Current Trends in Natural Sciences Vol. 4, Issue 7, pp. 82-87, 2015

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

STUDY REGARDING THE SIDE EROSION PROCESSES ON THE MIDDLE REACH OF DOAMNEI RIVER AND METHODS OF PREVENTING THEM

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Abstract
Doamnei River is a stream of small length in Romania, but that traverses a mountainous area and another one of the hills, flowing through Arges County. This last area is heavily anthropogenic effects of human intervention and is seen almost everywhere. The major result of human actions is the side erosion of the banks. This work aims to identify the banks affected by erosion, the banks that were done building works and identifying methods that can be stopped or diminished action-erosion.

Keywords: lateral erosion, river banks consolidation, anthropic actions.

1. INTRODUCTION

Doamnei River flows through Argeş County, having a general direction from north to south, springing from Făgăraş Mountains and flowing to Argeş River, northern from Piteşti. Regarding the length of the river, data is different, depending on the sources: 107 km (Vişan, 2010), 96 km (Mailat, 2012, Atlasul cadastrului apelor din România,1992), different values being explained by what is considered to be the point where Doamnei River is born or springs from. The surface of the catchment area of Doamnei River (Figure 1) is 1836 km^2 (Anuarul hidrologic, 2000), being a main sub-catchment area of Argeş River, with a percentage of 23.4% of its superior catchment area and nearly 15% of the total surface of the overall catchment area. The catchment area of Doamnei River has the following mathematical coordinates 45^0 36' 42'' and 44^0 51' 04'' northern latitude and between 26^0 02' 14'' and 24^0 44' 16'' eastern longitude. The slope of the river has an average value of 2.2%, the average altitude of the catchment area has a value of 1121 m, with a sinuosity coefficient of 1.3.

Table 1. Pluvial flooding **(Mândruț, 1994)**

Slope inclination (%)	Lengh of slop (m)						
	20	30	50	100	150	200	300
5-10	5.5	10.1	21.7	61.6	113.1	174.2	320.1
10-15	7.7	14.1	30.3	85.7	157.5	242.7	445.6
15-25	12.6	23.1	49.7	140.7	258.5	398.1	731.2
25-35	23.1	42.1	91.5	258.8	475.4	731.9	1344.8

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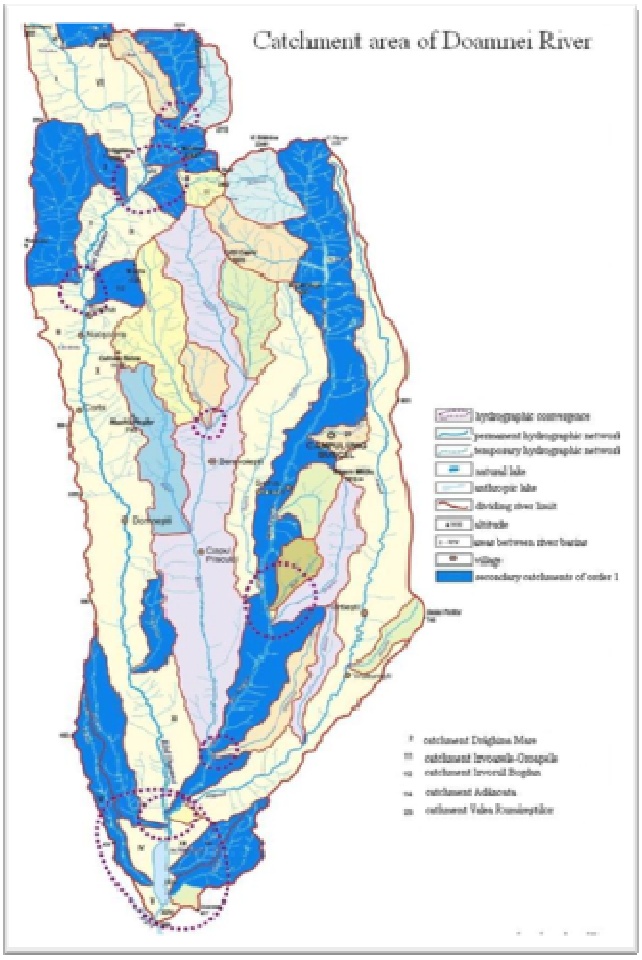

