

CHARACTERISTICS OF HYDRIC RISK PHENOMENA AND PROCESSES FROM THE SOUTHERN BĂRĂGAN PLAIN

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Abstract. Geographic studies conducted in Southern Bărăgan Plain involve elements of water analysis related to the management of water resources. This is a problem because the studied field is a sensitive area to ensure the need for water, especially at certain times of the year, such as those related to the vegetation phases of the crop plants. Hydric phenomena and processes are unique manifestations that introduce disturbances in the economic activity linked mainly to agriculture, but also damage to constructions. In addition, they also generate environmental problems through the many interferences that may occur. Analyses in this regard require the adoption of a working methodology, observations and experimental and itinerant measurements, as well as the use of databases from meteorological stations as well as cadastral or pedological ones or from the agricultural department.

Key words: tabular plains, loessoid deposits, compaction and erosion processes, floods.

1. INTRODUCTION

The Southern Bărăgan Plain by its morphographic and morphometric characteristics, as well as by its position within the regional geographic region, presents a series of features of the way in which the water phenomena and the processes of risk are manifested.

The unit under consideration has an anthropic use, especially in the area of agricultural land use and to a lesser extent living, being also a transitional unit for roads and access roads connecting the capital with Dobrogea economic and commercial centres.

Over time, and especially in recent decades, the role of water resources has been observed, and especially their control and management, seen as part of the geographical environment and the ecological zone system. Practically, the economic activities, which are predominantly agricultural, have a direct connection with the hydric factors, characterized by their manifestation regime, including the occurrence of water risk phenomena and processes, which may have varied evolutions, with notable effects.

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In the Southern Bărăgan Plain, the possibility of practicing agriculture without anthropic intervention on water resources can be thoroughly addressed in order to manage them and to use them for the establishment of highly productive crops.

From the analysis of the occurrence of the hydric parameters in the field of the plain we are pursuing a broader range of objectives, such as: building a profile database, applying a methodology of territorial analysis, knowing the degree of expansion of the phenomena risk, making maps and profile sketches.

An important objective may be to set the trigger thresholds that hydric risk processes and phenomena can have, as well as the limits to which they can reach.

The Southern Bărăgan Plain is located in the south - east part of Romania and of the Romanian Plain. In the southern and eastern parts it is bordered by the Danube Valley, north of Ialomița, and to the west stretches to the Mostiștea Valley.

The unit overlaps the basement of the Moesian Platform, over alluvial deposits - lacustrine, deluvial - proluvial and wind, a special note being given by the loess formations with implications in the landscape and in the hydrological functionality.

The plain is flat, representing one of the low relief units of the Romanian space. Almost the entire area is used for agriculture, developing crops that require ploughing. Climate conditions influence agricultural activities, due to the lack of rainfall, the unevenness of their production during the year but also over many years, the drought in various forms manifesting itself quite frequently. From biogeographic point of view, here is the steppe space, with a dry-adapted vegetation.

Under these circumstances, relief, climate and anthropic needs, the provision of water resources, especially for agricultural activities, can only be done by bringing water from natural sources, with the advantage of approaching the Danube River and the Ialomița River.

2. USED DATA AND METHODS

The analysis of hydrological risk phenomena and processes can be done by using data bases, consisting of data strings, collected at hydrological stations, hydrogeological drillings, field analyses, meteorological stations, etc..

The analysis methodology involves the correlation between different sets of values in order to establish the way of manifestation in the geographic space under study. This is how it is possible to distinguish the actions of water hazards, elements of interference between processes and phenomena, assessments on risk situations and analysis of the effects produced on economic activities and environmental conditions.

In the case of the present study, the questionable materials can be used, contributing to the realization of the territorial analysis system on the geographic

unit of the Southern Bărăgan Plain. For a space of such dimensions, elements are required to provide a picture of water events over a long period of time, as long as they can be "validated" by scientific substantiation. In the analysis of such a problem, we used: historical cartographic materials, topographical maps of the beginning of the detailed measurements on the territory as well as the topical maps, small scales as well as detailed maps, even plans drawing or cadastral directories. Of great importance are the remote sensing materials, such as satellite imagery in multispectral bands and aerophotographs.

