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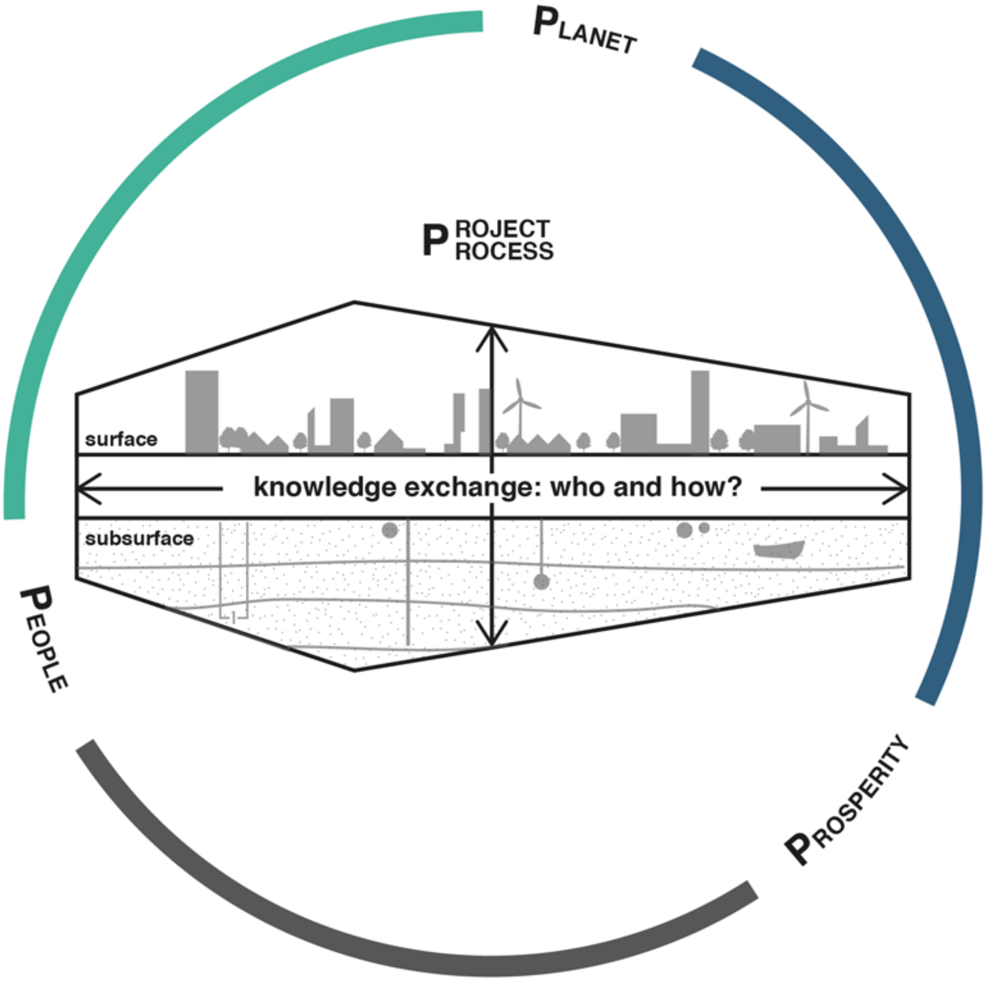

BALANCE 4P: Balancing decisions for urban brownfield redevelopment

Technical report of the BALANCE 4P project of the SNOWMAN Network coordinated call IV

JENNY NORRMAN[1], YEVHENIYA VOLCHKO[1], LINDA MARING[2], FRANSJE HOOIMEIJER[3], STEVEN BROEKX[4], RITA GARÇÃO[1], ALISTAIR BEAMES[4], JAAN-HENRIK KAIN[1], MATS IVARSSON[5], KAAT TOUCHANT[4]

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Department of Civil and Environmental Engineering
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Gothenburg, Sweden 2015
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Cover:
Conceptualisation of a holistic approach to urban brownfield redevelopment (Balance 4P). Illustration drawn by Janneke van der Leer, ©Chalmers University 2015.

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ABSTRACT

Land take as a result of urbanization is one of the major soil threats in Europe. One of the key measures to prevent further urban sprawl and additional land take, is redevelopment of urban brownfields: underused urban areas with, in many cases, soil and groundwater pollution. The latter issue can be a bottleneck for redevelopment of brownfields instead of green fields. A difficulty for brownfield redevelopments is that in urban projects the responsibilities, tools and knowledge of subsurface engineering and urban planning and design are not integrated; they depend heavily on each other but work in sectors. The urban designer usually deals with opportunities for socio-economic benefits while the subsoil engineer deals with the technical challenges of the site. Balance 4P suggests a holistic approach to brownfield redevelopment that (i) recognizes all phases of the urban redevelopment process which are influenced by the planning conditions set by laws, regulations, policy and institutions; (ii) acknowledges multiple subsurface qualities in the brownfield redevelopment project; (iii) promotes knowledge exchange between the surface and the subsurface sectors, across disciplines within each sector, and over time, about the subsurface qualities of the specific project; (iv) focus on the urban redevelopment project by identifying strategies for redevelopment that can fulfil a good quality of the built environment; (v) assesses the three P's (People, Planet, Profit/Prosperity) in each urban redevelopment phase; and (vi) puts the Process in focus rather than specific instruments by focusing on identification of WHO should be involved in the knowledge exchange process and HOW it can be mediated. The developed decision support framework is aimed to guide project teams willing to implement a more holistic approach in practice. The framework includes four steps carried out in iterative manner: (1) stakeholder analysis, (2) generation of redevelopment alternatives, (3) sustainability assessment of the alternatives, and (4) synthesis of the assessment results, including uncertainty analysis. The guidance describing the steps in the decision support framework and activities within each step can help to structure the decision process and provide support to project teams. The anticipated advantages of the holistic approach are redevelopment plans that allow for smart, cost-effective and sustainable solutions in the implementation process by making explicit use of subsurface information and knowledge in the planning process, and possibilities for more long-term sustainable planning with regard to the subsurface by increased awareness of the subsurface as a resource and the associated risks and possibilities.

Key words: brownfield, contaminated site, redevelopment, remediation, planning, sustainability assessment, holistic approach, decision process

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Preface

The Balance 4P project was carried out as part of the SNOWMAN Network coordinated call IV (http://www.snowmannetwork.com). The SNOWMAN Network and the national funders in this network are acknowledged for the received support: SNOWMAN (SN04-01), Formas (Dnr 216-2013-1813), Stichting Kennis Bodem (SKB, D3146), and OVAM (VITO contract nr 1310398). In addition, the Municipality of Rotterdam, Port of Rotterdam, Gebiedsteam M4H, Programmabureau Stadshavens Rotterdam, and Gemeentewerken Rotterdam are acknowledged for being willing to invest both money and time into the work with the case studies within the research project, and being enthusiastic about it. Hanna Kaplan, Christian Carlsson from the Gothenburg municipality, and Elisabeth Forsberg representing the private developers HSB and Balder are greatly acknowledged for investing time and efforts in the work with the Fixfabriken case study. All students and stakeholders participating in the Balance 4P project are acknowledged for contributing with time, their skills, experiences and knowledge. Paul Bardos, r3 environmental technology is acknowledged for contributing with his experience and knowledge in various discussions. We are also thankful to Tore Söderqvist, Enveco, who reviewed an earlier version of the report and provided invaluable comments. The authors are fully responsible for the content of the report.

Project acronym:
BALANCE 4P

Full Project Title:
BALANCE 4P: Balancing decisions for urban brownfield regeneration – people, planet, profit and processes

Project consortium:
Deltares, The Netherlands
Delft University of Technology, The Netherlands
VITO, Belgium
Chalmers University of Technology, Civil and Environmental Engineering and Architecture, Sweden
Enveco Environmental Economics Consultancy, Sweden
r3 environmental technology, UK

Project coordinator:
Jenny Norrman

Project coordinator organization name:
Chalmers University of Technology

Gothenburg, 2015

Jenny Norrman

Notations

List of abbreviations

ATES	Aquifer Thermal Energy Storage
BIS	Bodemkundig InformatieSysteem (=soil information system)
BOM	Brownfield Opportunity Matrix
BR2	Brownfield Remit/Response tool
BRO	Basisregistratie Ondergrond (=basic registration subsurface data)
DINO	Data en Informatie Nederlandse Ondergrond (=data and information Dutch subsurface)
DSS	Decision Support Systems
E.ON	The company e.on, a large energy supplier
EIA	Environmental Impact Assessment
ESS	Ecosystem Services
MCA	Multi Criteria Analysis
MA	Millennium Ecosystem Assessment
SA	Stakeholder Analysis
SAAM	Social Amenity Accessibility Metrics
SCORE	Sustainable Choice of REmediation
SEES	System Exploration Environment and Subsurface
SIA	Social Impact Assessment
SRT	Sustainable Remediation Tool

1 Introduction

1.1 Background

Land take as a result of urbanization is one of the major soil threats in Europe. One of the key measures to prevent further urban sprawl and additional land take, is redevelopment of urban brownfields: underused urban areas with, in many cases, soil and groundwater pollution. The latter issue can be a bottleneck for redevelopment of brownfields instead of green fields. A difficulty for brownfield redevelopments is that in urban projects the responsibilities, tools and knowledge of subsurface engineering and urban planning and design are not integrated; they depend heavily on each other but work in sectors. The urban designer usually deals with opportunities for socio-economic benefits while the subsoil engineer deals with the technical challenges of the site.

The global-wide trend of urbanization increases the importance of careful spatial planning in cities (OECD and CDRF, 2010). When considering climate change, population growth and increasing human demands for the living environment, the sensibility of sustainable development and redevelopment of the urban area is clear (Roberts and Sykes, 2000). Whereas urban redevelopment is a very old concept, sustainable development has more recently gained awareness worldwide (Hsu, 2014) (van Donk and Smit, 2009) (Gauzin-Muller, 2002), quickly gaining in popularity (Lakkala and Vehmas, 2013). In literature, several reasons have been named for this sudden increase in popularity of the concept of sustainable development: bad practices have led to sub-optimal solutions and unsustainable situations; population growth and the depletion of natural resources call for a change in development practice; and sustainability is now a well-known marketing strategy (Kumar et al, 2012). This increasing trend in sustainable development can be seen in most aspects of society: food production, clothing, energy use, architecture, and more and more in the spatial planning field as well. In order to prevent urban sprawl, decrease of property value and to increase the future liveability of the city, the redevelopment of derelict and often contaminated land within the urban area is needed (Chakrapani and Hernandez, 2012).

In the remediation sector, there is a broad on-going work to develop methods and tools that supports sustainable remediation. Remediation was earlier viewed as a sustainable action in itself, but today negative impacts of remediation are acknowledged, e.g. transport emissions and fatality risks, health risks during remediation, consumption of energy and materials, as well as being costly (Vegter et al., 2003; SuRF-UK, 2010). There is today an increasing demand for assessing remedial activities with regard to all three of the commonly mentioned sustainability dimensions: environment, economy and society. The International Standard Organization (ISO) currently works on a standard for sustainability evaluation of remedial actions and there are several SuRF (Sustainable Remediation Forum) organizations worldwide (USA, UK, Australia and New Zealand, Canada, Italy, the Netherlands, Taiwan and Brazil) that support this development. SuRF-UK suggested a general framework for assessing the sustainability of soil and groundwater remediation, broad enough to apply across different timescales, site sizes, and project types (Bardos et al., 2011). In accordance with Bardos et al. (2011), there are several attempts to incorporate sustainability in early phases of projects, as there is a general idea that the largest (sustainability) gains are achieved early in projects where they are still flexible.

The background to the Balance 4P project is the idea that a better cooperation between urban developers and subsurface specialists in early phases of the redevelopment process can accelerate urban brownfield redevelopment and potentially identify more sustainable redevelopment strategies.

1.2 The Balance 4P project: objectives and participants

The Balance 4P project is mainly funded by the SNOWMAN network[1], together with funding from the Municipality of Rotterdam, Port of Rotterdam and in-kind contribution from VITO, TUDelft and Deltares, and the municipality of Gothenburg. The overall aim of the project has been to develop a holistic approach that supports redevelopment of brownfields by integrating technical, environmental, economic and social aspects, and provide means for clearly communicating challenges and opportunities of site-specific subsurface qualities. By linking the holistic approach to rules and regulations, implementation in practice will be enabled. The different technical work packages of the project aim to:

- apply and assess methods for design of urban renewal / land redevelopment strategies for brownfields that embrace the case-specific opportunities and challenges (WP3);
- apply and assess sustainability assessment methods of alternative land redevelopment strategies to evaluate and compare the ecological, economic and social impacts of land use change and remedial technologies (WP4) [2];
- develop a practice for redevelopment of contaminated land in rules and regulations to enable implementations (WP5);
- describe the holistic approach in a concrete form in a decision support framework, pointing to steps to take, suggestions on existing tools and methods as well as important communication and participation tasks in the different phases of an urban renewal project (WP6).

The official project team consists of researchers with a diverse background, e.g. land management, urban design, urban planning, environmental economics, remediation and contaminated sites. Next to that, an important method in the project has been to work in a number of case studies (see Norrman et al., 2015), where also practitioners with different background have participated and contributed. During the course of the project, these practitioners have typically been categorized as surface and subsurface experts, but these two groups are in fact consisting of people with different expertise areas, e.g. urban planning, landscape architects, archaeology and cultural heritage, waste and waste water, geotechnics, remediation to mention some. Thus, at the core of this project has been the pronounced aim to try to bridge across competencies: research

[1] http://www.snowmannetwork.com/main.asp . The SNOWMAN network is a transnational group of research funding organizations and administrations in the field of Soil and Groundwater in Europe. The Balance 4P project was funded in the 4th SNOWMAN call, by SKB - Sustainable development of the subsurface (NL), OVAM - Openbare Vlaamse Afvalstoffenmaatschappij Flanders (BE), and Formas - Forskningsrådet för Miljö, Areella näringar och Samhällsbyggande (SE).

[2] Originally WP4 aimed at developing a new method for sustainability assessment of redevelopment strategies, but this objective was slightly changed during the course of the project due to the multitude of tools and methods already available and applied in the three countries and a greater focus on when and how available tools are suitable.

– practice and surface – subsurface. All participants have been forced to turn their views and to compromise, which in fact, has been a true resource for the project as a whole.

1.3 Aim and scope of report

The main aim of this report is to present the holistic approach and a guidance to a decision support framework to support working in line with the holistic approach. The holistic approach and the decision support framework, build on the results from several analyses (WPs 3, 4 and 5 above) and from working in practice with three case studies (see Norrman et al., 2015). This report thus summarises the main findings of the Balance 4P project.

The scope of the report is as follows. Chapters 2 to 5 describes the background to the work. Chapter 2: an overview of terminology and suggested features of holistic approaches to brownfield redevelopment earlier described in literature Chapter 3: a description of the spatial planning systems in The Netherlands, Flanders and Sweden, and the urban redevelopment process; Chapter 4: a description of current subsoil management in law and regulation in the three countries; Chapter 5: the four aspects of sustainability included in this work (people, planet, profit/prosperity and process/project).

The following Chapter 6, describes the methods used for the analyses carried out within the project. Thereafter, three chapters (7 - 9) present the results from these analyses. Chapter 7 describes the results of the inventory of available instruments to support sustainable brownfield redevelopment. Chapter 8 presents the results of comparing the three planning systems and summarises the current chances within existing laws and regulations to enhance the subsurface in the planning systems. Chapter 9 presents the final conceptualisation of the suggested holistic approach, the lessons learned from the case studies and the suggested decision support framework to support a holistic approach in practice and a guidance for users.

Finally, the main results are discussed in Chapter 10 and Chapter 11 contains some concluding remarks.

There are three appendices: Appendix A presents the full comparison of the three planning systems in table format; Appendix B shows an example inventory of stakeholders; Appendix C gives an overview and short description of available instruments.

1.4 Target groups

There are a number of different target groups the results of the project are aimed at:

1. Direct stakeholders, end users, professionals (and students) involved in urban redevelopment projects (such as municipalities, regional authorities, project developers, service providers, land owners, etc.);
2. The professional community, primarily related to the environmental and spatial planning fields and includes, among others, commercial developers;

3. The scientific community on the European level;
4. The wider community, i.e. people not involved in the environmental and spatial planning field, but interested in the project (e.g. national or regional regulators) and especially the cases (e.g. local regulators, local community in vicinity of cases, etc.).

Although the project results are interesting for the above target groups, the main user envisaged for the Balance 4P framework are municipalities or regional authorities, as many brownfield redevelopment cases start with the intervention of municipalities or regional authorities: "Their actions, or inaction, have a decisive impact on the manner and pace at which brownfield land is brought back into beneficial use, or the degree to which it might remain under-used or derelict" (HOMBRE, 2013).

2 Brownfield redevelopment

2.1 Terminology

The following sections provides the reader with an introduction to some of the terminology commonly used in relation to brownfield redevelopment.

Circular land use and management

Circular land management is the process of handling developed land, from the viewpoint of a continuous land use cycle that is aimed at facilitating smooth land use transition, thereby preventing unnecessary brownfield emergence.

Also the different management phases are interlinked in a continuous management cycle that does not just cover the transition phase itself, but starts already during the use phase, when changes in the benefits of the current land use and actual demand for services can be anticipated (Figure 2-1). Planning a well-managed transition can then be taken up in an early stage. Similarly, a forward looking perspective is used in the management and monitoring of the sustainability of the services provided by the new use, to prevent that its benefits will be too short-lived. (HOMBRE, 2014a).

Figure 2-1. The HOMBRE Zero Brownfield framework: administrative land management cycle (right cycle) addressing land use transitions in the land use cycle (left cycle). (HOMBRE project: Gaans and Ellen, 2014).

The land use cycle is considering developed land as a resource in a continuous rotation of development, use, abandonment, redevelopment and reuse. The end of a given use phase may or may not be a formal and adequate decommissioning of activities and clearance of the site. Ideally, it should be followed by the onset of development activities to realise subsequent use. Where the end of the current use phase and the transition to the subsequent use are not well managed, there is a risk that the site may turn into a brownfield.

Different colours

There are a number of different terms in the literature in the field of land regeneration and redevelopment, e.g. Greenfield, Greyfield, Brownfield and Blackfield.

Greenfield

A greenfield is a site in undeveloped, natural condition or one that is in agricultural use (Aurbach, 2005).

Greyfield

The term greyfield is not commonly used in Europe, but in the USA (EPA) it is an official term, defined as:

> *Greyfields are economically obsolescent, outdated, failing, moribund and/or underused real estate assets or land (EPA water office, 2012). Typical greyfield sites are commercial properties, previously used as parking lot, shopping centers and shopping malls, hotels or office buildings or multiple family residential buildings (Aurbach, 2005 and Wurtzler and Diluigi, undated).*

Brownfield

The underneath definition and elaboration is taken from the CABERNET network (Cabernet, 2006). Definition:

> *A brownfield is a site that has been affected by former uses of the site or surrounding land, is derelict or underused, mainly in fully or partly developed urban areas, require intervention to bring it back to beneficial use; and may have real or perceived contamination problems.*

Brownfields result from changing patterns of industry and development in many regions. The loss of the industry, the resulting unemployment and the reluctance of new investors to take on the technical problems and liabilities associated with brownfield sites, affect the economic prosperity of the region, particularly in urban locations. Municipalities are often unable to revitalise brownfield from within their own resources, and their city centres and environments remain degraded and under-utilised.

CABERNET has reported different definitions for brownfields used in different member states of Europe (Oliver et al, 2005).

Blackfield

"Blackfield" is throughout Europe and the USA not a commonly used term. In Belgium however, OVAM uses it as an official term for the very difficult to redevelop brownfields (i.e. a "C-site", see the description of ABC sites in the next section).

OVAM defines blackfields as follows (OVAM website, undated):

Blackfields are underused sites that need redevelopment but where the soil is so contaminated that private initiatives do not take place. Without intervention of governmental organisations, these sites will remain. This is considered as a serious problem, because pressure on open spaces will grow. The blackfields are as well large former industrial sites as well as smaller sites, often in the centre or on the boundaries of cities. These sites have a negative influence on their surroundings.

ABC sites

The current ease (and hence speed) at which brownfield sites are being redeveloped, depends largely on the perceived cost/benefit ratio of a redevelopment project (Type A, B, C site; Figure 2-2). For type A-sites, circular land use is realised through market mechanisms. For B sites, market mechanisms are normally not enough to start the redevelopment. Public-private partnerships are a solution to start up redevelopment. C-sites are the most difficult brownfields where a multitude of problems (e.g. heavy contamination, unfavourable location or conditions, etc.) hamper the redevelopment. Public intervention is needed to start redevelopment. Sustainable land management should ensure that all land is used well and facilitate that also type C-sites move faster through the land use cycle (Ferber et al., 2006).

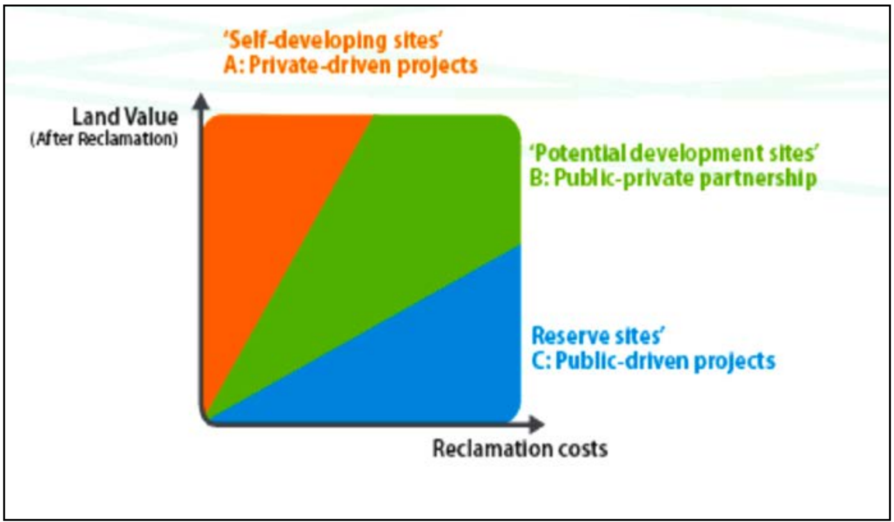

Figure 2-2. Schematic overview of A, B, C type brownfields (Ferber et al, 2006).

Currently in Europe it is unknown how many brownfield sites exist that are difficult to redevelop (sites type C) as each country has own definitions for brownfields. For example in Belgium, the term “blackfield” is used for a C-site, see explanation for blackfield above. A site can therefore be identified as a persistent brownfield in one country whereas in other countries the brownfield labelling remains absent.

2.2 Holistic approaches to brownfield redevelopment

Several projects have contributed to developing a holistic approach to brownfield redevelopment accounting for both sustainability aspects and planning issues (RESCUE, 2005; CABERNET, 2006; REVIT, 2007; HOMBRE, 2013). The CABERNET (Concerted Action on Brownfield and Economic Regeneration Network) network and the HOMBRE (Holistic Management of Brownfield Regeneration) project advocate holistic approaches that links physical interventions with people-focused interventions taking the sustainability perspective and involving stakeholders (CABERNET, 2006; HOMBRE, 2013).

The holistic approaches to brownfield redevelopment advocated in RESCUE (2005), CABERNET (2006), REVIT (2007) and HOMBRE (2013) have a number of essential features: regulation and policy, urban redevelopment process, subsurface aspects in planning, people involvement, and sustainability assessment.

Regulation and policy

The holistic approach acknowledges that regulation and policy can either create opportunities or obstacles for brownfield redevelopment (HOMBRE, 2013). The policies and regulations set on the different institutional levels must be analysed and improved to enable sustainable brownfield redevelopment.

Urban redevelopment process

The holistic approach to brownfield redevelopment recognizes that the redevelopment process constitutes of a number of phases (RESCUE, 2005; REVIT, 2007). Urban redevelopment of brownfields coincides with the land use cycle, i.e. considering developed land as a resource in a continuous rotation of development, use, abandonment, redevelopment and reuse (HOMBRE, 2013, 2014b). The circular land management phases are “anticipate change”, “make the transition”, and “check performance”. Different instruments are needed in different phases to support sustainable brownfield redevelopment (HOMBRE, 2014b).

Subsurface aspects in planning

Typically subsurface aspects as soil and groundwater contamination are considered late in the development process, i.e. realisation phase when the plan is approved, which may reduce the potential gains available from more sustainable remediation solutions (SURF-UK, 2010, NICOLE 2011). More holistic approaches suggest considering subsurface and remediation issues earlier in the initial and plan phases of redevelopment to facilitate greater sustainability gains later phases (RESCUE, 2005; CABERNET, 2006; REVIT, 2007; HOMBRE, 2013). Furthermore, CABERNET (2006) and HOMBRE (2014b) point out that soil contamination issues are only one of a multitude of aspects (including other subsurface qualities) which should be taken into consideration in the redevelopment process.

People involvement

People involvement is an essential feature of a holistic approach to brownfield redevelopment (see Cundy et al, 2013; RESCUE, 2005; CABERNET, 2006; REVIT, 2007; and HOMBRE, 2013). CABERNET (2006) recognizes two large groups of people that must be involved in the brownfield redevelopment process: “Citizens” and “People with professional skills”. A holistic approach implies a shift from site-based to people-based activities engaging multiple stakeholders into a redevelopment process (CABERNET, 2006). The CABERNET stakeholder model amended by HOMBRE includes the following stakeholder groups which should be involved into the redevelopment process: land owners, developers, professional advisors, academics, community groups, financiers, technology suppliers, and regulators (HOMBRE, 2013). Different stakeholders may be relevant in different phases of the redevelopment process.

Sustainability assessment

The essential parts of sustainability assessment are the selection of environmental, social and economic indicators, and the selection of a method for assessment of the impacts (performance) for a given scenario. Various indicators, methods and tools for sustainability assessment are introduced in studies advocating a holistic approach to brownfield redevelopment (RESCUE, 2005; CABERNET, 2006; REVIT, 2007; and HOMBRE, 2014b). The redevelopment scenarios (not solely remediation technologies) are suggested to be assessed with relevant methods and tools. Furthermore, HOMBRE (2014b) widens sustainability assessments to more stringent appraisal of (1) the potential “added value” of the site entailed by the new realised land use, (2) the benefit/cost ratio by linking the services provided by the redeveloped brownfield to site- and area-specific demands, and (3) synergies between different (remediation) technologies and between different land uses. The added value reflects the overall gain making the redevelopment project worthwhile. Assessment of the added value is very important for the B- and C-type sites (where redevelopment realised in part by public funding, to ensure that the overall sum of economic, environmental and social benefits for the stakeholders, including the local/regional community, is maximized (HOMBRE, 2014b).

3 Spatial planning systems

There are numerous definitions of spatial planning. One of the earliest definitions is as follows:

> *"Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organisation of space according to an overall strategy."*[3]

This comprehensive definition from the European Regional/Spatial Planning Charter, adopted in 1983 by the European Conference of Ministers responsible for Regional Planning (CEMAT), is not workable, but it illustrates the complexity of the discipline. Planning is at the same time policy and practice; and it needs to be concerned with all aspects of social, environmental and economic development in a coherent way. Moreover, the different developments each have their own rhythm; for example financial conditions change much faster than demographic profiles or eco-systems and planning decisions that involve large investments or infrastructure take a long time to realize while the needs of society may change rapidly. To plan ‘according to an overall strategy’ at all scales is therefore an illusion. Nevertheless, policy-makers set priorities that shape planning decisions and are steering to urban development when implemented. The term ‘spatial planning’ is often used at the same time for both these decisions (the substance of planning) and the governance system (the process of planning). For example the European project for planning and climate change adaptation ESPACE states:

> *“Spatial planning is a process that assimilates and interprets evidence-based knowledge to inform those activities that aim to ensure spatial development takes place in an appropriate, sustainable way, from a functional, social, economic and environmental point of view.”*[4]

For Balance 4P, the main interest lies in the *processes* of planning, and this is what is referred to when discussing ‘planning systems’ (Nadin and Stead, 2003). 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 the planning culture.

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

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[3] From: European Regional/Spatial Planning Charter adopted in 1983 by the European Conference of Ministers responsible for Regional Planning (CEMAT) www.coe.int/t/e/cultural_cooperation/environment/cemat/list_of_conferences/071_resol1983.asp January 2014

[4] www.espace-project.org/part1/part1_intro.htm#what March 2014

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 sectoral domains is taking place in the Netherland. This is done at all governmental organizations: on National level e.g. by merging the ministries of water and spatial planning; at provincial level by combining departments of soil and spatial planning; and at municipal level by merging engineering and urban development departments.

In the Netherlands, legislation is developed and adopted by central government. Until in 2010, the Ministry of Planning had responsibility to issue National Spatial Strategies followed by so-called key decisions with legally binding elements. In 2010 the Ministry of Planning was merged into of the Ministry of Infrastructure and the Environment (MinIE), thus spatial planning became in responsibility of MinIE while housing was assigned to the Ministry of Internal Affairs. Next to the ministry there are several research/planning offices such as The Netherlands Institute for Social Research SCP (*Social Cultureel Planbureau)* and Netherlands Environmental Assessment Agency PBL *(Planbureau voor de leefomgeving)*, Environmental Impact Assessment Commission (*Milieu Effect Rapportage Commissie)* and *Staatsbosbeheer* (Forestry) for the stewardship and management of forests. Archaeology is under supervision of Cultural Heritage Agency of the Netherlands (*Rijksdienst voor het Cultureel Erfgoed)* part of the Ministry of Education, Culture and Science. The development of policy and technology considering cables and pipes is supported by the Municipal Platform of Cables and Pipes[5]. The same type of institutional support on cables and pipes is also carried out by the Centre of Underground Building. The issues related to water resources are in responsibility of the Ministry of Traffic and Water, which was merged into MinIE in 2010. The operational department of *Rijkswaterstaat* (Infrastructure) is responsible for design, construction, management and maintenance of infrastructure facilities, i.e. the main road network, the main waterway network and water systems. An important independent institution that supports policy making and research with regard to flood mitigation, water and subsoil resources, planning, infrastructure and environment is Deltares.

In 2012 MinIE has issued Vision Infrastructure and Space (structuurvisie Infrastructuur *en Ruimte*) to set priorities for the development of the territory until 2040.This is the main frame for structure plans of the provinces on the regional scale, and the structure visions of municipalities that are made specific on the district scale in zoning plans. Planning has a long tradition expressed in the institutions, laws, policy, instruments and regulations that supports the system. In recent years deregulation is the trend. Planning responsibilities are shifted towards the municipal level while regulations are made simple and more interconnected. Private developers are invited to work in public-private partnerships to engage in urban development. *Welstandscommissie* is the

[5] www.gpkl.nl/

important committee that examines the quality of the urban plans with regard to architecture. It is an important check to have a private developer to adjust to a 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 cooperations started 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.

At the regional level, the role of the 12 Dutch provinces is strong in spatial management but mainly advisory in development planning. Dynamic regions form special planning agencies to create inter-municipal Structure Plans in a cooperative body of stakeholders. Initially this was often imposed out of national interest, for example 'Rijnmond Main Port' counterbalanced by bottom up initiatives such as '*Zuidvleugel*'. More and more municipalities join forces to gain position, such as '*Stedendriehoek*' or '*Achterhoek*'. These regional agencies are not regulated by law and depend on the participating municipalities. Most regional agencies strive to involve the private sector and be transparent in their goals and budgeting. Structure Plans are not legally binding but are usually considered in *Streekplannen* (regional plans). Provinces are obliged to have regional plans and zoning plans, urban development plans. Building applications are checked to fit the intentions of the Streekplan. The Structure 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 plan has negative effects on the environment, it may still be realized IF given a sound argumentation[6]. Water protection areas are considered in the provincial spatial plans, environmental and/or water regulation plans. Another important governmental institutions at the provincial level are the 24 Water Boards responsible for the larger water system, dikes, and the groundwater that is controlled by pumps. The provinces grant permits water extraction or Aquifer Thermal Energy Storage (ATES).There are 403 municipalities in the Netherlands. The City Council of the municipality approves major planning decisions on zoning plans and urban (re-) development at the municipal scale. Decisions are prepared in planning departments, for smaller municipalities with support from the provincial planning department. Consent for the modification of land use or building permits are issued at the municipal level. The municipal zoning plans and structure visions need to be assessed with the Environmental Impact Assessment (EIA) procedure.

In the Netherlands, public consultancy on the plan needs to take place before the formal approval. The spatial structure plans are revised/updated through an EIA procedure and an extensive process of stakeholder meetings and public consultation. Participation procedures are regulated at all planning levels by law. If contesters are not satisfied with the decision at local level, they can re-apply at provincial level and finally in court. Spatial planning in the subsurface is not arranged separately. The owner of the above ground is also owner of the subsurface. In the Netherlands only use functions in groundwater and deep subsurface need a permit (from province respectively Ministry of Economic Affairs). There is a possibility to appeal if the permit was not granted.

[6] www.achterhoek2020.nl/regio-achterhoek/

3.2 Flanders (Belgium)

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 policy. This situation has been even more complicated because of the division of the state into three regions: Flanders, Brussels and Walloon. Since the state reform in 1980, the Federation has no constitutional powers regarding spatial planning and de facto there exist nowadays three planning systems based upon regional autonomy. Flanders can be considered quasi sovereign within the federal state of Belgium with regard to planning and related policies (de Vries, 2015). 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 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 developed between 1962 and 2000 had to be checked by the King, and later the Flanders government. Since 2000, these urban design decrees are formalized by the provinces.[7] For changing parcels and changing function of a building a permit needs to be issued by the municipality.

