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HOMBRE

"Holistic Management of Brownfield Regeneration"

D 5.1: Valuation approach for services from *regeneration of Brownfields for* soft re-use on a permanent or interim basis

Creating opportunities from synergies between environmental, economic and social improvements

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Disclaimer

Summary

The HOMBRE project's overarching aim is to develop new approaches to improve Brownfield (BF) regeneration in terms of performance and sustainability in a holistic way and show new opportunities to generate greater value for private and public investors. At the core of HOMBRE's approach is the use of integrated processes (treatment trains) to deliver optimized benefits for targeted beneficiaries, i.e. delivering services. Thus, from HOMBRE's perspective, services from BF regeneration are fundamental as they multiply the chances to regenerate BF and provide new opportunities for developing economies, ecosystems and people.

From a conceptual point of view, HOMBRE's overarching strategy on leveraging value creation from BF re-use is shown in Figure A.

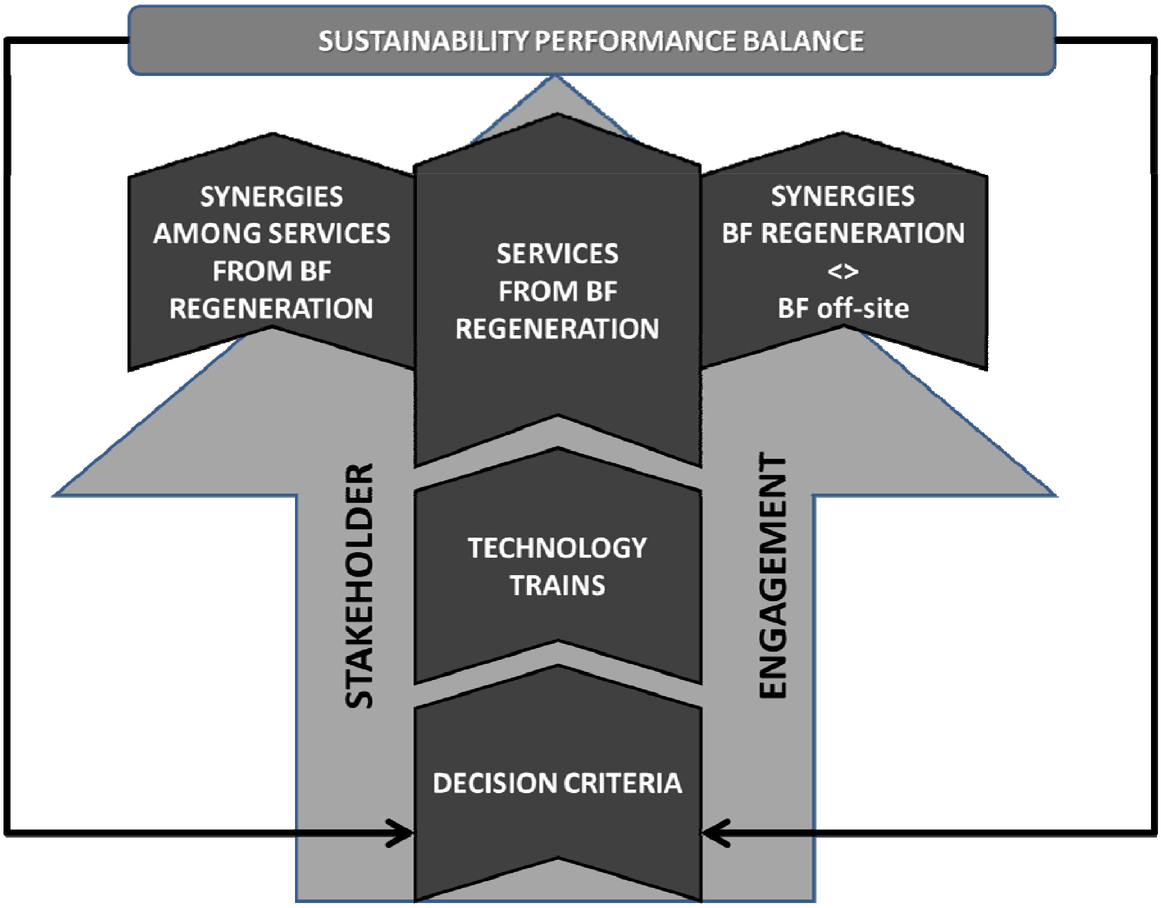


Figure A: HOMBRE Concept

The key elements towards value generation are:

- Sound criteria for deciding on best options to be implemented in all phases of Brownfield regeneration processes. Ideally these take into account broader issues of sustainability, not only during regeneration process but also considering future land-use and its operation / maintenance
- Treatment Trains (integrated processes) as a means of providing both solutions to site specific problems (risk, liabilities etc.) and tailored services from regeneration techniques and land use management operations

- Assessment of services and identification of synergies as a means of combining services and thus increasing the chances of and the value of Brownfield regeneration (synergies will be a mean to link site specific issues with local and regional issues)
- Sound and long term strategy for monitoring overall sustainability performance of projects, balancing wider costs and benefits resulting from Brownfield regeneration in order to adapt strategies and detect early signs of Brownfield resurgence.

Within the HOMBRE Work Packages (shown in Figure B), WP5 focuses on enabling soft end-uses of Brownfields. Its results will contribute towards the projects goal of creating a road map and framework for achieving "zero Brownfields".

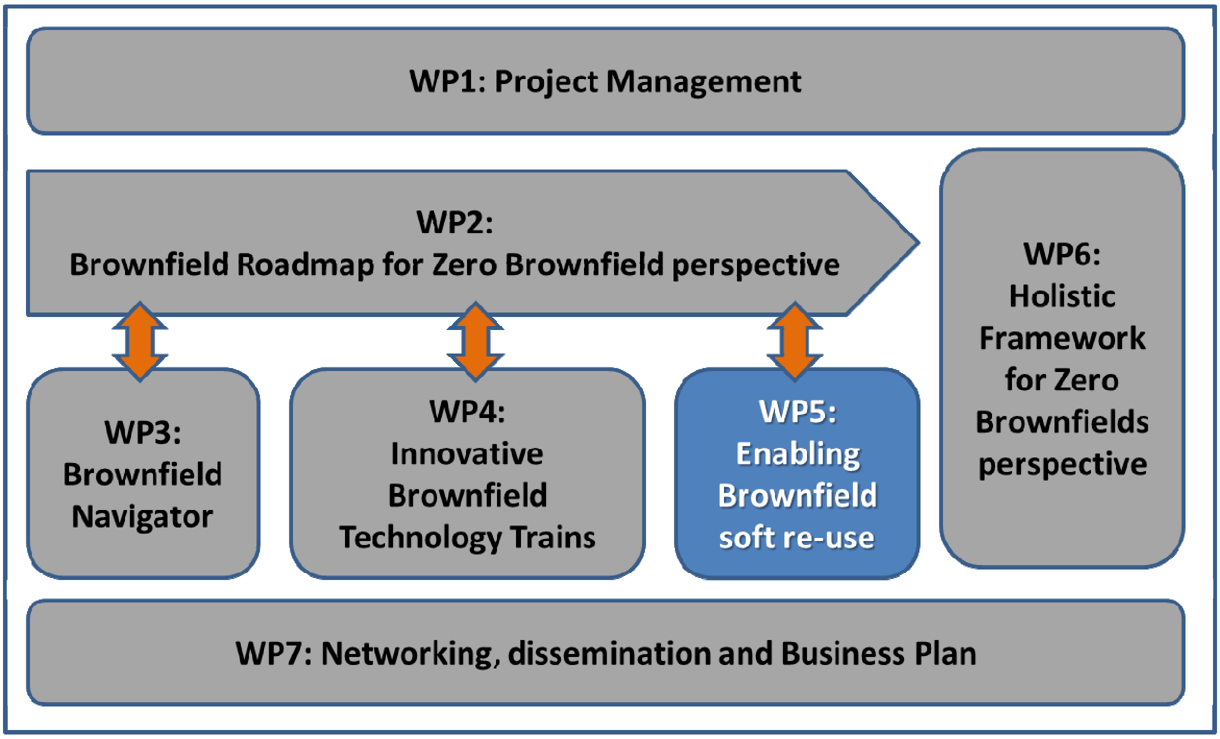


Figure B: Structure of HOMBRE's work packages

The shared recognition of useful value underpins the rationale for any public or private investment in Brownfields regeneration. The purpose of this report is to describe a valuation approach for services from regeneration of Brownfields for soft re-use on a permanent or interim basis. Synergies between improvements in environmental, economic and social services could leverage enhancement in the value of Brownfields regeneration and so help create expanded opportunities for Brownfields re-use. This report describes what are meant by services and synergies, and how the current practice in soft-end use regeneration might be supported by these concepts.

The development of this report is intended also to facilitate the on-going tasks of WP5:

- Task 5.2 "Decision support system on soft uses and technologies using the operating window concept";
- Task 5.3 "Use of bio-energy clusters for linking marginal urban Brownfield site re-use with sustainable urban energy.
- Task 5.4 "Technology development. Optimising two important low input technologies for greening urban Brownfield (operating window investigation)

This report contributes to HOMBRE WP5's approach to creating value from the regeneration of Brownfields. In particular, by addressing how stakeholders propose and estimate value from the regeneration of Brownfields into soft re-use (i.e. non-sealed soil based redevelopment of land). This report is organised in seven chapters:

1 Introduction Chapter 1 describes how WP5 has come to the goal of the HOMBRE project, the role of this report and the background of Brownfield regeneration for soft re-use in the light of contaminated and non-contaminated Brownfield land. Chapter 1 finishes with the scope and objective.
2 Soft re-use of Brownfields Chapter 2 describes soft re-use of Brownfields. We discuss the drivers for choosing soft re-use and acknowledge that the lack of economic drivers can stimulate soft re-use of Brownfields. This includes an overview how this is organised in European countries. Soft re-use in this report is focused on green infrastructures and biomass production for energy production
3 Regeneration of Brownfields for soft re-uses Chapter 3 describes the connection between soft-end uses and Brownfield land value. It then describes the broad strategies and techniques that are deployed for delivery of green infrastructure and biomass production on Brownfields.
4 Services from the regeneration of Brownfields for soft re-uses and opportunities for building value Chapter 4 describes how synergies between different benefits or services might widen the scope for Brownfields to be returned to productive use. It introduces the concept of "services" from the regeneration of Brownfields into soft re-uses, and shows how synergies can be designed into soft-end use regeneration schemes to create expanded opportunities for Brownfield regeneration.
5 Integrating processes using treatment trains to provide enhanced project services and value Treatment trains are used by HOMBRE as an overarching term to discuss the integrated processes and combinations that can deliver a Brownfields regeneration project. In particular the term is used to describe scenarios that deliver a range of project services that provide an enhanced value that can leverage Brownfields re-use. Chapter 5 provides a brief overview of the scope of treatment trains in a soft end –use context.
6 Valuing costs and benefits from regeneration Understanding *overall* value and making a convincing proposition of value to Private and Public Sector stakeholders, funders and investors is key to the successful delivery of the HOMBRE concept. Chapter 6 reviews tools that have been or could be used to examine value costs and benefits from regeneration. It reviews approaches to cost benefit assessment and sustainability appraisal. It describes the key role of understanding different stakeholder perspectives in understanding sustainability and in incentivising them to support a regeneration project. It proposes the use of a project or site conceptual model for sustainability as a tool to combine perspectives and provide a framework for determining *overall* value.

7 Site conceptual models for sustainability Chapter 7 describes how existing tools and concepts from contaminated land risk assessment have been adapted for use in considering sustainability for Brownfields regeneration projects, in particular the idea of a "sustainability linkage" and a "conceptual site model for sustainability" (or project model). It describes, using a simple example case study provided by C-CURE, how linkages can be combined in a conceptual model and used to support design of integrated "treatment trains" for regeneration of Brownfields to soft end uses, taking into account synergies and trade-offs. It also shows how sustainability conceptual models can be used to support and simplify sustainability assessment, implementation and verification and maintenance. It describes how the sustainability conceptual model is a crucial tool in enhancing and estimating the overall value of a Brownfields regeneration project

Introduction

The concept of "circular land management" underpins HOMBRE's thinking and is structured around the following key principles: avoiding new Brownfields, recycling existing Brownfields and compensating the effects of land consumption. The goal of HOMBRE within circular land management is to reduce the consumption of greenfield land and the production of Brownfield land. This can be achieved by maintaining land in productive use as far as possible, but where it falls out of use, to make sure its transition to a new land use is as rapid as possible. The return to use of land could be for built redevelopment, or for soft end uses such as urban green space. A possible intermediate scenario is that there may be an interim soft use, prior to longer term re-establishment into the land cycle.

Soft re-use of Brownfields

Regeneration of Brownfield areas for soft end uses, such as green areas for open space and amenity, is current practice in Brownfield regeneration in a number of countries. It is often the end-use for former mining and military areas, but transformation of industrial or urbanized land into soft-after uses is less frequent. The direct financial case for soft re-use regeneration can be hard to demonstrate clearly, although there is often a high societal demand.

The shared recognition of useful value underpins the rationale for any public or private investment in Brownfields regeneration. The purpose of this report is to describe a valuation approach for services from regeneration of Brownfields for soft re-use on a permanent or interim basis.

Within this report the term value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may include improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns.

Colloquially "hard" developments describe some form of building and "soft" end use describes forms of use that do not involve substantial construction. HOMBRE WP5 distinguishes hard and soft land usage using EU policy on soil sealing (EC 2012) as a context. Hard land usage is defined as re-use that predominantly contains built or paved development. Soft land-use is where the land remains unsealed and the soil remains in biologically productive use, for example for agriculture, wildlife habitat, forestry, amenity or landscaping. The two scenarios are not mutually exclusive. Many development scenarios include both types of usage, for example landscaping in generally built up areas, or a visitor centre on a Brownfield regenerated for public amenity. There are many successful examples of regeneration to soft end uses across Europe over the past 50 years. However, failures do occur, often because the maintenance of the restored land area ceases.

Some important drivers for soft re-uses of Brownfield land can be defined.

- In many European countries, densely urbanized areas still need the development of open spaces. For this, Brownfields sites are a key potential, because of their availability and relatively cheap purchase price
- A renaissance of new forms of urban gardening, community gardens and urban farming increases the demand and feasibility of adapting Brownfields for green uses
- Soft re-uses are an option for renewable energy generation (non-food biomass production)
- Soft after re-uses are means to create green infrastructures that offer several benefits for communities), i.e. for example mitigation of heat island effects and improvement of urban comfort, if designed appropriately at strategic locations. Green infrastructures with trees can help improving air quality in urban areas by filtering and retaining air particles and contaminants generated by traffic and industry. Green infrastructures can also help creating habitat for migrating birds and other species in urban and peri-urban areas.

In specific contexts where benefits of regeneration are not always easily identifiable as it is the case when brownfields are to be regenerated into soft end-uses, HOMBRE believes it is essential for public organizations in charge of financing projects to be fully aware of broader opportunities and benefits that can emerge from Brownfield regeneration and means to address not only local but also more global challenges (i.e. sustainable land planning, adaptation and mitigation towards climate change impacts, biodiversity, urban comfort as mitigation of heat island effect, noise etc.). This report will focus on evidencing how value from Brownfield regeneration into soft re-use can be enhanced, helping stakeholders identify and value new opportunities and benefits through the sound planning of regeneration processes and soft land uses. Based on the principle of providing project services from Brownfield regeneration to help address broader needs and demands from economy, society and the environment, this report will introduce the concept of "synergy" and evidence its relevance in value creation and enhancement in brownfield regeneration. Doing so, HOMBRE seeks expanding opportunities for brownfields reconversion into soft re-uses.

HOMBRE WP5 explores two broad soft re-use scenarios. The first scenario is regeneration for Green Infrastructure, including open space to provide urban amenity and other services. The second scenario considers the re-use of land for production of non-food crops. Both scenarios could potentially be used as an (interim) measure to manage urban Brownfield land, prior to a more permanent solution being found. Alternatively either of these might be a long term option for re-use of Brownfield, but could also be used in an interim way for returning Brownfield to productive use pending a long term solution.

Regeneration of Brownfields for soft re-uses

There are important connections between soft-end uses and Brownfield land value. The value of land is dependent on the type of land use and the demand for that land use. Markets discount the value of degraded land, such as Brownfield land, based on assumptions relating to the likely direct and indirect costs of rehabilitation. The effect of these constraints on a site's value can persist even after the completion of remediation. However, a *change* in land use can substantially increase land value, for example a change from an industrial use to a use for retail and housing. This change on value is dependent on location and market rates for similar land uses in the vicinity. For a Brownfield site this change in value may be sufficient to pay for site regeneration and also generate useful revenue from a future land sale. Brownfield sites with land contamination problems are likely to be particularly disadvantaged because of their higher liability burden. Away from economically active areas the profitability for less advantaged Brownfield sites may be borderline, or conventional regeneration may proceed only at a loss. It is the regeneration of less economically advantaged sites that HOMBRE seeks to facilitate. Soft-end uses may create opportunities for longer term and lower input regeneration, creating value for a range of stakeholders both directly connected with the site and in the locality of it. Developing a shared concept of value to support the necessary investment can overcome a major barrier to this soft end-use regeneration. This problem is recognised in several Member States, where institutional measures and organisations have begun to facilitate regeneration for these less advantaged sites.

There is a broad range of possible re-use strategies that can integrate with different services such as amenity or on-site energy production, either as a permanent or interim measure. Soft re-uses are mediated by plants, whether as part of the landscape of an open space, or for providing benefits of an urban "green lung" or for a productive purpose such as growing biomass. The growth of plants and hence the viability of soft re-uses is dependent on a suitable level of soil functionality. On many sites a series of interventions may be considered depending on the soft re-use envisaged:

- Engineering works
    - Removal of constructions and obstacles
    - Building infrastructure, for example paths and cycle trails, renewable energy such as wind or solar, a visitor centre, or facilities for biomass processing
    - Processing of by-products such as harvested biomass
    - Grading surfaces and geotechnical interventions
- Remediation of contamination in soil / groundwater
    - Treatment measures to prevent receptors, e.g. removal of hot spots were possible and necessary
- Management of soil
    - For cultivation
    - For specific environmental services such as carbon sequestration, or developing particular habitats
- Cultivation of plant cover.

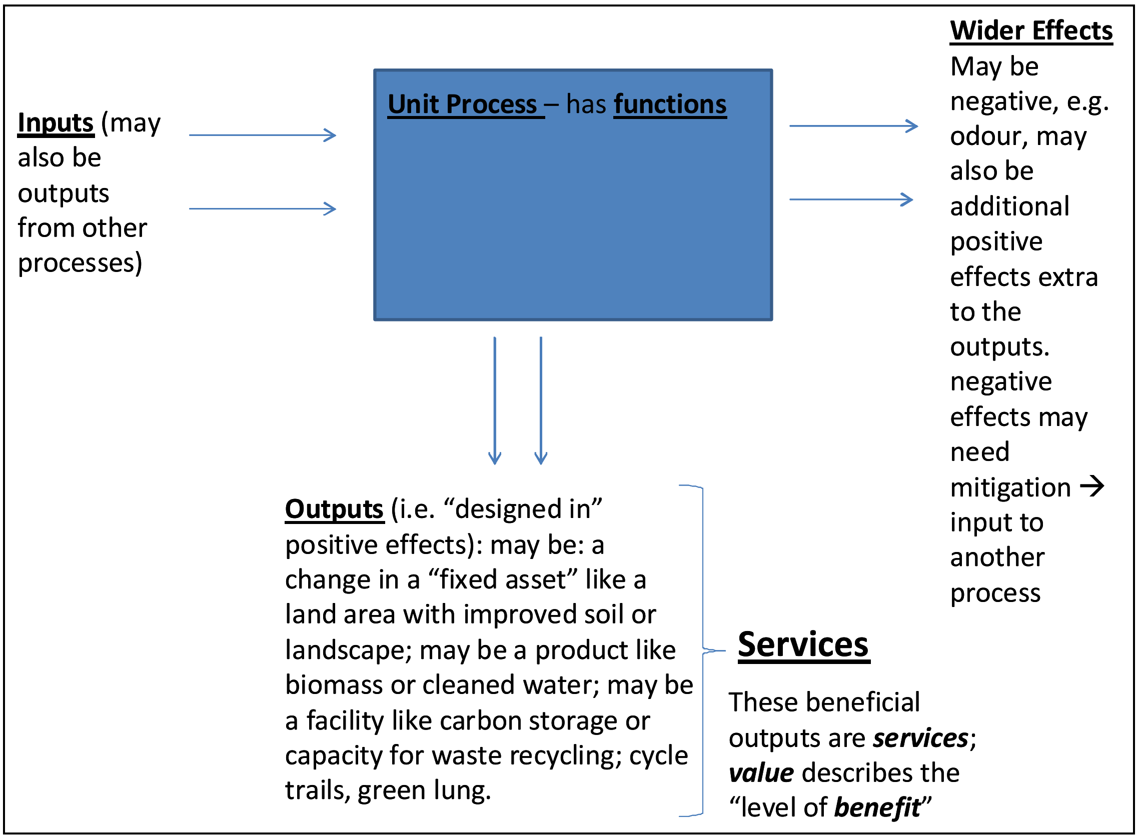
Services from the regeneration of Brownfields for soft re-uses and opportunities for building value

HOMBRE WP5 has adopted a functional description to better understand the linkage between regeneration services and project value. In WP5 the term *"project service"* is used to express the benefits obtained by specific beneficiaries or "receptors" (i.e. nature, people or society). In the context of HOMBRE, services are delivered through the implementation of processes during the regeneration of Brownfields and the maintenance of specific land uses. As such they constitute the specific outcomes of designed process as opposed to conventional "ecosystem services" which are naturally provided without technological inputs. The protection or enhancement of ecosystem services is itself a possible "service" which could be designed into a regeneration project..

There are three constituent elements for a project service to occur. These elements are:

- an intervention, in particular a process or technique (or a combination thereof)
- one or more outcomes (permanent or temporary effects) of the intervention
- a beneficiary of the outcomes

Some project services arise from the process of regeneration itself, and therefore may be one-off effects, albeit in some cases with hopefully permanent impacts (such as on land values). Other project services continue with the soft-end use of the site, for example the provision of open space for amenity and leisure, and as such may require on-going maintenance and management.



Conceptual model of unit process in Brownfield regeneration

Project services are the basis upon which value can be created that will leverage a Brownfield regeneration, by providing benefits that make the investment in regeneration worthwhile to specific constituencies or beneficiaries who will support it. These project services may be delivered by ecosystems, they may be delivered by non-ecosystem processes or they may be consequential economic benefits. Hence the project services from a Brownfield regeneration for soft end-use can include both ecosystem service benefits and wider benefits.
The exact choice of project services and the most efficient way in which they can be delivered determines the usefulness and hence the value of a regeneration project. Synergy describes a situation where a process or combination of processes on a site delivers several useful services in a way that provides a net improvement for the financial feasibility and sustainability of a project. In this case a process might be a remediation, process, a

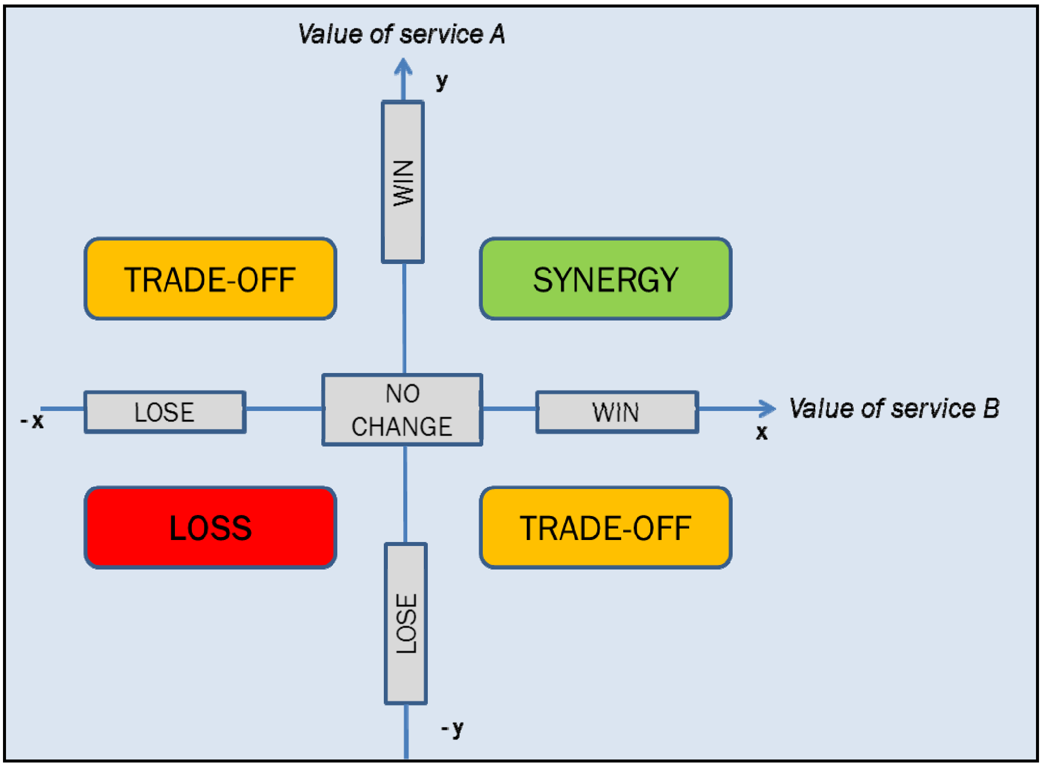
production process such as biomass cultivation or some other form of intervention such as public involvement in green infrastructure management. The types of synergy that might be possible in Brownfields regeneration for a soft end use include:

- Combining use on on-site and off-site biomass to gain economies of scale.
- Using biochar as carbon sink (climate change) and soil improvement for plant growth
- Green infrastructures as means to improve air quality, water storage, biodiversity landscape and urban climate comfort
- Unsealed soil as a way of improving aquifer recharge and water management

This overall approach is broadly the same as the process of "eco-dynamic design" which has been developed in the Netherlands.

Trade-offs describe situations where one service must be balanced against another service because while there are advantages in including both services in a project, there is some interference between them. For example a site might need to consider a trade-off between biomass production and open space green infrastructure to provide for both economic returns and providing amenity for a local community.

The objective of linking wider project services with Brownfield regeneration is to improve value for projects that would go ahead anyway and to enhance value sufficiently to allow projects to regenerate Brownfields which would otherwise remain stalled and effectively out of the land use cycle.



Schematic representation of interactions of services resulting from Brownfield regeneration and soft re-use of land – synergies and trade-offs

For soft-end uses there are three overlapping frames of reference:

- Strategic choices – these relate to how land is used in a planning sense, including as part of a portfolio of sites or across a region containing several Brownfields.

- Project choices – these relate to the exact choice of project services and the most efficient way in which they can be delivered, the concept of "synergy" is particularly important for maximising opportunities for enhanced service delivery from any particular project
- Sustainable choices – these relate to the overall benefits and impacts of the strategic and project choices made; while some aspects of sustainability will be addressed by particular project services (and strategic decisions).

The categories within each dimension can overlap. For example, a biomass production process on a Brownfield site may be both the on-going soft-end use and part of the regeneration process (providing remediation and soil restoration "services").

