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Comparative assessment of the GIS based bathtub model and an enhanced bathtub model for coastal inundation

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ABSTRACT:

Coastal zones are dynamic spaces where human activities and infrastructure are exposed to natural forces, climate change and extreme weather events such as storm surges. Coastal inundation is regarded as one of the most dangerous and destructive natural hazards, and while there are many studies to analyse these events, GIS based methods are limited. This research aimed at developing a GIS based enhanced Bathtub Model (eBTM) that improves on the widely used simple Bathtub Model (sBTM) to make it more appropriate to a storm surge related coastal inundation context. The eBTM incorporates beach slope, surface roughness and instils hydrological connectivity relevant for event scale coastal flooding, unlike the sBTM which only uses topographic elevation above sea level as input. For a test site in Cape Town, South Africa, inundation levels for 3 independent scenarios were calculated using the average spring tides level, extreme sea level for a 1-in-100-year storm and two sea-level rise scenarios. Each scenario was run on both the sBTM and the eBTM developed through this study. Comparing the results, the eBTM method overall produced more conservative inundation results and also produced less disconnected areas of (unrealistic) inundation. The eBTM also produces inundation water levels relative to structures, thus showing the potential for quantifying the coastal inundation risk to infrastructure, which is of relevance in the disaster response context. Additionally, the impact of using Digital Terrain Models (DTMs) instead of Digital Surface Models (DSM) on the inundation results was tested. The use of a DSM, including buildings and other objects, showed more realistic trajectories of the inundation water moving through the model area.