Flanders approved its Spatial Planning Decree in 1996 which provides a legal framework for the planning system in Flanders. The basic principles for Flanders Spatial Policies Plan from 2012 are: 'The Productive Landscape', 'The Long Term, Uncertainty and Governance' and 'Welfare and Well-being'[8]. These principles are steering in the system at the three planning levels: regional (the Flanders region), provincial (5 provinces) and municipal (308 municipalities). These three planning levels are hierarchical implying that the lower levels align themselves with the higher levels. The Regional Structure Plan (*Ruimtelijk Structuurplan Vlaanderen; RSV*) adopted by the Flemish Government in 1996 covers the Flanders region and stipulates planning at the provincial and municipal levels. RSV is translated into the Regional Implementation Plan (*Geswestplannen / Gewestelijke ruimtelijke uitvoeringsplannen; RUPs*). The regional urbanistic rules (*Gewestelijke stedenbouwkundige verordeningen; GSV*) are legally binding documents complementary to these plans and forms the basis for public control[9]. The Flemish Minister of Planning decides on and approves the changes in RSV prepared by Administration of Spatial Planning and Housing. GSV sets priorities for sectorial considerations and interests, focuses on urban areas, regional employment areas, open space and infrastructure (Larsson, 2006). At the provincial level, the permanent deputation of the province develops the Provincial Structure Plan (*Provinciaal ruimtelijk Structuurplan; PRS*) that covers the entire province and complies with RSV. After consultation with regional commission of advice, the provincial council temporally approves the plan, notifies the Flemish Government and submit the plan for public review. Comments of citizens, municipalities, adjacent provinces and the Flemish Government are collected and analyzed by the regional

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[7] www.ruimtelijkeordening.be/NL/Beleid/Vergunning/Vergunningnodig

[8] www.beleidsplanruimte.be March 2014

[9] https://orbi.ulg.ac.be/bitstream/2268/112982/1/Urban%20planning%20in%20Belgium%20-%20v2.pdf

commission of advice. The final PRS is then approved the Flemish Government and adopted by provincial council (Larsson, 2006). PRS is translated into the Provincial Implementation Plan (*Provinciaal ruimtelijke uitvoeringsplannen; RUPs*). Legally binding provincial urbanistic rules (*Provinciale stedenbouwkundige verordeningen; PSV*) apply to development at the provincial level. Finally, at the municipal level, the municipal council develops the Municipal Structure Plan (*Gemeentelijk ruimtelijk structuurplan; GRS*). After consultation with the municipal commission of advice, the municipality is temporally approves the plan, notifies the permanent deputation and the Flemish Government, and submits the plan for public review. The regional commission of advice collects and studies the comments from citizens, municipal councils of the adjacent municipalities, permanent deputations of the adjacent provinces and Flemish Government. The Flemish Government gives advice if the Provincial Structure Plan is absent. The final GRS is approved by the permanent deputation of the province and adopted by the municipal council. If PRS is absent, the final GRS is approved by the Flemish Government and adopted by the municipal council. GRS is translated into the Municipal Implementation Plan (*Gemeentelijke ruimtelijke uitvoeringsplannen; RUPs*). The municipal urbanistic rules (*Gemeentelijke stedenbouwkundige verordeningen; GSV*) are legally binding regulations for development at the municipal level. Both the Provincial and Municipal Structure Plans contain binding regulations, indicative elements and an informative part (Larsson, 2006). The Municipal Implementation Plan covers the entire municipality. The Sub-municipal Implementation Plan (*Bijzondere Plannen van Aanleg; BPA's*) covers the specific part of the municipality and contains description of the existing situation, road network, intended changes and regulations concerning the location, the type and the size of new buildings, regulations concerning (Larsson, 2006). At all the three levels, structure plans contain the vision of the use of space, whereas implementation plans contain regulations. All plans at all levels are legally binding. Similar to the Netherlands, the EIA procedure is carried out for all the plans produced at the three levels, however, in Flanders, only certified agencies can perform this task.

The above described Flemish planning system is however not effectively implemented in practice (de Vries, 2015). The Flemish and Dutch planning systems are comparable although Flanders is a region and the Netherlands is a country, because Flanders has a planning autonomy. The comparison can be of interest because (i) the countries are neighboring, having common language and a coherent planning regime, (ii) Flanders and the Netherlands have distinct cultural characteristics in the field of spatial planning, (iii) both countries are stable and wealthy democracies (de Vries, 2015). The planning history in the two countries is very different from each other. Under both the old and new planning systems the plans were foremost developed and used rather to provide a legal certainty about what is allowed to be built rather than to develop a planning strategy for coherent urban development (de Vries, 2015). As a result, the small scaled landscape of Flanders was urbanized in a scattered way leading to extreme sprawl. Furthermore, starting from the nineteenth century the national policy stimulated to build own houses, which has led to the fact that only 6% of Flemish inhabitants reside in rental houses and 75% of the people reside in own house (Dehaene and Loopmans, 2003). Result of this practice is that the urban development is much more scattered over the landscape, the so called Nevelstad being urbanized along roads with large landscape lots on the backside of these houses[10].

[10] http://176.9.39.46/nl/Issues/60

3.3 Sweden

The planning system in Sweden was established in the 1900s in order to ensure, through the control of the State, 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). The Environmental Quality Standards (*miljökvalitetsnormer*), which are mostly based on EU requirements, serve as an important instrument for achieving national environmental objectives (*miljömål*) in planning[11]. These objectives are e.g. "good built environment" (*god bebyggd miljö*), assuming consideration of the abovementioned public interests in planning, and "non-toxic environment" (*giftfri miljö*), promoting the environment free of toxic substances. In Sweden, municipalities (*kommuner*) historically have a planning monopoly, i.e. spatial plans are formulated, approved and adopted on the local level. The municipal planning monopoly was established by the Town Planning Act (*stadsplanelagen*) of 1907 which was substituted with the Planning and Building Act (*plan- och bygglagen*) of 1987, most recently revised in 2011. Planning is therefore carried out at the local level by municipalities with consideration of the national interests defined at the national level, and secured, promoted and coordinated at the regional level by the County Administrative Boards (*länsstyrelser*).

Similar to Belgium, the Government of Sweden (*Regering*) has no planning competence. However, there are a number of governmental agencies which define national interests (*riksintressen*), directives (*föreskrifter*), and guidelines (*allmänna råd*) that must be considered in planning. Control over the implementation of national policy in planning is done by 21 County Administrative Boards at the regional level through their supervision of the 290 municipalities. The National Board of Housing, Building and Planning (*Boverket*) monitors the function of the legislative system related to planning, management of land and water resources, urban development, building and housing. In respect to planning, the National Board of Health (*Socialstyrelsen*) issues recommendations regarding e.g. noise levels, ventilation and indoor air quality. Both authorities are administered by the Ministry of Health and Social Affairs and supported by Advisory Boards consisting of delegates who are commissioned by the Government. The Swedish Transport Administration (*Trafikverket*) develops long-term plans for the transport system on roads, railways and by sea and air. The Swedish Energy Agency (*Energimyndigheten*) works to increase the use of renewable energy, improved technologies, a smarter end-use of energy, and mitigation of climate change. Both *Trafikverket* and *Energimyndigheten* are administered by the Ministry of Enterprise, Energy and Communications. By starting the development of nuclear power and hydro power in the 1970s and bioenergy in the recent decade, Sweden has minimized the dependency on imported fossil fuels. The heating sector, to a large extent through district heating, is practically fossil fuel free as a result of the increased use of biomass and heat pumps. In the electricity sector the main sources of energy are also hydro power and nuclear power, as well as wind power. Through the Municipal Energy Planning Act (*lagen om kommunal energiplanering*) of 1977, the State has obliged municipalities to develop separate plans for the supply, distribution and use of energy. The Swedish National Heritage Board (*Riksantikvarieämbetet*), under the auspices of the Ministry of Culture, monitors legislation and disseminates information related to archeology, protection and preservation of cultural heritage and the historic

[11] http://www.miljomal.se/sv/Environmental-Objectives-Portal/

environment. The Swedish Environmental Protection Agency (*Naturvårdsverket*) administered by the Ministry of the Environment oversees environmental conditions and environmental policy and is, in particular, responsible for soil protection and inventory of contaminated sites.

Similar to the Netherlands and Belgium, The Government has also commissioned governmental expert bodies to support and advise the County Administrative Boards and municipalities on the relevant issues. The Swedish Geotechnical Institute (*Statens geotekniska institut*), SGI, is a geotechnical and geo-environmental research institute, which is responsible for geotechnical issues, e.g. relating to landslides and coastal erosion. The know-how of SGI is available for many sectors of society and comprises land use planning, foundation engineering and the technique of soil reinforcement, slope stability, ground energy, polluted land and sediments, re-use of by-products, and field and laboratory investigations. The Geological Survey of Sweden (*Sveriges geologiska undersökning*), SGU, is the state agency for issues relating to geology and hydrogeology. SGU promotes the use of geological information in planning and issues the permits for mineral exploration and extraction under the Mineral Act (*minerallagen*) of 1991.

In Sweden, regional planning is only undertaken for the Stockholm and the Gothenburg (*Göteborg*) regions. The Stockholm County Council (*Stockholms län landsting*) and the Gothenburg Regional Association of Local Authorities (*Göteborgsregionens komunalförbund*) are bodies responsible for regional planning in the respective region. Under the Planning and Building Act, the regional plan (*regionalplan*) is neither compulsory for the regional planning bodies nor legally binding for municipalities, thus only considered as guidance if adopted. Furthermore, only three regional plans were ever adopted in Sweden, all of them for the Stockholm County (Johnson, 2013). In the Gothenburg Region, regional planning is carried out without formal regional plans. Although municipalities (local level) have a planning monopoly, their planning decisions are strongly influenced on the regional level by the County Administrative Boards. During the consultation phase (*samråd*) in a planning process, these Boards coordinate and advise the municipality on national interests, environmental quality standards (including soil remediation), shore protection, inter-municipal issues, issues concerning health, safety, flooding and erosion. In the exhibition phase (*utställning*) of the local plans, the Boards issue examination statements (*granskningsyttrande*) that communicate the aspects which were advised on during the consultation phase. This examination statement is advisory for the municipality but may serve as a ground for appeal (*besvärshänvisning*) by affected parties (e.g. property owners, neigbouring municipalities) if it is not taken into consideration in the legally binding planning decision. The content of the adopted binding plan can be contested by appeal to the County Administrative Boards, whose decisions in turn can be contested to the Land and Environmental Higher Court (*Mark- och miljööverdomstolen*), and ultimately to the Supreme Court (*Högsta domstolen*). The Boards, for their part, can review municipal decisions if the issues raised in the examination statement were not addressed.

In Sweden, as already mentioned above, the Planning and Building Act establishes a municipal planning monopoly providing municipalities with a hierarchy of planning instruments: (*i*) the comprehensive plan (*översiktsplan*) which covers the entire geographical area of the municipality and constitutes legally non-binding development intentions of a municipality; (*ii*) the detailed plan (*detaljplan*), a legally binding plan that regulates development projects; (*iii*) special area regulations (*områdesbestämmelser*) e.g. on recreational amenities, communication routes, restricted areas and safety zones, and comprising legally binding land and water use restrictions; (*iv*) the building permit (*bygglov*) for erection of new buildings and alteration of old ones; (*v*) the demolition permit (*rivningslov*) for complete or partial demolition of the old buildings; (*vi*) the site improvement permission (*marklov*) for excavation/landfill that considerably alters the height of the ground, for tree felling and timber stands' establishing.

The detailed plans should comply with the comprehensive plan which in turn should comply with the regional plan (if any). Development of both the comprehensive plan and the detailed plan includes a series of consultations (*samråd*) of the municipality with the County Administration Board, neighboring municipalities, the public and other stakeholders. The municipality documents received comments in a consultation report (*samrådsredogörelse*) and declares its own position on the issues raised by other actors and stakeholders. During the consultation phase, environmental assessment (*miljöbedömning*) of the comprehensive plan is compulsory under the Environmental Code (*miljöbalken*) of 1998 but not so for the detailed plan. The environmental assessment process results in documentation of EIA (*miljökonsekvensbeskrivning*). EIA is performed for the detailed plan only if the municipality judges after screening (*behovsbedömning*) that the proposed development may cause substantial environmental impact (*betydande miljöpåverkan*). The EIA is often carried for the detailed plans which assume development of contaminated sites (LÖ, 2013)[12]. The EIA is usually carried out by the municipality in consultation with the County Administration Board and the neighboring municipalities. The results of an EIA are filed and presented together with the consultation report (*samrådsredogörelse*) and the proposed plan during the exhibition phase (*utställning*) giving the opportunity to interested parties to leave further comments.

Similar to the Netherlands and Flanders, public consultancy on the plan takes place also in Sweden before approval. Reformation of the planning system in 1987 has led to more communicative land use planning processes allowing communities to participate in decision-making and appeal the municipal decisions. Under this Act, the municipality is responsible for communication of planning intents, proposals, revised drafts and final plans to the public. In contrast to detailed planning, the comprehensive planning process includes the minimum level of citizen participation. During the consultation phase, the proposals for detailed plans are usually presented on screens in the town hall or equivalent. Further, the municipality presents the results of the exhibition phase on the municipal billboards and in local newspapers (Hedström and Lundström, 2013). During both the consultation and the exhibition phases, all interested stakeholders can comment on planning proposals. The comments are documented in reports (available to the public) providing the reasoning if the raised issues were not adressed. The content of the detailed plan can be appealed to the County Administration Board. However, since the comprehensive plan is not legally binding, it cannot be appealed but the residents can express dissatisfaction with the planning process, initiating a local appeal procedure (*kommunalbesvär*) under the Local Government Act (*kommunallag*) of 1991.

[12] http://www.ebhportalen.se/ebh/SiteCollectionDocuments/Fysisk-planering-EBH/Fororenade-omraden-i-fysisk-planering.pdf

In Sweden, the advisory comprehensive plans are reviewed each five-six years. The binding detailed plan is stipulated by the time of implementation (*genomförandetid*), usually 5-15 years (Hedström and Lundström, 2013). In contrast to the Netherlands and Belgium, all the plans, except for the regional plan of the Stockholm region, are developed, approved and adopted at the local level. However, concessions from the Government are needed for extraction of minerals (the Mineral Act of 1991), and such permits are granted on the national level. Moreover, archeological and soil remediation procedures are coordinated on the regional level.

In Sweden, urbanization started to take off after the 1930s and today 85 per cent of the population lives in urban areas[13]. In international comparison, the major cities are still quite small except for Stockholm. During the process of urban growth, dense townscapes have changed into low density urban landscapes that surround the historic cores. Through zoning, the urban landscape is typically separated into large districts of housing, industry, retail, leisure and education. Two thirds of the Swedish population live in buildings that are less than fifty years old (Nyström in Guinchard, 1997). As in many European cities, buildings and site layouts developed in the sixties follow modernist planning principles based on access to sunlight natural surroundings and traffic separation, and resulting in peripheral tower blocks in park like settings. The road, the open landscape and the shopping centre replaced the street, the city park, and the square. During this period – between 1965 and 1974 - one million houses were built with as aim affordable houses for everyone, a period known as the 'Miljonprogrammet'. However, Sweden also has a strong tradition of one-family housing and the same time period saw an extensive expansion of single housing, not least for the working class households. In the 1970's and 80's a strong public opinion came up against the Miljonprogrammet only giving priority to basic human needs as health and shelter while ignoring such aspects as social cohesion and liveability (see Section 5.1.1 for description of these aspects). In the nineties, a system shift has occurred in the housing policy phasing out state loans and housing subsidies for municipal housing companies (MHC) (Bengtsson, 2013). Furthermore, the decade following 2000 is characterized by sales of MHC and MHC estates, a strong trend towards transition from private and public rentals to tenant ownership cooperatives, and an abrupt decline in production of rental dwellings by municipalities because of the cut in state aid for housing (Bengtsson, 2013). This has led to a shortage of municipal rental dwellings in cities, e.g. Stockholm and Gothenburg. Therefore, from 2000 to nowadays the supply of housing in Sweden has been strongly dominated by private developers who, in contrast to municipalities, have financial resources for plan realisation and construction. The housing provision role of the municipality has thus shifted from production of public rentals to production of the plans aiming at both (1) maximizing the policy and development outcomes for the community, and (2) attracting investments from the private developers into plan realisation. Furthermore, being in line with the EU competition law, the revised Rental Act (*hyreslagen*) and a new Law on Municipal Housing Companies (*lag om allmännyttiga komunala bostadsaktiebolag*) which came into force in 2011 stipulate a formal transition of the MHC from a cost-based to a business-oriented model that follows trends in the property market.

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 was revitalized into working and living environments, which became popular among small households

[13] http://www.scb.se/sv_/Hitta-statistik/Artiklar/Urbanisering--fran-land-till-stad/

and professionals. Today, this interest in the city core is seeing yet another revival. All in all, one can see two main groups of people in Sweden today. The “new agrarians” who want to live close to nature and the “new urbanites” who want to live in the city centre close to all the facilities a city could offer. (Nyström in Guinchard, 1997) The last group can be seen as a main target group for the redevelopment of centrally located brownfields. The former brownfield of Hammarby Sjöstad 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 The urban redevelopment process

There are different ways to describe the different steps in redevelopment projects (Maring et al., 2013). Here, we have chosen to structure a typical urban redevelopment process as consisting of four phases: (i) Initiative, (ii) Plan, (iii) Realisation, and (iv) Maintenance (VROM, 2011; Verburg and Dam, 2004). The Initiative and Plan phases are considered to be part of the Planning process, whereas the Realisation and Maintenance phases are part of the Implementation process (Figure 3-1). Although these phases are in different degrees integrated or separated, this division serves to symbolise the planning on the one hand and the actual implementation of the plan on the other hand. Christensen (2014) uses a similar division into events over time to describe the urban development process from a value change perspective: concept development, the planning process and permits, the preparation of land, the construction of buildings and the sale, rent or use of the area.

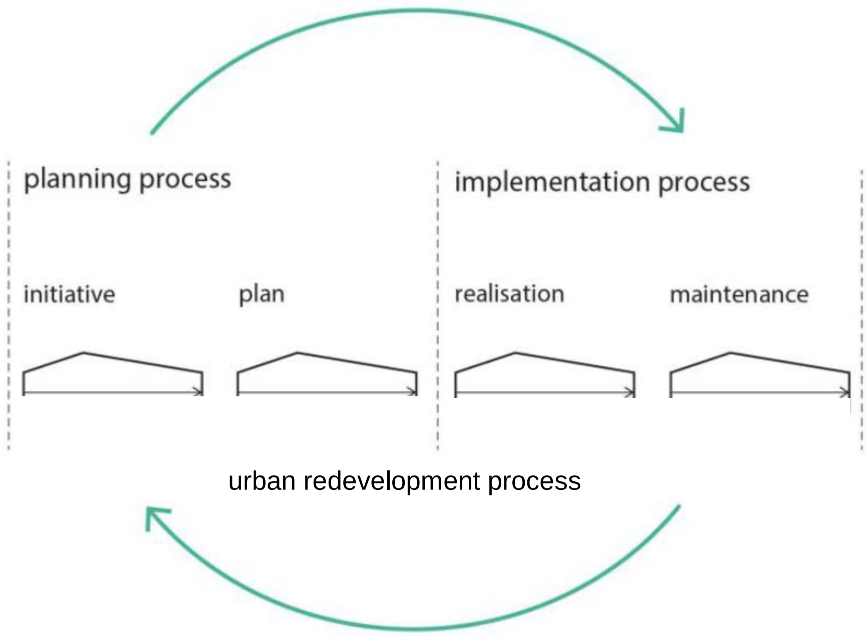

Figure 3-1. The urban redevelopment process. Illustration by F. L. Hooimeijer, drawn by Janneke van der Leer, ©Chalmers University 2015.

Although most articulated in the plan phase, each of the four phases in Figure 3-1 can generally be described as having two modes: opening up the field of choice to secure that as many relevant options as possible are included as basis for consideration (diverging) and narrowing down this field of choice through various types of decisions (converging) (Friend and Hickling, 2005). The diverging mode is thus an exploratory process to identify project options and defining system boundaries for the decision to be taken while the converging mode reduces complexity to allow for progression through the redevelopment process. The further the work is taken in each phase, the more focused the process gets as a result of choices and assessments made along the pathway (Friend and Hickling, 2005). At the end of each phase decisions are taken which allow launching the process into the following phase (Table 3-1). However, this is not usually a linear process since iterations between the phases happen often, especially so in existing urban areas, where maintenance of real estate is not the end but the starting point in the redevelopment process.

Table 3-1. Types of decision relevant in different phases of the redevelopment process (based on VROM, 2011; REVIT, 2007; Friend and Hickling, 2005; RESCUE, 2005; Verburg and Dam, 2004).

REDEVELOPMENT PHASE	DECISION ON
Initiative	Redevelopment vision
Plan	
Shaping/defining	System boundaries and program of demands
Designing	Urban design options
Comparing	Selection criteria and ranking of alternatives
Choosing	Redevelopment plan
Realisation	Remediation strategy Contractors and suppliers Quality assurance and certification
Maintenance	Monitoring Service-providers

As can be seen in Table 3-1, the plan phase consists of four steps of decision-making: shaping/defining, designing, comparing and choosing (Friend and Hickling, 2005). The former two of these steps open up the planning process and the latter two narrows it down.

The formal decision-making procedure is dictated by the regulatory setting and the institutional organization within which the decision is to be taken. There is often a difference between the legislation applicable in the planning process and in the realisation process, i.e. regulations and actors differ. The decision processes in the remediation sector are different compared to the urban planning sector. In urban planning, focus is more on mediating between different interests to reach an optimal solution (Friend and Hickling, 2005), whereas in e.g. soil contamination issues, there are often strict guideline values to comply with (see e.g. SEPA, 2009a).

4 Subsoil management

For the management of the subsurface, several planning instruments have been developed in the Netherlands, but none in Sweden and Flanders. Dutch national interests in the subsurface will be arranged in the National Spatial Planning Strategy for the subsurface STRONG. For other subsurface functions the provinces or municipalities will be responsible. However, the national government will facilitate the regional-local authorities by the development of decision frameworks, and making data and information available.

4.1 The Netherlands

Dutch National Spatial Planning Strategy for the subsurface STRONG

The National Environmental Policy Plan of 1997 stated that all sites with soil pollution should be known before 2005 and that all sites with serious risks shall be controlled prior to 2030. The Ministry of Infrastructure and the Environment (MinIE) is responsible for the organization of the soil remediation operation. Together with MinIE is also responsible for preparation of the National Spatial Planning Strategy for the subsurface STRONG. STRONG covers both deep and shallower subsurface[14] and is instigated by the fact that in the Netherlands the subsurface is being used more and more for different functions and the aspect of spatial relevance related to the subsurface is becoming of importance. In the fourth National Environmental Policy Plan, published in 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*).[15]

In May 2007 the INSPIRE EU-Directive entered in force, establishing an infrastructure for spatial information in Europe (among which: soil) to support Community environmental policies and policies or activities which may have an impact on the environment.[16] Following INSPIRE, soil information (not soil quality) are centrally being administered and enclosed in the Dutch Basis Registration Subsurface (BRO, in progress).[17] DINO and BIS give data and information (maps, services) for respectively deeper and shallow subsurface and will be integrated in BRO.[18]

Future developments in Dutch soil policy are summarized in Box 4.1.

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[14] www.rijksoverheid.nl/onderwerpen/bodem-en-ondergrond/ruimtelijke-ordening-ondergrond 23 January 2014

[15] www.bodemrichtlijn.nl/Bibliotheek/beleid/beleid-van-centrale-overheid/landelijk-beleid/beleidsblad-beleidsbrief-bodem

[16] www.inspire.ec.europa.eu/

[17] www.broinfo.nl/

[18] www.dinoloket.nl/ and www.wageningenur.nl/nl/Expertises-Dienstverlening/Onderzoeksinstituten/Alterra/Faciliteiten-Producten/Bodemkundig-Informatie-Systeem-BIS-Nederland.htm

Box 4.1. Future developments in Dutch soil policy (Lamé and Maring, 2014).

At the moment the Dutch environmental regulation and legislation is being transformed with the objective to facilitate spatial development by simplifying and combining many existing acts and decrees. As a consequence most of the Environmental Management Act (in total 15 existing laws) will be integrated in the Environment and Planning Act. Expectations are that the Environment and Planning Act will be empowered in 2018.

Currently, the major responsibility for soil is being decentralized. With a covenant (2010-2015) between the state government, provinces, municipalities and water authorities ambitions were formulated concerning remediation and sustainable use of the subsurface. Arrangements were made to reach these goals together. With the covenant, the major responsibility for soil is decentralized. A succeeding covenant is now being prepared and will be effective in 2016. One of the ambitions of the new covenant is to involve the private sector in the new arrangements.

The transition in soil regulation can be divided in two main streams:

1. Taking charge of the remediation operation

In the first covenant period, many sites are investigated and remediated, including most of the urgent sites. The next step is the management phase, aimed at contaminations that cannot be excavated, and that have a risk to spread.

This phase focuses on innovative management of these sites, e.g. on the application of different in-situ techniques and area based management of contaminated groundwater.

The link with spatial development is vital to the future of soil remediation in the Netherlands, as new ways of soil usage will initiate additional funding for remediation activities, especially if these can be combined with another land use, e.g. aquifer thermal energy storage (ATES). Soil remediation unrelated to spatial development is becoming redundant and is replaced by area based sustainable soil management.

2. Using the possibilities of the subsurface

Objective of the amendments is to focus on the sustainable use of the subsurface. This means that the use of the subsurface cannot be seen separated from spatial developments and societal challenges such as climate, energy, (ground)water and economic developments. The covenant addresses different functions of the subsurface. Themes such as sustainable use of resources (e.g. strategic groundwater resources) and energy (shale gas, effects of gas winning, soil energy) are topics of interest.

Because not all aspects can be arranged on the local or regional level, strategies are being prepared on the spatial planning of the subsurface. In 2012 this was done for subsurface pipes. In 2013 the national government started, in cooperation with local and regional governments, the preparation of a national strategy for the subsurface “STRONG”. In STRONG decisions will be made with respect to spatial planning with a national interest. It also should help local or regional governments to make decisions on spatial planning, both in urban and rural areas. The STRONG is planned to be ready in 2015. A strategy for shale gas (also expected 2015) will be an integral part of STRONG.

The envisaged transitions will involve different governmental organizations as well as private parties and research organizations. This collaboration aims to come to agreement on the use of the subsurface, the generation of knowledge and the necessary financial arrangements. Final objective is the implementation of sustainable use and management of the subsurface in daily practice.

Dutch Provincial Soil Visions

The first soil vision by the Province Zuid-Holland 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, a new Structural Vision was presented in 2014. This new policy document completely integrates 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 Figure 4-1). There are two main strategies: (1) soil use should be renewable, and if not possible, at least it should be manageable, (2) all uses should be acceptable. All Provinces have made soil visions[19] and several provinces are or have been working on a provincial Structure Vision.

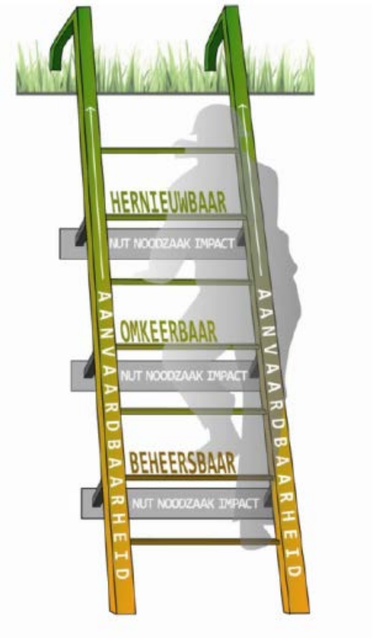

Figure 4-1. The Dutch "Bodemladder".

4.2 Flanders (Belgium)

The Ministry of Economic Affairs and the Belgium Geological Department are authorities at the national level responsible for soil management. The Flanders Department for the Environment, Nature and Energy (*Departement Leefomgeving Natuur and Energie*) is responsible for soil protection and remediation. OVAM (*Openbare Vlaamse Afvalstoffenmaatschappij*) is responsible for handling soil contamination issues. LNE-ALBON is responsible for the issues regarding the deeper subsurface[20]. *Vlaamse Milieumaatschappij* (VMM, Flanders Environment Agency)[21] is responsible for the issues related to the environment, water and health. The Flemish soil remediation decree drawn up in 1995 and updated in 2006 is the main legal document regulating soil remediation and protection. The headline of the Flemish soil policy is that all historical soil pollution has to be treated by 2036 and that all new pollution has to be prevented or be treated immediately. In Flanders, a lot of soils were contaminated by former uses (e.g. industrial activities). Because soil pollution poses a threat to both public health and ecosystems, the Flemish region has introduced in 1995 the soil remediation decree. The most essential topics in the decree are the land information register, the soil certificates and remediation. The land information register gives an overview of the contaminated sites in Flanders. Anyone who has intention to transfer land must have a soil certificate. The soil certificate informs and protects the

[19] An overview (in Dutch) of all provincial soil visions from 2009 can be found on: http://www.expertisebodemenondergrond.nl/upload/documents/Platform%20Bodembeheer/archief/overzicht_posters_visies.pdf

[20] www.lne.be/themas/beleid/mina4/leeswijzer/themas/bodemverontreiniging 10 April 2014

[21] www.lne.be/organisatie/structuur/afdeling-land-en-bodembescherming-ondergrond-natuurlijkerijkdommen

buyer by providing all relevant information available on the land parcel in the land information register (previous investigations performed on the site). A soil investigation is required for the ownership transfer of a risk area. Different phases are foreseen in the process: a preliminary soil investigation, a descriptive soil investigation, a soil remediation project and soil remediation works. If the preliminary soil investigation indicates a soil or groundwater contamination, OVAM orders a descriptive soil investigation. A distinction is made between historical (before 28 Oct 1995) and new contamination (after 28 Oct 1995). For historical contamination clean-up is required if a serious risk can be expected and clean-up will be scheduled according to priority. For new contamination, immediate clean-up is required if standards are exceeded. The investigations and the remediation are conducted by an authorized soil remediation expert. OVAM can decide ex-officio to conduct a descriptive soil examination, land remediation or other measures if the operator, user and owner of the land is not bound or not able to conduct a descriptive soil examination or remediation. Priority will be given to projects with a societal added value and high-risk contaminated sites. The rules governing the use of excavated soil has the objective to control the spread of enriched or contaminated soil and is also part of the soil remediation decree.

The new soil remediation and protection decree together with the adapted VLAREBO[22] (Order of the Flemish Government establishing the Flemish regulation on soil remediation and soil protection) entered into force on 1 June 2008 and focusses not only on soil remediation but also on soil protection (preventive measures). The curative part (soil remediation) builds on the principles of the previous decree. A proactive and project-based approach is central to the approach of potentially contaminated soils (mainly former landfills or industrial sites) which is currently in a residential zone.

In the search of alternative financing instruments for soil remediation, priority was given to the creation of sector funds. The preventive part on soil protection constitutes a framework with tools for a good protection policy based on the environmental permit conditions, adjustments of the infrastructure to protect the soil against new soil pollution and other measures already taken or yet to be taken measures to prevent new soil pollution. It aims to protect the soil against pollution and disruption, and to safeguard the valuable soils. The protection of soil against pollution aims as much as possible to preserve the target values for soil quality. These target values are laid down by the Flemish Government and meet the levels of pollutants or organisms on or in the soil, that are found as normal background values in not polluted soils with similar soil characteristics.

Recent updates for soil remediation

For mixed soil contaminations for which various players have a clean-up duty, a joint approach is stimulated. In case of a so-called 'complex contamination', the pollution is created in different periods and/or on different grounds, after which the pollutants are mixed. Multiple parties are responsible for the remediation, but it is technically not possible to determine exactly who is responsible for which part of the pollution. If these parties do not come to an agreement or solution, OVAM can formally qualify a site as

[22] Decree on soil remediation and protection and VLAREBO - https://nnavigator.emis.vito.be

a 'mixed soil contamination' and the financing is done on the basis of a distribution key determined by OVAM.

Brownfield decree (2007)

The redevelopment of brownfields is stimulated through an accelerated implementation of the ex-officio approach and this within the means of the brownfield Decree. More active involvement of the municipalities in the redevelopment of brownfields is provided by the financial support in the framework of the environmental cooperation agreement.

The Flemish Government stimulates and facilitates the redevelopment of brownfields by a brownfield covenant. In a brownfield covenant agreements are made between the Flemish Government, the project developer and/or land owner, investors and other authorities involved and this in such a way that at the start of the brownfield project there is clarity about certain temporal and procedural requirements and expectations. The brownfield covenant promotes the cooperation and synergy between the various project stakeholders and also provides some financial and tax benefits for redevelopers. The Flemish Government regularly publishes calls in the Belgian Official Journal which allows parties to apply for a brownfield convenant for a specific site. The Brownfield decree is very small and can only work because its reliance on other existing and adopted legislation for soil and spatial planning etc. In line with the provisions of the brownfield Decree of 30 March 2007, the Flemish Government of 21 March 2008 has established a ‘brownfieldcel’ (i.e. board advising Flemish Government about the admitted projects, the negotiations, closing of the covenants and the follow up of some projects). This ‘brownfieldcel’ consist of representatives of the various Flemish administrations which are involved in brownfield projects: leading officials responsible for department of economy, soil and waste agency and spatial planning department; 2 experts, 3 negotiators and Enterprise Flanders (process manager, administrative support and secretary).