Project designs will likely need to consider a range of synergies, trade-offs and potential net losses:

- Synergy describes the simultaneous enhancement of more than one service, for instance, because improving the value of one service can enhance the value of another service (for example non-food crops can help managing risks associated to soil contamination on a site as well as providing resources for bio-energy production)
- A trade-off refers to the increase of the provisioning of one service that is accompanied by the simultaneous decline of another service at the same location and resulting from the same intervention
- A loss describes a situation where two project services are incompatible, and trying to deliver both will result in poorer performance for both.

The role of different stakeholder interests has an enormous impact on analysis of synergies, trade-offs and losses because relative values may be very different for different stakeholder groups for any particular project service or wider impact.

Integrating processes using treatment trains to provide enhanced project services and value

A treatment train is an integrated system of techniques and processes implemented along the whole life cycle of a specific Brownfield regeneration project. The integrated system of technologies and processes should be designed in such a way that outputs from individual processes link to other processes with the final aim of incrementing the overall value of the BF regeneration project.

There are three drivers for designing treatment trains:

- **"BF problem push"** i.e. solving a specific Brownfields problem linked with land quality and land use,
- "**BF Direct Economic Opportunity - push**" regeneration driven by immediate economic goals (for CABERNET "Type A" sites)
- Key driver 3: "**Enhanced Services - opportunity pull"** i.e. treatment trains are designed in order to deliver a series of added values to specific stakeholders with specific interests.

The focus of WP5 is on Key Driver 3, which can reduce costs for projects that are required but are not profitable, or improve profitability of projects that are already economic.

Valuing costs and benefits from regeneration

For a brownfields regeneration to take place, someone has to be incentivised to invest in it. This is likely to depend on the regeneration outcome having a *greater* value than the value of the investment made. Within this report the term *overall* value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may be improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns (*direct financial value).* Overall value can therefore be seen as having three components:

- Direct financial value
- Tangible wider value
- Intangible wider value.

Cost benefit assessment describes a process of comparing the likely costs of a project with its benefits and is a form of economic valuation. Where this assessment is based on conversion to strictly monetary terms it is described as cost benefit analysis – CBA. Sustainability assessment (or appraisal) has been described as the process of gaining an understanding of possible outcomes across all three elements (environmental, social, and economic) of sustainable development. Sustainability appraisal is increasingly being used to understand overall value in support of decision making for both Brownfield regeneration projects. This reflects the increasing recognition of the wider potential benefits of Brownfield regeneration to sustainable development.

Overall value is essentially a function of the perceptions of stakeholders. Stakeholder involvement should also be formally included in sustainability assessment to provide a more robust and acceptable assessments, in accordance with the *Bellagio* principles. Valuation and sustainability assessment therefore go hand-in-hand with stakeholder engagement.

Existing approaches to CBA can represent direct financial values and tangible wider values and are well established techniques to support choices based on the balance of benefits to costs. However, CBA has serious limitations in terms of identifying the appropriate wider value considerations, and in terms of effectively valuing intangible externalities. Conversely, sustainability assessment with an appropriate level of stakeholder engagement can identify both tangible and intangible value considerations and rank choices accordingly. Sustainability assessment has major weaknesses in terms of being a convincing basis for financial investment decision making as there is no clear outcome in terms of value. HOMBRE proposes that providing transparency is a way forward in resolving this dilemma; providing that all stakeholders recognise that what is derived is a combined approach which on the one hand cannot fully monetise everything, but on the other hand provides a framework for monetisation where this is possible.

HOMBRE's proposal for a way forward in coming to a common understanding of overall value depends on the following:

1) The development of a clear and shared conceptual model for sustainability for a particular site or project
2) The conceptual model can be used as a basis for prioritising which factors are important, related to agreed criteria such as: the services expected from a particular regeneration project; regulatory and corporate limits and policies; other critical limits defined by the local context; and provision of an agreed rationale for the verification of project outcomes
3) An iterative approach to developing the conceptual model explicitly considering trade-offs and synergies as part of a design phase and options appraisal

4) The conceptual model could also be used to provide a robust linkage between sustainability appraisal and cost benefit appraisal, using a combined Multi Criteria Analysis (MCA) based cost benefit assessment. Such a combined approach could apply monetisation, if desired, to factors considered to be directly financial or economically tangible, and some other form of benchmarking for intangible factors
5) An appropriate level of stakeholder involvement to ensure that outcomes are generally acceptable, within an overarching framework for valuation that is also compliant with the Bellagio principles

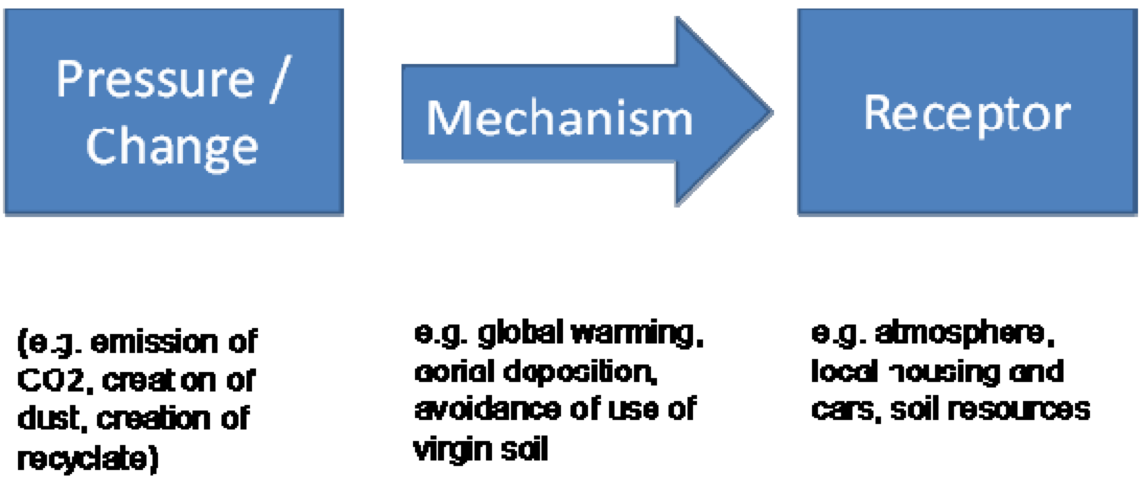
7 Site conceptual models for sustainability

Ideas of “linkages” and conceptual site models widely used in contaminated land risk assessment can be used to provide a tool for crystallising available and relevant information for “sustainability”. The aim is to help stakeholders recognise, prioritise and deal with the management of the sustainability for a particular site and project, and better understand *overall value*. An iterative development of such a conceptual model is likely to involve reviewing initial conditions, identify the most pressing sustainability concerns / opportunities, project design, option appraisal, understanding overall value, implementation, verification and maintenance.

A sustainability linkage is proposed as having three connected components:

- A source (pressure or change): this describes a factor that might cause an effect, for example the emission of CO_2 or an increase in road traffic
- A mechanism: this describes how harm or benefit might be brought to a particular receptor, for example the emission of PM10 particulate matter in road traffic exhaust; or an increase in congestion that causes delay to other road users; or an increased risk of accident from additional vehicle movements
- A receptor which is the constituent of economy, environment or society which could be affected by a change / pressure via a mechanism, for example human beings (i.e. society) via PM10 particulates or increased risk of accidents; or local economy via increased costs of delivery arising from congestion.

All three components need to be connected for a sustainability effect to exist. If a sustainability linkage exists there is a potential set of connections that can have an effect on sustainability (positive or negative) which can be described in a relatively precise way.



A common strategy for determining importance (and also prioritisation) can be applied across all linkages. This provides a means of identifying *significant* sustainability linkages, and any applicable thresholds. The assessment of importance and identification of thresholds can be based on four main principles:

1. The **importance** of a sustainability linkage providing one or more of the **project services** desired of the project: **Thresholds** can therefore be related to minimums required to deliver the project service.
2. The **importance** of a sustainability linkage to **meeting regulatory requirements**. **Thresholds** can therefore be related to what is specified in the regulatory requirement.
3. The **importance** of a sustainability linkage to **meeting policy requirements,** corporate or governmental. **Thresholds** may be related to norms expressed in policy documents, or may need to be agreed in a project specific way related to different policies.
4. The **importance** of a sustainability linkage to **meeting broader stakeholder requirements**: Local issues and particularly strongly held perceptions and views may also be very important developing a more generally acceptable model of sustainability for a site / project. **Thresholds** will be related to desired outcomes. However, desired outcomes may be in conflict, so may not be resolvable until an overall model of sustainability has been described and trade-offs and synergies can be analysed in a more rounded way.

Sustainability linkages can be combined using a network diagram to provide a more simplified representation than tables of linkages. The simple rule of thumb is that each pressure, mechanism and receptor is (as far as possible) only shown **once** in the network diagram, and arrows are used to show how they are interconnected by sustainability linkages. Hence the site conceptual model for sustainability can therefore be used for the same purposes of communication between stakeholders and improving transparency of decision making as is now regular practice for conceptual site models used in risk assessment and management. An example of network diagram is shown below at the end of the executive summary.

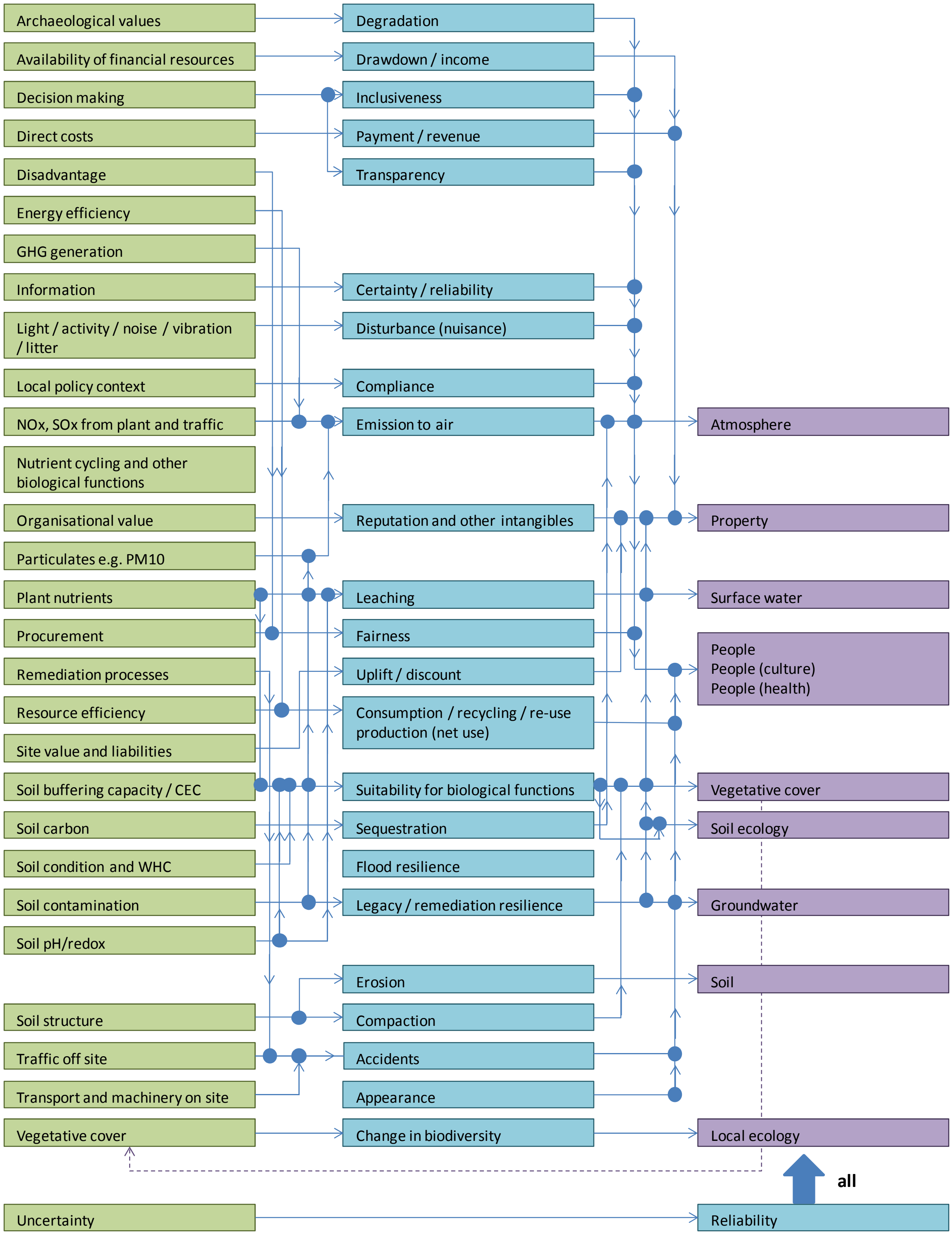
The conceptual model supports and develops iteratively across the phases of decision making and project realisation:

- Initial design work, including considering synergies, trade-offs and potential losses
- Decision making: sustainability assessment for options appraisal involving stakeholders to support sustainability management
- Implementation, monitoring and verification, maintenance
- Providing a framework to determine overall value

The importance of the site conceptual model of sustainability for overall value is twofold. Firstly, its use during optioneering in the design stages of the project identifies opportunities for maximising value by exploiting synergies, optimising trade-offs and avoiding net losses. Secondly, it provides a framework for assessing the components of overall value (direct financial value, tangible economic value and intangible values) both for selecting the treatment train approach likely to yield the greatest overall value for the smallest investment; and for monitoring outcomes to verify that the expected overall value is being achieved. The next HOMBRE WP5 Deliverable (D5.2) will describe how to apply conceptual site (project) models for sustainability to value based decision making

General conclusions

The overarching conclusions of this report are to reiterate HOMBRE's overall goal to add value during regeneration and after regeneration. This added value may even be enough to facilitate regeneration where it would otherwise be stalled. The approach suggested here of considering project services in an overall site conceptual model of sustainability to broaden opportunities for regeneration design and better determine overall value combines a range of existing concepts from work related to ecosystem services, sustainable development and stakeholder engagement, tools used in risk management and cost benefit assessment.



Archaeological values
Availability of financial resources
Decision making
Direct costs
Disadvantage
Energy efficiency
GHG generation
Information
Light / activity / noise / vibration / litter
Local policy context
NOx, SOx from plant and traffic
Nutrient cycling and other biological functions
Organisational value
Particulates e.g. PM10
Plant nutrients
Procurement
Remediation processes
Resource efficiency
Site value and liabilities
Soil buffering capacity / CEC
Soil carbon
Soil condition and WHC
Soil contamination
Soil pH/redox
Soil structure
Traffic off site
Transport and machinery on site
Vegetative cover
Uncertainty
Degradation
Drawdown / income
Inclusiveness
Payment / revenue
Transparency
Certainty / reliability
Disturbance (nuisance)
Compliance
Emission to air
Reputation and other intangibles
Leaching
Fairness
Uplift / discount
Consumption / recycling / re-use production (net use)
Suitability for biological functions
Sequestration
Flood resilience
Legacy / remediation resilience
Erosion
Compaction
Accidents
Appearance
Change in biodiversity
Atmosphere
Property
Surface water
People
People (culture)
People (health)
Vegetative cover
Soil ecology
Groundwater
Soil
Local ecology
all
Reliability

Contents

Glossary

TERM / CONCEPT	DEFINITION
Biomass – bio-energy	Bioenergy is renewable energy made available from materials derived from biological sources. Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood, wood waste, straw, manure, sugarcane, and many other by-products from a variety of agricultural processes.
Brownfield Circular land-use management	Land management concept structured around the following key principles: avoiding new Brownfields, recycling existing Brownfields and compensating the effects of land consumption.
Direct financial value	Direct financial value represents the monetary value of the completed project in terms of its monetary benefits (such as increase in capital values, and revenues) versus its direct financial costs
Eco-Dynamic Design	Process of designing infrastructure or areas whit an efficient use of natural processes or dynamics
Gentle remediation	Group of in-situ soil remediation techniques that do not have a significant negative impact on soil functions or structures (*definition by* ERA-NET project SUMATECS). This concept is based on an older concept of "extensive" (i.e. low input, long term) treatment technologies developed in the Netherlands over the 1990s The rationale is to both to minimize any negative effects of the remediation treatment process on soil systems, but also to reduce overall economic costs and management requirements.
Greenfield	An undeveloped area (agricultural, forest etc.) earmarked for residential, commercial or industrial development projects.
Greening	Action or process of transforming an area of land generally void of or poor in vegetation (i.e. sealed or highly build areas, mining areas, industrial areas etc.) into land where vegetation and plant growth will be enhanced. Though per se, the term does not entail the idea of sustainability of the transformation process. The aims of greening can be various and include for example the production of biomass, the creation of green infrastructures for amenities, the development of gardens etc..
Green Infrastructure	A strategically planned and delivered network of high quality green spaces and other environmental features, possibly delivering multiple benefits for both nature and society
Hard re-use (of land)	Colloquially "hard" developments describe some form of building. HOMBRE WP5 distinguishes hard and soft land usage using EU policy on soil sealing (EC 2012) as a context. Hard re-use of land is defined as re-use that predominantly contains built or paved development.
Intangible (economic value)	Intangible (economic value) represents the balance of benefits over detriments of a project for factors that cannot be easily monetised, or cannot be expressed in monetary terms in a way that all stakeholders agree with.
Interim use	Use of land until it can be put to another (better) use with higher value. Use of land capable of providing benefits on short term without compromising alternative uses on longer term. Interim use provides flexibility that is needed for sustainable spatial planning and land use. Interim use is especially suitable

	in areas with changing functions, high dynamics and areas in transition.
Landscape	An area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors (European Landscape Convention. CETS No.: 176; 2000)
Landscape ecology	Studying and improving relationships between ecological processes in the environment and particular ecosystems
Open space	Unsealed land or areas such as parks, forests, sport fields, riparian zones etc. where vegetation growth on soil is possible
Optioneering	Optioneering describes the process of identifying and debating different possibilities during the project design process
Overall value	Overall value has three components: (1) direct financial returns from services planned for a site / project / area PLUS (2) economically tangible wider benefits (e.g. uplift of surrounding property, reduced river pollution control costs) not specifically foreseen as a service PLUS (3) "goodwill" which is the value of wider services which are less easily monetised – "intangibles" (e.g. landscape, biodiversity etc).
Project service	Beneficial outputs planned by a project for particular recipients through tailored brownfield regeneration planning.
Regeneration	In the frame of this project, we will extend this concept to « sustainable regeneration" for which RESCUE (2005) has given the following definition: Sustainable Brownfield regeneration is the management, rehabilitation and return to beneficial use of brownfields in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways within the particular regional context.". In the frame of HOMBRE, regeneration is understood as "sustainable regeneration".
Remediation	This term is used specifically to describe processes leading to the management of environmental, human health or other risks, as part of an overall regeneration process
Service	In the context of economics, a service is an intangible commodity. More specifically, services are an intangible equivalent of economic goods.
Site conceptual model for sustainability	A site conceptual model for sustainability is a summary, supported by visualisation, of the sustainability linkages which relate to a site or project
Soft re-use (of land):	Colloquially "soft" re-use describes forms of use that do not involve substantial construction. Thus soft re-use and soft land-use is where the land remains unsealed and the soil remains in biologically productive use, for example for agriculture, habitat, forestry, amenity or landscaping. Examples of soft land usage include: land cultivated for non-food crops, urban green-space or parkland, nature conservation areas and public open space.
Supporting environmental techniques:	Techniques that do not directly contribute to brownfield regeneration itself such as restoration of soil quality, dismantling of infrastructures, soil remediation, soil upgrading operations etc., but are needed or beneficial to maintain site operation and land use over time. Such techniques could be: maintenance of green infrastructures (ponds, parks), operations on land for biomass production (harvesting, shredding) techniques for processing organic by-products generated on open space, renewable energy installation i.e.

	photo-voltaic panels in urban park etc.
Sustainability linkage:	Cause – effect relationship between a pressure or a change, a mechanism and a receptor by which a sustainability effect (positive or negative) occurs. Sustainability linkages form the constituent elements of site conceptual models for sustainability.
Tangible (economic value)	Wider effects of a project which are not included in its direct financial value but whose value could be monetised
Treatment Train:	Concept that defines an integrated system of techniques and processes (e.g. techniques for soil remediation, techniques for soil improvement, techniques that enhance plant growth, supporting environmental techniques and activities for maintenance of land-use over time etc.) implemented along the whole life cycle of a specific BF regeneration project. Ideally, the integrated system of techniques and processes should be designed in such a way that outputs from unit processes link to other processes with the final aim of incrementing the overall value of the BF regeneration project.
Unit process:	A process leading to a specific set of outcomes on the regeneration site. The unit process, may encompass several activities, but is geared towards at least one specific function. Each unit process has inputs, outputs. Additionally, unit processes will have wider effects, which may be positive or negative. The reason for using a unit process is that it delivers a (project service) which creates benefit and hence value.
Zero Brownfield:	Basic concept and ambition of HOMBRE aiming at reducing the amount of stalled Brownfield land towards zero. HOMBRE proposes achieving this in two ways: firstly by better land use in an overarching way using a "circular land management" concept and secondly, by facilitating the re-use of existing Brownfields in a site specific way, shifting them to areas of opportunity that will deliver useful services for society, instead of derelict areas that are considered to be a burden.

Abbreviations

AC	Avoided costs
BF	Brownfield
CBA	Cost Benefit Analysis
C.H.P.	Combined Heat and Power
CV	Contingent Valuation Method
DR	Dose-response
E.D.D.	Eco-Dynamic Design
EPP	Environmentally Preferable Products
GI	Green infrastructures
GRO	Gentle Remediation Options
HOMBRE	Holistic Management of Brownfield Regeneration
HP	Hedonic Pricing
MCA	Multi Criteria Analysis
T.T.	Treatment Trains
WTP	Willingness to pay

1 Introduction

In this chapter we describe how we have come to the goal of the HOMBRE project, the role of this report and the background of Brownfield regeneration for soft re-use in the light of contaminated and not-contaminated Brownfield land. Chapter 1 finishes with the scope and objective.

1.1 The HOMBRE project – Moving towards "zero-Brownfields"

In European common usage brownfields refer to previously developed land or derelict land, encompassing a range of sites in terms of size and location. The FP5 CABERNET project (2006) defined brownfields as sites which:

- Have been affected by former uses of the site or surrounding land;
- Are derelict or underused;
- Are mainly in fully or partly developed urban areas;
- Require intervention to bring them back to beneficial use; and
- May have real or perceived contamination problems.

A common feature of brownfield land is that its potential has been stalled through a period of abandonment, inactivity or under-use over an unacceptable period of time. CABERNET described how the link between potential land value in financial terms and likely reclamation costs controls the likelihood of land remaining Brownfield (see Section 3.1).

It is important to note that while land contamination affects development potential for some Brownfield sites, not all Brownfield land is contaminated. Where Brownfield is also potentially contaminated land, one of the key regeneration is the proper management of risks, e.g. the remediation of contaminated soil and groundwater. However, where is a broader regeneration domain that considers wider aspects of land use such as: soil sealing (EC Science for Environment Policy 2012A); the built structures that might be on a site or planned for a site; economic and social regeneration agendas and sustainable land use. Within this report:

- *Regeneration* is used to describe processes leading to the re-use of Brownfield land and its reintegration into the land use cycle
- *Remediation* is used specifically to describe processes leading to the management of environmental, human health or other risks, as part of an overall regeneration process.

There are potentially overarching benefits for Brownfields re-use which are not reflected in financial land values. These are linked to a wider sustainable development agenda. In practice sustainability is highly correlated with site specific factors. The EC RESCUE project has defined "sustainable Brownfield regeneration" as "the management, rehabilitation and return to beneficial use of the Brownfield land resource base in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally non-degrading, economically viable, institutionally robust and socially acceptable ways" (RESCUE Consortium 2005).

The importance of integrating Brownfield regeneration strategies into land and urban planning has been recognised as a key element of sustainable development among land planners, policy makers and sector practitioners in recent years. There has been an increasing desire to reduce drastically the consumption of greenfield land by urban sprawl through reusing (recycling) Brownfield land. For example, Germany launched an ambitious policy programme aimed at reducing greenfield land consumption from 110 ha/day to 30 ha/day by 2020. In the frame of this policy, the concept of "circular land management" emerged in Germany.

Table 1: **Potential Overarching Benefits of Brownfields Redevelopment (summarised from Paull 2008**

Environmental	• Reduced use of greenfield sites • Air quality improvements (from reduced transportation needs to more distant greenfield locations) • Reduced energy consumption and greenhouse gas production (from reduced transportation needs to more distant greenfield locations) • Water quality benefits • Environmental benefits (for example reduced negative ecosystem impacts)
Economic	• Site value • Neighbouring property values • Employment and investment benefits • Leverage of additional investment • Leverage of additional employment • Improvement in local property values • Improvement of local taxation revenues • Avoidance of greenfield infrastructure requirements / agglomeration benefits (e.g. greater urban density)
Social	• Reduced threat to public health • Reduced traffic (from reduced transportation needs to more distant greenfield locations) • Amenity benefits such as improved appearance • Health benefits

At the heart of the HOMBRE project is the ambition to create a paradigm shift to 'Zero Brownfields', where the amount of stalled Brownfield land reduces to zero. HOMBRE anticipates achieving this in two ways: firstly by better land use in an overarching way using a "circular land management" concept and secondly, by facilitating the re-use of existing Brownfields in a site specific way, (shifting them to areas of opportunity that will deliver useful services for society, instead of derelict areas that are considered to be a burden). This ambition will be met by looking at how synergies between different types of services might leverage change where none was feasible before.

