HOMBRE

Holistic Management of Brownfield Regeneration

HOMBRE's Role in Brownfields Management and Avoidance

Urban Land Management 2065

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Project Coordinator:
Hans van Duijne, Deltares, The Netherlands

Editors:
HOMBRE Partners

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Policy brief: Profitable places for people

Take home messages:

1. Europe's urban brownfield sites are valuable latent resources
2. Urban land use decisions should be expected to deliver a clear 'Return on Investment' (RoI)
3. Understanding urban systems in terms of their environmental, social, economic and governance performance is an essential part of sustainable urban land management
4. Looking for new opportunities with a future long term perspective in mind
5. Looking multiple land uses are both possible and most likely to deliver adequate RoI
6. Implementing (sub) surface technologies in serial or parallel can uplift RoI
7. Multiple soft end uses can deliver multiple services and uplift RoI for land unsuited or unneeded for hard development
8. Online map tools can assist local stakeholders identify creative land use options

Brownfield sites are the secret weapon in delivering sustainable European cities. Admittedly such sites have been affected by former uses of the site or surrounding area, they: are derelict or underused; are mainly in fully or partly developed urban areas; **may** have real or perceived contamination problems but certainly require intervention to bring them back to beneficial use (CABERNET 2007). They are often also in the **right place** to deliver **profitable places for people**. Brownfields were originally seen as a disease in their own right whereas they are in fact a symptom of structural change and ordinary cycles of human endeavor.

Over the past 40 years many European cities have made a transition from polluting, heavy engineering or mining centres to clean, service or advanced manufacturing centres. As an example Germany`s Ruhr or the UK's Leeds have transformed their environment and economy and are now reaping social dividends. Elsewhere examples show that the transition has either faltered or gone into reverse resulting in shrinking cities or mass youth unemployment.

An empirical approach to improved management of brownfields is increasingly unaffordable: "Build and let's see what happens" is a luxury of a bygone – pre Global Financial Crisis era. Too many redevelopment projects petered out once the initial capital outlay was exhausted.

"Invest with a predictable Return on Investment" (RoI) is the new norm. The challenge is making robust, reliable predictions of that RoI. However, conventional cost benefit analy-

sis is inadequate for appraising long term investments that span generations. Only by developing, and then regulating on the basis of a better understanding of complex, dynamic city systems, can the RoI of brownfield reuse be appreciated.

Cities serve similar functions, offer similar services and make similar demands. Yet they have distinctive features, resources and constraints. As such generic models of urban land management have a role to play in developing broad awareness but city specific models – conceptual, qualitative, and quantitative – are needed to gain the deep understanding needed for evidence based decision making. Going beyond static models, dynamic simulations of functioning cities can help discern the scale and nature of the consequences of different decisions and courses of action.

Tradition linear, sequential land use and management systems have been effective but often inefficient. Avoiding obvious unsustainable waste means **synergies** and **concurrent activity** are needed. Thinking about the land use after next, anticipating when a given parcel of land is likely to be free for reuse, seeking the **maximum service** out of a given consumption of resources.

HOMBRE considers urban **brownfields** as **a latent resource in sustainable urban land management**. As Europe's cities progress their need for land will fluctuate: some cities will need more land and some less. HOMBRE has developed both a new way of thinking – **decoupling the land use and land management cycles**; seeking synergies; expecting tangible value from soft reuses – and new techniques to improve city system understanding, simulate the effects of land reuse, enhance the environmental benefits of remediation and material recovery technologies. HOMBRE's Brownfield Navigator contains a flexible spatial visualization tool and signposts the HOMBRE tools and technologies described above.

Europe's policy of creative, stable and eco-efficient cities is nearer to being realised because of the deeper understanding and more sophisticated solutions HOMBRE has developed. Previous approaches to the built environment have revolved around a general linear pattern of land use based on a 'consume & dispose' approach to construction materials. Once buildings came to the end of their useful life, they would lie vacant or be demolished and most of the resulting debris would be discarded. A life cycle approach to both land use and resource stewardship is emerging in both land and construction materials. By dismantling rather than decommissioning, the creation of large amounts of unusable and highly problematic mixed waste is avoided by materials being reused or recovered. The past no longer has to – or even ought to – be the key to the future. We can both envision a new future and contribute to its delivery.

1 Introduction

EU 2050 net land take perspective

Over recent decades, land recycling has become a major concern in European regional policies. Land and soil are being increasingly recognised as vital resources in Europe's continued development. Since the 1990s the rate of land take in the EU is around 1000 km^2 per year and the European Commission intends to limit this land take and to promote re-use of the land in already built-up areas. Therefore comprehensive strategies and programmes to limit urban sprawl, to deal with the problems of shrinking cities and to encourage brownfield revitalisation have been developed in many cities, regions and countries of Europe.

Towards zero land consumption by 2050

Recent initiatives by the European Commission make the stewardship of soil resources and the management of land use activities as key policy objectives of the European Union. The flagship initiative „A Resource Efficient Europe" (COM(2011) 571 final) of the EUROPE 2020 Strategy explicitly recognises „land" as a resource and, for the first time, the European Commission's General Union Environment Action Programme for 2020, titled 'Living well, within the limits of our planet', sets a target for zero land consumption by the year 2050. An expected **communication in 2015 on "Land as a Resource"** will outline aims of:

- Raising awareness about the **value of land as a resource** for crucial ecosystem services (provisioning, regulating, cultural, etc.),
- Providing guidance for **further action at EU level** through the evaluation of the effectiveness of current policy instruments on the national, EU and global levels.

With this ambition and vision in mind, the European Commission launched a number of research and development (R&D) initiatives aimed at *preventing* sites from becoming brownfields and *regenerating* existing brownfields. The project Holistic Management of Brownfield Redevelopment (HOMBRE) is one of the R&D initiatives to support this ambition. HOMBRE aligns itself with this integrated perspective on land as a multi-purpose resource and also recognises the important role played by actors on the European level in influencing land use and its management.

HOMBRE results & benefits in a nutshell

From problem based to opportunity driven

The HOMBRE project's vision encompasses a wider view of and approach to the redevelopment of brownfields than contemporary practice would suggest.