Other subsurface aspects

Archaeology Protection Decree of 1993 protects archaeological remains in the soil. Since 2009, the cables and pipes in the subsurface are protected by decree of the Flanders region. A special permit is needed for excavation works. Application must be filed in a plan proposal at the KLIP (*Kabels en Leidingen Informatie Platform*), i.e. the information platform for cables and pipes that has over 300 members[23].

4.3 Sweden

Swedish soil policy is narrowed to deployment of “non-toxic environment” (*giftfri miljö*) strategy promoted in one of the Environmental Objectives (*miljömål*)[24]. The

[23] www.beleidsplanruimte.be] and http://www.ruimtelijkeordening.be/
[24] http://www.miljomal.se/sv/Environmental-Objectives-Portal/Undre-meny/About-the-Environmental-Objectives/4-A-Non-Toxic-Environment/

“non-toxic environment” objective advocates no man-made or extracted substances in the environment and aims to damp negative effects of non-naturally occurring substances on human health and biological diversity. In Sweden, soil quality standards are developed to handle three types of risks posed by contaminants in the soil: (1) human health risks, (2) risks to the soil environment, and (3) risks with regard to contaminant spreading to surface water and groundwater (SEPA, 2009a). The lowest contaminant concentration value among acceptable levels for the three risk types is used as a guideline value in a remediation project. Being typically the lowest, values for protection of the soil environment are often used, although the sites after soil treatment are planned to be utilised for construction purposes (Lundgren et al., 2006). Risks posed to the soil environment are usually assessed by screening contaminant concentration in the soil and comparing them to guideline values derived from Species Sensitivity Distribution (SSD) models (Swartjes et al., 2012), which are statistical dose-response models. In contrast to ecological risks assessment employed in the Netherlands, contaminants in both the topsoil and the soil at larger depths are considered to pose risks to the soil environment. Although the upper 2 m are specified as having impact on the soil functions (SEPA 2006), protection of the soil environment (*markmiljö skydd*) at large depths (deeper than 2-3m) is a common management practice for contaminated soils in Sweden.

In Sweden, there is no special law related to soils. During the planning process the information on soil and groundwater contamination is limited to the national inventory of contamination sites (MIFO, 1999).The Environmental Code (*miljöbalken*) applies to the issues related to soil contamination. However, there is no clear link between the Environmental Code and the Planning and Building Act with regard to development of contaminated sites (Swedish National Board of Housing and SEPA, 2006). Furthermore, different authorities are responsible for planning and soil remediation, which complicates redevelopment of brownfields. Figure 5-2 shows an overview of the coordination between the spatial planning stages and the stages in management of contaminated sites in Sweden, and in which stages the coordination is not straight-forward. When developing the detailed plan for the contaminated sites, it is important to (1) explore the contamination situation at the site e.g. previous investigations; (2) initiate EIA if screening (*behovsbedömning*) identifies that the proposed development of the site may cause substantial environmental impact (*betydande miljöpåverkan*); (3) evaluate whether the soil and groundwater quality complies with environmental quality norms for the intended land use by assessing the risk posed by contaminant to human health and the environment; (4) investigate possibilities for reduction of the identified risks; (5) develop a planning strategy considering the identified risks; (6) set the requirement for remediation and/or implementation of protection measures in the plan description; (7) ensure remediation and/or implementation of protection measures by imposing requirements in the detailed plan itself or the exploitation agreement (*exploateringsavtal*) with a developer (LÖ, 2013).

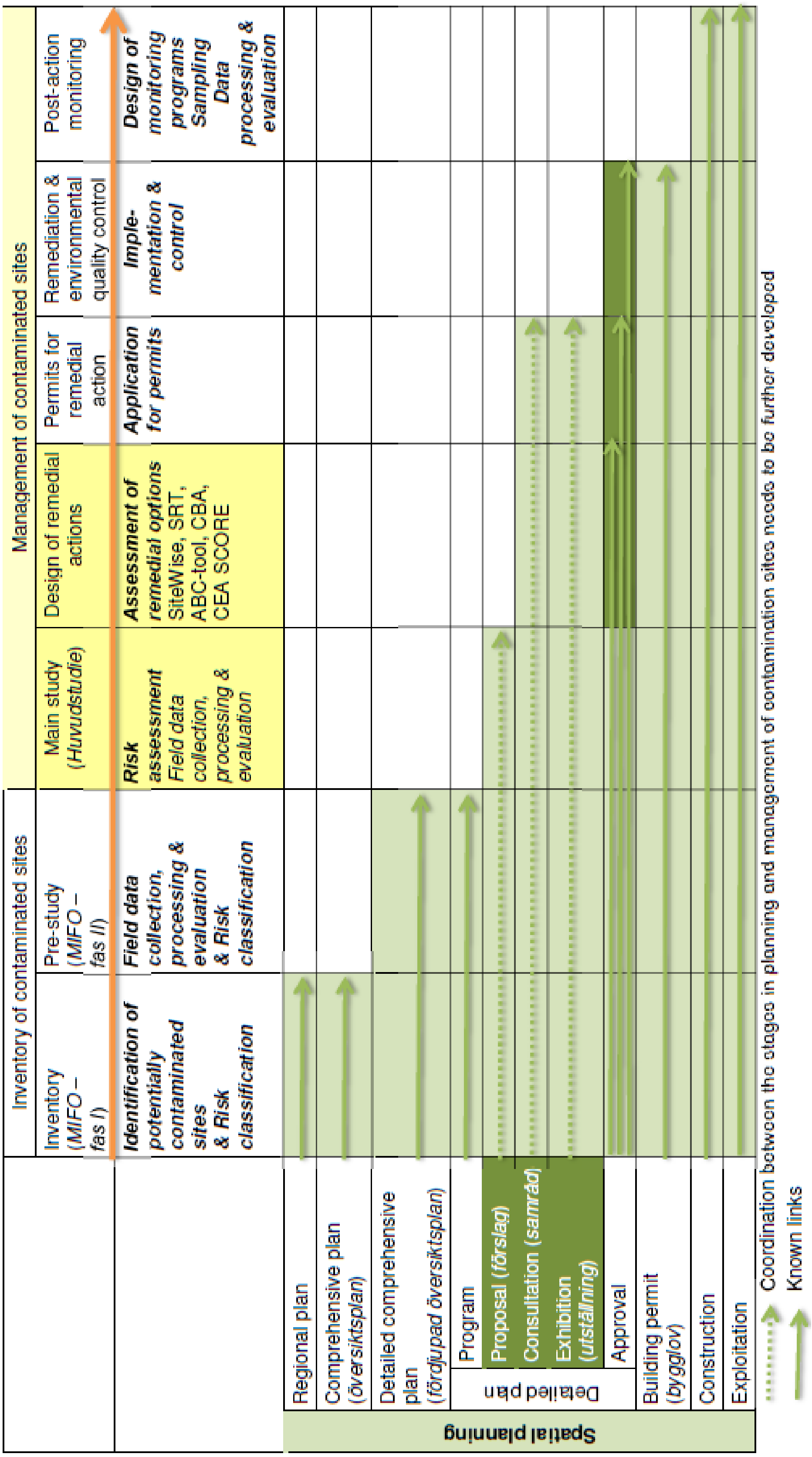

Figure 4-2. Coordination between the stages in planning and management of contaminated sites in Sweden (modified after Ulf Ranhagen: NV, 2006). MIFO: the national inventory of contamination sites.

Management and use of the subsurface are regulated by law. Legislation related to the subsurface can be divided into four groups: (*i*) “soil and groundwater quality” regulated by the Environmental Code; (*ii*) “archeology” regulated by the Heritage Conservation Act (*kulturmiljölagen*) of 1988; (*iii*) “use of natural resources” regulated by the Water Act (*vattenlagen*) of 1983, the Mineral Act (*minerallagen*) of 1991, the Peat Deposits Act (*lagen om vissa torvfyndigheter*) of 1985, and the Continental Shelf Act (*lagen om kontinentalsockeln*) of 1966; and (*iv*) “underground installations” regulated by The Pipelines Act (*rörledningslagen*) of 1978, the Water and Sewerage Act (*lagen om allmänna vatten- och avloppsanläggningar*) of 1970, the Public Heating System Act (*lagen om allmänna värmesystem*) of 1981, the Electrical Installations Act (*ellagen*) of 1985, and the Telecommunication Ordinance (*teleförordningen*) of 1985. Extraction of ground water is regulated by the Water Act. The Swedish sewerage system is in responsibility of the municipality but under the Public Water and Wastewater Plant Act (*lagen om allmänna vattentjänster*) of 2006. The water protection zones are regulated by the Planning and Building Act.

The Planning and Building Act provides guidance on the planning process on the land surface, but offers little support with regard to the subsurface. The Act e.g. states that an underground structure should be designed in such a way that it does not interfere with the land use at the surface (2Ch.8§). However, the value and sustainable use of underground space is today not effectively taken into consideration in the planning process in Sweden. Different responsible bodies hold various thematic maps for different subsurface aspects, e.g. hydrogeology, geology, archaeology. The available subsurface information is not systematically treated in the planning process (Norrman et al, 2015). Some underground civil constructions are classified as confidential, thus limiting open access to crucial subsurface information in the planning process. However, the archeological procedure is well-established and carried out by the County Administration Board in the initiative and plan phases of the development process (see Garção, 2015).

4.4 Best practice of integrating subsurface aspects in urban redevelopment

There is best practice on sectoral integration of different subsurface aspects, and there are examples of sustainable development that includes the subsurface in a secondary way. For example, the municipalities of Arnhem, Deventer and Maastricht in the Netherlands have municipal visions on the subsurface. There are many municipalities who have a focus on the subsurface as part of water management, or energy management (TTE, 2010). The area development of Lanxmeer (Culenburg), is a small scale, self-organized, sustainably conceptualized and internationally recognized example where social and urban quality is interwoven with smart development with nature (Figure 4-3). Here, permaculture as “a living environment that demonstrates the diversity, stability and resilience of natural ecosystems and creates conditions for social environments and conscious life-styles” is the steering perspective (quote by Kaptein from Woolthuis and Hooimeijer, 2013). The soil plays a self-evident part of this permaculture. Lanxmeer is a case in which collaboration (also for knowledge exchange) played a very dominant role. From the conception until the final realization, its development was a bottom-up ideological endeavour to create a permaculture village. After building a solid advocacy coalition with an interdisciplinary group of experts for the vision in 1995, an innovative consortium was formed of companies, (landscape) architects, urban designers, developers, energy companies, Water Board Rivierenland, Polder District, a waste water treatment company, and the (future) residents. All these stakeholders came in with their own interests and skills, making it a complex process of co-creation. Specialists wanted to develop and apply their knowledge, residents wanted to live in harmony with nature, and companies wanted to develop Lanxmeer as showcase.

Figure 4-3. Lanxmeer (Copijn).

In Sweden, Hammarby Sjöstad[25] is a well-known example for sustainable urban development and one of the first eco-friendly areas in Europe. The core of the environmental and infrastructural planning of Hammarby Sjöstad was jointly developed by Stockholm Water Company, Fortum and the City of Stockholm Waste Management Administration, and can be summarised in an eco-cycle model known as the Hammarby Model (see e.g. Pandis Iveroth and Brandt, 2011). The model explains the interaction between sewage and refuse processing and energy provision, as well as the added benefits to society of modern sewage, energy and waste processing systems. The overall goal “twice as good” required new ideas for energy, water, waste, transport, building design and construction site logistics. Here the subsurface does not play a part of the planning process as consciously as in Lanxmeer. The approach is more coming from urban system planning and not so much from a design concept such as permaculture. Another example in Sweden is Västra Hamnen in Malmö[26]. This site was earlier used as port, shipyard and industrial area and the new city district is built

[25] http://bygg.stockholm.se/Alla-projekt/hammarby-sjostad/ Hammarby Sjöstad – a unique environmental project in Stockholm.
[26] http://malmo.se/Stadsplanering--trafik/Stadsplanering--visioner/Utbyggnadsomraden/Vastra-Hamnen-/Om-Vastra-Hamnen.html

according to guidelines on sustainable energy use, green structure, waste solutions and a healthy indoor environment, with the vision that all energy should be locally self-sufficient and renewable. The project is seen as a national representative of sustainable urban development and has become an attraction for field trips and tourists to learn more about smart sustainable solutions.

Although the result of the redevelopment processes in both cases are sustainable/eco-friendly housing areas, the remediation of the sites before the development started has been of traditional excavation character. There was no focus on sustainable remediation strategies for the subsurface. Instead, contaminated soil has been replaced by clean new soil, in Västra Hamnen completely replacing the existing soil eco-systems with new constructed eco-systems (Strand, 2013). As few industrial heritage items are left, identity is created at the sites by the eco-friendly/sustainability concept. Some critics mean that having "ecology" in focus has had the effect that other sustainability aspects have not been considered in the redevelopment process (Strand, 2013).

In Flanders the same practice is recognizable. There are some good projects on sustainability, and also projects in brownfield areas, but even in these projects the focus is limited and sectoral. One of the concepts used in Flanders is the Ecopolis concept, where ecology is taken as starting point. As in the Netherlands, water is a common part of the development and also urban heating systems are popular in projects that are on the list of sustainable projects on the websiste 'DuWoBo'.[27] One of the projects is Den Draad (near Gent) on the site of a former steel cable factory (Figure 4-4). With the motto "Go Brownfield, Not Greenfield" the terrain was remediated and is now rebuilt with a lot of attention on water and biodiversity.

Figure 4-4. Den Draad near Gent[28].

[27] http://www.duwobo.be/index.cfm?n01=praktisch&n02=news&newsID=332
[28] http://www.dendraad.be/

4.5 The System Exploration Environment and Subsurface

This section introduces the reader to the System Exploration Environment and Subsurface (SEES) developed by Hooimeijer and Maring (2012). The method has been used in the three case studies (see Norrman et al., 2015).

In the Netherlands, the “layer approach” with an occupation, network and subsurface layer is currently a popular planning and design approach (see description of the approach in Hoog, Sijmons and Verschuuren, 1998). However, the layer approach was developed as a policy for prioritizing in urban development, not as an analysis, planning or design tool. It is far too abstract also for the use as a “knowledge brokerage tool” to have engineers and urban designers work together to narrow the gap between the “natural” and “human” system. The System Exploration Environment and Subsurface (SEES) is a method which supports and registers the knowledge exchange between experts of different fields. The method gives an overview of the urban system: it relates the "above ground" layers of people, cycles, buildings, public spaces and infrastructure to "subsurface qualities" divided in four themes: civil constructions, water, energy and soil (Hooimeijer and Maring, 2012), see Figure 4-5.

The SEES method is related to the Japanese LEAN thinking that by focusing on quality direct communication, and making and keeping clear appointments and therefore not on impossibilities, avoids mistakes (James and Jones, 1996). SEES is developed on the theoretical background of system approaches and complexity theory. 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. On the other hand the SEES is based on complexity theory to help understand that decision making has a nonlinear character. This results from unexpected behaviour and unforeseen consequences of interaction of agents (Koppejan and Klijn, 2011).

The SEES method is meant to be used in project teams, working on urban development. It guides the dialogue between the representatives of the technical and natural boundary conditions and the aboveground specialists that represent the social-economic requirements. It offers a systematic overview that enables the consultation of all necessary specialists and fields and gives an opportunity to search for clever connections. Because the subsurface is taken into account in the planning process by gathering and discussing all information in a systematic way, it is possible to make smarter urban designs. Smarter urban designs lead to more climate proof (think about the water issue), to energy-saving (soil energy), more sustainable (the identification of cycles) and to cheaper (earlier identification of benefits, problems and costs) designs.

The SEES matrix (Figure 4-5) is filled by project partners and experts from aboveground and subsurface in a half day workshop. The workshop is prepared by the experts, who have checked which themes are of importance in the project location and surroundings. The workshop starts with an introduction on the vision on the development area and maybe, if already done, the plan (usually an urban redevelopment plan). Second step is an introduction on the subsurface themes. Then the inventory of challenges, opportunities, points of attention starts, all points are identified in this scheme and first ideas for solutions or integration in the plan are exchanged. The last step is to connect people from aboveground and subsoil, action points for a follow up are agreed on.

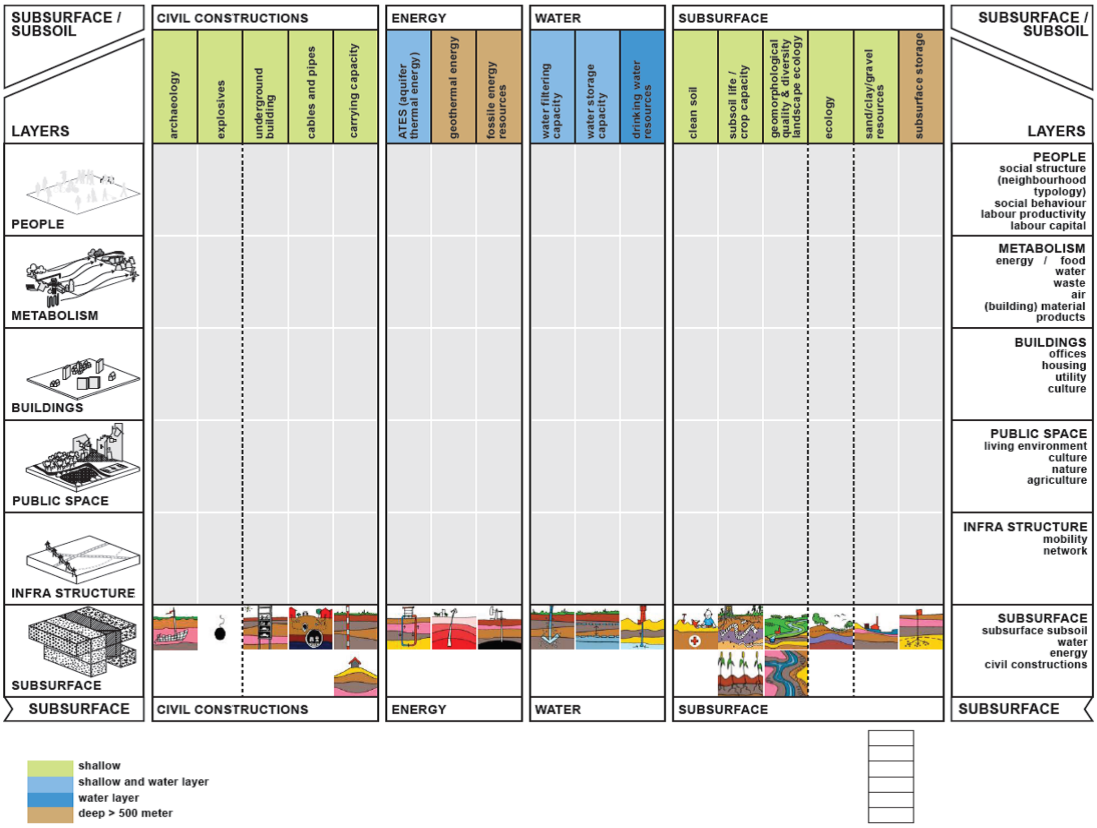

Figure 4-5. The System Exploration Environment and Subsurface (Hooimeijer and Maring, 2012).

5 The 4 P's of sustainability

The concept of sustainability is important both with regard to the execution of soil and groundwater remediation activities and brownfield redevelopment design. "Sustainability" when applied to brownfield redevelopment, involves the balancing and consideration of factors beyond managing, containing and /or removing contamination from the subsurface. The concept of sustainability or sustainable development is derived from the United Nations World Commission on Environment and Development (UNWCED) and its report "Our Common Future" and refers to meeting the needs of the present generation without challenging future generations from doing the same (UNWCED, 1987). The intergenerational time dimension is central to the concept, requiring that the burdens associated with a course of action do not extend into the future, as is the idea of avoiding environmental problem shifting, i.e. by taking care of a problem in one domain, one creates problems in another domain.

Mitigating present and future toxicological risks caused by contaminated land meets the requirement of intergenerational responsibility but may also bring about a shift in impacts from one media to another, or from one scale to another. For example, removing subsurface contamination at the expense of releasing air emissions due to fossil fuel consumption. Sustainable remediation and brownfield redevelopment therefore aims to avoid "trans-medial problem shifting" (Geldermann and Rentz, 2005), typically by balancing three impact categories, referred to as "the pillars of sustainability" (Figure 5-1): environmental, social and economic (SuRF-UK, 2010), or the Triple Bottom Line (UN, 2002 (Johannesburg)): People, Planet and Profit/Prosperity. Remediation and redevelopment scenario sustainability assessment approaches tend to integrate and borrow different impact assessment and aggregation methods to assess alternatives and to compare alternatives against each other. SuRF-UK (2011) presented a list of indicators that was intended to be used as a basis for identifying relevant criteria or impact categories for sustainability assessments of remediation scenarios on a site by site basis.

Figure 5-1. The common three pillars of sustainability representing the three P's of People, Planet and Profit and corresponding to social sustainability, ecological (or environmental) sustainability and economic sustainability.

Also in the built environment, there is an interest for assessing sustainability not only with regard to separate buildings, but increasingly so with regard to urban communities, e.g. BREEAM Communities and LEED for Neighbourhood Development (Haapio, 2012). Yigitcanlar and Teriman (2015) writes that sustainable urban development (SUD) is seen as a panacea to minimise externalities on the environment caused by widespread human activities. On the other hand, Woodcraft (2014) writes that social sustainability has developed as a new strand of discourse on sustainable development as a response to the dominance of environmental concerns and technological solutions in urban development, in combination with a lack of progress in tackling social issues. Already in 2004, Van Dorst and Duijvestein (2004) outlined two visions of sustainability in relation to the built environment as a result of a series of workshops: (1) “A better world” where liveability is the elaboration of “people” and a part of sustainable development, and (2) “A better environment” where environmental quality is in focus and liveability is a precondition for sustainable development. Since there is no single interpretation of sustainable development, they mean that in practice, in the built environment, sustainability becomes limited to themes like “liveability” and “energy efficiency” (Van Dorst and Duijvestein, 2004). Van Dorst and Duijvestein (2004) introduced a 4th P for Project in order to create a link between such different practical themes in operationalising sustainable development in the built environment. This fourth P for project stands for the quality of the built environment, or spatial quality.

In the following, the four P:s of sustainability (i.e. adding that introduced by van Dorst and Duijvestein, 2004) are further explored. The texts are based on other literature sources, and aims to have focus on operationalisation: – What are important features of the different sustainability domains in brownfield redevelopment projects?

5.1 First P: People

Several authors agree that the approach to, and the concept of, social sustainability is fragmented and vague (Vallance et al., 2011; Weingaertner and Moberg, 2011; Murphy, 2012; Cuthill, 2010; Littig and Grießler, 2005; Dempsey et al., 2011). Until now, it seems as if no conclusive definition of social sustainability has been agreed upon, although several lists or sets of aspects or indicators have been developed for a range of purposes (Murphy, 2012). Boström (2012) suggests that the reason for this may be that social issues have been considered of secondary importance since the concept of sustainable development was developed based on environmental sustainability. The social dimension is typically the least understood and approached dimension in remediation projects (Beames et al., 2014).

Vallance et al. (2011) identify three different sub-categories of social sustainability, based on different approaches to social sustainability: i) development sustainability, ii) bridge sustainability, and iii) maintenance sustainability. Development sustainability addresses a broad spectrum of issues ranging from tangible basic needs to less tangible needs concerning e.g. education, employment, equity and justice. It is based on the idea that poverty and under-development act as barriers to securing better social and bio-physical environmental outcomes. Bridge social sustainability on the other hand, explores ways of promoting eco-friendly behavior or stronger environmental ethics in order to build better connections (bridges) between people and the bio-physical environment. Finally, maintenance social sustainability speaks to the traditions, practices, preferences and places people would like to see maintained (sustained) or improved.

Socially sustainable redevelopment of brownfield sites relates to all these three aspects of social sustainability in some sense: development sustainability since redevelopment of brownfields involve looking at people's needs in the future plans of a site; bridge sustainability to lesser degree but potentially as a way of analyzing and improving redevelopment alternatives as to make them more sustainable and decision-makers more aware of various impacts; and maintenance sustainability in that it relates to the local impacts, needs and the stakeholder involvement of a redevelopment project.

In the following, we first outline social impact indicators, i.e. what kind of social impacts should be considered and potentially evaluated with regard to brownfield redevelopment projects. The literature is from remediation literature, urban development and social impact assessments. Secondly, there is a section on participation and learning since those are aspects frequently lifted forward with regard to sustainability issues. We also try to link how participation and learning is connected to social impacts.

5.1.1 Social impact indicators

Social impacts are changes in the well-being of people in communities caused by a given choice of action or policy. In the context of remediation and redevelopment of contaminated sites, social impacts are experienced primarily by those living or working around the site. The impacts can occur both during the operational phases of the remediation and/or redevelopment and after project completion once the site is re-occupied. In other words, social impacts occur throughout the implementation of the remediation and redevelopment project and as a result of the eventual land-use scenario.

At present there are two main approaches to evaluating social impacts (e.g. Magee et al., 2013). The first is a "top –down" approach using quantifiable metrics or indicators determined by experts. The European Environmental Agency applies top-down approaches as measures of progress towards policy objectives designed for promoting employment, combating poverty, improving living and working conditions, combating exclusion and developing human resources (Morford 2007, EEA 2012). The second is the "bottom-up" approach by which indicators are developed in consultation with the stakeholders that stand to gain and/or loose from a project. The two approaches are often combined, where indicators are designed in collaboration between experts and stakeholders.

The top-down approach allows for the automation of decision processes but requires the initial stage of selecting indicators. Inspiration for the definition of these criteria can be found in different fields. Sustainability assessment DSSs specifically for soil and groundwater remediation include a limited set of indicators which focus on the hindrance caused to the local community by on-site operations and the changes in risk levels associated with subsurface contamination. Such tools generally do not include the consideration of post-remediation and redevelopment impacts which are also important in a holistic context. Sustainability indicator sets from other scientific disciplines such as urban renewal and building construction are also relevant to brownfield redevelopment. Such indicators have been included in the development of existing Scenario Appraisal DSSs such as the Mega site Management Tool described by Schädler et al. (2011, 2012, 2013) and the Sustainable Brownfield Redevelopment Tool (SBR) described by Wedding and Crawford-Brown (2007).

Colantonio et al. (2009) make a distinction between spatial and functional measures of social sustainability. Spatial measures refer to the difference between tangible aspects of the environment and spatial design that enhance liveability and serve as a foundation for the less tangible social considerations which support the functioning of civil life, such as social cohesion and community empowerment through human capital. The sustainability assessment module MMT described in Schädler et al. (2013) focuses exclusively on physical attributes of the environment, land-use and spatial arrangement.

Another source of inspiration are Social Impact Assessments. Social Impact Assessment (SIA) is a feature of the Environmental Impact Assessment method, in which the social impacts associated with a policy change or development project can be predicted, evaluated, monitored and managed. A distinction is made between changes in the 'human environment' and changes in 'biophysical environment' (Burdge et al., 1996). The two are inextricably connected, although the scope of the SIA focuses specifically on changes that are defined as occurring in the 'human environment', i.e. changes that impact the lives of individuals and communities and their collective functioning. The goal of SIA is to go beyond simply avoiding negative consequences for communities or a given populace in question, and to maximize the desired policy and development outcomes (Vanclay, 2003). In this sense, SIA allows for both the most desirable alternative to be determined and for the chosen alternative to be optimized.

The general approach to SIA includes two fundamental steps. The first is screening the most detrimental impacts associated with the potential course of action and determining whether an SIA is indeed necessary. The second is in determining the relevant scope of the assessment (Gomez-Baggethun et al., 2013). The scoping step itself includes the identification of all relevant impacts. "Hard" or quantifiable impacts are identified via expert consultation and technical procedures. "Soft" impacts are determined in consultation with stakeholders. Both the approaches are essential in performing an exhaustive assessment of the potential scenarios and project outcomes (Vanclay, 2003; Gomez-Baggethun et al., 2013). Both approaches are used in designing the guidelines and metrics that will be used to evaluate the impacts.

A starting point for the development of case specific guidelines and metrics are the principles laid out by the international SIA communities (Gomez-Baggethun et al., 2013, Vanclay, 2003). The core values include preserving and encouraging social amenity and liveability, social cohesion between individuals and between communities (also referred to as social capital) and the empowerment and capacity building of communities (referred to as human capital) (Vanclay, 2003; 2006). The principles of SIA as defined by the International Association for Impact Assessment are as follows:

- Basic amenities are provided for
- Equity and distribution of impacts
- Vulnerable segments of the community are protected
- Social support networks are not disrupted

- Consideration of collective perceptions and attitudes (Social construction of reality)

Impacts can then be defined as changes that have an influence on these principles. Impacts have the following characteristics. They range in duration and spatial scale and can occur over a long period of time or over a short period of time. Impacts range in spatial scale and can occur over and a larger area or small area. They range in terms of being beneficial on one end of the spectrum to being detrimental on the other end of the spectrum and are therefore either positive, negative or somewhere in-between. They also range in terms of intensity and severity. Different impacts can compound one another causing a cumulative effect or counterbalancing one another. Finally, impacts can cause other impacts. The knock-on effect is referred to economics as multiplier effects. Once all relevant impacts have been defined, it is necessary to determine how they will be measured or taken into consideration.

Based on the above overview, frequently applied social impact indicators can be grouped into three crucial impact categories: Social Cohesion, Human Capital and Livability.

Social Cohesion

Social cohesion refers to a healthy and functioning civil life of a community brought about by positive social interactions, strong interpersonal bonds, communal solidarity and a sense of belonging to the community amongst its members. According to Chan et al. (2006), the social interaction within a socially cohesive society are typified by shared civic values and norms that include trust and a sense of belonging, as well as a willingness to participate in civil life. Broader definitions of social cohesion also include communal attributes such as respect for diversity, reciprocity, co-operation and shared challenges (CCSD, 2000). Social cohesion can be impaired by social exclusion and social conflict arising along societal “fault lines” that are characterized by cultural differences, inequalities or economic disparity (Noll, 2002). From a policy perspective, reducing social cleavages would facilitate a more socially cohesive society (Chan, 2006). From a spatial planning perspective, these cleavages can be made less apparent by arranging diversified residential areas. Vandevyvere (2010) proposes such an indicator under the title “social integration”, however the focus of his work is construction and development as opposed the urban renewal and redevelopment of existing communities. Re-arranging existing communities would not be possible.

Two specific elements of social cohesion have already been looked at in the existing literature, namely: encouraging social interaction through the provision of public meeting places; and the preservation of structures that provide the community with a sense of place. Possible indicators that can be used as a proxy for social cohesion are provision of meeting places that facilitate and encourage positive social interactions and social network building (CCSD, 2000) and the preservation of cultural and historical structures or features of physical location that provide community members with a “sense of place” and therefore a “sense of belonging” (Phillips and Stein 2011) (Chan, 2006). These aspects are intimately connected to the actual urban design of an area, not only land-use in more general terms.

Human Capital

Human capital refers to the marketable skills, employment experience and education accrued and is possessed by members of society that allow them to participate in the labour market and add economic value to an activity. According to Ostrom, the improvement of an individual's human capital is achieved through the "acquisition of new capabilities", whether this is through a conscious effort of improving ones skills, education and training or unconsciously through experience (Ostrom, 2000; Roseland, 2000). Human capital provides a community with the adaptive capacity to mitigate the negative consequences of changes in the economy and therefore sustain itself through changes in the national and regional economies (Parkins and Stedman, 2003; MacKendirk and Parkins, 2004). Human capital is therefore a factor that can help prevent future urban decay. Potential indicators that can be used as a proxy for human capital are the provision of educational facilities and/or opportunities and the creation of local employment opportunities during and after site remediation and development.

Liveability

Liveability and Convenience refers to a standard of human well-being facilitated by the provisioning and positioning of amenities in an urban environment. According to van Kamp et al. (2003), the term "liveability" is often used in descriptions of social indicators but without a universally accepted definition and different users of the term attribute different meanings to the term. Van Kamp et al. (2003) list seven definitions of "liveability" taken from the work of other authors, each with slightly different meanings, although within a general theme of attaining human well-being through the arrangement of human surroundings. Veenhoven is one of the authors mentioned and includes the term "habitability" in their definition (Veenhoven, 1999; Kamp et al, 2003). Therefore "Liveability" can be defined as the degree to which an environment is habitable and in which a certain standard of human quality of life or well-being is brought about by the state of that environment. Two key elements of liveable environments are made reference to in literature are: 1) provisioning of amenities and; 2) positioning in spatial arrangement terms of these amenities, as to make them accessible to community members. This includes for example the provision of space for retailers and green space in locality.

Van Dorst and Duijvestein (2004), who introduced a fourth P for Project in addition to People, Planet, Profit with regard to sustainable development in the built environment, means that this *quality of the built environment* belongs to the fourth P, see further section 5.4.