The concept of "circular land management" underpins HOMBRE's thinking and is structured around the following key principles: avoiding new Brownfields, recycling existing Brownfields and compensating the effects of land consumption (Ferber *et al*., 2011). In the circular land use management concept, the land use process is seen as passing through a cycle of different phases of land usage as depicted in Figure 1. Overall the land use process is, at present, a net consumer of greenfield land and a net producer of Brownfield land as a "waste". Hence the cycle is not in balance, having a relatively large outflow of land (Figure 1 arrow b) and relatively less inflow (Figure 1: arrow a and c)

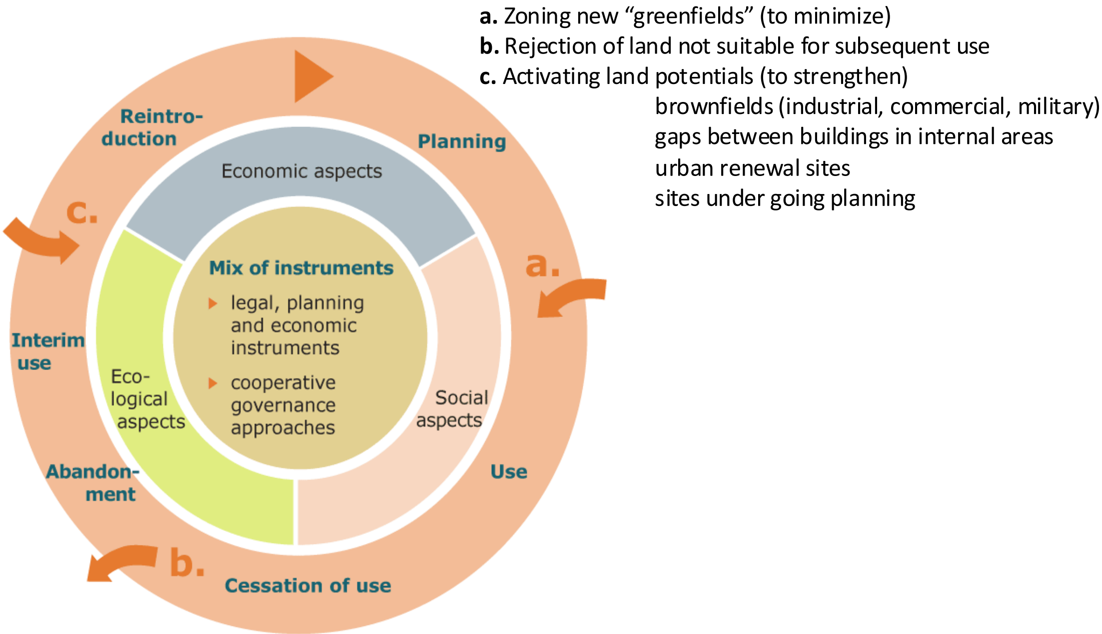


Figure 1: phases and potentialities of circular land use management (modified from Preuβ and Ferber 2006, for German Institute of Urban affairs)

The goal of HOMBRE within circular land management is to reduce the consumption of greenfield land and the production of Brownfield land. This can be achieved by maintaining land in productive use as far as possible, but where it falls out of use, to make sure its transition to a new land use is as rapid as possible. Clearly, there will always be a turnover of developed land, but in circular land-use this recycling process is rapid and the amount of land that becomes Brownfield is minimised, hence the goal of "Zero Brownfields". In this context Brownfield describes land that stays derelict or in an under-utilised or abandoned state for an unacceptable period. Where Brownfields exist currently, we expect that looking at synergies between different environmental services that may provide sufficient economic value to stimulate regeneration at these sites. The return to use of land could be for built redevelopment, or for uses such as urban green space. It is conceivable that in some cases land will be returned to a nearly greenfield status if there is no built development demand. A possible intermediate scenario is that there may be an "interim" use, prior to re-establishment into the land cycle. Interim land uses may be an important means of bring Brownfield back into productive use pending resolution of a longer term solution, and may also improve its longer term prospects.

This paradigm shift is only possible with a shared understanding of value that creates sufficient incentive to invest in brownfield regeneration. As a word value can be used to describe the monetary worth of something. In this report we have always prefaced this meaning of value as "financial value". However, value also has a wider meaning relating to the importance or preciousness of something. Hence overall value may exceed the financial value of land, but may also encompass a wider economic value for example related to the role that a regenerated site might play in enhancing a local economy, for example by improving surrounding financial land value or by improving well-being for a local community. The overall value of a regeneration project may provide a rationale for investment that is additional to direct financial return.

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Hence within this report the term (overall) value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may be improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns.

More holistically value can be expressed in the context of sustainable development, including environmental, social and economic components. In this context the same brownfield regeneration may have a range of values to different interested parties or stakeholders (developer, local community, local government etc.).

1.2 Brownfield regeneration and soft end uses

Within the HOMBRE Work Packages (shown in Figure 2), WP5 focuses on enabling Brownfields soft re-uses. Its results will contribute towards the projects goal of creating a road map and framework for achieving "zero Brownfields". It works in parallel with WP4 focuses on regeneration related to build ("hard") developments.

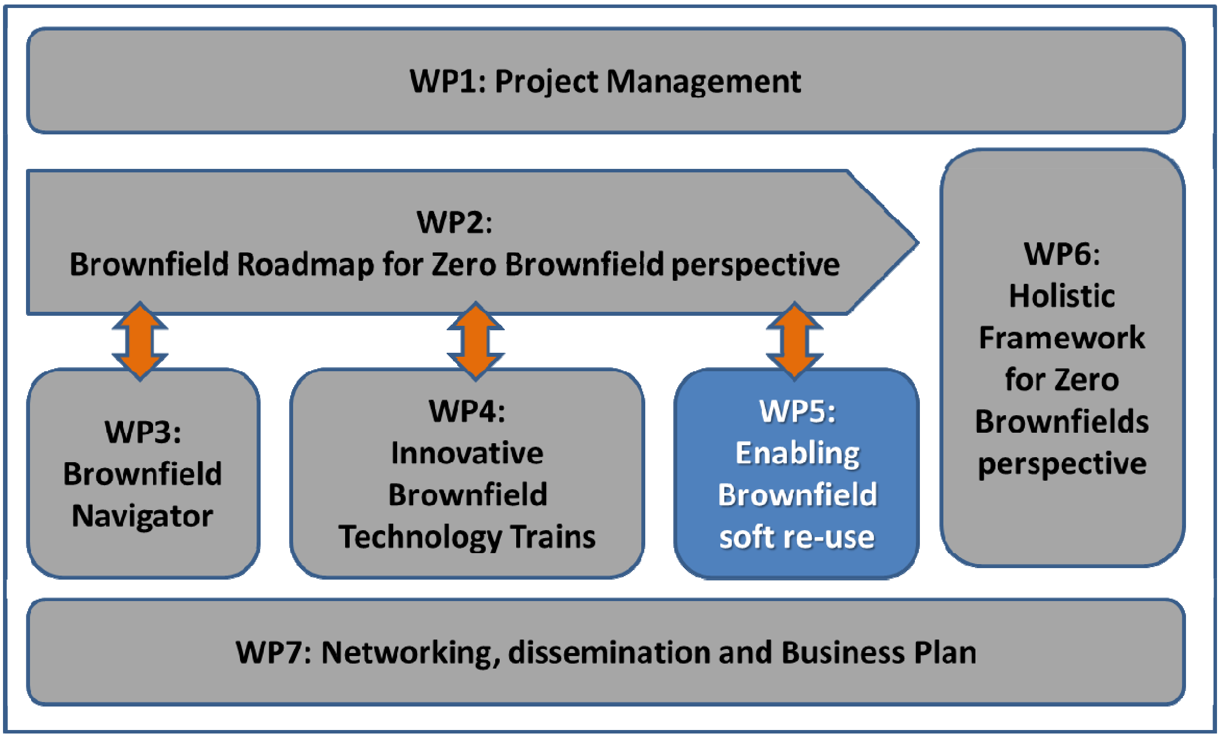

Figure 2: Structure of HOMBRE's work packages

Regeneration of Brownfield areas for soft end uses, such as green areas for open space and amenity, is current practice in Brownfield regeneration in a number of countries including Germany, United Kingdom and The Netherlands (RESCUE 2004, Thornton et al. 2007; Sarni 2009). It is often employed for former mining and military areas, but transformation of industrial or urbanized land into soft-after uses in municipal areas is less frequent. Factors such as land value, existing infrastructures, ownership interest and the cost of land reclamation make high value re-uses, i.e. “hard” redevelopment more favourable in many cases. In addition the first generation of European funding mechanisms enforced “hard” re-uses in order to support job creation and the economic restructuring of industrial regions. The economic case for soft re-use regeneration can be hard to demonstrate clearly, although there is often a high societal demand. Sometimes this kind of land re-use land can lead to long term financial burdens for owners and authorities, as they have to support the ingoing maintenance of the regenerated area. HOMBRE WP5 integrates thinking from a range of areas such as soft re-use of Brownfields, concepts of sustainable remediation and regeneration to promote synergy and so enhance regeneration project value by integrating regeneration with additional environmental services.

There is an expanding knowledge-base that can be used to draw out how sustainability should be addressed. Projects such as SU:BRIM and RESCUE (CL:AIRE 2006, 2007a and b; RESCUE 2003 and 2005) have begun to explore “sustainable regeneration” of Brownfields. A number of formal and informal networks worldwide are now in process of debate on achieving sustainable development when remediating or regenerating damaged sites or land area. These include national initiatives such as SuRF in the USA, SuRF-UK, SuRF-NL, SuRF-Australia as well as national initiatives in other countries, e.g. Canada and Italy. The two major European stakeholder networks, NICOLE and COMMON FORUM, are also active in this field. Across all of these initiatives debate is centring on how sustainability benefits can be assessed and maximised and how negative impacts can be avoided or limited. In terms of sustainability assessment and management a range of guidance, valuation approaches and tools have been or are being developed essentially focussing on soil and groundwater remediation technologies. These tools and instruments have proven to be valuable supports for selecting optimum remediation treatments and strategies based on environmental, economic and social criteria (2nd International Conference Sustainable Remediation 2012).

Frameworks and approaches proposed by SuRF-UK, NICOLE and others (SuRF USA, EURODEMO, Sustainable Remediation Framework Australia) while labelled as “sustainable remediation” are cognisant of this wider domain and the importance of an integrated consideration of remediation and regeneration. Important sustainability “gains” are possible when remediation is considered as part of the regeneration process, rather than an “end of pipe” problem once the regeneration agenda has been set. This view is fully in line with the HOMBRE view that the synergies possible from providing multiple services (environmental, social and economic) through regeneration may be important in leveraging more and faster Brownfield regeneration towards a “zero-Brownfields” goal. Nowhere is the close integration of remediation and regeneration agendas more evident than where land is being restored for soft-re-uses, where indeed the on-going management of the site over time may be both the regeneration and the remediation of the site combined.

Planning policies in many countries often seeks to promote sustainable development. However, even though the relevance of considering sustainability of remediation “right from the outset of a regeneration project” may have been identified in policy, its implementation in practice is still often hampered by several barriers (legal, governance, lack of communication between authorities etc.). As a consequence, the perceived success in achieving sustainability of regeneration projects is often narrowed down to a relatively narrow range of criteria.

1.3 Report scope and objective

A shared recognition of *overall* value underpins the rationale for any public or private investment in Brownfields regeneration. The purpose of this report is to describe a valuation approach for services from regeneration of Brownfields for soft re-use on a permanent or interim basis. Synergies between improvements in environmental, economic and social services could leverage enhancement in the value of Brownfields regeneration and so help create expanded opportunities for Brownfields re-use. Therefore, this report describes what are meant by services and synergies, and how the current practice in soft-end use regeneration might be supported by these concepts.

The development of this report is intended also to facilitate the on-going tasks of WP5:

- Task 5.2 "Decision support system on soft uses and technologies using the operating window concept";
- Task 5.3 "Use of bio-energy clusters for linking marginal urban Brownfield site re-use with sustainable urban energy.
- Task 5.4 "Technology development. Optimising two important low input technologies for greening urban Brownfield (operating window investigation)

This report describes HOMBRE WP5's approach to using synergies to create value from the regeneration of Brownfields. In particular, this report addresses how stakeholders propose and estimate value from the regeneration of Brownfields into soft re-use (i.e. non-sealed soil based redevelopment of land).

Within this general aim this report discusses:

- The soft re-use of Brownfields (Chapter 2)
- Regeneration of Brownfields for soft re-uses (Chapter 3)
- Services from regeneration of Brownfields into soft re-use and synergies (Chapter 4)
- Soft re-use treatment trains (Chapter 5)
- Valuing costs and benefits from regeneration (Chapter 6)
- Improving the connection between project valuation and achieving sustainable development (Chapter 7)

Findings for Chapter 1: Introduction - key findings

The concept of "circular land management" underpins HOMBRE's thinking and is structured around the following key principles: avoiding new Brownfields, recycling existing Brownfields and compensating the effects of land consumption. The goal of HOMBRE within circular land management is to reduce the consumption of greenfield land and the production of Brownfield land. This can be achieved by maintaining land in productive use as far as possible, but where it falls out of use, to make sure its transition to a new land use is as rapid as possible. The return to use of land could be for built redevelopment, or for soft end uses such as urban green space. A possible intermediate scenario is that there may be an interim soft use, prior to longer term re-establishment into the land cycle.

Regeneration of Brownfield areas for soft end uses, such as green areas for open space and amenity, is current practice in Brownfield regeneration in a number of countries. It is often employed for former mining and military areas, but transformation of industrial or urbanized land into soft-after uses is less frequent. The direct financial case for soft re-use regeneration can be hard to demonstrate clearly, although there is often a high societal demand.

The shared recognition of useful value underpins the rationale for any public or private investment in Brownfields regeneration. The purpose of this report is to describe a valuation approach for services from regeneration of Brownfields for soft re-use on a permanent or interim basis.

Within this report the term value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may be improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns.

2 Soft re-use of Brownfields

In this chapter we describe soft re-use of Brownfields. We discuss the drivers for choosing soft re-use and acknowledge that the lack of economic drivers can stimulate soft re-use of Brownfields. In section 2.3 we give an overview how this is organised in European countries. Soft re-use in this report is focused on green infrastructures and biomass production for energy production.

2.1 Defining soft re-uses

Colloquially “hard” developments describe some form of building and “soft” end use forms of uses that do not involve substantial construction. HOMBRE WP5 distinguishes hard and soft land usage as defined by EU policy on soil sealing (EC 2012) as a context. Hard land usage is defined as re-use that predominantly contains built or paved development. Soft land-use is where the land remains unsealed and the soil remains in biologically productive use, for example for agriculture, wildlife habitat, forestry, amenity or landscaping. The two scenarios are not mutually exclusive. Many development scenarios include both types of usage, for example landscaping in generally built up areas, or a visitor centre on a Brownfield regenerated for public amenity. Examples of soft land usage include: land cultivated for non-food crops, urban green-space or parkland, nature conservation areas and public open space (see for example Figure 3). .

Figure 3: Left: example of soft land use, a tree farm. Middle: example of mixed land use, both hard and soft, a park with pavement and grassland. Right: example of hard land use, an urban playground.

2.2 The historical development of soft re-uses for Brownfield sites

Perhaps the earliest well recorded Brownfield regeneration project is the Lower Swansea Valley (Bromley and Humphrys 1979), which encompassed landscape regeneration across a large area in South Wales, UK. This area of South Wales had been characterized by metal extraction and processing in the region for 300 years (Newell and Watts 1996). After the Second World War, industrial activity declined and a heavily contaminated site was left behind. A drive for reclamation was born out of the desire of Swansea Council and other after the war, to remove the industrial dereliction and pollution of the valley and return the area to active land-use. Eventually a feasibility study, the Lower Swansea Valley Project, (LSVP) began in 1961 and it produced its final report in 1967. Regeneration of the area began in 1966 /1967 and continued through the 1970s over several hundred hectares (US EPA 1992). Regeneration of the land largely consisted of regrading cover systems, tree and grass planting, river management and some areas restored for hard usage. The terms of reference of LSVP from 1961 are quite interesting (and modern) from a sustainable development perspective. They were: "to establish the factors which inhibit the social and economic use of land in the Lower Swansea Valley and to suggest ways in which the area should be used in the future." These included the economic and social aspects of sustainability, but there is no mention of human health or environmental protection. Early attempts at re-vegetation were hampered by vandalism and arson. Community involvement, particularly including young people, and the opening of green space for leisure such as walking became an important part of providing a robust and sustainable long term solution[1].

Regeneration of Brownfield to softer uses in an effort to improve community well-being also followed the ending of primary industries in the 1980s, for example projects on Brownfields for Garden exhibitions in Hamm in Germany and Glasgow in the UK (Engel, 1988) see Figure 4. In Hamm a vacated coal mine was redeveloped to a large park for a garden exhibition and later further developed for leisure and social purposes. In Glasgow a festival site was developed along the south bank of the river and on reclaimed land from the former dock.

Figure 4: Garden exhibition in Glasgow 1982

In France, a systematic interim soft re-use programme was developed in the French region of Lorraine in 1987. Over 3,150 ha of Brownfield area were treated as part of a large scale landscape concept over a period of 10 years. Buildings on brownfield sites have been demolished and new green infrastructures have been created following an overall master plan. Despite the limiting public funding for demolition, landscaping and interim greening, the negative impacts of Brownfields have been removed. Sites remained classified as "Urban land" in the local development plans. Today many of the sites have been developed as attractive business areas (Longuet et al. 1987).

In Germany IBA Emscher Park regeneration, which took place from 1989 – 1999, represented an early regional scale landscape integration of soft re-use Brownfield projects and green spaces in the "Emscher Landschaftspark" see Figure 5. The creation of the Landschaftspark Duisburg Nord in the 1990's on a former steel work area presented a new approach of landscape architecture on former Brownfields by including existing buildings and

[1] See: http://www.welshcopper.org.uk/en/copper-guides_lsvp_reclamation.htm, http://www.welshcopper.org.uk/en/copper-guides_lsvp_history.htm and http://www.youtube.com/embed/nG7R2nMxWAk; http://www.youtube.com/watch?v=BCT1rFB9weU&feature=player_embedded

infrastructure in the concept. (Minister für Stadtentwicklung, Wohnen und Verkehr des Landes Nordrhein-Westfalen, 1988). The main function is now recreational where old structures such as the former gas tanks and buildings are used for climbing, diving etc.

Figure 5: Emscher Park as it is used after regeneration

Italy‘s first urban forestation project began in the 1970s at Parco Nord Milano, in northern Italy, which has one of the highest population densities in Europe. The urban forest was mostly developed on Brownfield land, and was declared a Regional park in 1975. The design of this 600 ha park is intended as a “work in progress” with processes of change still going on. Local community involvement has been an important influence in this green infrastructure development. The park now includes woods, hedges, meadows, lakes, ponds vegetable gardens, children playgrounds, and sports fields.

The common denominator of these examples is that soft re-use provided a green infrastructure. More recently there has been increasing interest in the use of brownfield land for non-food crops, which can provide some kind of economic return to at least partially offset site management costs (Bardos *et al*, 2010). These non-food crops are typically used either for renewable energy production or as bio-feedstocks. An example of this is a new project in Porto Torres Sardinia Italy, where a former refinery site is to be used for producing bio-feedstocks for bio-plastics production. The project contemplates the creation of a 3rd generation bio-refinery, using non-food agricultural crops on the former refinery site to produce bio-polymers. This industrial plant will be combined with a power plant fed by agricultural biomass waste, thus providing in the site integrated solutions for the biomass produced.

Not all soft re-use regeneration projects are successful. A particular problem for green infrastructure projects is their need for on-going maintenance and management and their resulting costs. For example, the Liverpool Garden Festival in the UK was created on the site of a former municipal landfill in 1983 at a cost £25m. The festival saw one million visitors and was a local and national success story. However, no funding allocated post restoration and the site is now derelict (see Figure 6), one of many such projects that failed the sustainability test. It has been estimated that to “re-restore” this site will cost £10million. Interestingly spending an additional £2 million into a financial investment product in 1984 would have created sufficient revenue year on year to have secured the site’s future. (Hall 2009, quoted in Bardos 2009).

Figure 6: A recent view of the Liverpool Garden Festival site

A new dimension of Brownfield problems had arisen with the integration of the central European, former communist economies into the EU (starting in 2004 with Poland, Slovenia, Slovakia, Lithuania, Latvia, Hungary, Estonia and Czech Republic), which have some large areas of degraded land. With their inclusion in the EU Brownfield land bank, soft re-use options have increased in importance. With the fall of the Berlin Wall in 1989 Germany re-united and encountered these brownfield problems directly. For example, many large scale projects, such as the creation of new lake districts in former opencast lignite mining areas of Eastern Germany are being carried out[2].

From former Brownfield regeneration projects some important drivers for soft re-uses of Brownfield land can be defined.

- In many European countries, densely urbanized areas still need the development of open spaces. For this, Brownfields are a key potential, because of its availability and relatively cheap purchase price
- A renaissance of new forms of urban gardening, community gardens and urban farming increases the demand and feasibility of adapting Brownfields for green uses
- Soft re-uses are an option for renewable energy generation (non-food biomass production)
- Soft re-uses are means to create green infrastructures that offer several benefits for communities (leisure, culture or ecosystem services, see chapter 4), i.e. for example mitigation of heat island effects and improvement of urban comfort, if designed appropriately at strategic locations. Green infrastructures with trees can help improving air quality in urban areas by filtering and retaining air particles and contaminants generated by traffic and industry. Green infrastructures can also help creating habitat for migrating birds and other species in urban and peri-urban areas.

[2] www.leipzigerneuseenland.de

2.3 HOMBRE's focus on soft re-use

HOMBRE WP5 explores two broad soft re-use scenarios. The first scenario is regeneration for Green Infrastructure, including open space to provide urban amenity and other services. The second scenario considers the re-use of land for production of non-food crops. Both scenarios could potentially be used as an (interim) measure to manage urban Brownfield land, mostly prior to a more permanent solution being found. Either of these might be a long term option for re-use of Brownfield, but could also be used in an interim way for returning Brownfield to productive use pending a long term solution.

2.3.1 Green Infrastructure

Green infrastructures can be created in many places, covering natural and semi-natural areas in urban, rural and marine areas, including restored lands (EC Science for Environment Policy 2012B). The four broad roles that GI performs are:

- Protecting ecosystem state, building ecological networks and improving biodiversity
- Improving ecosystem functioning and promoting ecosystem services
- Promoting societal wellbeing and health
- Supporting the development of a green economy, and sustainable land and water management.

As such open spaces in urban and peri-urban contexts can take many forms and provide multiple services see Figure 7. Some examples of open space are:

- public parks (societal leisure, ecology, heat reduction, water storage, increasing air quality, etc.)
- riparian zones for flood protection (ecology, increasing water quality, water storage, CO_2 fixation, etc.)
- sport fields (societal leisure, ecology, heat reduction, water storage, etc.)
- biodiversity reserve, natural parks (ecology, water storage, increasing biodiversity, education, heat reduction, increasing air quality, etc.)
- urban forests (ecology, increasing biodiversity, CO_2 fixation, education, heat reduction, increasing air quality, etc.)
- allotments (ecology, fruit & vegetable production, education, societal leisure, etc.)

Figure 7: Illustrations of soft re-use, left peri-urban park, right urban forest

The essential role of good quality open space to provide multiple benefits for society and the environment in the urban area is increasingly recognised. Being aware of these benefits and being able to identify and evaluate them to finally integrate them in urban planning strategies has been at the centre of political agendas, projects and studies in recent years (Vandermeulen et al., 2011). The benefits derived from the presence of open space in urban areas are manifold. Some examples of such benefits are:

- improvement of quality of life (green infrastructures provide elements to mitigate noise and improve aesthetic aspects of inner cities, community cohesion through sharing common place to meet and exchange, mitigation of urban heat island effect),
- improved health (open spaces provide citizens with space for physical/sports activities),
- better environment (unsealed surface allow better water infiltration to subsoil in urban areas, trees have proven to have positive effects on air quality by removal of air pollutants)
- economic value (residential property value is increase if located nearby urban open spaces)
- Open space plays a crucial role in the social landscape, delivering significant benefits not only for communities such as health benefits, improvement of land values, sense of belonging and improved cohesion. It also appears to be associated with reduced demand on health and social services (Land Trust etc) .

Box 1 provides two case studies of successful regeneration of BF into green infrastructure.

In order to deliver maximum benefits to communities and the economy, open space needs sound planning from conceptualisation, completion and into the long term future management of the open space created. After care and maintenance on open space land need to be understood as additional costs to be accounted for within the BF regeneration project overall costs, although in terms of social benefits these activities can also be estimated as added value of the project's outcomes (Doick *et al.* 2009).

Box 1: Green Infrastructure from BF – two examples

Griftpark in Utrecht, The Netherlands. A gasworks that was active in the city centre from 1860-1960 to provide the city with gas derived from hard coals. The process of gas winning resulted in a soil contamination that was only discovered in the 1970s. It consisted of oil, cyanide, hydrocarbons and tarry substances, found over an area of 10 ha in soil and groundwater between 35-50m deep. An attempt to remediate the soil artificially partly failed, because of the magnitude of the contamination and high costs. From 1993 to 2002 the city of Utrecht isolated a total of 8 ha of former gasworks area, stopping the spreading of contamination via groundwater flows by placing sheetpile walls and avoiding public contact with the contaminated soil. After that, a green park has been developed for common use at the surface. Volunteers have set up a playground, petting zoo and are maintaining the ecological quality of the green open space. Polluted groundwater is pumped up and cleaned at the spot. Likewise, collected rainwater is being re-used at the spot. In terms of costs, it is estimated that the implemented soft after use saved the city an investment of 200 k€ on a yearly basis. The setup has won a Dutch prize for sustainable soil quality (Stichting Infrastructuur Kwaliteitsborging Bodembeheer) in 2009. More information on http://www.utrecht.nl/smartsite.dws?id=119738 and PhD-thesis (Souren, 2006).

The Beam Parklands in Dagenham, UK The Beam Parklands in Dagenham is one of London's newest parks. It won the Brownfield Briefing award for the 'Best Use of Landfill Or Brownfield Land'. Beam Parklands, a 53 hectare multifunctional wetland, which opened in summer 2011, was delivered by a partnership between the Environment Agency, The Land Trust, London Borough of Barking & Dagenham, London Borough of Havering, London Development Agency and Design for London. The judges at the Brownfield Briefing Awards recognised that the benefits delivered by Beam Parklands show clearly that the best use of Brownfield land does not necessarily mean development. What makes the wetland parkland special is its primary function as a flood defence. The land protects 570 residential properties, two primary schools, three social clubs and 63 industrial and commercial properties on its doorstep and downstream. When the area is not flooded, which is the vast majority of the year, it is serves as multifunctional open space that the community can use and where nature can thrive (taken from LandTrust, http://www.thelandtrust.org.uk/community/news-detail.html?NID=649) .

Green infrastructure is likely to become increasingly important also in the context of the increasing urbanisation of the world's population, and consequent expansion of developed areas (Hulsman et al. 2011, KPMG International 2012).

2.3.2 Land for biomass production

Urban Brownfields offer an opportunity to provide biomass production for energy production without competing with food production or nature conservation (Bardos *et al.* 2012). Biomass is an option which can provide power, heat and biofuel. In addition to low production costs, biomass is storable and able to provide energy when demanded. Small and medium sized Brownfields will not achieve yields comparable to those of large agricultural areas but nevertheless such uses have economic benefits, particularly if they are linked within the same locality. In particular, this approach contributes to the implementation of a sustainable development that causes for the improvement of urban sites and contributes to the establishment of a circular land use management. An example of BF use for biomass is provided in Box 2.

Box 2: Biomass production BF

Gelsenkirchen. Germany In Germany on the outskirts of Gelsenkirchen, 22 hectares of a former coalmine ("Hugo") have been redeveloped to include biomass production. This is a new concept whereby biomass production is carried out along with leisure and recreational use. Biomass production will start by short rotation crops (SRC). Further details on this site will be given in the frame of task 5.3's deliverable "Guidance for delivering bio-energy clusters for linking marginal urban Brownfield site re-use with sustainable urban energy" due by month 45.

2.3.3 Interim use

The concept of interim soft re-use of sites in urban areas allows beneficial re-use of land for biomass or green infrastructure as a temporary measure, pending a long term decision (for example for a built development). This may have an application that allows some land re-use during low points of the economic cycle that restores some functionality (and hence value) to land during this period. This may facilitate new future developments, for example creating a greater scope for residential development following soft re-use landscape enhancement.

When long term solutions for BF regeneration are considered non-viable or if there is no demand of such solutions, interim uses can offer opportunities for landowners to generate benefits on short term. Interim regeneration projects can in turn generate sufficient interest among stakeholders to serve as driver for long term regeneration solutions (RESCUE, 2004).

