ABSTRACT

Keywords: Călina Watershed, soil erosion, geospatial analysis (GIS), land use, geomorphological factors, soil conservation measures

The Călina River Basin is located in the Central Moldavian Plateau, in the northeastern part of Romania, with coordinates between 46°6' and 46°50' north latitude and 27°5' and 27°25' east longitude. It is drained by the Călina stream, a tributary of the Șacovăț River, forming part of the Prut River Basin. The basin's surface is characterized by a fragmented relief, with variable altitudes, which directly influences the processes of water runoff and soil erosion. The highest point in the area is the Măgura Gârbești Hill, which reaches 422 m altitude, while the lowest regions are found in the river meadows, where the altitude drops below 100 m.

From a geological point of view, the Călina river basin belongs to the sedimentary zone of the Moldavian Plateau, being predominantly composed of deposits of Proterozoic, Cretaceous and Miocene age. The geological formations are composed of clays, marls, sands and sandstones, which are highly susceptible to erosion processes and landslides. The petrographic characteristics and geological structure influence the stability of the land and the ability of the soils to retain water, which makes certain sectors of the basin prone to accelerated degradation.

The climate of the area is temperate-continental, with excessive influences, specific to the eastern region of Romania. The average annual temperature varies between 8 and 9°C, with cold winters, in which temperatures can drop below -15°C, and dry summers, with temperatures frequently above 30°C. The precipitation regime is uneven, with an annual average between 550 and 600 mm, with the highest amounts recorded in May and June. In certain periods, heavy precipitation can cause accelerated erosion, torrential rains and landslides. The prevailing winds blow from the west and northwest, playing an important role in wind erosion, especially during dry periods, when the soil is dry and prone to deflation. The predominant soils in the Călina basin are represented by cambium chernozems, gray soils and brown-luvite soils, characterized by moderate to high natural fertility. However, in areas with a steep slope, soil fertility is affected by surface erosion processes and the loss of the upper horizon. In low-lying regions, where there are accumulations of eroded material, alluvial soils with higher fertility are found, favorable for agriculture.

In terms of vegetation, initially the river basin was covered by deciduous forests, specific to the hilly stage, dominated by oak (*Quercus robur*), hornbeam (*Quercus*

petraea), hornbeam (*Carpinus betulus*) and beech (*Fagus sylvatica*). These forests ensured a water balance and natural protection against erosion. Currently, the forested areas have been significantly reduced, being replaced by agricultural land, which contributed to the amplification of erosion and soil degradation phenomena.

In conclusion, the Călina river basin presents a series of characteristics that favor the occurrence and intensification of erosion processes. The fragile geological structure, the variable climate with irregular precipitation, the rugged relief and the inappropriate use of the land contribute to soil degradation and the decrease of agricultural productivity. These aspects highlight the need for effective soil protection measures and anti-erosion management, which contribute to the stabilization of the land and the reduction of the risk of loss of the fertile layer.

The realization of this study required a complex approach that combined documentary analysis with field observations, so as to provide a detailed picture of the characteristics of the Călina watershed and the erosion processes that affect it.

In the first stage of the research, an extensive documentation process was carried out, through which data on the geological structure, terrain morphology, soil types and land use were collected and analyzed. For this purpose, topographic and pedological maps at various scales were used, as well as information taken from institutional databases. Among the essential sources were the Vaslui Agricultural Directorate, the National Agency for Land Improvement and various institutions specialized in natural resource management. An important tool in this analysis was the high-resolution orthophotomaps, which allowed for a precise mapping of land use and the changes it has undergone over time.

In order to gain a detailed understanding of the terrain morphology and slope dynamics, a Digital Elevation Model (DEM) was used, generated based on historical topographic plans. This facilitated the creation of thematic maps that highlighted the altitudes, inclination and orientation of the slopes, as well as the distribution of slopes. This information is essential in the analysis of erosion processes, since topography plays a determining role in the intensity of soil degradation phenomena.

The validation of these data was based on direct field observations. These field campaigns aimed to document active geomorphological processes, such as landslides, surface erosion and ravine formation. Existing anti-erosion measures were also analyzed, monitoring their effectiveness in protecting the soil. In addition to these observations, comparisons were made between the existing maps and the reality on the ground, in order to identify any discrepancies and to better understand the dynamics of changes in land use.

By combining geospatial analysis methods with field data, the research was able to provide a detailed picture of how natural factors and human activities influence soil erosion in this region. The multidisciplinary approach led to a clear diagnosis of the existing problems and to a way of identifying possible solutions to reduce the negative effects of erosion on agricultural land.