The step-change realised is a move from a stand-alone, problem-oriented approach such as development comprising monolithic housing estates or focusing on in situ and ex situ remediation activities, towards a more all-encompassing approach focusing on synergistic use of urban brownfields by deploying different technologies combined with local and regional opportunities, to provide multiple services that meet

Find, communicate and realise opportunities with all actors: the Brownfield Navigator

Generic BFN tools and functions

- Map and Sketching
- Notepad
- Example library
- Rounds Model
- Reference library

Module Anticipating Change

- Anticipating BrOWnfield Emergence Tool methodology (BOWET)

Module Make the Transition

- Vision Ambition & societal demands
- CircUse Management Tool
- Regulation checklist
- BR2 tool
- Workshop for Technology Trains
- Brownfield Opportunity Matrix
- Bioenergy tool
- Construction & Demolition waste tool
- Scenario evaluation

Module Check Performance

- Check achievements

the demands of Europe's citizens for sustainable urban development.

Synergies between improvements in environmental condition, economic performance and social services can leverage the return on investment of brownfield redevelopment and help expand opportunities for brownfield re-use.

Create synergies by combining different approaches

Technology trains that deliver multiple services have been developed and tested to serve as examples for end-users. The wide range of services possible (by deploying "hard- and soft uses") needs to be tailored for each site and setting. "Hard uses" are engineered solutions which have direct impacts on the subsurface, water, energy or construction conditions. "Soft uses" are directed more to so-called green approaches such as using bio energy, dealing with carbon sequestration and improving soil. They usually have an impact in the mid- to long term.

The Brownfield Navigator (BFN) software guides end users through the process of anticipating and accelerating the return of the brownfield to beneficial use and beginning the redevelopment process. The life cycle of urban land use and the associated management cycle are at the core of this BFN and the results of the different project elements are comprehensively included. The HOMBRE case study partners have reported that using the BFN generated new insights and approaches to their sites and encouraged them to modify their daily practice to a more comprehensive way of brownfield redevelopment.

HOMBRE case study site: **Genoa (Polcevera Stream valley), Italy**

View on parts of the case study site in Genoa, Italy

Polcevera Stream valley is an important link between the eastern and the western part of the city of Genoa, in Northwestern Italy. Genoa is part of an important transit for the north-south transport of goods, especially along the European corridor 24 Genoa-Rotterdam.

At the moment the Polcevera stream delta is a heavily urbanized area, inside the borough of Cornigliano, with a steel industry brownfield lying to the west of the stream for about 6 ha. The Polcevera stream mouth hosted steel industries on the west bank that ceased production in 1996 due to the iron crisis. In 1998 a bufferzone was created around the industrial area.

Two stakeholder workshops were held in Genoa. The participants tested the Brownfield Navigator (e.g. sketching tool, vision/ambition tool and biomass flowchart) and the Brownfield Opportunity Matrix.

2 The "Zero" Brownfields concept: The Land Management and Land Use Cycles

All land in a built up area should contribute to sustainable urban development. When a land use ceases to be beneficial to society, land management should facilitate the transition towards another sustainable use.

Land use, especially in urban areas, is dynamic: cities need to adapt to changing societal needs *and* opportunities (for jobs, health, living standards, logistics, etc.) as well as building in resilience to environmental stresses caused by climate change. HOMBRE realised from the outset that one of the keys to improve brownfield redevelopment is a better understanding of the life cycle of urban land use and of the specific role brownfields – their emergence, persistence, and redevelopment – has within this cycle. Brownfields emerge when a given land use, for example a factory or business estate that provided a large number of jobs, turns from being highly beneficial to society to having a marginal or even detrimental effect or simply comes to an end. As such, brownfields are a symptom of changing times. While the presence of brownfields provides the necessary "free" space for new developments within the urban environment – to meet evolving societal demands – brownfields often persist for longer than desirable. The customary view is that a negative legacy of the former use, such as local unemployment or contamination, poses too costly a barrier to overcome. HOMBRE argues that a clearer vision on what the brownfield site has to offer in responding to current and emerging societal challenges would help overcome such barriers.

From brownfield restoration to brownfield redevelopment

HOMBRE fosters a shift in mindset from contemplating brownfield *restoration,* which basically only looks back on what has been lost, to brownfield *redevelopment*, taking a forward looking perspective of new opportunities for future developments. Indeed, with changing societal needs, restoring the past may not be a sustainable solution. HOMBRE therefore offers tools and techniques that help uncovering this potential of brownfields to provide beneficial services anew and, based on this, help develop a vision for overall sustainable urban development and successful social redevelopment. Where pathological remnants from the past need to be addressed, HOMBRE advocates searching for suitable "Technology Trains" that combine remediation – to remove legacy problems – with the provision of new useful services such as energy generation, space creation or materials recovery. Examples are the on- or off-site re-use of excavated soil and construction waste which typically arises with site redevelopment, or exploiting the synergy between seasonal aquifer thermal energy storage and in-situ bioremediation of organic contaminants.

