# Harmony between surface and subsurface?

***Fransje Hooimeijer,*** [1] ***Linda Maring*** [2], ***Lidewij Tummers*** [3]
***with the cooperation of Jenny Norrman,*** [4] ***Yevheniya Volchko,*** [4] ***Jaan-Henrik Kain,*** [5] ***Kaat Touchant and Steven Broekx*** [6]
TU Delft, Faculty of Architecture & Built Environment, Department Urbanism, Chair of Environmental Technology and Design[1] and Chair of Spatial Planning,[3] Deltares department urban soil and water management,[2] Chalmers University Goteborg Department of Civil Engineering[4] and Architecture[5] and the Flemish Institute Technological Research.[6]

f.l.hooimeijer@tudelft.nl

**keywords**: subsurface, spatial design, planning, trans disciplinary approach

**Abstract (300 words)**

Urban designers are often accused of limiting their view of the subsurface to the back of their drawing paper. However, the subsurface not only houses a lot of functions crucial to urban construction like infrastructure, carry capacity, heat and water, it also carries the natural system crucial for urban quality and health. In the light of the current climate change, energy transition and the financial crisis these issues have become more important for different reasons. The subsurface stores water and plays a role in cooling the city, geothermal heat is renewable energy and using the subsurface intelligently can be financially rewarding. In addition, urban renewal is a more preferred option compared to taking new land (green fields). These areas do not have an empty soil system, as they are already used in many ways. 'Urban design with the subsurface' should be considered a new frontier in urban planning and design.

A barrier in urban projects is that responsibilities, tools and knowledge of subsurface engineering and urban planning and design are not integrated; they work together but in a sectorial manner. The urban designer usually deals with the opportunities for socio-economic benefits and the subsoil engineer deals with the challenges. The subsurface and the surface are different worlds, not only on a practical level of fabricating the city, but also in policy. This paper reflects on the research results from the project BALANCE 4P - *Balancing decisions for urban brownfield regeneration - people, planet, profit and project/processes*, that looks into this segregation and tries to find an answer on the question how to integrate the subsurface better into urban development. It is a cooperation between researchers from three countries Sweden, the Netherlands and Flanders that are active in integrating the subsurface in urban development. The paper first clarifies the connection between the subsurface and the surface using the System Exploration Environment and Subsurface. In the second part the results of the comparison of the three planning systems and best practices in the three countries are discussed. The criteria for the comparison of the planning systems is based on Commin, this is a method developed in BSR INTERREG IIIB project.

## 1 Introduction

Urban designers are not used to taking the subsurface as part of urban development. Nevertheless, the subsurface accommodates numerous functions crucial to urban construction, such as infrastructure, carry capacity, heat and water. Moreover, it also carries the natural system crucial to urban quality and health. In the light of the current climate change, energy transition and the financial crisis these issues have become more important for different reasons. The subsurface stores water, plays a role in cooling of the city, provides geothermal heat as renewable energy and using the subsurface intelligently can be financially rewarding. Besides, urban renewal (brownfield development) is the preferred option over taking new land (greenfield development). In brownfields the subsurface is not untouched, it is already

used in many ways. The research project BALANCE 4P - *Balancing decisions for urban brownfield regeneration - people, planet, profit and processes*, aims at developing a holistic approach that supports sustainable urban renewal through the redevelopment of contaminated land and underused sites.[1] The question is how to integrate the subsurface better into urban development. The research is conducted by a consortium from the Netherlands, Belgium and Sweden and is funded by the SNOWMAN NETWORK[2] (Knowledge for sustainable soils), that aims to stimulate 'traveling ideas' concerning the integration of the subsurface in urban development. This is not a new concept as ideas have been traveling for centuries. Indeed, especially knowledge of soil and water – the main components of the subsurface – has been exported to other countries. It were the Dutch who, due to the challenging condition of the subsurface in their territory, developed a high standard of knowledge about water construction and spread this over the world. In Scandinavia a few examples are Kastellet in Copenhagen, built by the Dutch architect and engineer Henrik Rüse in 1648, and in Goteborg (partner in the research project) the Dutch design with crossing channels and the checkered system of streets resembles those of Jakarta (Batavia) or Manhattan (New Amsterdam) and Naarden in Netherlands. The use of soil and water to build fortifications shows how the subsurface as a natural condition has been crucial to urban development. The fact that it has been done for centuries and is now part of our urban and technological history emphasises the human heritage that is also left in the subsurface. It is not an untouched place: there are traces of human culture in the form of archaeology, but also in the form of more contemporary underground buildings and infrastructure like cables and pipes.

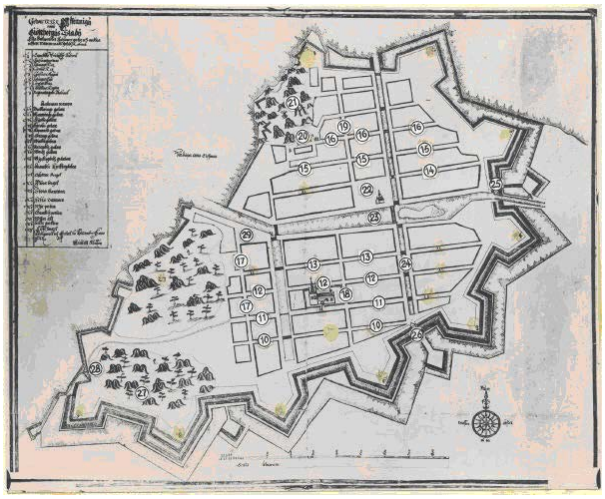


Figure 1: Fortification in Goteborg

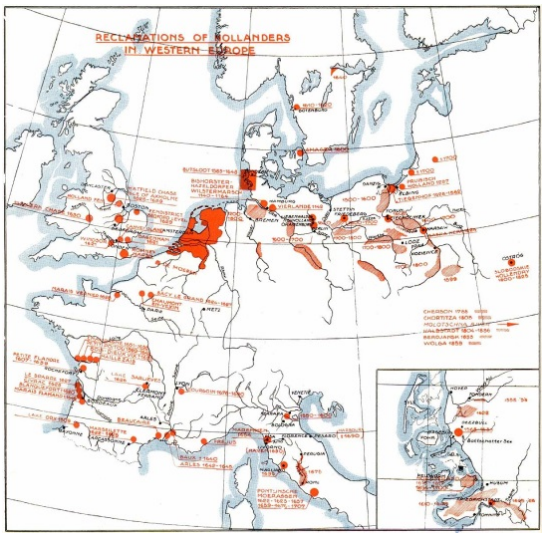



Figure 2: Travel of Dutch knowledge of reclamation over Europe

The example of fortifications shows in addition the influence of the subsurface on the main urban structures of cities. These are often a direct result of the manner in which the citizens have dealt with the characteristics and morphology of the landscape. Large infrastructures like dikes, waterways and roads are usually fitted with the territorial characteristics due to the construction and costs. The natural conditions not only steer main structures in the urban tissue but also determine the design of the public space. Here again the choice for materials, plants and trees are tuned with the characteristics of the location to make sure pavement is stable and plants and trees grow in that specific location. The subsurface as a part of urban space is therefore important for the current tasks of urban renewal and nature restoration. Urban designers are often accused of limiting their view of the subsurface to the

