EMPIRICAL MODELS FOR TOTAL BED LOAD ESTIMATION

CALIBRATION AND RANGE OF APPLICATION OF DIFFERENT MODELS

Warin Bertschi[1], Gabi Hunziker[2], Hans Kienholz[1]

Since the early eighties, several empirical models for total bed load estimation during extreme events have been developed by different authors. All these models have in common that they were developed and tested on local conditions only. Therefore, they can hardly be transferred to other areas or regions because of lacking knowledge about parameter settings.

GOALS

This study aims to adapt well-known empirical bed load estimation models for extreme events (Zeller [1985], Kronfellner-Kraus [1982], D'Agostino [1996], Hampel [1980]) to Swiss conditions and to point out their different strengths and weaknesses. Furthermore, the input data needed for (the individual) models should derive on the basis of available digital data. Thus an objectively comprehensible procedure should be ensured. The final product represents a recommendation for the derivation of the parameters, for the calibration of the models and for the extent of their areas of application.

INVESTIGATION AREAS AND REFERENCE VALUES

The models were tested on altogether 133 mountain torrent catchments in the prealps or alpine region. They are distributed on the following groups of geologies: "Crystalline", "Lime", "Flysch" and "Molasse". Estimated bed load volumes derived from hazard assessments serve as comparison and calibration sizes. First of all, a comparison row of a bed load volume with a recurrence interval of 100 years had to be derived from known, estimated bed load volumes. With the aid of this comparison row the models could then be adapted and calibrated.

DIGITAL INPUT DATA

The available digital data in Switzerland, in particular the digital elevation model, the stream network, the Hydrologic Atlas of Switzerland (HADES) as well as the geotechnical map represented the basis for the computation of the input parameters. Analyses during the collection phase made clear that these basic data meet the above mentioned standards of this study.

---

1 University of Bern, Geographical Institute, Hallerstrasse 12, CH-3012 Bern, Switzerland (phone: +41-(0)31-6318859; fax: +41-(0)31-6318511; e-mail: bertschi@giub.unibe.ch, kienholz@giub.unibe.ch
2 Abteilungsleiterin Naturgefahren, Geo7 AG, Neufeldstrasse 3, CH-3012 Bern, Switzerland (phone: +41-(0)31-3004433; fax: +41-(0)31-3027611; e-mail: gabi.hunziker@geo7.ch

RESULTS

This study allows making recommendations for the application range as well as for the settings of the models.
Important for the application of these models is the fact, that with **increasing** catchment areas the proportional adjustment-quality does **not decrease**. The given recommendations can be used for catchment areas with sizes from one to ten km^2.

The adjustment of the models was achieved by minimizing the deviation between estimation (comparison raw) and modelling. This way, the models could be centred optimally in the estimated values. Fig. 1 displays how different factors (pos. factor = modelled bed load/estimated bed load, neg. factor is inverse) are distributed over the different geologies. The nearer the factors lie to 1 or -1, the nearer lies the modelling value at the measured value.

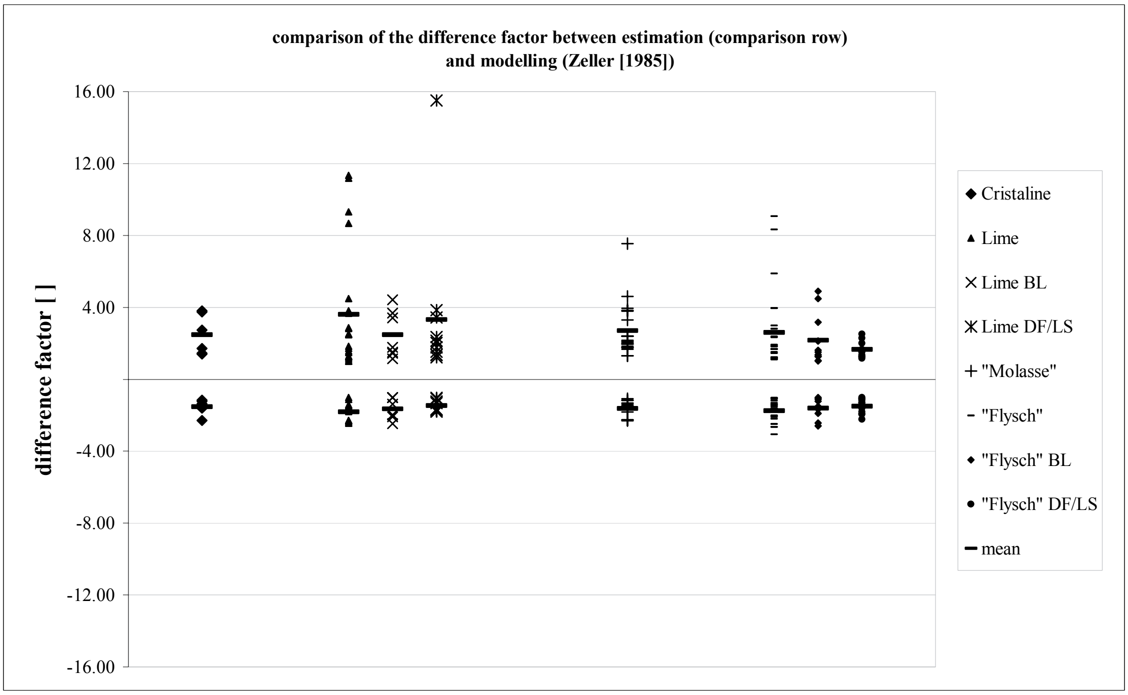

Fig. 1: Overview of the positive and negative difference factors, modelled with the Zeller [1985] model (pos. factor = model bed load/estimated bed load, neg. factor is inverse; BL = “normal” bed load, DF = debris flow, LS = landslide)

The computations for all mentioned models lie on an average around the factor 2 - 3 over and/or 1.5 - 2.5 under the estimations.
Furthermore it can be said, that the very simple models of Zeller and Kronfellner Kraus (one or two input parameters) provide equally good adjustment results as more complex models with a large number of input parameters do.

RANGE OF APPLICATION

The results of this study can serve practitioners as orientation guide for their fieldwork, but should be interpreted and used with the necessary care. Furthermore it could be a possibility for public authorities to control estimations or to check what type of mountain torrent it is.

Keywords: mountain torrent, bed load estimation, empirical model