While there is a worldwide trend towards increasing urbanisation, in some areas city populations are shrinking. This is particularly significant in areas where industrial and manufacturing activities have diminished. Because of the economic circumstances in these areas, without some form of public intervention these sites will remain unused, and potentially derelict, for the foreseeable future. The consequence of this is the presence of blight upon the surrounding areas and communities and the loss of an opportunity to renew the community in a sustainable manner. High cost of reclamation / regeneration and low market values, constitutes a specific challenge for many cities and regions for hard re-uses. Interim regeneration for "soft re-use" allows beneficial re-use of the land on a temporary basis, with the capacity for it to be held as a development reserve in case of an economic upturn. Two examples of interim BF use for biomass are provided in Box 3.

In The Netherlands cases of temporary nature are known for the harbour of Amsterdam and several other vacant sites in municipalities. A Dutch project[3] 'Traveling gardens' creates gardens in urban Brownfields until building contracts are present and building activities can

[3] http://www.arnhem.nl/Wonen_en_leven/Projecten/Reizende_tuinen

start. Temporary nature gives ecological habitats the possibility to grow in densely populated areas and the public surrounding the opportunity to enjoy nature.

The German Institute for Urban Affairs (DIFU, Deutsches Institut für Urbanistik) defines interim use as *the temporary activation of vacant land or buildings with no foreseeable development demand* (DIFU, 2006). Interim use may also be implemented where there is foreseen development demand, but not in the immediate future. The use made of the vacant land can be manifold (e.g. renewable energy plants such as solar and wind power, open space, interim biomass production, restoration or up-lift of abandoned buildings for social and cultural events...), thus interim uses are designed to be temporary; ideally they can also be mobile or impermanent so they can be re-located when re-use developments begin. In contexts of economic depression, interim uses can present economic opportunities in comparison to permanent re-use developments, since interim use require significantly less initial capital. Examples of such interim use projects on Brownfield sites can include community gardens, farmers markets, public event spaces, and interim use parks.

Box 3: *Interim* biomass production BF – two examples

Example 1 Gelsenkirchen. Germany See Box 2 above. On the former coal mine Hugo leisure and recreational use are combined with temporary or permanent biomass production. Biomass production will start by short rotation crops (SRC).
Reference for "Biomassepark Hugo" [4]

Example 2 Halle Germany In Halle/Germany residential buildings were dismantled due to vacancy and soil preparation undertaken in an area of 3 hectares of former urban housing. The intermediate use of biomass production was established through planting of poplar trees as short rotation crops for energy purposes since 2006.

Further details on around both sites will be given in the frame of task 5.3's deliverable "Guidance for delivering bio-energy clusters for linking marginal urban Brownfield site re-use with sustainable urban energy" due by month 45.

[4] http://www.rag-montan-immobilien.de/index.php?SiteID=712

Findings for Chapter 2: Soft re-use of Brownfields - key findings

Colloquially “hard” developments describe some form of building and “soft” re- use, forms of use that do not involve substantial construction. HOMBRE WP5 distinguishes hard and soft land usage using EU policy on soil sealing (EC 2012) as a context. Hard land usage is defined as re-use that predominantly contains built or paved development. Soft land-use is where the land remains unsealed and the soil remains in biologically productive use, for example for agriculture, habitat, forestry, amenity or landscaping The two scenarios are not mutually exclusive. Many development scenarios include both types of usage, for example landscaping in generally built up areas, or a visitor centre on a Brownfield regenerated for public amenity. There are many successful examples of regeneration to soft re-uses across Europe over the past 50 years. However, failures do occur, often because the maintenance of the restored land area ceases. Whereas it can be assumed that earlier brownfield regeneration projects for soft re-use were often initiated for restoring social and economic image of an area affected by urban/industrial dereliction and blight, more recently other drivers seem to play a key factor for motivating soft re-use regeneration.

Some important drivers for soft re-uses of Brownfield land can be defined.

- Densely urbanized areas still need the development of open spaces. For this, Brownfields are a key potential, because of its availability and relatively cheap purchase price
- A renaissance of new forms of urban gardening increases the demand and feasibility of adapting Brownfields for green uses
- Soft re-uses are an option for renewable energy generation (non-food biomass production)
- Soft after re-uses are means to create green infrastructures that offer several benefits for communities), i.e. for example mitigation of heat island effects and improvement of urban comfort, if designed appropriately at strategic locations. Green infrastructures with trees can help improving air quality in urban areas by filtering and retaining air particles and contaminants generated by traffic and industry. Green infrastructures can also help creating habitat for migrating birds and other species in urban and peri-urban areas.

HOMBRE WP5 explores two broad soft re-use scenarios. The first scenario is regeneration for Green Infrastructure, including open space to provide urban amenity and other services. The second scenario considers the re-use of land for production of non-food crops. Both scenarios could potentially be used as an (interim) measure to manage urban Brownfield land, mostly prior to a more permanent solution being found. Either of these might be a long term option for re-use of Brownfield, but could also be used in an interim way for returning Brownfield to productive use pending a long term solution.

3 Regeneration of Brownfields for soft re-uses

Chapter 3 describes the connection between soft-end uses and Brownfield land value. It then describes the broad strategies and techniques that are deployed for delivery of green infrastructure and biomass production on Brownfields.

3.1 Value and regeneration opportunities

Ultimately the financial value of land depends on what somebody is prepared to pay for it. The value of land is dependent on the type of land use and the demand for that land use (Syms and Weber 2003). Markets discount the value of degraded land, such as Brownfield land, based on assumptions relating to the likely direct and indirect costs of rehabilitation. For example, Bartke (2011) reviews how markets evaluate contaminated land in some detail. As well as likely rehabilitation costs, important constraints on value include financial risks from litigation, financing costs, concerns over future marketability and a stigma associated with land dereliction. The effect of these constraints on a site's value can persist even after the completion of remediation, with Bartke (2011) finding a 10% reduction in Germany. However, a good location, the passage of time and an ability to pass on financial risks can have a beneficial effect on site value.

However, a *change* in land use can substantially increase land value, for example a change from an industrial use to a use for retail and housing. This change on value is dependent on location and market rates for similar land uses in the vicinity. For a Brownfield site this change in value may be sufficient to pay for site regeneration and also generate useful revenue from a future land sale.

Development of such land usually proceeds therefore under the influence of market forces. The FP5 CABERNET project (Ferber *et al.* 2006) categorised Brownfield sites as "A", "B" or "C" as represented in Figure 8 below:

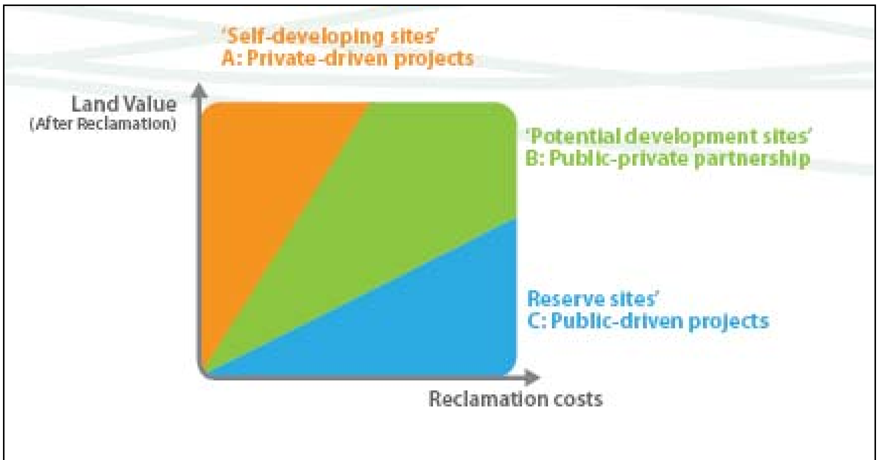

Figure 8: CABERNET ABC model for Brownfield sites (taken from CABERNET, 2006: Sustainable Brownfield Regeneration)

- A Sites – are economically viable and the development projects are driven by private funding
- B Sites – are on the borderline of profitability. These projects tend to be funded through public-private co-operation or partnerships
- C Sites – are not in a condition where regeneration can be profitable. Their regeneration relies on mainly public sector or municipality driven projects. Public funding or specific legislative instruments (e.g. tax incentives) are required to stimulate regeneration of these sites

The economic status of a site can be affected by:

- Indirect as well as direct costs of the regeneration,
- Predicted revenues / return from the site
- The type of financing and the associated financial risks
- National and local taxes and their perceived risk of fluctuations
- Any development agreements between the land owner and / or the municipality and the developer

The FP6 PLUREL project found that Brownfield sites also appear to have a negative effect on surrounding property values (Longo and Hughes 2008)

Brownfield sites typically carry environmental liabilities. Liabilities relate to potential losses, typically monetary, but other types of loss are possible, for example reputational (NICOLE 2011). Since the late 1990s the principal factors limiting the market value of Brownfield land have been the environmental liabilities associated with potential and actual contamination problems (NICOLE 2011) and to a lesser extent the cost and impact of decommissioning existing facilities (NICOLE 2009). Recovery of value has depended on the mitigation of these concerns. The implication therefore is that brownfield sites which are contaminated are more likely to fall into "B" and "C" categories as they carry a larger liability burden.
The HOMBRE concept is that the combined value of environmental services that are outputs of integrated processes or "treatment" trains may both improve the economic case for regeneration of these sites and increase the social and environmental value – and hence investment interest from the Private and Public Sectors in supporting regeneration.

Wider concepts of value, and sustainable use of land, have had an increasing role in stimulating regeneration, in response to the social costs of long term dereliction for surrounding communities (American Planning Association 2011, SSCI 2010). Although there have been sustainable development-like drivers for regeneration in some countries for many decades (Bardos *et al.* 2012), the importance of achieving sustainable Brownfield regeneration is now widely recognised in Europe (RESCUE 2005). Plant *et al.* 2012 suggest that the developments in legislative tools and policy combined with the limited availability of public funds provide a major opportunity to shift the policy focus for contaminated sites from costs and liability to value creation. They suggest that this dynamic is supported by a societal shift identified by the Netherlands Environmental Assessment Agency to an "energetic society": a society of articulate citizens, with an unprecedented reaction speed, learning ability and creativity (Hajer 2011). Undoubtedly the same opportunity applies even more widely to Brownfields regeneration.

Potential additional “services” from a regeneration project that may enhance the value of regeneration, and hence willingness for Public or Private Sector investment, form a combined services approach include the following:

- Revenue generation from renewable energy, feedstock or carbon offsets
- Capital appreciation by improving land values or the Brownfield and its surroundings
- Meeting local policy goals, for example for biodiversity, sustainability, CO_2 reduction and quality of life
- Meeting national and international policy goals, for example the Environmental Liability Directive with *compensatory* nature, Water Framework Directives, Green Infrastructure Approach, Thematic Strategy on the Urban Environment, Air Quality Framework Directive and Environmental Impact Assessment (http://europa.eu/legislation_summaries/index_en.htm)
- Providing amenity, for example areas for leisure, cycle routes, education, pleasant living environment
- Direct benefits from associated ecosystem services enhancement, for example flood protection, water quality management, urban cooling, urban air quality management, noise reduction
- Indirect benefits, for example local community health and well being
- Benefits for shareholder value via managing site ownership liabilities and also via intangibles such as reputation

HOMBRE WP5 focuses on two soft re-use scenario: biomass or other renewable energy production and green infrastructure. These may be applied singly on a particular Brownfield, or in tandem. For example, land use could be arranged as of mosaic (Davies and Scurlock 2004; SNIFFER 2010) of amenity and conservation space[5] with areas for biomass or wind energy production (US EPA 2012). A range of mixed or mosaic scenarios have been developed in the Netherlands by the Innovation network combining landscape, biomass and nature to multifunctional land-use. However, priorities for green infrastructure and forestry can conflict, and integrated planning approach from an early stage is necessary to find an optimal balance (Mell 2011).

In Italy a good example of integration among production and green infrastructures is in Trento Province, where the traditional activity of timber production is driven by naturalistic forestry management practices, able to i) enforce the ecological network, ii) maintain jobs and high level production and iii) enhance the touristic attractiveness (see forest-timber-energy production thread in www.filieralegno.provincia.tn.it).

[5] Some forms of biomass (e,g, willow coppice) may carry high biodiversity and conservation value (Bardos *et al.* 2010).

Policy and taxation mechanisms may also create Private sector interest in supporting regeneration. Key amongst these are subsidies and mechanisms to generate renewable energy and to offset carbon, and new development levies for infrastructure. For example, in the UK, government has targeted "decarbonising" of new development through the 2008 Climate Change Act[6]. The stringent targets envisaged may be hard to meet in commercial development, creating high building costs and perhaps diminished saleability. However, an alternative approach may be to offset *some* of the desired carbon savings via a soft re-use on a regeneration site such as biomass, wind or solar to provide an overall zero carbon goal across an integrated project. An example of a planning levy in the UK is the Community Infrastructure Levy [7](CIL) which will allow local authorities the capacity to use a levy on developments to support infrastructure, which could support development of stalled Brownfield sites. These two developments may be integrated, for example, so that a local energy management company could be established by a local authority and support biomass based re-use of Brownfield.

Regeneration benefits create value for different stakeholders. Shared benefits may offer advantages such as reduced project cycle times through streamlined permitting and zoning (US EPA 2012). While these benefits may be drivers of shared value, a major challenge is how to explain these values in economic and financial terms that support a case for investment, and demonstrate a return on investment.

3.2 European experiences to cope with the lack of economic drivers for soft re-uses

In several countries public organisations have been set up to manage degraded land where economic drivers for regeneration are lacking. As an example of such public organisation, Bilbao Ria 2000 may count among the first to be created with this purpose in the early 90's. The entity was created with the intention of recovering former industrial space around and within the city of Bilbao in the Basque Autonomous Country[8]. It is a non-profit entity, product of a cooperation commitment on the part of several public authorities (municipalities, local governments, regional government, authorities of the port, administration for infrastructure development etc.) in a common task to transform the metropolitan area of Bilbao. BILBAO Ría 2000 coordinates and executes projects in relation to city planning, transportation and the environment. These are carried out with a global approach focusing on the urban directives drawn up by the planning authorities.

Another example of these initiatives was the Land Trust in England (formerly the Land Restoration Trust). This organisation was set up as an independent charitable trust by government following sustained campaigning, and taking advantage of the experience gained by the Groundwork charities in delivering the Changing Places programme which succeeded in achieving community based restoration for 21 sites (accounting for 1,200 hectares) over the late 1990s[9]. The Land Trust has been set up to take the responsibility for sites which are deemed not suitable for hard re-uses. It focuses on projects that involve local people and

[6] http://www.decc.gov.uk/en/content/cms/legislation/cc_act_08/cc_act_08.aspx
[7] http://www.communities.gov.uk/planningandbuilding/planningsystem/communityinfrastructurelevy/
[8] http://www.bilbaoria2000.org/ria2000/index.aspx
[9] www.millennium.gov.uk/cgi-bin/item.cgi?id=1155&d=11&h=24&f=46&dateformat=%25o-%25B-%25Y

organisations to create high quality public open space such as country parks, wetlands, community woodlands and ecology parks[10].

In France, the "Etablissement Public Foncier" Nord-Pas-de-Calais/France (EPF) supports local authorities in the revitalization of Brownfields. Nowadays, a development towards a "land policy service" takes place in the field of urban redevelopment, environmental remediation and circular land use. EPFs are responsible exclusively for land-based interventions, but they are not in charge of urban development projects. Currently there are 32 EPFs in France. In a start-up phase of 10 years the financing is ensured by a regional development-related tax. Additional contributions come from the state, municipalities, departments, the European Regional Development Funds ERDF and the private sector. EPF provides a functioning model of cooperation between management and land owners, allowing active land interventions. http://www.epf-npdc.fr/

In Germany the main objective of the Bahnflächenentwicklungsgesellschaft (BEG) Nordrhein-Westflalen is the conversion of railway land which is no longer required. The BEG was established in 2002 by the state of North Rhine-Westphalia and the Deutsche Bahn AG, acting as shareholders. The task of the BEG is to redevelop non-operational railway buildings and tracks (2000 ha in 205 municipalities in 2010). The previously implemented re-uses range from the redevelopment of the station buildings and the development of integrated business areas (trade/service/housing) to the installation of ecological compensation areas and bicycle lanes. Funding is based on a specifically developed "contract model". The Deutsche Bahn AG adds the non-operational land to the pool. The state has allocated € 20.45 million in the municipal finance law in 2001. http://www.beg-nrw.de.

In the Netherlands there is no central institute or authority that is concerned with the redevelopment of Brownfields (Lamé 2010). The Dutch government (Ministry of Housing, Spatial planning and Environment) did instigate several soil contamination policies after discovering major soil pollution sites in the 70s. Most recent are the Soil Quality Decree and the Soil Quality Regulation (2008). In practice, local authorities are concerned with the regeneration of Brownfields (Alphenaar & Nauta 2011). They set up the spatial planning program for the total Brownfield area, with future functions and obligatory soil quality norms. Land owners and future users are then charged with individual redevelopment projects. In most cases the idea of 'Polluter pays the bill' is applied, but in case of 'old' contaminations the project could stagnate, because often it is unclear who is responsible for the contamination. Here the future land use can be adapted to the state of the contamination, based on soil quality norms. In this case soft re-use can be an interim strategy provided that people are not exposed to the contaminated soil. (Alphenaar & Nauta 2011). Finally, all contaminations labelled as "urgent" are planned to be cleaned or the risks to be contained before 2015 in a national programme.

In Italy the delocalisation of industrial areas increased local Brownfield management practices, generally involving high public involvement. In Genoa for example all the Brownfields are held by public organisations (state, region, municipality, etc.) with some private investors' presence. Since 1997 "Sviluppo Genova" is leading the redevelopment programs in the city of Genoa (http://www.sviluppogenova.com/) and since 2003 the regeneration of the Cornigliano area, where a HOMBRE case study is located. This site is managed by Società per Cornigliano (http://www.percornigliano.it/).

[10] www.thelandtrust.org.uk

Similarly in Naples area, “Bagnolifutura” has been managing the Brownfield regeneration in Bagnoli since 2002 (http://www.bagnolifutura.it/).

The above examples show clearly how determinant public intervention is for Brownfield regeneration when apparently economic benefits and opportunities are lacking. In such contexts where benefits of regeneration are not always easily identifiable i.e. as those when BF are to be regenerated into green land, HOMBRE believes it is essential for public organizations in charge of financing projects to be fully aware of broader opportunities and benefits that can emerge from Brownfield regeneration into soft re-use. The following sections and chapters will focus on evidencing how value from Brownfield regeneration into soft re-use can be enhanced, identifying and valuing new opportunities and benefits through the sound planning of regeneration processes and soft land uses. Based on the principle of providing beneficial services from Brownfield regeneration to help address broader needs and demands from economy, society and the environment, guidance will be provided to help readers identify synergies between benefits (services) from Brownfield regeneration and these broader needs. In doing so, HOMBRE seeks to identify/demonstrate expanding opportunities for brownfields reconversion into soft re-uses.

3.3 Strategies for soft re-use

Regeneration to soft re-uses (i.e. unsealed soil) may take advantage of a range of processes depending on the specific context of the site, across several categories or types:

- Soil management interventions, for example to assist cultivation or ecosystem management
- Plant based interventions, for example cultivation of biomass, management of ecosystems (some Brownfield sites may be managed specifically for uniquely evolved ecosystems)
- Water management interventions, for example irrigation, flood management
- Risk management as required (requirements will be affected by the other management interventions):
    - Remediation, particularly “gentle remediation”- see section 3.4.2 below,, although more intensive radiation work may be necessary depending on the nature of the contamination problems to be managed
    - Institutional controls, such as controls on access to some areas of the site, planning conditions or indeed constructs such as dense vegetation to limit access, or manipulating vegetation type to manage ecological risks
- Linked environmental technologies, for example biomass conversion, generation from wind or solar power, water reclamation, waste recycling, which both support the regeneration process and its maintenance as well as providing valuable environmental services themselves.
- Community, business and voluntary involvement processes: sites may be important opportunities for community engagement (see example in text box 4 below). They may provide opportunities for education, leisure and employment perhaps in particular sheltered employment for vulnerable individuals. A range of processes or practices related to these may therefore form part of the mosaic of work that assists maintenance of the regenerated area into the future.

Given the nature of these land uses, i.e. based on plants, plants growth development of complex green infrastructures, restoration or establishment of resilient ecosystems, harvesting

of biomass, it becomes obvious that time represents a critical factor to consider for Brownfield regeneration planning for soft re-uses. The creation of green infrastructures requires time for their full development. Site specific considerations can slightly modulate the speed of the above mentioned processes (quality of soil, climate, influence of other environmental factors such as symbiosis with other ecosystems etc.) and will need to be considered for deciding on the viability of alternative soft re-use solutions.
The investment case is likely to be different where interim land use change for soft re-use is being considered. Some key criteria to be considered in the planning of interim soft uses may address following issues:

- awareness and information of urban planning objectives and potential modifications
- design of soft use shall contemplate adaptability to future changes in land use, i.e. the planned soft use shall be easily adaptable to mixed hard/soft use of land (some soft interim land use can represent an attractive asset for future housing developments as it increases their value)
- interim use shall be easy to be dismantled to lower costs in case of drastic land use change (from soft use to 100% hard use)
- presence of necessary key supporting facilities assets (infrastructures like roads for access to land with machinery for maintenance works, existence / vicinity of energy production plants for valorisation of biomass…)

Hence a holistic and strategic approach is needed to designing the regeneration approach and which techniques to use. An example decision framework for biomass production on Brownfields is given by the Rejuvenate project (Bardos *et al*. 2010).

Box 4: ***Example of community engagement on BF regeneration***

One interesting example of land regeneration that supposed strong community engagement has been the Westergasfabriek Cultural Park in the city of Amsterdam, the Netherlands. On this former industrial site land regeneration has consisted in the creation of parks with green open space, water bodies and facilities for cultural events and places for people to meet (since 1992). It seems today the park owes its fame and success to the development strategy, based on the integration of various reclamation ideas and values generated by the newly created landscape. Site regeneration involved multiple stakeholders with different priorities and expectations. The project team had to manage complex communication and the success of the project was partly due to having temporary use and long-term development at the same time. Before land restoration was initiated, the site was famous for being a heavily polluted area where social conflicts between land users (squatters) and neighbouring communities were frequent. For some time, the area was thought to be redeveloped in real estate plots as land location was economically very attractive. Finally when the decision to regenerate the site into a green space was taken, the area immediately became a mediation tool between the different social subjects involved. The Park now counts several renovated historic buildings used as community meeting area and events sites and is extensively used by the citizens. (www.project-westergasfabriek.nl).

3.4 Techniques for the regeneration of BF into soft re-uses

Soft re-uses are mediated by plants, whether as part of the landscape of an open space, or for providing benefits of an urban "green lung" or for a productive purpose such as growing biomass. The growth of plants and hence the viability of soft re-uses is dependent on a suitable level of soil functionality. At Brownfield sites, soil functionality may be limited for one or more of a number of reasons:

- Soil may be absent and need to be replaced or "formed", for example on a clay landfill cap or former industrial area
- Soil may be sealed for example beneath concrete hard-standing
- Soil may be interrupted by buried constructions or services
- Soil quality (chemical) may be poor (e.g. organic matter content, plant nutrient content, low pH
- Soil may be contaminated, for example by industrial contaminants or by salinity, both risks to human health and any requirements for plant cultivation need to be managed
- Soil physical quality may be low (e.g. high soil density, low porosity and bad structure)
- Soil ecology may be poor, for example low population, low species diversity, missing particular groups of soil animals or types of mycorrhizal fungi
- Soil surfaces may be unstable and/or subject to erosion (for example slopes on a spoil heap).

There will be cases where the particular circumstances of a site and the conditions prevailing upon it create a unique ecology and/or landscape which is considered worthy of preservation in its own right for example the protected conservation site at the Phoenix United Mine[11]. Brownfield terrain may also create opportunities for re-use without substantial intervention, such as the *Little Alps* in Belgium which are being developed for touristic purposes (Rubbers 2009). An ecologically informed approach can also produce significant cost benefits by building on the natural regeneration often found on derelict sites (Handley 1996).

On many sites a series of interventions may be considered depending on the soft re-use envisaged:

- Engineering works
    - Removal of constructions and obstacles
    - Building infrastructure, for example paths and cycle trails, renewable energy such as wind or solar, a visitor centre, or facilities for biomass processing
    - Processing of by-products such as harvested biomass
    - Grading surfaces and geotechnical interventions
- Remediation of contamination in soil / groundwater
    - Treatment measures to prevent receptors, e.g. removal of hot spots were possible and necessary
- Management of soil
    - For cultivation
    - For specific environmental services such as carbon sequestration, or developing particular habitats
- Cultivation of plant cover

[11] www.sssi.naturalengland.org.uk/citation/citation_photo/2000114.pdf

In some cases a particular technique may provide more than one intervention: for instance charcoal amendment may assist contaminant immobilisation facilitate plant growth by managing soil pH (Sneath *et al.*, 2009, F. Verheijen *et al*. 2010), and provide carbon sequestration benefit. However, some interventions may be in conflict. For example organic matter addition to improve soils may also increase mobility of trace element contaminants and so change risks from contamination, although these effects appear to be site and circumstance specific (Bardos *et al* 2010).

3.4.1 Engineering works

Removal of constructions and obstacles

Before regeneration of contaminated land, constructions and other obstacles may need to be removed. For example, the regeneration of BFs may require the demolition of existing structures (buildings, industrial plants, tanks, etc.) that lead to the production of construction and demolition waste (C&DW) and other excavated materials that must be dealt with.
Some buildings may have been constructed with materials containing substances considered hazardous, such as e.g. asbestos, PCB, heavy metals, certain paints, etc… Therefore good practice requires the identification, degregation and disposal or valorisation of any hazardous materials for example dismantling of roof structures and elimination of asbestos.
Demolition methods will greatly influence the performance of further C&D waste management practices. Generally, two major categories of demolition practices are distinguished: intensive demolition and selective demolition.
Intensive demolition (see Figure 9) is a non-selective method in which all types of demolished materials are mixed together.

Figure 9: Intensive demolition: explosive demolition (left) and long arm reach for mechanical demolition (right). Source: www.aeded.org

Selective demolition facilitates recovery of construction and demolition (C&DW) materials for beneficial reuse/recycling, thus minimizing the burden on municipal landfills and public filling areas.
Many materials from intensive and most of all from selective demolition can be reused and recycled before they need to be managed and eliminated as waste. Following the Directive

2008/98/EC waste materials or products should be firstly reused before being recycled. Mineral wastes from C&D can perform mechanical functions in the formation of soils in Brownfield areas where soils are missing and need to be imported as for example in techniques related to landfill cover systems. Risk management issues for the re-use of C&D materials on applications in contact with soils or as part of soil elements need to be addressed case by case and in line with legal requirements in force at national or regional level.

