SEDIMENT DEPOSITION ISSUES IN THE IRRIGATION/DRAINAGE CANALS IN VOJVODINA

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Abstract:

The paper outlines the significance of studying and analysing sediment deposition issues in irrigation/drainage canals in Vojvodina. This problem needs to be properly addressed considering the total length of the canal network, that is, the total volume of sediment to be removed by dredging if the functional performance of the canal network is to be restored and maintained. Much of the effort needs to be focused to the polluted sediments with a severe risk for the environment. Sediment pollution is caused by the point and non-point sources of pollution. Taking one irrigation/drainage canal as the example, essential chemical properties of the sediment, heavy metals and hazardous and toxic substances contents are being analysed and presented in the paper.

Keywords:
sediments, mud, drainage/irrigation canals, disposal of muds

1. INTRODUCTION

Canal network in the territory of Vojvodina (the northern part of Serbia) is relatively dense, reaching total length of approximately 20.000 km (about 10 m/ha), with canals being in direct contact with agricultural arable land and without any protection whatsoever. Streamflow velocities and sediment transport regime in these canals cause deposition of fine sediments and silt generation at some specific sites along the canal network. Additionally, untreated or partially treated wastewaters are being directly discharged into

these canals by about 300 recorded polluters; while diffuse discharges from agriculture in general, and in the region of Vojvodina in particular, may substantially contribute to non-point surface water pollution [6]. Under the said circumstances, the quantity as well as the quality of sediment in some canal sections are the obvious areas of concern. That is, according to the standards set by the Public Water Authority in charge for regular canal network maintenance the total volume of about 2 million m^3 of sediment is to be dredged annually.

Deposition of sediment in the irrigation-drainage canal network is an undesirable, yet inevitable occurrence in the course of the use and operation of any canal network system. Apart from the sediment deposited in the bottom and consequently reducing the designed, basic purposes and the functional performance of the canal network as well as hydraulic works constructed on them, the physical, chemical and biological properties of these sediment deposits are becoming issues of more immediate concern. Nutrients contained in the sediments may adversely affect water quality and uses, intensify eutrophication and growth of vegetative cover in the canals, with no limitations regarding the disposal of dredged sediment in the surrounding areas, due to its favourable impact on soil properties and fertility. However, increased content of hazardous and toxic substances in the sediment, followed with further degradation of suspended solids due to accumulation of pollutants, raised concentration or synergic effects of the said substances, etc. can have serious impacts (toxic, pathogenic, carcinogenic, mutagenic, etc.) not only on the canal system but also on the environment in which dredging sediment is disposed and stored.

2. MATERIAL AND METHODS

Apart from the fact that almost no field investigation works and studies in regard to sediment suspended in irrigation/drainage canals in Vojvodina have been carried out [1], there are still no generally accepted criteria related to sludge and sediment quality evaluation and clearly defined conditions for the disposal and storage of dredged sediment in most of the European countries [2], [3], [4]. For the purpose of pollution prevention and control and environmental protection, stringent legislation in the form of standards, criteria, norms, etc. may (and must) be introduced, calling for the classification of sludge and sediment as per the content of hazardous substances. Given the content of hazardous and toxic substances is below established limit values, such sludge and sediment could be stored and used (deposited and spread on the land) without any limitation. If, on the contrary, sediment concentrations exceed threshold limits, they are to be classified as hazardous waste requiring specific rehabilitation procedure involving disposal of the dredged material in special containers with previous treatment, if applicable [7].

Physical and chemical properties usually taken into account in various classifications for evaluating sludge and sediment quality are the following: sieving, dry matter content, organic compounds, heavy metals, total hydrocarbons, polychlorinated biphenyls and pesticides. The existing criteria are more or less consistent with regard to the relevant substances and matters the presence of which is to be determined, with some differences, however, with regard to the maximum permissible levels (MPL), i.e. limit values for permitted concentrations in sediment.

