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Šileryte, Rusne; Wandl, Alexander; van Timmeren, Arjan

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Impact Modelling for Circular Economy: Geodesign Discussion Support Environment

Rusne Sileryte, Alexander Wandl, Arjan van Timmeren
Faculty of Architecture and the Built Environment
Delft University of Technology
Delft, the Netherlands
r.sileryte@tudelft.nl, a.wandl@tudelft.nl, a.vantimmeren@tudelft.nl

Abstract

Transitioning towards circular economy requires changes in the current system which yield a number of impacts on such fundamental values as human health, natural environment, exhaustible resources, social well-being and prosperity. Moreover, this process involves multiple actors and requires careful considerations of ample spatial information. While plenty of systems have already been developed to support the decision-making process, up to date no standardized framework exists for spatial modelling of impacts. The poster is based on the ongoing research and aims to suggest a standardized, yet flexible approach for impact modelling using the core concepts of GIS. The framework is expected to ensure consistency and comparability between outputs of automated simulations and elicitation of impacts defined by stakeholders and prepare impact modelling guidelines that aim to overcome the characteristics of a single project and be reused in other GDSEs.

Keywords: Geodesign, Resource Management, Impact Modelling

1 Introduction

Transitioning towards circular economy and turning waste into resource is essential in order to enhance the security of supply for raw materials, stimulate GDP growth, reduce environmental impacts as well as simply increase quality of life (Bourguignon, 2014). This transition involves and therefore requires participation of planning authorities, environmental organisations, actors in waste and resource management and many others. The complexity of the system requires its careful conceptualisation, existing process analysis, forecasting, exploration of alternative solutions and impact simulation and assessment. The broad scope and the strong geographical relations of the problem fit well into the planning approach supported by geodesign (Steinitz, 2012).

The project of REPAiR (Resource Management in Peri-Urban Areas) aims to provide a Geodesign Decision/ Discussion Support Environment (GDSE) as a tool to assist local and regional authorities in creating integrated spatial development strategies for circular economy that are specific for the place at hand, transdisciplinary and eco-innovative.

Proper communication and trust between the support environment and its users is crucial for the successful performance. However, up to date no common approach exists for spatial modelling and therefore communication of probable environmental, financial, social and other impacts. The poster is based on the initial stage of ongoing research and aims to suggest a standardized, yet flexible approach for GIS-based modelling of relevant impacts.