[1] Brownfields are sites which: have been affected by former uses of the site or surrounding land; are derelict or underused; are mainly in fully or partly developed urban areas; require intervention to bring them back to beneficial use; and may have real or perceived contamination problems (http://www.cabernet.org.uk/?c=1134)
[2] http://www.snowmannetwork.com/main.asp

back of their drawing paper. When reconstructing an existing urban area, it is important to realize that the subsurface is already being used in many ways and that restoring nature in these areas asks for a completely different approach towards urban development. 'Urban design with the subsurface' should be considered a new frontier in urban planning and design.
A barrier in urban projects is that responsibilities, tools and knowledge of subsurface engineering and urban planning and design are not integrated; they work together but in a sectorial manner. The urban designer is usually dealing with the opportunities for socio-economic benefits and the subsurface engineer deals with the challenges rising from matching the natural system with the urban plans. The subsurface and the surface are different worlds, not only on a practical level of fabricating the city, but also in policy. This even further hampers the collaboration and potentially raises a barrier changing current practice. This paper reflects on the research results from the project BALANCE 4P and aims at showing the relation between the subsurface and surface and learn and propose the direction for integration. In order to do so the paper first clarifies the connection between the subsurface and the surface using the System Exploration Environment and Subsurface (SEES) that offers a systematic approach towards the surface and the subsurface as one spatial system. Then the results of the comparison of planning systems and best practices in the three countries is discussed. The criteria for the comparison of the planning systems is based on BSR INTERREG IIIB project COMMIN.[3] The conclusions drawn attempt to provide a better understanding of the relation between the subsurface and the surface in the design of urban plans.

## 2 Unifying subsurface and surface: a system approach

The current development of comprehensive strategies and the actual implementation of measures contributing to sustainable urban development are still a big challenge, particularly in the dynamic and complex context of cities. Existing decision support tools and methodologies for developing urban strategies that concentrate on climate change and energy reduction seem to focus on measuring impacts and the modelling of scenarios (Sheppard and Shaw 2007). To unify the subsurface and the surface and to be able to understand it as one system the System Exploration Environment and Subsurface is developed on the theoretical background of system approaches and complexity theory. The system approach is a method to study phenomena as emergent properties of the interrelated whole with a mutual consistency and in interaction with the surroundings (Heylighen 2000). This makes the object of study simpler, but still enables to give meaningful understanding of issues that deal with elements of a different nature and coherence. The complexity theory helps understanding that decision making has a nonlinear character. This results from unexpected behaviour and unforeseen consequences of interaction of agents (Koppejan & Klijn, 2011). Rhodes (2008) calls this the "performance landscape", a model of the system where agents can fall back on to keep standing in the continuous change within the system and external influences of changing other systems that are related.
A system approach that is at the current base of planning and design practice in the Netherlands is the 'Layers Approach' (Hoog, Sijmons and Verschuuren 1998). It builds on the "ecological inventory" of Ian McHarg (McHarg 1967) that his students called "the layer cake" (Whiston Spirn 2000). It was brought to the Netherlands by Meto Vroom; in the 1990s it was developed as a strategic planning concept (De Hoog, Sijmons and Verschuuren 1998). The original approach distinguishes three types of connected layers: occupation, network and substratum layer. These layers represent the spatial system, characterised by different rates and types of (potential) spatial development and change (Fig.

[3] http://www.commin.org/

1). The aim of the model was to be a simple and quick-witted strategic planning concept, thus it was not designed for the use to describe or explain the environment and its use. However, in the Netherlands the Layers Approach is frequently used for these purposes. The success of the Layers Approach means that it is a good starting point for a method that supports the cultural change to sustainable use of the subsurface in urban development.

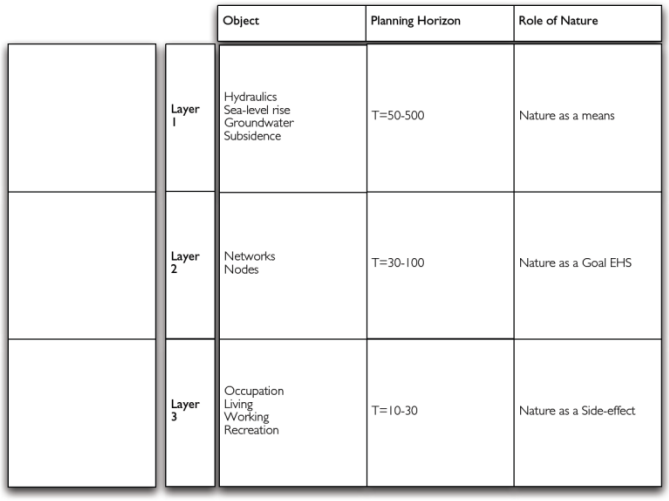


Figure 1: The layers approach (Hoog, Sijmons and Verschuuren 1998)

On the shoulders of the Layers Approach stands the System Exploration Environment and Subsoil (SEES), designed using the experiences with, but also the criticism on the Layers Approach (Van Schaik 2007). It is expanded with the fundamentals of urban design (Heeling, Meyer & Westrik, 2002), regional sustainability analyses (Rotmans 1998) and for the subsurface the Underground Qualities (ruimtexmilieu.nl) connected to an eco-system services approach. The result is the SEES with six functional layers with different dynamics, professionals and knowledge fields: people, metabolism, occupation, public space, infrastructure and subsurface (Hooimeijer and Maring 2013). SEES connects the subsurface information with the urban surface in order to inspire and setting clear boundaries for the development of the urban surface. It is used for analysing potential problems, chances, demands and supports a creative interaction early in the process of urban planning.
The subsurface is of important value for the natural system and thus for the human system. The "subsurface " includes everything below (land-)surface. In a Dutch project entitled "*manual planning with the subsurface"*[4] subsurface qualities supporting the surface were defined. These qualities can be organised in the categories: producing, regulating, carrying and informative qualities, following the view of many ecosystem services studies (figure 2).

[4] Handreiking plannen met de ondergrond on www.ruimtexmilieu.nl is a website that is built in commission by former Ministry of Transport, Spatial Planning and Environment by H2Ruimte, TNO, Dauvellier Planadvies, MoceaN and Alterra.

