Evidence of hydromorphological alteration under present-day sand mining and management works. Case studies on Romanian rivers

Changements hydromorphologiques induits par les gravières et les travaux de gestion. Etudes de cas sur les rivières Roumaines

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RÉSUMÉ
Alors que le besoin en granulats dans l'industrie de la construction est à la hausse, l'emplacement des gravières dans des secteurs fluviaux sensibilisés par les mesures de protection contre les crues (incision des canaux, digues) peuvent perturber leur dynamique hydro-sédimentaire. Partant de l'évaluation de l'impact à l'échelle locale des gravières sur des rivières sélectionnées du sud de la Roumanie, le projet vise à atteindre les objectifs suivants : 1) Concevoir une base de données cartographiques des opérations d'extraction du sable, à l'aide d'images satellites et d'observations de terrain ; et 2) Apprécier l'effet synergique de la dégradation du lit entre les activités d'extraction des granulats dans la plaine inondable et les interventions dans la gestion des rivières. Dans cette étude, on introduit le cas du tronçon Pociovalișteа de la rivière Gilort, à travers des observations terrestres et UAV, sur le fonctionnement hydromorphologique et les types de perturbation de la dynamique hydro-sédimentaire. Les images UAV ont révélé des problèmes d'érosion latérale et verticale assez forte au droit et en aval des gravières et du secteur aménagé. Aussi, les changements dans la morphologie du lit de la rivière, observés sur les images satellites, ont fait preuve de la dégradation du lit de la rivière au cours des 10 dernières années, sous l'influence possible de l'avancée des gravières vers le lit mineur et des travaux de creusement de la rivière comme mesure contre les inondations. La perspective du projet est de contribuer à la mise en place d'un cadre législatif intégré, pour l'octroi des permis d'extraction des granulats et de la gestion du risque inondation.

ABSTRACT
While the need for aggregates is increasing in the construction industry, sand mining activities in river sectors subjected to erosion, either due to natural causes or following the implementation of flood protection measures (channel incision, river dikes) could lead to hydro-morphological alterations. Based on the evaluation of the local impact of sand mining operations on selected rivers in southern Romania, the project aims to achieve the following objectives: 1) Designing a cartographic database of gravel and sand mining operations, using satellite images and field observations; and 2) Evaluating the impact of the aggregate extraction activities and river management interventions. In the present study, we introduce the case of the hydromorphological alterations and the hydro-sedimentary functioning of Gilort river at Pociovalișteа reach, investigated using ground and UAV observations. The UAV images revealed a fairly strong lateral and vertical erosion alongside and downstream the Pociovalistea reach. Also, frequent changes in the river morphology, observed on satellite images, have shown the degradation of the riverbed over the last 10 years, under the possible influence of the sand mining operations and as a consequence of the channel deepening works for flood protection reasons. The project aspires to contribute to an integrated legislative framework in the regulatory process for the granting of sand and gravel exploitation permits and flood management measures.

KEYWORDS
Hydromorphological alteration, Romanian rivers, sand mining, satellite imagery, UAV

1 INTRODUCTION

Despite the efforts to achieve the objectives of a good state of water bodies, set at the level of the European Union by the Water Framework Directive (WFD, 2000/60/EC), human actions continue to lead to hydrological and morphological pressures on European rivers (Fehér et al., 2012; Poikane et al., 2019). Among the hydromorphological alterations faced by the rivers, in the context of the growing demand for sand and gravel for building purposes, cumulative impacts of sand mining on dams, hydromorphological dynamics and facies diversity, and on riverine richness loss are stemming (Koehnken & Rintoul, 2018). In Romania, the legislation and practice in river management, flood protection measures and aggregates exploitation are not always hand in hand. Therefore, we are witnessing the hydrological and morphometrical changes under the impact of man-made activities.

Starting from several situations of co-occurrence of different types of pressures on Southern Romanian rivers, the research aims to identify cases of river reaches affected by hydro-morphological changes, under the potential impact of sand mining, often associated with other human interventions. In order to customize the objective, poignant examples are brought from rivers such as Argeș, Jiu and Gilort which, to a certain degree, as seen from the induced hydromorphological alterations on some sectors, could be considered cases of non-compliance between basin management measures and economic activities (e.g. sand and gravel mining).

