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An automated method to detect fluvial stability levels using digital elevation models: The case of the Vesdre valley (Belgium)

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Fluvial stability levels (mainly represented as terraces) have often contributed to determine the past tectonic activity and/or climatic conditions which have, directly or indirectly, controlled the incision of rivers in various regions during the Quaternary. In most studies, fluvial stability levels have been obtained by retrieving the longitudinal profiles of the river's previous alluvial plains from their traces preserved in the present topography. However, in the case where the preserved traces, usually recognised by interpreting topographic maps, aerial photographs and field data, are too few, the inferred profiles may be questionable. Yet, the now available high-quality and high-resolution digital elevation models (DEMs) offer an opportunity to increase greatly the quantity of information usable to reconstruct longitudinal profiles. Therefore, relying on the classical principles of terrace analysis, the purpose of this work is to develop a new method based on this data source to better constrain the profile reconstruction. Moreover, by defining particular procedures of image and numerical processing, the analysis can be completely automated from the primary data contained in the DEMs. The main principle of the method is to produce bivariate histograms showing the relation between slope and relative altitude (i.e. with respect to the altitude of the current alluvial plain) for all pixels of successive sections covering the whole valley length. Then, for each section histogram, we smooth the curve joining the minimum slopes observed at every relative altitude and we assume that the minima of the smoothed curve locate the altitudes of the 'terrace' elements preserved in the section. We have successfully tested this method in the Vesdre valley of eastern Belgium, representative of the rivers incised in recently uplifted areas in temperate climatic conditions. Main

advantages of such an automated DEM-based approach are its objectivity (despite the empirical fixing of thresholds at different steps of the analysis), its exhaustivity (depending on the DEM quality and resolution) and its rapidity (allowing fast and coherent analysis of many rivers in an extended region). Next steps of the study, currently in progress, are the evaluation of the meaning of some imposed conditions, an analysis of consistency between our results and field data and an attempt to automatize the profile reconstruction itself.