During the field trips measurements were carried out using the *Leica* topographic level, 3 m telescopic topographic level, 50 m roulettes, *Bosc* telemetry, *Garmin* GPS.

GIS applications, in these situations, are designed to quantify risk situations so that they can be converted into graphical materials, practically in water risk maps.

3. RESULTS AND DISCUCTIONS

3.1. Morphographic and morphometric features of the hydrographic network of the Southern Bărăgan Plain

The studied plain is a fairly smooth one, where the level differences are small, the altitude ranging between 18 and 93 m, amid a large general area measuring 2920 km². This has an influence on the surface flow, the slope of the relief being quite small (Fig. 1), most of the surface having a slope of up to 1°.



Fig. 1. Map of slopes from Southern Bărăgan Plain

Larger altitudes are located on the northern side, and the smallest to the south, hence the general inclination of the plain, follows this direction.

The hydrographic network has a low density of only 0.2 km/km^2 , mainly concentrated in the western half, within medium and small river basins (Vânăta, Argova and Gălățui). In the central eastern part there is a stretched surface with an endorheic surface drain that measures not less than 679 km^2 , within which some subsectors can be separated, bounded by water pools (Fig. 2).



Fig. 2. Hydrographic areas from Southern Bărăgan Plain

The hydrographic network consists of less developed valleys formed by geomorphological processes specific to loessoid formations covering the plains. A defining feature of the configuration of the valley network is related to how confluences are made, namely the angles under which they are made. Thus, in most cases, the confluences have broad, even straight angles, forming the fork valleys (Coteț, 1964).

For a large area, such as the Southern Bărăgan Plain, the interior valleys have moderate lengths, even small, we could say, which shows the deficiency of the flow, with implications for the water functionality in the studied environment (Fig. 3).

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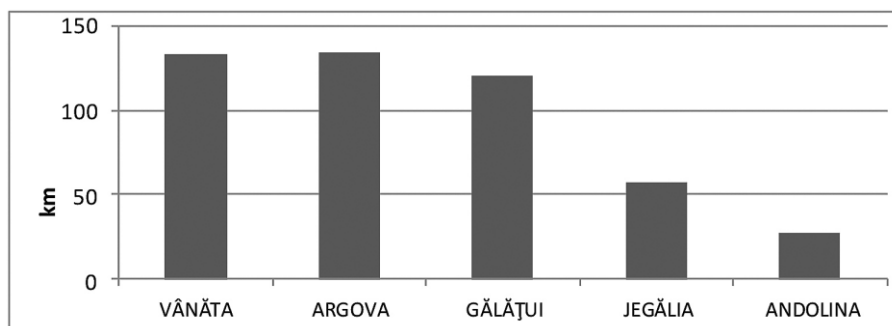


Fig. 3. Length of the main valleys from Southern Bărăgan Plain

The longest valley is Argoa, with a length of 134 km, followed by the west, while in the eastern part of the plain, the valleys are very few and short, the largest being Jegălia, with a temporary drainage of water.

In general, it will be interesting to see and analyze the degree of connection between the length of the valleys and the hydrologic hazard element on a space with such geographic features.

3.2. Manifestations of the hydric hazards

On the surface of the plain, situations may arise where excess water produces floods and flooding or an opposite phenomenon such as drought.

Flooding in turn can be differentiated according to the relief forms where it occurs. The highest degree of production is caused by *crov floods*, due to the high density of these compression moulds with a micro depression aspect. *Floods* also occur in the valleys. These are rare, however, both in the frequency of their production and in the low density of the valleys in Southern Bărăgan.

Crov floods are more common in the spring, as they occur in the conditions of rich rainfall due to the existence of a layer of snow on the ground. Crovs have a poor water drainage system. In fact, they have a micro endorheic character, the water accumulates within them, and its elimination is by infiltration and evaporation. Under these conditions, the water can extend over the entire surface occupied by the crov, where it stays for a period of time.

