Geophysical Research Abstracts
Vol. 17, EGU2015-13830, 2015
EGU General Assembly 2015

A new modelling framework and mitigation measures for increased resilience to flooding

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Flooding in rivers and estuaries is amongst the most significant challenges our society has yet to tackle effectively. Use of floodwall systems is one of the potential measures that can be used to mitigate the detrimental socio-economical and ecological impacts and alleviate the associated costs of flooding. This work demonstrates the utility of such systems for a case study via appropriate numerical simulations, in addition to conducting scaled flume experiments towards obtaining a better understanding of the performance and efficiency of the flood-wall systems.

At first, the results of several characteristic inundation modeling scenarios and flood mitigation options, for a flood-prone region in Scotland. In particular, the history and hydrology of the area are discussed and the assumptions and hydraulic model input (model geometry including instream hydraulic structures -such as bridges and weirs- river and floodplain roughness, initial and boundary conditions) are presented, followed by the model results. Emphasis is given on the potential improvements brought about by mitigating flood risk using flood-wall systems. Further, the implementation of the floodwall in mitigating flood risk is demonstrated via appropriate numerical modeling, utilizing HEC-RAS to simulate the effect of a river's rising stage during a flood event, for a specific area.

The later part of this work involves the design, building and utilization of a scaled physical model of a flood-wall system. These experiments are carried out at one of the research flumes in the Water Engineering laboratory of the University of Glasgow. These involve an experimental investigation where the increase of force applied on the floodwall is measured for different degrees of deflection of the water in the stream, under the maximum flow discharge that can be carried through without exceeding the floodwall height (and accounting for the effect of super-elevation). These results can be considered upon the implementation phase of floodwalls, when the floodwalls are placed at any arrangement other than parallel to the flow (e.g. along river bends in meandering channels or at river junctions). Such considerations can lead to site-specific optimal designs of direct flood defenses with the rising floodwall system, both in terms of product performance as well as cost efficiency.