Building infrastructure

As already stated above (see section 2.1.) in certain circumstances, the regeneration of brownfields into soft re-uses may not exclusively consider the development of green areas i.e. unsealed surfaces, covered with vegetation, but also include the construction of specific "hard" built infrastructures in limited areas.
Examples of built infrastructures on soft land-use could be:

i) access roads and pathways in parks
ii) visitor centre on a brownfield regenerated for public amenity,
iii) infrastructures aimed at improving landscapes, mitigating visual and/or sound nuisances (i.e. construction of integrated sound barriers to protect public from nuisance generated by traffic around urban park)
iv) construction of industrial plant for the valorisation of biomass into bioenergy
v) installation of renewable energy infrastructures i.e. wind or photo-voltaic park,
vi) construction of infrastructures for storing necessary maintenance machinery or other goods etc…

Considering the objectives pursued with the regeneration of brownfields into soft re-uses, as for example: provide compensation measures to soil sealing in urban areas by restoring soil permeability and water infiltration capacities, restoration of soil ecosystems' functionalities to support plant growth etc., particular attention should be addressed to eco-friendly and sustainable construction techniques that support the restoration of soil functionalities.
Among others, good practices in building infrastructures may consider following issues:

- Minimization and mitigation of soil sealing (see: EC Technical Report 2011-050: Report on best practices for limiting soil sealing)
- Installation of rain water catchment facilities on building roofs and sealed surfaces and re-use for irrigation of or infiltration for groundwater recharge
- Establishment of green roofs (green walls) to maintain evapotranspiration, mitigate heat island effect, improve energy efficiency in buildings, contribute to biodiversity and create habitats for invertebrates, birds…
- Valorisation and re-use of C&D waste generated during dismantling and demolition of old infrastructures and buildings
- Sound building/infrastructure design for reducing environmental impacts during construction and use phase, complying with following standards and regulation:
    - BREEAM (UK, Netherlands and Spain): The BRE Environmental Assessment Method is based on measures of performance set against established benchmarks, to evaluate a building's specification, design, construction and use. The measures include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes.
    - HQE: French Standard of High Environmental Quality in buildings

- EPBD: Energy Performance of Buildings Directive 2010/31/EU, as well as addressing issues for reducing energy consumption also addresses issues related with CO2 emissions and carbon neutral buildings
- CPD, Construction Products Directive 89/106/EEC,
- WFD, Waste Framework Directive 2008/98/EC

Processing of by-products

The management and maintenance of land either used for biomass production or for public amenities (open space) generate a series of by-products and waste all over the life cycle of land-use. These by-products and other residual materials require sound management practices and adequate processing in order to both minimize negative impacts resulting from the use of land and eventually provide further benefits after valorisation.
By-products generated from the maintenance activities and use of open spaces, urban parks i.e. green infrastructures may consist of the following materials: leaves and branches generated from tree pruning, green waste from hedge trimming and other plant residues like grasses from weeding and cutting. Possible valorisation processes of such residues are:

- **Thermal conversion processes:** through these processes, by-products are valorised in the form of heat and/or power. Major processes are:
  - **Combustion:** common process of firing. Common systems are furnaces (production of heat in home installations or industrial plants) or boilers (production of steam for energy).
  - **Pyrolysis:** process of thermic decomposition of organic material in absence of oxygen. This process generates other by-products like liquid fuels (tars) and biochar (carbon).
  - **Gasification:** process by which biomass by-products are converted into gas (also called syngas = synthetic gas) at high temperatures (>700ºC) and without combustion (controlled oxygen amount). Syngas can be used as fuel to generate heat and/or power.
  - **Co-firing**: practice consisting in combustion of by-products in existing conventional heat and power plants where they are used as fuel together with other fossil fuels (coal, gas, petrol), an alternative valorisation can consists in combustion of by-products in cement plants.

- **Biochemical conversion processes:**
  - **Anaerobic digestion, fermentation, bio-methanation**,: through these processes, the organic material is degraded by micro-organisms in absence of oxygen. Pre-treatment operations may consist in separation of unwanted elements (inert materials, plastics, metals…) and shredding of organic fraction. Principle outputs of anaerobic digestion are methane, water (liquor) and digestate. Whereas methane can further be used as fuel for transport or electricity and/or heat generation, digestates can be treated and recycled as high quality compost in agriculture, gardens, horticulture and landscaping. Generally, anaerobic digestion plants are coupled with a CHP (Combined Heat and Power) plant. In the following figure the key elements of anaerobic digestion are represented, also including process outputs and possible uses.

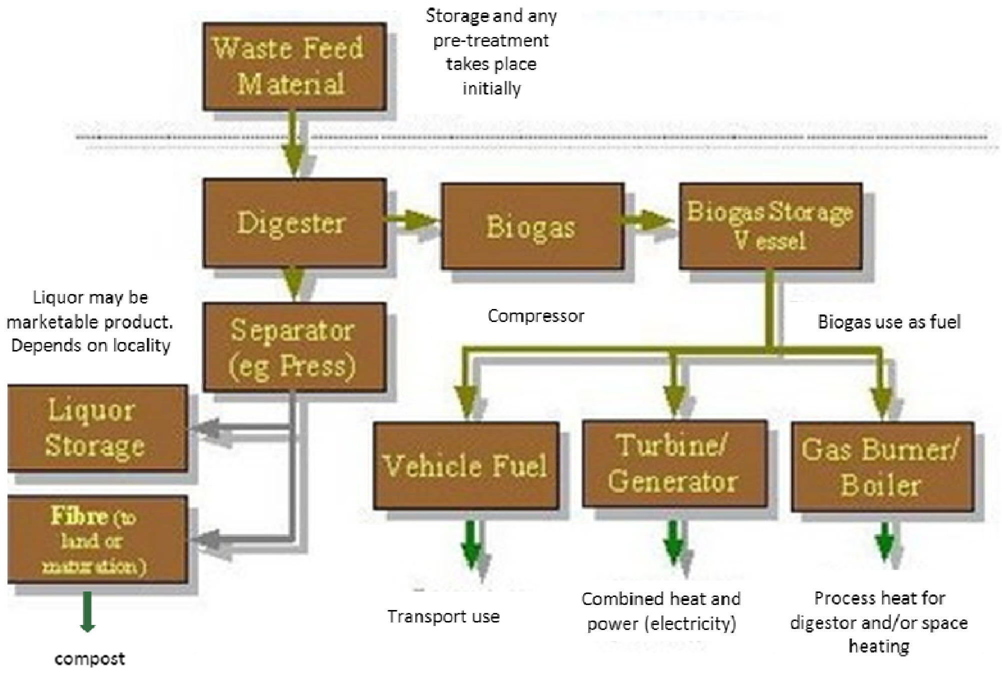

Figure 10: Flow chart diagram of anaerobic digestion process (adapted from www.anaerobic-digestion.com)

- **Composting**: through this process, organic matter is decomposed by aerobic micro-organisms to generate compost which can be used as fertilizer and soil amendment. Pre-treatment of organic matter may consist of shredding. Composting facilities may range from small scale up to larger industrial composting plants. For bigger installations, most common composting systems are: windrow composting (physical manipulation of pile to allow aeration or organic matter), aerated static pile composting (aeration occurs with installed systems, no physical manipulation of pile, either outdoor or indoor), in-vessel composting (closed systems, reactors), and vermicomposting. Composting processes require regular control of organic matter moisture and temperature as well as mechanisms aimed at keeping organic matter aerated regularly (aeration systems like perforated pipes, tractor mounted compost turner etc.). Depending on type of composting technique and location of installations, nuisances due to odours may occur and need to be managed (i.e. installation of bio-filters on closed systems).

- **Mechanical treatment and re-use on land** (on-site or off-site): apart from above mentioned techniques for green waste processing, alternative options may simply consist in chipping and shredding green waste and re-using it as organic matter in soil amendments i.e. in gardens, agriculture, horticulture and parks. In such practice, decomposition of organic matter occurs in-situ.

Cost optimization of by-product processing might contemplate synergies and opportunities offered by shared installations, i.e. HUB-CLUSTERS where by-products and residual materials from other sources i.e. food and beverage industry and agriculture would also be processed.

Grading surfaces and geotechnical interventions

Especially relevant on brownfields, where it is probably that soil quality and topography have been modified and disturbed over decades, grading, stabilisation and other geotechnical interventions may become necessary to adapt site conditions and topography to new uses. Soils on brownfields may be characterised by their relative scarcity (absence or thin soil layers on abandoned mining sites, abandoned and uncontrolled landfills, former industrial sites etc.), poor chemical quality (poor nutrient, mineral and organic matter contents and eventually presence of contamination) and un-adapted composition or texture (composed of filled-in materials, i.e. gravels, industrial waste like slags, or compacted impermeable soils) to enable proper plant growth. When it comes to regenerating brownfields into soft re-uses, i.e. support plant growth, a priority issue for stakeholders is to condition the site in order to dispose of enough soil (thickness) with adequate quality (texture and chemical composition) and topography (slope).

In absence of soil layer or insufficient soil thickness on site, importation of soil forming materials (natural or recycled aggregates, earth etc.) grading and other geotechnical operations may become necessary. The purpose of grading will be to provide more suitable topography for land-uses to control surface runoff and minimize soil erosion and sedimentation.

In the field of brownfields, geotechnical interventions may represent appropriate options to address eventual risk management issues linked with the presence of contaminants. In this case, geotechnical interventions may consist in cover, isolation and confinement systems of contamination sources. Such interventions contribute in impeding the mobilisation of contaminants through leaching, runoff, wind erosion and deposition, plant uptake and further avoid harming sensible receptors (humans, surface and groundwater and ecosystems). Cover systems may be realised with particularly impermeable soils (i.e. clay) in combination with geomembranes as barriers and additional topsoil layers to enable establishment of plant roots and further re-vegetation (i.e. evapotranspiration systems as landfill covers). While implementing these techniques, special care should be taken since the designing stage in order to minimize overall environmental impact and maximize resource management (preferential use of recyclates when possible, shorten distances for material import, adapt soil quality to plants in order to minimize further maintenance and amendments needs etc.)

3.4.2 Remediation of contamination

Conventionally regeneration of contaminated land for soft re-use has involved the use of cover systems with re-vegetation and/or removal of contamination hot spots. Remediation, i.e. treatment based mitigation of contaminants using biological, chemical or physical processes) has been largely restricted to smaller land areas for hard re-use. However, conventional remediation techniques using cover systems or removal are costly, and also do not *treat* contamination. In addition, conflict can occur between the needs of soil remediation and soil restoration (soil functionality). Intensive remediation techniques with a strong impact on soils (for example changing pH, removing organic matter, removing soil, heating or solidifying) are not consistent with maintaining and improving soil functionality. While more intensive interventions may be required to deal with particular “hot spots” of contamination, their use is likely to be limited in terms of geographical scale; and the soils so treated may need additional interventions to recover soil functionality.

In general use of less intensive remediation techniques is more likely to be consistent with the maintenance and improvement of soil functionality. This strategy is also more likely to be economically feasible given the scale and limited finances of regeneration projects for Type "B" and "C" sites for which soft-end uses are most likely. These less intensive remedial approaches may take longer, but this may also be consistent with the time fares necessary for soil improvement and plant cultivation works for soft end-uses.

Gentle remediation techniques have been defined by an ERA-NET project (SUMATECS) as *in situ* techniques that do not have a significant negative impact on soil function or structure (Onwubuya et al 2009, Sumatecs Consortium 2008); and is based on an older concept of "extensive" (i.e. low input longer term) treatment technologies developed in the Netherlands over the 1990s (Bardos and van Veen 1996). This SUMATECS project uses the word Gentle Remediation Option (GRO). The rationale is to both minimize any negative effects of the remediation treatment process on soil systems, but also to reduce overall economic costs and management requirements. GROs may offer a cost effective alternative for soft re-uses that also has a treatment effect on contamination, rather than simply containing it or transferring it. Plant based techniques have become attractive alternatives to conventional cleanup methods in some situations due to their relatively low capital costs and the inherently aesthetic nature of planted or "green" sites (ITRC 2009). The SUMATECS project and its successor Greenland Project[12] are primarily based on phyto-technologies; and show how plant and stabilisation (immobilisation) based techniques may be combined, as set out in Figure 11 below.

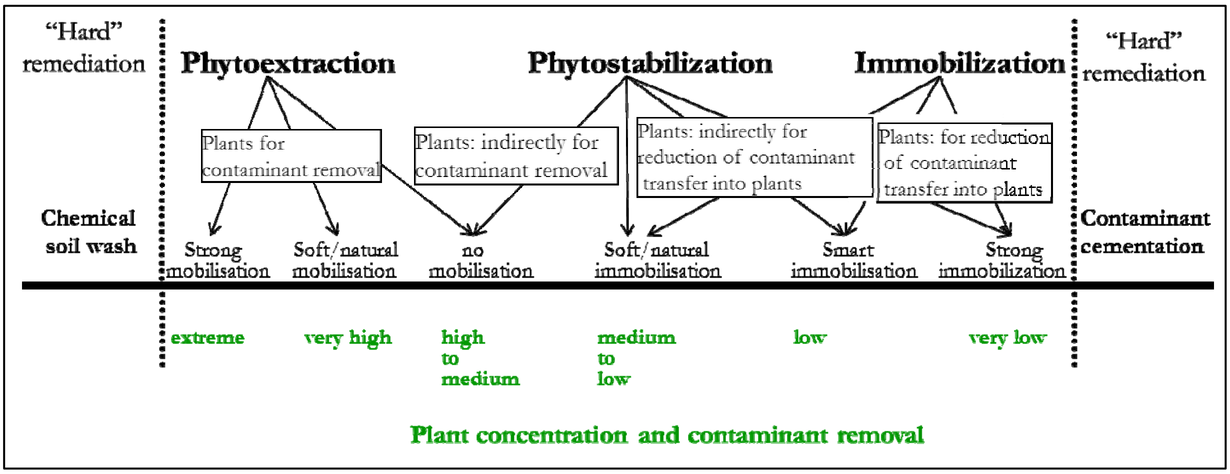

Figure 11: Schematic classification of a range of "gentle" remediation options (after Onwubuya et al., 2009).

However other types of techniques may also pass the "GRO" threshold, to provide the following broad categories:

- Plant based interventions
- Extraction
- Stabilisation
- Containment
- In situ stabilisation
- In situ biodegradation
- Low intensity in situ chemical degradation (redox)

12 www.greenlandproject.eu

- Monitored natural attenuation.

Further information on specific techniques will be provided in the frame of task 5.2 deliverable "Guide – Decision Support for soft re-use implementation based on operating windows" due by month 40.
Key information on techniques will be collected in a "fiche" format. A draft template for such fiches can be found in Annex 1. Major objective of the fiches is to provide key indicators to be considered for techniques selection and further performance monitoring. Altogether, the fiches shall provide at first glance an overview on key factors that could represent obstacles or at the contrary opportunities of implementing specific techniques on a specific site. Identifying these obstacles and opportunities will guide stakeholders in screening options best suited for their specific case. Further indications on when the fiches' data come to play are given under section 5.2 "Principles of Treatment Trains design". Information contained in the fiches shall be translated into a format that can be usable by the Brownfield Navigator, (an ICT tool consisting of an interactive design table combined with planning tools developed in WP3 (see Figure B in Summary section) to support stakeholders in decision making.

3.4.3 Soil management

Soil management for plant cultivation

The surface of a Brownfield may require some intervention before it is fit for purpose for whatever type of vegetative cover is envisaged. The vegetative cover may be:

- Some form of biomass or bio-feedstock crop
- Grass for amenity purposes such as a sports area or an area for recreation
- A semi-natural landscape such as meadow or woodland
- A specific habitat design (see below)
- A functional plant application such as an "alternative vegetative cover" for a former landfill site or a phyto-remediation process.
- A particular type of vegetation that has spontaneously emerged on the site

In many cases a master plan for a site may include several of these components. A particular vegetative cover may fulfil more than one of these purposes.

The soil management required will depend on the vegetative cover required and the state of the existing site surface. Four broad initial strategies can be distinguished:

1. No or limited intervention (for example where the existing site ecology is deemed worthy of preservation)
2. Soil improvement operations, for example where some normal top soil functionality exists, but intervention is needed to change or improve soil condition, fertility and or nutrient status
3. Soil forming operations where there is no functioning soil cover
4. Engineered approaches to delivering subsoil and top soil horizons for a specific purpose on a specific surface, for example to enable safe tree propagation on a clay landfill cap.

Little or no intervention by soil management measures will be needed for Brownfields where the soil status of the Brownfield is already within the desired requirements. An illustrative experience is the on-going Italian project in La Spezia Gulf, where the ENI LNG (Liquid Natural Gas) Terminal of Panigaglia is located. In 1992 the Ministry of Environment asked to improve the ecological infrastructure in order to mitigate the visual impact from the sea and compensate with vegetation. Today the project offers a typical coast landscape with a ‘promenade plantée’ and Mediterranean shrubs, planted on a sort of roof garden on 8.000 m^2 of concrete. This is the only case in Italy where an operating industrial location contains post-industrial landscape assets.

Figure 12: ENI LNG Terminal of Panigaglia in La Spezia Gulf, Italy

In relation with soil improvement measures, the benefits of compost use in soil are well established (EC 2003): they improve the carbon pool and organic matter content of soil, they supply valuable plant nutrients, they improve soil processes of fertility, they improve the condition of soil for plant growth for example by enhancing their ability to store and supply water and their structure and the resilience of that structure. Even for biomass crops that are conventionally regarded as “low input” such as SRC willow, organic amendments such as sewage sludge have been found to improve yields (e.g. Adegbidi et al. 2003). Soil improvement will also play an important role in the on-going maintenance of Brownfields restored for soft re-use, where the demands on the soil cannot necessarily be met by naturally occurring processes of nutrient and organic matter cycling, for example where biomass crops are being produced or the site is used for recreation and sport. Soil organic matter content is strongly affected by the vegetation management regime, for example accumulating under conditions of permanent cover, but is a very gradual process. Observations by the European “Soil Service” project (SoilService Consortium 2012) have found that this accumulation may not occur for plantations of perennial biomass crops (grown on agricultural soils). Hence, on-going maintenance inputs of exogenous organic matter (e.g. from composts) might appear to be helpful.

In some cases the marginal land will not have a functioning soil, in which case a series of “soil forming” interventions will need to be carried out. Soil-forming materials substitute for, or supplement, natural soils in the course of land reclamation. The material should, with appropriate surface treatment and the use of amendments as necessary during the period of aftercare, be capable of sustaining the required vegetation beyond this term by the implementation of normal management practices. Soil forming requirements will be site specific but may include the need for addition of stony or aggregate materials or other major mineral components, and/or organic matter for adapting / improving soil structure properties (Bending *et al.* 1999, Foot and Sinnett 2006).

A more specifically engineered approach may be necessary, for example a landfill surface may have been completed using clay rich subsoil which will not only have poor nutrient status, but may also prevent the physical growth of plant roots and may also have very poor drainage. In this circumstance it may be necessary to "form" distinct subsoil and topsoil layers. Landfill surfaces are a special case as it will also be important that the biomass crop does not damage the landfill cap and create a migration route for hazardous levels of methane to the surface (US EPA 2006). However, a good restoration will be protective of the cap, preventing desiccation and erosion, and also promoting the oxidation of any fugitive emissions of methane. Biomass production (as SRC) has also been used as a means of treating landfill leachate, with water removal by transpiration and treatment of leachate substances within the biomass root zone (Environment Agency 2008).

Management of soil for specific environmental services such as carbon sequestration, or developing particular habitats

There are two basic forms of carbon management benefit that may result from the use of Brownfield land for soft re-use, in particular, for bio-renewables:

- Emissions reduction: a permanent effect resulting from the substitution of bioenergy for fossil carbon resources, and
- Sequestration: a temporary effect resulting from changes in organic carbon levels in managed soils and the standing crop of biomass on-site.

Sequestration in soils and biomass is seen as temporary as it depends on the continuation of a particular land management regime, and may then gradually diminish over time as the biomass standing crop changes and soil organic carbon is gradually oxidised by natural processes. Additionally, Carbon impacts from biomass use of land may result from soil disturbance by cultivation and soil nitrogen metabolism (Bardos *et al.* 2010).

Carbon neutrality may be an important opportunity for biomass on marginal land projects to generate value. Carbon neutrality means that – through a transparent process of measuring emissions, reducing those emissions and offsetting residual emissions – net calculated carbon emissions equal zero. This concept can generate value in two ways: firstly it may be a means of allowing a larger redevelopment project to achieve carbon neutrality for example by calculating the cumulative carbon balance for a project that includes built redevelopment and biomass on a particular site; and secondly, for European projects, by generating income from *voluntary* offsetting of carbon emissions (Bardos *et al.* 2010).. For example, in the UK a code for voluntary sequestration projects has been produced for woodlands establishment (Forest Research 2011).

Adoption of soil carbon sequestration strategies for Brownfields may have important wider benefits. Enhancing soil carbon content appears to be associated with improvement in broader soil functionality (SoilService Consortium 2012). In addition, local authorities may have specific responsibilities in securing greenhouse gas (GHG) reductions, for example this applies in the UK (Planning & Climate Change Coalition 2012). Restoration strategies for Brownfield land for soft re-uses may assist in GHG mitigation.

Soil management for the creation of specific habitats focusses on three aspects:

- Surface morphology
- Soil type and soil quality
- Soil wetness (either by groundwater or by surface water)

The morphology aspect is mostly carried out at the start of a habitat creation and follows the environmental requirements of a certain habitat. Wetlands, rivers and lakes may need specific measures such as excavation or soil supplements for the creation of lowering or heightening in the landscape. Such habitats may need a diverse morphological soil surface for the requirement of open water with different depths (open water of rivers, lakes and pools), groundwater influenced soil in the upper layers (wetlands and shores) and higher parts for dry areas (redirection of water flow, refugee spots). The morphological modifications influence the factors that form the plant site conditions: wetness, soil pH status, soil nutrient status, soil toxicant status, and soil moisture status (Mitsch & Gosselink 1993, Beumer 2009). Therefore, soil morphology is highly connected to the second and third aspects: soil quality and soil wetness. Soil quality (pH status, soil nutrient status and soil toxicant status) can either be directly influenced by applications or removal of upper soil layers. The removal of upper soil layers is often applied to remove a surplus of nutrients or toxicants (highly dependent of the specific habitat requirements). As already mentioned, the soil wetness is highly affected by the soil morphology, it affects: surface water inflow, groundwater influence, or soil drying out possibilities. The soil wetness will influence the soil quality in terms of redox status and availability of nutrients and toxicants in the soil. The three soil management aspects are difficult to separate because they are highly integrated and affect each other.

The presence of a certain soil is mostly a matter of timescale and setting the right environmental conditions. In the process of soil maturing the soil type will be formed that meet the habitat requirements. It is also possible to speed up this maturing by excavation until bare soil. It could not always be done because excavation (soil morphological modification) influences the other aspects as well, and can result in a discrepancy with the desired habitat requirements.

Another form of soil management with the purpose to create a certain habitat is to rely on natural processes (or the enhancement of these). A critical parameter to consider in this type of management practices will be the time scale as natural processes may take longer to provide expected results. These natural processes can be:

- soil type and morphological changes through sedimentation via floods or winds
- soil quality changes through vegetation growth
- soil conditions may change through vegetation growth
- soil quality changes by animal activity

3.4.4 Plant cultivation

In extensive green infrastructure (GI) such as parks, natural areas, green corridors etc. traditional forestry techniques are frequently adopted and fitted for adverse conditions such as derelict urban spaces and Brownfields. In many cases soil needs to be imported (landfilling) or improved in quality. The planting schemes change a lot according to the area and climate, but foresee a density between 800-2000 plant/ha, with a water need in continental and Mediterranean climate around 80.000-240.000 l/ha/year for the first 3 years from planting.

In intensive GI such as gardens, allotments, tree rows, roof garden, etc. advanced garden design techniques are used. These allow green areas of limited scale, usually less than one hectare, to be developed under various contexts, including heavily urbanized areas, thanks to specific techniques. The planting density is very variable, but the preparation phase can be labour-intensive due to substrate preparation over concrete or walls, hanging supports, waterproof membranes, extensive irrigation, feeding and maintenance. GI like swales and rain gardens help mitigating impacts of climatic extreme events (floods) in land with low permeability.

Cultivation and production of biomass on Brownfield land has been reviewed in detail by the Rejuvenate project (Bardos *et al.* 2010). The selection of a suitable crop depends on local climatic conditions (which will vary from site to site even within a region) and the topography and size of the marginal land area, as well as the availability of markets / outlets for the biomass produced.

The Rejuvenate project concluded that four broad stages can be used to refine choices for bio-renewables on marginal land.

1. Crop suitability: primarily considers from a range of possible biomass crops which crops are able to grow in a region with a potential local market. This will include an assessment of both climate and site topography. For convenience, this stage provides a biomass crop short list. Each subsequent stage is likely to reduce the length of this list as a more refined solution is found.
2. Site suitability: considers whether the site conditions are suitable for particular biomass crops in the short list and what the environmental risks of crop production might be; a site may be suitable already for some crops or can be made suitable by soil / risk management interventions. If an on-site conversion facility is being considered then the suitability of the site for this facility must also be considered and any necessary interventions (for example infrastructure considered. Furthermore, the impacts arising from any site management activities for risk and soil management and facility development need to be properly considered.
3. Value: there is a direct cost benefit equation as to whether the benefits of using a site for biomass are worth the investment needed, but also a wider sustainability consideration, considering for example aspects such as improvement in biodiversity, carbon sequestration or local community enhancement. It may be appropriate to include other measures to increase overall project value, for example integrating other forms of renewable energy production with the site re-use, or combining biomass use with the re-use of agricultural residues.
4. Project risk: once a firm project concept has been elaborated, and its value is attractive to its developers, the project planning needs to then ensure its viability as far as possible before any major investment takes place. Three broad considerations are important: technology status, detailed diligence (e.g. of financial partners and project partners) and developing a broad stakeholder consensus.

Findings of Chapter 3: Regeneration for soft end-uses - key findings

The value of land is dependent on the type of land use and the demand for that land use. Markets discount the value of degraded land, such as Brownfield land, based on assumptions relating to the likely direct and indirect costs of rehabilitation. The effect of these constraints on a site's value can persist even after the completion of remediation. However, a *change* in land use can substantially increase land value, for example a change from an industrial use to a use for retail and housing. This change on value is dependent on location and market rates for similar land uses in the vicinity. For a Brownfield site this change in value may be sufficient to pay for site regeneration and also generate useful revenue from a future land sale. Brownfield sites with land contamination problems are likely to be particularly disadvantaged because of their higher liability burden. Away from economically active areas the profitability for less advantaged Brownfield sites may be borderline, or conventional regeneration may proceed only at a loss. It is the regeneration of less economically advantaged sites that HOMBRE seeks to facilitate. Soft-end uses may create opportunities for longer term and lower input regeneration, creating value for a range of stakeholders both directly connected with the site and in the locality of it. Developing a shared concept of value to support the necessary investment can be a major barrier to this soft end-use regeneration. This problem is recognised in several Member States, where institutional measures and organisations have begun to facilitate regeneration for these less advantaged sites.

There are a broad range of possible re-use strategies that can integrate with different services such as amenity or on-site energy production, either as a permanent or interim measure. Soft re-uses are mediated by plants, whether as part of the landscape of an open space, or for providing benefits of an urban "green lung" or for a productive purpose such as growing biomass. The growth of plants and hence the viability of soft re-uses is dependent on a suitable level of soil functionality. On many sites a series of interventions may be considered depending on the soft re-use envisaged:

- Engineering works
  - Removal of constructions and obstacles
  - Building infrastructure, for example paths and cycle trails, renewable energy such as wind or solar, a visitor centre, or facilities for biomass processing
  - Processing of by-products such as harvested biomass
  - Grading surfaces and geotechnical interventions
- Remediation of contamination in soil / groundwater
  - Treatment measures to prevent receptors, e.g. removal of hot spots were possible and necessary
- Management of soil
  - For cultivation
  - For specific environmental services such as carbon sequestration, or developing particular habitats
- Cultivation of plant cover.

