River Bed and Stream Bank Monitoring

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Abstract: The development of riverbed is systematically monitored for selected streams by collecting samples of bed load sediments in the long term. A new, non-destructive, method for testing stability and failures of dikes and banks was been developed under grant No. 103/04/0741 and has been reliably tested under laboratory conditions.

Key words: sediments, streams, physical models, electrical impedance spectrometry, monitoring

Introduction

Bed formation processes in streams and subsequent bank stabilization by timely monitoring of disturbances and their maintenance are processes which vary in time and subject to the effects of weather. The frequent occurrence of high waters in streams in the Czech Republic in recent years and the need to protect human life and property, urgently drew our attention to the necessity of monitoring watercourses in individual basins. The Laboratory for Water Management Research of the Institute of Water Structures has cooperated with Povodí Odry s. c. [Odra Basin State Enterprise] for a long time. They have been taking sediment samples since about 1962. A summary report has been compiled from this, serving not only Povodí Odry s. c. as technical background for the management and maintenance of individual watercourses, but also as background for planning and for decision making in the security survey and supervision. In the monitoring of riverbed-formation processes in "difficult" stream sections, the use of models is warranted. A physical model is used, for example, for the planning of measures to address difficulties, and a mathematical model for obtaining a survey of riverbed development. Here, as well as for in situ measurements, the high level of modern measurement techniques and the processor's skill are irreplaceable.

The handling of the grant project, GA CR number 103/04/0741 "Optimization of monitoring methods of free water level movement and its affects in earth dikes", resulted in the development and testing of a new method for non-destructive monitoring of banks stability and failures using electrical impedance spectrometry.

Sediments samples and the modelling of problematic watercourse sections

Samples of sediments and suspended matter, of the top layer or the bottom bed have been collected at the Brno Technological

Short scientific paper

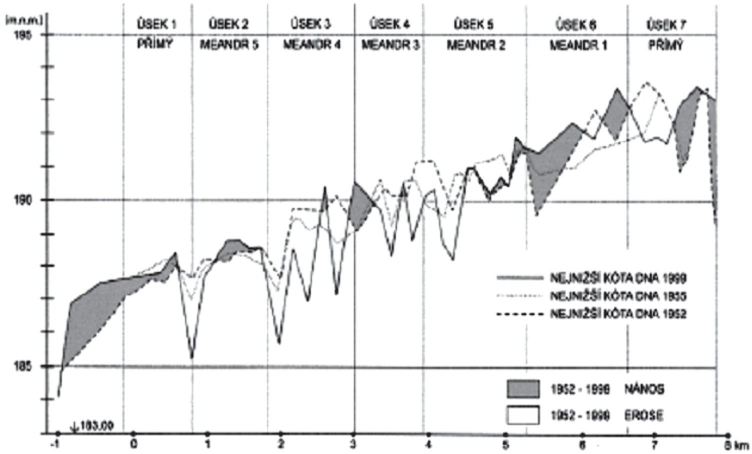

Figure 1. Erosion and sedimentation in the boundary meanders of the Odra River, 1952-1999.

University for a long time. An overall summary for the watercourses has been made with Povodí Odry, s. c., Ostrava. We studied the meander formation on the boundary section of the Odra River for the WWF Auen, FRG within an EU programme. The courses of the lowest bottom have been recorded from the viewpoint of development from 1952 to 2000, as is evident in Fig. 2, described in VESELY (2002). These samples and their analyses are also important in the mathematical and physical modelling of watercourses and their structures.

The mathematical modelling of water flow in stream channels has become a necessity

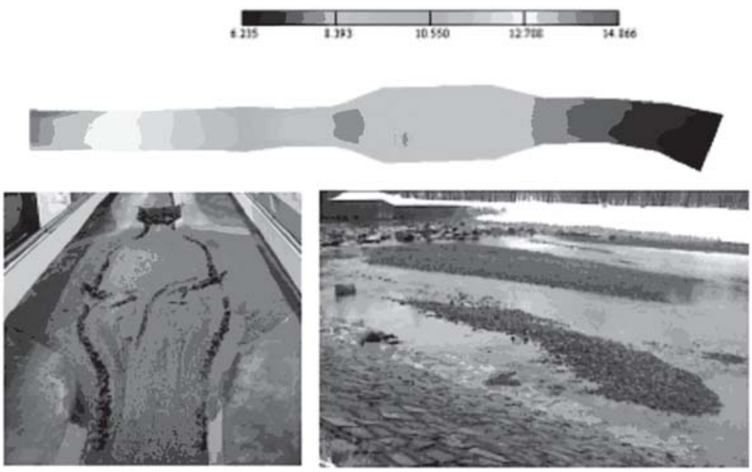

Figure 2. Watercourse section with a pear-shaped structure – – a 2D model, software CCHE2D, a physical model; a problematic watercourse section in nature

for the control of water flow in watercourse networks. Mathematical modelling is, in comparison with physical modelling, a method which is much more acceptable from the viewpoint of obtaining information about the watercourse with regard to time and funds. The water flow in the channel causes the movement of particles from the environment of which it is composed and on which the water flows. Thus modelling of the sediment and suspended solids with bottom deformation has become ever more important in order to forecast future watercourse channel development (Fig.2).

Electric impedance spectrometry – one method for the monitoring of these features

Electronic impedance spectrometry (EIS) has become, due to its descriptive nature, a popular analytic method and has ranked first in the study of the physical and chemical properties of materials and living tissues. The basic principle of the method is the measurement of frequency characteristics of the impedance of the structure or material being measured (Fig.3).

For water level measurement, the two-terminal method has been used, while for surface deformation determination, the four-terminal method has been applied, capable of indicating fine impedance changes because of parasitic impedances. This is why its further potential is now being examined in connection with the relative monitoring of the movement of endangered banks and slopes. A proper measurement technique involving an impedance spectrometer and stainless steel electrodes has been designed and built.

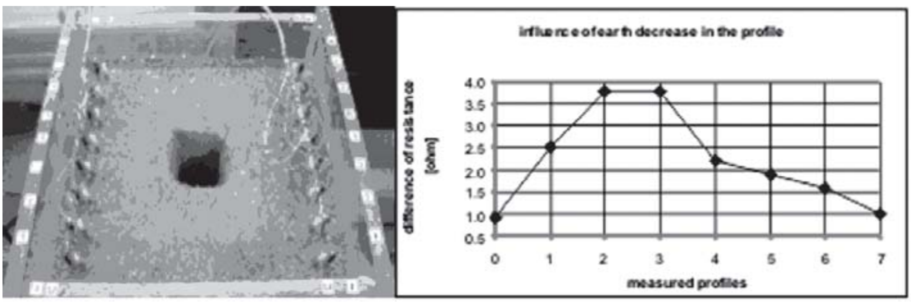

Figure 3. Measurement technique, a physical model and the results of impedance changes

Conclusions

Systematic modeling of watercourses is necessary both from the point of view of capacity and administration point of view. The use of the information obtained is also important from the flood-control point of view, both in extensive and local floods. Mathematical and physical modeling provides the necessary accessories for administration, organization, and investment plans produced by watercourse administrators. Electric impedance spectrometry is suitable as a non-destructive method for monitoring stability and local watercourse levee failures. We also recommend it for more general use, particularly by watercourse administrators, or for monitoring protective dikes.

Acknowledgements

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References

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