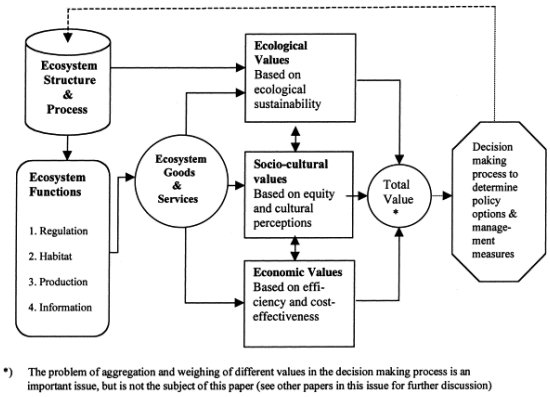



Figure 2 Framework for integrated assessment and valuation of ecosystem functions, goods and services. (De Groot et al, 2002)

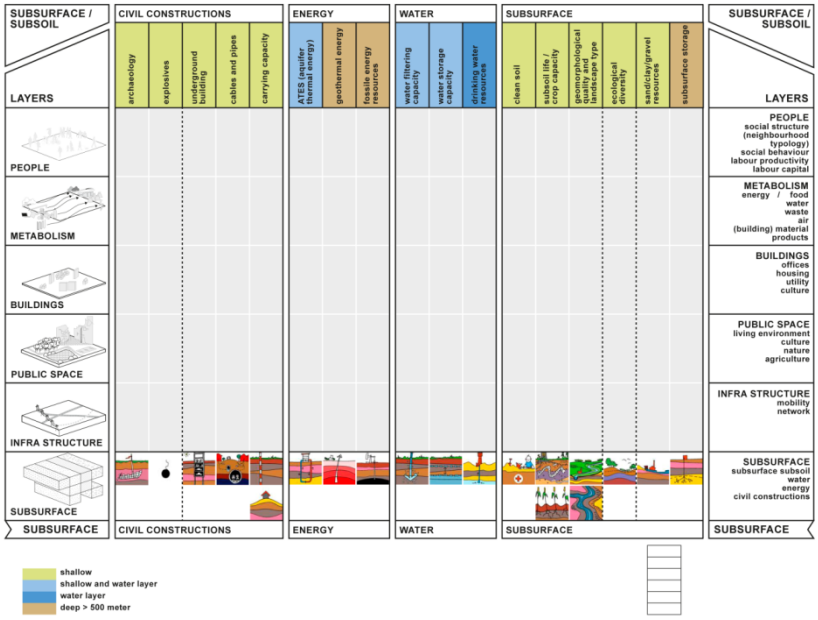



Figure 3 System Exploration Environment and Subsurface with the underground on the Y-axes used for integrating subsoil conditions into urban development. (Hooimeijer and Maring 2013)

This ecosystem related view does not connect with the spatial planning perspective, for this purpose in the SEES the recognizes the groups: water, soil, energy and civil constructions. These connect better to themes in urban planning and design and have a more logic connection. The connection between these groups and spatial design are now elaborated on.

## 2.1 Water and subsurface

The categories water and subsurface or soil are together important, as described in the introduction, for the main structures of urban development. The water system is above and in the ground that, together with important qualities of the soil like morphology and landscape type were crucial for locality and main set up of early settlements. The group water contains the qualities: water filtering soil, water storing soil and resources for drinking water. But, the water system must be considered as one system with soil. Water flows through our natural system in surface and subsurface: a the river is groundwater you can see. The soil qualities are: healthy and clean soil, storage of materials, resource for minerals, crop capacity, “living soil”, geomorphology, diversity landscape and ecological diversity.

In a large country like Sweden there are various types of soil present. The dominant soil of Sweden is till coming from the archaic bedrock of granites and gneisses. Other small areas have clayey till from younger sedimentary limestone, and in addition, vast areas of central Sweden are covered by heavy and fertile sea-bottom clays raised out of the sea by postglacial land uplift. One-fifth of the country, especially in rainy south-western Sweden and the cold far north, is covered by marshland and peat. As introduced the development of the larger cities was done with Dutch expertise. Also today the issues with flooding from rivers and salting up rivers from sea level rise are comparable to the Dutch problems (Rotterdam Climate Initiative 2014).
In Dutch and Flemish polders these two groups of subsurface qualities are coming together in the cooperation in "dealing with thick water" the characterization of the conditions of the territory. Polder cities in the Netherlands are the examples of how building on the wet and soft territory was only made possible by the attitude of 'strict control'. To deal with the water a technical plan was needed to ensure that water could be discharged and controlled, and that city canals maintain a constant water level. In most cases expansion of the city was initiated by building an encircling outer canal, which was connected through the inner area by means of a sequence of parallel canals. The outer canal was primarily built for drainage, but also had a military or defensive function and a transport function with access to warehouses (Burke 1956). The water level of the canal system was regulated and excess water discharged by means of sluices and windmills. Then, the reclaimed land needed to be raised to the required protection level, consolidated and prepared for building. Mud excavated from the canals was used for raising the land level, and was supplemented by fill, which often needed to be transported from far away. In the layout of the city the waterways were offering the function of public space as well. Since the whole enterprise was costly a maximum infill with buildings was done.
The level of the (ground)water is crucial for the main structure of the city:

> . . . *everything is controlled by the level of raising the area: the layout of the system of waterways, the water storage surface, the sluice system, and pumping stations. A city laid out as a boezem town must be designed differently to a polder town that has lowered its groundwater level.* (Van Eesteren 1934)

*Boezem* and polder towns are both examples of coherent urban structure and public/civic space design. The technique in the Netherlands deals with load-bearing capacity, compressibility, permeability, moisture retention capacity, drainage and growing environment is building-site preparation:

> *Building-site preparation is the science of matching the location of the projected urban features to the soil and water conditions and the technique of making those conditions suitable for urban projects.* (Segeren and Hengevel 1984)

## 2.2 Civil constructions

Building-site preparation in the Netherlands and Flanders is the bridge between water, soil and the third group of subsurface qualities: civil constructions. In Sweden it has less impact due to their more stable soils to build on, but of course there the subsurface also contains the following qualities: cultural historical importance and archaeology, unexploded ordnance (UXO), underground structures, foundations, cables and pipes. These qualities are all human additions to - or interventions in - the subsurface system. Especially the cables and pipes are fixing the urban structure and restraining for public space. When urban blocks are replaced as part of urban renewal it is very costly and timely to reorganize the cables and pipes network. They put restrictions to the design of space because they take up a lot of space where for example trees cannot be placed.

## 2.3 Energy

The fourth category is energy in which Underground or Aquifer Thermal Energy Storage (UTES, ATES), geothermal energy, resource fossil energy are the identified qualities. The relation to urban development is spatial in the sense that for ATES there is a need to organize the hot and cold wells in order not to have interference and low production. For geothermal energy use there needs to be a urban district heating system with a large amount of houses.

