Modelling tipping points in development trends of a global urban system by spatiotemporal trend detection methods

Urban systems are dynamic and complex environments, combining social, environmental and technological dimensions. With accelerating urbanisation, they are increasingly vulnerable to global challenges associated with change, including demographic and climate change. Disruptive and catastrophic phenomena, such as floods, landslides or uncontrolled settlements (slums), affect a growing population. The density of people, infrastructure and services, as well as the global reach of urban settlements, puts urban systems at risk of cascading that reverberate rapid changes globally. It is therefore crucial to have an in-depth understanding of how the global urban system works and how it is changing in order to shape future living conditions in a way that is rational and sustainable, but also 'fair' in terms of economics and social cohesion.

The proposed study aims to bridge a gap between the complex character of global urban systems and the current practice in urban growth modelling. On the one hand, despite the international reach of global cities, examples of simulations of urban expansion on a global scale are scarce and of coarse-grained resolution. On the other, the number of applications including the non-stationary character of complex urban environment is limited. Therefore **the aim of the presented study is to identify and conceptualise tipping points in the spatiotemporal trends of the global urban system, by simulating the development of urbanised areas on global scale at an unprecedented resolution of 100 m.**

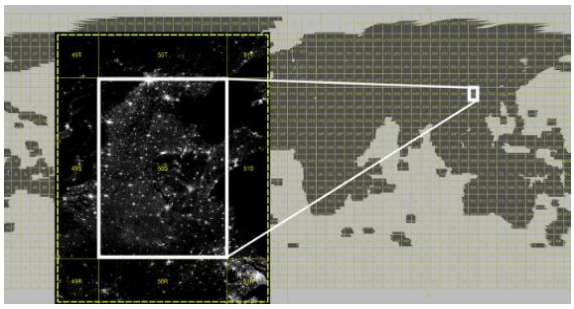
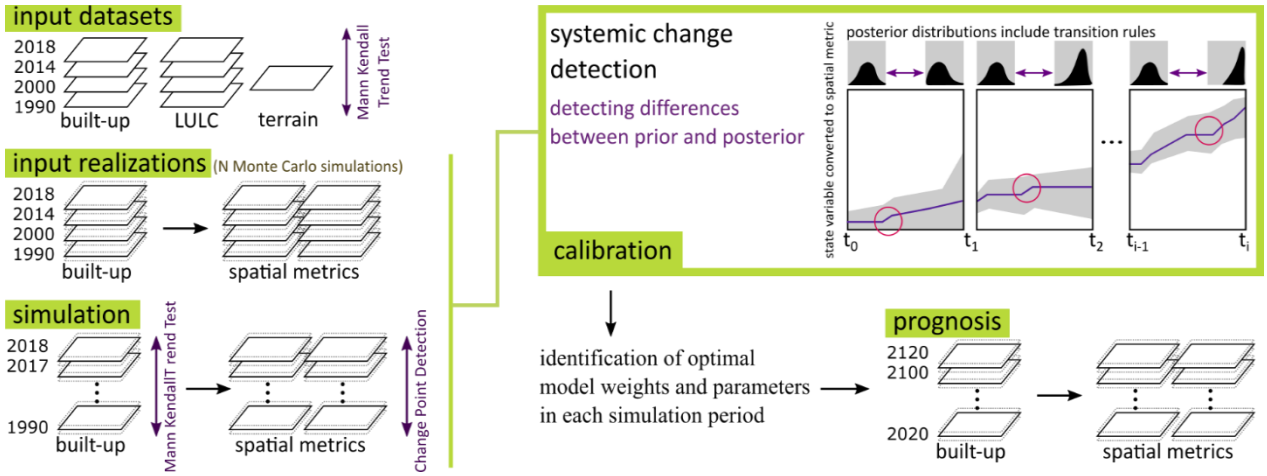


Fig. 1. Multi-modelling schema: one model per UTM zone

The results of the study will enable detailed identification of trends and tipping points in the spatial development of cities on a global scale. This will enable the validation of spatial policies implemented. The "output" of the project is therefore an urban development model based on the concept of parallel computing: The simulation will be carried out separately for each zone of the UTM grid, based on the settlement network and land cover in the given zone and in neighbouring zones (Fig. 1).

The methodological aim of the project is to propose a scheme for identifying development trends in the global urban system and extrapolating the identified trends into simulations predicting the future development of urbanised areas (Fig. 2).



Ryc.2. Identification of tipping points in the urban system and extrapolation of development trends into model projections

The research will result in a harmonised dataset of built-up areas on a global scale at a resolution of 100 m with projections to 2100. There are multiple potential applications of such data in urban research: in analyses of urban morphology and population distribution, energy consumption, urban agriculture, climate change, or risk management. In light of increasingly frequent global and catastrophic events, the developed method for detecting tipping points can be used as a practical tool to support decision makers in understanding and governing abrupt changes in the urban environment.