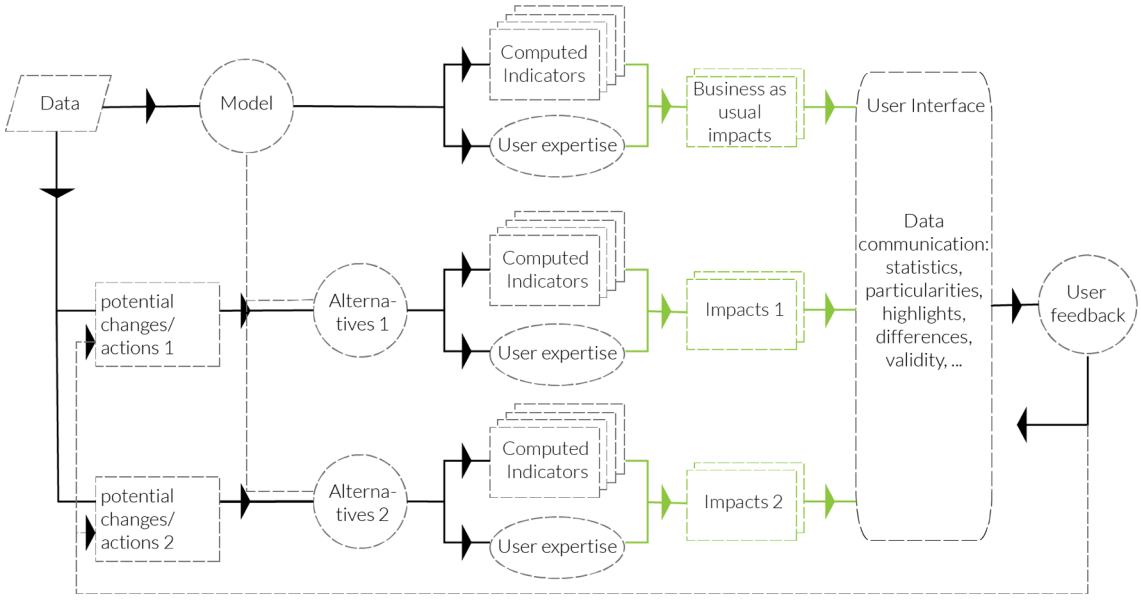
2 Methodology

The strategies for the enhancement of circular economy will be developed in Peri-Urban Living Labs (PULLs) that are processes during which key actors collaboratively generate creative innovations (REPAiR, 2015). These processes will be supported by a GDSE as a customised interactive GIS-based tool which will allow the storage of relevant data and models, testing of alternative eco-innovative solutions and evaluating their impacts. The inherent characteristics of PULL require that the emphasis of GDSE would lie on visualisation and impact communication, rapid assessment and feedback, rather than automated optimization of given variables.

The GDSE is meant to rather support than replace human judgements and improve effectiveness rather than efficiency of a process (Uran and Janssen, 2003). Therefore, the environment is characterised as ‘discussion’ rather than ‘decision’ support as it must have the capacity to stimulate social interaction and discourse in the pursuit of the collective goals.

The standardized framework of spatial modelling of impacts will help to ensure consistency between outputs of automated simulations and expert judgement, introduce higher levels of transparency and comparability, enhance trust and prepare impact modelling guidelines that aim to overcome the characteristics of a single project and be reused in other GDSEs.

Figure 1: A general framework of the GDSE. Highlighted parts indicate place in the system where impact modelling takes place either as an output of an automated procedure or expert judgement.



3 Impact Modelling

Five major groups of impacts are considered: impact on human health, impact on natural environment, impact on exhaustible resources, impact on social well-being and impact on prosperity. Based on the changes a certain solution will entail on the initial data, impacts will be estimated in two ways – one is through automated simulation models, the other is through expert judgement as illustrated in Figure 1.

This research aims to go beyond impact reduction into a numerical proxy unit and focus on optimized user awareness of the impact assessment processes and their certainty. In order to achieve this the standardization is based on the 5 core content concepts of GIS as described by Kuhn and Ballatore (2015): Location, Field, Network, Object and Event.

4 Application of Core Concepts

Static impacts with irrelevant time stamp, that matter only in one specific location, can be modelled as Locations with any numerical, nominal or even 3D-scene-based attributes. An example of a 3D scene attribute would be visual impact that can be modelled as a static scene related to a specific geographical Location. The scene does not change over time and only matters in that particular Location. Moreover, it needs qualitative rather than quantitative evaluation (e.g. considering aesthetics), therefore should be presented for user's judgement.