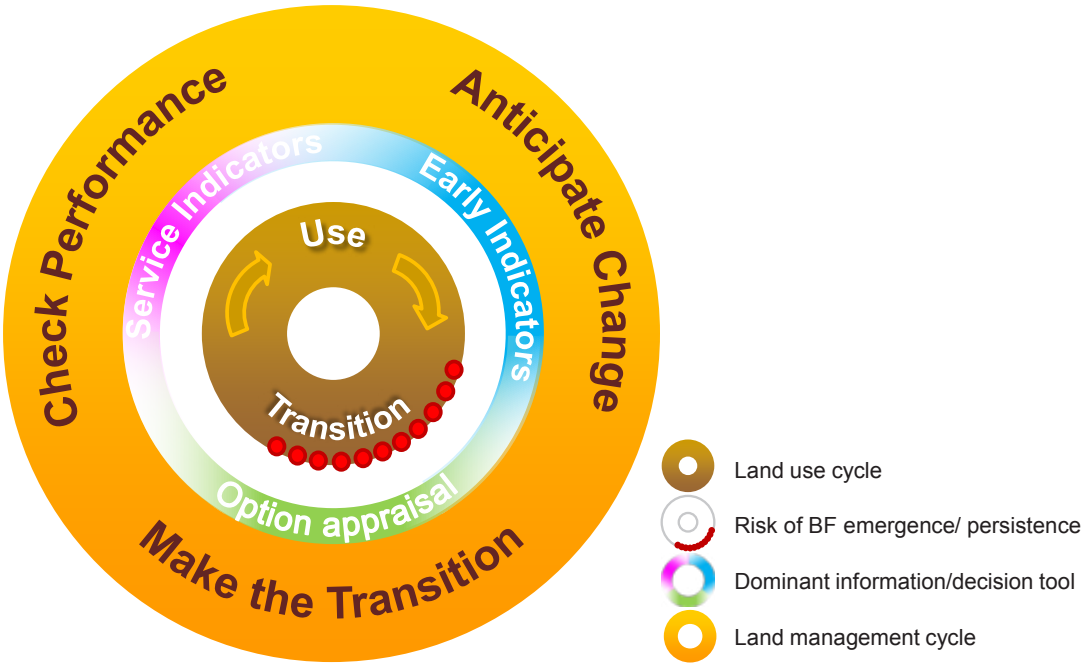

Figure 1: The HOMBRE Zero Brownfield framework: administrative land management cycle (outer cycle) addressing land use transitions in the land use cycle (inner cycle).

Towards sustainable land use: cyclic land use and management

The dynamics of urban land use are cyclical: site developments are planned, realised and then utilised and maintained until the development is decommissioned or simply abandoned, after which a new cycle for site re-development starts. The land use cycle comprises periods of beneficial use alternated with periods of transition. Brownfields are periods of wasteful unfulfilled potential. The paradigm shift presented by HOMBRE is that land use and land management each have their own tempo and do not – and need not – necessarily run at the same pace. The land management considered is that which is within the remit of administrative authorities or other agencies that have long term (multi-cycle) responsibility for sustainable land use within an area or portfolio of sites. Ensuring BF redevelopment obviously is about transitions in land use, but it should not be limited in time to these periods only. Therefore, the management phase of "Making the Transition" is preceded by "Anticipating Change", and followed by "Checking Performance". Together, these phases provide management continuity throughout the life cycle of urban land use and should shorten the time land lies idle or underused.

Creating the HOMBRE Zero Brownfield framework

Figure 1 illustrates the (outer) administrative land management cycle decoupled from the dynamics of the (inner) urban land use cycle and thereby avoid unnecessary emergence and undue persistence of brownfields. For this, the term 'Zero Brownfields' was coined in analogy to zero waste. It is not meant to imply that no underused or vacant land should ever exist, but that this brownfield land should receive proper management attention and that its transition to beneficial use should not be stalled for an excessive period.

The basic land use cycle comprises two phases of Use and Transition. The red dots indicate where in the land use cycle there is a danger that brownfields may emerge and persist

HOMBRE case study site: **Markham Vale, UK**

The former Markham Colliery (left) and plans for Markham Employment Growth Zone

Markham is a former colliery in Derbyshire UK. The colliery closed in the early 1990s, with the majority of the site laying derelict until the Markham Employment Growth Zone (MEGZ) began planning redevelopment in the early 2000s. The colliery was one of the main employers in the North East of Derbyshire area and its loss is partly the responsible for the higher than average depravation and child poverty in the area. MEGZ's objectives are to create 5000 jobs in a sustainable environment. The site is largely in the transition phase the land use cycle.

The site consists of three employment zones covering 120 hectares, along with the two former tip areas totalling more than 100 hectares. The North tip includes a short rotation coppicing scheme and public open space including areas of particular habitats.

In consultation with the MEGZ management team, the Brownfield REMIT/RESPONSE (BR2) systems tool and the Brownfield Opportunity Matrix (BOM) have been applied retrospectively look at the regeneration strategy on the site.

for too long. Of course the duration of subsequent use phases may vary considerably: from less than a year in case of temporary or interim use in anticipation/preparation for more permanent use, to decades or even centuries. The land management cycle is represented by the outer cycle. The brownfield redevelopment phase is more generically termed “Make the Transition” as, from a Zero brownfield perspective, the transition from one beneficial land use to another could skip any stage of dereliction. A clear benefit of land management within the HOMBRE Zero Brownfield framework is restricting the magnitude and duration of negative societal impacts from land in decline.

Tools to support the HOMBRE Zero Brownfield framework

The HOMBRE Zero Brownfield framework includes guidance for the use of tools in each of the management phases. HOMBRE proposes a number of tools that help in analysis and decision making for “Making the Transition”. These include tools to explore possible synergies between decommissioning, remediation and site redevelopment. Other tools secure and support adequate stakeholder participation. How the specific brownfield site can best contribute to sustainable development, according to the stakeholders, depends on the contemporary societal challenges to be addressed, what resources and services the site has to offer, and what development actions or interventions are feasible and how they will affect the wider urban system. Suggestions and examples are provided on how to assess the sustainability of both techniques and methodologies used in the redevelopment process, and of the envisaged land use.

Monitoring and control: the keys for successful land use management

In the “Anticipating Change” phase, so called early indicators are monitored to detect changes in the balance between societal costs and benefits of contemporary land use and to signal whether an area or site is at risk of becoming underused. Such signals should trigger management interventions, for example a change in policy, either to prolong the sustainability of the contemporary land use or to accelerate a desired transition. In both cases, “Anticipating Change” helps limit the duration of dereliction and the magnitude of negative societal impact. Early awareness also encourages planning for transition to be taken up at an early stage. This has the added advantage of providing more time for stakeholder consultations, including the search for potential investors. It also allows for exploring synergies between upcoming redevelopment projects and more strategic timing of consecutive transition projects at different sites. Both aspects can contribute to further limiting the need for greenfield developments.

The management cycle includes the “Checking Performance” phase to determine the actual sustainability of the new land use. In addition to checking project goals were achieved, it calls for monitoring performance against the defined service needs and sustainability objectives. Setting up this post-transition monitoring ensures a forward looking perspective and prevents benefits of the new land use being too short-lived. Even longer term monitoring, to determine if the land use services realised continue to meet changing societal needs and challenges, should then become part of the early indicator monitoring, which effectively closes the Zero Brownfield land management cycle.

