Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 209 (2017) 61–74

Procedia Engineering

www.elsevier.com/locate/procedia

Urban Subsurface Planning and Management Week, SUB-URBAN 2017, 13-16 March 2017, Bucharest, Romania

Drawing the subsurface: an integrative design approach

F.L. Hooimeijer[a] *, F. Lafleur[a], T.T. Trinh[a]

[a]*University of Technology Delft, Julianalaan 134, 2628 BL Delft, The Netherlands*

Abstract

The sub-surface, with its man-made and natural components, plays an important, if not crucial, role in the urban climate and global energy transition. On the one hand, the sub-surface is associated with a variety of challenges such as subsidence, pollution, damage to infrastructure and shortages of space for new urban systems. On the other hand, the sub-surface presents opportunities in terms of solutions for flooding, reduction in heat stress, and decentralized energy systems. Therefore, it is necessary to place sub-surface issues in their appropriate perspective, to enable a more resilient design that brings together ecosystem services, climate and urban systems, and which takes full account of the dynamics of the subsoil. To achieve this, the sub-surface must be an integral part of above ground planning and design. Organization of the sub-surface needs to be reflected visually in relation to - consideration of (surface) spatial morphology. The objective of this paper is to question the role of architectural representation of the subsurface. Discussion of architectural representation should include 'design thinking'. An important element of design thinking is the concepts that are used to guide the design process. For this reason, this research tests the role of visualization in relation to a case from the Dutch context and more specifically to subsidence. The approach is built on a systematic processing of contextual information of the site under development, using the System Exploration Environment, Subsurface and results in a Technical Profile. Using input from subsurface specialists to rethink the urban landscape results in realisation of synergies between subsurface elements and the (re)design of vital urban infrastructure.

Keywords: subsurface; urban design; visualisation; knowledge brokerage.

* Corresponding author. Tel.: +31 (0) 6 24555 315.
E-mail address: f.l.hooimeijer@tudelft.nl

1877-7058
10.1016/j.proeng.2017.11.131

1. Introduction

The sub-surface, with its man-made and natural components, plays an important, if not crucial, role in the urban climate and global energy transition. The sub-surface is associated, on the one hand, with a variety of challenges such as subsidence, pollution, damage to infrastructure and shortages of space for new urban systems. On the other hand, the sub-surface presents opportunities in terms of solutions to flooding, reduction in heat stress, and therefore, it is necessary to place sub-surface issues in their appropriate perspective to enable a more resilient design that brings together ecosystem services, climate and urban systems, and which takes full account of the dynamics of the subsoil.

Soil dynamics in the western part of The Netherlands are subject to natural and human induced subsidence: the land surface moves down as the peat landscape shrinks due to pumping and to the lack of recharge of groundwater levels due to soil sealing in urbanized areas [17]. This adds to complications caused by climate change and transitional problems associated with renewable energy. Subsidence puts pressure on maintenance budgets in urban areas because sand has to be continually added to public space to keep it levelled with the entrances of homes, to stabilize the connections of sewers to dwellings and make sure there is a sufficient free-board (distance between groundwater and surface level) [22]. In addition, subsidence affects the water system: groundwater level rises relatively to the surface level and makes those buildings built on slabs (shallow foundations) suffer from wet (unhealthy) basements. On the other hand, houses that are built on wooden bearing piles are founded in deeper layers of sand - and thus do not subside - risking exposure of the piles if they emerge above the level of the groundwater. When the wood is in contact with air, it will oxidize and rot; this is a huge expense for the owners who have to undertake foundation restoration. Tackling the problem of subsidence can also be used as an opportunity to accelerate the use of innovative technologies that will be discussed in this paper. It is a matter of recognizing the subsurface as a combination of natural and man-made features and recognizing potential cascading effects between the two. Solutions beneficial to a range of problems can then be recognized. In order to achieve this, knowledge management is crucial, involving technical information in the planning and design of the city [12].

This paper argues that in knowledge management, the role of visualization of the sub-surface as a technical space, the ‘engine room of the city’, is crucial. Typically, urbanists, consider that everything beneath the surface as a little more than the back of their drawing paper: a flat and invisible part of the city. Yet, there is an element of truth in this. Since the Industrial Revolution, urban and civil engineering have developed as two independent disciplines. Civil engineers focus on the technicalities of making an urban plan possible. Urban designers respond to the socio-economic interests of stakeholders and on translating these into spatial and functional plans. The current need for renewed cooperation is threefold. Firstly, the sub-surface plays an important role in the urban climate. Larger rainstorms of short duration flood the largely covered soil in cities whilst open soil plays a major role in water storage and drainage. In addition, open soil also reduces urban heat stress and is the basis for growing green that also has the effect of heat reduction. The second pressing issue to address is the energy transition towards renewable: ATES systems and geothermal energy currently contribute 0,058% to the 5,9 % [11] of renewable sources, but have the potential to provide up to 3.4 % of the target of 20% of energy from renewable sources by 2020 [13]. Thirdly, there is a financial driver to be smarter with the subsurface because construction or adaptation of underground structures is very expensive. The subsurface is literally the unseen foundation for all visible urban interventions and influences the affordability of urban quality.

Subsidence is a problem that aggravates the effects of climate change and affects the transition to renewable energy systems. Subsidence reduces the water storage capacity in the subsoil, harms the infrastructure of energy systems and puts pressure on maintenance budgets for public space. This last issue is a key determinant for the design of public space.

The question is: In what way and to what extent does the subsurface need to be represented architecturally in order to support a new script that consciously links the surface and subsurface in urban development processes and products? The Intelligent Subsurface project [11] has led to insights in, and the establishment of methods that support, interdisciplinary design and development. It is important that the step from hard technology to the design of public spaces and larger urban structures is done consciously. To be able to do this, the Technical Profile must be developed; a visualization that connects the knowledge of the engineers and the designers.