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A new Educational Open-source eBook for Modeling River Hydro-morphodynamics

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The analysis of hydro-morphodynamic processes in river ecosystems involves modeling complex natural processes based on continuously growing data sets. Typical tools involved in such analyses embrace numerical models, GIS software, and high-level programming languages. Teaching the application of these tools is part of many environmental and geoscience-oriented study courses though the tool development partly roots in other disciplines, such as civil or software engineering. Thus, the holistic understanding of tools for hydro-morphological modeling and assessment of river ecosystems is an interdisciplinary challenge that is often solved in practice through multi-institutional collaboration. Yet, even public academic institutions tend to teach the usage of proprietary software that is embedded in a chain of even more, often expensive, proprietary software applications. In addition, the teaching of software refers to a presently up-to-date version, and its application can quickly become outdated.

To address the challenge of teaching interdisciplinary tools for modeling and analyzing river ecosystems, we have created an online eBook (available at https://hydro-informatics.com) that exclusively explains the use of open-source and open-access software. The eBook goes beyond our institutional teaching, and we do our best to keep the descriptions of software applications up-to-date. In addition, we offer more than IT assistance through detailed explanations of physical processes and mathematical equations involved in river ecosystem modeling. For instance, we explain geomorphological principles and the development of equations for calculating fluvial sediment transport. In cross-disciplinary application examples, we also feature ecohydraulic principles of river landscape analysis, for example, to calculate habitat suitability based on two-dimensional numerical model outputs. To this end, we explain and demonstrate the installation and use of the high-level programming language Python, the numerical modeling software BASEMENT and TELEMAC, the usage of git and Markdown, and the geospatial software QGIS on common operating systems (including and with preference: Linux). Ultimately, we also offer sample data sets, self-learning checks, exercises, and troubleshooting solutions to keep the barrier to free teaching as low as possible.