3 Tools & Methodologies

A wide range of tools and methodologies to support the HOMBRE Zero Brownfield framework were developed by HOMBRE. Managing an intervention typically follows a linear, but iterative process (Figure 2). HOMBRE has translated this process into the HOMBRE Zero Brownfield framework. Figure 3 shows how the different management elements are linked with the cycle and which tools are available for support in practice. The tools are described further below.

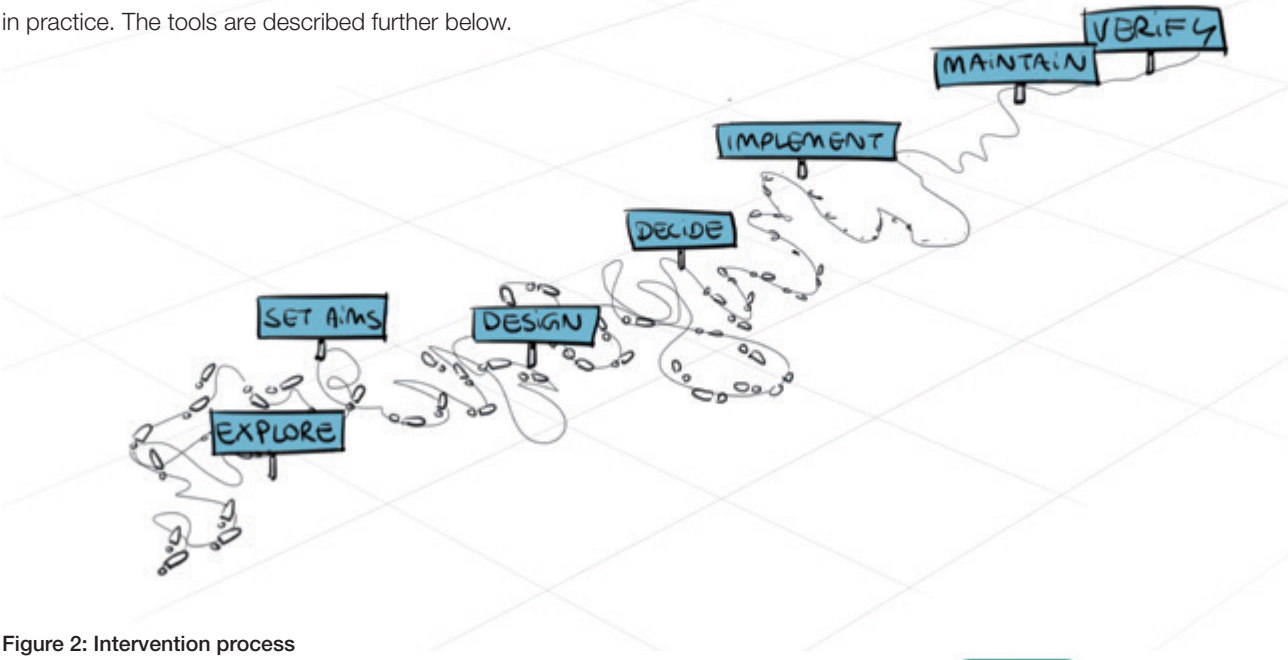

Figure 2: Intervention process

Figure 3: Tools to put the HOMBRE Zero Brownfield framework into practice

3.1 Early Warning Indicators

To apply the HOMBRE Zero Brownfield framework in practice, those in charge need adequate information that enables them to prepare for upcoming changes and look ahead for potential solutions and synergies. The urban management level that HOMBRE had in mind primarily, when developing its framework, is that of municipalities responsible for local development and spatial planning. However, private developers or public agencies that own or manage a portfolio of sites could also benefit.

Become aware of changes: early warning indicators

A list of around 40 "Early Warning Indicators" was developed as a starting point for early warning monitoring. Changes in these indicators can signal if a management intervention in the land use cycle is required to either prevent a brownfield from being created in the near future or to take early action for a well-managed transition of land use. The indicators are grouped into subcategories within the main dimensions of sustainable development: economy, society and environment. As an example, a selection of indicators within the four economic subcategories is shown in Table 1. Not surprisingly, the economic drivers are found to dominate brownfield formation.

As local situations will always differ, the table also shows the general line of thinking to follow to prioritise and select indicators. Starting from relatively broad categories that influence brownfield emergence (second column), and that may or may not be relevant in the local context, more specific issues can be identified (column 3), leading to a final selection of indicators (column 4). This line of thinking can also identify additional indicators – outside the suggestions given in the list- that are particularly suited for a given municipality or responsible organisation. An important aspect in the selection of early indicators for brownfield emergence is that the information should be easily available, preferably from information sources that are already in use within the organisation. Relevance and availability are the two main criteria in the selection of early warning indicators.

The added value: from analysis towards prioritisation

The Early Warning Indicator can also serve in a first step to spatially single out those urban areas that are particularly in need of monitoring or preventive actions. Thus, policy measures aimed towards more sustainable urban development can be more effective. The HOMBRE Anticipating BrOWnfield Emergence Tool (BOWET) proposes a four steps approach to identify the potential of brownfield emergence in various districts of a study area. Steps to be followed are:

Table 1: Selection of economic indicators from the HOMBRE list of Early Warning Indicators

CATEGORY	Issues indicators might need to consider	Suggested indicators	Effect on short/long term < 10 years >	Scale Local/ Regional/ National/Global	Source for data / info
Restructuring of economic activities	Composition of GDP	Percentages of GDP in industrial and service sector	Short term and long term	Local National	EUROSTAT National statistics
	Employment	Long term unemployment	Long term	Local National	EUROSTAT Local / national statistics
	Real estate market	Property price	Short term	Local	Local / national statistics Online directories Property assessment cooperation
Transportation	Accessibility, mobility, operational efficiency	Lost time due to congestion	Short term and long term	Local	Local infrastructure plans
	Safety	Number of accidents	Short term and long term	Local	Local statistics
	System Preservation	Age of distribution of infrastructural elements	Long term	Local	Local infrastructure plans
Urban sprawl	Property Price	Ratio of the property price in a municipality to the adjacent municipalities	Short term and long term	Regional	Real estate agents
Recession	Withdrawing investment from region/area	Industrial production	Short term and long term	National Global	EUROSTAT National statistics
		Wholesale-retail sales	Short term and long term	Local	Chamber of commerce

1. Define the spatial limits of the study area and urban units within and procure relevant base maps
2. Select the most relevant early warning indicators for the study area
3. Gather spatially differentiated data for the chosen indicators and evaluate the potential for brownfield emergence for each urban unit
4. Compare results to maps of existing brownfields – to generate general predictive models for brownfield emergence – and consult local experts to discuss the validity of the results

The resulting visuals and maps are especially valuable in initiating a dialog process with stakeholders.