The duration of crov floods is influenced by seasonal climatic conditions, with water ranging from one day to more than 20 (Fig. 4).

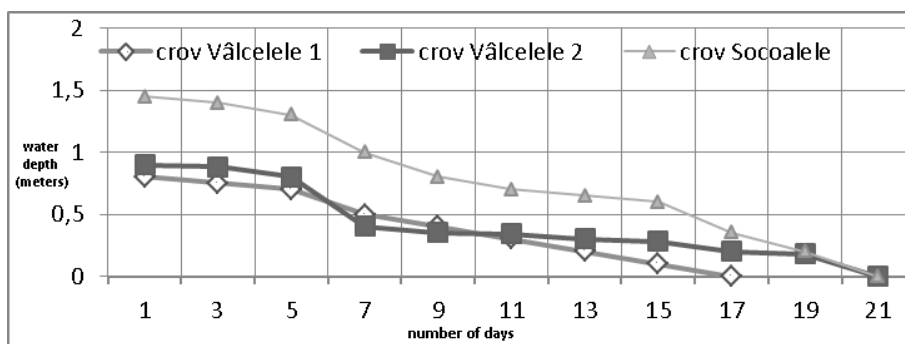


Fig. 4. Flooding's duration in the three monitored crovs

For the study, three crovs were chosen, where experimental measurements were made. These crovs are located near Vâlcelele - crovs 1 and 2, and a crov was measured in Socoalele, a town that was hardly tried over time by such phenomena (Table 1).

Table 1. Analysed crovs

Crov name	Crov surface	Surface of maximum water extention
Vâlcelele 1	1.8 ha	0.6 ha
Vâlcelele 2	1.3 ha	0.4 ha
Socoalele	3.1 ha	1.1 ha

The observations were made during 21 days from April 2016 with fixed measurements taken at 2-day intervals. Crovs have larger areas, and within them the maximum water level has occupied some of them, as shown in the following table.

Watering of the crovs was done after a period of heavy rainfall, during which 89 mm/m² fell during February and March, of which 22 mm in only 24 hours, until April 3, when the measurements began. The measurements for lake surfaces calculation were made on the first day by using a "Bosch - GLM 150, Profesional" telemetry.

As can be seen from the above graph (fig. no.4), the water was maintained at two of the crovs until the 21st day, while on another crov, it dried up after 17 days. The latter crov was occupied in a fairly large proportion of water (30%), but the water infiltration drainage system was more efficient. Also from the graph we can see that between 5 and 9 days, the decrease of the water level was faster, due to

the weather conditions, characterized by high temperatures and sunny days. During the 21 days no rainfall was recorded.

Floods and flooding in the valleys. This type of water phenomenon occurs less frequently, this being due to the high water infiltration in the soil, the wide flanks with low slopes and the ratio between the average amount of atmospheric precipitation and the flow of water through the valleys. Through the valleys of the Southern Bărgan, flow small water quantities, as the morphometric characteristics of the valleys, such as the less developed beds and meadows. Floods can occur in most of the valleys, but floods occur only at the points of confluence between the valleys.

In order to illustrate the frequency of floods and flooding production in the Southern Bărgan valleys, we analysed a series of data from the Agricultural County Direction from Călărași, where during the period 1980 - 2013 observations were made in this respect, on the valleys: Gălățui, Furciturii, Argova and Vânăta. The data transposed on a chart shows the following situation (Fig. 5).