4 Services from the regeneration of Brownfields for soft re-uses and opportunities for building value

Chapter 4 describes how synergies between different benefits or services might widen the scope for Brownfields to be returned to productive use. It introduces the concept of "services" from the regeneration of Brownfields into soft re-uses, and shows how synergies can be designed into soft-end use regeneration schemes to create expanded opportunities for Brownfield regeneration.

4.1 Services from regeneration of Brownfields into soft re-uses

In the context of economics, a service is an intangible commodity. More specifically, services are an intangible equivalent of economic goods[13]. OECD describes environmental services as qualitative functions of natural non-produced assets of land, water and air (including related ecosystem) and their biota. . These can be disposal services, productive services or consumer / consumption services[14].

HOMBRE WP5 has adopted a functional description to better understand the linkage between regeneration services and project value. In WP5 the term *"project service"* is used to express the benefits obtained by specific beneficiaries or "receptors" (i.e. nature, people or society). In the context of HOMBRE, services are delivered through the implementation of processes during the regeneration of Brownfields and the maintenance of specific land uses. As such they also constitute the specific outcomes of designed process as opposed to conventional "ecosystem services" which are naturally provided without technological inputs. . A possible "service" designed into a regeneration project is of course the protection or enhancement of ecosystem services.

There are three constituent elements for a project service to occur. These elements are:

- An intervention, in particular a process or technique (or a combination of thereof)
- One or more outcomes (permanent or temporary effects) of the intervention
- a beneficiary of the outcomes

Some project services arise from the process of regeneration itself, and therefore may be one-off effects, albeit in some cases with hopefully permanent impacts (such as on land values). Other project services continue with the soft-end use of the site, for example the provision of open space for amenity and leisure, and as such may require on-going maintenance and management.

This concept of "services" is in line with the concept of ecosystem services defined by the Millennium Ecosystem Assessment[15] but is not (yet) precisely aligned with it. An ecosystem is a way of describing nature's functioning and it consists of components (plants, animals, microorganisms, water, air etc.) and the various interactions between them. Almost every

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13 www.investorswords.com
14 http://stats.oecd.org/glossary/detail.asp?ID=843, accessed Nob 2012
15 http://millenniumassessment.org/en/index.aspx Accessed November 2012

resource that humankind uses on a day-to-day basis relies directly or indirectly on nature. The benefits that humans derive from nature are known as *ecosystem services* (World Resources Institute[16]). The types of intervention that regeneration might employ to develop soft end-uses are often what would be described as “eco-engineering”, see Box 5.

Ecosystem services can be divided into four categories: provisioning services, regulating services, habitat or supporting services, and cultural services. The TEEB Foundation (The Economics of Ecosystems and Biodiversity) is an international initiative hosted by the UN Environment Programme which draws attention to the global economic benefits of ecosystems and biodiversity. The TEEB Foundation has published a perspective on ecosystem services in urban management (TEEB 2011), setting out the key ecosystem services important in an urban context, summarised in Table 2.

The concept of ecosystem services is relatively mature though R&D continues improving understanding and valuation approaches. Much of the associated literature appears to focus on the improvement of governance models, assessment and evaluation methods. The goal is to better exploit the outcomes/benefits provided by natural / semi natural green infrastructures with the final aim of integrating this type of assets in environmental planning and policy arena (Millennium Assessment 2005, TEEB 2011 and the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) 2010). Assessment of Ecosystem Services (Millennium Ecosystem Assessment) is about making policy makers and society aware about the existence of these functions and the opportunity to exploit them in a way that makes public investments profitable. Assessment operates from a project level (creation or investment in green infrastructure) up to local/regional level, and seeks to consider both the direct and indirect values created by ecosystem services (Vandermeulen et al. 2011). Tools like national accounting and input-output tables can be used to value all the benefits generated for the economy and society (Grêt Regamey, 2007). Vandermeulen et al., (2011) have proposed a twin track approach to valuation of green infrastructures and services they provide. One assessment level is set at project scale and the second on regional scale. The project scale essentially considers so called "direct benefits" of the creation of the infrastructure, whereas at regional level, economy levers and indirect value for the development of the region are taken under the loop.

[16] http://www.wri.org/project/ecosystem-services-indicators

Box 5: Examples of ecosystem services and eco-engineering

The ecosystem services concept has become the basic principle on which eco-engineering has developed. Eco-engineering is where ecosystem restoration is being used to provide the community with "project services" as defined above. The ecosystem is engineered in a way that certain ecosystem services will be accentuated or emphasised, for the benefit of particular stakeholders. Natural processes or organisms are being used for other functions than "Nature", because they provide project services of use for stakeholders.

Examples of eco-engineering are provided below:

Noordwaard polder, The Netherlands: A polder is being reclaimed for flood management purposes (climate adaptation) so it was thought that surrounding dykes would have had to be heightened to ensure flood protection. A willow-forest was designed as a strip in front of the dyke providing ecosystem restoration (or creation) and a project service. These trees will break waves and result in a wave height reduction of 80%, making the heightening unnecessary. Provided service: flood defence.
Intervention: establishment of willow forest
Outcome: dispersed impact of waves
Beneficiary: local community
Service: (lower cost) flood protection

Peat reinforcement: In unstable soils like peats, construction can be a problem. An eco-engineering solution to this problem is the designed activation of particular micro-organisms by injecting various additives. The project service provided by the microbial are excretions that stop the oxidation of peat and stabilise the subsurface. This technique has been used for the construction of a cycling lane through a peat area.
Intervention: injection of microbial substrate
Outcome: stabilisation of ground
Beneficiary: construction company / cyclists
Service: facilitated construction

Achteroeverconcept: Achteroever is an artificial wetland, supporting Lake IJsselmeer in The Netherlands. The wetland is a spirally designed water body with heavily vegetated sides. The project service provided by the vegetation is water purification, as the vegetation will take up nutrients and contaminants, purifying the lake water.
Intervention: establishment of vegetation
Outcome: removal of plant nutrient from water
Beneficiary: local water board
Service: water purification

Table 2: TEEB Perspective on ecosystem services in urban management

Provisioning services (*Ecosystem services that describe the material or energy outputs from ecosystems.*)	• Food • Raw materials (*) • Freshwater (*) • Medicinal resources

Regulating services (*The services that ecosystems provide by regulating the quality of air and soil or providing flood and disease control, etc*)	• Local climate and air quality regulation (*) • Carbon sequestration and storage (*) • Moderation of extreme events - such as flooding (*) • Wastewater treatment (*) • Erosion prevention and maintenance of soil fertility (*) • Pollination (*) • Biological control (?)
Habitat or supporting services (*These services underpin almost all other services. Ecosystems provide living spaces for plants or animals: they also maintain a diversity of plants and animals*)	• Habitats for species (*) • Maintenance of genetic diversity (*)
Cultural services: (*These include the non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits.*)	• Recreation and mental and physical heath (*) • Tourism (*) • Aesthetic appreciation and inspiration for culture art and design (*) • Spiritual Experience and sense of place (*)

Note: * Linked to potential beneficial outcomes from soft re-uses of Brownfields – assuming no human consumption of produce from this land

Examples of project services that can be directly mapped to ecosystem services include the following.

- Regulating ecosystem services to fit with project services such as:
    - Creation of opportunities for sustainable urban drainage solutions
    - Mitigation of pollution (i.e. from site contaminants) – although this may not necessarily be caused by an ecosystem *per se*, it may be the result of an *in situ* stabilisation agent for instance
    - Waste re-use and recycling for urban settlements (e.g. creating opportunities for beneficial re-use of composts, digestates or aggregate)
- Material ecosystem services fit with project services such as closing (urban / natural) cycles or cradle to cradle approaches and include the re-use of resources from the former Brownfield use, for example steel and other recyclates; and services related to the preservation of attractive man-made environments, including the built or landscape environment.
- Cultural ecosystem services link with project services such as provision of amenity and leisure.

Furthermore, enhanced delivery of many of the ecosystem services listed in Table 2 could be a designed in outcome of a soft end-use, and so a project service (see Section 4.2.1).

However, the ecosystem service concept does not fully align with the concept of services for three reasons:

- Not all benefits or improvements in value achievable from Brownfield regeneration find a direct translation within the scope of ecosystem services, for example the generation of recyclate during a Brownfield regeneration is a result of human activity rather than an ecosystem service.
- Some project services are *consequential* economic benefits. These include the recovery of land values for the site and surrounding areas, the facilitation of wider developments, improvements in balance sheets, benefits for intangible values for the project participants such as reputational benefits and removal of reliance on primary and also less secure resources (for energy and raw materials). These consequential benefits tend to have a major bearing on the economic viability of Brownfields regeneration, and the investment case that can be made for it.
- The ecosystem service concept describes a “steady state” of provision; benefits from Brownfield regeneration accrue both from the *outcome* of the regeneration process (outcome = operational phase of the new use of land, i.e. public park, urban forest, biomass production etc.) which may be more or less a steady state, but also from the *process* of reaching that outcome (processes used to regenerate the site).

Hence project services may be delivered by ecosystems, they may be delivered by non eco-system processes or they may be consequential. Hence the project services from a Brownfield regeneration for soft end-use can include both ecosystem service and other components. Project services may arise from the regeneration process itself (for example via supporting re-use of materials) or from the consequent soft-end use. The soft-end use is therefore an asset that provides on-going delivery of services.

Project services are the basis upon which value can be created that will leverage a Brownfield regeneration by providing benefits that make the investment in regeneration worthwhile to specific constituencies or beneficiaries who will support it:

- Private investors
- Local community
- Wider public good.

The local community and the wider public are also investors in Brownfields regeneration processes. This may be manifest as a direct financial input for example via grant funding or taxation advantages; via levies on wider development initiatives to support local community infrastructure (e.g., DCLG 2008); and also indirectly as contributors and stakeholders with interests in regeneration.

The value of the Brownfield regeneration rests on project services resulting from:

i) **<u>project’s end point</u>**, i.e. the soft re-use and its short/medium/long term benefits and services,

ii) **<u>means of creating the soft re-use</u>**, i.e. taking sustainability as key criteria and the provision of services as objective for process design and optimization

Consequently *valuation* of Brownfield regeneration is critically dependent on an accurate inventory of project services, and value can be enhanced by expanding the range of service delivery. The concept of finding *synergies* between project services is that of providing a route to expanding service delivery without unacceptably increasing project costs, so that overall net value becomes more attractive. Project sustainability overlaps with project services but is not strictly aligned with them for two reasons:

1) Service delivery may have sustainability impacts (for example emissions to air or water, use of resources etc)
2) Service delivery may create wider benefits not explicitly valued as a project service (for example improved soil functionality)

Hence, robust and exhaustive assessment of services provided by Brownfield regeneration projects is the basis for value proposition for Brownfield regeneration projects and contributes strongly to its overall sustainability appraisal (see Chapter 6).

Table 3 sets out a series of services (based on the TEEB ecosystem service suggestions) that could be used to identify and review the benefits of Brownfield regeneration projects for soft-re-uses.

Table 3: HOMBRE concept of project services delivering value / benefit from soft re-use regeneration of Brownfield sites

Sustainable development connection (see Chapters 6 and 7)	Examples	Value	Beneficiary**	Ecosystem services*
Environmental	Raw materials from biological processes (biomass or feedstock) Raw materials solely from human activities Improvement of water resources	R R NC	I I LC	Provisioning
	Local climate and air quality regulation Carbon sequestration and storage Moderation of flood events Wastewater treatment Waste re-use and recycling Pollution mitigation Soil management Sustainable urban drainage Pollination Biological control (?)	NC R NC R R NC NC R NC NC	LC I LC I OS I I I WS WS	Regulating
	Soil quality (Habitats for species) Biodiversity	NC NC	WS WS	Habitat or supporting services

Societal	Amenity for recreation and mental and physical health	NC	LC	Cultural services:
	Tourism and leisure	R	I	
	Aesthetic appreciation and inspiration for culture art and design	CC	WS	
	Spiritual Experience and sense of place	CC	LC	
	Built and landscape environment	CC	LC	
Economic	Land value	ET	I	“consequential”
	Balance sheets (e.g. removal of liabilities, accrual of revenue)	ET	I	
	Reputational value	EN	I	

Notes
* Not all of the examples result directly from a biological or ecosystem process
** Principle beneficiary, there may well be others for example local community benefits may be a rational for public sector funding involvement
Value: R = revenue generation opportunity; NC = natural capital; CC = cultural capital; ET = economic capital – tangibles; EN = economic capital – intangibles
Beneficiary: I = investor or funder in the project; LC = local community; WS = wider society; OS = other suppliers

The idea of consequential project services is not a major departure from contemporary thinking for ecosystem service evaluation, Figure 13 below is taken from guidance produced by the World Business Council for Sustainable Development on Corporate Ecosystem Valuation (WBCSD 2011). Table 3 makes the ecosystem-related business risks, benefits and opportunities explicit in a meaningful Brownfields context, and also links them to the three elements of sustainable development, in order to facilitate their linkage to sustainability assessment (see Chapter 7). Table 3 also includes business risks, benefits and opportunities arising from Brownfields regeneration that do not directly arise from biological systems.

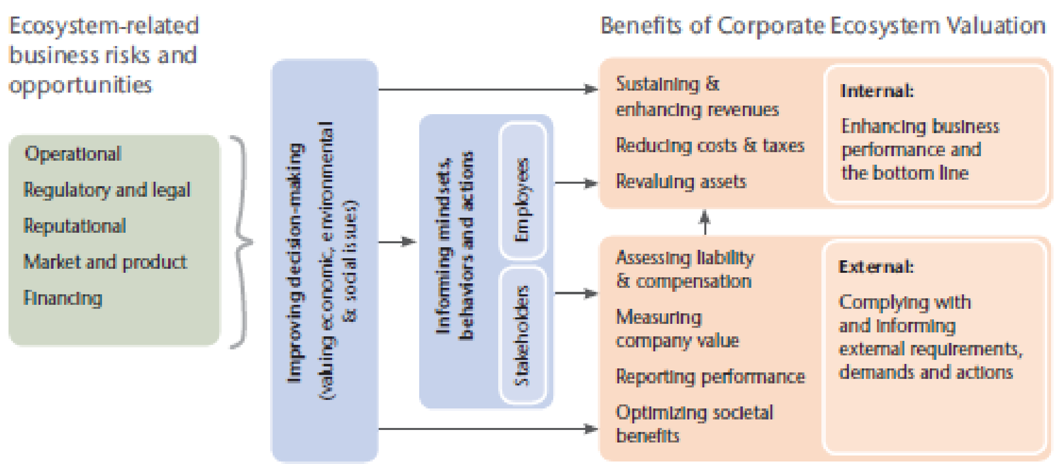


Figure 13: Business benefits of undertaking ecosystem service valuation (fremWBCSD 2011)

4.2 Designing tailored project services for Brownfield regeneration for soft end-use planning

The design process needs to start with the selection of which project services should or could be provided by specific BF regeneration projects and the consequent regenerated land. The value of a potential project depends on the services it can deliver. Identifying the broadest possible range of services increases the chances of finding a combination that will deliver optimum value. Therefore the design process requires a wide-ranging vision, detailed consideration of different stakeholder needs and robust and transparent decision making procedures that can be revisited and considered in an iterative way. Suggestions for these will be developed in HOMBRE Deliverable 5.2. For soft-end uses there are three overlapping frames of reference:

- Strategic choices – these relate to how land is used in a planning sense, including as part of a portfolio of sites or across a region containing several Brownfields, the concept of "interim land use" is particularly relevant for soft land uses
- Project choices – these relate to the exact choice of project services and the most efficient way in which they can be delivered, the concept of "synergy" is particularly important for maximising opportunities for enhanced service delivery from any particular project
- Sustainable choices – these relate to the overall benefits and impacts of the strategic and project choices made; while some aspects of sustainability will be addressed by particular project services (and strategic decisions), these choices may also have wider benefits and impacts that affect the overall sustainability of any particular Brownfields regeneration project. Parallel to the concept of synergy is the concept of "trade-offs" (discussed later), which may be particular helpful in understanding how to make balanced decisions amidst competing priorities.

Hence the dimensions of the decision making process include the range of project services, the frames of reference for choices and where the site is in the regeneration process, as summarised in Figure 14. The categories within each dimension can overlap. For example, a biomass production process on a Brownfield site may be both the on-going soft-end use and part of the regeneration process (providing remediation and soil restoration "services").

4.2.1 Strategic choices

The circular land management concept, described in Chapter 1, is analogous life cycle thinking and includes the same paradigm shift from "cradle to grave" to "cradle to cradle". In circular land management, land as a resource, journeys through different phases of activity to support a particular use, and then ultimately transitions to a new use. Brownfield sites are essentially when land as a resource has fallen out of use. Circular land use is predicated on a belief that because land is absolutely a limited resource, land resource efficiency is a critical factor. This can be translated into several goals, minimising the use of virgin (greenfield) land; prevention of land falling out of use; and where land is out of use, i.e. Brownfield, it can be returned to use as quickly and sustainably as possible. These goals lead to several consequences for strategic choices for soft end-uses:

- The new use of the regenerated land should be durable so that and the regeneration investment wasted, this means that the re-use must be both financially viable and sustainable from the very beginning of BF projects up to future land use, after care and maintenance.

- In some cases soft end-uses could "fill in" while a more permanent renewal strategy is devised. This "interim use" strategy might be particularly important in maintaining a functional use of land during economic down turns or on a regional basis pending a more concerted policy development.
- Regeneration where the land can efficiently fulfil a range of roles (synergy) may reduce requirements for greenfield site use.

That means on the way towards successful Brownfield soft re-use, *"the journey is also part of the reward"*.

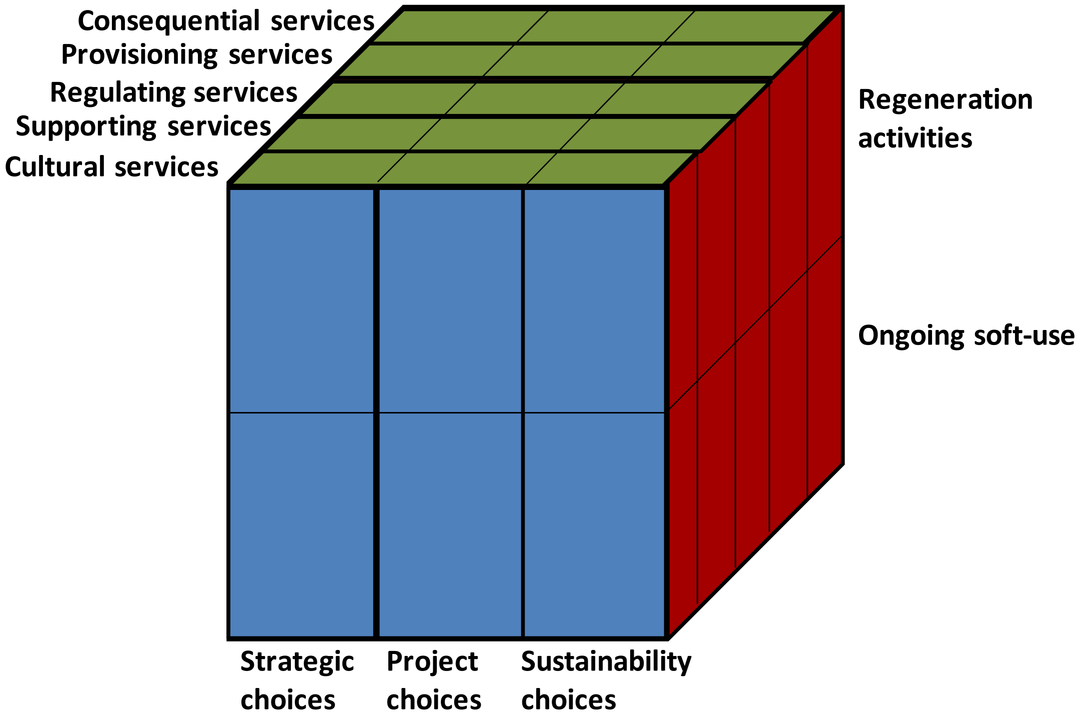


Figure 14: Dimensions for Decision Making for Soft End-Use Regeneration (completed Rubik's cube)

Other strategic choices affect how any particular Brownfield site is managed as part of a group. For example, local authorities may seek to exercise planning control over a number of Brownfield locations, zoning different areas for different uses across a range of soft and hard applications to design a sustainable urban landscape. Conversely organisations may own or managers a portfolio of Brownfield sites, some close together and others more distant. It may be in their interest to co-ordinate regeneration of their portfolios to create broader opportunities that might be available from a single site, or to create efficiencies from managing the regeneration of several associated sites simultaneously. An example of this type of efficiency is the "hub and cluster" approach developed for CL:AIRE (2012) where a central site provides central soil management services for excavated sites from several adjacent locations. An emerging interest is linking together site management actions on a regional scale to provide broader ecosystem service opportunities, for example in the context of river basin management.

This report focuses on the delivery of services and sustainability from individual brownfield regeneration projects. However, the choices of services, and the broader context of sustainability assessment, may well reflect a wider strategic context. HOMBRE WP3 is developing a Brownfield Navigator to integrate this strategic context with individual project choices.

4.2.2 Project Choices

The exact choice of project services and the most efficient way in which they can be delivered determines the usefulness and hence the value of the regeneration. Synergy describes a situation where a process or combination of processes on a site delivers several useful services in a way that provides a net improvement for the financial feasibility and sustainability of a project. In this case a process might be a remediation process, a production process such as biomass cultivation or some other form of intervention such as public involvement in green infrastructure management.. The types of synergy that might be possible in Brownfields regeneration for a soft end use include:

- Combining use on-site and off-site biomass to gain economies of scale.
- Green landfill covers as landscape feature and evapotranspiration cover
- Using biochar as carbon sink (climate change) and soil improvement for plant growth
- Green infrastructures as means to improve air quality and urban climate comfort
- Unsealed soil as a way of improving aquifer recharge and water management

To better understand how the process of Brownfield regeneration and services provided by soft re uses can be managed HOMBRE has developed a conceptual model to describe "processes", their linkage to services and how they might be combined, as illustrated in Figure 15. The model is centred on a *unit process*, i.e. a process leading to a specific set of outcomes on the regeneration site. The unit process, may encompass several activities, but is geared towards at least one specific function, for example: use of an *in* situ stabilisation agent that prevents contaminant migration; soil quality improvement works using composts; or thermal energy recovery from biomass. The conceptual model describes several features shared by all unit processes. Each unit process has inputs, for the thermal conversion of biomass example the inputs might be biomass harvested on site and sourced externally. Each unit process has outputs, for example combined heat and power from the thermal conversion of the biomass. The reason for using a unit process is that it delivers a (project service) which creates benefit and hence value. Value is related to the amount of benefit and its usefulness. Additionally, unit processes will have wider effects, which may be positive or negative, for example flue gas emissions, or creation of recyclable ash. These wider effects may require additional unit processes for their exploitation or mitigation, and will also affect the overall sustainability of the unit process application.

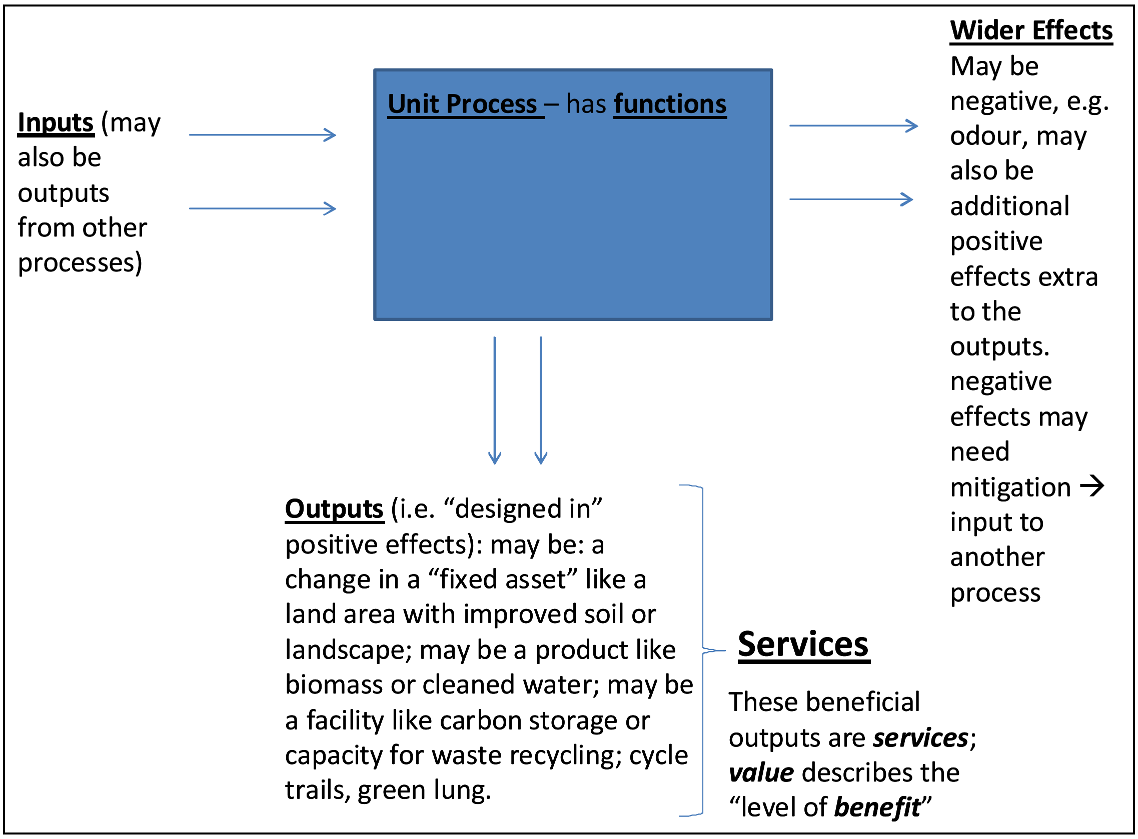


Figure 15: conceptual model of unit process in Brownfield regeneration

Hence the selection of unit processes to deliver a particular regeneration project must be based both on the project services desired and their wider effects, see Figure 16. The project services are defined by the benefits the project objectives are planned to provide. The identification of benefits is derived from the wishes of the project stakeholders. The level of the benefits that can be practically delivered as services by the various project processes determines the value of the project (proposed). This value may be enhanced or limited by the various wider effects of the processes (see Section 4.2.3). The overall value needs to be sufficient to justify the investment any particular project requires. The "value" will often be different for different groups of stakeholders but will be based on:

- Financial viability
- Delivery of particular sustainable development policy objectives (for example in local area strategies)
- Other sustainability concerns (for example raised by local stakeholders such as community groups).