5.1.2 Participation and social learning

Sustainable development is typically associated with public participation as an important part of social sustainability. Different degrees of public participation can be described across a scale from "informing", or even "manipulation", to "citizen control" (Arnstein, 1969), where information is a type of one-way communication, and citizen control is where citizens themselves manage and decide over some resource (Franzén, 2012). The levels in between can be described as "consultation", "co-thinking", "co-designing” and “decision-making” (Franzén, 2012). Chess et al. (2002) presents a similar scale for public participation from ”authority control” via “information”, “consultation level 1” (as a formality), “consultation level 2” (real consultation), “shared control” to the highest level of “citizens control”. Both Franzén and Chess state that the role of the citizens (the public) should be clear from the start but also that different groups should be asked about which level of participation they would prefer.

Murphy (2012) explores the social pillar and outlines participation as one important theme and a critical concept in the SD discourse; Participation is believed to lead to enhanced social inclusion by individuals and groups that join participatory processes, and from policy perspective, participation of more social groups is believed to lead to more legitimate policy decisions. Murphy (2012) relates participation to social cohesion in that by including a range of voices, increased public engagement would promote social cohesion and social sustainability.

As described in Section 2.2, several authors has pointed to the need of involving stakeholders in brownfield redevelopment projects. For brownfield redevelopment projects (or any project that requires a stakeholder engagement),it is crucial to map the stakeholders that are or should be involved, i.e. to make a stakeholder analysis (SA). The exact definition of a stakeholder may vary somewhat (Cundy et al., 2013) but in principal is a stakeholder a person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity (ISO Guide 73:2009, 3.2.1.1). It is important to define why an SA is performed, so the result is the right information needed for the specific task. Stakeholder analyses can be used for the preparation and evaluation of projects (ODA, 1995; Grimble and Chan, 1995), for the facilitation of stakeholder involvement in participatory projects or in cooperative resource management (MacArthur, 1997; Grimble and Chan, 1995), for strategy development by project managers to assure the implementation soundness of projects or policies (Crosby, 1992; MacArthur, 1997; Varvasovszky and Brugha, 2000), for understanding the general issues related to conservation and degradation of natural resources (Grimble and Chan, 1995; Grimble and Wellard, 1997), and for a comprehensive analysis to understand better past policy making processes or to assist in formulating new policies (Varvasovszky and Brugha, 2000; Hermans, 2005).

In brownfield redevelopment projects, different kinds of SA’s might be needed for different tasks. It is also important to realise that the stakeholder group, or their interests, might change during the project and the management phases. Therefore it is wise to repeat the stakeholder analysis for each management phase or when (major) changes occur in boundary conditions, involved parties etc.

Cundy et al. (2013) outlines some general principles of good practice for stakeholder engagement with regard to Gentle Remediation Options (GRO) in brownfield redevelopment projects, as the authors mean that for those specific remedial options there is a clear need to move beyond informing and consulting stakeholders to full collaboration and empowerment.

5.2 Second P: Planet

The second P of Planet addresses environmental sustainability which seeks to improve human welfare by maintaining natural capital and thus enabling (*i*) the supply of ecosystem goods and services in a long term and (*ii*) absorption of human wastes within the biophysical capacity of the ecosystem (Goodland, 1995). Goodland (1995) defines natural capital as the stock of assets provided by the ecosystem (i.e. soil, water, air, and biota) which delivers goods and services critical for human well-being. Thus, ecosystem goods and services are the beneficial flows arising from natural capital stocks and fulfilling human needs (Dominati et al., 2010). In more simple words, the ecosystem services (ESS) are the benefits humans derive from nature (MA, 2005). There are a lot of discussions on how to define and categorize the ESSs (TEEB, 2010), see Section 5.2.1 for detail. However, the concept of ESSs holds an anthropogenic view on nature and acknowledges the instrumental value of the ecosystem, i.e. considering the ecosystem (its components, processes and functions) *as means of achieving* human well-being. Thus, some authors recognize that valuing of the ESSs is related to People and Profit, see Section 5.2.2 for detail. By taking a nature-centred perspective, humans must acknowledge the intrinsic value of ecosystem components, processes and functions and perform assessment of impacts of any planned action on functioning of the ecosystem for its own sake (i.e. not necessarily linked to its capacity to generate the benefits fulfilling human needs).

There are different methods that can address the P of Planet e.g. assessments of environmental impact, carbon footprint, and ecosystem services. The Strategic Environmental Assessment (SEA) and the Environmental Impact Assessment (EIA) are standard procedures accepted on the European Union level[29] and widely applied for public plans or programmes and individual projects respectively. Since the SEA procedure (on the basis of Directive 2001/42/EC) for the plans and programmes originates from EIA, it is typically EIA-based[30]. SEA should be combined with EIA to avoid double work[31]. The EU Directive 2011/92/EU[32] provides a guidance on EIA for individual projects. This procedure includes assessment of the effects on a wide range of different areas e.g. humans, fauna, flora, soil, water, air, climate, landscape, material assets and the cultural heritage. The EIA covers impacts resulting from both implementation (construction) and maintenance (operation) of the project in question, i.e. the use of natural resources, the associated air emissions, nuisances, waste and eventual pollution. Furthermore, a guidance was recently developed for integrating more stringently climate change and biodiversity into EIA of a project[33].

The carbon footprint assessments are widely used in soil remediation projects to support decision making on the remediation alternative that produces least air emissions and waste, and uses least natural resources (see e.g. Ferdos, 2011). Carbon footprint assessment methods were operationalized with a number of tools, e.g. SRT[34],

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29 http://ec.europa.eu/environment/eia/home.htm

30 http://ec.europa.eu/environment/eia/pdf/2012%20SEA_Guidance_Portugal.pdf

31 http://ec.europa.eu/environment/archives/eia/pdf/final_report_0508.pdf

32 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0092&from=EN

33 http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

34 http://www.aecom.com/News/Innovation/_projectsList/U.S.+Air+Force+Sustainable+Remediation+Tool; https://clu-in.org/products/tins/tinsone.cfm?num=66247610

SiteWise[35], and Carbon Footprint of Remediation[36]. The assessment metrics in these tools usually include greenhouse gas emissions to atmosphere, total energy consumption and changes in natural resource services (Brinkhoff, 2011). The footprint assessment may also include a Life Cycle Analysis (LCA) of the materials used in the remediation project.

The following section provides a brief overview of the ecosystem services concept.

5.2.1 Ecosystem services (ESS)

Ecosystem services (ESS) are both market and non-market products and services from the natural environment that contribute to human well-being both in the economy and in society. These benefits are not always taken into consideration in policy decisions, resulting in sub-optimal outcomes. The most obvious and tangible products delivered by nature, that most people are familiar with, are food and natural materials such as fibre or wood. These products are extracted and traded in commercial markets and thus have a market price which can be affected by changes in its supply and consumers' demand for the product. . There are however products and services which are not traded that society depends on, such as the conversion of CO_2 to oxygen and carbon, nutrient cycling, flood protection and climate regulation. Attributing values to these products and services allows decision makers to more broadly understand the trade-offs they are making. The goal of broadening the scope of consideration is to avoid unintended consequences of society's use of the environment is analogous with the objectives of sustainable development.

The Millennium Ecosystem Assessment (MA) (Figure 5-2) is a commonly accepted framework that allows for a structured approach to understanding the stocks and flows of the different products and services delivered by nature (Defra, 2007). Four broad categories are defined: provisioning services, regulating services, cultural services and supporting services. The ESS approach on the other hand and the MA framework specifically, allows decision makers to track the causal chains of events that result in impacts as well as the auxiliary effects that may also be worthy of consideration. For example, in Figure 5-2, water purification and fresh water require nutrient cycling. Clean water contributes to the basic materials required by society. An auxiliary function of sufficient basic materials such as water is security. It is also then evident that the least tangible criteria (social cohesion, human capital and liveability described in Section 5.1.1) are actually supported and enhanced by the natural environment.

[35] http://www.sustainableremediation.org/news/tag/sitewise
[36] http://www.sgf.net/web/page.aspx?refid=2679

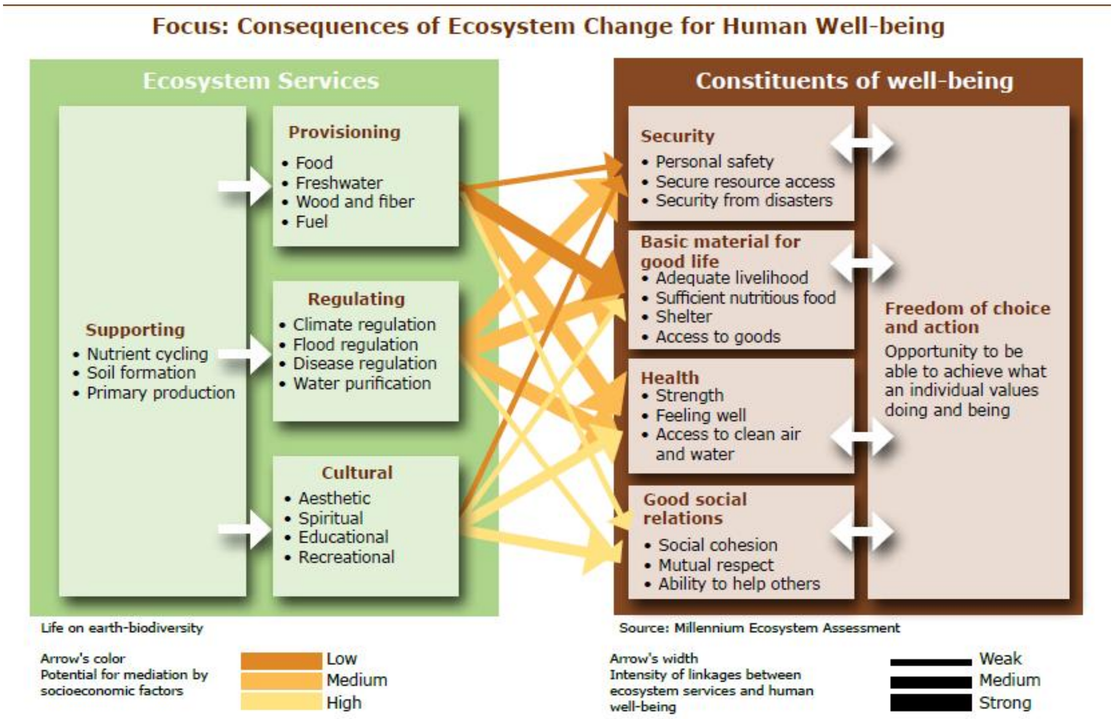

Figure 5-2. Millennium Ecosystem Assessment framework (Defra, 2007).

Sustainability assessment frameworks and tools and ecosystem valuation methods allow decision makers to consider a broad range of relevant factors therefore avoiding unintended consequences and externalities to the furthest extent possible. Integrating the ESS approach into the sustainability assessment frameworks and appraisal tool for brownfield redevelopment will expand the system boundaries of consideration and allow for a more holistic assessment methodology. The system boundaries of the existing approaches can be expanded in three key areas by the inclusion of an ESS approach:

1. Societal benefits of restoration: The societal value of restoring brownfields and hence preserving greenfields elsewhere can provide useful information and a further motivation why it is desirable by public authorities to intervene and provide public funds to perform brownfield restoration.
2. Scenario selection: The contribution to global ecosystem services of restoring or establishing ecosystems of different brownfield redevelopment scenarios can be accounted for in the decision making process. Small scale changes in the built environment and the use of green zones contribute to the supporting, provisioning and regulating services derived from the ecosystems on a regional and global scale.
3. Design: Besides choosing between scenarios ecosystem service calculations typically consider potential supply of services based on the natural conditions of a specific location (what can we potentially achieve on a location?) and existing demands for services (what is desired on a location?). The concept can on the one hand be used for vision building and stakeholder discussions (which type of ecosystem services are desired the most, not desired or not wanted for a site). On the other hand it can be used to better scope design and create win-win situations for realizing different services (where on the site is the maximum potential for water infiltration or water storage, carbon sequestration, etc.).

5.2.2 Relevance of ESS assessment to the P of Planet

The supporting ESSs (results of ecosystem components, processes and functions) and the final ESSs (provisioning, regulating and cultural result of supporting ESSs) are usually attributed to the environmental domain of sustainability (see e.g. Potschin and Haines-Young, 2011; CISES, 2013). However, it is important to point out that some authors distinguish between different aspects of ecosystem functions (see e.g. de Groot et al., 2002; Jax, 2005; Fisher et al., 2009; Volchko et al., 2013), i.e. function as (i) result of complex interactions between ecosystem components through the universal driving forces of energy and matter, and (ii) service for humans to generate human well-being. The former aspect relates to internal functioning of the ecosystem assuming *no human beneficiaries* (Fisher et al., 2009; Volchko et al., 2013). The latter aspect implies that humans benefit from the ecosystem and thus may place (1) community-based values on ecosystem services (ESS) reflecting attitudes, preferences, and intentions; and/or (2) economic values revealed by market data (if any) about ESS, or other ways to find out people's willingness to make economic trade-offs such as the willingness to pay (WTP) for ESS (SAB, 2009). Thus, both types of values derived from the *ESS valuation* process are relevant to the socio-cultural and economic domains of sustainability (Volchko et al., 2013). On the other hand, the process of *ESS identification* and *quantification* (i.e. their qualitative and quantitative assessment) is supported by evaluation of the ecosystem conditions, using driver, pressure and state indicators (MAES, 2014). Thus, biophysical mapping and assessment of the state of ecosystems form an essential part of qualitative and quantitative assessment of ESS. This type of ESS assessment can of course be attributed to the environmental domain. It should be recognized that such evaluation of ecosystem conditions, defined as the capacity of the ecosystem to deliver services (MAES, 2014), has an anthropocentric view on nature and does not acknowledge nature's intrinsic value relevant to the P of Planet in the triple bottom line of sustainability.

5.3 Third P: Profit/Prosperity

Economic sustainability can be defined as maintenance of capital, or keeping capital intact (Goodland, 2002). Capital maintenance has been achieved if the capital has remained unchanged over a certain period of time with any excess treated as profit. Different economic analysis methods are available to measure profitability of enterprises (project). These methods either focus on internal effects of a project, e.g. financial analysis, or take a societal perspective, e.g. cost-benefit analysis. The latter methods rely on welfare economics which uses microeconomic techniques to evaluate changes in human well-being in monetary terms at the aggregate economy-wide level (e.g. Johansson, 1993, de Rus, 2010, Söderqvist et al., 2015). The upscaling is usually achieved by including in economic assessment the external positive and negative effects of the project, i.e. externalities – benefits and costs for a society which are neither connected to direct gains and expenses of the project nor reflected in market prices. Greenhouse gas emissions from transport and increased provision of ecosystem services as a result of remedial actions are examples of negative and positive externalities respectively (Söderqvist et al., 2015). Externalities are usually associated with environmental change and are in some case very challenging in practice to monetize, i.e. express in monetary terms.

More than four decades ago Daly (1973) stressed an urgent need for transition to steady-state economy which operates within the limits of the ecosystem, i.e. "neither depletes the ecosystem beyond its regenerating capacity nor pollutes it beyond its absorptive capacity" (Basiago, 1990). Global concern over the critical state of many ecosystems and habitats caused by economic activities has called researchers and policymakers to explore the implications of such dramatic environmental changes for human well-being and decision-making. The interdisciplinary research involving ecologists, economists and other scientists has resulted in a definition of ecosystem services and their assessment frameworks to support decision-making in the projects that may lead to environmental change (e.g. Daly, 1997; Costanza et al., 1997; de Groot et al., 2002; MEA, 2005; Ekins et al., 2003; TEEB, 2010).

Many valuation methods, e.g. stated and revealed preference methods, are developed to value environmental changes associated with management actions in order to provide a better basis for decision-making (Hanley and Barbier, 2009). Valuing ecosystem services which can be seen as externalities allows for decision makers to understand the potential value of preserving and restoring natural areas and biota, as well as understanding the losses incurred to human well-being when these resources are overexploited or destroyed. The economic values of ESS reflect people's willingness to make economic trade-offs, e.g. WTP for ESS. Monetization through WTP hinges on the individualistic view that well-being is determined by the degree of preference satisfaction (Hausman and McPherson, 1996). However, whereas willingness to make economic trade-offs is directly connected to, and constrained by, personal income, the same individual taking a community well-being perspective can place another kind of value, e.g. ethical value, on the same service, not necessarily reflected in their (Volchko et al., 2013). Thus, there might be a fundamental difference between their roles as consumers and citizens (Sagoff, 2007). These other types of values assuming community-based perspective on human-wellbeing is therefore differ from economic values and related to the P of People. Both types of values should be accounted for in the decision-making process. The inclusion of ecosystems services valuation in natural resource management and spatial planning, by definition, expands the conventional system boundaries of decision making to include externalities. It is however crucial for decision making to realize that a positive economic outcome for society as a whole accounting for externalities is something else than a positive financial outcome for potential redevelopers, e.g. reflected as return on investment.

5.4 Fourth P: Project

As stated in the beginning of Chapter 5, the fourth P for Project introduced by Van Dorst and Duijvestein (2004) to operationalise sustainable development in the built environment, stands for the quality of the built environment as a result of an urban project. The quality of the built environment relates to its spatial quality, its relations across scales, (bio)diversity, robustness and aesthetics. The reason for introducing a fourth P is to link the different themes of the other three P:s and to find balance and synergies between those, i.e. a strategy for action. Van Dorst and Duijvestein (2004) capture the needed strategic activity by introducing this fourth P of Project to the triple bottom line approach and illustrated that as a "tetrahedron for construction" (Figure 5-3).

Further, they conceptualise that the tetrahedron also can be used for other objectives, e.g. if the goal is sustainable living, the tetrahedron is rotated with social quality on top – and where the other qualities supports the quality on top. Thus, although the conceptualisation is in no way a simple solution, the authors mean that it is a frame of mind and can be a way of monitoring a project to check whether all relations have been identified. Van Dorst and Duijvestein (2004) mean that it ensures that the relation between the practical tasks of each theme (e.g. liveability or energy efficiency) and the theory of sustainable development is kept forefront to avoid environmental problem shifting (e.g. economic development at the expense of the environment).

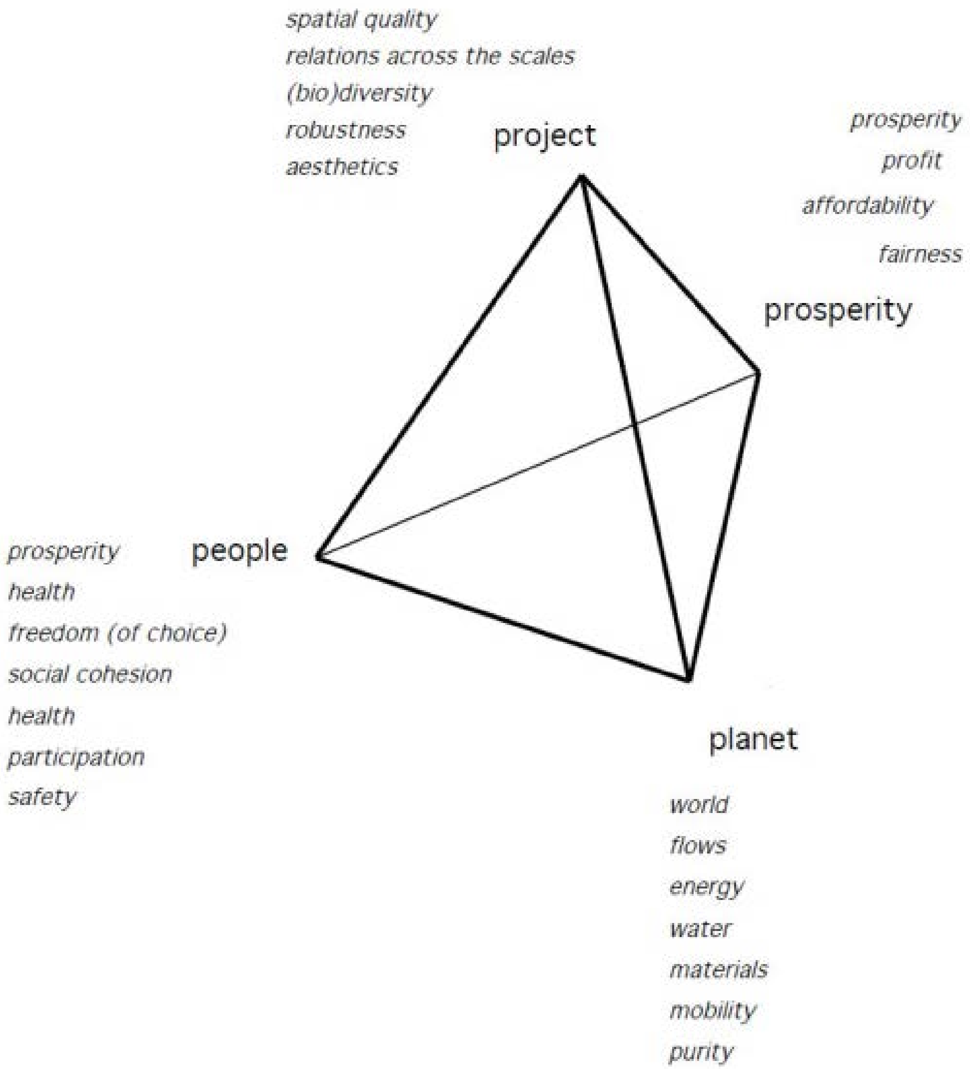

Figure 5-3. The tetrahedron of sustainable construction based on the sustainability triangle, after UN (2002, Johannesburg): People, Planet, Prosperity and associated themes (Van Dorst and Duijvestein, 2004).

Representing the fourth P of Project in Figure 5-1 is shown in Figure 5-4.

Figure 5-4. The common three pillars of sustainability representing the three P's of People, Planet and Profit, with the addition of the fourth P of Project.

6 Methods

This section provide a brief description of the methods used to derive the results presented in Chapters 7-9.

6.1 Case studies

An important method in this project has been to use case studies as a mean of applying and testing the outcomes of different activities and instruments applied. Case studies are powerful in that they provide real cases with the inherent complexity that exists and opportunities for learning, but may be limited in terms of being able to generalise results from the cases. However, in relation to social sciences, Flyvbjerg (2006) argues against common misunderstandings about case-study research and that it in fact is necessary to produce exemplars. In this project, case studies from the Netherlands, Belgium and Sweden were used: Merwevierhavens, Alvat and Fixfabriken respectively). A full detailed description of the cases and the work carried out within the case studies can be found in Norrman et al. (2015).The three studied sites have different characteristics regarding the subsurface conditions, ownership relations, development visions, governance, and the phase of the redevelopment process (Table 6-1).

Table 6-1. Brief overview of the case study sites.

CASE STUDY / LOCATION	PROPERTY TYPE	PHASE	COMMENT
Merwevierhavens/ Rotterdam, The Netherlands	The east part “city harbours” that is going to be redeveloped from mainly being an industrial area into an area with mixed use.	Initiative	A lot of data on subsurface was available, but was rather focused on subsurface problems than chances.
Alvat/ Buggenhout, Belgium	An abandoned and underused industrial area located along the river Scheldt. There is no clear vision on future land use.	Plan	Extensive investigations and partial remediation of the contaminated soil were carried out.
Fixfabriken/ Gothenburg, Sweden	A former industrial area located in an attractive part of the city is going to be redeveloped into an area with mixed use, primarily housing.	Plan	Limited information on contamination and other subsurface conditions e.g. archaeology, geotechnical situation.

The Merwevierhavens and the Fixfabriken sites are former industrial areas which are going to be transformed into areas with mixed uses, including residential housing. The former site is in the initiative phase of the redevelopment process, whereas the latter is in the plan phase. Both sites are attractive for developers because of good communication possibilities and the central location in the city, which significantly influences property values and thus allows for a market-based redevelopment. The Alvat case is also a former industrial area but differs from other two sites, because public interventions are needed for remediation of the heavily contaminated soil and the site redevelopment. The Alvat site is in the plan phase, however no clear vision on future land use was yet developed because of the presence of a serious soil contamination, and an uncertainty about the ownership situation (the site owner has gone bankrupt).

The case studies has been realised using desk studies, individual consultations with stakeholders, and stakeholder workshops. Three types of workshops have been carried out: (i) for knowledge exchange between subsurface and surface sectors; (ii) for integration of the sustainability assessment results, and getting feedback on the case study results as well as on the suggested decision support framework (Section 9.3); and (iii) with students from urban design and subsurface engineering. Involved stakeholders contributed with their experiences and knowledge of the real world complexity, as well as their feedback to the analyses made in the cases. Involved students helped the project team researchers and case holders to “think out of the box”, to offer opportunities to practice certain workshop measures and to give more content-rich discussions with the case holders.

6.2 Stakeholder analysis

A stakeholder analysis (SA) was carried out in each of the three case studies in order to identify relevant stakeholders for consultations, feedback on and development of a decision support framework for brownfield redevelopment. Different methods for performing a SA are available. The Crosby method (Crosby, 1992) was used in the Balance 4P project. This method has proved to be effective in the EU FP7 project Holistic Management of Brownfield Regeneration (HOMBRE). The objective of the SA for brownfield regeneration and redevelopment projects is to get support for the local managers and to help organizing the necessary means: knowledge, budgets and support for the redevelopment. A summary of the Crosby method is provided in Table 6-2.

Table 6-2. Procedure for stakeholder analysis: general steps of the Crosby method (Hermans, 2005).

STEP	CROSBY METHOD
General purpose of SA	Support for analysts or local managers in policy projects
Identify stakeholders	Draw initial ample list of stakeholders and relative importance
Collect primary input data	Use local informants to complete stakeholder table
Structure and analyse data	Fill in stakeholder tables / matrices (Table 6-3 and Table 6-4)

Stakeholders that should be taken into account are groups that can provide a benefit to the issue (such as strengthening the authority of decision maker, add resources, etc.) or that can weaken the authority or position of the decision makers. Note that stakeholders do not necessarily have a positive input on decision making. Groups that influence the activities of an organisation should also be taken into account. For example local community or consumers; although not always organized well, they can have a large influence towards the choices that are made.

It is however not necessary to consider all potential stakeholders. Only stakeholders that have real interest in the particular issue, and that mobilize resources (the quantity and types) to affect outcomes regarding that issue should be taken into account (Crosby, 1992).

Table 6-3 can be used to fill in the stakeholders and their position on the issue. Below, an explanation is given on the issues that are addressed in the columns.

- Group: name for the stakeholder group (or single person).
- Group’s interest in Issue: those interests that will be affected by the decision to be taken (just the most important ones).
- Resources: the resources the group possesses that can be used in the decision making (knowledge, information, leverage, money).
- Resource Mobilization Capacity: can the group mobilize these resources quickly or slowly? This is important when looking at the dynamics of the decision making. If a decision needs to be taken quickly, but the resource (eg knowledge) can only be delivered slowly, this resource is of less importance than previously thought.
- Position on issue: The position should be examined. People can be strongly negative (- -), slightly negative (-) or slightly positive (+) or completely positive (+ +). The - - take a lot of energy and will in many cases not be convinced. However, a way to handle this opposition (reduce negative impact) is necessary in the strategy for decision making. For the (–), a convincing argument could be enough to become (+). The (+) and (+ +) can be activated and sustained for the issue (Figure 6-1).

Table 6-3. Example of a blank stakeholder analysis table (Crosby, 1992).

GROUP	**GROUP’S INTEREST IN ISSUE**	**RESOURCES**	**RESOURCE MOBILIZATION CAPACITY**	**POSITION ON ISSUE**

Figure 6-1. Different stakeholders' position on issue and way to approach them.

In Table 6-4 the participation of stakeholders can be defined: how to involve the stakeholders in the different phases of the project. This is a choice that is based on (e.g.) available means and position towards the issue (see Table 6-3). Not everybody needs to be involved in the same way. For example: if there is sufficient money, extra resources from stakeholders that provide money are not necessarily required; it can be a better choice to focus to groups that pose societal opposition.

Inform: let the stakeholder know what is happening. It implies little or no input from the stakeholders except where it goes beyond their tolerance level.

Consult: expect some input from the stakeholder. This may be only in one area of the project. To consult implies good two-way communication with timely replies. It may mean attendance at meetings.

Partnership: implies active communication and decision making between the project and the stakeholder. They will be involved in all major decisions and attend all important meetings.

Control: some stakeholders will need a different strategy. Their involvement needs specification and monitoring. This can be a strategy for service providers (need do their job within time) or strongly negative groups (will not help the project, but can do damage).

Table 6-4. Example of a blank stakeholder participation matrix (based on ODA, 1995; MacArthur, 1997 and Maring et al., 2013).

PHASE*	**TYPE OF PARTICIPATION**			
	Inform	**Consult**	**Partnership**	**Control**
Plan phase				
Implementation phase				

*Phases can be adapted to the commonly used project phases. These phase names can differ per country or discipline.

It is important to realize that filling in Table 6-3 and Table 6-4 gives an overview. The stakeholder's behaviour and their management strategies cannot fully be predicted by these tables. It requires effort to guarantee analytical soundness and to prevent personal bias (Hermans, 2005).

6.3 Stakeholder consultations

Stakeholder consultations were arranged in a series of workshops in each case city, with content and procedures depending on the characteristics of each case context. The objectives were to get input and feedback on the decision support framework for sustainable brownfield redevelopment for subsequent improvement. Two web-based seminars with participation from all three countries were held to get further input and feedback from stakeholders on the suggested holistic approach and a decision support framework.

6.4 Student involvement

There has been extensive student involvement in the case studies as described in Norrman et al. (2015). Apart from the case study related student involvement, one student doing internship at Deltares carried out an inventory of sustainability assessment instruments within the scope of the Balance 4P project (Kok, 2014). The summary of the inventory results is a part of a decision support framework guiding the assessor to ensure inclusion of subsurface and sustainability assessments into early phases of the redevelopment process.

6.5 Inventory and categorization of instruments

An inventory of sustainability assessment instruments was carried out in order to create a guide for the assessor providing a brief description of the tool/method, its relevance to the redevelopment phase and to the identified categories. The categorization is based on the primary objective of application of instruments, including several subcategories (Figure 6-2): *Information and Education, Design Development Options, Assess Project Options and Support Aspect of Project*. The categorization was deliberately chosen not to be based on approach (e.g. environmental, economic, etc.) since many instruments encompass multiple approaches. The instruments that fall under the category 'Support aspect of the project' are very specific, but were nevertheless explored because they are useful in brownfield redevelopment projects.

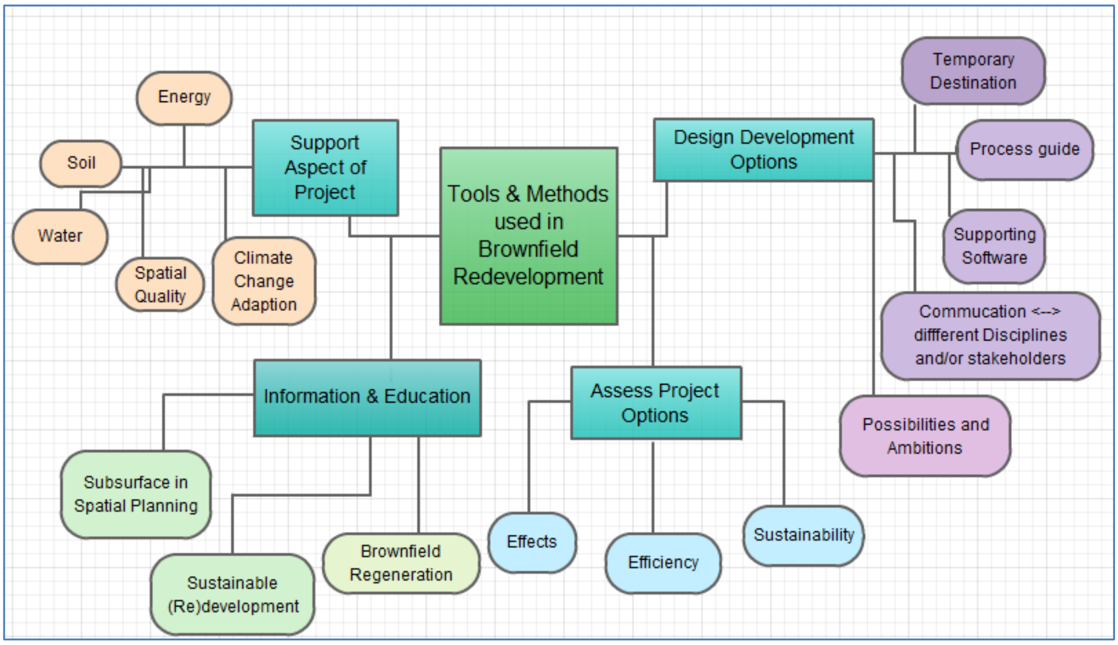

Figure 6-2. Categorization of instruments used in brownfield redevelopment (Kok, 2014).

'Design Development Options' incorporates all instruments that could have a function in the development of project options: defining the general direction of the development; stimulating cooperation and communication between stakeholders or between different disciplines; supporting software; process guides or lists of concepts to attend and temporary destination.

'Tools supporting aspect of project' is a mixture of tools that can be used to assist in addressing one of the aspects of the project: they provide information or guidance in the fields of energy, soil, water, spatial quality and climate change adaption.

