

EGU2020-5609

<https://doi.org/10.5194/egusphere-egu2020-5609>

EGU General Assembly 2020

© Author(s) 2020. This work is distributed under the Creative Commons Attribution 4.0 License.



Uncertainties in Chi analysis: implications for drainage network and divide stability

Jens Turowski¹, Wolfgang Schwanghart², Kim Huppert¹, and Claire Masteller³

¹GFZ German Research Centre for Geosciences, 5.1 Geomorphology, Potsdam, Germany (turowski@gfz-potsdam.de)

²University of Potsdam, Institute of Environmental Science and Geography, Karl-Liebknecht-Str. 24-25, DE-14476 Potsdam-Golm, Germany

³Department of Earth and Planetary Sciences, Washington University in St. Louis, USA

In recent years, Chi analysis has become an important tool for tectonic and geomorphic analyses of longitudinal and planform patterns of river networks. Predicated on the commonly observed inverse scaling between drainage area and slope in rivers and integrating drainage area, the metric Chi has several advantages over other topographic metrics used to describe river long profiles. For a steady state river, Chi scales linearly with elevation, simplifying visual interpretation and further analysis. As an integral property, it also reduces scatter in noisy topographic data. In addition, comparison of computed Chi values to the steady state assumption are a popular tool to determine the stability of river networks and mobility of drainage divides. In this application it is thought that the drainage divide is mobile when Chi values are unequal at adjacent channel heads when integrated from a common base level. These differences in Chi are now frequently used to map mobile and stationary divides and to interpret their spatial patterns in terms of tectonic forcing.

As the interpretation of divide mobility relies on a difference in Chi values across the divide, the question arises: how magnitude of cross-divide differences in Chi is necessary for a statistically significant result, given inherent uncertainty in calculations of Chi and the topographic data from which they are derived? Currently, uncertainties in Chi have not been formally evaluated. As such, it remains unclear how robust measurements of differential cross-divide Chi are as a proxy for interpreting drainage divide mobility. Here, we argue that uncertainties in differential cross-divide Chi depend on the location and length of the drainage divide. In a discrete representation of topography, we identify two sources of error. The first source of error can arise if a pixel is incorrectly assigned to a catchment on one side of the divide due either to error in the topographic data or uncertainty in the delineation of drainage area from a digital elevation model (DEM). The second source of error arises because the divide is a linear feature, which cuts across individual pixels in a gridded DEM. Thus, a pixel at the boundary of one designated catchment typically contains area that should drain to its neighboring catchment. We develop an analytical description of these sources of error and show that uncertainties in differential cross-divide Chi can be of the same order as the cross-divide difference in Chi itself. The results from the analytical

solution are consistent with a numerical assessment of Chi uncertainties from flow routing on DEMs using multiple flow directions. We discuss scaling with drainage area, and the implications for drainage network mobility using type examples.

How to cite: Turowski, J., Schwanghart, W., Huppert, K., and Masteller, C.: Uncertainties in Chi analysis: implications for drainage network and divide stability, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-5609, <https://doi.org/10.5194/egusphere-egu2020-5609>, 2020