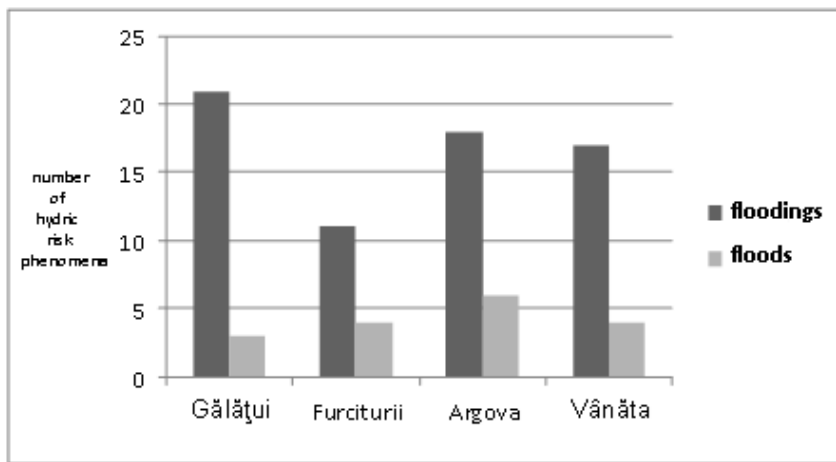


Fig. 5. Frequency of floods and flooding on the main valleys from Southern Bărgan Plain

Dryness and drought periods. The surface of the Southern Bărgan Plain is one of the most affected by these atmospheric phenomena. The analysis of the data obtained by measurements at meteorological stations have showed (Octavia Bogdan, 1980) the existence of an average of 6-7 drought periods per year. Droughts can stretch over different periods of time, some reaching 21-22 days. The months with the most drought days are September (15 days) and October (14.5 days), followed by August (13 days).

The most severe are the pedological droughts, leading to soil drying. For the relief, the cracks and fissures occurring in the soil are important, which results in increased erosion processes, including the wind process, as the soil horizon and part of the loessoid deposits are broken down to fine particle, which are then taken over by the wind. This fact also affects hydrography, the valleys and especially the river beds, suffering clogging processes, through the wind transport of dust.

Hydrodynamic and mechanical phenomena and processes. The displacement of liquid water leads to a series of hydrodynamic processes, which ultimately lead to increased hydric risk, floods and flooding, and land degradation. Within this category of phenomena and processes can be included: surface erosion, concentrated flow, ravining and torrentiality. The action of these processes and the development of specific relief forms are factors that lead to rapid water transport on the slopes and increased water risk.

Diffuse streaming occurs by moving water on the slope in form of a sheet, followed by moving fine soil particles from the middle and upper sides of the slope to its base. The process, called areolar erosion, can lead to the uncovering of plant roots, especially the scuffle ones, and in fact to the degradation of the soil horizon.

Measurements made on water samples that went on the slopes of the Gălățui Valley during a torrential rain on July 12, 2011 showed that 17 grams of fine material was taken over a litre of water. The amount of water lost was 11 l/m^2 , resulting in the following calculation: $10\,000 \text{ m}^2$ (one ha) $\times 11 \text{ litres} = 110\,000$ litres. If we multiply this quantity of water by 17 g/l , we obtain 1.87 tons of material transported per hectare at the average level of the slopes.

Concentrated streaming is a process that occurs in certain sectors of the flanks, with moderate slopes, materialized in water flow concentration in the form of narrow and elongated streams. After the rain stopped, there remains a number of ditches, with depths and widths of decimetres or centimetres and lengths of tens of meters or only a few meters, called gullies. In Southern Bărăgan, such forms appear in the middle or lower sector of some valleys, such as those seen on Vânăta, Argova, Gălățui and Furciturii. Exceptionally, gullies have also formed on the edges of crows, observed in Socoalele, on a ploughing ground at the beginning of August 2013, after heavy rainfall.

In general, the gutters degrade farmland, and from a hydrological point of view, they lead to rapid evacuation of the water from the flanks, which leads to floods.

The instrumental measurements, with punctual and experimental character, made on the Argovea Valley at a number of 8 gutters aimed at establishing the existing ratio between the length of the gutters and the quantity of water transported in the conditions of very close dimensions in the section (Fig. 6).