Therefore, in the Călina river basin, soil erosion is a complex phenomenon, determined by the interaction between natural factors and human intervention. The main elements of this erosion are climatic characteristics, terrain morphology, geological structure and soil type, while agricultural activities and land use play a decisive role in accelerating or diminishing this process.

As mentioned above, one of the most important factors determining the intensity of erosion is the precipitation regime. Torrential rains in the warm season have a major effect on soil stability. Being high-intensity precipitation, they produce rapid water runoff on the slopes, entraining soil particles and contributing to the formation of ravines. Rapid snowmelt at the end of winter also causes a sudden increase in surface runoff, increasing soil loss.

The riskiest erosion season is spring, especially May, but also in June, when strong storms can cause significant soil loss. During these months, agricultural crops are not sufficiently developed to protect the soil, and the large quantities of water resulting from precipitation create ideal conditions for accelerated erosion. In the case of slopes exposed to the north, snow persists for longer, and its late melting can trigger other negative phenomena that favor erosion.

The configuration of the relief strongly influences degradation because steep slopes and sloping lands are much more susceptible to erosion, especially if they are used for agriculture, without adequate soil protection measures. The phenomenon is less aggressive in regions with gentler slopes, but can become problematic in the event of extreme rainfall or inappropriate agricultural practices. Land use is another major influence on the erosion process. Practicing unsustainable agriculture, such as plowing on the slope, lack of protective vegetation and overexploitation of land, accelerates the process of soil degradation. Changes in the structure of agricultural property in recent decades have led to the emergence of small agricultural areas and excessive fragmentation of land where the implementation of effective anti-erosion measures is difficult. Small farmers face financial and logistical limitations that make it difficult to apply effective solutions, while large landowners can invest in modern soil protection technologies.

Soil erosion is not only an environmental problem, but also an economic one. The decrease in agricultural productivity imposes additional costs on farmers and affects the

sustainability of production in the long term as well as the loss of the fertile layer. The eroded soil is transported by surface waters and reaches lakes and rivers, where it contributes to their clogging, affecting the hydrotechnical infrastructure and reducing the efficiency of irrigation and water supply systems.

Therefore, natural and anthropogenic factors together contribute to the intensification of erosion in the Călina river basin. If adequate protection measures are not implemented, this phenomenon risks amplifying, with negative effects on both agriculture and the environment. Essential for protecting the soil and maintaining the ecological balance of the region is the identification of efficient and sustainable solutions to combat erosion.

The subchapter entitled "The role of vegetation in reducing soil erosion" analyses how vegetation can contribute to preventing soil loss and can influence hydrological dynamics and land stability. Land devoid of vegetation is much more exposed to this phenomenon, while it is highlighted that forests and natural grasslands in temperate zones significantly reduce erosion. It is also demonstrated what impact the type of crop has on soil degradation, showing that certain plants protect the land more effectively than others.

Precipitation interception is one of the main mechanisms by which vegetation prevents erosion. The foliage and stems of plants reduce the direct impact of raindrops on the soil, and the root system has the property of stabilizing soil particles, thus limiting the transport of sediments. It is known that the efficiency of interception depends on the type of vegetation and its density, with conifers having the greatest capacity to retain water throughout the year.

There are Romanian researches, in the resorts of Turda and Perieni, which have shown that the level of erosion varies depending on the type of crop and climatic conditions. Some of the results indicate that perennial grasses are the most effective in preventing erosion, while corn crops are the most vulnerable.

Studies carried out in Mădârjac, in Iași County, allowed the determination of anti-erosion protection indices for the main agricultural crops, providing a classification of them according to their capacity to protect the soil.

While winter wheat provides protection only in the first part of the growing season, leaving the land exposed after harvest, alfalfa, in its third year of growth, proved to be the most effective in combating erosion. Other crops, such as peas, soybeans, and sugar beets, provide moderate protection, while corn and beans had low efficiency. Due to the reduced vegetative mass and soil exposure during periods of heavy rainfall, the least performing were spring barley and early potatoes.

Analyzing the influence of precipitation on soil erosion, it was demonstrated that maximum 24-hour precipitation has a major impact on sediment transport, especially in the summer months. Depending on the ability of crops to retain soil and reduce runoff

velocity, it is determined that the value of anti-erosion protection indices varies. Therefore, the application of sustainable agricultural practices, such as crop rotation and the use of plant protection strips, can contribute to reducing the negative effects of erosion.

