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Journal of Hydrology 318 (2006) 17–23
Journal of Hydrology
www.elsevier.com/locate/jhydrol

On parameters estimation in dynamic model of suspended sediments

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Received 25 July 2003; revised 18 May 2005; accepted 3 June 2005

Abstract

Dynamics of suspended sediments in the shallow Szczecin Lagoon, located on the border between Germany and Poland, were simulated with a simple box-type model. A direct search optimisation method was used to estimate the model's parameters. The sensitivity analysis of model parameters indicated that model output is most sensitive to settling velocity. The results point out the importance of prior assessment of parameters values before applying the formal optimisation procedure.

Keywords: Suspended sediments; Resuspension; Parameter estimation; Model; Sensitivity analysis

1. Introduction

The aims of our study are to understand the sedimentation, re-suspension and spatial transport processes and to develop modelling tools that could help to obtain more reliable management strategies to increase water transparency. Increased water transparency is expected to enhance macrophyte growth and spatial coverage. Macrophytes stabilize the sedimentation process, decrease flow velocities and reduce re-suspension. They would fuel a self-enhancing process resulting in an improved water quality. In addition to positive ecological effects, this would have important positive consequences for bathing tourism.

Suspended particles transported by currents consist of organic and mineral compounds. Especially organic particles can contain considerable amounts of nutrients, heavy metals and organic substances. In shallow lakes and estuaries they can be easily re-suspended during episodic storm events and transported far away from the pollution source (Dyer, 1989).

Luettich et al. (1990) presented a simple box-type model to simulate the dynamics of suspended sediments in the shallow lake environments. The model was calibrated against measurements of suspended sediments concentration in the western part of Lake Balaton (Keszthely bay) during two

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doi:10.1016/j.jhydrol.2005.06.015

Nomenclature

E	erosion rate (mg l^{-1} s^{-1})	K	empirical factor
H	water depth (m)	n, p	power exponent
S	concentration of suspended sediments (mg l^{-1})	W	wind speed (ms^{-1})
		t	time (s)
h	wave height (m)	α	empirical wind factor
h_c	critical wave height (m)	β	settling velocity (ms^{-1})

weeks period in August 1985. Despite its simplicity it showed good agreement with observation within a wide range of model parameter variations. The authors explained this by the negligible role of lateral transport in this particular case.

In this paper a similar but slightly modified model was applied to calculate variations of suspended sediments (S) concentration in Szczecin Lagoon. The direct search unconstrained optimisation method (Nelder and Mead, 1965) was used to find the best combination of model parameters. Numerical experiments showed importance of the prior selection of initial values of parameters.

2. Field site

With an average annual flow of 550 m^3 s^{-1} (IMWM, 1999) the Odra River is one of the largest rivers in the Baltic Region (Fig. 1). Due to a large, partly densely populated and industrialized catchment area of 120 000 km^2 the river transports large amounts of nutrients, heavy metals and organic substances in dissolved and particulate form.

Between 1993 and 1997 the average annual nutrient input into the Odra River was 12,840 t P and 124,250 t N (Behrendt et al., 2001). The annual suspended particulate matter load is more than

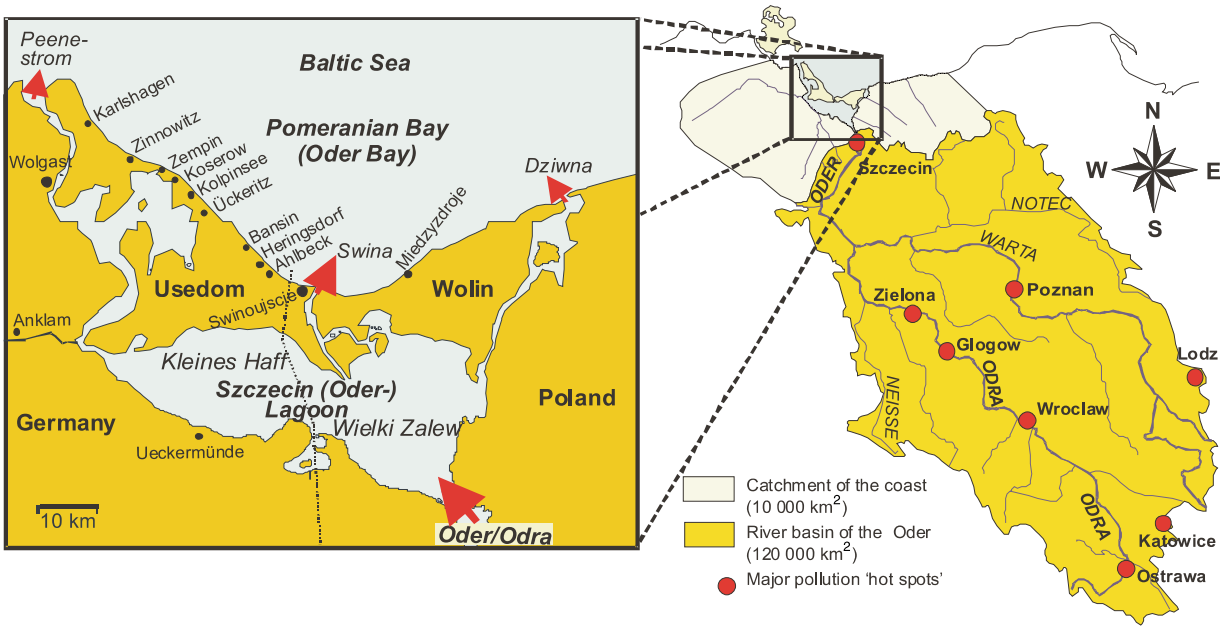

Fig. 1. Odra estuary.