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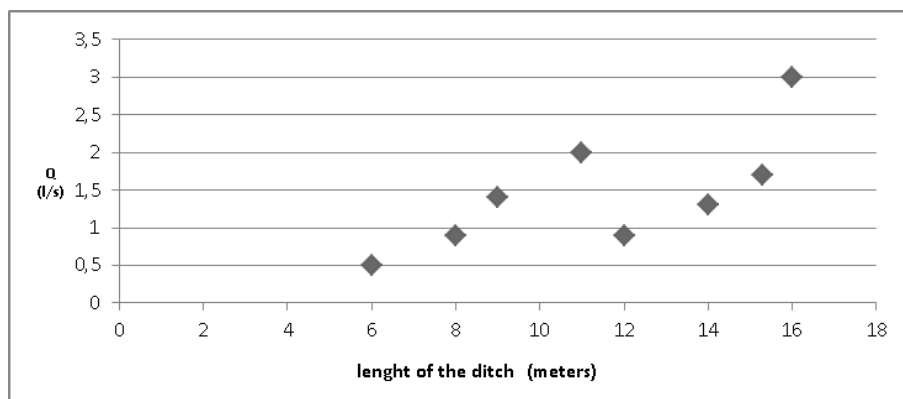


Fig. 6. Correlation between the length of the ditch and the water flow in rainfalls time

From the analysis of the graph above, it is noted that there is a direct ratio between length and flow. The exceptions are based on the flanks' slope on which the gullies have developed.

Ravenation and torrentiality are processes that create advanced erosion in soil patches and alteration, while also contributing to rapid water evacuation from precipitation and increased water levels in valleys. Such processes are not missing from Southern Bărăgan, but are rarely encountered, due to the small level differences and low slopes. The area where such situations occur, corresponds to the Ialomița slope of the plain, where by deepening, ravens and torrents intersected the groundwater, contributing to lowering the piezometric level and increasing the risk of drought. Ravene or even torrents, appear on the steep slopes of lakes in the valleys of the plain, such as Gălățui or Mostiște. In some cases, their development has started from the degradation of irrigation channels or their water supply stations.

Stationary hydric phenomena and processes. The moisture excess occurs at the surface of the soil and can be encountered on agricultural fields or at the base of the slopes belonging to the interior valleys. In the Southern Bărăgan Plain, the causes of this water phenomenon are: excess rainfalls in a short time (80-100 mm/m²/48 hours), excessive irrigation followed by the rise of groundwater level, rapid melting of the snow layer.

At the level of the studied surface, the most visible effects are on agricultural land use. Thus, crops such as wheat and maize show declines in production or total compromise for the agricultural season concerned.

One of the localities affected by such water processes is Cuza Vodă, through the Ceacu village, with a position at the base of the field, in a lower and narrower area of the Danube's first terrace. A follow-up of these processes over the period 2012-2014 shows that these occurred annually, but especially in 2012, due

to the existence of a late snow cover (March) and the fall of large quantities of precipitation in May-June and then in November (Fig. 7).

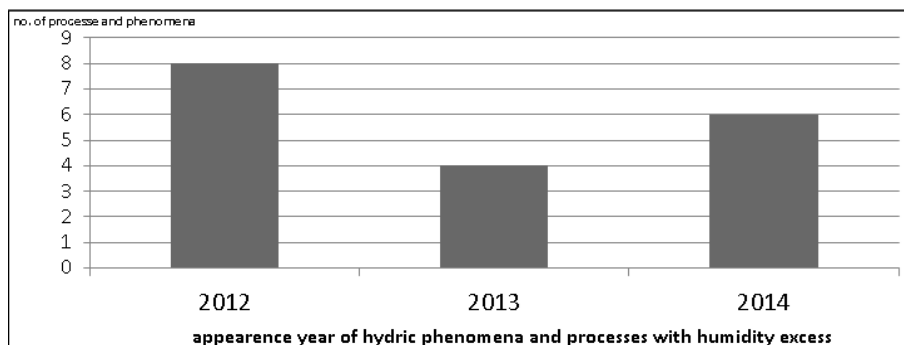


Fig. 7. Appearance frequency of hydric phenomena and processes around the Ceacu locality

The most affected by the excess moisture was the agricultural land from the eastern part of the town, from Călărași.

Hydric interference - degradation of water quality. By interference we understand the phenomenon of combining two masses of water with distinct properties (Sorocovschi, 2017). In Southern Bărăgan, interferences can occur between: groundwater and anthropic (irrigation), floodwaters and those from interior valleys, water from excessive rainfalls - groundwater and valleys.