A workshop with local authorities and other stakeholders in which the results are discussed can initiate thoughts about the possibilities for meaningful intervention. A test to assess the feasibility and relevance of the methodology has been carried out and applied on two European towns. The results of the test run have shown that is indeed possible to obtain modelling equation for the prediction of brownfield emergence. To date only site specific implementations of the full tool have been developed however the methodology is available in the Brownfield Navigator.

Figure 4: Consultation meeting with city officials to explain the early warning indicator results

3.2 The Brownfield REMIT/RESPONSE (BR2) tool for Understanding urban system dynamics

The 'Brownfield REMIT/RESPONSE (BR2) tool is a systems based analysis tool which allows a deeper understanding of an urban system and supports the comparison of the impacts and weaknesses of different redevelopment options for a site.

The interacting network of population, environment, economy and regulation in an urban area constitutes a complex system. When deciding between potential future uses for a site, particularly a long-term brownfield site, it is important to consider, not just each potential use in isolation but also the site's place within the wider urban system and whether that new use would work with or against that system.

The BR2 technique utilises a matrix-based systems analysis approach which a cross-section of stakeholders populate and analyse in order to compare potential re-use scenarios, assessing how each would interact with the prevailing urban system: identifying likely problem areas and bottlenecks affecting the ultimate success of the project, and whether the project itself fits within the system or is disconnected from it.

Within agreed system boundaries (for example: within a particular planning authority's boundaries) BR2 divides the system into a number of generic urban system components (table 2). Relationships between pairs of components are considered sequentially and scored according to importance to the system and the site, initially using simple binary coding where a '1' indicates that one component affects another and a '0' indicates no effect, along with justification for the designation. Semi-quantitative scoring systems are then used so that the relative importance of each interaction and whether the effect is positive or negative is captured for a further analysis.

BR2 uses these scores to populate a matrix. Each row and each column of the matrix are summed and these represent the particular component's effect on the system (row, termed 'CAUSE') and the system's effect on the component (column, 'EFFECT').

Plots of Cause versus Effect are then produced (C,E plots). The position of each component on the chart and how its position changes for each potential re-use scenario is used to determine the interactivity of the whole system and of each individual component and hence how vulnerable the system is to change. The dominance of a component in the system and its critical relationships are then used to indicate potential weaknesses.

Table 2: BR2 Generic Urban System Components

❍ Biodiversity	❍ Public Economic
❍ Natural Environment	❍ Private Economic
❍ Built Environment	❍ Individual Economic
❍ Demographics	❍ Local Institutional Controls
❍ Quality of Life	❍ Central/EU Institutional Controls

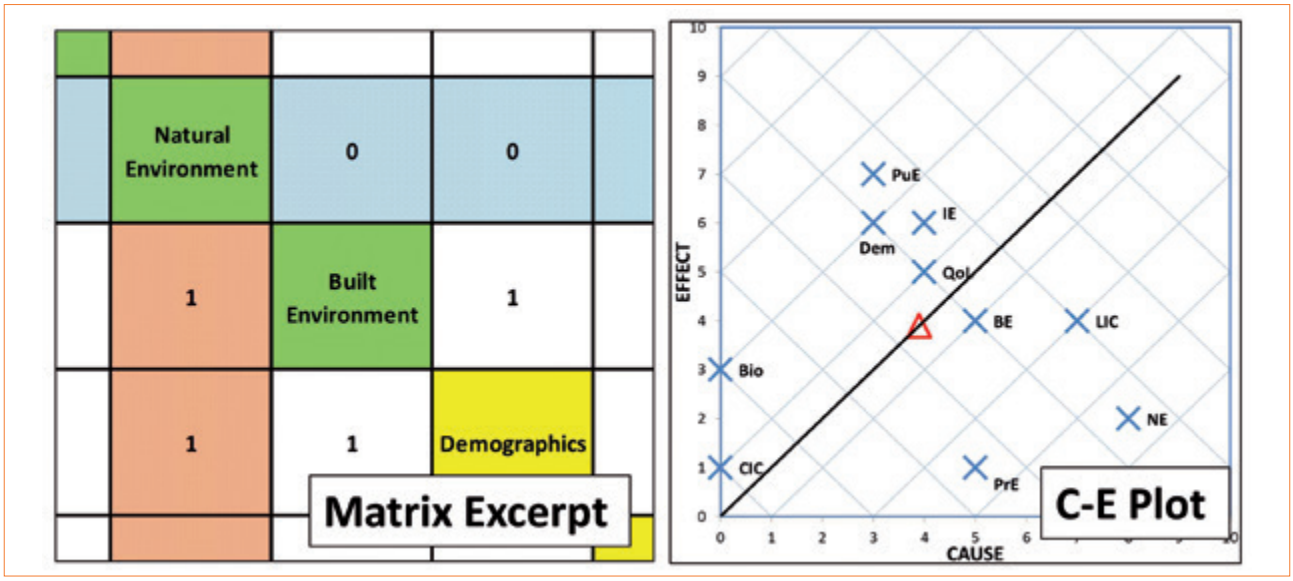

Figure 5: An excerpt from a completed Interaction Matrix (left) and Cause-Effect plot (right)

3.3 Technology Trains for brownfield redevelopment: on track for unlocking latent value

Technology trains draw on knowledge and techniques from different fields to overcome environmental and resource challenges in brownfield redevelopment by systematically assessing resource and service supply and demand of the redevelopment site and its vicinity.