The operational objectives of the paper are: 1) mapping the river sectors in Southern Romania, affected by sand and gravel mining, via satellite images; and 2) analyzing the potential impact of sand mining on riverbed morphology and hydro-sedimentary dynamics, in conjunction with other types of interventions taken at the local level (especially flood defense measures). In this communication, a case study of a sector affected by hydromorphological alterations on the Gilort River is presented.

2 STUDY AREA

In Romania, an important number of rivers on their lower sectors between the Carpathians and the Danube, are exploited for riverine aggregates mining. These operations, targeting both sand and gravel extraction, are spawned in the floodplains most of the time, but occasionally, they expand in or indirectly affect the riverbeds, or are located in sensitive river reaches (along meanders, downstream reservoirs or in protected areas).

In this case study, we attempt to focus on the Gilort River, affected in its middle and lower sector by about 10 sand mining operations. Two of them are approx. 5 km downstream from the town of Novaci, in Pociovalișstea village. Gilort River Basin (S = 1348 km^2; L = 116.2 km) is located in SW Romania and it is a second order tributary of Danube. It is characterized by high suspended sediment concentrations during floods (on some events reaching more than 2000 mg/l at Novaci gauging station). Along the selected reach, there is a Natura 2000 site, called “The Gilort River”, a protected natural area of Community (European) interest, part of the European Natura 2000 network. Pociovalișstea Reach under study (extended over 1 km length) belongs to the Subcarpathian sector of Gilort river, which is affected by torrential erosion and sedimentation of detrital material during floods.

3 METHODOLOGY

For the case study of Gilort river, at Pociovalișstea Reach, diachronic analysis of satellite images over the last 10 years was done, to evaluate the evolution, changes and alteration of its morphology, questioning sand mining potential impact in conjunction with the flood defense measures.

The response of the Gilort riverbed, in terms of hydro-sedimentary dynamics and morphological changes have been described by field observations in August, October and November 2021 (UAV surveys and *in situ* observations of fluvial processes and microforms).

4 RESULTS AND DISCUSSION

Along the Pociovalișstea reach, there have been two sand mines operating in the last decade. The one in the upstream (SM1) is still active. From the satellite imagery analysis, we could measure an expansion of the SM 1 from ~12000 m^2 to ~20,000 m^2 between 2011 and 2021. As the sand and gravel pits developed and advanced toward the river, the banks have retreated by lateral erosion, with the riverbed widening from approximately 35 m to 67 m downstream the two sand mines. This process may have been induced by the advance of sand mining towards the river banks, but especially by the channel deepening, in order to increase the surface of the active section and, therefore, the maximum volume that can pass through the riverbed during floods.

Although in this Subcarpathian depression sector of Gilort River, where the slope decreases, the processes of alluvial accumulation would normally dominate the morphology of the riverbed, a few of the new islets, which we can spot on satellite images, are nothing more than the newly emerged and eroded marly foundation. The ground observations and the UAV surveys also showed the emergence of the coarse marly material from the foundation (Figure 1). This might be one of the several hydromorphological alterations arising after 10 years of sand mining combined with somewhat ineffective flood defense measures (river regularization and channel deepening).