3. RESULTS AND DISCUSSION

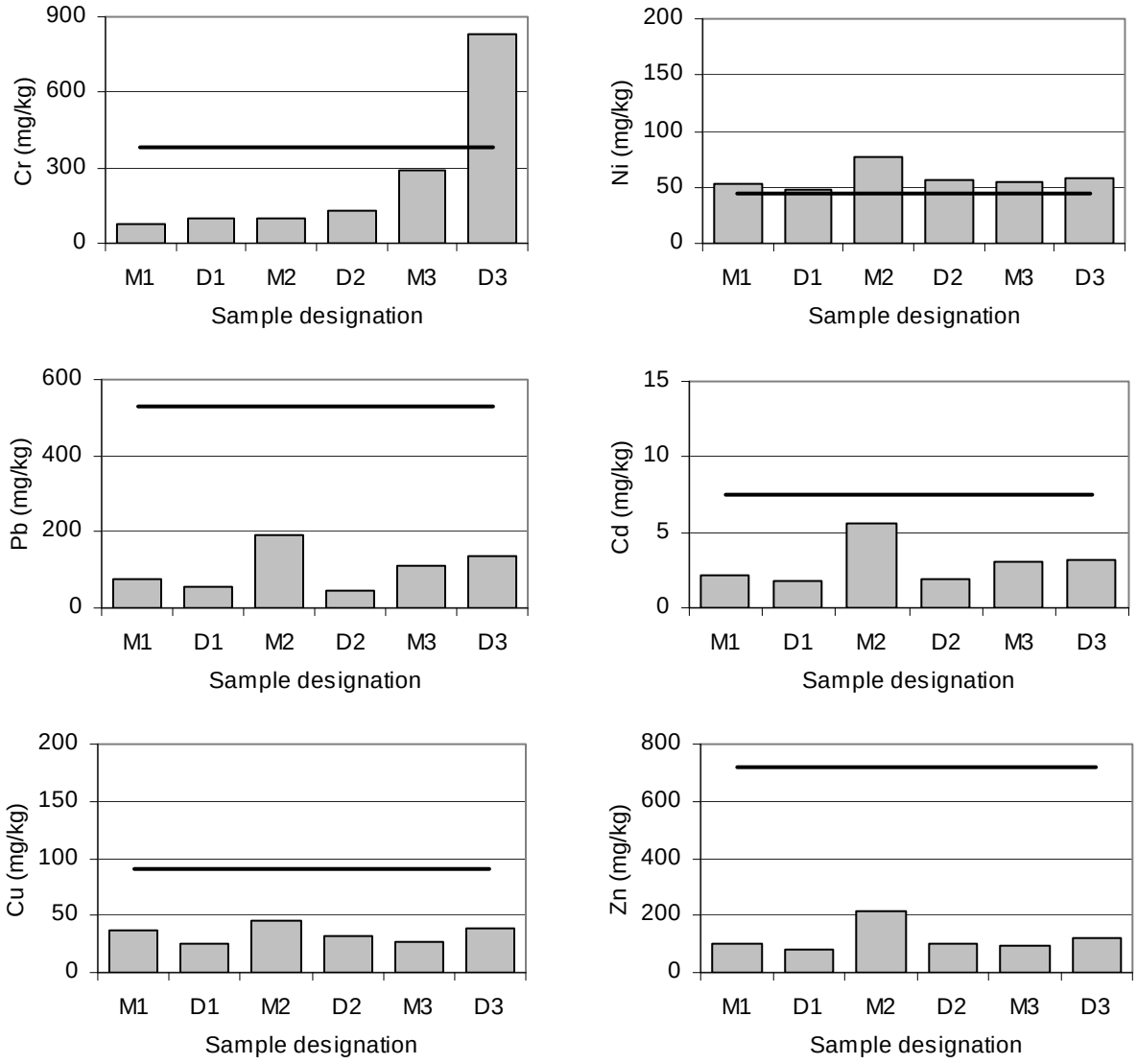
Suspended sediment in water bodies may contain, for the most part, necessary macro and micro nutrients, humus organic compounds and other ingredients improving properties of the soil onto which dredged sediment is to be deposited and spread. This referees particularly to the arable land, its texture and fertility, and consequently, to the yield and quality of the crops. Thus, reasons for the use of sediment on the land for agricultural purposes are more than obvious. It is clear that non-contaminated sediment may have positive impact on the land, and one of the basic principles calls for the incorporation of sediment in the land whenever possible. On the other hand, however, sediment may contain heavy loads of nutrients and other unwanted substances with harmful affects on the land, crops and public health. Great care and caution is, therefore, needed in handling and depositing sediment in the environment, as well as the introduction of restrictive measures in its application in agricultural sector, that is, in its spreading or injecting on the farmland.