The selection of unit processes can therefore be directly linked to the creation of value through the delivery of services. Consideration of wider range of potential services is potentially a means of enhancing value. Value may be enhanced further if unit processes, or closely linked unit processes integrated within a "treatment train" are able to deliver an extended range of services for a smaller level of investment than would be required for delivering services individually. In other words: as *synergy*. This design of projects with enhanced value may be a means of leveraging Brownfield regeneration which would otherwise not be seen as viable, and so create new regeneration opportunities. Synergistic design requires a broad knowledge both of regeneration processes and opportunities to link additional services to the regeneration project. The investment case for these broader project schemes is critically dependent on a coherent, transparent and convincing *value proposition*.

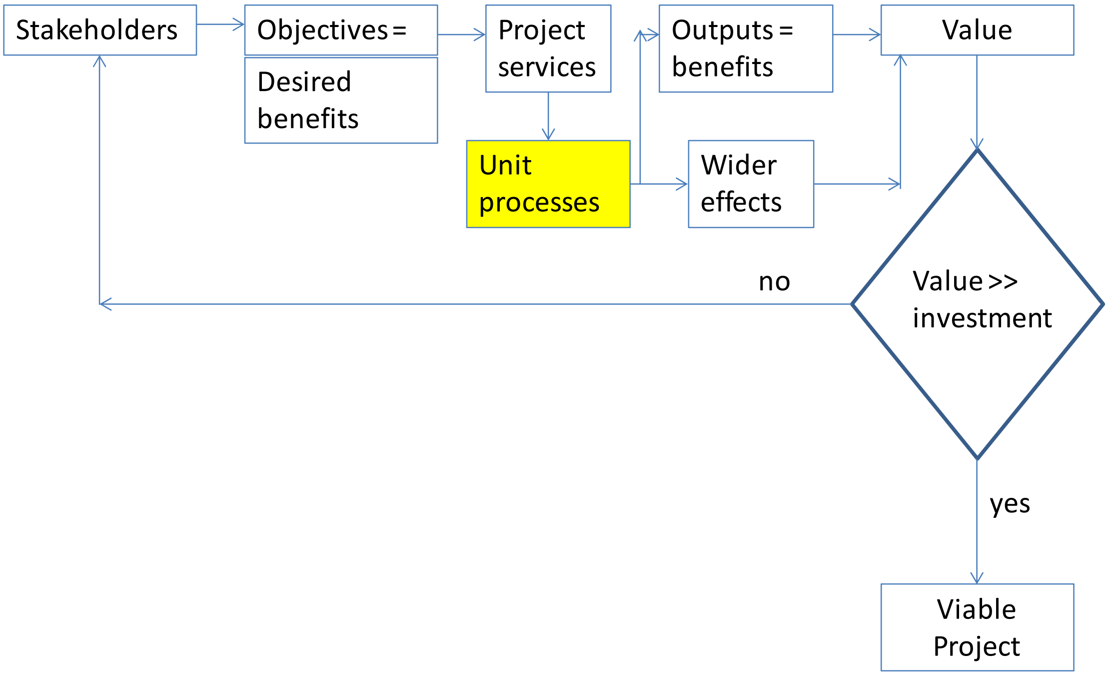


Figure 16: Rationale for selecting project unit processes

Some outcomes of the project will be a result of the synergy between the unit processes taking place. In other words these outcomes are "emergent" properties; i.e. they do not come from any single unit process but are a result of the combination of processes. An example for WP5 "soft re-use" might be the landscape value of a green area; the unit processes might be biomass production, or making hiking trails, habitat creation but neither unit process on its own creates the value of the landscape. The term "outcome" has been defined as following: *outcomes are the intended (and unintended) results of a project's or activity's outputs. Outputs and outcomes are not one and the same. An output is immediately produced by the project such as number of jobs created or hectares of land reclaimed; whilst outcomes are frequently longer term and harder to measure, such as changing behaviours and attitudes.* The LandTrust.

It is also important to consider the overall wider effects of regeneration. Where positive, these "collateral" effects even though not specifically addressed in process design phase, may provide substantive sustainable development outcomes. Similarly, negative effects will also need to be identified for their impacts on receptors to be mitigated with adequate measures. Balancing positive and negative effects and costs will need to be considered in decision making during project planning. Doing so, wider uncounted benefits get also included in overall project valuation. Valuation of project outcomes and wider effects (positive and negative) will be site specific and reflect a variety of stakeholders' opinions and priorities engaged in the decision making process.

This overall approach is broadly the same as the process of “eco-dynamic design” which has been developed in the Netherlands[17]. Eco-dynamic design strives to use environmental dynamics into spatial development, not only for mitigation of negative effects but also for achieving additional positive effects on natural value, soil, water, air quality, recreational values and environmental. Applying the eco-dynamic design approach to Brownfield regeneration the Brownfield owner determines the primary function or service, but will be searching for synergies with other functions (secondary). The primary benefit serves the Brownfield owner, while secondary benefits serve other local and regional stakeholders. Note that secondary benefits can be equally important as primary benefits to reach successful Brownfield regeneration (because of the additional value they provide, for example supporting better community health, or improving local amenities). Eco-dynamic design and its similarities with the suggested approach of HOMBRE WP5 are described in more detail in Annex 2.

4.2.3 Sustainable Choices

The selection of unit processes implies a range of wider positive and negative effects which affect the overall sustainability of the regeneration project. These effects may already be recognised in particular local or corporate policies, but possibly not in an overarching way as concepts of sustainable regeneration and sustainable remediation are still in development.

There is a concept used in eco-design and life cycle thinking called Environmentally Preferable Products (EPP). This concept has been defined by the United Nations Conference on Trade and Development (UNCTAD, 2004). This organisation describes EPP as products that cause significantly less environmental harm at some stage of their life cycle than alternative products that serve the same purpose. Thus, it serves as core principle for the design, production, use and end of life of products / services with the aim of lowering their overall environmental impact to minimal levels. This concept also holds important lessons for the selection of unit processes in a regeneration project.

Making choices on best indicated uses and services will be the result of balancing overall costs (environmental, social and economic) and benefits resulting from the regeneration project on the long term. Table 3 above gives some examples of specific services provided along the regeneration process and BF soft re-use.

Any sustainability assessment is dependent on the “system” and “life cycle” boundaries assigned to it. In particular for a soft-end use, the sustainability of a Brownfield regeneration project must consider both the works that lead to the restoration of a site and also the on-going soft end-use implemented for the land. As a consequence, Brownfield regeneration project planning and sustainability appraisal needs to consider the whole cycle of site use as the frame to assess benefits and burdens. This perspective is represented in Figure 17.

[17] www.ecoshape.nl

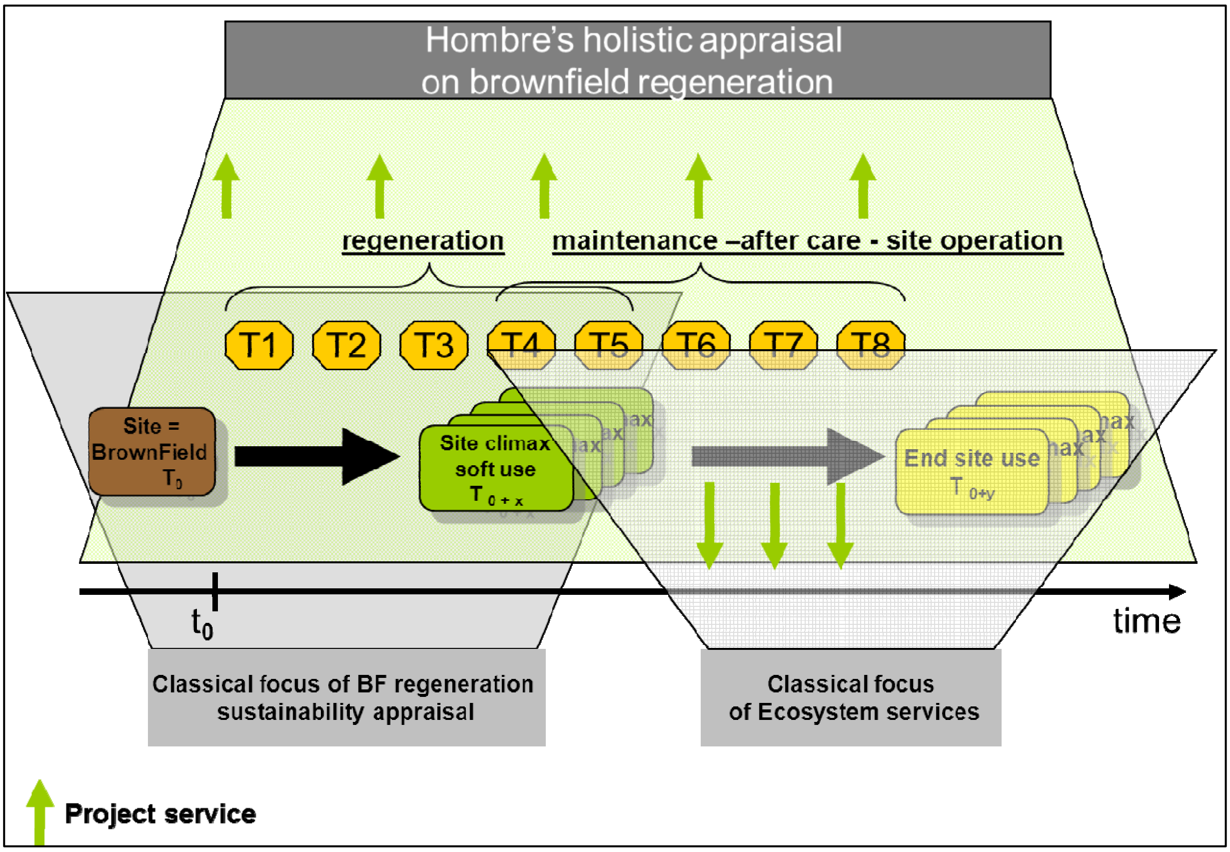


Figure 17: HOMBRE's holistic approach on identification of services in Brownfield regeneration and soft re-use

4.2.4 Synergies, trade-offs and creating opportunities for Brownfield regeneration

The objective of linking wider project services with Brownfield regeneration is to improve value for projects that would go ahead anyway and to enhance value sufficiently to allow projects to regenerate Brownfields which would otherwise remain stalled and effectively out of the land use cycle. The way that this linkage of project services is achieved is by integrating different unit processes together, as described above. Each unit process also results in wider impacts which may be positive or negative and these affect how effective integration can be. Furthermore, project services may both support each other or impair each other, for example, where land is used for biomass production it cannot be so readily used as open space. Hence, project design will likely need to consider a range of synergies, trade-offs and potential net losses as suggested by *Rodriguez et al.* (2006) in the context of ecosystem services appraisal (see Figure 18). The same kind of concept can apply to project services:

- Synergy describes the simultaneous enhancement of more than one service, for instance, because improving the value of one service can enhance the value of another service (for example non-food crops can help managing risks associated to soil contamination on a site as well as providing resources for bio-energy production)
- A trade-off refers to the increase of the provisioning of one service that is accompanied by the simultaneous decline of another service at the same location
- A loss describes a situation where two project services are incompatible, and trying to deliver both will result in poorer performance for both.

Similarly, the wider effects of particular unit processes, and their engineering and delivery configuration, result in synergy, trade off or loss. For example, the use of *in situ* soil stabilisation agents would be synergistic with phyto-stabilisation as benefit would be increased and neither approach would incur a "trade-off". On the other hand the use of *in situ* soil stabilisation agents would be antagonistic with phyto-extraction, and both processes would likely suffer some degradation in performance, i.e. an overall loss in remediation performance.

A clear understanding of potential synergies, trade-offs and losses is very important in optimising project design. A particularly tricky question will be in assessing whether it is appropriate to support the provision of one service with regard to a possible decline of another service. Identification of synergies and trade-offs helps decision makers to better understand the sometimes hidden consequences of selecting different project design configurations.

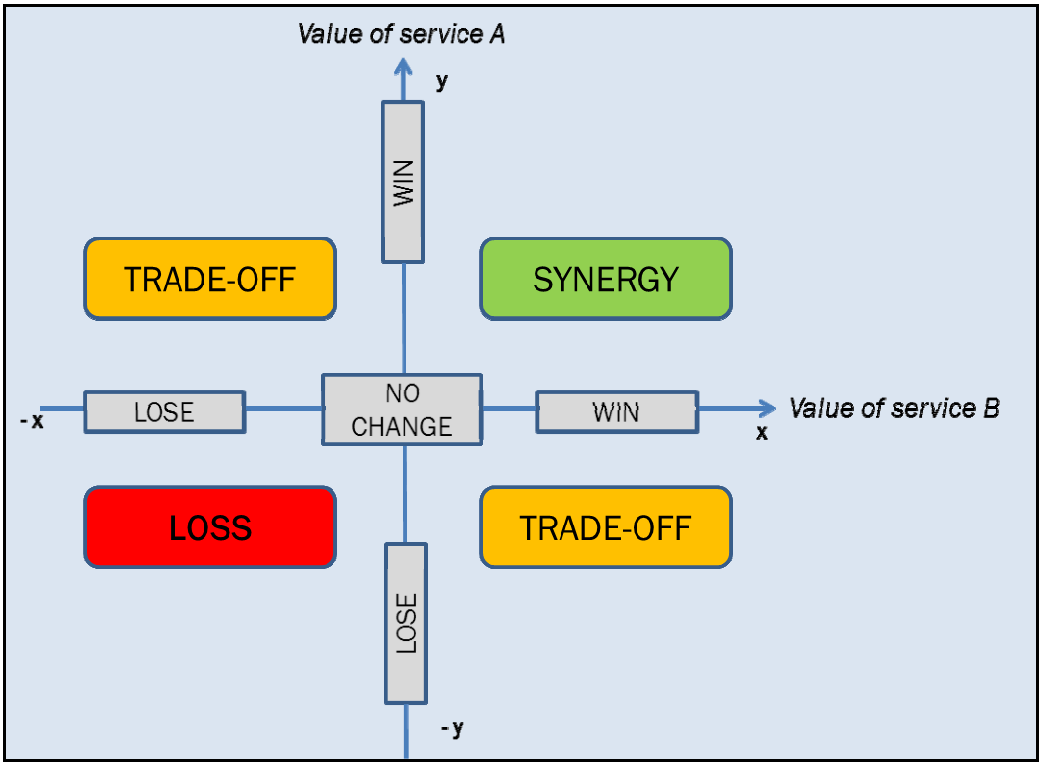


Figure 18: Schematic representation of interactions of services resulting from Brownfield regeneration and soft re-use of land – synergies and trade-offs (inspired from Haase et al. 2012)

The role of different stakeholder interests has an enormous impact on analysis of synergies, trade-offs and losses because relative values may be very different for different stakeholder groups for any particular project service or wider impact. Sustainability appraisal of proposed combinations of unit processes / service delivery is a potentially useful way of reconciling different opinions and assessing the overall "value" of a project. This should be underpinned by a shared "conceptual model" for sustainability so that reflects different stakeholder perspectives and allows the impacts of these differences in opinion on possible decisions to be tested. An overarching "sustainability conceptual model" can also provide a framework for financial assessments (for example focused on effects directly related to services) as well as a wider cost benefit assessment that considers both "private" and "public" factors (see Chapters 6 and 7).

Optimising value is also contingent on stakeholders being aware of the potential range of project services and how they can be delivered. Many examples of integration are cross-sectoral, linking diverse fields for example leisure, waste management, public health, agricultural or horticultural production for example. The second WP5 report D5.2 will focus on providing a decision-support resource that allows stakeholders to take a cross-sectoral view of opportunities independent of their core skill set and interests.

Evident in the design process is the need for processes of communication, dialogue and engagement with different stakeholders to develop shared visions and constructive collaborations. This is likely to be particularly true for soft-end uses which by their nature are extensive in area and have significant benefits (and impacts) for many different groups. The FP7 Greenland project is currently reviewing processes for stakeholder engagement for "gentle remediation" and its key findings will support the guidance on decision making being offered by HOMBRE Deliverable 5.2.

Synergies, trade-offs and losses also describe the possible outcomes from strategic choices, for example relating to managing Brownfields across municipalities or as a portfolio of sites. This discussion at a strategic level forms part of the work of WP2 and the development of the Brownfield Navigator in WP3.

Findings for Chapter 4: Services from the regeneration of Brownfields for soft re-uses and opportunities for building value - key findings

HOMBRE WP5 has adopted a functional description to better understand the linkage between regeneration services and project value. In WP5 the term *"project service"* is used to express the benefits obtained by specific beneficiaries or "receptors" (i.e. nature, people or society). In the context of HOMBRE, services are delivered through the implementation of processes during the regeneration of Brownfields and the maintenance of specific land uses. As such they constitute the specific outcomes of designed process as opposed to conventional "ecosystem services" which are naturally provided without technological inputs. A possible "service" designed into a regeneration project is of course the protection or enhancement of ecosystem services.

There are three constituent elements for a project service to occur. These elements are:

- An intervention, in particular a process or technique (or a combination thereof)
- one or more outcomes (permanent or temporary effects) of the intervention
- a beneficiary of the outcomes

Some project services arise from the process of regeneration itself, and therefore may be one-off effects, albeit in some cases with hopefully permanent impacts (such as on land values). Other project services continue with the soft-end use of the site, for example the provision of open space for amenity and leisure, and as such may require on-going maintenance and management.

Project services are the basis upon which value can be created that will leverage Brownfield regeneration by providing benefits that make the investment in regeneration worthwhile to specific constituencies or beneficiaries who will support it. These project services may be delivered by ecosystems, they may be delivered by non eco-system processes or they may be consequential economic benefits. Hence the project services from Brownfield regeneration for soft end-use can include both ecosystem service benefits and wider benefits.

The exact choice of project services and the most efficient way in which they can be delivered determines the usefulness and hence the value of a regeneration project. Synergy describes a situation where a process or combination of processes on a site delivers several useful services in a way that provides a net improvement for the financial feasibility and sustainability of a project. In this case a process might be a remediation, process, a production process such as biomass cultivation or some other form of intervention such as public involvement in green infrastructure management. The types of synergy that might be possible in Brownfields regeneration for a soft end use include:

- Combining use on-site and off-site biomass to gain economies of scale.
- Using biochar as carbon sink (climate change) and soil improvement for plant growth
- Green infrastructures as means to improve air quality and urban climate comfort
- Unsealed soil as a way of improving aquifer recharge and water management

This overall approach is broadly the same as the process of “eco-dynamic design” which has been developed in the Netherlands.

Trade-offs describe situations where one service must be balanced against another service because while there are advantages in including both services in a project, there is some interference between them. For example a site might need to consider a trade-off between biomass production and open space green infrastructure to provide for both economic returns and providing amenity for a local community.

The objective of linking wider project services with Brownfield regeneration is to improve value for projects that would go ahead anyway and to enhance value sufficiently to allow projects to regenerate Brownfields which would otherwise remain stalled and effectively out of the land use cycle.

For soft-end uses there are three overlapping frames of reference:

- Strategic choices – these relate to how land is used in a planning sense, including as part of a portfolio of sites or across a region containing several Brownfields.
- Project choices – these relate to the exact choice of project services and the most efficient way in which they can be delivered, the concept of “synergy” is particularly important for maximising opportunities for enhanced service delivery from any particular project
- Sustainable choices – these relate to the overall benefits and impacts of the strategic and project choices made; while some aspects of sustainability will be addressed by particular project services (and strategic decisions).

The categories within each dimension can overlap. For example, a biomass production process on a Brownfield site may be both the on-going soft-end use and part of the regeneration process (providing remediation and soil restoration “services”).

Project designs will likely need to consider a range of synergies, trade-offs and potential net losses:

- Synergy describes the simultaneous enhancement of more than one service, for instance, because improving the value of one service can enhance the value of another service (for example non-food crops can help managing risks associated to soil contamination on a site as well as providing resources for bio-energy production)

- A trade-off refers to the increase of the provisioning of one service that is accompanied by the simultaneous decline of another service at the same location
- A loss describes a situation where two project services are incompatible, and trying to deliver both will result in poorer performance for both.

The role of different stakeholder interests has an enormous impact on analysis of synergies, trade-offs and losses because relative values may be very different for different stakeholder groups for any particular project service or wider impact.

5 Integrating processes using treatment trains to provide enhanced project services and value

Treatment trains are used by HOMBRE as an overarching term to discuss the integrated processes and combinations that can deliver a Brownfields regeneration project. In particular the term is used to describe scenarios that deliver a range of project services that provide an enhanced value that can leverage Brownfields re-use. Chapter 5 provides a brief overview of the scope of treatment trains in a soft end –use context.

In the context of regeneration for soft re-uses, HOMBRE WP5 describes a treatment train as an integrated system of techniques and processes implemented along the whole life cycle of a specific Brownfield regeneration project (e.g. techniques for soil remediation, techniques for soil improvement, techniques that enhance plant growth and supporting environmental techniques) as illustrated in Figure 19. The objective of such approach is both to enable and eventually maintain in time a planned soft re-use with the aim of delivering benefits to a wide panel of potential beneficiaries or receptors (ecosystems and environment, core project stakeholders, wider communities). Ideally, the integrated system of technologies and processes should be designed in such a way that outputs from individual processes link to other processes with the final aim of incrementing the overall value of the BF regeneration project.

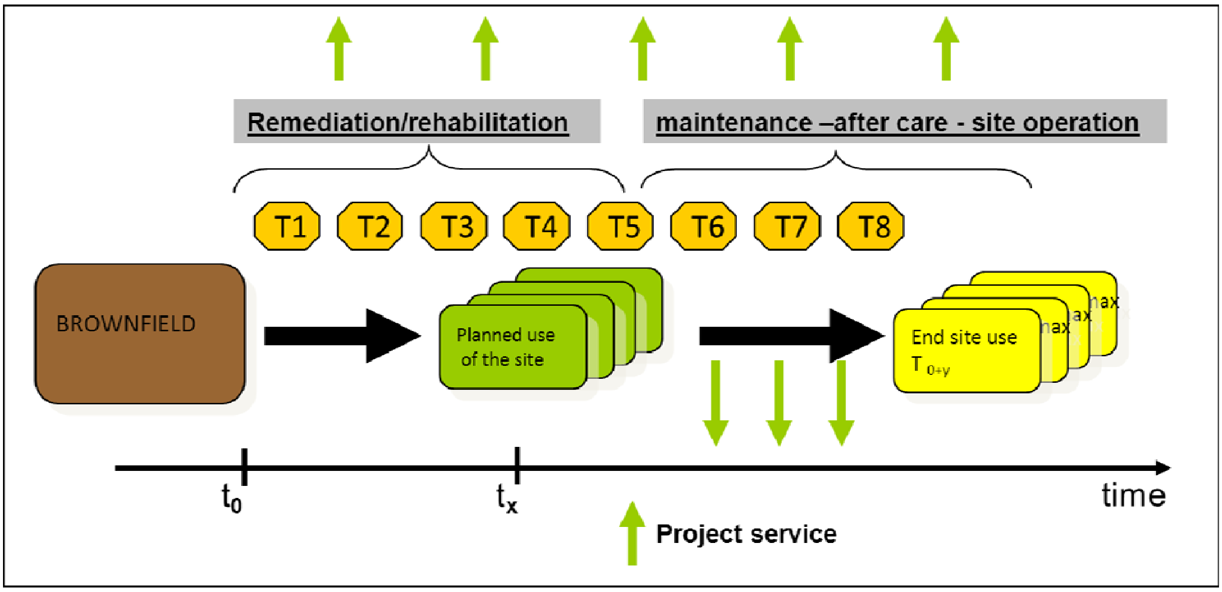


Figure 19: Conceptual model of a soft re-use treatment train

The implementation of Treatment Trains can be used to deliver multiple value gains along the trajectory of a BF regeneration / redevelopment project, both in the context of financial viability and achieving sustainability. These gains can be found at the level of:

- Individual process, for example by selection of processes for efficiency and sustainability
- Project level: integrating processes to provide an enhanced range of project services and hence value; and careful design of the integration to find

Synergies and symbiosis effects between techniques (e.g. outputs of a process can feed in another process) and how the outputs of various processes can present emergent properties

- Strategic level: considering how planned soft re-use provides useful services for specific beneficiaries in a wider urban renewal context.

Treatment trains should be designed in such a way that their combined effects increase the overall services and benefits from BF soft re-use regeneration, thus creating more value for land and higher interest for private and public investors.

There are three drivers for designing treatment trains:

- Key driver 1: **"BF problem push"** i.e. solving a specific BF (site) problem linked with land quality and land use, e.g. pushed by legal requirements (contamination, waste management and other due diligence) BF regeneration is predominantly driven by legal requirements and land problems (no specific opportunity for profitable redevelopment of the BF into hard/soft re-use has been identified)
- Key driver 2: "**BF Direct Economic Opportunity - push**" BF regeneration is driven by economic goals i.e. increased market value of restored land, opportunity of providing useful services to communities etc. (demands and needs of such services have been expressed by stakeholders, or opportunities to increase project value have been identified by project developers and/or contractors). This applies to for CABERNET "Type A" sites
- Key driver 3: **"Enhanced Services - opportunity pull"** i.e. treatment trains are designed in order to deliver designed-in services and enable a specific land-use associated with specific services. These services provide a series of added values to specific stakeholders with specific interests.

The focus of WP5 is on Key Driver 3, which can reduce costs for projects that are required but are not profitable, or improve profitability of projects that are already economic. The value gain will therefore relate to efficiencies that improve financial viability and improvement of overall sustainability. Figure 20 illustrates that an integrated project delivering a range of services may be comprised of several unit processes. The key features are that the overall integrated process is designed to deliver particular outputs from its inputs. These outputs define the projects financial value. However the combination of processes also has a range of wider effects (positive or negative). Within the integrated system individual unit processes are linked, in particular, that the outputs from some unit processes will be inputs for others. In addition the wider effects of the overall scheme will be the amalgamation of the wider effects of the component individual processes. In some cases these may be mutually compensatory. Some wider effects may require mitigation and so serve as the input for another unit process.