# 3 Balance4P – comparing the Netherlands, Flanders and Sweden

The quest of unifying the subsurface and surface has been pursued in the research project BALANCE 4P - *Balancing decisions for urban brownfield regeneration - people, planet, profit and project/processes*.[5] The project aims at delivering a holistic approach that supports sustainable urban renewal through the redevelopment of contaminated land and underused sites (brownfields). The balance and synergy between the three P's of the Triple Bottom Line; people, planet and profit, are at the base of an urban project. This complex process requires innovative and strategic action, with in depth knowledge of aspects and new conceptual ideas on their integration in a given situation. This crucial strategic activity, that we consider at the base of sustainable urban development, is captured by Van Dorst and Duijvestein (2004) by introducing the fourth P of Project and/or Process to the triple bottom line, representing the strategy of action (figure 4).

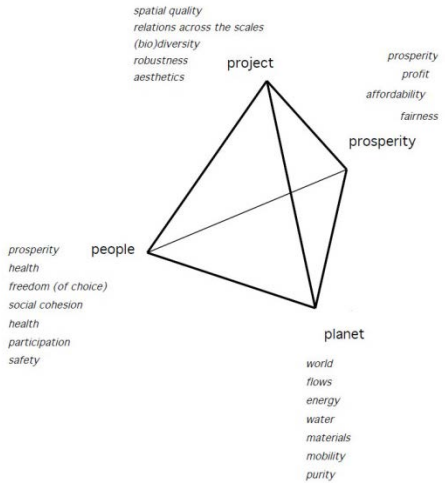



Figure 4: The tetrahedron of sustainable construction based on the sustainability triangle, after Johannesburg 2002: People, Planet, Prosperity and associated themes. (Van Dorst & Duijvestein, 2004)

The fourth P represents Project in which the skill is represented that integrates sustainability aspects in a balanced design that warrants spatial quality. The skills that are referred with Process are about the interaction between stakeholders and their institutional context to realize this design (Van Dorst & Duijvestein, 2004). Important part of the Balance4P research is therefore the analysis of the possible chances or challenges for integrating the subsurface engineering and urban planning sectors by formal institutions (regulations), informal institutions (how things are usually done) and technological entrepreneurship (process of cooperation between the professionals). The planning systems and building practices in the three participating countries the Netherlands, Sweden and Belgium (Flanders) are studied for a better understanding of how the subsurface can be taken into urban development.

[5] Cooperation between Chalmers University of Technology, Department of Civil and Environmental Engineering and Department of Architecture, Göteborg SWEDEN, Deltares and VITO Flemish Institute Technological Research, Mol, BELGIUM

When using the term 'planning system' (Nadin & Stead, 2003) it refers to the processes of planning. Moreover, the professional structure of planning does not only consist of formal, written procedures and regulations. The unwritten assumptions and concepts, for example about the role of inhabitants, the reliability of government or the importance of nature, form planning culture. These influences, as far as they are important for subsurface engineering, are investigated in the project Balance4P.
Several organizations have made compendia of spatial planning systems in Europe. To structure the investigation the Isocarp International Manual is used which features all partner countries of Balance4P (Ryser & Franchini 2008). A comparative table created by the COMMIN Interreg IIIB project provides a useful framework to structure the comparison.[6] To describe planning systems, COMMIN uses 5 categories: constitutional, national scale, regional scale, local scale and participation. The guiding principles and objectives defined for planning are analysed and principal planning institutions are identified. Then the Planning Acts and other legally binding contexts and other types of planning documents that are commonly used and generally recognised are investigated.
To fit the framework better to the Balance4p project some crucial questions were added to COMMIN. For each scale the question is posed if and how soil management is handled. In order to make the link to the building practice, as an important part of urban development, the following questions are also added:
1. Who initiates urban development?
2. what type of process is used?
3. what role does the government play?
4. How is knowledge integrated in the plan and design process?
5. how is subsoil inserted in the development process.
These questions are important to understand how the planning system is brought into the plan process of an urban development for each country. The results of this investigation is in short reflected don in the following three paragraphs.

## 3.1 The Netherlands

Because of its wet and soft territory the Netherlands has a strong tradition in governance from an early age (Hooimeijer 2011, van der Cammen 2005). Especially flood management, a main condition for spatial development, has been institutionalized and considered of national concern since the start of the Monarchy in 1814 (Van der Woud 1987). It is said that the creation of polders brought with it the necessity for collaboration and the resulting '*polder model*' characterises the negotiation process of which 'poldering' is the verb (Lendering 2005).
Spatial planning in the Netherlands is seen as a public task for centuries and put into law in 1901 in the Housing Act. Traditionally, next to flood prevention a major issue concerns balanced territorial development. Since the 1970s planning had to respond to the new environmental policies and in the current neo-liberal era we see the government reconsidering their central role and diverting responsibilities to lower governments and the market. Presently a process of integrating sectorial domains is taking place in the Netherland. This is done with governmental organizations, for example National, by merging the ministries of water and spatial planning; at provincial level, where departments of soil and spatial planning are combined; and at municipal level, where engineering and urban development departments have merged.
On the national scale, in 2012, the Dutch Ministry of Infrastructure and the Environment (MinIE) issued the *Structuurvisie Infrastructuur en Ruimte* (Vision Infrastructure & Space; SVIR) to set priorities for the development of the territory until 2040. This is the main frame for structure plans of

[6] www.commin.org accessed 16 Dec 2013

the provinces on the regional scale, and the structure visions of municipalities that are made specific on the district scale with the use of zoning plans (that are the only binding spatial plans).
Planning in the Netherlands has a long tradition expressed in the institutions, laws, policy, instruments and regulations that supports the system. In recent years deregulation is the trend. Responsibilities are shifted towards the municipal scale and regulations are made simples and more interconnected. For area development, that is due to the financial crisis and considerations of sustainability is limited to urban renewal, also private developers are invited to work in public private partnerships to engage in urban development. An important institution that is under pressure in the more liberal approach of urban planning is the *welstandscommissie*, a committee that does a qualitative check of the urban plans on architectural quality. It is an important check to have a private developers adjust to the public consensus, a typical aspect of the polder model. The committees were started at the beginning of the twentieth century when the municipalities by the Housing Law of 1901 were obliged to make an expansion plan and housing cooperation's were instituted to build large scale social housing. However, in the current shift towards a more liberal urban development it is experienced as an undesirable controlling body.
Another important institution that is to warrant the quality of spatial development is the Environmental Impact Assessment. The *Structuurvisie* and Zoning Plans need to go through the Environmental Impact Assessment (EIA) procedure. The main purpose of the EIA is to ensure that decision makers have all necessary information. Even though the advice of this national advisory institute is not binding, a negative advice is usually a strong base for preventing these plans through a court order. However, when a plan is assessed to have negative effects on the environment, it may still be build, depending on the decision makers.[7]
Urban development in the Netherlands for the past century has been governmental driven, and filled in by private developers or housing corporations who were the semi-governmental body for social housing. There has not been a large tradition of individual house owners building their houses. This is however recently heavily stimulated by the government, called the participation society (covering more areas than urban development.
Considering subsoil management the Netherlands are already on their way in bringing it into the planning system. There is a national vision on soil in development, called STRONG, and several provincial visions on soil produced. Furthermore, municipalities are looking into how to integrate subsoil aspects into zoning and master plans.