Therefore, this study also shows that vegetation plays a crucial role in maintaining the hydrological balance and preventing soil degradation. Properly managed, forests, grasslands and agricultural crops ensure land stability, reducing soil losses caused by intense precipitation and surface runoff. An essential strategy for protecting land and maintaining the productivity of agricultural soils, in the long term, consists of preserving and rehabilitating vegetation.

The analysis of soil erosion in the Călina river basin highlighted the impact of significant soil losses on the sustainability of agriculture in the region. The study aimed not only to quantify these losses, but also to assess their implications for land fertility, water resource availability and, last but not least, the economic viability of farmers. In this regard, in order to provide a clear picture of the phenomenon, detailed maps were generated that analyze the morphometry of the land, its use and the distribution of soil losses, using a numerical terrain model based on historical topographic plans.

To determine soil losses, the Universal Soil Loss Model (USLE) was used, integrated to local conditions through the Moțoc method (1975), which takes into account a series of factors such as precipitation erosivity, soil susceptibility to erosion, slope and length of slopes, land use and existing anti-erosion measures. The erosion factor, caused by precipitation, was determined based on climatological data from a period of over 30 years, analyzing the impact of the rainfall regime on the lands in the basin.

An essential role in modeling the erosion phenomenon was played, of course, by the pedological diversity of the Călina basin. The most common soils, such as cambic chernozems, brown luvic soils and regosols, were evaluated according to their susceptibility to erosion. This analysis highlighted that regosols and eroded soils are the most vulnerable where intense precipitation accelerates the degradation process, especially on steep slopes.

In areas intensively cultivated with corn and sunflowers, where the soil remains exposed for a large part of the year, the results of the study showed that arable land is the most affected by erosion. In contrast, forests and meadows have a protective role, contributing to reducing soil loss. Therefore, cultivation on contour lines, the introduction of vegetal strips and the expansion of forest areas as well as the implemented protection measures have highlighted the importance of this factor in adopting soil conservation strategies.

Significant differences were highlighted between the different areas of the basin regarding the distribution of soil loss. The area shows moderate losses on approximately half of it, but in areas with steep slopes and without adequate protection measures, erosion exceeds 20 t/ha/year, reaching, in some regions, critical values of over 30 t/ha/year. The problem of these losses arises not only for soil fertility, but also for the hydrological infrastructure, contributing to the clogging of rivers and the decrease in drainage capacity.

To combat this phenomenon, the study proposes measures to reorganize land use, by converting vulnerable arable land into pastures, orchards and forest curtains, along with the implementation of soil conservation techniques adapted to local conditions. In order to ensure the sustainability of agriculture and the long-term protection of land in the Călina river basin, finally, the analysis emphasizes the need for integrated land resource management. Therefore, the analysis of land use in the river basin could contribute to reducing the erosion phenomenon in the Călina river basin, because it highlighted an unbalanced distribution of agricultural areas, with a predominance of intensively cultivated arable land, to the detriment of natural vegetation. What has led to significant soil loss and degradation of land fertility is the fact that most of the land is intended for corn, wheat and sunflower crops, without effective anti-erosion protection measures. This has accelerated erosion, affecting not only agricultural production, but also the quality of water resources by clogging rivers and accumulating sediments in low-lying areas.

To counteract these negative effects and improve the sustainability of land use, the study proposes a series of measures to reorganize the spatial occupation of the basin. Thus, some lands are recommended for conversion into permanent pastures or forest plantations, which would stabilize the soil and reduce the transport of sediments on areas with high risk of erosion, identified especially on steep slopes and in areas with poor soils. Also for this purpose, it is proposed to expand the areas occupied by forest curtains, both on the edge of agricultural lands and near watercourses, to prevent soil loss and protect the hydrological infrastructure.

Regarding the lands that will remain in agricultural use, it is recommended to apply some conservative agricultural technologies, such as minimal soil work, direct sowing, practicing cover crops and using grassy strips to reduce the impact of water on cultivated lands. Applying a crop rotation system that includes legumes and perennial crops could be another valuable contribution to improving soil structure and reducing nutrient losses.

By implementing these measures, we will be able to favor the reduction of annual soil losses by up to 50% in critical areas, improving both the fertility of agricultural lands and the stability of the hydrographic ecosystem. According to the study, an integrated land use planning, correlated with appropriate technical and legislative measures, is

essential for maintaining the sustainability of the Călina river basin and for preventing the continuous degradation of land resources.