The technology train concept aims to define the playing field in which technological solutions needs to be found to enable the brownfield sites redevelopment in an economic, ecological and socially acceptable way. As at each brownfield site the obstacles and boundary conditions are different, it is unrealistic to formulate a complete list of technologies that can potentially be applied in the redevelopment of brownfield sites. Therefore a framework is developed to define the playing field within which technologies have to operate. This framework seeks to effectively use resources that are present at the brownfield to fulfil demands on goods and services that are needed in the redeveloped site.

Assembling technology trains at brownfield sites: Key considerations

An important aspect of assembling a technology train is a set of key considerations for specific brownfield sites. These should be the subject of structured workshops with some or all stakeholders during the Make the Transition phase. The considerations are divided into three categories of questions:

1. Local context to define relevant fields for technology trains
   a. What are the early warning indicators for brownfield site emergence and/or what are the identified barriers for brownfield redevelopment?
   b. What are the adverse effects if nothing is done on the brownfield site?
   c. What are the (local) policies on energy supply/greenhouse gas emission, water quantity, environmental quality, waste handling to establish demand for services
   d. What are the markets and opportunities in the region for services that can potentially be provided by the brownfield site to define which supply is needed
2. Defining the scope for technology design: how can technology trains support the redevelopment plan of the brownfield site in time and space?
   a. Application of technologies to enhance the competitiveness of the redeveloped brownfield compared to greenfield development (e.g. lower remediation and infrastructure or utilities costs during redevelopment and lower energy costs during usage)
   b. Application of technologies that contribute to meeting demands (and policy targets) outside the brownfield site without major investments with respect to:
      i. energy usage / Greenhouse gases (renewable energy generation or sequestrating carbon),
      ii. water management (buffering storm water, aquifer recharge, tertiary polishing),
      iii. water quality (removing or immobilizing large scale (mobile) contaminants in groundwater and surface water),
      iv. noise and visual impact (barrier function),
      v. risk of accidents (cordon sanitaire function)
3. Elaborating the technology trains
   a. How to organise technological interventions during brownfield redevelopment?
   b. How to organise their financing during brownfield redevelopment

Technology trains are directed to fit basic demands for goods and services at brownfield sites, namely 1) Energy and water,

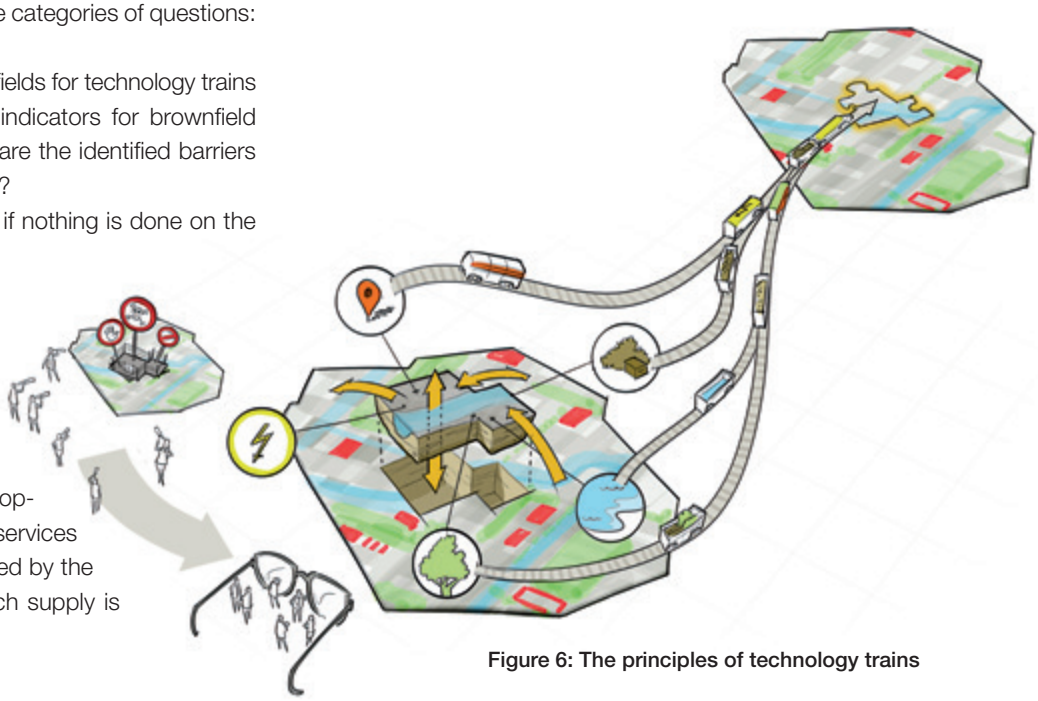

Figure 6: The principles of technology trains

2) building material and soils, and 3) Soil and water. Assembling technology trains results from technology pull processes that balance supplies and demands at a specific brownfield site.

Examples for technology trains: hard technologies trains for different demands

Three specific technology trains were elaborated by HOMBRE as examples to represent the different basic demands for goods and services (corresponding to the three basic demands, above):

Technology Train 1. Aquifer Thermal Energy Storage (ATES) combined with bioremediation of chlorinated ethenes to reduce primary energy demand for buildings and improve aquifer quality. The extraction and re-infiltration of large volumes of groundwater (more than 50,000 m^3 per year per well) for ATES affects the soil chemistry and thereby the redox processes. In Fe(III) reducing aquifers, the mobilization of organic compounds improved the bioremediation potential which reduced the need for additional (more costly) interventions. Long term operation of ATES systems can therefore contribute to improved groundwater quality.

Technology Train 2. Solidification/Stabilization of contaminated (industrial) soils by carbonation. This technology train aims to minimise off-site disposal by converting the contaminated soil on site into building and construction materials that can be used on the site itself or the surrounding areas. This combination of remediation and materials manufacture was shown to be a promising approach for obtaining a product with sufficient mechanical strength to be used in civil engineering application and improved physical/chemical behavior (i.e. minimal leaching).

Technology Train 3. Reinforcing unstable soils by the EcoGrout process. In the EcoGrout process, cementation of soil particles is achieved by the reaction between $CaCl_2$ and $NaHCO_3$ which are injected in the aquifer or other porous matrix. The CO_2 produced by the Ecogrout reaction may be employed to aid the stripping of Volatile Organic Compounds, such as toluene or trichloroethene, from groundwater.