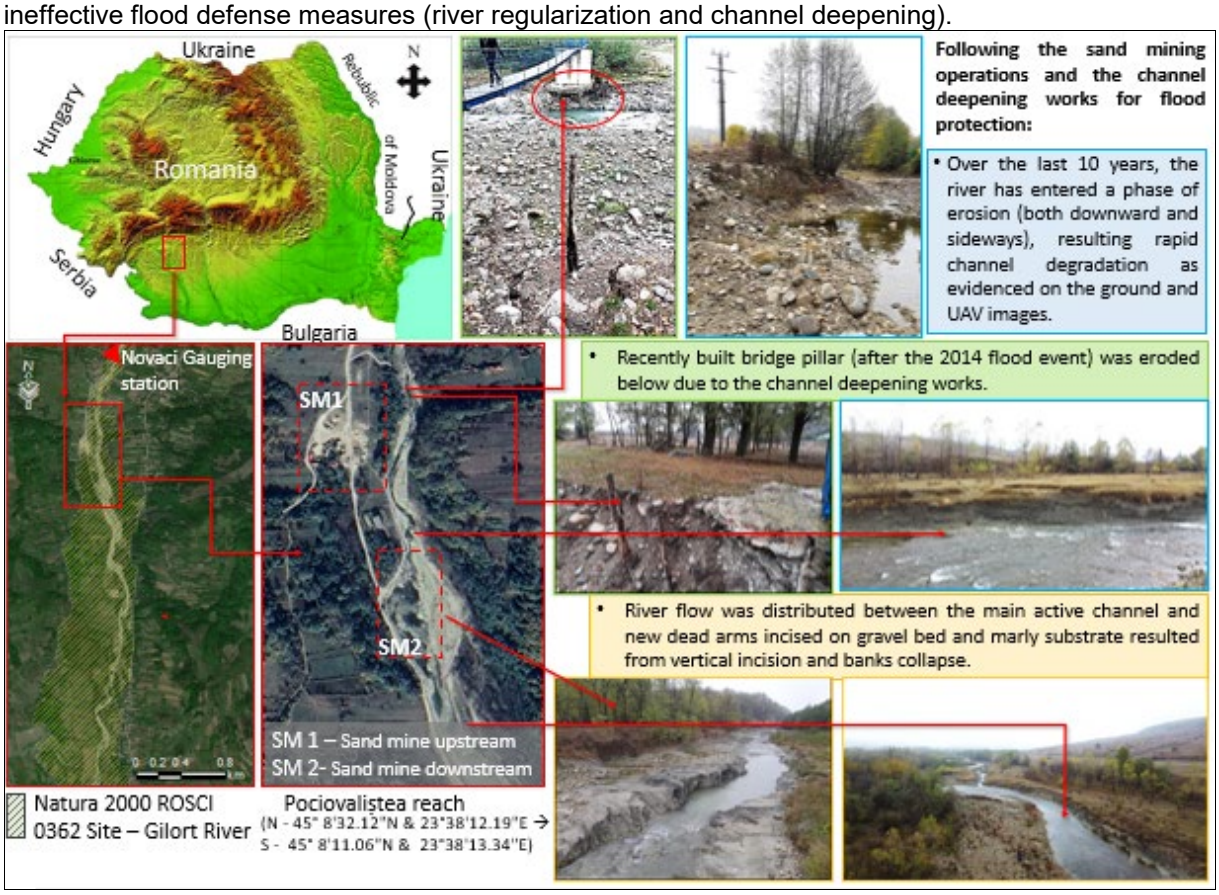

Figure 1. Evidences of potential man-made hydromorphological alterations along Pociovaliștea Reach

Over the last decade, the riverbed incision of the river has been accompanied by the withdrawal (and even collapse) of the banks in some places, as witnessed by the fresh soil and alluvial layers exposed and by the pioneer vegetation colonizing the newly secluded riverbank forehead. During the low and average flow regime of the Gilort river at Pociovalistea reach, the gravel infilled dead arm on the right caused the main stream current to resume vertical and lateral erosion mainly towards the left bank.

5 CONCLUSIONS

The satellite and *in situ* (ground and UAV surveys) observations on hydromorphological alterations on Gilort River led to findings that could be further used in basin management plans and in future restoration projects, given the importance of the river reach, as a Nature 2000 site under protection.

Field observations (using UAV and ground surveys) revealed a number of consequences on the Gilort river morphology and hydro-sedimentary functioning at Pociovaliștea reach. The man-induced evolution of the Gilort river (channel deepening measures – directly and sand mining operations – indirectly), affected the riverbed by incision and uncontrolled lateral erosion. Also, increased runoff and erosion force altered the fluvial microforms, jeopardizing the infrastructure objectives.

Our case study on Pociovaliștea reach of Gilort River plainly shows the aftermath of sand mining activities, combined with ill-conceived water management interventions. To prevent environmentally hazardous economic activities and unsound river regulation measures, coordination should be achieved between national and local authorities, specifically in relation to the river basin management plans, regulatory process for granting sand mining operation permits and protected areas regulations.

LIST OF REFERENCES

Fehér, J., Gáspár, G., Veres, K.S., Kiss, A., Austnes, K., Globevnik, L., Kirn, T., Peterlin, M., Spiteri, C., Prins, T., Laukkonen, E., Heiskanen, A.-S., Semerádová, S. and Künitzer A. (2012). *Hydromorphological alterations and pressures in European rivers, lakes, transitional and coastal waters*. CENIA, Prague, 77 p.

Koehnken, L. and Rintoul, M. (2018). *Impacts of Sand Mining on Ecosystem Structure, Process and Biodiversity in Rivers*. WWF, 163 p.

Poikane, S., Zohary, T. and Cantonati, M. (2019). Assessing the ecological effects of hydromorphological pressures on European lakes. In: *Inland Waters*, 10(2), 241-255.