Figure 1. The catchment area of Doamnei River **(Vişan, 2010)**

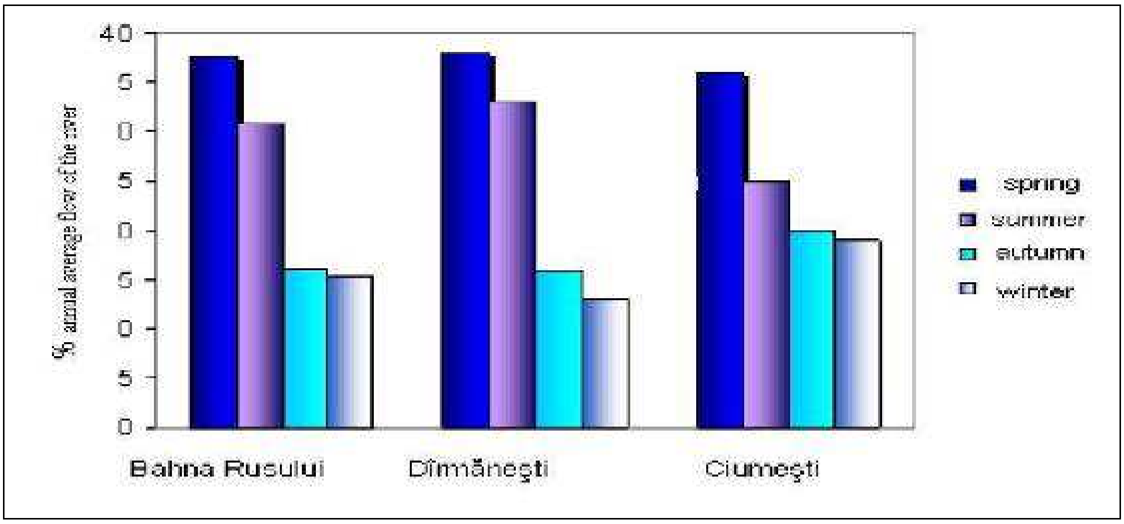

Figure 2. Doamnei River: seasonal variation in river flow **(Vişan, 2010)**

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The biggest quantity of wash (solid flow) which is transported by the river is reported during summer, at Dărmăneşti station and during spring, at Ciumeşti station (Figure 2). Though, it also depends on the length of the slopes and on the incline of their cliffs, especially coming from pluvial flooding (Table 1).

2. MATERIALS AND METHODS

Studies in this paper were carried on field, using the itinerary method, applied during the length of the Doamnei River flow, of the observations made in the field, the comparative analysis with the hydrological and geographical maps. Field research started from the left shore of Doamnei River, from a point located northern from Domneşti, with the GPS coordinates N 45º 12´ 59.59", E 24º 50´ 45.31" and end in the point located under the bridge near Purcareni crossed by european road E 574. The mathematical coordinates and the altitude were registered with the GPS. The monitored length reaches approximately 47 km, which also includes the length of the dead (dried) river beds.

3. RESULTS AND DISCUSSIONS

On the studied area, as a general feature, we mention that the shores lithological nearly consist of only deposits of sedimentary rocks which, from the geomechanicpoin of view, display a high friability degree, being either sedimentary uncemented rocks (gravels, sands, loessoid sands), either, in most cases sandstones or low cemented conglomerates, diorite sands, sandy clays and diorite clays. This favors the sideway erosion and is a significant natural factor.

Second, another natural factor that contributes to a predisposition of sideway erosion of this manifestation is the fact that the shores have accentuated slopes which determine the intensification of erosion through gapping, pluvial erosion, landslips and landfalls.

A third natural factor is also the type of longitudinal profile of the river on its middle flow, which generates high flowing speeds and a large volume of kinetic energy which is dissipated as erosion.

Next to this natural factors, a series of anthropic factors operate in a direct or indirect manner, which lead to the amplification of the sideway erosion effect.

The presence of gravel pits (Figure 3) has led to the growth of the flowing speed of water, and the emergence of eddy currents in the location of the laminar flow has led to vertical erosion in the valley floor and in the minor river bed of the river, and also to the destruction of the shores through the emergence of sideway erosion.

This is manifested through the dissipation of the higher kinetic energy of the water, due to the increase in the level difference. Even the access roads to the gravel pits are built in parallel with the shore in more areas, fact that leads to the disappearance of the vegetation.

