

# Measuring and Modeling Urban Dynamics: Impact on Quality of Life and Hydrology. Setup of Methodology.

*Frank Canters<sup>1</sup>, Tim Van de Voorde<sup>1</sup>, Okke Batelaan<sup>2</sup>, Jef Dams<sup>2</sup>, Yves Cornet<sup>3</sup>, Marc Binard<sup>3</sup>, Rudi Goossens<sup>4</sup>, Guy Engelen<sup>5</sup>, Carlo Lavalle<sup>6</sup> and José Barredo<sup>6</sup>*

1. Vrije Universiteit Brussel, Department of Geography, Brussels, Belgium; [fcanters@vub.ac.be](mailto:fcanters@vub.ac.be)
2. Vrije Universiteit Brussel, Department of Hydrology and Hydraulic Engineering, Brussels, Belgium; [batelaan@vub.ac.be](mailto:batelaan@vub.ac.be)
3. Université de Liège, Unité de Géomatique, Liège, Belgium; [ycornet@ulg.ac.be](mailto:ycornet@ulg.ac.be)
4. Ghent University, Geography Department, Ghent, Belgium; [rudi.goossens@ugent.be](mailto:rudi.goossens@ugent.be)
5. Vlaamse Instelling voor Technologisch Onderzoek (VITO), Mol, Belgium; [guy.engelen@vito.be](mailto:guy.engelen@vito.be)
6. Joint Research Centre, Land Management and Natural Hazards Unit, Ispra, Italy; [carlo.lavalle@jrc.it](mailto:carlo.lavalle@jrc.it)

## ABSTRACT

Urban change processes that have taken place over the last decades are affecting the human and natural environment in many ways, and have stressed the need for new, more effective urban management approaches based on the notion of sustainable development. The problem analysis, planning and monitoring phases of a sustainable urban management policy, however, require reliable and sufficiently detailed information on the urban environment and its dynamics, as well as knowledge about the causes, chronology and effects of urban change processes. Remote sensing imagery is an important data source for monitoring and modeling urban change and its environmental impact. With the recent launch of high-resolution sensors like Ikonos and Quickbird, which allows more detailed mapping of complex urban areas, the potential of satellite remote sensing for urban change analysis has substantially increased. At the same time, interpretation of medium-resolution data from sensors like Landsat TM/ETM+, SPOT-HRV, etc. at the sub-pixel scale, based on spectral unmixing approaches, offers interesting perspectives for an improved use of historic time series of medium-resolution imagery in the monitoring and modeling of urban growth.

The goal of the proposed research is to investigate how EO can contribute to a better monitoring, modelling and understanding of urban dynamics, and its impacts on the urban and suburban environment. Both recent, high-resolution (HR) data, as well as medium-resolution (MR) time series will be used, separately and in combination, to improve the monitoring and modelling of urban change processes, based on innovative mapping approaches, spatial metrics and spatial dynamic modelling. One of the main objectives of the research is to examine how spatial metrics, derived from remotely sensed imagery, may lead to more objective descriptions of urban form that may be used for intra-urban and inter-urban comparison, as well as for urban change analysis. To this end, new urban metrics will be developed, including metrics that are based on the mapping of land-cover gradients (e.g. density of built-up area or vegetation), obtained through sub-pixel classification of medium-resolution imagery or aggregation of

high-resolution land-cover classifications. While most remote-sensing-based studies on urban morphology only consider two-dimensional structure, in this research also stereoscopic and multi-scopic imagery will be used to extract information on the vertical structure of urban areas, which is obviously important in describing urban form. The proposed metrics will be used to complement detailed land-use maps in the historic calibration of a spatially-dynamic land-use model of the type cellular automata similar to, and based on, the EU-MOLAND model, which is among the most advanced and versatile models of the kind. The use of RS-derived metrics should improve the calibration of the model and facilitate the detection and incorporation of the main drivers of urban growth. Research will focus on two urban areas in Europe (Dublin, Istanbul), which are part of the MOLAND project. Remote sensing derived gradients and metrics, as well as the output of the land-use change modeling for Dublin and Istanbul, will be used to study the consequences of urban dynamics in terms of population density and distribution, quality of life and environment. A substantial part of the research will focus on the impact of urban growth on runoff. To this end, detailed information on urban land cover, obtained from time series of remotely sensed data, as well as future land-use patterns, linked to alternative planning scenarios, will be used as input for spatially distributed runoff modelling. Calibration of the runoff model will be based on a data assimilation approach, making optimal use of information with respect to land cover and evapotranspiration, obtained from the available time series of remotely sensed data. Based on the outcome of the model, the future risk of flooding under extreme rainfall conditions, for different development scenarios, will be assessed.