## 3.2 Flanders

In practice not Belgium, but the regions Flanders, Brussels, and Walloon are considered national level. In the Balance4P project the comparison and cooperation is done within the Flanders context, and the focus lies on spatial planning and soil management of that region.
Spatial planning in Belgium has been a complex balance between local initiative and a liberal government. First infrastructure and later also social housing were done by the central government that created the conditions and supplied the budgets. The very small scale scattered landscape of municipalities were responsible for the realization of the national policy. This situation has been even more complicated because of the division into three regions: Flanders, Brussels and Walloon. Since the state reform in 1980, the Federation has no constitutional powers regarding spatial planning, only some regarding environmental issues, and de facto there exist nowadays three planning systems based upon regional autonomy. At the background of all three lies the (then national) Planning Act of 1962, which inheritance is still present in legislation and district plans (IMPP 2008). Until the 1970s spatial planning in Belgium was a national issue. Guiding principle from that time was the functionalist

[7] www.mer.nl

approach of separating industrial, residential and leisure areas. Before the Urban Design Act (1962) Environmental Impact Assessment decrees belonged to the Municipal Law and there was no assessment procedure to see if they were carried out. Building and parcelling decrees made between 1962-2000 had to be checked by the King, and later the Flanders government. Since 2000, these urban design decrees are formalized by the provinces.[8] For changing parcels and changing function of a building a permit needs to be issued by the municipality.
The basic principles for Flanders Spatial Policies Plan (2012) are: the 'Productive Landscape', 'The Long Term, Uncertainty and Governance' and 'Welfare and Well-being'.[9] These principles are steering in the system of three planning levels: the region, provinces and municipalities that work together on principles of subsidiarity and - topdown - framework control and translated into RUP's (spatial implementation plans). The institutions, laws, instruments, policies and regulations that surround this system are very comparable to the Netherlands. Like in the Netherlands, spatial plans are subject to Environmental Impact Assessment procedures, however, in Flanders, only certified agencies can perform EIA's. Unlike the Netherlands, a *Watertoets* (Water Impact Assessment) is needed not only for governmental pre-plans but also for private developments that apply for building permissions. Even though the planning system is comparable, the elaboration of these is very different due to the planning conditions described above. Next to the fact that the already small scaled landscape was urbanized in a scattered way and the strong role of the municipalities, it was also stimulated from the nineteenth century on to build your own house with the result that only 6% lives in rental houses and 75% of the people own their house (Michel Dehaene, Maarten Loopmans 2003). Result of this practice that the urban development it much more scattered over the landscape, the so called *Nevelstad* being urbanized roads with large landscape lots on the backside of these houses.[10]

Figure 5: Flanders *Nevelstad* (google earth)

## 3.3 Sweden

In 1810, land in Sweden became a tradable commodity through a law granting landownership rights to Swedes regardless of their social class. However, uncontrolled development of privately owned land led to urban sprawl, low hygiene standards, fire hazards, lack of space for public functions and speculations on the housing market (Blücher, 2013). The planning system was therefore established in the 1900s in order to ensure the balance between public and private interests with respect to land use (Blücher, 2013). Public interests that are promoted and included in planning are health and safety, cultural and ecological values, environmental and climate aspects, social issues, aesthetics, resource efficiency and growth (Hedström and Lundström, 2013). Historically in Sweden, municipalities have a

[8] www.ruimtelijkeordening.be/NL/Beleid/Vergunning/Vergunningnodig
[9] www.beleidsplanruimte.be March 2014
[10] http://176.9.39.46/nl/Issues/60

planning monopoly, i.e. spatial plans are formulated, approved and adopted at the local level. Planning and urban development is also connected to property formation (Kalbro and Mattsson, 1995). In the latest revision of the building and planning legislation (SFS 2010:900)[11], municipalities may define special regulations in the detailed plan that specify property subdivisions, land reserves for jointly owned facilities, easements, utility easements and similar. Until May 2011, these special regulations could be documented in a separate property subdivision plan complementing the detailed plan.
Examples of Swedish national policies documents are the national transport plan, prepared by the Swedish Transport Administration, or the establishing and management of nature protection areas by the Swedish Environmental Protection Agency. These set out the larger scale guidelines that are filled in on a municipal scale.
The institutions on a national and regional scale are working close the ones on municipal scale. That is where the plans are made and the different checks to the quality of the built area is done. In contradiction to the Netherlands and Sweden, the EIA is only performed if the municipality judges that the proposed development may cause "substantial environmental impact". EIA is usually carried out by the municipality in consultation with the County Administration Board and the neighboring municipalities.
In Sweden urbanization only started to take off after the 1930s, today 85 per cent of the population lives in urban areas (STATISTICS SWEDEN, 2007). The leading cities are in international comparison still quite small, except for Stockholm. During this process of growth, dense townscapes have changed into low density urban landscapes that surround the historic cores. The urban landscape is separated into large districts of housing, industry, retail, leisure and education. Two third of the Swedish population live in buildings that are less than fifty years old. (Nyström in Guinchard, 1997) During this period – between 1965 and 1974 - one million houses were built with as aim affordable houses for everyone. This period is in Sweden also known as the '*Miljonprogrammet'*. In the 1970's and 80's a strong public opinion came up against the *Miljonprogrammet* that only gave priority to basic human needs as health and shelter. Context, identity, cultural meaning and diversity became important as well as the importance of historic place. As a result of that, the abandoned city core were revitalized into working and living environments, which became popular among small households and professionals. There are now to types of environments: 'the new urbanites' for who wants to live in the city centre close to all the facilities a city could offer and 'the new agrarians' who want to live close to nature. (Nyström in Guinchard, 1997) The first group can be seen as a target group for the redevelopment of brownfields around the center of the city. The former brownfield of Hammarby Sjö is a good example in that respect. It shows the possibilities of living close to the city core and the reduction of car-use of its residents by investing in public transport.