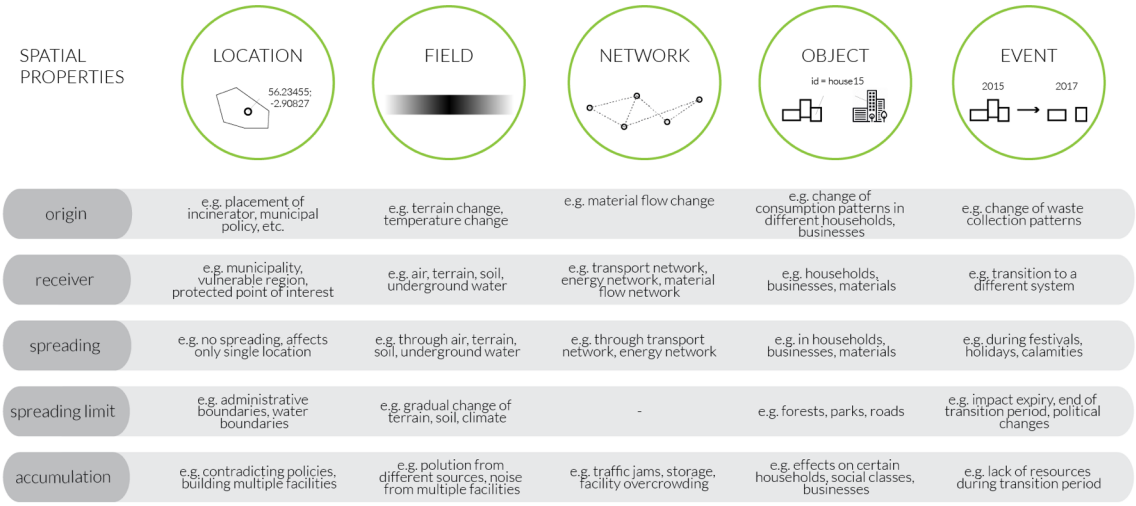
Those impacts that directly follow the first law of geography (Tobler, 1970) can be modelled as Fields, where a value can be calculated at each distinct point following a certain formula or interpolating (extrapolating) from the known points. Typically, this concept is used to describe such phenomena as odour, temperature, radiation, noise, etc. However, the concept may also be adapted for more metaphysical and rather qualitative phenomena, such as perceived tranquillity or safety, especially when explored on a bigger scale. Alternatively, the function of odour or noise can be weighted by the proximity of residential or public spaces to emphasize the relevance.

Networks are useful to represent those phenomena, which are related to each other through non-geographical relations, meaning that objects having high influence on each other do not necessarily have to be close in geographic space. This concept can prove to be very useful for modelling impacts coming from the material flows, when the actual road of transition between locations is not as important as the sequence of these transitions. Also, propagation of health impacts may be anticipated more accurately through Network-based modelling of work-home relationships rather than geographical proximity. Finally, even safety can be modelled as a network, which indicates how safe is the passage between certain Locations or Objects, or even how safe the transition between multiple Events is.

Objects may be related to a geographical location or not. While representation of physical static Objects such as incinerators, containers, houses, public spaces is quite straightforward, the concept may also be used to represent dynamic Objects that do not have clear spatial boundaries, such as biological species or exhaustible resources. An impact on Objects may be caused both through geographical or network relations and may have a temporal dimension or not.

Finally, those Locations, Fields, Objects or Networks that have a certain time of validity can be modelled as Events. Events should be used for modelling impacts that happen only for a certain period of time and have starting and/or ending points, for example, exhaustion of certain resources or behavioural changes due to temporal triggers.

Figure 2: Spatial properties of impacts described as core concepts of GIS as suggested by Kuhn and Ballatore (2015). A few examples are given for each spatial property and a corresponding GIS concept.



SPATIAL PROPERTIES	LOCATION	FIELD	NETWORK	OBJECT	EVENT
origin	e.g. placement of incinerator, municipal policy, etc.	e.g. terrain change, temperature change	e.g. material flow change	e.g. change of consumption patterns in different households, businesses	e.g. change of waste collection patterns
receiver	e.g. municipality, vulnerable region, protected point of interest	e.g. air, terrain, soil, underground water	e.g. transport network, energy network, material flow network	e.g. households, businesses, materials	e.g. transition to a different system
spreading	e.g. no spreading, affects only single location	e.g. through air, terrain, soil, underground water	e.g. through transport network, energy network	e.g. in households, businesses, materials	e.g. during festivals, holidays, calamities
spreading limit	e.g. administrative boundaries, water boundaries	e.g. gradual change of terrain, soil, climate	-	e.g. forests, parks, roads	e.g. impact expiry, end of transition period, political changes
accumulation	e.g. contradicting policies, building multiple facilities	e.g. polution from different sources, noise from multiple facilities	e.g. traffic jams, storage, facility overcrowding	e.g. effects on certain households, social classes, businesses	e.g. lack of resources during transition period

The core concepts may also be mixed and combined together in order to fully represent impacts in multiple scales and contexts. Figure 2 gives multiple examples of spatial properties of impacts and a corresponding GIS concept.

5 Acknowledgements

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