'Information and Education' includes information sources and guidelines on incorporating the subsurface in spatial planning; performing sustainable urban redevelopment; adapting to climate change and information and case study databases for brownfield redevelopment.

'Assess Project Options' contains instruments used to evaluate the effects, cost-efficiency or to rate sustainability of a project (option).

6.6 The COMMIN method

To structure the investigation and comparison of the planning systems in the Netherlands, Belgium and Sweden, the Isocarp International Manual which features all partner countries of Balance 4P was used (Ryser and Franchini, 2008). The comparative table created by the COMMIN Interreg IIIB project provided a useful framework to structure the comparison.[37]

To describe planning systems, COMMIN uses 5 categories:

- Constitutional
- National scale
- Regional scale
- Local scale
- Participation.

First it identifies the guiding principles and objectives defined for planning as well as principal planning institutions. Second, it summaries the Planning Acts and other legally binding contexts and types of planning documents that are commonly used and generally recognised. This covers 1) culture and informal institutions and 2) formal institutions (regulations). As an addition to COMMIN, for each scale, the question if and how soil management is handled is also raised. Further, to capture 3) the drivers and processes in urban development in the three countries and to make the link to the building practice, additional questions were added to COMMIN:

1. Who initiates urban development?
2. What steps are taken into the process, related products?
3. What role does the government play in the development?
4. How is knowledge integrated in the plan and design process?
5. How is subsurface taken into in the development process?

These questions are important to understand how the planning system in each country sets the conditions that steer urban development and how the subsurface is taken into account.

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

7 Instruments

The overview of sustainability assessment instruments is based on studies by Kok (2014) and Beames et al. (2014) and carried out as parts of the Balance 4P project. This chapter provides a brief summary of the inventory of sustainability assessment instruments (Section 7.1), classification and comparison of the tools used in remediation projects (Section 7.2), and some reflections upon the use of instruments (Section 7.3). Further, brief descriptions of the identified instruments are presented in Appendix C and Norrman et al. (2015) presents the instruments that were applied in the case studies.

There is a gap between having a sustainable development ambition for a project and actually achieving a sustainable development. In order to assist the development process of a spatial project, various methods and tools exist that connect a sustainable approach to practice. A method, a process or a supporting model is meant to guide the user towards a certain goal. By the LUDA Compendium (2005) a ***method*** is defined as a procedure followed in order to accomplish a task, sometimes in accordance with a particular theory. A ***tool*** is a program that gives the user a tangible result. The LUDA Compendium defines it as a 'concrete or abstract product used in applying a method'. The collective term ***instrument*** is used in this report.

7.1 Inventory of instruments

There are numerous instruments that can be used in the urban planning process: they support workshops with stakeholders, calculate the projects' effects on the natural system, increase cost-efficiency, provide a framework according to which an entire project can be executed, rate the sustainable performance of a project and more. Using the categorization method described in Section 6.5, Figure 7-1 gives an idea of the many different instruments that are available and what use they might have in a redevelopment project; though an instrument can have multiple applications or approaches. For example, the 'BREAAM-NL Spatial Development'-certificate can be both listed in the 'Design Development Options' category, being used as a list of actions to attend to when executing a project sustainably - and in the 'Assess Project Options' category (Bouwinnovatie, 2013). These instruments can be used in different phases of the redevelopment. A brief description of the identified instruments can be found in Appendix C. Section 7.2 describes assessment tools that fall into category *Assess Project Options* in more detail from a remediation perspective.

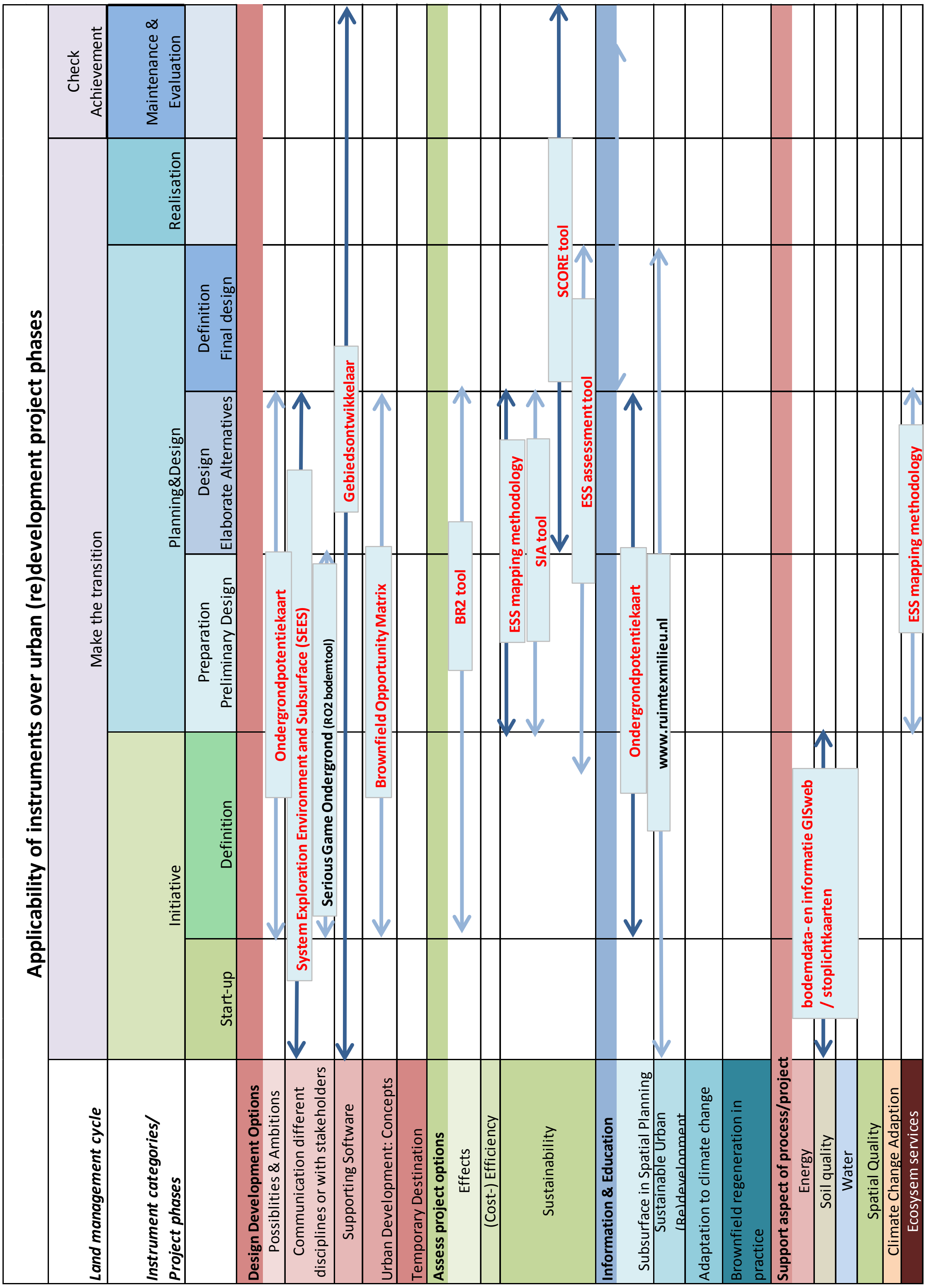

Figure 7-1. Instruments along the project phases (based on Kok, 2014). The tools in red were applied in the case studies.

7.2 Classification of sustainability assessment instruments for remediation projects

"Soil and groundwater remediation is primarily intended to reduce and manage the risks to human beings and ecosystems posed by contaminated sites, therefore bringing about positive environmental changes that are beneficial to society. Determining the most appropriate course of action when faced with soil or groundwater contamination requires the consideration of technologies or approaches that can effectively remove the contamination to the required target level within project-defined time and cost constraints. An additional set of criteria based on the principle of "sustainable development" has recently given rise to the discourse on "sustainable remediation", with the intention of not only reducing the risk posed by soil and groundwater contamination but also doing so in a way which brings about a net benefit in terms of broader environmental, social and economic considerations (SuRF-UK, 2010). Decision support systems (DSSs) provide for a structured method of comparing alternative courses of action that differ in terms of impacts (Matthies et al., 2007). The existing sustainability assessment DSSs for soil and groundwater remediation can be classified into two broad types." (Beames et al., 2014).

The first and most common type of tool, is referred to as a "sustainability appraisal" DSS (Pollard et al., 1999; Sullivan 2002) focusing on sustainability of remediation technology options. In the last decade however, there has been a shift towards the development of another kind of sustainability assessment tool that facilitates other parts of the remediation decision process. This second type of DSS considers the social and economic impacts associated with the eventual site re-use and is intended for large scale remediation and redevelopment projects or brownfield revitalization. This second type of tool will be referred to here as Scenario Appraisal DSSs. Figure 7-2 illustrates the steps in the planning process that precede the specific type of sustainability appraisal.

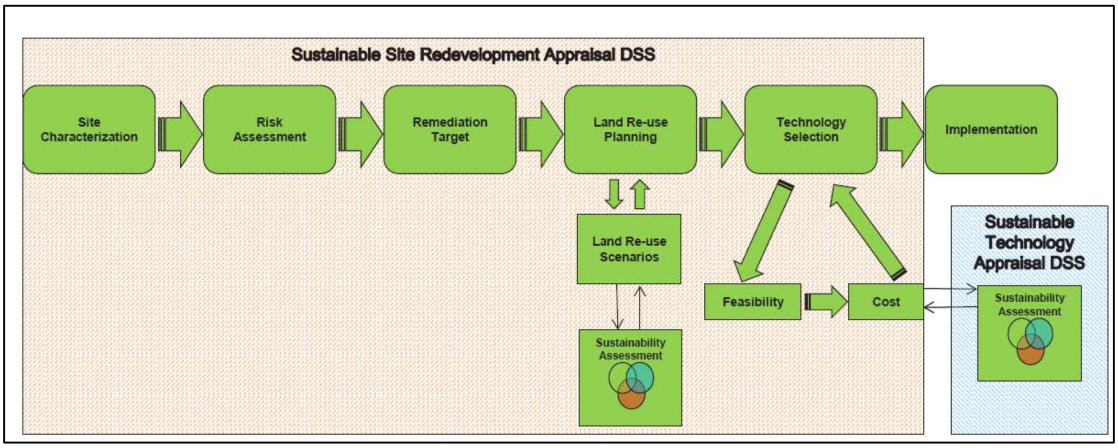

Figure 7-2. Schematic presentation of stage in remediation planning process where sustainability is assessed. Two types of tools exist: Sustainable Site Redevelopment Appraisal and Sustainable Technology Appraisal (Beames et al., 2014).

7.2.1 Technology “Sustainability Appraisal” DSSs

Sustainability appraisal DSSs are used to identify the most sustainable remediation technology options out of the possible alternatives. The sustainability appraisal is performed after determination of the intended land-use, remediation target and feasible technologies (see Figure 7-2). It only assesses the potential sustainability of the feasible technology alternatives.

There are DSSs that identify feasible technologies according to the geo-hydrological conditions and type of contamination (e.g. PRESTO, Onwubuya et al, 2009). Other DSSs also provide financial cost estimations of different technologies according to site-specific inputs, along with sustainability criteria. Examples include SRT and REC (US AFCEE, 2010; Beinat el al., 1997).

Most sustainability appraisal DSSs perform fairly extensive LCA based environmental footprint calculations e.g. SRT, Carbon Footprint of Remediation (SGF, 2014) and the ABC-tool (Maring et al., 2004). The current state of the art of sustainability appraisals typically consider only the environmental impacts of remediation operations. The socio-economic impacts are considered either in limited detail or are not accounted for beyond on-site operations during the remediation process. This limited consideration of the social and economic elements of sustainability stands in contrast to what is prescribed in guidance material from sustainable remediation forums such as SuRF-UK (2011).

The SCORE model (Rosén et al., 2015) is a tool that accounts for a wider range of social and economic impacts, see also brief description in Norrman et al., 2015. The SCORE tool builds upon previous work by Rosén et al. (2008, 2009, 2013). The evaluation of social and economic impacts depends on the chosen system boundary, thus widening the system boundaries also requires taking a different set of impacts into account. The SCORE tool widens the conventional system boundaries found in other tools.

7.2.2 Scenario Appraisal DSSs

As Bardos et al. (2011) points out, at earlier stages, i.e. in a local spatial planning stage, there are wider opportunities for sustainability considerations. The second type of sustainability assessment DSS or Scenario Appraisal DSS considers the impacts of eventual site occupation and land-use in line with Bardos et al. (2011). Megasite Management tool suite (MMT) and DESYRE are two examples of this newer type of tool and were developed to facilitate the various planning phases of large scale remediation projects. Such tools are innovative, in that they integrate different steps in the remediation planning process and because they consider social and economic impacts once the site re-occupied. These tools however, do not consider community and environmental impacts during remediation operations, which also stands in contrast to the holistic approach prescribed by remediation forums. An additional challenge for existing scenario appraisals systems is their relative complexity making them inaccessible to end users and therefore seldom applied in practice.

Once the remediation targets for a site have been determined (see Figure 7-2), the scenario appraisal DSS generates different on-site land use scenarios. These tools (such as MMT) evaluate the different scenarios according to a selection of sustainability indicators. MMT also reflects the contaminant hotspots and groundwater plumes allowing developers to optimize their remediation strategy in accordance with the eventual land-use plans.

7.2.3 Comparison of sustainability assessment instruments for remediation projects

As stated, the narrow focus of several Technology "Sustainability Appraisal" DSSs on on-site environmental impacts stands in contrast to what is advocated in the concept of sustainable development and leads to poor balancing of the three dimensions (environmental, economic and social) of sustainability (SuRF-UK, 2010; UNWCED, 1987). Broadening the scope of the assessment from only a few environmental indicators and financial costs to also considering social impacts and indirect economic impacts, will influence the sustainability performance of the remediation alternatives. A broader scope of evaluation comes closer to including all the impacts deemed to be important by remediation forums such as SuRF-UK and provides a more holistic account of how different courses of action impact not only the natural environment, but also the human environment.

Indicators should be based on information that can be easily obtained by remediation professionals and includes all relevant considerations on-site and off-site. On-site environmental impacts during the remediation process should be linked to their eventual social and economic impacts.

Table 7-1 includes an overview of the sustainability indicators used in the CO2 Calculator, SRT, REC and GoldSET tool. Three are publicly available: (1) the CO2 Calculator (request at www.ovam.be) (Praamstra, 2009), (2) the Sustainable Remediation Tool (SRT) (request at www.afcec.af.mil) (US AFCEE, 2010) and (3) the Risk Reduction, Environmental Merit and Costs tool (REC) (request at www.ivm.vu.nl) (Beinat et al., 1997). The fourth tool, (4) GoldSET (Golder Associates, 2012), is not publicly available (information about the tool can be found at www.gold-set.com). Table 7-1 shows how the tools differ from one another and how the tools differ from what is prescribed by SuRF-UK. What is immediately evident from the table, is that the environmental aspect or pillar of sustainability is the most detailed in terms of indicators covered in the tools. The social impact aspect is the least detailed. The reason for this is that the tools were originally developed by environmental engineers with little knowledge of metrics that are applicable to socio-economic impacts.

Table 7-1. Indicators considered in technology sustainability appraisal tools categorized according to the three pillars of sustainability and are also divided up according to whether they are related to remediation operations or site re-occupation. Quantitative (X) and qualitative (O) indicators included in each tool as well as indicators proposed by SuRF-UK (S) and those not considered in the tools (-). Source: Beames et al. (2014).

		CO_2 Calculator	SRT	REC	GoldSET	SuRF UK
Environmental						
Clean-up (during operations)						
On-site	Primary energy consumed and CO_2 emissions (e.g. excavation, drilling, groundwater extraction and purification)	X	X	X	X	S
	Energy consumed and CO_2 emissions produced cleaning soil on-site	X	-	-	-	-
	Energy consumed and CO_2 emissions produced laying clean fill soil	X	X	-	-	-
	Other air emissions (SO_X, NO_X, PM_{10})	-	X	X	-	S
	Water consumption	-	-	X	X	S
	Waste generated on-site	-	-	X	X	S
	Short-term ecological impact on-site	-	-	X	O	S
Off-site	Energy consumed and CO_2 emissions produced transporting waste soil off-site	X	X	X	-	S
	Energy consumed and CO_2 emissions produced transporting workers, materials and equipment	X	X	-	-	-
	Energy consumed and CO_2 emissions produced treating dumped water off-site	-	-	X	-	-
	Energy consumed and CO_2 emissions produced cleaning soil	X	-	-	-	S
	Soil consumed off-site	-	-	X	-	S
	Waste generated off-site	-	-	-	O	S
	Short-term ecological impact off-site	-	-	-	O	S
Site Re-use	Soil quality	-	-	X	O	S
	Groundwater quality	-	X	X	O	S
	Surface water quality	-	-	X	O	S
	Erosion of contaminated soil	-	-	X	O	S
	Sediment quality	-	-	-	O	S
	Free phase product removal	-	-	-	O	-
	Contaminated groundwater migration	-	-	-	O	S
	Long-term ecological impact	-	X	X	O	S
Economic						
Clean-up (during operations)	Total costs	-	X	X	X	S
	Net present value	-	-	X	X	-
	Litigation costs	-	-	X	O	S
	Additional costs due to delays and technology failure	-	-	X	O	S
	Additional costs due to logistical challenges	-	-	X	O	-
	Technological uncertainty on cost	-	X	X	O	-
	Permit and regulation related costs	-	-	-	O	S
	Use of financing opportunities	-	-	-	O	S
	Local business opportunities created	-	-	-	O	-
	Local employment opportunities created	-	-	-	O	S
Site Re-use	Increased economic value of area	-	X	-	-	S
	Reuse of property by developer	-	-	-	O	S
	Corporate reputation of developer	-	-	-	O	S
	Local business opportunities created	-	-	-	O	-
	Local employment opportunities created	-	-	-	O	S
Social						
Clean-up (during operations)	Workers' health and safety	-	X	X	O	S
	Community health and safety	-	-	-	O	S
	Duration of operations	-	-	-	X	-
	Nuisances and hindrance to community	-	-	-	O	S
	Legal requirements met	-	-	-	O	S
	Good management practices	-	-	-	O	-
	Ethical practices and local equity	-	-	-	-	S
	Site security	-	-	-	-	S
	Uncertainty and evidence	-	-	-	-	S
	Community involvement	-	-	-	-	S
Site Re-use	Soil vapour intrusion impact on human health	-	-	X	O	-
	Protection of potable water supply	-	-	-	O	S
	Preservation of historical or culturally significant buildings or space	-	-	-	O	S
	Public space created	-	-	X	O	-
	Impacts on the landscape (aesthetic)	-	-	-	O	-

Key
(X) Quantitative
(O) Qualitative
(S) Proposed by SuRF-UK
(-) Not Considered

The evaluation of the indicators and structures of the four tools highlight the differences in the scope of the tools, how indicators are calculated and how this ultimately influences the results generated by the tools. As shown in the review by Beames et al. (2014), the results of the tools differ in terms of their indicator selection and how their indicators are measured and weighted. The indicators that are common across the tools tend to focus on environmental impacts related to on-site processes and total financial costs. Off-site impacts, impacts that are felt after remediation and impacts associated with reoccupation of a remediated site are considered less thoroughly across the tools, particularly with regard to the economic and social dimensions of sustainability, i.e. a poor balancing of the three dimensions (environmental, economic and social) of sustainability.

7.3 Reflections

The existing Decision Support Systems (DSS) described under 7.2 use a sectoral approach to impact categorization and characterization which differs from the holistic systems based approach that underpins ESS valuation (see also Section 5.2.1, 5.2.2 and 5.3). The impact assessment methods in the DSSs consider impacts at a specific point in time and at a specific geographical location. The impact is therefore considered in isolation without considering the interaction with other impacts and without considering the processes and flows prior to the impact under consideration. The ecosystem services concept is yet to be integrated into these decision support instruments. Some elements of the approach have however been adopted in remediation technology evaluation and remediation technology appraisal tools, e.g. the Multi-Criteria Analysis- based method, Sustainable Choice Of REmediation (SCORE) by Rosén et al. (2015). The focus in these tools is on the value of soil and groundwater restoration. The economic part of SCORE considers supporting, provisioning, regulating and cultural ecosystem services that may be impacted by remediation (Söderqvist et al., 2015). The environmental part of SCORE provides the possibility to assess the effects of remedial actions on soil functions (Volchko et al., 2014). The soil function assessment results may serve as input for qualitative assessment of ESS supported by the soil system. Furthermore, cultural ecosystem services, i.e. cultural heritage, may be assessed qualitatively in the social part of SCORE. The semi-quantitative ESS mapping and evaluation methodology in Ivarsson (2015) was developed within the Balance 4P project in order to be applicable in the planning process, but may be extended to full monetary valuation.

There is a multitude of instruments to guide sustainable development both in urban planning as well as in remediation projects. The instruments have been developed in different regulatory contexts and with different concepts/ideas of sustainability and for different tasks in the phases of redevelopment. The instruments can focus on one or multiple aspects of sustainability. They can be focused on different phases of redevelopment: e.g. to support the planning and design (e.g. SEES) or remediation (e.g. SCORE). Because of the multitude of angles and purposes of instruments, it is difficult to rank them: this would be comparing apples and oranges. For application of the instrument the following boundary conditions are necessary. The user needs to:

- be allowed to (managerial approval, e.g. for the time to spent),

- be able to (necessary resources: data, information, knowledge, stakeholders, organisational power), and
- want to (to add something extra / special to a project, the right questions need to be asked and the people need to be enthusiastic about it).

Always, when using instruments one needs to look carefully at the objective of the instrument and assess if the application has multiple values for the task to perform. As Bartke and Schwarze (2015) state, there is no perfect tool, there is always a trade-off between what is scientifically most correct and what is applicable.

8 Current planning conditions and possibilities for improvement

8.1 Comparison of the planning systems in three countries

When comparing the Netherlands, Sweden and Belgium, the first conclusion is that planning systems in these countries are incomparable as entities. There is basically not one Belgium with a national planning culture, tradition, laws etc. Flanders' citizens consider Flanders as their national government. Therefore, within the project Balance 4P, the comparison is made between the Netherlands, Sweden and Flanders.

For the comparison, a number of questions were added to the COMMIN framework to understand also the building practice and how the subsurface is taken into account. The resulting mainframe is shown in Table 8-1. For the detailed comparison of the planning systems, see Appendix A.

Table 8-1. The mainframe for understanding and comparing the planning systems with regard to subsurface, expanding the COMMIN system.

	The Netherlands	Sweden	Flanders
Constitutional	State – municipality Strong constitution, public responsibility, planning for public cause	**Municipal planning monopoly** - state Strong constitution, public responsibility, planning for public cause	State – prove- municipality Strong constitution, public responsibility, planning for public cause
National	Ministry of Infrastructure and Environment Environmental Act EIA (Independent)	Ministry of Health & Social Affairs, Ministry of Environment Planning & Building Act Environmental Code EIA done by municipality	Ministry of Environment, Nature & Energy Planning Decree EIA done by certified expert
Regional	12 provinces Water boards Structural plan, water assessment and ATES control	**21 County Administrations** **5 Water authorities** Göteborg & Stockholm	12 provinces Water boards Structural plan
Local	Planning & Building department Vision, master plan, zoning plan = strongly related to building permit Subsoil management: archaeology, water, remediation and cables and pipes	Planning and Building often separate departments Municipal (**290 mun.**) comprehensive plan, detailed municipal comprehensive plan, detailed development plan Subsoil management: archaeology, **water**	Planning & building department Municipal structure plan, municipal implementation plan
Participation	organized	organized	organized
Building practice	% house owners From top down changing to bottom up (existing city)	% house owners Public – private development	% house owners Bottom up development

Planning is culture! Even though the structure of institutions, law, policy, instruments and regulations of the three countries do not differ that much, there are quite different cultures in them that organize the planning system and determine the outcome, see Table 8-2. These cultures have grown from historical developments, the geographies of the territories and population density. Netherlands and Flanders are comparable in historical developments and geography, for example shown by the fact that water is an important spatial component in both countries. This is much different from Sweden, where water plays a somewhat less significant role. That size matters is recognizable with regard to the level on which spatial planning control is manifested. As Sweden is a large country it is sensible to leave municipalities in control whereas in the Netherlands, being a small country, a strong spatial planning on the national scale makes maximal use of the land. The Netherlands has since the Housing Law in 1901 had the tradition of large scale (social) housing and a very low percentage of people building their own house. Flanders has had the same type of system, with the distinction that even though the planning is "top-down", urban development has for the dominant part been in the hands of private developers supported by local policy. The scale of urban development projects differs quite a lot between private developer driven (small scale) and public bodies developing whole city districts at the same time. An observation is that the Netherlands is currently moving towards a more "bottom-up" governmental system (driven from the municipality scale level) similar to that of Sweden and also towards a more bottom-up development practices by private developers as executed in Flanders and Sweden.

Table 8-2. Overview of approaches to planning and building in the three countries.

	PLANNING SYSTEM	**BUILDING PRACTICE**
The Netherlands	Top Down > Bottom Up	Top Down > Bottom Up
Sweden	Bottom Up	Bottom Up
Flanders	Bottom up > Top Down	Bottom Up

When comparing the building practices in the three countries, it can be observed that only the Netherlands is still in transition from top down to bottom up building practice in contrast to Sweden where the shift has occurred in the nineties (see Section 4.3 for details) and to Belgium where a bottom up pattern in building activities has been taking place for ages. In the Netherlands, the municipality, and later the project developers, were expecting such top-down building projects. However, due to the financial crisis the building practices have changed towards a more bottom-up approach of redevelopment of existing neighbourhoods. In Sweden, private developers now also dominate the planning process to a much larger degree, since the resources at the municipality are more and more limited. In both Sweden and Belgium there has always been a tradition of people building their own houses and this bottom-up approach is still there. When comparing the developments in subsoil management in the three countries (see Chapter 5) and its integration into the planning process, it is obvious that the Netherlands is ahead. In Sweden, some efforts have also been made to coordinate the planning process with management of the contaminated soil, since this has been acknowledged to be associated with some difficulties (see Section 5.3).

8.2 Chances for enhancing subsurface integration into the current planning systems

A holistic view on the urban redevelopment process recognizes that this process operates within the planning conditions that are the result of all levels in the planning system (local, regional, national) and their respective laws and regulations, policy, institutions and planning cultures (Figure 8-1).

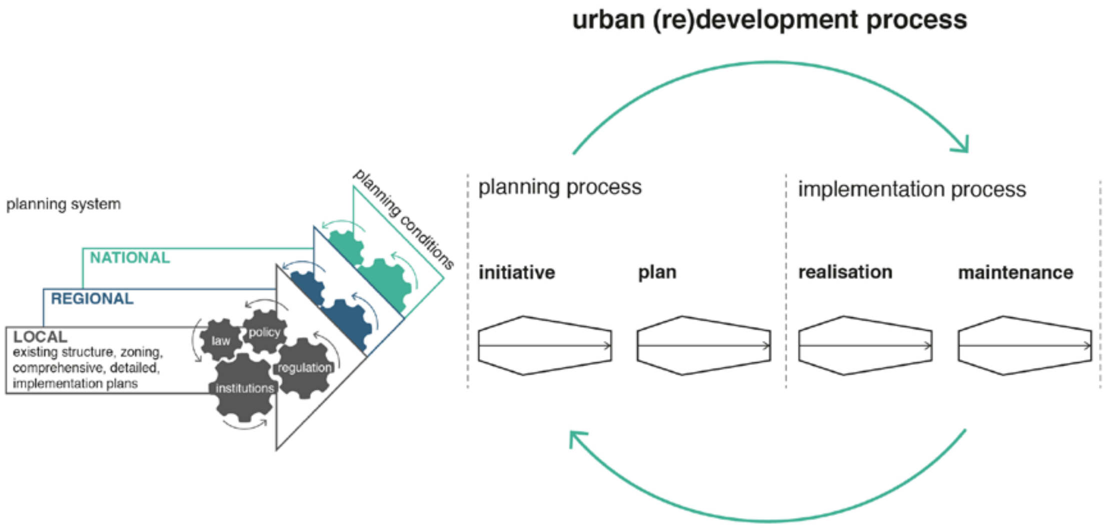

Figure 8-1. A holistic view on urban redevelopment process. Illustration by F. I. Hooimeijer, drawn by Janneke van der Leer, ©Chalmers University 2015.

The urban redevelopment process has the planning conditions as a regulatory context and includes both a planning process and an implementation process, each with different phases. A holistic view holds that not only surface but also subsurface aspects should be duly considered in the planning process which is seldom done in practice nowadays in any of the three countries. The subsurface should be seen as important as aboveground aspects in each phase of the urban redevelopment process (Figure 8-2).

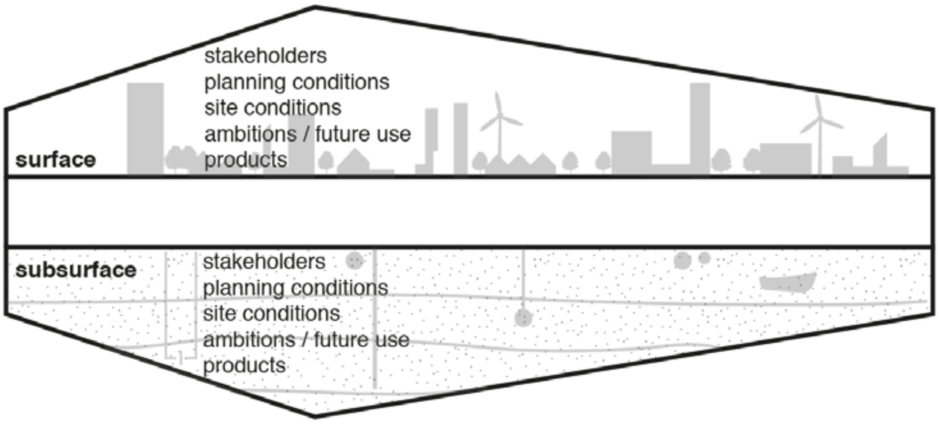

Figure 8-2. Both surface and subsurface aspects should be considered in each phase of the urban redevelopment process. Illustration drawn by Janneke van der Leer, ©Chalmers University 2015.

There are four common spatial planning subjects across the planning systems of the Netherlands, Belgium and Sweden, and these can potentially be expanded also to subsurface: Heritage (Malta Convention[38]), Environment (Environmental Assessment Procedures[39]), Nature (Natura 2000[40]) and Water (Water Framework Directive[41]). All four spatial planning subjects already have a strong position at the different levels of governance (national, regional, local).

For these four urban planning subjects, the integration of above ground and underground aspects can be enhanced in different ways: 1) in law and regulation, 2) in policy and vision, 3) by structured knowledge exchange between stakeholders, and 4) in the design/construction process, see the summary in Table 8-3. For each regular planning theme, different aspects of the subsurface can be integrated. Here, four categories of subsoil qualities (Hooimeijer and Maring, 2012) are used to give an indication of the possibilities:

1. civil constructions (archaeology, underground building, cables and pipes, foundations);
2. water (storage and filtering capacity, drinking water);
3. energy (Aquifer Thermal Energy Storage (ATES), geothermal and fossil energy); and
4. soil ecology (clean soil, morphology, ecology, landscape diversity, minerals).

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[38] Malta Convention, 1992: http://conventions.coe.int/Treaty/EN/Treaties/Html/143.htm, accessed September 2015.

[39] Environmental Impact Assessment (EIA) Procedures: http://ec.europa.eu/environment/eia/home.htm, accessed September 2015.

[40] Natura 2000: http://ec.europa.eu/environment/nature/natura2000/index_en.htm, accessed September, 2015.

[41] Water Framework Directive: http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm, accessed September 2015.

Table 8-3. Identified chances for enhancing subsurface into the current planning systems with regard to four spatial planning subjects: Heritage, Environment, Nature and Water, relating to four subsoil qualities: Civil constructions, Water, Energy, and Soil. Chances are related to i) law and regulation, ii) policy and vision, iii) knowledge exchange, and iv) design/construct.

TOPICS IN SURFACE PLANNING →		Heritage	Environment	Nature	Water
CHANCES FOR ENHANCING THE SUBSURFACE BY	Law and regulation	*Chances for:* - Including the subsurface in planning regulations about heritage, environment, nature and water - Including the subsurface in Environmental Impact Assessment and Water Assessment Test - Subsurface in zoning plans through paragraphs about heritage, environment, nature and water			
	Policy and vision	*Chances for:* - Visions on the subsurface in local and regional plans, local policies, as well as in individual projects			
	Knowledge exchange	*Chances for:* - Interdisciplinary cooperation - Developing new knowledge by cooperative learning			
	Design / construct	*Subsurface in plan and design process needs:* - Better frame of reference - Better instruments (subsurface potential map) - Cultural change from how it is done now			
CATEGORIES OF SUBSURFACE QUALITIES →		Civil constructions Soil	Civil constructions Soil Water Energy	Water Soil Energy	Water Soil Energy

Law and regulation

In law and regulation there are opportunities for including the subsurface in planning about heritage, environment, nature and water. In current redevelopment processes of cities, especially heritage is considered an opportunity for reuse of built structures to make urban change more sustainable. It is also an opportunity for making better use of meaning and context in new developments to maintain/create identity. Heritage protection is established by law and made a self-evident part of planning and plan processes. Usually there are specific paragraphs dedicated to heritage in structure and zoning plans. Expanding this practice to archaeology and other human structures in the subsoil is a significant opportunity. In Sweden, law and regulation is already strong with regard to protection of archaeological remains.