## 3.4 Comparison of planning systems

In order to understand the mainframe of planning systems in relation to urban (re)development the following diagram is made:

[11] http://rkrattsdb.gov.se/SFSdoc/10/100900.PDF

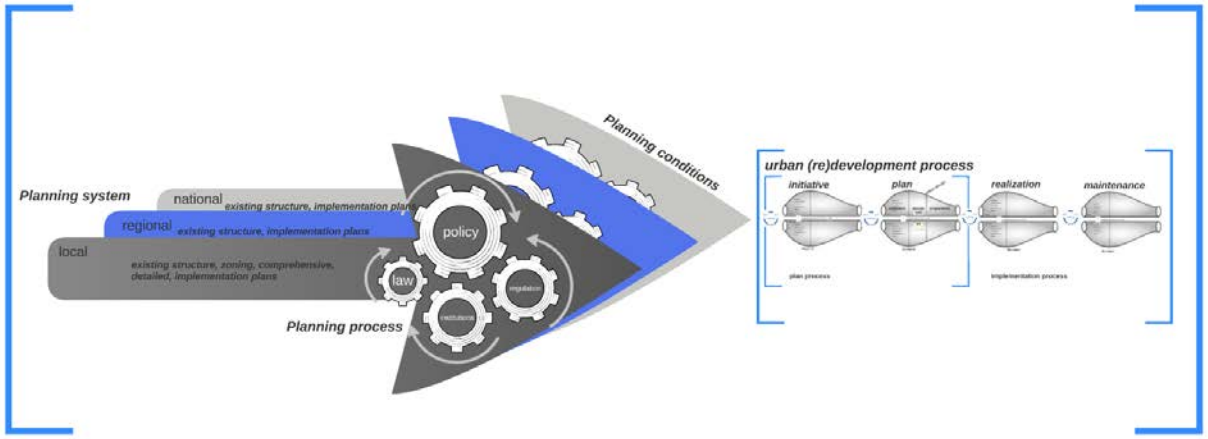



Figure 6: overview of planning system, planning process, together setting planning conditions to the urban (re)development process in which the plan and design process are situated.

It shows how the planning system is a process in which the radars if law, regulations, policy and institutions work together on different scales the influence each other and set the planning conditions for urban (re) development. The urban (re)development consist of four phases that are interrelating. The initiate and plan phase are part of the plan process, the realization and maintenance phases of the implementation process. The plan phase has been made more specific in dividing it into a definition, design and preparation step. The design process is done during this phase. This mainframe is applicable to the three countries in the study.
The European Union is the umbrella of law and regulations for each country. This is steering them in the same direction in subsoil theme's like water, archaeology and nature. Other than that it is impossible to compare something as intangible like planning systems. The perception, interpretation and informal application of formal laws, regulations and policy characters each country. This is not only recognizable on the scale of the nations, but also transferred to the lower scales of regions and municipalities. Planning is culture, and this becomes clear when formally the Netherlands, Flanders and Sweden have very comparable laws, regulations and instruments but these are applied differently with various results. Culture has to do with historical developments, geography of the territory and people density. Netherlands and Flanders are comparable in historical developments and geography. This is for example shown in the fact that water is an important spatial component in these countries, this is much different in Sweden. That size matters is recognizable in the level on which spatial planning control is manifested. Sweden is such a large country that it is also sensible to have municipalities in control. The Netherlands is such a small country that is has been sensible to have strong spatial planning on a national scale to make maximal use of the land. In Flanders this has been the same, with the distinction that even though the planning is top-down the urban development for the dominant part has been in the hands of private developers supported by local policy. This also influences the scale of development, and the final output. The main conclusion is that the Netherlands is moving to a more governmental bottom-up system that is used in Sweden and also a more bottom up development practice as it is used in Flanders.

| | **Planning system** | **Building practice** |
|---|---|---|
| **Netherlands** | Top Down > Bottom up | Top Down > Bottom up |
| **Sweden** | Bottom Up | Top Down |
| **Flanders** | Bottom up > Top Down | Bottom up |

Figure 7: overview of developments in planning system and building practice .

Most interesting is the difference in purpose of the Environmental Impact Assessment. All three countries use this instrument but in the planning and plan process it has quite another purpose and role; additionally for each country there are quite different stakeholders in urban development who are supposed to make them.


Figure 8: overview of developments in planning system and subsoil management .

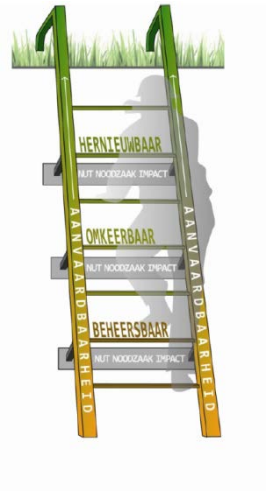
## 3.5 Subsoil management

From gathering information and doing interviews about the three planning systems and their subsoil management it already became clear that in all three countries planning and subsoil are two worlds, two domains. The experts in one domain have no overview what so ever over the other domain and the other way around. Subsoil elements are now predominately perceived as nuisances for development, however as described above the subsoil landscape also offers opportunities.

The development of policy about subsoil is only done in the Netherlands. After starting making policy that only considers pollution in 1997, the fourth National Environmental Policy Plan (2001) the Dutch government reconfirmed its intention to end the transfer of environmental costs to future generations. In 2003, the scope of soil regulation was also widened from quality to soil management with the "soil policy letter" (*beleidsbrief bodem*).[12]

The categories energy and soil are today covered in the national vision on spatial planning of the subsurface (STRONG) which covers both deep and shallower subsurface[13] and is instigated by the fact that in the Netherlands the subsurface is being used more and more for different functions and thus this domain gains spatial relevance. Also on a regional scale authorities have an agreement in a soil convent. which involves wrapping up of the soil remediation operation, as well as the decentralizing of the soil regulation to regional and local authorities.

There is also a 'soil vision' by the Provence Zuid-Holland that was part of a policy plan about ecology, water and environment (2006). It took another seven years to make the official Soil Vision (2013) that introduces a new approach towards soil, more based on spatial planning. One of the main conditions in order to do that was also by merging the departments of soil and spatial planning in the organization of the Provence. Only a year after this Soil Vision came out a new Structural Vision is presented in 2014, this new policy document integrates completely the former soil vision in its attitude towards soil and integrating it into spatial planning. One major instrument that supports better weighing of soil value and better decision making is the *Bodemladder* (see image). Two main strategies of action are part of this way of working: first that soil use is renewable, and if not that




[12] www.bodemrichtlijn.nl/Bibliotheek/beleid/beleid-van-centrale-overheid/landelijk-beleid/beleidsblad-beleidsbrief-bodem
[13] www.rijksoverheid.nl/onderwerpen/bodem-en-ondergrond/ruimtelijke-ordening-ondergrond 23 January 2014

soil can be redeveloped and at last it should be manageable. Second main strategy of action is that all uses should be acceptable.

