EGU2020-4251
https://doi.org/10.5194/egusphere-egu2020-4251
EGU General Assembly 2020

Simulation of Floating Debris during a Flash Flood Event

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Under climate change, extreme weather events such as storms and intense rainfall has become far more frequent. This is evidenced by the outburst of multiple flood events in the recent years in the UK and other parts of the world. Induced by intense rainfall, flash flooding is one type of wide-spread natural hazards that can pose serious threats to people's lives and properties. Most likely happening in steep rapid-response catchments following localized high intensity rainfall, flash floods are characterized by rapid rise of water level and high flow velocities in channels and floodplains. The violent flood waves can remove and transport heavy objects such as cars and tree, imposing extra risk to people and infrastructure, e.g. bridges.

On 16th August 2004, the coastal village of Boscastle in north Cornwall, UK, was devastated by a flash flood following an exceptional amount of rain that fell over eight hours. The village suffered extensive damage and notably, some 100 vehicles were washed to downstream and into the sea, some of which blocked bridges and altered flood hydraulics. This work aims to reproduce the flood event including floating debris dynamics using a new coupled hydrodynamic model. The coupled modelling tool predicts the flooding process using a finite volume shock-capturing model that solves the fully 2D shallow water equations (SWEs), which is coupled with a discrete element model (DEM) to simulate the interactive dynamics of floating objects. The coupled model is further accelerated by implementation on modern GPUs and is therefore well-suited for simulation of large-scale transient flood hydrodynamics enriched with floating debris. The simulation results are first confirmed by comparing with maximum flood depths collected after the event. Further simulations are carried out to investigate the influence of floating vehicles on flood hydrodynamics and understand how they block bridges and alter flood paths. The simulation results are consistent with observations captured during the event.

Key Words: Flash flooding; Hydrodynamic model; Shallow water equations; Discrete element model; Floating debris