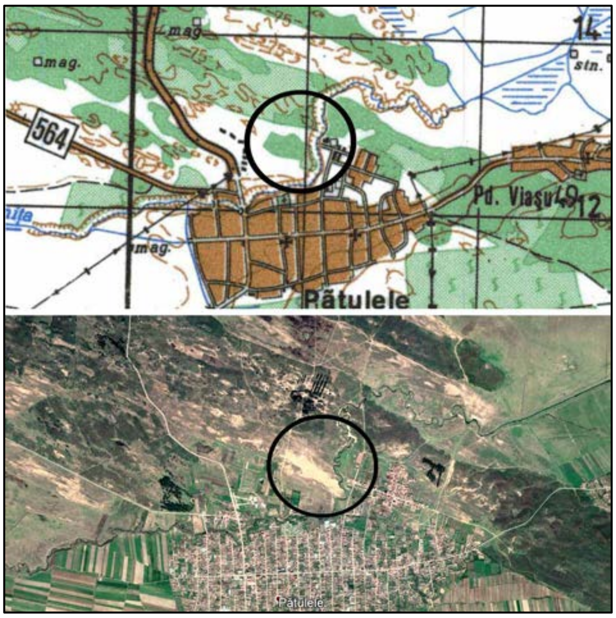

Figure 13. Sand dunes reactivated North of Pătulele: a. Mulberry tree forest-Topographic map 1979; b. Sand dune-Google Earth PRO (accessed April 2020)

Studies analysing the spatial-temporal land-use changes in using data provided by Corine Land Cover in the Southern Oltenia show significant amendments at the level of land use classes, certain categories playing an essential role in stopping or reducing the negative effects of these changes: dunes stabilization, but also keeping optimal hydrological conditions and preventing soil erosion as well (Prăvălie & Sîrodoev 2013).

Secondly, the reliability of the results obtained is supported by the validations made during the field visits. Spatial-temporal analysis of the hydrographic network on the cartographic documents is confirmed by the observed changes in the landscape.

Given this study results, we can claim that the surface of swamps and lakes has been drastically reduced in the last 40 years, from 1,510 ha to 346 ha. All these drained lands have been transformed into arable land (Fig. 14).

Figure 14. Human interventions within the Blahnita river basin: a. Dams along the Blahnita River (Bucura settlement): b. Swamps and ponds transformed in arable land (N. Bălcescu settlement)

All the human interventions on the hydrographic network and on the vegetation in the Blahnita river basin have determined changes in the landscape by accelerating some geomorphological processes. The sands carried by the winds from W-NW to E-SE were deposited and fixed in the forest areas and in the crops between Jiana and Pătulele, as well as inside the localities in this area. But another sand from the former swamps and lakes, now drained and dried, has joined the sand on deforested or uncultivated areas, and advanced further, reactivating some dunes, such as southwest of Jiana Veche, north of Patulele and north of Izvoarele. A clear evidence of dune activation, observed and measured during the 2020 field research (GPS South S82-T), is north of Pătulele (Fig 15). Its development is very clear on the western bank of Blahniţa, which is rising almost 1m from the eastern one. Fortunately, in this case, the advance is stopped by the Blahniţa river and Pătulele village.

5. CONCLUSIONS

The study highlighted the land conditions at the limits of the Blahnița river basin: a glacis to the north; a top of a ridge, strongly eroded by torrential valleys; gullies and landslides at the eastern limit and a witness of erosion to the west, with visible traces of rain-wind modeling.

By a series of topographic surveys carried out in the field visits from 2018-2020, the variation of the flow slope of the Blahnița River was highlighted: values from 4 to 2‰ up to the confluence with the Orevița and much lower values (1.8 to 0.06‰) until the exit from the Blahniţa Plain to the Danube Floodplain.

The digital analysis of the hydrographic network and of the verifications and information obtained in field visits leads to the following conclusions:

- At the 1978-1981 stage, there was an irrigation system with a distribution canal, built on the northern route of the Blahniţa River where it has a Northwest-Southeast direction, between Rogova and the confluence with the Orevița stream, built with no retaining walls and earthen dams for flood protection on both sides. From this canal, the water was distributed on secondary canals, by gravitational flow


Figure 15. Sand dunes reactivated North of Pătulele (Răducă – June 2020)

to the south and west. West of Nicolae Bălcescu to the west of Pătulele, a canal was built on Blahnița with the same characteristics, in order to drain the ponds upstream.

- By 1992, the northern canal had been extended to Bucura Swamp. The northwestern part of Bălcescu Swamp was drained and the drainage canal was built up to Ontolea Lake, which was united with Rotunda Lake at that time.

- In the penultimate stage (2002), the Bucura and Bălcescu ponds were drained, and on the route of Hotărani and Băieș swamps (also drained) there was a temporary and meandered stream. The Bucura water stream was also largely clogged. The Orevița was channelized with a simple earthen wall canal from Vânju Mare to its discharge. The entire route of the Blahniţa River in the plain area was channelized, except for Ontolea and Rounda lakes and the north of Pătulele village.

- In the current stage (2020) on the temporary Hotărani - Bălcescu water stream, an earthen canal was built to avoid digressions, and the Valea lui Stan water stream that descends from the piedmont to Vânju Mare was also channelized, and the Bucura water stream is completely clogged. Ontolea and Rotunda lakes are the only ones left with water surface. Rotunda Lake, a private property, is being adjusted for sport fishing, the Blahnița canal being built at the property boundary.

We consider that this study, by highlighting the regularization of the course of the Blahnița River, the hydrostatic level of the groundwater aquifer, as well as by identifying the areas with swamps and puddles, contributes to local management of the land. Moreover, we want this research to contribute to the enrichment of the scientific base and to the endeavors capitalizing on wetlands in the lower Danube basin, areas which are currently unused.

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