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Urban flood control in coastal mega-cities: Shanghai

Briefing Note

A briefing on research from the Climate Science for Service Partnership (CSSP) China for decision-makers in China No. 02

An integrated framework for the assessment of flood risk mitigation strategies under future uncertainties in coastal mega-cities has been developed (Hu et al., 2019). The framework includes a decision-support tool that has been applied to central Shanghai. The results show that drainage capacity plays a dominant role and that the trade-offs between grey and green flood mitigation solutions need to be considered to reduce the risk of flooding.

Mega-cities and climate change

With a population greater than 10 million, mega-cities are typically the most prominent centres of population and economy in a country (United Nations, 2018) and therefore well placed to play a leading role in responding to climate change challenges.

In a warming climate, coastal mega-cities (e.g. Shanghai) will face increasing flood risk caused by increased precipitation (under the current protection standard) which poses a significant challenge for flood protection planning. Rapid urbanisation, which is associated with anthropogenic heat and artificial land cover, may lead to urban rain island effect with localised inundation events as a consequence. Moreover, land subsidence and sea level rise have caused a decrease in urban drainage capacity in coastal cities. In addition to these complex physical factors, long-term planning to manage flood risk will be further challenged by uncertainty in socio-economic factors and contested stakeholder priorities.

Understanding the extent to which these factors will increase the risk of flooding is key to taking actions in a warming climate.

A planning-support tool, which considers the entire cascade of factors and its uncertainties, provides a promising framework to address the challenges of increasing flood risk, and to inform adaptation and mitigation strategies.

Key findings

- **Flood risk decision-support tool developed -** the tool takes into account the uncertainty in future rainfall patterns and intensity, the physical and economic damages resulting from extreme rainfall events and the cost-effectiveness of different mitigation options.
- **Tool applied to a coastal mega-city -** the framework was implemented to the reoccurrence, in the 2050s, of a record-breaking extreme rainfall event in Shanghai. Different factors causing uncertainty of future extreme flood events were identified and assessed to support future planning for flooding protection in Shanghai.
- **Sea-level rise and land subsidence key concerns for flood control** - a decrease in the capacity of urban drainage systems, caused by sea level rise and land subsidence, will play a dominant role in worsening future inundation risks in central Shanghai.
- **Combination of grey and green infrastructure -** the negative environmental impacts of grey solutions (e.g. deep tunnel construction) and the environmental benefits of green ones (e.g. Sponge City in China) are difficult to measure and typically underestimated by planners. A combination of grey and green infrastructure is preferred, taking into account their environmental impacts while reducing inundation risk.
- **Knowledge co-creation –** given future uncertainty and conflict of priorities, a knowledge co-creation process that includes scientists, policy-makers, infrastructure experts and other stakeholders is crucial for a trade-off analysis of alternative flood control solutions.

Urban Flood Image: Kelly Sikkema, Unsplash

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Institute for Environmental Analytics

SUSTAINABLE DEVELOPMENT GOALS

Implications

When dealing with the risks and uncertainties posed by future climate change, there is an increased demand for wise and visionary decision-making. One area that still needs attention is the co-development of climate services to engage both providers and users to bridge the gap between the scientific research and practical applications.

The Climate Science for Services Partnership China (CSSP China) programme provides a good opportunity to enable better management of the risks of climate variability through the strong strategic collaboration it has established between scientists, policy-makers, and stakeholders. (Golding et al.,2017).

Huangpu River, Shanghai. Image: Pixabay

Recommendations

- **Employment of planning-support frameworks for decision-making.** Such frameworks can enable city planners and other stakeholders to take into account multiple factors and their uncertainties for flood control under climate change.
- **Consideration of future climates and human activities.** For future flood control, a proactive planning strategy is required to strengthen drainage capacity affected by sea level rise and land subsidence.
- **Balancing between grey infrastructure and green solutions.** Trade-offs between these measures for flood risk management should be considered by city planners, especially when planning new cities, e.g. Xiong'an New Area in China.
- **Establishing synergies between different actors and sectors.** Engagement between decision-makers, scientists and sectoral experts should be encouraged. This will motivate applied research and thus potentially produce solutions that are more tailor-made and effective.
- **Increasing capacity in the utilisation of climate information.** Raising awareness of climate change among decision-makers is needed, together with a capacity-building campaign in the effective use of climate information.

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