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INCREASING FLOOD RISK IN THE MEKONG DELTA – A HOMEMADE PROBLEM?

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Teaser

Human encroachment on the river system or natural factors: what are the influences and how heavily do they factor in? Researchers at the GFZ quantitatively modelled the impact.

Keywords

Mekong, Vietnam, Can Tho, flood, dyke, high dykes, hydrology, tides, spring tide, river, river system, flooding, flood control, water level

The Mekong Delta is an enormous flood plain in southern Cambodia and Vietnam. The delta was created over thousands of years by Mekong flooding, which occurs annually each monsoon season. Floods are an essential component of the delta and responsible for its formation and continued existence. Floods also form the basis of the high agricultural productivity in the delta due to nutrient-rich sediment deposition. They also prevent saltwater from entering the delta. Floods are therefore considered in a positive light by the locals. Society, the ecosystem and the economy have adapted to the annual floods.

Unusually strong floods, characterized in the Mekong Delta not only by the maximum water level, but also by the duration of high water levels do, however, represent a danger to the population. The extreme flooding in the summer of 2000, for example, caused immense damage and led to almost five hundred human fatalities. In this case, the dangerous floods were concentrated in the regions along the border between Cambodia and Vietnam. The areas further downstream, however, particularly the largest city and the economic centre

that lies in the Vietnamese portion of the delta, Can Tho, were only slightly affected by the flood.

Fig. 1: Flooded street in the Vietnamese city of Can Tho during the Mekong flood of 2011. (Photo: Do Thi Chinh/GFZ)

This catastrophic event prompted the Vietnamese government to take action. Large-scale flood measures were implemented, particularly in the most affected areas – those along the border to Cambodia: the "Plain of Reeds" and the "Long Xuyen Quadrangle." Large portions of the floodplains were protected by high dykes here, which were designed to protect the areas against flooding similar to what had occurred in the year 2000. The dyke rings were furnished with floodgates, with which the area could be flooded in a controlled manner or the area could be fully protected against the flood. This regulation led farmers to increasingly cultivate crops during the following years even during the flood season in the normally flooded areas. This, however, resulted in a reduction in the natural flood protection through the flood areas.

The next unusual flood occurred in 2011 but was less extreme in height and duration than the 2000 event. The newly implemented flood protection measures were effective in the regions that were most severely affected during the last event. There was comparatively little damage in the Plain of Reeds and the Long Xuyen Quadrangle. In Can Tho, however, flooding of a magnitude that had never been observed before occurred and resulted in extensive economic damage. The public as well as politicians then denounced the new high dyke system and the resulting missing upstream flooding areas. Controversial discussions arose, especially between the upstream and downstream provinces in the Mekong Delta. They were in need of strong scientific insights. How did such high water levels come about?

In order to support the controversial discussion with verifiable and quantitative statements on the cause of the flooding in Can Tho, researchers from the German Research Centre for Geosciences GFZ and the Southern Institute of Water Resources Research in Ho Chi Min City carried out a modelling study. Scientists first reconstructed the floods of 2000 and 2011 using a hydraulic model. Subsequently, the boundary conditions of the two flood events—that is, the influx into the Mekong Delta and the tidal levels at the estuaries of 2000 and 2011—as well as the dyke systems of 2000 and 2011, were systematically exchanged and combined. The scientists could therefore quantify the impact stemming from the three relevant factors: “dyke system”, “flood level” and “tidal level” on the flooding depths and duration in the different regions of the Mekong Delta. This also included the question whether and in what way the expansion of the dyke system would increase the risk of flooding in Can Tho.

Fig. 2: Even a flood peak reduction of only 10cm would have a considerable effect and reduce the flood risk for many inhabitants. (Photo: Do Thi Chinh/GFZ)

The research showed that the expansion of the dyke system actually caused an increase in the flood depths and duration downstream, particularly in the central part of the Vietnamese Mekong Delta, including in Can Tho. The maximum water level increased by nine to thirteen centimetres due to the high dyke rings, and the flooding duration was prolonged by fifteen days. The modelling carried out by the scientists showed, however, that only a portion of the observed water levels and flooding could be explained in this way. The tidal level in 2011 had considerably more impact. Even far from the sea – Can Tho lies almost eighty kilometres from the coast – the tides were noticeable and increased the water levels upstream. Due to the temporal coincidence of the peak discharge of the

flood with the spring tide in the first half of October 2011, higher maximum water levels of 19-32 cm were caused in the central delta. This means for Can Tho that approximately a third of the higher water levels in 2011 could be attributed to the dyke system upstream. The tidal level together with the temporal evolution of the flood, however, had a distinctly greater impact.

