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Flood detention area modelling based on nationwide topographic data: ALS-DTMs vs. conventional DTMs

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Topographic depressions have an important role in hydrology. These effects on hydrological processes are caused by changes in the water balance and runoff response of a watershed. Nevertheless, research has focused in detail neither on the effects of acquisition and processing methods nor on the effects of resolution of nationwide grid digital terrain models (DTMs) on topographic depressions. Recently, many countries have conducted nationwide ALS (Airborne laser scanning) surveys for DTM purposes. Thus, detailed comparison between nationwide ALS-DTMs with different grid sizes and DTMs that represent more conventional acquisition methods, such as photogrammetric methods, is needed for different study fields. In here, the objective is to delineate the difference of depression variables between nationwide DTMs with different acquisition methods, processing methods and grid sizes. Our depression detection is based on nationwide 25x25 m and 10x10 m DTMs and 2x2 m ALS-DTM produced by NLS of Finland. ALS-DTM2 was resampled to 10x10 and 25x25 m DTMs. Thus, it was possible to compare DTMs that represent the same grid size but different acquisition and processing methods. The variables considered are the mean depth of the depression, the number of its pixels, and its area and volume. Shallow and single-pixel depressions and the impact of mean filtering on ALS-DTM were also examined. Quantitative methods and error models were applied. According to our study, the depression variables were dependent on the scale, area and acquisition method. When the depths of depression pixels were compared with the most accurate DTM based on accurate VRNS-GNSS (Virtual Reference Stations, Global Navigation Satellite Systems) field survey data, the maximum errors created the largest differences between DTMs and hence represented the amount of the depth error. The mean filtering of ALS-DTM2 focuses on the small and shallow depressions, and is thus suitable for using in flood risk management. According to our results, the decision about the suitability of the available DTMs for a specific purpose is good to make on the demands of the problem settings. In studies with a relatively low demand for accuracy, awareness of the error, its level and effects on analyses in general is sufficient. In more accurate studies, the awareness of the varying spatial accuracy and the knowledge about certain typical characteristics of available DTMs to represent a studied terrain variables is essential. On the whole, the ability of a DTM to accurately represent depressions varied uniquely according to each depression, although DTMs also displayed certain typical characteristics. Thus, a DTM's higher resolution is no guarantee of a more accurate representation of topography in flood detention studies.