Problematic of anti-erosion and anti-abrasion protection of significantly threatened localities

Jan Deutscher, Miloslav Šlezingr, Petr Pelikán, Kateřina Sedláčková, Ondřej Hemr, Markéta Kupská, Petr Čech

INTRODUCTION

This project covers a wide range of topics connected to bank erosion. During 2021, several partial tasks have been addressed. Most importantly: A) estimation of the volume of eroded banks (case study Zajeci); Evaluation of the effectiveness of stabilization measures by B) wave hindcasting model; and by C) Grain size distribution of eroded material (both case study Hulín).
Notably, Students in the Project team were also supported in their own research such as: D) The evaluation of ecological stability in rural landscape; and E) soil classification according to its granulometry.
Given the extent of the work, only A and B are shown here.

THE VOLUME OF ABRADED BANKS AS AFFECTED BY DIFFERENT SOILS (CASE STUDY ZAJEČÍ)

Fig. 1 Situation of Zajeci reservoir

The reservoir Zajeci is a post-mining lake originated from a sand and gravel mining pit. It has the shape of a rectangle (ca 600 x 350m). Given the predominant wind direction, the eastern bank is the most affected by the wave load. There are three distinct soils present – loam (70 m), gravel sand (150 m) and rubble (120 m). (TAB. 1)

Period in 2021	Starting date	Ending date	Days	Precipitation (mm)	Total material loss (m3)	Gravel sand	Loam	Rubble
1	07.06.	21.07.	44	43.05	2.90	2.29	0.27	0.34
2	21.07.	01.09.	42	109.16	2.63	0.67	0.42	1.54
3	01.09.	07.10.	36	38.79	1.03	0.42	0.14	0.47
Total			**122**	**191**	**6.57**	**3.38**	**0.83**	**2.36**

Tab. 1 The volume of abraded banks in measured periods

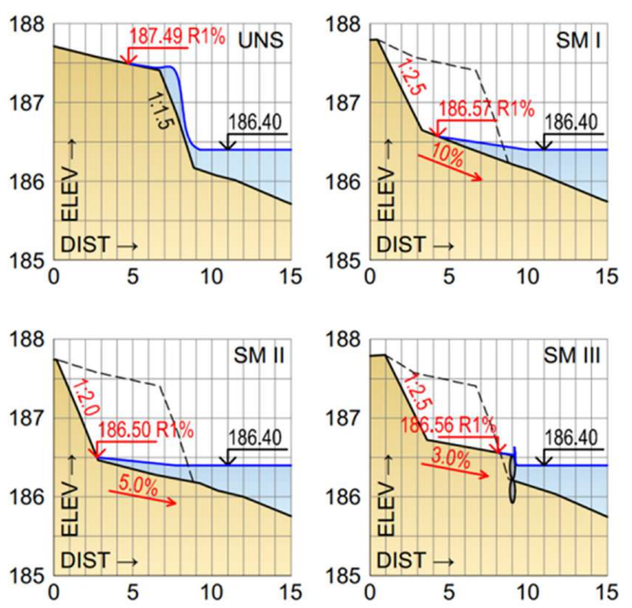
The total volume of eroded material over the 122 days was calculated to reach 6.57 m^3 along the 340 m long shoreline. This corresponds to approximately 1.93 m3 per 100 meters of shoreline. The total loss reached 3.38, 0.83 and 2.36 m^3 for gravel sand, loam and rubble soils respectively. The relative loss in each of the soils reached 2.25, 1.19 and 1.96 m^3 per 100 meters of shoreline.
This indicates that the gravel sands were the most susceptible to erosion, almost twice as much as loam. These results can be related to a whole year (365 days) to almost 20 m^3 of material which corresponds to 5.78 m^3 per 100 meters of shoreline every year.

ldf.mendelu.cz

Fig. 2 The abrasion cliff and GPS surveying

LOW-COST SHORELINE EROSION MITIGATION MEASURES AS VERIFIED BY WAVE HINDCASTING

The analysis of wind-driven wave run-up was performed in Hulín gravel pit where three distinct types of stabilization measures (SM I, II and III) were realized in 2019. The hypothesis was that milder bank slopes induce lower wave run-up of the waves and thus mitigate the erosion processes.



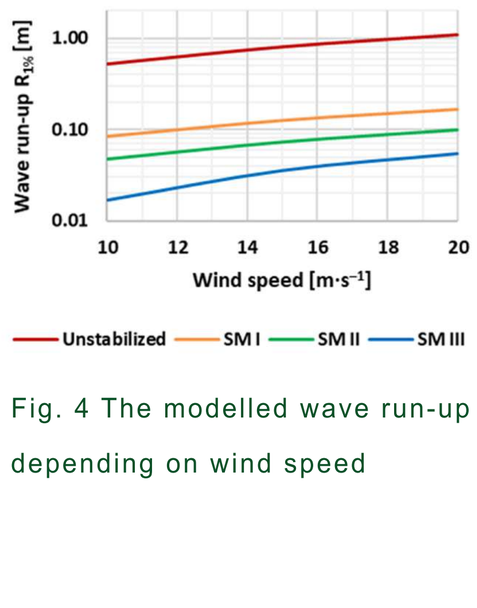


Fig. 4 The modelled wave run-up depending on wind speed

Fig. 3 Cross sections of upper parts of the stabilisation measures (vertical exaggeration5×). The scenario of wind speed 20 m·s–1 that causes H13% waves of 0.41 m height is shown.

Sloping played an important role in the stability of the banks as the diverse shoreline shapes induced different wave run-ups (Fig. 3). E.g. in the case of SM II, the mild slope of 5% resulted in only 0.1 m high run-up as compared to the UNS 1.09 m run-up which corresponds to almost 90% greater effectiveness. SM III eliminated the load of waves the best by the combination of an obstacle object (vegetated timber log) and mild upper 3% sloping. The potential effectiveness of SMs was mainly affected by different wind conditions that change the wave run-up (Fig. 4). The results affirmed that the milder the sloping, the less energy is loaded on the bank, mainly because the energy of the waves is dissipated over a longer distance.

CONCLUSION

The results of our research indicate that unless stabilization measures are constructed, substantial amount of material is eroded every year from the banks of reservoirs. The wave run-up model offers a unique tool for appropiate sizing of the SMs for individual cases and scenarios. The combination of mild sloping and vegetation obstacles offers a low-cost, yet reasonably effective way of erosion mitigation.

MENDELU
Faculty of Forestry and Wood Technology