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Understanding coevolution in Deltas: A Bayesian Network Model

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Coevolution in deltas would reflect the feedback loop or interaction between natural processes and human actions: each has an effect on the other and hence an inter-dependent interaction initiates and continues. Deltas are dynamic systems and engineered adaptations have played a key role in their development, in some cases over centuries. Mid to low latitude deltas have been densely populated over lengthy time scales, and humans have implemented various engineered interventions in order to maximise the provisioning services of the delta, as well as reduce the vulnerability of the delta residents and economy to hazards such as coastal flooding. This has led to the natural delta system responding through various pathways, including increased rates of subsidence and reduced river flooding and sedimentation. In order to alleviate this, humans have implemented further engineered interventions, and thus the cycle continues. An example of this process is the construction and upgrade of dikes to reduce river and coastal flooding has continued in deltas for hundreds of years. This has positive impacts of reducing flood risk and exposure. However, this has led to a reduction in the volume of sediment able to enter the land and has consequently increased the rate of subsidence within the diked areas. Delta stakeholders are investing and trialling a variety of techniques, including tidal flood management to attempt to counteract this negative consequence and thus increase the height of the land.
While there is substantial evidence to support coevolution (Welch et al., 2017), this relationship has proven difficult to quantify in any detail, with delta specific data being unavailable and also causal relationships difficult to form, due to the variables being affected by many parameters. In order to be able to make informed decisions about the future management of deltas, stakeholders need to be able to understand these relationships. In this study, Bayesian Network Modelling has been used as a technique to explore these relationships and investigate plausible future deltaic states for a delta that is exposed to flooding (both coastal and riverine), based upon different adaptation trajectories. This presentation will explain the steps involved in creating and operationalising the model, and introduce some preliminary results. The model was formed using relationships described within literature, for populated deltas around the world, and was quantified using expert opinion. The model can be split into three key sections: The initial flood event, the impact of this flood event and then the engineered response that was used. The model then loops back to the flood event, forming a loop, which continues through time. The model aims to give an overall, general understanding of coevolution in deltas, which can be applied to populated deltas across the world at scales ranging from polder level through to whole delta level.

WELCH, A. C., NICHOLLS, R. J. & LAZAR, A. N. 2017. Evolving deltas: Coevolution with engineered interventions. Elem Sci Anth, 5, 49.