Table 1. *Basic chemical properties of sediment samples taken from the characteristic points along the Aleksandar canal*

Sample designation	Humus %	N %	P_2O_5 mg/100g	K_2O mg/100g
M1	6.56	0.433	22.7	36.5
D1	4.66	0.307	42.5	120.0
M2	3.40	0.225	26.8	10.0
D2	1.13	0.075	12.7	13.5
M3	1.34	0.080	59.3	31.0
D3	2.77	0.183	147.0	50.0

For the illustration purposes follow the results of the studies conducted in the Aleksandar canal in the vicinity of the town of Zrenjanin with the purpose of determining sediment properties. This irrigation/drainage canal is 9,5 km long, with the drainage basin gravitating towards the canal covering the area of about 4,000 ha, average width of the canal bottom is 2.5 m, depth from 2.5 - 3.0 meters and flow of about 1 m^3/s. The basic purpose of the

Aleksandar canal is to drain excess surface and ground waters from the agricultural fields. The canal, which is located adjacent to the municipal industrial zone, receives industrial and urban wastewaters of different origin and conveys and discharges them to the final receiving water body- the river Begej [5].



(M1, D1 - km 4+250; M2, D2 - km 1+850; M3, D3 - km 0+900)

Fig. 1. *Heavy metals content in sediment samples taken from the canal bottom (M), depots with stored sediment (D) in the Aleksanadar canal nearly Zrenjanin as compared to MPL from Regulation on permissible quantity of toxic and hazardous substances in the soil, Official Gazette of the Republic of Serbia, no. 23, 1994 [8]*

In the course of 2001, samples were taken and analysed to heavy

metals content and other essential chemical parameters from one section of the said canal just before dredging, as well as from the old depots at which previously dredged sediment was stored. Microlocations of the taken samples are as follows: upstream before receiving water from the polluters (designated: M1 - sediment from canal, D1 - sediment from the depot; at km 4+250) - control sample, from the middle section just before municipal sewer system (M2, D2; km 1+850), and downstream after receiving water from the polluters (M3, D3; km 0+900).

Conducted chemical analyses of the sediment samples indicate to increased content of humus, nitrogen, phosphorous and potassium, with concentrations in the samples as shown in the *Table 1*.

The analysis results also showed that taken sediment samples from the canal itself and from the sediment depots contained heavy metals - classified as toxic and hazardous. Some of the examined parameters were found in the concentrations exceeding threshold limits for sediment disposal in the environment (*Fig. 1*).

4. CONCLUSIONS

Issues related to the sludge and sediment quality assessment, conditions under which suspended sediment may be dredged and stored or spread in the environment (particularly on the cropland) are to be treated and addressed as issues of immediate concern in our country, too (due both to the volume and the properties of sediments), with the trend of getting more prevailing in the coming period.

Sediment removal is an essential prerequisite for ensuring normal functional performance of the canal network as well as hydraulic works constructed on it; navigation and flowing capacity, etc.; and for enabling undisturbed operation of the municipal and industrial waste water treatment plants.

To this end, provisions and criteria under which sediment may be dredged and stored or used in agriculture are to be clearly defined and conformed. Special attention is to be devoted to the environmental, surface and ground waters protection, and before all, to the cropland, foodstuffs and food production protection. Plans and expectations in regard to sale and promotion of agricultural products from Vojvodina at the European marketplace could be implemented only if appropriate legislation governing this area is duly taken into account, such as EU Directive on the use of sludge in agriculture or the most recent document on sludge the implementation of which is to be expected soon.

Furthermore, it is to be noted that the issue of sediment suspended in the watercourses (particularly in irrigation and drainage canals) and reservoirs stretching over the surrounding agricultural land for the maintenance purposes requires more research work and studying if adverse impacts on the environment, human, animal and plant health are to be avoided. Sediments of inadequate quality may negatively affect the properties and intended water uses of a water body in which they are formed and suspended. To this effect, an efficient and regular sediment monitoring system is to be established in the water bodies.

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