# 4 Discussion: Integrating subsurface in surface

In the project Balance4P a holistic approach is developed that supports sustainable urban renewal through the redevelopment of contaminated land and underused sites.[14] In order to implement this approach the planning system and building practice is analysed. Most opportune way to integrate the subsurface into spatial planning is by making logical connections into subjects of planning and plan making that are already there. Starting from the European level, via the national level to the building practice there are four urban planning themes in the three studied countries that can be expanded to subsurface: heritage, environment, nature and water.

| **World of Planning** | Heritage | Environment | Nature | Water |
|---|---|---|---|---|
| Law and regulation | chances for:<br>- Including the subsurface in planning regulations about heritage, environment, nature and water<br>- Including the subsurface in Environmental Impact Assessment and Water Assessment Test<br>- Subsurface in zoning plans through paragraphs about heritage, environment, nature and water | | | |
| Policy and vision | chances for:<br>- Visions on the subsurface in structure plans | | | |
| Knowledge exchange | chances for:<br>- interdisciplinary cooperation<br>- developing new knowledge<br>- knowledge management to handle uncertainties in qualitative manner | | | |
| Design/construct | Subsurface in plan process and design process needs:<br>- Better frame of reference<br>- Better instruments (subsurface potential map)<br>- Culture change from how it is done now | | | |
| | Civic constructions<br>Soil | Civil constructions<br>Soil<br>Water<br>Energy | Water<br>Soil<br>Energy | Water<br>Soil<br>Energy |

Figure 9: overview of chances for integrating the subsoil in the planning system

## 4.1 Law and regulation

In law and regulation there are chances for including the subsurface in planning about heritage, environment, nature and water. Especially heritage in current redevelopment of cities is considered a chance for reuse, which is considered more sustainable, and a chance for using meaning and context in new developments. The heritage protection is set by law and made a self-evident part of the planning and plan process. Usually there are specific paragraphs dedicated to heritage in spatial plans.

[14] Brownfields are sites which: have been affected by former uses of the site or surrounding land; are derelict or underused; are mainly in fully or partly developed urban areas; require intervention to bring them back to beneficial use; and may have real or perceived contamination problems (http://www.cabernet.org.uk/?c=1134)

Expanding this practice to archaeology and other human structures in the subsoil could be a chance. Taking the environment into account is secured in all three countries with the Environmental Impact Assessment. It is also applicable to plans of different scale an nature in which also the subsurface is relevant. Through EIA, synergy between the natural system, the (civil constructed) conditions of the site can be brought to spatial plans. Nature protection is also well organized starting on the European level with Natura 2000 and then for each country on all scales. Considering the subsurface as part of this natural system is quite evident and there is a chance to make a logical connection when making these laws and regulations. In the Netherlands and Flanders there is the Water Assessment Test, also this current regulations could be expanded with the subsoil considering groundwater is part of the water system as a whole.

## 4.2 Policy and vision

As the Dutch case shows there is a great chances for visions on the subsurface in structure plans, or also taking the subsurface into policy in order to stimulate to take it earlier into the planning and plan processes. On different scales these visions could emphasize other qualities of the subsurface, but together they could offer spatial plans a sound base to develop upon. Here of course also the connection to the planning themes of heritage, environment, nature and water could be made.

## 4.3 Knowledge exchange

Especially knowledge exchange is key for a better integration of the subsurface in to surface urban development since it also enhances interdisciplinary cooperation, it could lead to new knowledge and it is possible with knowledge management to handle uncertainties in qualitative manner. There is a need for conscious knowledge management, brokerage and mediation that translates data information that can be worked with.

## 4.4 Design/construct

The subsurface in plan process and design process needs a better frame of reference, better instruments (subsurface potential map) and a culture change from how it is done now. Taking into account subsoil conditions in the plan and urban design process of urban designers is rather new. Especially for the plan process there should be better knowledge management of what and how data from the subsurface could be transferred into information that is relevant for the state of affairs in the process.

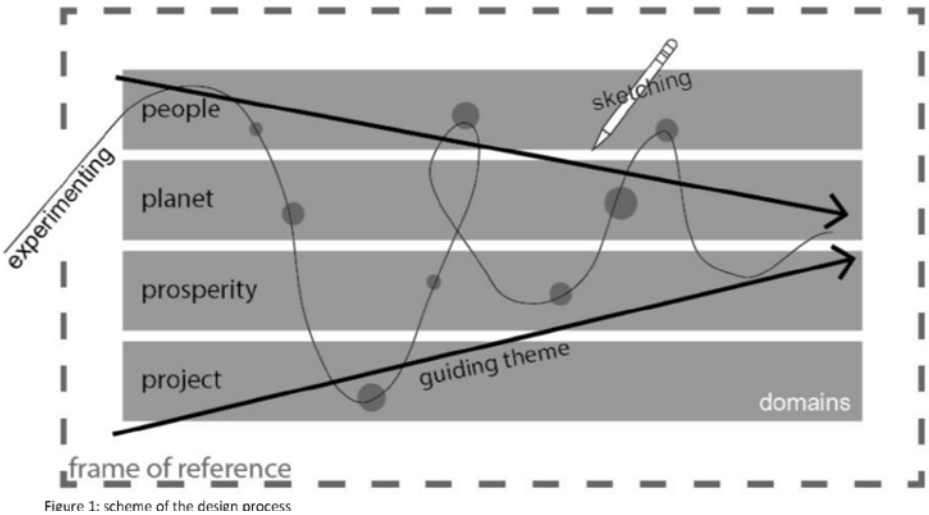



Figure 1: scheme of the design process

Figure 10: the urban design process (Van der Graaf 2014)

Even though the process of designing is ambiguous, personal and somewhat intangible, Van Dooren, Boshuizen, Van Merriënboer, Asselbergs and Van Dorst (2013) brought its essence it into a

framework. This framework is not a step by step guide for a successful design process, but an overview of five generic elements involved in designing, making the design process explicit in a more clear and structured way. The five elements are:
1. Experimenting: trying out different alternatives, out of the box thinking
2. Guiding theme or qualities: taking the programme or a another idea as startingpoint/concept
3. A frame of reference or library: examples of other designs or principles
4. Sketching/modelling: representation of ideas
5. Domains: design is about making space with structures, for functions and within an urban and societal, historical and philosophical context.

It can take some time before urban designers are used to deal with subsoil conditions, but the benefits are great. To take advantage of the potential qualities of the subsoil, its aspects should be investigated at the beginning of (1) experimenting in the design process. Although subsoil aspects derive from a wide variety of expertise's, it is not to the urban designer to investigate all of them himself. By collaborating with the different experts, the urban designer can get an understanding of the context. It is to the designer to investigate the spatial effect on surface level and create a coherent design, which relates to the subsoil characteristics of a site. The urban designer can get a better understanding of subsoil condition by translating the data into his own language of (4) sketches and models. This could be a subsoil potential map in which the main characteristics of the subsoil and their spatial effect on surface level are made clear. This way, the urban designer can start experimenting and make relations between different solutions, which can strengthen each other and contribute to a coherent end result. Urban designers should start experimenting with the unknown aspects of the subsoil, so they expand their knowledge and experience. If the urban designers becomes familiar with modelling the data, know how subsoil aspects effect their spatial design on surface level and can pick generic solutions from a (3) frame of reference, then taking into account subsoil conditions becomes as common as relating urban designs to the spatial context of the built environment. Subsoil conditions should not be seen as an obstruction in the urban design process, but needs to be dealt with as part of the (5) domains and then has the potential to enrich the final design (Van der Graaf 2014).