The intensification of agriculture and of road building near the river, parallel to the shores, has led to the disappearance of riverside coppices on nearly 50% of the shores' length in the studied area. Spontaneous forest vegetation was replaced by agricultural ecosystems. Agricultural fields reach the river shores in most cases (Figure 4) and there rarely left a forest vegetation line (Figure 5), being represented only by several isolated trees or shrubs from generally young hydrophile species (*Salix, Alnus, Populus, Clematis, Sorbus, Sambucus*). In someplaces, with high shores, locust trees were planted. Though, approximately 75% of the forest vegetation on the shores was noticed to be consisting of forest bunches, with different species, with widths of tens or hundreds of meters. In this area, the lateral erosion does not manifest, as the shores are well stabilized. From the vegetation perspective, the left shore displays approximately 47% forest or bush vegetation (including the tree

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alignments). As for the right shore, forest or bush vegetation stretches nearly 53% of the length, including artificial alignments.

On some areas, where bridges exist, the shores were protected against erosion through concrete parapets or gabions, on the upstream bridge areas, such as: upstream the bridge in the center of Domenşti (Figure 6), the dams continue on both shores for approximately 1 km; the area of the bridge in the Coşeşti parish, with nearly 700 m of concrete shores (457m altitude) (5); Pietroşani, downstream of the bridge that links the location to the village of Bădeşti (parish road 2), banks with concrete for nearly 150 m of the right shore and 400 m on the left shore (433m altitude). Upstream the bridge are concrete shores (Figure 7), with compact forest vegetation on the left shore and with an planted trees alignment on the right shore (Figure 8). In the end, high floods through the consolidation of the bases located in the minor and major river bed through concrete buildings, and also through the protection of the shores with concrete and gabions (Figure 9a, 9b). On other areas, the shores display evident erosion phenomena, manifested through falls or gapping: the area of the bridge that links Coşeşti with Priseaca (Figure 10a), the right shore in the area of Bădeşti village (Figure 10b), gaps in the left shore, in loess, Domneşti. In other areas, erosion manifestations are in the beginning stage or potential.

Figure 3. Gravel extraction near Dărmăneşti

Figure 4. Agricultural fields on the river shores, near Pietroşani

Figure 5. Line of trees along the left bank of the river, near Purcăreni

Figure 6. Reinforced concrete river bank, Domneşti

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In an indirect manner, the different waste deposits, especially vegetal waste, such as branches, can lead to transversal gridlocks of the river bad, high floods and implicitly to the erosion of the shores.

Figure 7. Concrete shores, Coşeşti

Figure 8. Reinforced concrete river bank, near Pietroşani – Bădeşti bridge

Figure 9 a, b. Protection of the banks with gabions (a) and concrete (b) for the bridge, Purcăreni, E 574

Figure 10a. Erosion, right river bank, Coşeşti

Figure 10b. Erosion, right river bank, Bădeşti

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In an indirect manner, the different waste deposits, especially vegetal waste, such as branches, can lead to transversal gridlocks of the river bad, high floods and implicitly to the erosion of the shores. Such illegal waste deposits were noticed in the area of Pietroşani, on the right shore, (N 45° 11´56.52", E 24º 50´ 9.31" GPS coordinates), or on the left shore, (N 45º 08´ 49.32", E 24º 50´ 55.44" GPS coordinates, including pieces of asbestos-cement) or in the area of the road Dărmăneşti-Valea Rizei (N 45º 01´ 35.51", E 24º 53´ 10.52"coordinates), with high deposits of waste on the left shore, including large quantities of branches and, again, fragments of asbestos-cement.

GPS coordinates, including pieces of asbestos-cement) or in the area of the road Dărmăneşti-Valea Rizei (N 45º 01´ 35.51", E 24º 53´ 10.52"coordinates), with high deposits of waste on the left shore, including large quantities of branches and, again, fragments of asbestos-cement.

4. CONCLUSIONS

Degradation processes of the shores can be cancelled or reduced on their amplitude through:

- Creating protection dams in the affected areas.
- Maintaining the forest, bush or herbal vegetation on the slopes.
- Afforestation of the shores that lack vegetation and reducing the anthropic actions that influences the shores degradation such as grazing on the river shores.
- Protecting the shores through gabions or concrete parapets.
- Interdicting the existence of gravel pits in critical areas from the perspective of sideway erosion risk exposure.
- Reducing the deforestation from the catchment area of the river and the afforestation of some deforested areas.
- The conservative regularization of the river, by differently approaching of the way amendment and by recalibrating the minor river bed.

5. ACKNOWLEDGMENTS

This work of author Magdalin Leonard Dorobăţ was supported by the strategic grant POSDRU/159/1.5/S/138963 - PERFORM, co-financed by the European Social Fund – Investing in People, within the Sectorial Operational Programme Human Resources Development 2007-2013.

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