Taking the environment into account is secured in all three countries through the Environmental Impact Assessment (EIA). This is applicable to plans at different scales in which also the subsurface is relevant. Through EIA, synergies between the natural system, the (civil constructed) conditions of the site, and the development plans can be brought together thus promoting integrated planning.

Nature protection is well organized starting at the European level with Natura 2000 and then in each country on all scales. The need to consider the subsurface as part of natural systems is 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, and also this current regulations could be expanded with the subsoil considering that groundwater is part of the water system as a whole. Also Sweden is implementing the water framework directive, and all water bodies are given a classification.[42] However, regular sampling in all Swedish waterbodies is at the moment not implemented due to the high number of water bodies.

Policy and vision

As already being practised in the Netherlands there is a great opportunity for including visions on the subsurface into structure plans, and also for bringing the subsurface into policy in order to stimulate early consideration in the planning process as a whole and in the plan process of individual projects. On different scales, these visions could emphasize other qualities of the subsurface, and together they could offer a sound base for structure plans. The connection to the planning themes of heritage, environment, nature and water could be made here as well. By including the subsurface in policies and visions, practitioners on the municipalities will be "forced" to consider the subsurface explicitly in plans.

On a very local scale, it is possible to include visions on the subsurface in specific projects. However, this is then depending on project leaders and practitioners willing to work with such issues.

Knowledge exchange

Especially knowledge exchange is a key for a better integration of the subsurface into above surface urban development. Since it enhances interdisciplinary cooperation, it could lead to development of new knowledge and improved knowledge management. Knowledge exchange makes it possible to handle uncertainties in qualitative manner. Direct and conscious knowledge exchange between surface and subsurface sectors in early phases will also promote integrated plans. In traditional planning practice, knowledge exchange is often practiced by means of documents, reports and formal meetings. Here, there are opportunities to improve the current practices on knowledge exchange on subsurface and surface by applying existing instruments for multi-stakeholder collaboration.

Design/construct

Including the subsurface in the plan process and the design process needs:

- Better frames of reference;
- Better instruments (e.g. subsurface potential map);
- Cultural change from how it is done in current practices.

[42] https://www.havochvatten.se/hav/samordning--fakta/miljomal--direktiv/vattendirektivet.html (accessed 2015-11-09).

Taking the subsoil conditions into account in plan and urban design is a rather new concept for urban designers. Especially for the plan phase there should be better management of what and how knowledge and data from the subsurface could be translated into information that is relevant and possible to use in the process.

Even though the process of designing is ambiguous, personal and somewhat intangible, Van Dooren et al. (2013) unravel it into a framework (Figure 8-3). 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. These five elements are:

1. Experimenting
2. Guiding theme or qualities
3. A frame of reference or library
4. Sketching/modelling
5. Domains.

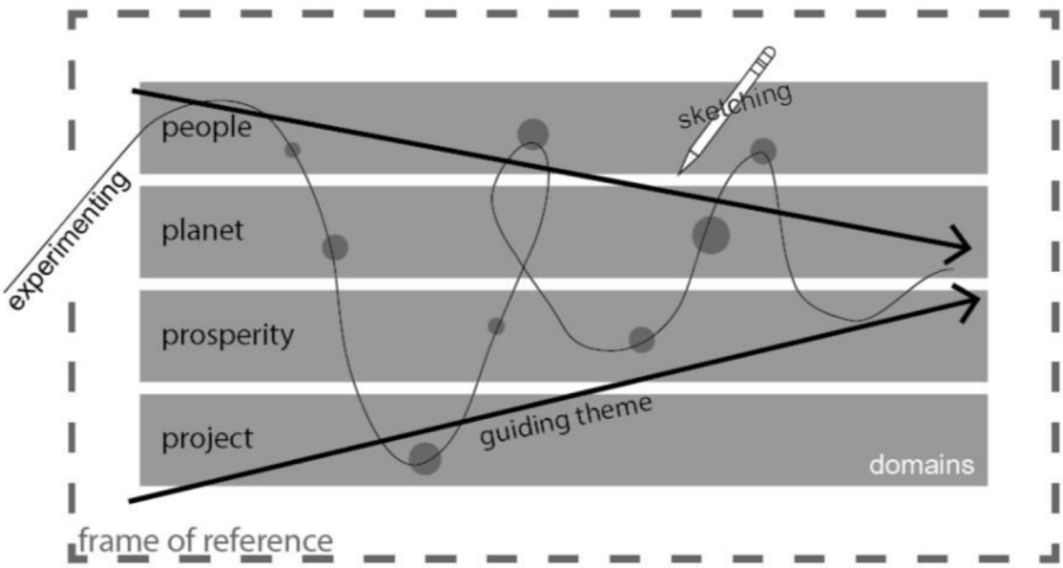

Figure 8-3. A conceptual framework for the design process (original Van Dooren et al., 2013; altered by P. van der Graaf, 2014).

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. As subsoil aspects derive from a wide variety of expertise, it cannot be up to the urban designer to investigate all of them her-/himself. By collaborating with the different experts, the urban designer can get an improved understanding of the context. It is up to the designer to investigate the spatial effects 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 her/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 effects 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 become familiar with modelling such data, know better how subsoil aspects effect their spatial design on surface level and can pick generic solutions from a (3) frame of reference, then taking subsoil conditions into account 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 a self-evident part of the (5) domains and as having the potential to enrich the final design.

9 Balancing decisions for urban brownfield redevelopment

9.1 Conceptualisation of a holistic approach to urban brownfield redevelopment (Balance 4P)

Drawing on the background in Chapters 2-5 and on the results in Chapters 8, the holistic approach to brownfield redevelopment suggested by Balance 4P (Figure 9-1) aims to integrate:

- All phases of the urban redevelopment process, all of which are influenced by the planning conditions set by laws, regulations, policy and institutions.
- Acknowledgement of multiple subsurface qualities in the brownfield redevelopment project.
- Knowledge exchange between the surface and the subsurface sectors, across disciplines within each sector, and over time about the subsurface qualities of the specific Project.
- Focus on the urban redevelopment Project, i.e. identifying strategies for redevelopment that can fulfil a good quality of the built environment.
- Sustainability assessments of redevelopment alternatives capturing the three P's (People, Planet, Profit/Prosperity), which must be considered and evaluated in each urban redevelopment phase, and support the quality of the built environment (Project).
- Putting the Process in focus rather than specific instruments to support sustainable urban development by focusing on identification of WHO should be involved in a knowledge exchange process and HOW it can be mediated.

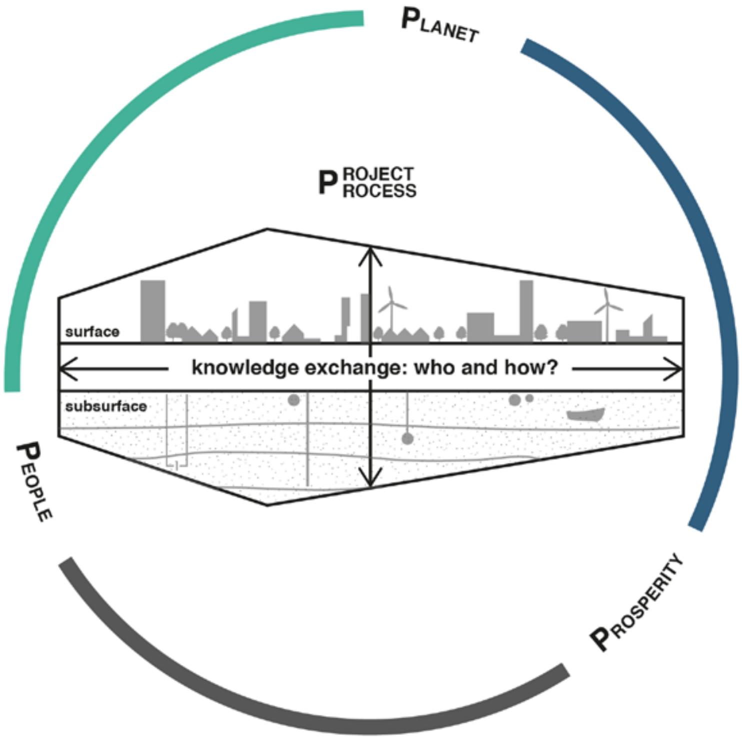

Figure 9-1. Conceptualisation of a holistic approach to urban brownfield redevelopment (Balance 4P). Illustration drawn by Janneke van der Leer, ©Chalmers University 2015.

In the redevelopment process, the holistic approach is defined by an iterative process of project phases that are characterized by the 4P strategy of action, in which stakeholders, planning conditions, site conditions, ambitions and future use, and the development of products (like visons, urban plans or implementation plans) are investigated and/or activated. To enable the suggested holistic approach to operate, subsurface is ideally enhanced by all the four ways suggested in Table 8-3, i.e. enforcement in law and regulation, inclusion in policy and vision, knowledge exchange between surface and subsurface sectors, and integration in urban design. Subsurface inclusion in the early phases of the redevelopment process can however face limited interest of the stakeholders and planners due to the lack of support in policy, law and regulation. An increased support may lead to changes in the planning conditions and thus facilitate a practical implementation of the suggested holistic approach to brownfield redevelopment.

Knowledge exchange is a key aspect for better integration of the subsurface into the urban redevelopment process. For each phase, it is important to identify WHO is going to take part in knowledge exchange and HOW it can be mediated effectively. The question of WHO is also depending on what type of activity is going to take place. As the format of the knowledge exchange is typically not regulated, there is also a need for someone to orchestrate this knowledge exchange, i.e. there must be someone consciously including this activity within the planning process.

Further, it is important to consider and evaluate the three P's of sustainability (People, Planet, Profit/Prosperity) in each urban redevelopment phase. The above mentioned factors that may change planning conditions, knowledge exchange and sustainability assessment results may motivate planners and urban designers to account for both sustainability aspects and subsurface qualities in their plans and designs respectively.

The crucial fact that the 'triple bottom line' should be made specific for urban development to have a clear strategy, is by Van Dorst and Duijvestein (2004) captured by adding the fourth P of 'Project'. This fourth P can also be seen as the P of Process and relate to the interaction between stakeholders and their institutional context to develop and realize an urban plan or design. Here we adopt this view with a special focus on the integration between the surface and the subsurface sectors. The P of Project is here also represented by the qualities that are added by integrating subsurface engineering knowledge into the urban project and specifically into the plan phase of the redevelopment process. The P of Process is here also represented by the interaction and knowledge exchange between the actors in the surface and the subsurface sectors. Hereby, we also mean that it is the process that is in focus, and not the specific instruments to support the process since their applicability and suitability are expected to differ from case to case.

For working towards a practical implementation of the holistic approach, a generic framework to primarily support decisions on e.g. a vision, a plan, or a design in the redevelopment process (Table 3-1) is a way to concretise the holistic approach. In order to develop and test such generic framework, we have used the three case studies from the Netherlands, Belgium and Sweden in the Balance 4P project (see Section 6.1 for overview and Norrman et al. 2015 for detail). In the case studies we focused on (1) the possibilities for enhancing knowledge exchange between the surface and the subsurface sectors in the initiative and plan phases, and (2) a structured approach to generate and evaluate redevelopment alternatives with regard to sustainability aspects from a decision support perspective.

9.2 In practice: lessons learned from case studies

Working in case studies provides insights into what is practically possible and what is associated with practical challenges, which in turn gives feedback towards a decision support framework development. The three case studies used in the Balance 4P project (Section 6.1) are presented in detail in Norrman et al. (2015), but some of the lessons learned from the case study work is repeated here, since it has implications for the development of a generic framework (see Section 9.3).

The SEES methodology (Section 4.5) was tested in all case studies but was most effective where it was used in a workshop setting, i.e. using direct communication. The SEES methodology provided important insights to planners with regard to possibilities and challenges associated with subsurface qualities at the site. It was effective for supporting knowledge exchange between experts in the surface and in the subsurface sector. However, it requires preparations from the participating experts to communicate subsurface information in an approachable form.

It was clear from the Merwevierhavens (the Netherlands) and the Fixfabriken (Sweden) case studies that there is a lot of subsurface information available (e.g. archaeology, geology, and hydrogeology), but it is not systematically treated in the planning process due to the established planning culture. However, available information on soil and groundwater contamination can be very limited in the early redevelopment phases, thus experts are needed to interpret and understand the uncertainties of the available information. Further, it is important to have all subsurface information from both municipality and private companies. The lesson learned from the Merwevierhavens case was also that there is a need for new procedures for transferring subsurface information (in particular, on cables and pipes) when property ownership passes from private to public owners and vice versa.

From the Fixfabriken case, it was found that a structured approach for generating and assessing (urban redevelopment) alternatives can strengthen the work of urban planners. A structured approach can support the evaluation of how well different alternatives meet a variety of requirements: the political goals and visions of a project, but also aspects of sustainable urban development which may not be pronounced in the goals of the specific project.

Redevelopment of brownfields deals with complex systems, and especially so when fully including all subsurface qualities. It was found that all aspects cannot be covered in one type of assessment and instead a combination of instruments should be used to assess sustainability with regard to all pillars. There was also challenges in bringing in too detailed quantitative analyses for assessing redevelopment alternatives in the early plan phases, due to communication and use of results, as well as data availability. Instead qualitative (or semi-quantitative) analyses appeared more applicable in the early phases of the redevelopment process.

A concern is that the methods for subsurface inclusion and sustainability assessments can face limited interest of the stakeholders and planners in the initiative and plan phases due to the complexity of urban redevelopment projects and high degrees of uncertainty in the assessment results. Therefore it is important that there is someone with a clear interest and responsibility for the process to incorporate subsurface into the planning procedures - otherwise it may seem useless to stakeholders. This was especially a challenge in the Alvat case (Belgium), where the municipality responsible for the development of a plan, was not explicitly involved in the case study work. There is a need for a “process-holder” in the brownfield redevelopment case who is responsible for knowledge exchange within each phase and the information transfer between the phases of the redevelopment process.

9.3 A generic framework for supporting sustainable brownfield redevelopment

Based on the lessons learned from cases studies, a generic framework has been outlined (Figure 9-2), in order to support brownfield redevelopment project teams to work towards a holistic approach. The suggested framework aims to provide a structured approach to generate and evaluate redevelopment alternatives with regard to sustainability aspects and has a specific focus on project-specific opportunities for knowledge exchange in the redevelopment process. It aims to enhance knowledge exchange between the two worlds of the subsurface and the above surface sectors by supporting the user with regard to WHO should be involved in the knowledge exchange and HOW this knowledge exchange can be realised with regard to which tools and methods can be used. The main focus of the Balance 4P project has been on integrating subsurface aspects in the initiative phase and the plan phase to enhance opportunities for sustainable brownfield redevelopment. The framework was tested on the cases either in the initiative phase (Merwevierhavens, the Netherlands) or in the plan phase (Alvat, Belgium and Fixfabriken, Sweden).

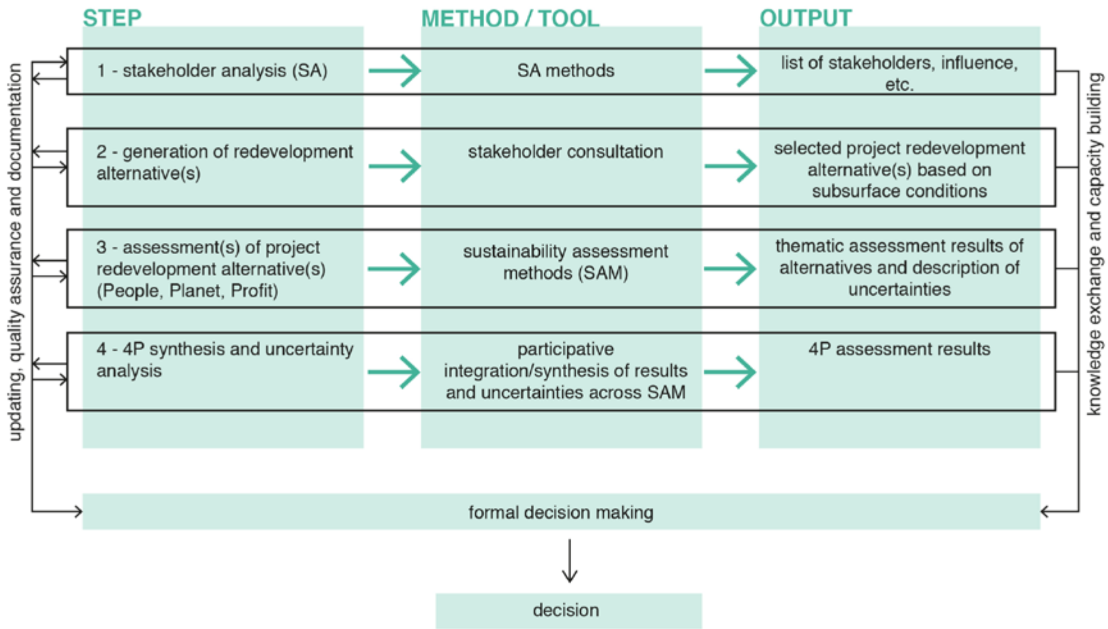

Figure 9-2. A suggested generic framework to support sustainable brownfield redevelopment by (1) enhancing knowledge exchange between surface and the subsurface sectors and (2) to provide a structured approach to generate and evaluate redevelopment alternatives with regard to sustainability aspects. Illustration drawn by Jenneke van der Leer. ©Chalmers University 2015.

The suggested framework includes four steps: (1) stakeholder analysis, (2) generation of redevelopment alternatives, (3) sustainability assessment of the alternatives, and (4) synthesis of the assessment results, including uncertainty analysis and evaluation of the Project (Figure 9-2). Each step represents activities that support knowledge exchange between disciplines, cooperative learning, and inclusion of the three P's in assessing alternative redevelopment scenarios. The fourth P of Project is represented by the specific project and the Process is represented by the work flow in the framework. Each step provides input to the next step but the nature of the work is optimally iterative. Such iteration is important for gradually refining the results, incorporating new information, involving new stakeholders and ensuring the overall responsiveness of the project to changing conditions. It is also important to assure the quality of the results, properly document them and communicate the essence to stakeholders, project team members and decision-makers in approachable formats. The outlined four steps in the decision support framework are meant to support formal decision making in each phase.

It is generic enough to be applicable in each of the four phases of the urban redevelopment process, but the lessons learned from the cases are based on application and evaluation in the early phases and suitable instruments may differ between the steps and phases. The following subsections provide a guidance for project teams willing to engage in enhancing the subsurface into the planning process within existing legislation and planning conditions, i.e. to adopt a holistic approach.

Step 1: Perform stakeholder analysis

Use a method that has proven effective for stakeholder analysis, such as the Crosby method (see Section 6.2). Several activities are involved in this step:

i. Perform a quick scan of stakeholders and draw initial ample list of stakeholders and their relative importance.
ii. Check that all relevant stakeholder groups are represented in the list, e.g. land owners, developers, professional advisors, academics, community groups, financiers, technology suppliers, and regulators. Also include absent voices, such as future inhabitants, future generations, disenfranchised groups, animals, plants etc.
iii. For each group identify the interests to be affected by decisions.
iv. For each stakeholder identify available resources (e.g. knowledge, information, leverage, money), resource mobilization capacity (e.g. low, medium, high) and position on issue (e.g. negative, slightly negative, slightly positive, completely positive).
v. Determine how to involve the stakeholders in the different phases of the project (inform, consult, partnership or control)
vi. Document the stakeholder analysis results.
vii. Revise when necessary (e.g. new stakeholders appear, new activities are planned).

It should be kept in mind that stakeholders' positions on issue identified in (iv) may differ from their actual behaviour in the next step of the framework. Time and effort can and should be saved by involving only interested stakeholders and those who can provide important input. Who provides important input, can potentially be difficult to outline why it is important to make the stakeholder analysis as broad as possible and to engage people with different perspectives in the SA. The involvement of stakeholders may change between the phases of the redevelopment process. It is required to refine the stakeholder analysis e.g. when phases of the redevelopment process change or when a knowledge gap is identified.

Step 2: Generate redevelopment alternatives

This step is aimed at facilitating knowledge exchange between the surface and subsurface sectors when generating redevelopment alternatives:

i. Choose the instrument for generating redevelopment alternatives (examples of instruments are given in Appendix C, Table C-1), based on your knowledge, experience, available resources, cultural setting etc.

ii. Identify which stakeholders to involve for the specific activity, based on the stakeholder analysis performed in Step 1. Ensure that there are representatives from both the surface and subsurface sectors. Engage the identified subsurface professionals in preparing subsurface information about the site in a format approachable for non-experts.
iii. Plan and carry out the knowledge exchange activity/activities using the chosen instrument as communication platform.
iv. Generate redevelopment alternatives that considers the identified opportunities for subsurface inclusion and the challenges presented by the subsurface. In the initiative and the plan phases, the urban designers can then use this information along with existing above surface information to generate redevelopment alternatives.
v. Document redevelopment alternatives (e.g. draw sketches, describe in text).
vi. Revise and refine as new information becomes available (if possible).

From the case studies carried out within the Balance 4P project it was clear that sufficient time and resources must be available for compilation of available subsurface information and its transformation into formats understandable for stakeholders. Application of the SEES methodology in workshop settings in the Dutch and Swedish cases and individual interviews in the Belgian case have both proven to be effective ways for knowledge exchange between subsurface and surface sectors. Still, interdisciplinary cooperation and collaborative learning is best achieved by physical meetings where all relevant stakeholders are actively involved. The SEES matrix also guides in identifying which relevant experts (surface and subsurface) should be present.

In the Merwevierhaven case study, two SEES workshops proved to be an effective way for generating redevelopment alternatives with special focus on subsurface inclusion (see Norrman et al., 2015). The first workshop can be used to sort out the subsurface aspects relevant to the study area. The second one can be used to refine information from the first workshop focusing on the identified subsurface qualities.

Step 3: Assess sustainability of redevelopment alternatives

This step aims to support deliberate consideration of the three P's (People, Planet, Profit/Prosperity) in the brownfield redevelopment Project. The advice for this step is based on the work in the case studies, the work presented in Chapter 7, and the overview of instruments in Appendix C. The following activities are involved in this step:

i. Explore available instruments for sustainability assessment, e.g. by screening of Table C-2 (Appendix C).
ii. Study and assess the purpose/category of potential instruments, the context they were developed in and their relevance e.g. with regard to the current phase of the redevelopment process, covered aspects of sustainability and access requirements.
iii. Check the resources necessary for using the instruments, e.g. availability of necessary time, data and expertise, and possibilities for stakeholder interactions.
iv. Check compliance of the instruments with regulatory frameworks.
v. Choose appropriate instruments for sustainability assessment based on the activities i - iv above.

vi. Identify which stakeholders to involve, based on the stakeholder analysis performed in Step 1.
vii. Identify how to involve stakeholders based on why they are to be involved, i.e. to inform, consult, partner up, and/or control (see Section 6.2).
viii. Perform sustainability assessment of redevelopment alternatives using the chosen instruments.
ix. Perform uncertainty and sensitivity analyses of assessment results to identify the most sensitive variables in the assessment models.
x. Identify overlaps between instruments and review potential gaps.
xi. Document the assessment results in a format understandable for all relevant stakeholders and decision-makers.
xii. Revise and refine as new information becomes available (if possible).

From Chapter 7 it is clear that there is a multitude of sustainability assessment instruments that have been developed for different purposes and different contexts. Instruments seldom cover all aspects of sustainability (Table C-2; Appendix C), but may to some degree overlap. However, even if there are overlaps, i.e. instruments evaluating same type of effects, the results from different instruments may vary.

Different methods and tools should be combined in order to address all three P's of sustainability. It is also possible to use sustainability assessment methods which do not explicitly consider the subsurface if subsurface qualities have been fully integrated in the generation of alternatives.

One of the lesson learned is that bringing in detailed analyses into early redevelopment phases (initiative and plan) is associated with a number of challenges, i.e. communication and use of results, as well as data availability. Instead qualitative or semi-quantitative analyses are advised for sustainability assessment in early phases of the redevelopment process.

Step 4: Synthesize the assessment results

A participatory synthesis of results is an important final step. It is proposed to be performed as a qualitative and integrating analysis of the outcomes together with relevant stakeholders. The outcome of such a deliberation is not necessarily integrated into one final number, but can be used as input for further stakeholder discussions and subsequent decision-making. The assessments of the triple P's aim to support the fourth P, i.e. the urban project, to reach a high quality of the build environment. The following activities are involved in this step:

i. Prepare the "synthesis activity" with relevant stakeholders (e.g. workshop) to communicate and discuss the assessment results.
ii. Identify which stakeholders to involve, based on the stakeholder analysis performed in Step 1.
iii. Communicate the assessment results in an approachable format.
iv. Discuss with stakeholders how the different assessment results affect ranking of redevelopment alternatives.
v. Discuss the uncertainty and sensitivity analyses results (if any).
vi. Discuss how the different analyses overlap.
vii. Document the main discussion points

viii. Revise analysis if necessary (step 3) and arrange a new “synthesis activity” (if possible).
ix. Collect all documents from Steps 1 – 4 and prepare a summary report to provide a basis for formal decision-making.

The assessment results generated by different instruments may affect ranking of redevelopment alternatives in different ways, as was the case for the Belgian and Swedish study sites (see Norrman et al., 2015). Thus, it is important to take time and prepare presentation of the assessment results in a structured way and in approachable formats. This activity, however, may be not only time consuming but also effort consuming. When communicating the summary of results, the objective should rather be to bring complementary knowledge to the table and facilitate and inclusive discussion of the assessments than to arrive at a single number or score.

10 Discussion

The holistic approach to brownfield redevelopment suggested by Balance 4P is process-oriented. It includes the main features advocated in the previous studies (RESCUE, 2005; CABERNET, 2006; REVIT, 2007; HOMBRE, 2013), i.e. acknowledgement of regulation frameworks and policy, a holistic view capturing different redevelopment phases, inclusion of subsurface in planning, people involvement and sustainability assessment of redevelopment scenarios. The complementary features of the holistic approach to brownfield redevelopment by Balance 4P are: (1) knowledge exchange between the surface and the subsurface sectors, across disciplines within each sector, and over time about the subsurface qualities of the specific project, (2) assessment of the three P's (People, Planet, Profit/Prosperity, Project) *in each urban redevelopment phase*, and (3) identifying WHO should be involved in the knowledge exchange process and HOW it can be mediated.

The current state of the art in planning regulations, policy and planning practice in the three countries (the Netherlands, Belgium and Sweden) was examined with regard to the possibilities and obstacles for integrating the subsurface in the planning and design process (Chapter 3 and 4). There are four spatial planning subjects, which are in common in the three planning systems and which potentially can be expanded to subsurface: Heritage, Environment, Nature and Water. For these four urban planning subjects, the integration of above- and underground aspects can be enhanced in different ways and thus enable implementation of the holistic approach: (i) in law and regulation, (ii) in policy and vision, (iii) by structured knowledge exchange, and (iv) in the design/construct process. In order to improve chances for subsurface inclusion in the planning process by necessary changes (i) in law and regulations, (ii) policy and visions, there is a need to communicate the anticipated advantages of the holistic approach implementation to policymakers. The developed decision support framework guidance is focused on chances for (iii) knowledge exchange in the redevelopment process and is aimed to support the teams willing to bridge the two worlds of the subsurface and the surface sectors in the planning process and as a result produce (iv) better plans and designs.

The decision process guidance supports the user with regard to WHO should be involved in the knowledge exchange and HOW the knowledge exchange can be realised, i.e. with regard to which tools and methods can be used to enhance knowledge exchange between surface and subsurface. Crucial for efficient knowledge exchange is to deliver the right information in the right format, at the right time and at the right place[43]. The information should be delivered in a format that is understandable to the receiver – "show the maps but be the legend yourself" (Postma, 2011).

People involvement is an essential feature of the holistic approach to brownfield redevelopment by Balance 4P similar to RESCUE (2005), CABERNET (2006), REVIT (2007) and HOMBRE (2013). Balance 4P like CABERNET (2006) recognizes two large groups of people that must be involved in the brownfield redevelopment process, i.e. (1) the community and (2) people with professional skills. However, focus for the Balance 4P project has been on the knowledge exchange between specific fields of expertise in the planning process. A stakeholder analysis is a first step in the suggested

[43] This conclusion was derived from the BIELLS project, 'Bodem Informatie Essentieel voor Landelijke en Lokale Sturing' (The Netherlands), e.g. Busink and Schouten (2006).

decision support framework, and in this study the Crosby method has been used. The relevant stakeholders may be representatives of both groups, although the involvement in the case studies of Balance 4P was not including the community as such. The community may be involved in generating of redevelopment alternatives in Step 2 of the suggested framework. In planning practice of the three countries (the Netherlands, Belgium and Sweden), citizens' attitudes, views and expectations associated with the intended land use are usually considered and mediated with interests of other involved stakeholders to reach an optimal planning solution. In order to facilitate inclusion of subsurface into the future plans and designs, people with special skills should be involved into the knowledge exchange process. Furthermore, sustainability assessments of the redevelopment scenarios may also demand contributions from both groups: citizens and experts.

Local community involvement is today often seen as an important part of sustainable development. However, it is not without challenges. How it is realised in practice and how it relates to the formal decision-making hierarchy are important aspects to consider. A literature review by Reed from 2008 shows that already then, and several years back, there has been an increased demand and implementation of stakeholder participation in both national and international policy guidelines for conducting environmental projects. Even if there are some proof of that stakeholder participation processes can increase the quality of decisions related to environmental projects, few tests have been done to support this or other potential benefits (Reed, 2008). Furthermore, the quality of the decisions is strongly dependent on how the decision process is designed, where the process should focus on the participation itself (Reed, 2008). A number of methods have been developed to facilitate the transmission of information as well as its selection and aggregation, aiming to foster learning in participatory processes. However, these methods for participatory processes should be context-driven, i.e. methods should match goals and purposes of the participatory process as much as the attributes of stakeholders and participants (Newig et al., 2008; Stringer et al., 2006). Participatory processes put high demands on flexibility and diversity of methodological skills of project organisers (Newig, 2008). Importantly, when champions[44] as facilitators of community do not emerge, reliance on traditional public participation processes fails to promote community involvement and the redevelopment progress may be stalled (Gallagher, 2009). Thus, it is important to carefully plan when and how to involve community into a redevelopment process. Cundy et al. (2013) specifically stresses the importance of stakeholder involvement in brownfield remediation redevelopment projects where gentle remediation options (GRO) can be implemented.

In this report it has been little focus on absent groups, or groups with weak voices, e.g. future generations or other groups in society that have little capacity to make their voices heard. Although the issue of intergenerational equity is at the heart of sustainable development, there are also possible challenges with equal distribution of benefits from brownfield redevelopment projects (Dale and Newman, 2009). Liveability in focus without considering aspects of equity may lead to gentrification of the retailscape and a shift to higher-income residents, forcing out potentially existing middle and lower-income residents (Dale and Newman, 2009).

[44] Champions are individuals whose behaviours significantly extend their formal roles, here in the setting of public participation (Gallagher, 2009).

Practical implementation of the holistic approach may be achieved either top-down or bottom-up. The former implies that policymakers stipulate subsurface inclusion in the planning process by necessary revisions in law and regulations, policy and visions. This may trigger the changes in the current planning conditions and influence well-established planning culture. The bottom-up implementation demands enthusiasm and a free will from the stakeholders and planners to fully consider subsurface in early phases of the redevelopment process and produce better plans and urban designs. The decision support framework by Balance 4P is aimed to support such efforts. It is anticipated that the associated extra expenses in the initiative and plan phases can be compensated by more cost-effective subsurface solutions in the plan realisation phase. Costs with regard to subsurface inclusion in the early phases and benefits with regard to subsurface solutions in the realisation phase should be carefully evaluated and fairly distributed between planners and developers. Implementation of the holistic approach in planning practice may enhance the chances for maximizing the added value of the brownfield site especially of the B- and C-types where redevelopment realised in part by public funding.

Furthermore, to enable practical implementation of the holistic approach to brownfield redevelopment, there is a need for a brownfield process manager who is trained to be a process-holder, responsible for knowledge exchange within each phase and the information transfer between the phases of the redevelopment process. The urgent need for this new type of brownfield specialists has also been stressed by CABERNET (2006). The brownfield managers nowadays are usually trained geologists and environmental engineers who have technical skills to solve contamination problems, however wider skills are needed in order to deliver long-term successful redevelopment. There is therefore a need for the education program in higher education which is aimed to develop a range of essential skills required by a brownfield process manager (CABERNET, 2006).

11 Concluding remarks

- The holistic approach to brownfield redevelopment by Balance 4P has the following features:

  (i) recognizes all phases of the urban redevelopment process which are influenced by the planning conditions set by laws, regulations, policy and institutions;
  (ii) acknowledges multiple subsurface qualities in the brownfield redevelopment project;
  (iii) promotes knowledge exchange between the surface and the subsurface sectors, across disciplines within each sector, and over time, about the subsurface qualities of the specific project;
  (iv) focus on the urban redevelopment project by identifying strategies for redevelopment that can fulfil a good quality of the built environment;
  (v) assesses the three P's (People, Planet, Profit/Prosperity) in each urban redevelopment phase; and
  (vi) puts the Process in focus rather than specific instruments by focusing on identification of WHO should be involved in the knowledge exchange process and HOW it can be mediated.