Hydric interferences trigger a series of processes and phenomena, which may be physical, chemical and mechanical (Sorocovschi, 2017).

Physical interferences are those that affect: temperature, colour and water transparency. Changes in the water *temperature* are made by the action of the man to transport the water to the irrigation system channels, there being a certain return in this respect. The irrigation water is taken from the string of ponds, built in the interior valleys, and another part of the Danube River, even by inversely pumping the inner valleys. In such situations pumping stations take up water and produce a vertical mixture of water strata with different temperatures.

The colour of the water changes through the interference between the effluent from the cattle or pig breeding farms and the watercourses, as it has been for many years for the Furciturii Valley. At present, liquid manure from farms is used as an organic natural fertilizer on vegetable farms (the case of the farm in Floroaica village), which has led to changes in the colour of groundwater, including fountains.

Transparency of water may be affected by some water-related interference. Thus, the most frequent changes in water transparency in the groundwater layer. Situations of this type are specific to the periods when fieldwork is carried out on

agricultural fields such as ploughings. They come to fragment the soil components into very fine particles of the type of dust, which is then transported by the infiltration water to the groundwater which in turn can rise after heavy rainfall. In the case of water from the ponds in the interior valleys, transparency can be affected by the abundant vegetation that appears near the banks, but also at the tail of the lake, where there are even spots of embellishment.

Chemical pollution of the water in Southern Bărgan is done by practicing agriculture, especially through agrochemicals, related to application of fertilizers, herbicides, insecticides and amendments to soil pH correction. Thus, irrigation during dry summer periods contributes to taking chemical elements such as nitrogen, phosphorus, potassium, calcium and others and transporting them through the water vertically to the phreatic layer. The water samples taken from the premises of the large farms in Perișoru, Floroaica and Dor Mărunt showed an increase of these elements in the chemical concentration of water.

The degree of perception of water hazard.

In the Southern Bărgan Plain, the perception of this element is reduced, being different from one locality to another depending on its position or the frequency or intensity of production of such phenomena. Thus, the inhabitants of the villages on the valleys and especially in the southern part of the plain, to the Danube, take into account such situations, and in this respect the protection dikes, the drainage channels, the deepening of the valley in the main valleys, the leaving of spaces water retreat, near valleys, etc.

One of the problems is related to crov floods, where farmers are directly involved, by the effect these processes have on the productivity of crops practiced.

The development plans of localities, be they rural ones, take into account the water hazard, as evidenced by the prohibition of building dwellings near the valleys. Such situations are specific to rural localities: Vâlcelele, Valea Argovei, Dor Mărunt and others.

Making questionnaires on the perception of hydric risk, shows that the best perception is at the institutional level, through the implementation of the emergency plans. The majority population is based on historical information related to the production of such phenomena, so they have not built near the watercourses or in the crov spaces. There is a population segment, of allohtone origin, who is not aware of this risk and insists on the use of exposed areas, even for construction.

Damage caused by hydric hazards.

At the level of the Southern Bărgan Plain, the water phenomena cause economic and environmental damage. Crop floods are the ones that lead to declining agricultural productivity, even its total compromise on the affected areas. In addition, there is soil salting, gleaning and pH change, which requires expensive

agro-technical and agrochemical works. In some situations, excess humidity can also affect built spaces, due to a poor surface drainage.

All excess moisture can lead to pollution of the groundwater by taking chemical and organic elements applied to crop plants, such as herbicides, insecticides, chemical and organic fertilizers. It can come to the situation where groundwater from the wells becomes polluted, thus being unfit for human consumption.

Of great importance is another form of hydric hazard, namely drought. This reduces agricultural productivity and even compromises it. In order to combat the effects of droughts, networks of irrigation and underground pipelines have been built into the studied space. They are currently poorly maintained or even degraded and out of use.

Regarding the characteristics of the hydric hazard at the level of the Southern Bărăgan Plain, by the way of manifestation, it is noticed that the biggest problems are caused by the lack of water or, on the contrary, by the crop floods. Being a predominantly agricultural area, the most affected is the agricultural production, which influences the local economy.

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