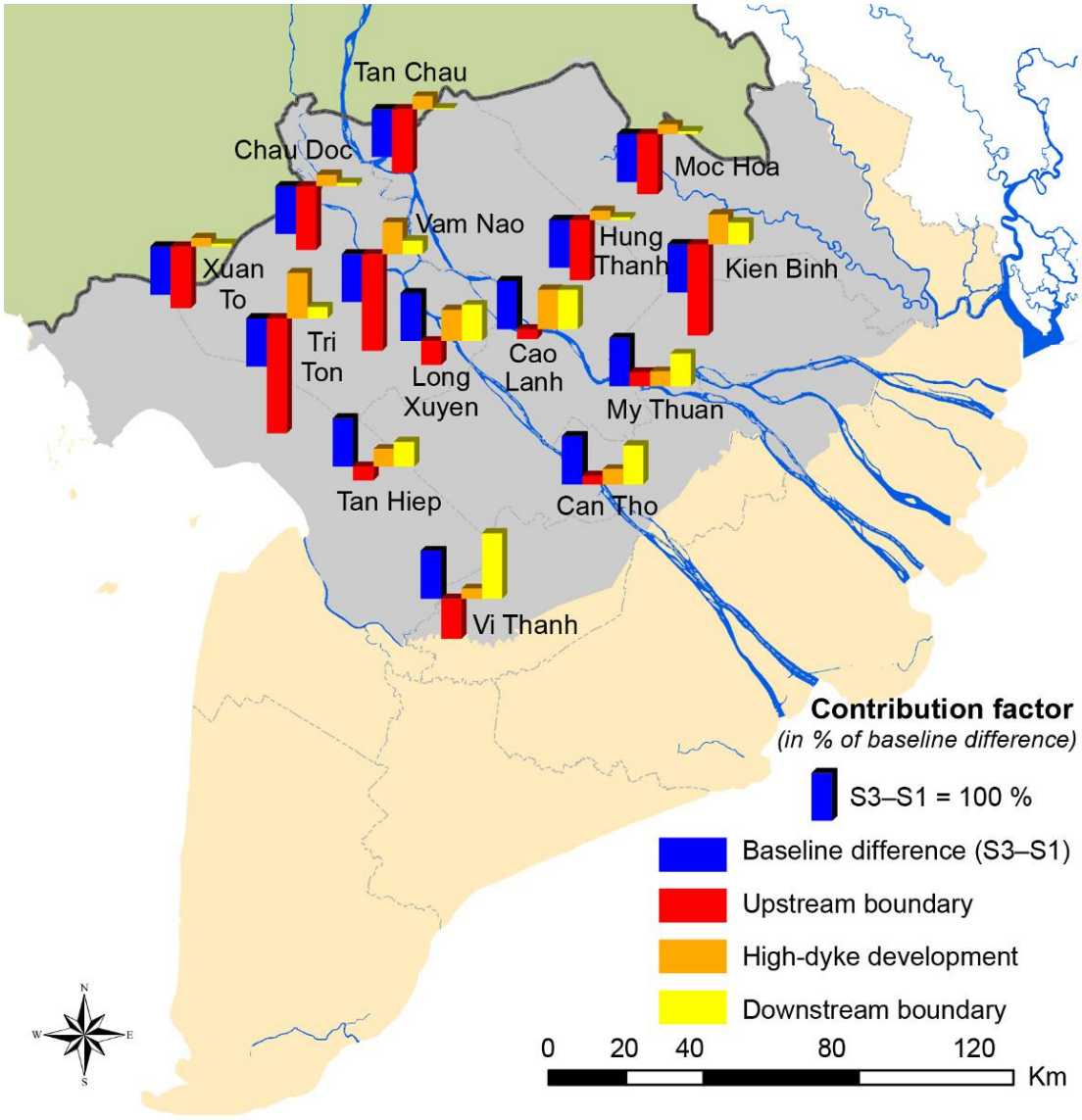

Fig. 3: Difference in maximum water levels between the 2011 flood (S3) and the 2000 flood (S1) and the isolated influence of changed influencing factors: Flood discharge (upstream boundary), dike system (high-dyke system) and tide level (downstream boundary). (Map: Triet et al., 2017, p. 4007 / Article under CC BY 3.0 licence)

Each of the influencing factors mentioned has a very different effect on individual measuring stations in the delta: tides, timing and dimensions of a flood's peak runoff and new dyke systems. Because only the regulation of the dyke system's locks can be directly influenced, the results can be used to formulate recommendations for integrating the agricultural areas protected by dykes into a flood protection concept. With sufficiently reliable flood run-off predictions and taking into account the expected tidal levels, protected areas in the Plain of Reeds and the Long Xuyen Quadrangle can be flooded in a

controlled manner to reduce the flood peak. Even a reduction of ten centimetres would noticeably curtail the flood risk given the low topographic elevations in the delta. Against the background of rising sea levels and the observed land subsidence in the Mekong-Delta—something that would, for example, lead to a higher risk of flooding for broad sections of the Mekong-Delta—appropriate flood management plans are urgently needed. The possibilities presented, including the dyke systems, could occupy a critical place in such plans. The dyke systems should therefore not be perceived as a threat (in the central delta) by the population and by politicians or as a means of increasing production (in the northern delta). Rather, they offer effective means in flood protection and minimising economic damage in the entire Mekong Delta. Apart from direct flood protection, regular flooding should take place in all flood areas with the aim of maintaining sediment input in those areas. Large-scale sediment input is ultimately the only means available to counteract the effective sea level rise, which comprises the actual climate change-induced sea level rise and the land subsidence.

References

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