# 5 Conclusions

The main conclusion of this investigation is that it is almost impossible to grasp something as dynamic and fluid as planning systems and second that the difference between the three countries is based in the cultural and not the planning system differences. The comparison of cultures alike results into conclusions about differences, formal systems can be the same but informally work out very differently. However, the research did focus on finding a holistic approach to be about similarities. In all three countries the subsurface  is the new frontier for urban designers, it is a question about nature and heritage, it is about tension between urban structure and public space design, expressed or should be the conclusion un-expressed in the dealing with the subsurface. Especially in urban renewal the question of what is nature considering the subsurface should be asked.

There is not only a gap between the worlds of surface and subsurface, also the difference between the nature of the planning processes and the uphold procedures that come from it is large. It is the difference between a common view or comply with strict guideline value.

The holistic approach therefor not a rigid manual,  is an attitude that should be reflected in the domains of planning and urban development, in the formal and the informal institutions. There is a need for more examples that show how the two domains can be joined. How the subsurface make a meaningful contribution to the design of urban structures and public space like it has been in the past.

**References:**


Blücher (2013). Planning Legislation in Sweden – a History of Power over Land-use. In: Planning and Sutainable Development in Sweden, Lindström, M.J., Fredriksson, C. Witzel, J. (Eds.). Sweden: SandvikensTryckeri AB.

Burke, G.L. (1956). The Making of Dutch Towns: A Study in Urban Development from the Tenth to the Seventeenth Centuries. London: Clever-Hume.

Cammen, van der (2005) *The self made land*

Dehaene, M., Maarten Loopmans (2003) De argeloze transformative naar een diffuse stad. Vlaanderen als Nevelstad. Agora jaargang 19 nummer 3 – 2003

Dooren, EJGC van, Asselbergs, MF, Dorst, MJ van, Boshuizen, E & Merrienboer, J van (2013). Making explicit in design education: generic elements in the design process. International Journal of Technology and Design Education, 2013, 1-19.

Eesteren, C. van (1934). Algemeen Uitbreidingsplan Amsterdam. Amsterdam: Dienst Publieke Werken Amsterdam

Graaf, P. van der (2014) Integrating the subsoil in Urban design How to take subsoil aspect into account in the process of urban designing. Theory paper master thesis University of Technology Delft.

Groot, Rudolf S de, Matthew A Wilson, Roelof M.J Boumans. (2002) A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics Volume 41, Issue 3, Pages 393–408

Heeling, J.; Meyer, V.J..& Westrik, J. (2002). De Kern van de Stedebouw in het perspectief van de 21ste eeuw. Dl. 1. Het ontwerp van de stadsplattegrond. Amsterdam, SUN.

Heylighen, F., (2000). "Referencing pages in Principia Cybernetica Web", in: F. Heylighen, C. Joslyn and V. Turchin (editors): Principia Cybernetica Web (Principia Cybernetica, Brussels

Hoog, M. de, Sijmons, D, & Verschuren, S. (1998). 'Herontwerp van het Laagland' In: Het Metropolitane Debat, Bussum: THOTH.

Hooimeijer, F.L. (2011) The tradition of making: polder cities. Delft: TU Delft

Hooimeijer, F.L., L. Maring (2013) Ontwerpen met de Ondergrond. in: Stedebouw & Ruimtelijke Ordening 2013/6

Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context, in: M.Conan, Landscape Architecture, Dumbarton Oaks: Trustees for Harvard University.

Koppenjan, Joop and Erik-Hans Klijn (2011) Complexity, which complexity? Three perspectives on complexity applied to decision-making on revitalizing the Center of Rotterdam South. Paper for ASPA (American Society of Public Administration) conference "Challenges of making public administration and complexity theory work" Rotterdam , Erasmus University Department of Public Administration, June 23-25, 2011

Lendering, J. (2005): *Polderdenken. De wortels van de Nederlandse overlegcultuur*. Amsterdam: Athenaeum.

McHarg, I. (1967) An Ecological Method for Landscape Architecture, Landscape Architecture 57 (2): 105–107.

Nadin, V., and D. Stead (2003): *European Spatial Planning Systems, Social Models and Learning* disP-The Planning Review 44, no. 172 35–37.

Nystrom, L. Urban Culture and Environmental Sustainability in: Guinchard, C. (ed.) (1997), "Swedish planning; Towards Sustainable Development". Swedish Society for Town and Country Planning, Stockholm, (P.26.)

Rotmans, J. & Dowlatabadi, H. (1998). Integrated assessment of climate change: Evaluation of methods and strategies, in S. Rayner & E. Malone, eds, 'Human Choice and Climate Change: An International Social Science Assessment', Batelle Press.

Rotterdam Climate Initiative 2014 Connecting delta cities, resilient and climate adaptation strategies. Rotterdam

Ryser, J., and T. Franchini, eds. (2008): *International Manual of Planning Practice*. 5th ed. Den Haag: ISOCARP [http://www.isocarp.org/index.php?id=141 5 Dec 2013]

Schaick, J. van & Klaasen, I.T. (2007). Dynamics of urban networks as basis for the re-development of Layers Approach es. In: Conference Proceedings International Seminar on Urbanism and Urbanization. TUDelft, Faculteit Bouwkunde

Segeren, W.A. and H. Hengeveld (1984). Bouwrijp maken van terreinen (Preparing sites for building). Deventer: Kluwer

Sheppard, S., & Shaw, A. (2007). Future visioning of local climate change scenarios: Connecting the dots and painting pictures to aid earth system governance. Vancouver: Department of Forest Resources Management/Landscape Architecture Program, Forest Sciences Center.

STATISTICS SWEDEN (2007), "Yearbook of Housing and Building Statistics 2007.", Energy, Rents and Real Estate Statistics Unit, Stockholm.

Van Dorst, M.J. & Duijvestein, C.A.J. (2004). Concepts of sustainable development - The 2004 International Sustainable Development research conference – Conference proceedings 29-30 march University of Manchester, UK.

Whiston Spirn, A. (200) Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context, in: M.Conan, Landscape Architecture, Dumbarton Oaks: Trustees for Harvard University.

Woud, A. van der (1987): *Het lege land, de ruimtelijke orde van Nederland 1798-1848*. Amsterdam: Meulenhof