HOMBRE case study site: **Solec Kujawski, Poland**

View of the case study site in Solec Kujawski (left) and view on parts of the brownfield site with half full creosote container (right)

The urban and postindustrial case study Solec Kujawski is located in Northern Poland on the Vistula River. At the terrain a former manufacture for wood impregnation was located between 1876 – 2001. This led to a heavy contamination of the ground and groundwater with PAHs, BTEX and phenols.

Since July 2013 the area is being remediated stepwise using co-financing from the EU Cohesion Fund for National Programme “Infrastructure and Environment”.

HOMBRE held 3 stakeholder workshops there in April 2013, June 2013 and September 2014 – one of them together with the EU project TIMBRE. The stakeholders (amongst others mayor/vice mayor, city representatives, local authorities) intensively discussed and exchanged on the Early Warning Indicators, HOMBRE land use and management cycle, “Golden Rules” for Technology Trains.

3.4 Assisting soft re-use of brownfield sites

Soft re-use of brownfield sites, such as for biomass production or green space, can provide services which enhance regeneration, both in their own right and when integrated with hard uses such as for buildings. One of the underpinning concepts of HOMBRE is that redevelopment projects that deliver a broader range of services have improved overall sustainability and economic value. The totality of services delivered by a completed project is seen as the project drivers that incentivise the investment necessary for a redevelopment to take place.

Soft re-use: an opportunity for interim and/or permanent solutions

Some important drivers for soft re-uses of brownfields can be identified:

- In many European countries, densely urbanised areas still need the development of open spaces. Brownfield sites are potential locations for such open space.
- A renaissance of and innovations in urban gardening, community gardens and urban farming increases demand for urban brownfields.
- Soft re-uses are an option for renewable energy generation (non-food biomass production).
- Soft re-uses, if designed appropriately and sited at strategic locations, represent green infrastructure that offers communities such as mitigation of heat island effects, improved urban comfort.
- Trees can improve urban air quality by filtering and retaining air particles and contaminants generated by traffic and industry as well as providing shade and eye-candy. Green infrastructure provides habitat for migrating birds and other species.
- Many leisure activities are more enjoyable and effective in soft rather than hard landscapes (e.g. Nordic walking, ball games, boot camps, cricket).

In specific contexts where the conventional financial benefits of redevelopment are not always easily identifiable, as is the case when brownfields are to be deployed for soft end-uses, decision-makers should be fully aware of the broader opportunities and benefits that can emerge. Soft re-uses can address not only local but also regional and even global challenges (for example climate change resilience, energy generation, preserving biodiversity, reducing car dependency, offering educational and health facilities).

HOMBRE's decision guidance is based on an iterative discussion process supported by simple tools to help decision makers identify what services they can expect from possible interventions on their site, how these interact and what the initial default design considerations might be. It supports the activities taking place during the pre-exploratory and exploratory stages of decision making, with the objective of improving overall sustainability and value. The screening tool used is called the "Brownfield Opportunity Matrix" and has been developed under HOMBRE for soft end uses only.

Figure 7: Site visit during a stakeholder workshop at the HOMBRE case study site in Solec Kujawski, Poland.

3.5 The Brownfield Opportunity Matrix option appraisal tool

The "Brownfield Opportunity Matrix" is a simple Excel based screening tool to help decision makers identify what services they can get from soft reuse[1] interventions for their site, how these interact and what the initial default design considerations might be. The matrix essentially maps the services that might add value to a redevelopment project against the interventions that can deliver those services, as shown in broad terms in Table 3.

Table 3: Main services and interventions within the Brownfield opportunity matrix

Services	Interventions
❍ Soil Improvement	❍ Soil Management
❍ Water Resource Improvement	❍ Water Management
❍ Provision of Green Infrastructure	❍ Implementing Green Infrastructure
❍ Risk Mitigation of Contaminated Soil and Groundwater	❍ Gentle Remediation Options
❍ Mitigation of Human Induced Climate Change (global warming)	❍ Other Remediation Options
❍ Socio-Economic Benefits	❍ Renewables (energy, materials, biomass)
	❍ Sustainable Land Planning and Development

The matrix identifies where there are strong synergies between interventions and services, and also the relatively infrequent occurrences of antagonism. Wherever a particular intervention delivers a service, this interaction creates an opportunity to add value. The matrix describes the kinds of value that each opportunity might generate.

The types of value generated by soft re-use considered are:

- **Revenue Generation Opportunity**
- **Natural Capital:** developed in a number of ways, including (but not limited to) providing green infrastructure, improvement of the local climate, improvement of water resources and mitigation of contamination (protecting and enhancing local ecosystem/environment).
- **Cultural Capital:** developed by improving the social environment (by improving the aesthetics of an area and/or creating a sense of place/belonging for e.g.) and can be a direct result of an increase in natural capital.
- **Economic Capital – tangibles:** e.g. increase of land and property values in the area (feeding back into Cultural Capital) providing benefits to the local community and also the investor.
- **Economic Capital – intangibles:** benefits that are immeasurable but can include for example, an improvement of the image of the investor (be it a company or individual).

The brownfield opportunity matrix: mapping prospects and identifying potential values

Thus, the matrix can be used to map the prospective range of opportunities that might be realised by a brownfield redevelopment project and the project's consequent sources of value. For each opportunity there is a hyperlink to additional information, including a case study. There is also supporting information to describe the various services and interventions listed in the matrix.

Overall the brownfield opportunity matrix can:

- Support initial identification or benchmarking of soft re-use options for brownfields at early stage
- Support exploratory discussions with interested stakeholders
- Provide a structure to describe an initial design concept, in support for example of planning applications
- Provide a structure for more detailed sustainability assessment of different re-use combinations, and similarly for cost benefit comparisons.

1 i.e. uses where the soil is not sealed by buildings or other infrastructure

3.6 Service indicators; guidance for development and monitoring

In the ideal Zero Brownfield scenario, an impeding transition has been identified well in advance, all relevant stakeholders have been involved at the appropriate time and, with the use of their creativity and the HOMBRE tools, an innovative and sustainable redevelopment project has been realised. So will they now live happily ever after?