- The suggested decision support framework is aimed to guide project teams willing to implement a more holistic approach in practice and supports the features listed above. The framework includes four steps which should be carried out in an iterative manner: (1) stakeholder analysis, (2) generation of redevelopment alternatives, (3) sustainability assessment of the alternatives, and (4) synthesis of the assessment results, including uncertainty analysis. The framework may guide the project teams on WHO should be involved in the knowledge exchange and HOW the knowledge exchange can be realised, i.e. with regard to which tools and methods can be used to enhance knowledge exchange between surface and subsurface.

- Several instruments are available for subsurface inclusion in the redevelopment process. A multitude of instruments for sustainability assessment exists. These instruments have been developed for different purposes and different contexts. Furthermore, the instruments seldom cover all aspects of sustainability, but may to some degree overlap. Different methods and tools should be combined in order to address all three P's of sustainability and to support the Project-specific challenges and opportunities. It is also possible to use sustainability assessment methods which do not explicitly consider the subsurface if subsurface qualities have been fully integrated in the generation of redevelopment alternatives. A tool that can support the process of communication and knowledge exchange efficiently is good enough if there, at the same time, is a conscious process of ensuring that all relevant aspects are considered, and if not covered by one tool, that additional analyses are carried out.

- The guidance describing the steps in the decision support framework and activities within each step may (1) structure the decision process and provide support to project teams; (2) enhance chances for subsurface integration into the planning process by knowledge exchange; (3) facilitate selection of appropriate instruments for sustainability assessment; and as a consequence (4) ensure production of better plans and urban designs.

- Practical implementation of the decision support framework and the holistic approach may be associated with the following obstacles:

  (a) lack of regulatory and policy support for systematic inclusion of subsurface in the planning process;
  (b) the quality of the information transfer during the redevelopment process when involved actors and applicable regulatory frameworks change over time;
  (c) limited interest of the stakeholders and planners for subsurface inclusion and sustainability assessments in the initiative and plan phases due to the complexity of urban redevelopment projects and well-established planning culture;
  (d) constrained planning project budget and unclear distribution of risks and costs between developers and planners with regard to subsurface investigations and solutions: who is willing to pay for early investigations if future revenues are highly uncertain?

- The anticipated advantages of the holistic approach are (i) redevelopment plans that allow for smart, cost-effective and sustainable solutions in the implementation process by making explicit use of subsurface information and knowledge in the planning process, and (ii) possibilities for more long-term sustainable planning with regard to the subsurface by increased awareness of the subsurface as a resource and the associated risks and possibilities.

- The importance of subsurface inclusion into the planning process and the anticipated advantages of the holistic approach to brownfield redevelopment should be communicated not only to the scientific and professional communities but also to policymakers, in order to make them do revisions in planning law, regulations and policy, and thus trigger necessary changes of the current planning conditions and influence planning culture.

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Appendices

Appendix A – Comparison of planning system using COMMIN

Table A-1. Comparison of the spatial planning systems in the Netherlands, Sweden and Flanders.

Source for criteria: COMMIN THE BALTIC SPATIAL CONCEPTSHARE reference to the original document http://commin.org/en/planning-systems/comparison-of-planning-systems/			information filled by BALANCE4P NETHERLANDS Spatial Planning	information filled by BALANCE 4P is highlighted with light blue, the text in dark blue is based on COMMIN SWEDEN Spatial Planning	information filled by BALANCE4P FLANDERS Spatial Planning
CONSTITUTIONAL	1 Planning legislation	Which types of by-laws exist outside the central legislative council(s) of the state and by whom are they adopted?	Municipalities have the right to enhance the national building law with local regulations (gemeenteverordening)	Only the parliment (Riksdagen) can develop new and improve old laws in the field of planning.	Land and building Decree(to regulate social housing); Decree for renewal (to prevent empty stock); Housing Act
	2 State-municipal division	Which constitutional principle(s) regulating state-municipal relations exist and what is it called?	Planning Act (Wet Ruimtelijke Ordening)	State-municipal relations are regulated by municipal self-government.	Before 1970s, the Belgian Federal Government was the planning authority; this are now the regional governments. Brussels, Flanders and Walloon
	3 What are main responsibilties of:	state	Main responsabilities of the state are: legilative; Structure vision infrastructure & space	Protection of national interests and sectoral planning are main responsibilities of the state.	Flanders planning system operates on a subsidiarity principle. Competences are regulated in 1996 Spatial Planning Decree
		regional and	Main responsabilities of the Provinces are: regional vision (Streekplan); check land-use plans against Streekplan; management of infrastructure; assist municipalities. Grant permits considering the middle deep layers. Water Boards are there for organising and maintaing the water system.	The County Administration Board (the main regional authority) is responsible for guiding and scrutinizing municipal comprehensive plans with regard to national interests and for adressing appeals to municipal detailed plans.	Provincial plans are checked by the regional department; Provinces checks the municipal plans.
		municipal planning agencies	Municipal planning departments make development plans and land-use plans (bestemmingsplan; issue local ordinances and grant building permission. also involved by subsurface user functions related to land use planning (bestemmingsplan)	The municipality is responsible for comprehensive planning and legally binding detailed planning.	Main responsibilities of the municipal planning agencies is making Spatial Structure Plans and Implementations plans.
	4 Access to public authority matters	The people's right to be informed and their right to give their voice: Are they defined as constitutional rights and what is the name for that principle?	Yes, Wet Openbaarheid Bestuur New plans need to be published online.	Yes. The free access to official documents (offentlighetsprincipen) and citizens' participation in planning are the constitutional rights of citizens.	Yes, Flanders has a Decree Publicity of Governance. Plans need to be published.

	5 Property rights	Does the constitution protect property rights against public intervention and what is the constitutional principle in case of public taking?	Yes, the constitution protects property rights against public intervention. In case of public taking the principle of expropriation for public needs against compensation is applied.	Yes, property rights are protected against public intervention by the constitution. Under the Expropriation Act, the privately owned land can be expropiated for public needs (e.g. using the compulsary purchase procedure); the market value of the expropriated parcel is compensated to the landowner.	Yes, the constitution protects property rights against public intervention. In case of public taking the principle of expropriation for public needs against compensation is applied.
	6 Public rights to the use of land	Is there a general access to land and water and is there a specific right for it?	general access to land and water is not regulated. so-called 'recht van overpad' is private and historically present or not in contracts	According to "everyman's right" (allemansrätt) everyone has the right to cross and stay temporarily on another's land and water areas provided his behaviour is not disruptive and he does not cause any damage. The right is guaranteed in the Constitution (Chapter 2, article 18, [Sveriges grundlagar]). It is allowed to pick mushrooms, wild berries, pinecones, wild flowers and suchlike on another person's land (regulated in Chapter 12, Section 2, Penal Code [brottsbalk 1962:700]).	The freedom to roam, or everyman's right is the general public's right to access certain public or privately owned land for recreation and exercise. The right is sometimes called the right of public access to the wilderness or the right to roam.
	8 Groups to be prioritized in planning	Is planning meant to give favour to particular groups of the population and if so, which groups are favoured?	Planning is meant to balance acces to urban resources for all citizens	All groups of the population ara eqaly treated in planning.	Planning is meant to balance acces to urban resources for all citizens
NATIONAL	1 Planning organization	A) Are the legal responsibilities for planning and management at national level within one ministry?	Legal responsibilities for planning and management at national level lie with the Ministry of Infrastructure and Environment (housing = Min. Internal Affairs). and Minsitry of Economic Affairs	No, different ministries have different legal responsibilities for planning and management at national level. E.g. the Swedish National Board of Housing, Building and Planning [Boverket] is a central government authority administered by the Ministry of Health and Social Affairs responsible for planning legestation. The Environmental Protection Agency [Naturvårdsverket], the Ministry of the Environment, responsible for legislation with regard to natural resource management in planning projects.	Legal responsibilities for planning and management at national level lie with the Ministry of the Environment, Nature and Energy
		B) What is the name of the planning law at national level?	Wet Ruimtelijke Ordening (Territorial Planning Act). Soon Environmental Act	The Planning and Building Act is the name of the law at national level.	The name of the law at Flanders level is Planning Decree
	2 Laws of particular importance in planning	Which laws have a particular importance in planning at national level?	A number of Laws have impact on planning such as: Environmental Code, Noise pollution Act; Roads & dangerous transport Act, Railway Act (etc), Mining Law, WBB?	Environmental Code, The Roads Act, The Railways Act are laws having a particular importance in planning at national level.	Structural plans give guidelines. Decreeing power lies in implementation plans

3 Regulations and instruments in central government policies and planning	A) Which policy guidelines exist in central government policies and planning?	The National Territorial Structure Vison (SVIR) is informed by international competetiveness, flood protection and	The central government policy that governs a planning process includes environmantal quality objectives summarized e.g. in The Swedish environmental objectives system 2013 (http://www.miljomal.se/Global/24_las_mer/broschyrer/the-swedish-environmental-objectives-system-M201301.pdf).	SVIR 2012: Productive landscape; long term uncertainty & governance; welfare & wellbeing
	B) Which legally binding regulations exist in central government policies and planning?	A legally binding regulation in central government policies and planning is the Territorial Planning Act.	The Planning and Building Act and Environmental Code are legally binding regulations in central government policies and planning.	A legally binding regulation in central government policies and planning is the Planning Decree and a number of ordinances.
4 EU regulations	Which EU regulations are adopted/ applied?	Natura 2000, Soil Protection Act; Malta Treaty, Water Framwork Directive, Environmental Impact Assesment	Natura 2000, Water Framework Directive, Waste Directive, Environmental Impact Assessment	Natura 2000, Soil Protection Act; Malta Treaty, Water Framwork Directive, Environmental Impact Assesment
5 Subsoil management (*Included by BALANCE 4P*)	**Which instruments / regulations considering soil management are applied?**	There is a Nation Structure Vision Subsoil (STRONG) in preparation; soil convenant and SV shalegas (both in preparation), Basis registration subsoil (EU INSPIRE) National rspronsibility is >500m mostly considering oil and gas winning. For Cables and Pipes there is KLIK info-system and also archaeology is steered on national level.	Legislation related to the subsurface can be divided into four groups: (i) "soil and groundwater quality" regulated by the Environmental Code; (ii) "archeology" regulated by the Heritage Conservation Act (kulturmiljölagen) of 1988; (iii) "use of natural resources" regulated by the Water Act (vettenlag) of 1983, the Mineral Act (minerallagen) of 1991, the Peat Deposits Act (lagen om vissa torvfyndigheter) of 1985, and the Continental Shelf Act (lagen om kontinentalsockeln) of 1966; and (iv) "underground installations" regulated by The Pipelines Act (rörlrdningslagen) of 1978, the Water and Sewerage Act (lagen om allmänna vatten- och avlopsanlägningar) of 1970, the Public Heating System Act (lagen om allmänna värmesystem) of 1981, the Electrical Installations Act (ellagen) of 1985, and the Telecommunication Ordinance (teleförordningen) of 1985.	
6 Nature conservation and cultural heritage	Which nature conservation instruments, and which instruments relating to cultural heritage are applied?	Nature conservation instruments applied are: Flora & Fauna Act Heritage is protected by Monuments Act.	Environmental Code and The Heritage Conservation Act are nature conservation instrument and cultural heritage instrument respectively.	Nature, Forrest, Bird, Protecten Flora & Fauna and Habitat Decrees; Protection of Monuments and Town and City Scapes (1976), Decree Protection of Landscape (2010) and Decree Protection of Archaeology (1993)

	7 Integration of sectoral aspects	A) Are there certain bodies/ instruments for integration of sectoral aspects?	Structure visios, Regional Plans & zoning plans integrate sectoral aspects	Legally binding land and water use restrictions through special area regulations (områdesbestämmelser) in comprehensive plans, e.g. recreational amenities, communication routes, restricted areas and safety zones.	The Spatial Structure Plans are the integration of sectoral aspects.
		B) Which formal duty for integration of sectoral aspects exists?	Environmental Impact Assesment	Integration of sectoral aspects is a formal duty of the County Administrative Boards.	
	8 Environmental Protection *(Included by BALANCE 4P)*	**Is there an independent Environmental Impact Assesment Committee?**	Yes, it requires structure plans and zoning plans to consider all relevant data of environmental assesment in order to make a sound decision, advice is not binding but in case of a law suit it's advice is ussually adopted by the court	No, Environmental Impact Assessment (EIA) is done on the municipal level only for (not legally binding) comprehensive plans in consultation with the County Administration Board and sometimes neighbouring municipalities. EIA for the legally binding detailed plans is performed only if the municipality judges (behovsbedömning) that the proposed development may cause "substantial environmental impact" (betydande miljöpåverkan).	The project needs to hire an certified EIA expert to lead the team of experts that make the report. This certification is to ensure quality of the report and takes a procedure leaded by th Environmental Licences department and supported by different other departments. The report is assesed by the Department of EIA.
REGIONAL	1 Territorial organization	A) Are decentralized state agencies, regional and municipal entities acting authorities in planning?	Yes, decentralized state agencies, regional and municipal entities are acting authorities in planning.	Yes, decentralized state agencies, regional and municipal entities are acting authorities in planning. However, the municipality has a planning monopoly. Regional bodies only consult to ensure national and public interests in a planning process.	Yes, decentralized state agencies, regional and municipal entities are acting authorities in planning.

		B) What is the territorial unit of the regional level, what is the decentralized state authority and what is the regional planning authority? (*Included by BALANCE 4P*)	The territorial unit at regional level is the Province, for regional planning and inter-municipal coordination. The decentralized state authority is the Province administrative board. The regional planning authority is the Regional planning body.	Regional planning is only undertaken for the Stockholm and the Gothenburg regions. The Stockholm County Council (Stockholms län landsting) and the Gothenburg Regional Association of Local Authorities (Göteborgsregionens komunalförbund) are governmental bodies responsible for regional planning in the respective region. Regional plan is adopted only for the Stockholm County. In the Gothenburg Region, regional planning is carried out without formal regional plans. In orther cases the County Administration Boards are regional bodies which does not have planning competence but consult and coordinate the municipalities in the planning process to secure national and public interests in the plans.	The territorial unit at regional level is the Province, for regional planning and inter-municipal coordination. The decentralized state authority is the Province administrative board. There are also Arrondissements.
	2 Forms of planning at regional levels (planning process)	Which forms of planning/ planning processes exist at regional level?	superimposed or self-organized regional (planning) associations	The forms of planning/ planning processes at regional level are regional development programming, regional planning for Stockholm County and Gothenburg region.	The Provences and Arrondissements are part of the three step planning system of Flanders, regional and municipal scale.
	3 Statutory categories of plans (planning products)	Which statutory categories of plans/ planning products exist at regional level?	Statutory categories of plans ar regional level are development program and structure vision by the Provencies, the water Boards make Water Plans	The regional development programme and the regional plan (voluntary) are plans/ planning products at regional level carried out for Gothenburg and Stockholm respectively.	The Provincial Development Agency makes a Spatial Structure Plan. This is translated to a Spatial Implementation Plan.
	4 Body mandated for initiating and approval of plans	Which body is mandated for the initiation and the approval of plans at regional level?	The Provincial council are mandated for the initiation and approval of regional development programmes	The Stockholm County Council (Stockholms län landsting) and the Gothenburg Regional Association of Local Authorities (Göteborgsregionens komunalförbund) are governmental bodies mandated to initiate and aprove regional plans and programmes respectively in the respective region. Any County Concil can initiate regional planning.	The Flanders government.
	5 Binding force of regional plan	A) Is the regional plan binding on subordinate planning?	Yes, municipalities must check building applications to provincial stuctural plans. The water boards do the water assesment of plans.	No, the regional plan does not have a binding force on subordinate planning.	Yes, municipalities much check building applications to structure and implementation plans

	6 Subsoil management ***(Included by BALANCE 4P)***		A numer of provinces made a Soil Vision that is aiming at integrating the subsoil in planning. Methods to integrate subsoil in spatial planning like the Soil Ladder Provinces and water boards are responsible for watermanagement, the province for layer inbetween (aquifers) in relation to extraction permits, they also deal with contamination. The water boards maintain the regional water system, dikes, pumps and open water. The Province is also framing archaeology.	The concession from the Government is needed for extraction of minerals, The permits for mineral extraction are granted on the national level. The archeological and soil remediation procedures are coordinated on the regional level by the County Administration Boards. The County Administration Boards also oversee hazardous activities, such as energy facilities, quarries and mines.	Waterboards and *wateringen* for water management. For contaminated soil there are Brownfield decrees and convernants.
LOCAL	1 Territorial organization	a) Which local territorial unit(s) exist(s)?	rural *buitengebied,* village *dorpskern,* town *stad, area* wijk	The municipality is a territorial unit at municipal/ local level.	Municipality
		b) Is the local planning authority also the local building authority?	Planning and Building are 2 departments of the same authority	No, the local planning authority and the local building authority are different entities by law.	*Planning and Building are 2 departments of the same authority?*
	2 Local planning authority bodies	A) Which are the local committees and/ or the local supreme authority for initialization and adoption/ endorsement of plans?	The local committee for initialization and adoption/ endorsement of plans is the Standing committee for planning matters (various names, depends on the municipality) and the local supreme authority for initialization and adoption of plans is the Municipal council.	The Standing committee for planning matters (various names, specific name depends on the organisation of the municipality) is the local committee for initialization and adoption/ endorsement of plans. The Municipal Council is the local supreme authority for initialization and adoption of plans.	*The local committee for initialization and adoption/ endorsement of plans is the Standing committee for planning matters (various names, depends on the municipality) and the local supreme authority for initialization and adoption of plans is the Municipal council.?*
		B) Do legally notified instruments exist to cooperate between municipalities and which are the instruments?	Legally regional collaboration may be superimposed by national government, sometimes it is a voluntary initiative of municipalities (non legally notified)	Yes, the regional plan is a legally notified instrument to cooperate between municipalities (used only for Stockholm County). Otherwise, despite the planning monopoly of municipalities, the State has right to interfere in municipal planning in order to protect structures of national interests, national resources and inter-municipal issues.	Yes, on the provincial lever the Structure Vision and the Implementation Plan are putting links between smaller units.
	3 Forms of planning	A) Which forms of planning for the territorial unit exist at local level?	Vison for municpal level, Masterplan for distict level (both no binding status) and then on the lowest level the Land use plans (bestemmingsplan) are the legal instrument for planning at local level. These are under development towards and Environmental Plan	The municipal comprehensive plan is the form of planning for the territorial unit at local level.	Spatial Implementation Plans are the legal instrument for planning at local level

		B) Are there plans for various levels and how are they called?	City Vision, Master Plan, Urban Design Plan (Zoning Plan), Public Space Plan	Yes, there are two levels: (i) municipal comprehensive plan (översiktsplan), and (ii) municipal detailed plan (detaljplan), and special area regulations (områdesbestämmelser). In some cases the comprehensive plan can be deepened (fördjupad översiktsplan).	Yes, there are plans on two levels the Municipal Structure Plan and the Municipal Implementation Plan
	4 Regulation instruments of local plans	*A) Are land use zoning categories required in local plans?*	Yes, land use zoning categories are required in 'bestemmingsplan'	Yes, there is a separate legally binding planning product called special area regulations (områdesbestämmelser) with land and water use restrictions, e.g. restricted areas and safety zones, land reservations for communication routes. The municipality can reserve land (markreservat) for public purposes in the datailed plan, e.g. streets, electrical communication network, other communications for public purposes.	Yes, land use zoning categories are required in Municipal Structure and Impementation Plan
		B) Which formulations are applied for giving future directions in local plans?	Master plans contain guidelines; Zoning plans provide legally binding regulations concerning land-use and building envelope.	Comprehensive plans contain not legally binding guidelines. Detailed plans provide legally binding regulations concerning building and land use.	Structure Plans (sometimes called Master Plans) contain guidelines; Implementation Plans provide legally binding regulations concerning land-use and building envelope but also maintenance.
	5 Overall local plan	A) What is the name of the overall local plan(s), and is it legally binding?	The overall local plan is usually the Municipal Development Vision. It is not legally binding	The overall local plan is the municipal comprehensive plan, which covers the entire municipality. It is not legally binding.	The overall local plan is the Municipal Structure Plan. It is legally binding
		B) What are the main components of the overall local plan(s)?	The main components of the overall local plan are diagnoses, vision, maps and indicative timetable	The plan (översiktsplan) that covers the municipality, consulatation report (samrådsredogörelse) and revision statement (granskningsyttrande) are the main components of the overall local plan.	The main components of the RUP are diagnoses (situation physical, jurisdictional, spatial option), urban guidelines in maps, drawings and texts.
		C) Which statutory zoning and land use categories are shown on the plan map?	Identification of districts and their future development, thematic in housing area or centre district.	The comprehensive plan containes specifications on the intended use of land and water areas within the boundaries of the municipality; descriptions on how national interests and environmental quality standards are ensured; how the municipality is intended to develop and protect the built environment; how the comprehensive plan complies with regional and national objectives, plans and programmes with regard to sustainable development; how the municipality ensures housing provision in a long run.	The following should be clear from the plan: the vision of and intended use of land in the area,

	D) Is the time horizon of the overall plan(s) positively limited and for how long?	It differs per city but it usually is about 30-50 years.	The comprehensive plan should be revised at least every 5-6th year. No any legally binding time horizon limitations for the comprehensive plan.	There are no horizon limits.
6 Detailed plans	A) Is there a free right to initiate a detailed development plan, what categories of these plan(s) exist and are they legally binding?	Yes, there is a free right to initiate a detailed development plan, the municipality need to check the plan before implementation against formal existing plans & regulations	Yes, a detailed plan there can be initiated by private landowners but the municipality can refuse the initiative without a right of appeal (municipal planning monopoly). The detailed plan is legally binding.	The municipality makes the Municipal Spatial Implementation Plans.
	B) Are time limits set for the public handling of detailed development plans and is the time horizon/ validity of these plan(s) positively limited?	Zoning Plan needs to be updated within max 10 years	There are no time limits set by law for the public handling of detailed plans. The time horizon of the detailed plan is positively limited: the not used development rights are protected up to 5 - 15 years.	There is no time limit.
	C) Which statutory land use zoning categories exist in detailed development plans?	Type of plan, type of usage (housing, water, traffic, garden, sports, recreation, nature, societal, trade, green, mixed, service, industry, trade, culture, centre, forrest, agriculture and office), double zoning, type of hindrance contour, type of plan, type of juristicial level.	Land use zoning categories in the detailed plan are (i) districts (kvartermark) with different types of use, e.g. industrial, commercial, residential, mixed; (ii) public spaces (allmänna platser), e.g. recreational amenities, communication routes; (iii) water areas (vattenområden) with different types of water use; and (iv) land reservations (markreservat) for public purposes, e.g. streets, electrical networks, other communications for public purposes.	Boarder, Usage: housing four types), centre (two types), shops, leisure, industry, green, public space, trade and right of sale.
7 Development control	A) Which statutory density measures are implemented in addition to land use zoning categories?	In addition to land use zoning categories different means are used to regulate building within blocks, height of structures, number of storeys, floor space etc.	Different means are also used to regulate building within districts, i.e. height of structures, number of storeys, floor space etc.	In addition to land use zoning categories different means are used to regulate building within blocks, height of structures, number of storeys, floor space etc.
	B) What are the statutory categories of building permit matters?	Statutory categories of building permit matters are: Building permit, Demolition permit, *woonruimteontrekking* permit.	These are (a) building permit (bygglov), (b) demolition permit (rivningslov), and (c) site improvement permit (marklov).	Statutory categories of building permit matters are: Building permit, Demolition permit, divide permit, change of groundfloor permit. Urban development permits: plot permit, function change permit and care permit.
	C) What are the categories of permits for projects requiring building application and are there time limits for the permit`s validity?	Buildingactivities may require a 'light' of 'full' building permit and need to start within a year.	The permits' validity is limited to a two year time period.	The permits' validity is limited to a two year time period.

		D) What relation has the Zoning plan to the building permits? *(Included by BALANCE 4P)*	The zoning plan is checked to see if the building application is meeting the requirements in that zone. There is a very strong connection.	There is a very strong connection between building permits and the leaglly binding detailed plan. The latter is checked to see if the building application meets the requirements in the detailed plan.	The RUP plan is checked to see if the building application is meeting the function requirements in that zone. There is a very strong connection. Private people can ask for a change of of RUP.
	8 Subsoil management *(Included by BALANCE 4P)*		Through the Zoning Plan some categories of the subsoil are touched on a munipal level. But next to water, remediation, archaeology and cables and pipes there is no active management or vision. Some municipalities are working on a Master Plan for the subsoil.	Only archeological procedures integrated into a detailed planning process (early stage). The soil remediation procedures are usually carried out in the late stage of detailed planning or after approval of the detailed plan. Contaminated soil related issues are handled on both municipal and regional levels, but since the division of responsibilities is not clear in the legislation the Swedish Environmental Protection Agency is currently inquiring into this issue. There are special regulations in the detailed plan defining land reserves (markreservat) for jointly owned facilities (gemensamhetsanläggningar), easements (servitut), and utility easements (ledningsrätter).	Through the RUP some categories of the subsoil are touched on a munipal level: level and relief of the ground floor, pavement of the lots.
PARTICIPATION	1 The entitlement to inform and the right to get access to information (answers sorted by levels)	Are there statutory requirements for informing the public and public access to information?	Zoning Plans need to be available online	Yes. Firstly, the constitution principle of free access to official documents (offentlighetsprincipen) garantees public access to information. Secondly, the rules for regional planning in the Planning and Building Act ensures that the public is informed and has access to information.	All RUP's are availeble online.
	2 Particular participatory instruments beyond information in the planning process	Are there statutory instruments for public participation during the preparation of plans like number of hearings, meetings, etc.?	Yes, plans need to be made public and a period of time that citizens can appeal to the plans.	There are no statutory instruments for public participation at regional level during the preparation of regional development programmes but regional plans require public reviews, public exhibition and comments on public opinions. The public has possibility to leave comennts on the municipal comprehencive plan during the exhibitaion phase (utst'llning). The public is involved during preparation and exhibition of the detaied plans.	Yes, plans need to be made public and a period of time that citizens can appeal to the plans.

	3 The public opportunity to challenge the plan after the plan is formally adopted	Is there an option for an appeal in order to challenge the plan after it is formally adopted?	No	Nobody can appeal in order to challenge the comprehensive plan after it is formally adopted, because it is not legally binding. But the residents can express dissatisfaction with the planning process initiating the local appeal procedure (kommunalbesvär) under the Local Government Act (kommunallag) of 1991. The content of the adopted legally binding detailed plan can be contested by appeal to the County Administrative Board, whose decisions in turn can be contested to the Land and Environmental Higher Court (Mark- och miljööverdomstolen), and ultimately to the Supreme Court (Högsta domstolen). The detailed plans can be appealed to the County Administration Board on the reginal level.	No
BUILDING PRACTICE	**1. Who initiates urban development? (*Included by BALANCE 4P*)**		Municipalities used to get a assignement for building a certain amount of houses in their region form the national state. Provences support these numers in their structure plan, municipalities would initiate the developement. Today development takes formost place in existing urban tissue, the initiative is with the project developer, housing cooperation or self organized citizens. private house ownership is 56%, housing association 30 %.	There are several models of the development process depending on the ownership conditions within the development area and the role of the developer in the process. Initiative may come from the municipality because of need for housing, non-residential development or the enlagement and improvement of infrastructure provision. The initiative in changing the land use may also be taken by owners of a prospective development area.	Private developers, more than 70% percent of the houses are private property.
	2. What steps are taken into the process, related products? (*Included by BALANCE 4P*)		There is an initiation phase that looks into the feasability and formulates a vision, then there will be a masterplan, a urban design plan and design for public space.	The process consists of vision formulation and detailed planning of the development area. When developer owns land, he playes an active role in a planning process. Municipality and developer may agree that land for puplic purposes, e.g. streets and green, is to be conveyed to the municipality and that developer reserves space for services and communal facilities.	Land owners develop their lot in relation to the RUP. But land can also remain unbuild for a long time.

3. What role does the government play? (*Included by BALANCE 4P*)	The government changes from initiator and producer to facilitator. They bring parties together and set out tenders for cooperations to propose a development.	The Government through its representative at the regional level (County Administration Board) ensures protection of structures of national interests, national resources and inter-municipal issues in the planning process. Planning of high-, rail-, tram- and subways is in responsibility of Government under the Road Act (väglagen) of 1971 and the Railway Act (järnvägslagen) of 2004.	The government does not take initiative in urban development. Land exploitation is not excucted like in the Netherlands, they have tax as main source of income.
4. How is knowledge integrated in the plan and design process? (*Included by BALANCE 4P*)	Technical support always came from the municipality. In the new organic development it is unclear what the role of the municipality is in supporting knoledge integration.	Technical support comes from responsible divisions at the County Administration Boards and the municipality, as well as consulting agencies.	unknown
5. How is subsoil inserted in the development process? (*Included by BALANCE 4P*)	There is now no common practice concerning introducing subsoil into the developent, this works through experts who enter late in the process.	Archeological procedures integrated into a planning process. Planning of subsurface electrical installations and municipal facilities (pipelines) are integrated into the planning process. The soil remediation procedures are usually carried out in the late stage of detailed planning or after approval of the detailed plan.	there are some urban development rules that include the subsurface.

Table A-2. Expanded COMMIN system – the Netherlands.

The Netherlands				
Spatial development:	**institutions**	**laws**	**policy/instruments**	**regulation**
EU	Board of European Ministers of Spatial Planning		European Spatial Planning Charter (1983); European Spatial Development Perspective (2003)	
		Waste Directives Natura 2000		
				EU Guidelines energy performance for buildings (EPBD)
			INSPIRE Directive (2007): information gathering	
National	Ministry of Infrastructure and Environment (Institute for Social Research, Environmental Assesment Agency)	Spatial Planning Act (2008) > Environmental Act	Structure Vision Infrastructure and environment 2040 (2012)	
		Nature Protection Act Noise Polution Act Transport Dangerous Substances Act		
	Ministery of Internal Affairs	Building Act (2012)		Building Codes
	Environmental Impact Assesment Commission	Environmental Protection Management Act		Environmental Impact Assesment (for structure and zoning plans)
			Ministerial guidelines (no law) for gas and inflamable liquid transport: distance around networks. External Safety ordonance: obligation to register risk with dangerous material.	
		Public Health Act	National Waste Magement Plan (LAP) National Environment and Health Plan 2008-2012 Noise and Fine dust zoning	
	Ministry of Education, Culture and Science (Cultural Heritage Agency)	Monuments and Historic Buildings Act		
	Forestry (staatsbosbeheer)			
Regional	Regions Provences		Regional Plan Structure Plan Area Profiles Spatial Qualities Provincial Environmental Ordonnance	
Local	VNG			Model Ordonannces (modelverordeningen)
	Municipalites		Vision, Master Plan Architectural Quality Assesment	Zoning Plan Building Permits

Water	institutions	laws	policy/instruments	regulation
EU		Water Framework Directive Urban Wastewater Directive Ground Water Directive		
National	Ministry of Infrastructure and Environment (Deltares) National Water State Department	Water Act Environmental Management Act	National Water Plan Safety Qualification Primary Defence (veiligheids kwalificatie keringen)	
Regional	Provence Water Authority	Water Level Decree	Regional Water Plan Water Plan waterschapslegger	Province regulates infiltration and extraction of water (new Waterwet/Water Act in preparation) Water Assesment Test
Local	Municpality		Water Plan local waste-water plan	
Subsoil	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Directive on Waste Directive on Landfill of Waste	European Soil Strategy	
National	Ministry of Economic Affairs Ministry of Infrastructure and the Environment (TNO)	Mines Act Soil Protection Act (1987) Excavation Act Evironmental Management Act Nature Protection Act	STRONG (National Spatial Planning Strategy for the subsurface) (expected 2015) Information System Soil Soil Polici Letter (2003) Soil Convent	
Regional	Provences		Soil Vision/Soil Ladder	soil remediation
Local				soil remediation
Civil constructions	**institutions**	**laws**	**policy/instruments**	**regulation**
EU			European Convention on the Protection of the Archaeological Heritage (1992)	

National	Ministry of Economic Affairs (Municipal Platform of Cables and Pipes, Cultural Heritage Agency, Centre of Underground Building) Ministry of Education, Culture and Science (Cultural Heritage Agency)	Information Exchange on Underground Infrastructure Act (WION) Excavation Act Archaeological Heritage Management Act Monuments and Historic Buildings Act	KLIC External Safety ordonance: obligation to register risk with dangerous material.	
Regional	Provences		Structure scheme pipelines (SBUI): national main network for provinces to incorporate in structure plans. Provincial Research Agenda Archaeoly Policy Culturel Heritage; Programme Heritage	
Local	Municipality	Environmental Management Act		sewer regulations Local regulations considering cables and pipes in general.
Energy	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Energy Strategy Plan (2013)	Energy Technologies and Innovtion (2013)	
National	Ministry of Economic Affairs, Ministry of Infrastructure and the Environment and Ministry of Social Affairs and Employment	Nuclear Energy Law: regulates ministerial competences for storage of radio-active waste; Strategy on Shale Gas (expected 2015)	SER energy agreement (2013)	Energy Prestation Certificate
Regional	Provinces		IPO agreement geothermal	license issued under the General Provisions Environmental Law (Wabo) (open systems) reporting closed bottom energy ATES (recorded in amending soil energ , no separate Amvb)
Local				

Table A-3. Expanded COMMIN system – Sweden.

