HEIBRIDS
HELMHOLTZ EINSTEIN INTERNATIONAL
BERLIN RESEARCH SCHOOL IN DATA SCIENCE

Admission Round 2020

Project Title	**Data Mining Dynamic Human Behaviors for Flood Risk Assessment in Coupled Human-environment Systems**
Project leads / supervisors	Prof. Dr. Andrea Cominola (TU, ECDF) PD Dr. Heidi Kreibich (GFZ, Helmholtz)

Project description

Flooding events in urban and non-urban settings represent a major cause of insured losses, with costs of several billion US$/year globally (e.g., US$ 60 billion in 2016). Both people and infrastructural assets are vulnerable to flood events, which are becoming increasingly frequent and severe as a consequence of climate change, extreme rainfall events, and the increasing number of people living in flood-prone areas. Several quantitative approaches for flood risk assessment exist in the literature. They rely on statistical methods and hydrological models to quantify the expected risk as a function of hazard (i.e., flood extent depth), exposure (of people/assets), and vulnerability (damage). Yet, there is limited integration of dynamic human behaviors in such methods. Human behavior dynamics play a key role in affecting the impact and recovery time of floods in coupled human-environment systems. The perception of risk, as well as adaptive behaviors for prevention, preparation, response, and recovery during flood events (e.g., accessing weather warnings, donating money for recovery) depend on several individual and collective socio-psychographic determinants. One of the key challenges in quantitative risk assessment at present is how to integrate information on dynamic human behaviors in risk assessment models. These should then inform precautionary and emergency measures and risk management approaches which mitigate flood risk.

This project addresses the above challenge as articulated in these three specific questions: (i) which data and approaches can be utilized to better understand and model relevant human behaviors before, during, and after flood events? (ii) how can relevant human behaviors be learned from the above data and integrated in dynamic flood risk assessments to support decision-making in risk management and climate adaptation? (iii) which environmental and economic benefits can be achieved by embedding human behaviors in flood risk models?

The project is structured according to the following activity plan. The activities of Year 1 will focus on data identification, gathering, and data mining to gain knowledge about behavioural dynamics. Methods relying on open and crowd-sourced data (e.g., mobile phone usage, data from social media) will be prioritized. In Year 2, the first prototypes of behavioral models will be developed and integrated in risk assessment models. Finally, activities in Year 3 will be focused on model validation, testing, and application with data from different contexts.

The main expected outcomes of the project are quantitative knowledge about behavioural dynamics and flood risk changes and the developed models to inform flood-risk management policy.

Important publications related to the topic

Bubeck, P., Botzen, W. J. W., Kreibich, H., Aerts, J. C. J. H. (2013): Detailed insights into the influence of flood-coping appraisals on mitigation behaviour. - Global Environmental Change, 23, 5, pp. 1327-1338. DOI: http://doi.org/10.1016/j.gloenvcha.2013.05.009 (Highly cited in field)

Cominola, A., Nguyen, K., Giuliani, M., Stewart, R. A., Maier, H. R., & Castelletti, A. (2019). Data mining to uncover heterogeneous water use behaviors from smart meter data. Water Resources Research, in press.

Cominola, A., Giuliani, M., Castelletti, A., Rosenberg, D. E., & Abdallah, A. M. (2018). Implications of data sampling resolution on water use simulation, end-use disaggregation, and demand management. Environmental Modelling & Software, 102, 199-212.

Cominola, A., Spang, E. S., Giuliani, M., Castelletti, A., Lund, J. R., & Loge, F. J. (2018). Segmentation analysis of residential water-electricity demand for customized demand-side management programs. Journal of cleaner production, 172, 1607-1619.

Cominola, A., Giuliani, M., Piga, D., Castelletti, A., & Rizzoli, A. E. (2015). Benefits and challenges of using smart meters for advancing residential water demand modeling and management: A review. Environmental Modelling & Software, 72, 198-214.

Kreibich, H., Di Baldassarre, G., Vorogushyn, S., Aerts, J. C. J. H., Apel, H., Aronica, G. T., Arnbjerg-Nielsen, K., Bouwer, L. M., Bubeck, P., Caloiero, T., Do, T. C., Cortès, M., Gain, A. K., Giampá, V., Kuhlicke, C., Kundzewicz, Z. W., Llasat, M. C., Mård, J., Matczak, P., Mazzoleni, M., Molinari, D., Nguyen, D., Petrucci, O., Schröter, K., Slager, K., Thieken, A. H., Ward, P. J.,Merz, B. (2017): Adaptation to flood risk - results of international paired flood event studies. - Earth's Future, 5, 10, pp. 953-965. DOI: http://doi.org/10.1002/2017EF000606

Kreibich, H., Botto, A., Merz, B., Schröter, K. (2017): Probabilistic, Multivariable Flood Loss Modeling on the Mesoscale with BT-FLEMO. - Risk analysis, 37, 4, pp. 774-787. DOI: http://doi.org/10.1111/risa.12650

Kreibich, H., Bubeck, P., Van Vliet, M., De Moel, H. (2015): A review of damage-reducing measures to manage fluvial flood risks in a changing climate. - Mitigation and Adaptation Strategies for Global Change, 20, 6, pp. 967-989. DOI: http://doi.org/10.1007/s11027-014-9629-5

Kreibich, H., van den Bergh, J. C. J. M., Bouwer, L. M., Bubeck, P., Ciavola, P., Green, C., Hallegatte, S., Logar, I., Meyer, V., Schwarze, R., Thieken, A. H. (2014): Costing natural hazards. - Nature Climate Change, 4, pp. 303-306. DOI: http://doi.org/10.1038/nclimate2182