Service indicator: visualise performance and benefits of your efforts

At this stage a consideration of potential future situations is needed. Awareness of changes in those external conditions (for which the project was more or less optimised) is needed as with time they may affect the realised benefits of the land use. To check on this continued performance so called Service Indicators, which represent these benefits and potential impacts, can be monitored. Based on various schemes for developing indicators, HOMBRE identified as the four key steps:

1. **Agree on goals/objectives**
   Identification of appropriate Service Indicators may begin in the 'making the transition' phase as in that stage the societal challenges to be met and also wider sustainability goals are defined by the stakeholders
2. **Select relevant Service Indicators**
   A similar approach to that used in selecting the Early Warning Indicators can be followed here, going from broader goals as defined, to issues of particular importance, to indicators that are both relevant and practical to monitor.
3. **Obtain baseline data**
   This is both a test of the ease of monitoring and the clarity of definitions, protocols, and other operational aspects as well as setting the baseline with which to compare the forthcoming monitoring data. In the case of a Brownfield redevelopment project, the baseline could either represent the "old" situation that is now going to improve, or the newly realised situation that – within certain margins-is to be maintained.
4. **Define targets**
   Using the goals and objectives from step 1 and the baseline data from step 3, realistic targets can be set in terms of upper and/or lower limits for the selected indicators. At this stage the actions that should be taken if those limits are breached should also be decided.

Service Indicator monitoring can then provide relevant management information, for example the time it takes to fully realise the various benefits envisaged of the new land use, the effect of external drivers on if and how fast the targets are reached, and not least if at some point the benefits of the new land use are at risk of falling below the required limits and additional effort or action is needed to safeguard the contribution of the project to sustainable urban development. The set of Service Indicators may shrink with time, as some may become irrelevant when targets are reached or no further change is anticipated. In the longer term, project based Service Indicator monitoring can be integrated into the more general Early Warning Indicator monitoring, providing information on when – not if – a new Zero Brownfield land management intervention may be called for.

Figure 8: Stakeholders at Genoa case study site in Italy working with the brownfield opportunity matrix

3.7 The Brownfield Navigator – tool for spatial teamwork

The Brownfield Navigator (BFN) aims to facilitate a more holistic appraisal of brownfield redevelopment opportunities and early stakeholder involvement by offering an attractive online collaboration tool.

What is the BFN?

The BFN is an online environment which accompanies and supports decision makers, thought leaders and stakeholders through the different management phases in the land cycle. The BFN is divided into three modules, corresponding to the three land management phases: anticipating change; make the transition, check performance. In each module, the BFN offers information, examples, visualization possibilities and tools. The BFN offers access to the HOMBRE tools described before. Although all phases of the land management cycle are represented, the emphasis is on the "make the transition" phase.

Users can create their own project specific brownfield session in the BFN. The session is secured with a username and a password. Only people provided with this login information can enter the session. In the BFN-session, users can upload and store the brownfield information: maps, sketches, data, decisions made, stakeholder analyses, opportunity plans and feasibility plans. The user can use the BFN for different purposes, in different phases of the project and in the order that is suitable for the user. Unique among other online mapping tools, BFN uses the language and provides mapping symbols relevant to land management and land use visioneering. The BFN includes a library of brownfield redevelopment projects throughout Europe, which include the transitions that were are taken up as well as the societal challenges that were dealt with and benefits that were provided. This was found to be very useful during the Markham Vale case study. BFN also contributes to the process of brownfield redevelopment. It can be used in discussions with stakeholders, for example when discussing current situations, ambitions or future land use scenarios. In this case the easy to use map-functionality facility allows users to draw, add notes or symbols and then save and share sketches can simplify the production of a spatial overview and record the outcomes of discussions.

Finally

The BFN is currently freely available online (bfn.deltares.nl). It can be used on desktop, laptop or tablet computers. The BFN collection of generic tools allows customization for site specific situations and tasks. Since the BFN is based on Open Software architecture users can add functionality (e.g. financial modelling or route visualization) or approach the BFN creators Deltares for such services bfn@deltares.nl.

The Brownfield Navigator: your instrument to support sustainable land use management

4 HOMBRE Case Study Sites

The HOMBRE project involved several case studies located in different parts of Europe:

- Gelsenkirchen, Germany: former coal mining area (22ha)
- Genoa, Italy: industrial and urban area (22 ha)
- Halle/Saale, Germany: urban area (3ha)
- Markham Vale, UK: mining and urban area (220 ha) – additional case study site in the project
- Solec Kujawski, Poland: urban and post-industrial area (80 ha)
- Turceni /Jiu, Romania: mining and rural area (250 ha)
- Terni, Italy: industrial area (10 ha)

The target of the involvement of these sites was to

- Learn from case stakeholders' experiences and knowledge to understand relevant drivers and pressures around brown-field origination and barriers for regeneration
- Introduce stakeholders to HOMBRE's outcomes and tools, test their applicability and feasibility.
- Support stakeholders to find visions and opportunities for bringing their brownfields back to beneficial land use again.

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The deliverables of HOMBRE can be found at the project website **www.zerobrownfields.eu**

HOMBRE tool/product	For more information
Early Warning indicators	D2.1 "Early Indicators for Brownfield origination"
Service Indicators	D2.2 "Cost effective monitoring within the Circular Land Management Framework"
Anticipating BrOWnfield Emergence Tool (BOWET)	D3.3 "Evaluation of test results from the Brownfield Navigator use in case studies"
Technology Trains	D4.1 "In Depth Analysis and Feasibility of the Technology Trains" D4.2 "Report of testing of principles and description of critical design parameters of technological and process aspects of the technology trains" (lab results) D5.4 "Operating windows of two important low input technologies for greening urban brownfield" (lab results)
Brownfield Opportunity Matrix	D5.2 "Decision support for soft end-use implementation"
Brownfield Remit /Response (BR2)Tool	D6.2 "Integrated Framework for systematic evaluation of brownfield regeneration options"
Brownfield Navigator	D3.1"Decision support for successful regeneration of brownfields" Website: bfn.deltares.nl

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