Sweden				
Spatial development:	**institutions**	**laws**	**policy/instruments**	**regulation**
EU	Board of European Ministers of Spatial Planning		European Spatial Planning Charter (1983); European Spatial Development Perspective	
		Waste Directives		
		Natura 2000		
				EU Guidelines energy performance for buildings (EPBD)
			INSPIRE Directive (2007): information gathering	
National	Ministry of Health and Social Affairs (National Board of Housing, Building and Planning [*Boverket*], Swedish Environmental Protection Agency, National Board of Health [*Socialstyrelsen*])	*riksintresse has 13 laws*		
		Planning and Building Act (*Plan- och Bygglagen - PBL (2010:900*)		Planning and Building Ordinace (plan- och byggförordningen 2011:338) Houskeeping Ordinance [Hushållningsförordningen 1998:896]
		Environmental Code (Miljöbalken (1998:808)		Regulation on implementation of the Environmental Code (Lag om införande av miljöbalken 1998:811) Environmental Impact Assessment Ordinance (Förordningen om miljökonsekvensbeskrivningar 998:905)
	Ministry of Health and Social Affairs (National Property Board of Sweden [*Statensfastighetsverk*]) Ministry of Culture (Swedish National Heritage Board [*Riksantikvarieämbetet*])	Cultural Heritage Act (kulturminneslagen 1988:950)		
	Ministry of Health and Social Affairs (National Land Survey *Lantmäteriet*)	Property Subdivision Act (fastighetsbildninglagen 1970:988) Utility Easement Act (ledningsrättslagen 1973:1144) Joint Installation Act (anläggningslagen 1973:1149)		Registration of jointly owned facilities (gemensamhetsanläggningar), easements (servitut), and utility easements (ledningsrätter) in Land Registration System (fastighetsregister)

	Ministry of Environment - Miljödepartamentet (*Swedish Environmental Protection Agency - Naturvårdsverket)*	Environmental Code (Miljöbalken 1998:808) Lag om införande av miljöbalken (SFS 1998:811) Förordningen om avgifter för prövning och tillsyn enligt miljöbalken (SFS 1998:940)		Förordningen om miljökonsekvensbeskrivningar (SFS 1998:905)
		Expropriation Act (expropriationslagen 1972:719) Pre-emption Act (förköpslagen 1967:868) Joint Land Development Act (lagen om exploateringssamverkan 1987:11)	These property rights-related laws serve as important instruments for plan implementation and land development	
	Ministry of Enterprise, Energy and Communications (Transport Administration [*Trafikverket*])	Road Act (väglagen1971:948) Railway Act (järnvägslagen 2004:526)		
Regional	County Counsil *(Landstinget)* is the link between national and municipality		Environmental quality standards, shorelines and human health, safety, risks, flooding, erosion. Regional Plans (*Regionplan)* and Regional Development Strategies (*Regionala utvecklingsstrategier)*	
Local	Municipality (Urban Planning Departments *(Stadsbyggnadskontoret)*, Urban Planning Committees *(Stadsbyggnadsnämnden)*		Municipal Comprehensive Plan (*Översiktsplan) and Parts of a Comprehensive Plan (* Fördjupad översiktsplan*)*	Detail Plan *(detaljplan)*
			building permit (bygglov) demolition permit (rivningslov) site improvement permit (marklov)	Area Regulations (*Områdesbestämmelser)*

Water	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Water Framework Directive Urban Wastewater Directive Ground Water Directive		
National	Ministry of Health and Social Affairs (National Board of Housing, Building and Planning *(Boverket))*	Planning and Building Act (*Plan- och Bygglagen - PBL (2010:900*)		

	Ministry of Environment - Miljödepartamentet (Swedish Environmental Protection Agency - Naturvårdsverket)	Environmental Code (Miljöbalken (1998:808) Water Act Public Water and Waste Water Plant Act (lag om anmälla vattentjänser) 2006		
Regional				
Local				Area Regulations (*Områdesbestämmelser)*
Subsoil	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Directive on Waste Directive on Landfill of Waste		
National	Ministry of Health and Social Affairs (*Swedish Environmental Protection Agency, Swedish Geotechnical Institute)* Ministry of Enterprise, Energy and Communications (Geotechnical Survey of Sweden)	Environmental Code (Miljöbalken 1998:808) Peat Deposits Act (lagen om vissa torvfyndigheter 1985) Mineral Act (minerallagen 1991) Continental Shelf Act (lagen om kontinentalsockeln 1966)		
Regional				
Local				*Special regulations in the Detail Plan (detaljplanebestämmelser), i.e. land reserves (markreservat) for jointly owned facilities (gemensamhetsanläggningar), easements (servitut), utility easements (ledningsrätter)*
Civil constructions	**institutions**	**laws**	**policy/instruments**	**regulation**
EU			European Convention on the Protection of the Archaeological Heritage (1992)	
National	Ministry of Culture (Swedish National Heritage Board [*Riksantikvarieämbetet*])	Heritage Conservation Act (kulturmiljölagen 1988)		

	Ministry of Enterprise, Energy and Communications (Swedish Energy Agency [*Energimyndigheten*])	Electrical Installations Act (ellagen 1985) Public Heating System Act (lagen om allmänna värmesystem 1981) Pipelines Act (rörledningslagen1978) Water and Sewerage Act (lagen om allmänna vatten- och avlopsanlägningar 1970)		Telecommunication Ordinance (teleförordningen 1985)
	Ministry of Health and Social Affairs (National Land Survey Lantmäteriet)	Joint Installation Act (anläggninglagen 1973:1149) applies to facilities common to two or more properties e.g. parking C12 play C14 water and sewarege facilities constructed and maintained by property owners Utility Easements Act (ledningsrättslagen 1973:1144) applies to e.g. water and sewrege facilities constructed and managed by municipalities (legal bodies), telephone lines		Registration of jointly owned facilities (gemensamhetsanläggningar), easements (servitut), and utility easements (ledningsrätter) in Land Registration System (fastighetsregister) by National Land Survey (lantmäteriet)
Regional				
Local				

Energy	institutions	laws	policy/instruments	regulation
EU		European Energy Strategy Plan (2013)	Energy Technologies and Innovtion (2013)	
National	Ministry of Enterprise, Energy and Communications (Swedish Energy Agency [*Energimyndigheten*]) Ministry of Health and Social Affairs (Lantmäteriet)	Municipal Energy Planning Act (lagen om kommunal energiplanering 1977:439) Utility Easements Act (ledningsrättslagen 1973:1144) applies to heating main, high- and low-voltage power lines		
Regional				

Local		Energy plan (energiplan)	Special regulations in the detailed plan, i.e. land reserves (markreservat) for jointly owned facilities (gemensamhetsanläggningar) and utility easements (ledningsrätter)

Table A-4. Expanded COMMIN system – Flanders.

Flanders (Belgium)				
Spatial development:	**institutions**	**laws**	**policy/instruments**	**regulation**
EU	Board of European Ministers of Spatial Planning		European Spatial Planning Charter (1983); European Spatial Development Perspective (2003)	
		Waste Directives		
		Natura 2000		
				EU Guidelines energy performance for buildings (EPBD)
			INSPIRE Directive (2007): information gathering	
National		Planning Act (1962)		
national/Flanders	Flanders Department for the Environment, Nature and Energy (Department Space and Monuments)		Regional Zoning Plan *(gewestplan);* gradually replaced by Spatial Structure Plans (RUP)	Planning Planning Decree 1996
			Spatial Structure Plan Flanders SVIR 2012	
				Decree Protection of Monuments and Town and City Scapes (1976)
				Decree Protection of Landscape (2010)
	Flanders Department for the Environment, Nature and Energy (Flanders Environment Administration)			Nature, Forrest, Bird, Protecten Flora & Fauna and Habitat Decrees
				EIA decree (Milieueffectenrapport)
				Spatial Safety Report (ruimtelijke veiligheidsrapport; RVR)
	Flanders Department of Mobility and Public Works			Mobility Impact Assessment (mobiliteitseffectenrapport; MOBER)
Regional	Provences and Arrondissements (Provincial Development Agency)		Regional Spatial Structure Plan	Regional Spatial Implementation Plan
			Provincial Spatial Structure Plan	Provincial Spatial Implementation Plan
			Strategic Plan Tourism and Recreation and Scheldeland	
Local	Municipality	Local Government Act 1991	Municipal Spatial Structure Plan	Municipal Spatial Implementation Plans
Water	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Water Framework Directive		
		Urban Wastewater Directive		
		Ground Water Directive		
National	Flanders Environment Agency	Surface Water Act		

			Sigmaplan (flood protection)	
Regional	Provinces Water Boards			Decreet Integraal Waterbeleid
Local	*Watering*			Water Assesment Test
Subsoil	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Strategy & Soil directive: protection and remediation. Covering, pollution, erosion, loss organic material, saltification, densification, biodiversity, landslides); Directive on Waste Directive on Landfill of Waste	European Soil Strategy	
National	Ministry of Economic Affairs (Belgium Geological Department)	Mining of Minerals Act		
National /Flanders	Flanders Department for the Environment, Nature and Energy (Public Waste Compagny) Brownfield Cel		Subsoil Information System Brownfield Decree	Soil Protection and Contamination Decree (2006) > Brownfield decree Brownfield Covernant
Regional				
Local				
Civil constructions	**institutions**	**laws**	**policy/instruments**	**regulation**
EU			European Convention on the Protection of the Archaeological Heritage (1992)	
National /Flemish	Flanders Department for the Environment, Nature and Energy (Department Space and Monuments, Flemisch Insitute for Heritage) Platform of Cables and Pipes			Decree Protection of Archaeology (1993) KLIP information system cables-pipes
Regional				
Local				
Energy	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Energy Strategy Plan (2013)	Energy Technologies and Innovtion (2013)	
National				Energy Prestation Certificate
Regional				
Local				

Appendix B – Example Inventory of stakeholders

Table B-1 shows an example of an inventory of stakeholders.

Table B-1. Example of stakeholder inventory (After: DPNH - Handreiking Ruimtelijke Adaptatie, Van de Ven et al. 2014).

PARTY	SPECIFIC
Municipality	College mayor and alderman
	public works
	sewerage / urban water
	roads
	spatial planning and design
	Landscape architecture
	maintenance public buildings
	maintenance public green
	police / fire fighters
	economics
	social affairs
	Engineering office
	other
Water board	administration
Province (region)	counsil
	spatial planning
	road maintenance authority
	other...
National government	ministry of Infrastructure and environment
	other …
Knowledge providers	service providers /advisors
	research institutes
Waterworks	Winning
	Distribution
Housing corporation	Name
Network operator	Electricity
	Gas
	Telecom/internet
	Water (see also waterworks

PARTY	SPECIFIC
Real estate sector	shopping centres
	theatres / cinema
	hospital
	nursing home// home for the elderly
	amusement park
	zoo
	Other ...
Green / garden companies	Name
Building companies	Name
Local industry	Type 1
	Type 2
	Other ...
Banks	Name
Insurance companies	Name
NGOs	Association
	interest group
	Other ...

References

Van de Ven., Frans, Jelle Buma, Tjaart Vos. (2014) Deltaprogramma Nieuwbouw en herstructurering, Handreiking Ruimtelijke Adaptatie: Handreiking voor de uitvoering van een Stresstest Klimaatbestendigheid. Version 1.0. Ministerie van Infrastructuur en Milieu. Available on: http://www.ruimtelijkeadaptatie.nl/l/library/download/urn:uuid:cf3cc550-a321-47ce-98a4-9fe66831b0c5/handreiking+stresstest.pdf?format=save_to_disk&ext=.pdf

Appendix C – Overview of instruments

Tools and methods to support generation of redevelopment alternative(s) and subsurface inclusion

Table C-1. Overview of the selected tools/methods to support generation of redevelopment alternatives and subsurface inclusion (based on Kok, 2014).

Tool/method	Description	Phase [a)]	T/M [b)]	Access	Language
System Exploration Environment & Subsurface (SEES)	The SEES method supports an interactive workshop with experts from surface and subsurface fields, and other stakeholders in order to lift forward obstacles and chances associated with subsurface in the planning process. Subsurface: civil constructions (archaeology, cables and pipes, unexploded ordnance etc.), energy (aquifer thermal energy, geothermal energy, fossil energy resources), water (water filtering and storage capacities, drinking water resource), soil quality, soil ecological diversity, geomorphological quality and landscape type, sand/clay, gravel resources, subsurface storage. The method takes into consideration the 3 P's: People, Planet and Profit/Prosperity (in terms of the mapped opportunities/obstacles). The method was applied in the all three case studies for generation of redevelopment alternatives with focus on subsurface. Link: https://publicwiki.deltares.nl/display/SEES/HOME+English	I, P	M	Free	Dutch English
De Bodem: Een Stevige Basis *'The Soil: a Solid Base'*	A method supports the optimal implementation of the subsurface in spatial planning. Subsurface: groundwater, energy, soil quality and ecology, archaeology, cables and pipes, underground civil constructions. Link: http://www.bodemambities.nl/Voorbeelden/De_bodem_een_stevige_basis	I, P	M	Free	Dutch
Ontwikkelingsmodel Ondergrond *'Development Model Subsurface'*	A guide for organisations that are engaged in spatial development: how to incorporate the subsurface in this process? After a test to see to which degree the subsurface- and planning departments are currently cooperating, the organisation follows steps to improve cooperation. Subsurface: SQA, groundwater, energy, soil ecology, cables and pipes. Link: http://soilpedia.nl/Wikipaginas/Ontwikkelingsmodel-ondergrond.aspx	I, P	M	Free	Dutch
Zeven sleutels voor waardevolle afweging *'Seven keys for a valuable consideration'*	Guidelines for incorporating the subsurface in the spatial planning process. Subsurface: pipes and cables, underground facilities, carrying capacity, archaeology, soil ecology, soil chemical quality, energy, groundwater. Link: http://www.cob.nl/kennisbank/webshop/artikel/zeven-sleutels-voor-een-waardevolle-afweging.html	I	M	Free	Dutch
Brownfield Opportunity Matrix (HOMBRE)	The 'brownfield opportunity matrix' is a means of identifying and discussing soft re-use restoration opportunities. It provides a means of identifying services from the restoration project and the interventions requited to deliver them (Bardos et al. 2016). Subsurface: SQA[c)].	I, P	T	Free	English

	Link: http://bfn.deltares.nl Bardos, R. P., Jones, s., Stephenson, I., Menger, P., Beumer, V., Neonato, F., Maring, L., Ferber, U. Track, T. and Wendler, K. (2016) Optimising Value from the Soft Re-use of Brownfield Sites. *Submitted to special issue AquaConSoil in STOTEN.*				
Eco-Dynamisch Ontwerpen '*Eco-Dynamic Design'*	A method helps to clarify the sustainability objectives in infrastructure projects and translate them into a concrete and coherent package of measures that combine the dynamics of the natural system with possibilities in necessary construction works. Subsurface: soil ecology. Link: http://www.deltares.nl/nl/expertise/100847/lijninfrastructuur-en-industrie/2041785	P	M	Free	Dutch
Ondergrond Stratego *'Subsurface Stratego*'	A communication platform for stakeholders aimed at identifying obstacles for (conflicting interests in) underground space use in the planning process. Subsurface: cables and pipes, thermal energy storage, other underground civil constructions. Link: http://www.grontmij.nl/ondergrondstratego	I, P	M	Com-mercial	Dutch
Serious Game Ondergrond '*Serious Game Subsurface'*	A multiplayer computer game that educates the user about the role and importance of the subsurface in spatial planning. The interests of different stakeholders are represented in roles to provide insight into each others' position. Subsurface: archaeology, geology, cables and pipes, soil contamination, groundwater, underground constructions, energy. Link: http://www.bodemtool.nl/?page_id=261	I	T	Com-mercial	Dutch

[a)] The urban planning phase for which the tool/method was developed (the applicability of tools/methods does not necessarily depend on the phase but on the data availability). I: initiative phase. P: plan phase. R: realisation phase. Mn: maintenance phase.
[b)] M: method, T: tool.
[c)] SQA: Soil quality aspects related to contamination.

Tools and methods for sustainability assessment

Table C-2. Overview of the selected tools/methods for sustainability assessment (further developed from work by Kok, 2014).

Tool/method	Brief Description	Phase[a)]	M/T[b)]	P1[c)]	P2[d)]	P3[e)]	Access	Language
Category I: Sustainability assessment of remediation alternatives								
Multi-Criteria Analysis (MCA) incl. CO_2 calculator	The method was developed by the Public Waste Agency of Flanders (OVAM) for assessing the sustainability of remediation alternatives. It considers 3 main impact categories (environmental, technical and financial) using both qualitative and quantitative indicators. The environmental aspect is divided into 'local' and 'regional/global' impacts. The CO_2 calculator is used to evaluate one of the 'regional/global environmental impacts', that being the carbon footprint of the different remediation alternatives. The performance of the remediation alternatives are determined by weighting and aggregating the indicator values. The method was used in the Belgian case for sustainability assessment of remediation alternatives in the urban plan/design phase. Link: http://www.ovam.be/batneec-evaluatie-met-co2-calculator	R	M/T	+	+	+	Free	Dutch
SCORE (Sustainable Choice of REmediation), incl. Cost-Benefit Analysis (CBA)	SCORE is an MCDA method which allows for transparent assessment of the sustainability of remediation alternatives at contaminated sites. SCORE evaluates the performance of alternatives relative to a reference alternative in the economic, environmental and social sustainability domains. The economic domain is addressed by means of CBA. Qualitative assessment is performed in the environmental and the social domains using scores. Although the tool was designed for remediation projects and the later development phases, it was used in the Swedish case study for sustainability assessment of redevelopment scenarios in the plan/design phase. Link: http://publications.lib.chalmers.se/records/fulltext/183067/local_183067.pdf	R	M/T	+	+	+	On request	English
DESYRE (DEcision Support sYstem for REhabilitation of contaminated sites)	DESYRE is a GIS-based software composed of six interconnected modules that provide site characterization, socio-economic analysis, risk assessment before and after the technologies selection, technological aspects and alternative remediation scenarios development (Pizzol et al., 2009). The decisional process implements a Multicriteria decision analysis (MCDA) methodology which supports the ranking of rank remediation technologies and the selection of alternative remediation scenarios to be discussed with decision makers and stakeholders. It can support the definition of remediation plans and the design of remediation/regeneration plans. Moreover, it can support the analysis of different land uses on the basis of a socio-economic perspective. Subsurface: SQA[f)], HR[h)]. Pizzol, L., Critto, A., Marcomini, A., 2009. A spatial decision support system for the risk-based management of contaminated sites: the DESYRE DSS. In: Marcomini, A., Suter, G.W., Critto, A. (Eds.), Decision Support Systems for Riskbased Management of Contaminated Sites. Springer, New York. Link: http://www.iemss.org/iemss2002/proceedings/pdf/volume%20tre/287_critto.pdf	(P), R	T	+	+	+	Free/ On request	English

Sustainable Remediation Tool (SRT)	The SRT tool allows for the comparison of the following remediation technologies according to sustainability metrics: excavation, soil vapor extraction and in-situ thermal desorption, in the unsaturated zone; and pump and treat, enhanced bioremediation, in-situ chemical oxidation, permeable reactive barriers and monitored natural attenuation in the saturated zone. The tool combines an environmental footprint assessment and a total cost evaluation. SRT also includes a module for allowing stakeholders to weight the different environmental impacts and total cost. Subsurface: SQA[f)]. Link: http://www.aecom.com/News/Innovation/_projectsList/U.S.+Air+Force+Sustainable+Remediation+Tool	R	T	+	+	+	On request	English
GoldSET	GoldSET is an MCDA-based tool developed for oil and gas, public sector, waste water management, transportation, mining, remediation and construction. Management alternatives are compared using a range of different quantitative and qualitative indicators within four general sustainability domains: environmental, social, economic and technical. Subsurface: SQA[f)]. Link: www.gold-set.com	I, P,	T	+	+	+	Commercial	English
Risk Reduction, Environmental Merit and Costs tool (REC)	The tool is a decision support system based on multi-attribute value theory considering contaminant risk reduction, environmental impacts and costs associated with remediation alternatives. Subsurface: SQA[f)], ER[g)]. Link: http://www.ivm.vu.nl/en/projects/Archive/REC/index.asp	R	T	+	+	+	On request	English Dutch
Symbiosis in Development (SiD)/ Urban renaissance	'Urban Renaissance' is a system for sustainable redevelopment of neighbourhoods, cities and regions, using the Symbiosis in Development (SiD) framework as a basis. The tool uses eight categories: materials, energy, ecosystem, species, health, culture, happiness and economics. Link: http://www.except.nl/en/articles/148-symbiosis-in-development-sid	I, P, R, Mn	M	+	+	+	Commercial	English
Category II: Sustainability assessment of reuse scenarios at brownfields								
Matrix Decision Support Tool (MDST) or SAMLA	The tool provides a basis for discussion and interactivity in the spatial planning process. It includes an assessment of environmental, social and economic aspects to support climate-change adaptation strategies and other municipal management and land-use decisions, such as potential soil remediation strategies (Andersson-Sköld, 2014). Subsurface: SQA[f)]. Andersson-Sköld, Y., Suer, P, Bergman, R., Helgesson, H., 2014. Sustainable decisions on the agenda – a decision support tool and its application on climate-change adaptation, Local Environment, DOI: 10.1080/13549839.2014.922531 Link: http://www.swedgeo.se/upload/publikationer/Varia/pdf/SGI-V612.xls	I, P	T	+	+	+	Free	Swedish
Megasite Management tool suite (MMT) (TIMBRE)	'MMT' is a software tool for finding the optimal reuse scenario for large contaminated sites based on (remediation) costs, economic feasibility and a sustainability assessment. It involves stakeholders in determining problems and sustainability indicators for the site and it guides the process from the initiative up to the planning phase: the optimal scenario is determined and represented in a map of best practice land-use classes. Subsurface: SQA[f)], HR[h)]. Link: http://www.ufz.de/index.php?en=19610	I, P	T	+	+	+	Free	English German

Site Assessment and Land Re-Use Planning Tool (SAT) (TIMBRE)	A web-based decision support tool for defining the optimal land-use scenario for the site based on subsurface remediation costs, the market value of land and assessments of health risks and sustainability. 'Expert' and 'light' versions are available. Subsurface: SQA[f)], HR[h)]. Link: http://www.d-site.de/index.php/activities/software-development/web-based-site-assessment-tool-sat	I, P	T	+	+	+	Free	English
SMARTe	SMARTe is a decision support system for developing and evaluating future reuse scenarios for potentially contaminated land. SMARTe includes open source tools for stakeholder analysis, assessment of HR and ER, and financial calculation. Subsurface: SQA[f)], ER[g)], HR[h)]. Link: www.smarte.org	I, P	T	+	+	+	Free	English
Brownfield Remit/Response (BR2) tool (HOMBRE)	A systems-based approach, Brownfield REMIT/RESPONSE (BR2), to assess the impact of brownfield redevelopment on the surrounding urban area has been developed. This utilises REMIT/RESPONSE combined with urban theory to develop a dynamic model of the generic impact of brownfield redevelopment that when combined with site-specific information can be used to identify and compare the impact of different redevelopment options.. Subsurface: SQA[f)]. Link: http://www.zerobrownfields.eu/HombreTrainingGallery/HOMBRE_D6.2_final.pdf Accessed August 2015	I, P	T	+	+	+	Free	English
Category III: Sustainability assessment of urban planning scenarios with specified subsurface aspects								
Omgevingswijzer *'Environment Indicator'*	A tool helps to assess the sustainability of projects in a systematic manner. By rating impacts on indicators in the environmental, social and economic domains, a clear overview of project performance is provided to project members in order to facilitate scenario assessment and communication. Subsurface: SQA[f)], energy. Link: https://omgevingswijzer.org/	P	T	+	+	+	Free	Dutch
Ambitieweb *'Ambition web'*	A web-based diagram for defining the level of ambitions for a project using 7 'sustainability' themes, i.e. energy and climate, materials, accessibility, water and soil, nature, living environment, and profit. Used to facilitate workshops with stakeholders. Subsurface: SQA[f)]. Link: http://www.aanpakduurzaamgww.nl/pdf/Het%20Ambitieweb%20%28factsheet%29.pdf	I	T	+	+	+	Free	Dutch
Duurzaamheidsprestatie op Locatie (DPL) *'Sustainability Achievement on Location'*	A sustainability assessment tool with multiple applications: assessment of the sustainability of project scenarios; comparison and monitoring of neighbourhoods; setting sustainability ambitions for a project and improve communication on integration of the subsurface and natural system in urban planning. Modules include Subsurface, Financial profile, Climate, BiodiverCity, and Business area. Subsurface: geological value, archaeology and cultural history, soil, groundwater, biodiversity, carrying capacity, renewable energy from the ground, water, underground construction, cables and pipes. Link: http://www.ivam.uva.nl/dpl-ondergrond	I, P	T	+	+	+	Commercial	Dutch
BodemTool (Soil Tool)	A software tool allowing for 3D visualization of the planning area, including the subsurface. It helps to assess the effects on people, planet, profit, project and public. Subsurface: soil structure, cables and pipes, and underground facilities. Link: http://www.bodemtool.nl/	I, P	T	+	+	+	Commercial	Dutch
Category IV: Sustainability certification in development projects								

BREEAM and the Code for Sustainable Homes	A method that supports local planning authorities by providing them with a guide on sustainable design and construction, and a scheme for rating and certifying the performance of new homes. Link: http://www.breeam.org/page.jsp?id=268	I, P, R, Mn	M	+	+	+	Com merci al	English
BREAAM-NL Gebiedsontwikkeling *'BREAAM Spatial Development'*	A method that not only consider the sustainability performance of a single building, but of an entire area. Area developments are assessed on six sustainability categories: area management, synergies, resources, land development, welfare/prosperity and area climate. Subsurface: Link: http://www.breeam.nl/gebied/breeam_gebied/	I, P, R, Mn	T	+	+	+	Com merci al	Dutch
Category V: Complementary assessments								
Cost-Benefit Analysis	A method for assessing the economic value of the parcel after remediation and redevelopment. The method was used in the Belgian case study to calculate net income for alternative redevelopment scenarios and alternative configurations of land use (industry, residential low and high density), i.e. the amounts available to cover for expenses and risks for the investor. Link: http://www.ruimtelijkeordening.be/NL/Diensten/Onderzoek/Studies/articleType/ArticleView/articleId/8833/Analyse-van-de-financiele-gevolgen-van-ruimtelijke-beslissingen-kader-en-beschrijving-van-enkele-situaties	R, Mn	M	-	-	+		Dutch
Social Impact Assessment (SIA)	The SIA tool is developed by the City of Gothenburg for planning and design phase of development process. It is a simple matrix, which takes four different social aspects into consideration: Cohesive city, Interactions, Everyday life and Identity. Those aspects are analysed with regard to five different scales: Buildings and places, Neighbourhood, District, and City. The matrix was used in the Swedish case study to investigate the social impacts with regard to alternative redevelopment strategies against the current situation. Link: https://goteborg.se/wps/wcm/connect/7a225b9b-821e-435d-80ba-f3fba09fd443/OPA_SKA.pdf?MOD=AJPERES	P	T	+	-	-	Free	Swedish
Nature Value Explorer (NVE)	The Nature Value Explorer is an online tool, developed for the Flemish government, to explore the impact of ecosystem restoration on human welfare. Different valuation techniques can be applied: (i) qualitative scoring how important a service is in a specific area, (ii) quantitative valuation of the importance of ecosystem services in physical terms (e.g. tons of C sequestration, amount of visits per year), (iii) monetary valuation of the societal value. The tool was used in the Belgian case study to monetize ESS[j]). Link: www.natuurwaardeverkenner.be	P	T	-	+	+	Free	English Dutch
Biodiversity check	The tool is developed by the non-profit organization "Vrienden van Heverleebos and Meerdaalwoud" (VHM) with the purpose to provide insight to project developers and urban planners into the impact of spatial developments on the value of nature and biodiversity of a certain project site. The tool was used in the Belgian case study for qualitative assessment of the effects on ESS[j]) associated with redevelopment scenarios. Link: www.biodiversiteitstoets.be	P	T	-	+	-	Free	Dutch

ESS mapping (Ecosystem Services' mapping)	A method for mapping changes in ESS[i] (associated with different redevelopment scenarios) includes three principal steps: (1) identification, (2) quantification, and (3) valuation. The process is guided by a "check list" made up of soil and urban ESS gathered from the literature. The method was used in the Swedish case study for qualitative assessment of the impacts on ESS (i.e. addressing only Planet). Reference: Ivarsson, M. (2015). Mapping of Eco-System Services in the Fixfabriken area. Method development and case study application.	I, P	M	-	+	+	Free	English

[a] The urban planning phase for which the tool/method was developed (the applicability of tools-methods does not necessarily depend on the phase but on the data availability).
I: initiative phase. P: plan phase. R: realisation phase. Mn: maintenance phase.
[b] M: method. T: tool
[c] P1: people. [d]P2: planet. [e]P3: profit. . -: no indicators incorporated in instrument. +: indicators incorporated in instrument.
[f] SQA: soil quality aspects related to contamination. [g] ER: ecological risks. [h] HR: human health risks. [i] ESS: ecosystem services.

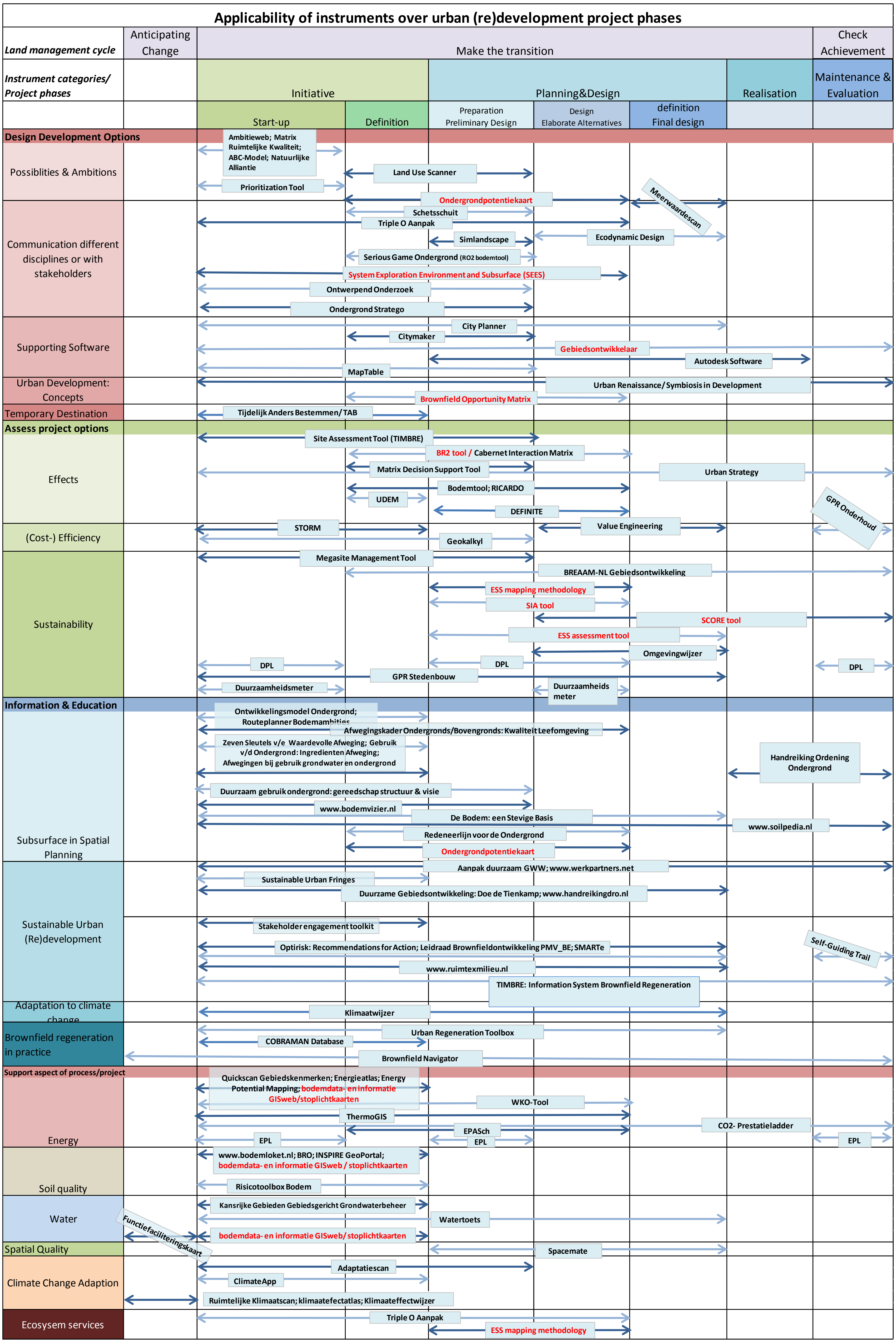

Figure C-3. Overview of the classified per category instruments along the project phases (Kok, 2014).