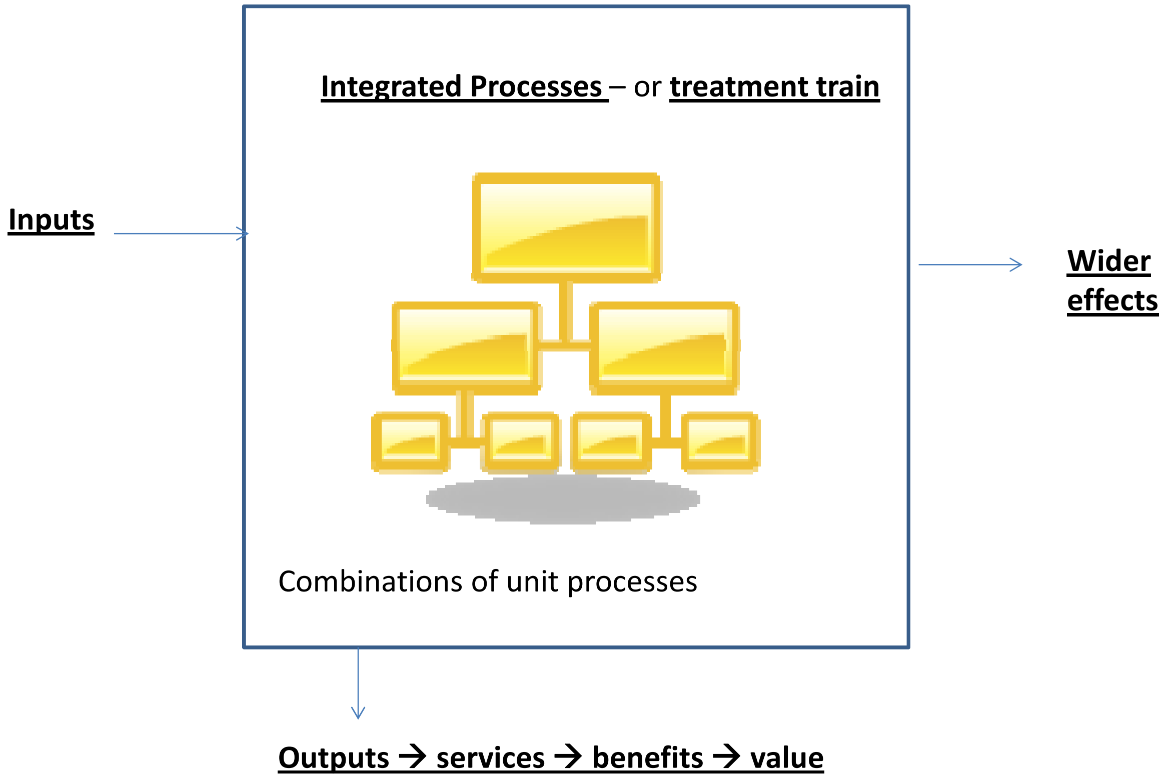


Figure 20: Linking of Unit Processes in a Treatment Train

Findings for Chapter 5: Integrating processes using treatment trains to provide enhanced project services and value

A treatment train as an integrated system of techniques and processes implemented along the whole life cycle of a specific Brownfield regeneration project. the integrated system of technologies and processes should be designed in such a way that outputs from individual processes link to other processes with the final aim of incrementing the overall value of the BF regeneration project.

There are three drivers for designing treatment trains:

- **"BF problem push"** i.e. solving a specific Brownfields problem linked with land quality and land use,
- "**BF Direct Economic Opportunity - push**" regeneration driven by immediate economic goals (for CABERNET "Type A" sites)
- "**Enhanced Services - opportunity pull"** i.e. treatment trains are designed in order to deliver a series of added values to specific stakeholders with specific interests.

The focus of WP5 is on Key Driver 3, which can reduce costs for projects that are required but are not profitable, or improve profitability of projects that are already economic.

6 Valuing costs and benefits from regeneration

Understanding *overall* value and making a convincing proposition of value to Private and Public Sector stakeholders, funders and investors is key to the successful delivery of the HOMBRE concept. This chapter reviews tools that have been or could be used to examine value costs and benefits from regeneration. It reviews approaches to cost benefit assessment and sustainability appraisal. It describes the key role of understanding different stakeholder perspectives in understanding sustainability and in incentivising them to support a regeneration project. It proposes the use of a project or site conceptual model for sustainability as a tool to combine perspectives and provide a framework for determining *overall* value.

6.1 What is value?

For a brownfields regeneration to take place, someone has to be incentivised to invest in it. This likely depends on a *greater* value of the regeneration outcome than the value of the investment made. Within this report the term *overall* value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may be improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns (*direct financial value).*

A recent UK report (Defra 2012) reviews options for the economic assessment of *remediation* benefits for contaminated land. It proposes a concept called "Total Economic Value". This comprises two components: "use" values related to the direct benefits of bringing land back into use for built or soft development; and "non-use values" which are benefits derived from knowledge that a particular resource is maintained. Plant *et al* (2012) attempt to describe types of value and how to combine different stakeholder perceptions of value in a system they call *value-based land remediation*. Based on social science theories of value and institutional analysis, they distinguish:

1. Monetary value - material or monetary worth (e.g. increased property value);
2. Importance or worth - the regard that something is held to deserve (e.g. cultural heritage);
3. Individual and organisational values - principles or standards of behaviour.

They suggest that during the decision-making process the perceptions of value held by different participants interact, and the decision is made according to a pre-existing institutional hierarchy that dictates the relative influence of opinions. They distinguish between the narrow goals of a remediation project and its ability to deliver "spill-over effects" that provides wider benefits. They suggest that a more open consideration of opinions about value can improve this delivery of wider benefits. Hence there is an emerging body of opinion that value is a wider concept than direct financial return alone, and this view has a wider resonance for brownfield regeneration.

More holistically value can be expressed in the context of sustainable development, including environmental, social and economic components. In this context the same brownfield regeneration may have a range of components of different value to different interested parties or stakeholders (developer, local community, local government etc.).

Determination of *overall* value recognises that for each stakeholder a project will have a *direct financial value* and a *wider value*, reflecting their interests and type of participation in the project. This wider value may include components that have *tangible* or *intangible* economic value. A tangible cost is a quantifiable cost related to an identifiable source or asset. Tangible costs represent expenses arising from such things as purchasing materials, paying employees or renting equipment. An intangible cost is not directly quantifiable but relates to an identifiable source. Examples include losses in productivity, customer goodwill or drops in employee morale. Valuation of intangible business assets is increasingly important to the investment industry, as they underpin medium to longer term financial performance[18]. Brownfield regeneration examples are:

- A public agency may provide financial support to facilitate a brownfield regeneration project with limited or zero effective financial return. However, the wider value of the project to the agency might include tangible benefits such as an improved local taxation base, and intangible benefits such as meeting a particular policy objective.
- A developer would most likely expect a significant direct financial return on its investment, for example in terms of higher property value; but may also benefit from the project wider value. Its tangible benefits might include securing adjacent development land. Its intangible benefits might include improved reputational value.

Therefore, while incentivisation will depend on *return on investment*, this return should consider the *overall* value of a project to provide a true benchmark of benefits against "cost". However, stakeholders will vary in their appreciation of overall value, probably in three broad ways:

1. The types of benefits that are valued
2. The extent of their interest in intangible benefits
3. The extent to which particular sustainability benefits are seen as being of economic interest.

Stakeholders may also consider different types of investment. Clearly a project can only be leveraged by direct financial support, but financial requirements may be reduced or mitigated other kinds of "wider" investment, for example:

- Tangible "in kind" support, for example time costs from public bodies to support project planning, or community support in providing site security or carrying out tasks such as planting and maintenance – this support is tangible because paid time costs are being avoided
- Intangible "moral" support (e.g. which reduces decision, planning costs and risks of delay), perhaps most important from the local community and public.

Moral support may be particularly important for creating the climate in which a public financial investment can be made in a project. It should not be forgotten that the people of a community are an investor in a project, particularly for a soft-end use because they can contribute largely to the vitality of places even if they are not direct financial contributors.

Figure 21 illustrates how a value based approach can be used to illustrate incentivisation for a brownfield regeneration project, where return must be greater than investment. The case for investment (the *value proposition*) provides the incentivisation and depends of the value of the return. Overall value is shown as a "pie" chart comprising direct financial value and also tangible and intangible economic values. Each stakeholder is likely to provide and expect different things from a project, so would have different pie charts for the same project. The *value proposition* for a brownfields project must therefore clearly describe the balance of benefits to costs for each stakeholder involved. The best deals are those where everyone is a

[18] Descriptions are taken from www.investopedia.com, accessed January 2013

winner – if a stakeholder perceives their return is less than their investment then they will most likely be against the project.

For wider aspects of sustainability to be included they must somehow be linked to one or more of the three components of value. It would seem likely that for many (but not all) stakeholders the most persuasive linkage would be to direct financial value, followed by tangible and then intangible wider value.

Conventionally the tools used to review, collate and compare benefits (return) to investment are described as cost benefit assessment. These tools ascribe financial or economic values to varying degrees for the costs (investments) and likely benefits (returns). These are reviewed in the next section.

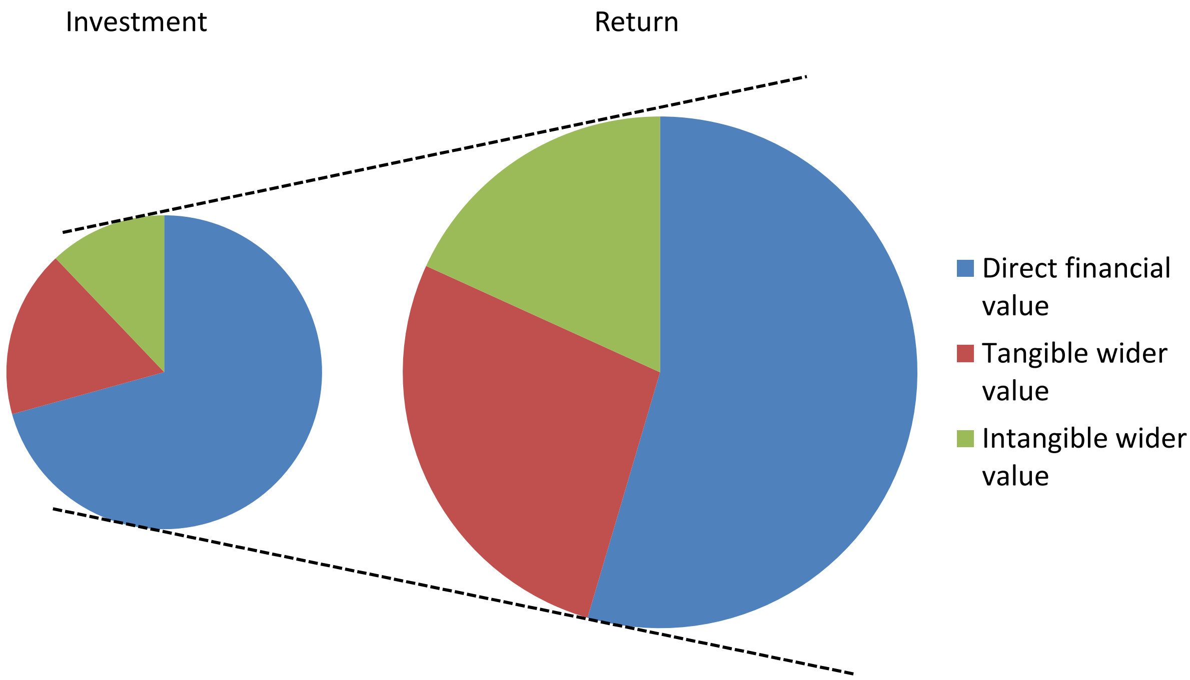


Figure 21: Changing value incentivising regeneration for a single stakeholder.

6.2 Cost benefit assessment valuation tools

Cost benefit assessment describes a process of comparing the likely costs of a project with its benefits and is a form of economic valuation. Where this assessment is based on conversion to strictly monetary terms it is described as cost benefit analysis – CBA (Commonwealth of Australia 2006). CBA is also sometimes referred to as cost benefit appraisal.

There is a long track record of using CBA as a way of weighing up the advantages of a project proposal for likely investment requirements in both Public and Private Sectors, for example to assess infrastructure works in the Netherlands[19] and in the UK (Fisher 2012), and it has also been widely applied to contaminated site management decision making (Bardos 2008a; 2008b). CBA is a form of economic analysis in which costs and benefits are

[19] OEEI-method: www.rijksoverheid.nl

converted into monetary values for comparison. It is used to provide an understanding of level of benefit (or value of a project) compared with its costs. The common feature of formal CBA is an attempt to express all values (costs and benefits) using a single monetary unit, to determine a single financially based investment rationale.

CBA boundaries can be quite tightly drawn, focusing entirely on the direct costs of rehabilitation processes and any uplift in financial value as a result of the regeneration for specific project partners. These are known as “private costs”.

However, CBA can also consider wider costs and benefits. Wider considerations that might be valued include benefits and impacts on third parties, including indirect effects, and potentially considering society as a whole, in particular where public money is being used to support a regeneration initiative (Doick et *al.* 2009). Examples include impacts of construction traffic or improvements in public access to open space, respectively. These are known “public costs”.

A related term is externalities, which may be positive or negative. An externality is an effect of a purchase or use decision by one set of parties on others who did not have a choice and whose interests were not taken into account. Externalities can be difficult to value in monetary terms, and a range of methods have been used for this (Bardos *et al.* 2011A, Hanley and Spash 1994, Mullberg 1996):

- Contingent Valuation Method (CV) is based on surveys of consumers’ opinions about their willingness to pay (WTP) for something; or their willingness to accept (WTA) compensation for it.
- Hedonic Pricing (HP) is based on relationships between effects (e.g. noise levels) and the price of marketed goods (e.g. houses), and assumes that markets are operating effectively and purchasers are fully aware of effects.
- Production Function Methods infer value from marketed goods and services. Avoided costs (AC): quantify averting expenditure (i.e. how much are people willing to pay to avoid or protect themselves from a decrease in environmental quality). Dose-response (DR) applies economic modelling, e.g. physical effects of contamination on the environment are evaluated and used within an economic model.

All of these valuation methods are subject to errors and bias based on the assumptions used when they are applied, are complex and are not always seen as reliable by project stakeholders, particularly when they are not economists. Survey based techniques, such as WTP assessments for environmental issues can be influenced by the behavioural complexity of those views the assessment is based on, for example their political affiliations (Atkinson and Mourato 2008, Dupont and Bateman 2012). It is fairly widespread to see standard values for benefits or costs used as part of CBA, for example value of a human life which may not be convincing to all stakeholders involved in regeneration project decision making.

Where Brownfield projects include explicit goals related to environmental services that are costs or benefits (or both) for project partners, then these become included in the private costs and benefits of the project, although the difficulties in monetary valuation remain the same.

Deciding which impacts to include or exclude from the assessment, as private or public costs, is likely to vary on a site-by-site basis. In many instances, it is difficult to assign a strictly monetary value to many of the wider cost or benefit effects. Hence, CBA approaches, described as “cost effectiveness analysis” involves a combination of qualitative and quantitative methods (Environment Agency 1999; 2000). An example applied to site remediation is given in Harbottle *et al.* 2008. Another example is given in the Austrian context, where works have been initiated to introduce a modified cost effectiveness analysis as a tool to support transition towards more sustainable soil remediation strategies (UBA Austria, 2010). The method applied in Austria contemplates a weighing system (comparable to multi-criteria analysis) for estimating benefits generated by the application of specific remedial options related with the costs supported to implement the remediation.

Economic valuation is increasingly being used to demonstrate the benefits for public goods such as landscapes and green infrastructure (Vandermeulen *et al.* 2011, Allin and Henneberry 2010). However, it has weaknesses and should be used with caution. It is also important that the people in organisations commissioning CBA are able to fully consider the subtleties and nuances inherent in the technique (Atkinson and Mourato 2008). Anecdotal information suggests that sustainability criteria are not used in an exhaustive or consistent way in CBA, although some wider benefits and costs and third party concerns may be considered. This is perhaps unsurprising given the difficulties in reliably and demonstrably valuing externalities described above; and the fact that consistency in approach to sustainability appraisal for brownfields regeneration and contaminated land remediation is only beginning to emerge (see Section 6.4). Attempts have been made to carry out economic valuation for greenspace infrastructure development considering both direct and indirect values (e.g. Vandermeulen *et al.* 2011). However, the limitations of formal CBA mean that some stakeholders, in particular campaigning organisations, may be highly resistant to the use of cost benefit analysis as a justification for decision making (Ackerman 2008).

Less formal approaches to cost benefit assessment, which do not rely on monetary conversions for all factors, may use some form of index, typically based on a multi-criteria analysis (MCA) of different benefits or impacts. Examples from the remediation sector include UK guidance for “cost effectiveness analysis” (Environment Agency 1999 and 2000) and the Dutch “REC” tool which uses indices of cost, risk management performance and “environmental merit (Van Drunen et al. 2000). MCA based cost effectiveness assessment tools related to Brownfields include the German *Soil - Value – Balance* system (UBA 2000).

6.3 Importance of sustainability in determining value

Sustainability assessment (or appraisal) has been described as the process of the process of gaining an understanding of possible outcomes across all three elements (environmental, social, and economic) of sustainable development. Sustainability management is the discipline of integrating sustainability assessment in decision making (Bardos *et al.* 2011). Sustainability appraisal is increasingly being used to understand overall value in support of decision making for both Brownfield regeneration projects (RESCUE 2003, CL:AIRE 2006, 2007a and b, REVIT Consortium 2007) and contaminated land remediation (2nd International Conference Sustainable Remediation 2012). This reflects the increasing recognition of the wider potential benefits of Brownfield regeneration to sustainable development described in Section 1.1 and a wish to manage projects to provide more sustainable outcomes. A number of formal and informal networks worldwide are now in process of debate on achieving sustainable development when remediating or regenerating of damaged sites or land areas such as former industrial sites or land contaminated diffusively by atmospheric fallout, see Table 4.

Table 4: International Developments in Sustainable Remediation and Sustainable Brownfield Regeneration (adapted from Bardos et al. 2011B)

Name	Geographical Coverage	Outputs and Web links	Comment and Current Working Definition of 'Sustainable Remediation'
AFCEE Sustainable Remediation Tool	Focussed on USA and USAF bases (Forbes *et al.* 2009)	Sustainable Remediation Tool, SRT. www.afcee.af.mil/resources/technologytransfer/programsandinitiatives/sustainableremediation	No formal definition
Department of Defense (US)	US armed forces	www.ert2.org/t2grsportal.drivers.aspx	US Government memorandum instructing armed forces to consider sustainability in remediation decisions.
EURODEMO+	EU	EURODEMO 2007.	No formal definition, but proposes that sustainability can be assessed across a range of indicators, with eco-efficiency-indicators being particularly useful.
ITRC, Interstate Technology & Regulatory Council	USA and Canada	ITRC 2011	Working group on "Green and sustainable remediation" established. No definition to date.
NICOLE Sustainable Remediation Working Group	EU network, industry and business led	NICOLE 2010 and 2012	"an approach which the stakeholders involved with a project have agreed has a broad balance of beneficial environmental economic and environmental consequences"
Sustainable Remediation Forum (SURF)	Largely USA based	SURF 2009. www.sustainableremediation.org	"In fulfilling our obligations to remediate sites to be protective of human health and the environment we will embrace sustainable approaches to remediation that provide a net benefit to the environment"
SuRF-Australia	Australia	http://www.crccare.com/working_with_industry/surf.html	Early drafts of the Australian approach draw heavily on the principles, definitions and approaches described in the SuRF-UK framework.
SuRF-UK	Largely UK based	CL:AIRE 2009 and CL:AIRE 2010 www.claire.co.uk/surfuk	"The practice of demonstrating, in terms of environmental, economic and social indicators, that the benefit of undertaking remediation is greater than its impact, and that the optimum remediation solution is selected

			through the use of a balanced decision-making process”
USEPA Green Remediation	USA, US EPA led linked with other initiatives	US EPA 2008, 2009. www.clu-in.org/greenremediation/	“Green Remediation: The practice of considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefit of cleanup actions.”
Common Forum	EU network, regulator led	www.commonforum.eu	Developing a technical paper on the linkage of sustainability with risk based land management
Megasite management Tool suite (MMT) Germany	German major research project output	www.safira-mmt.de	Guidance and software tools to support the regeneration of megasites, including option appraisal, costing, project valuation and sustainability appraisal
EC RESCUE	FP5 Project	RESCUE, 2003, 2004, 2005	EC RESCUE developed a toolkit to support the sustainable regeneration of Brownfield land, including guidance on sustainability assessment techniques
UK SU:BRIM Project	Academic research	CL:AIRE 2006, 2007a and b, www.subrim.org.uk	SUBR:IM was a research consortium linking science, engineering and social science to address Brownfield redevelopment

Sustainability appraisal / assessment for both *regeneration* and *remediation* domains are considered in this chapter for several reasons:

1. Their scope of considerations show considerable overlap (see Table 5), indeed some sustainable remediation frameworks explicitly consider brownfield projects and the linkage between remediation and brownfield regeneration (e.g. CL:AIRE 2010, NICOLE 2010);
2. Environmental liabilities are typically a dominant factor in cost barriers to Brownfield regeneration, as discussed in Chapter 3;
3. The end use of a site in a development process defines possible remediation alternatives, so early consideration of remediation with the regeneration process can deliver sustainability gains (Bardos et al. 2011A, NICOLE 2011, CL:AIRE 2010, Contaminated Soil Plan 2007-2012, The Basque Country).
4. Regeneration and remediation decision-making involves overlapping stakeholder interests, so a consistent approach will avoid confusion;
5. Regeneration and remediation processes may sometimes be combined;
6. Many of the opportunities for expanding environmental services from Brownfield regeneration centre on linking remediation with additional services such as renewable biomass energy or changed land use to provide ecological and/or amenity functions (green infrastructure).

Nowhere is the close integration of remediation and regeneration agendas more evident than where land is being restored for soft-re-uses, where indeed the on-going management of the site over time may be both the regeneration and the remediation of the site combined.

Table 5: Definitions of "sustainable remediation" and "sustainable regeneration"

Sustainable Remediation	Sustainable Regeneration
Encompasses four broad aims: achieving risk based land management; ensuring that the wider effects of this risk management action are acceptable; ensuring the engagement of stakeholders and the transparency of decision making processes; and supporting balanced outcomes in terms of the environmental, social and economic elements of sustainable development (Bardos et al. 2011B).	The management, rehabilitation and return to beneficial use of the Brownfield land resource base in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally non-degrading, economically viable, institutionally robust and socially acceptable ways" (RESCUE Consortium 2005).

From HOMBRE's perspective sustainability assessment is an important tool for identifying potential synergies and trade-offs between different project services, for example:

- For built development, combining aquifer thermal energy storage and groundwater remediation (HOMBRE Deliverable D 4.1).
- For soft re-use of sites, combining "gentle" remediation with biomass energy recovery.

6.4 Sustainability valuation tools

Sustainability appraisal is an approach for exploring the sustainability value of a project which depends on how well a particular endeavour is able to meet the goals of sustainable development. Sustainable development was defined by the World Commission on Environment and Development (WCED) in 1987 in the *Brundtland Report* as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987). This definition underpins policy in Member States and the European Union as a whole. Sustainability concepts have been further refined in a series of sustainable development world summits in Rio de Janeiro (1992) and Johannesburg (2002), with a major summit planned for 20 - 22 June 2012, in Rio de Janeiro, Brazil[20].

The consideration of "sustainability" in remediation or regeneration is subjective for several reasons:

- Some benefits and impacts reflect opinions which will vary between situations and people, for example the need for amenity, the beauty of a landscape etc. This is well illustrated in a recent case study form Portugal which examined how different stakeholders perceived sustainability for a former mine site (Dias Sardinha et al., 2013).
- The process of sustainability assessment depends on choices of which concerns to consider and their relative importance;
- The outcome of the sustainability assessment depends on the way in which any comparisons or measurements might be integrated; the avoidance of duplicate considerations; and how to communicate and exchange information during the assessment process (e.g. between different stakeholders).

[20] http://www.earthsummit2012.org/

Sustainable remediation / regeneration frameworks or decision support tools therefore tend to be based on means of providing a flexible, systematic, transparent and recordable process of making these choices.

The recent UK project Sustainable Urban Brownfield Regeneration: Integrated Management (SU:BRIM) describes sustainability assessment as a consultative process which seeks to find consensus between the different project stakeholders (Pediaditi *et al*., 2005). If any stakeholder does not agree with the underlying assumptions or method on which a sustainability assessment is based, they are also unlikely to support its findings. Sustainable remediation frameworks also strongly endorse early engagement with stakeholders (CL:AIRE, 2010, NICOLE, 2010).

There is no "standard" technique for assessing sustainability, and a range of approaches are in use or development, for example:

- The SuRF-UK framework is explicitly related to sustainable remediation, but is relevant to Brownfields and soil management more widely, and has also been used as a model for sustainable management of dredged materials. It is based on taking a tiered approach to understanding sustainability based on stakeholder views of key sustainability issues, supported by a checklist of 15 broad headline groups of sustainability considerations. It identifies that key decisions are made *before* remediation selection that affect the likely sustainability outcome of remediation as well as at the remediation option appraisal stage. It explicitly considers the Brownfields redevelopment scenario.
- NICOLE's road map and sustainable remediation guidance also identifies that key decisions are made *before* remediation selection that affect the likely sustainability outcome of remediation as well as at the remediation option appraisal stage. It provides generic guidance on the relationships between sustainability and risk management, and on assessment tools and indicators for sustainability appraisal
- The RESCUE project suggests that sustainability appraisal should be based on site-specific metrics developed through a stakeholder process (RESCUE 2005)
- The MMT tool (Morio *et al.* 2011) is a software based tool for spatial planning and evaluation of Brownfield redevelopment options. Besides a range of economic and ecological models, it offers two different indicator-based approaches to assess sustainability. The first one, a set of fixed indicators allows assessing the suitability of different land-use types in regional context of the particular site. The second one explicitly considers spatial planning options. Here, stakeholders define site-specific problems and relate them to indicators suitable for measuring sustainable development.
- SU:BRIM suggest a staged approach where sustainable development priorities are identified, and indicators for sustainability assessment are agreed on the basis of those priorities (CL:AIRE 2007b);
- An informative standard for "sustainable remediation" is under development by ISO[21].

Generally, sustainability appraisal tends to be based on assessments of indicators / criteria. These are measurements or comparisons of individual factors that contribute to an overall understanding of sustainability, for example: direct costs, greenhouse gas emissions etc.

[21] ISO/TC 190/SC7 N 278 Resolution - Helsinki 12

Sustainability appraisal techniques employ some means of aggregating individual assessments of indicators to provide an overall understanding of "sustainability". Key stages are typically:

- Identifying a need for sustainability assessment
- Identifying which stakeholders to involve and when
- Agreeing on objectives for the assessment
- Agreeing on the scope of the assessment
- Agreeing on the sustainability assessment approach
- Execution of the sustainability assessment.

The tools used to carry out sustainability assessment range from simple tabulations of key issues, through to qualitative approaches, scoring or ranking based approaches and potentially quantitative approaches. The nature of quantitative approaches and their information needs and costs means that they tend to focus on a selection of sustainability criteria only, e.g. carbon footprint or LCA (Bardos *et al.* 2011A). There is a general consensus among those interested in developing *sustainable remediation* that the choice of which tools to use should follow a tiered approach using simpler techniques first (CL:AIRE 2010, EURODEMO, 2007, NICOLE, 2010, SURF, 2009). This is also in line with more suggestions for good practice in sustainability assessment (Pollard et al., 2002, Therival, 2004). For example, in the UK ODPM (2005) suggest that: *a sustainability assessment need not be done in any more detail, or using more resources, than is useful for its decision making purpose*.

A common feature of all of these tools is that there is some means of aggregating assessments of individual considerations or "indicators" into some form of holistic understanding of sustainability, to reduce complexity and facilitate decision-making and discussion. Table 6 gives some examples of the many hundreds of sustainability indicators which have been published. The individual considerations may be chosen in a variety of ways, for example, they may relate strictly to specific objectives set out in published policy documents; they may be chosen from lists of indicators used by other assessments; they may reflect specific stakeholder concerns – including corporate sustainability policies; and in practice a variety of courses may influence the final section of considerations used in any one sustainability assessment.

Table 6: Some examples of Sustainability Indicators from Previous Publications Listed in CL:AIRE 2009 with Some Potential Bearing on Brownfield Regeneration

- Abstractions for the public water supply from surface water and groundwater
- Accelerate the clean-up of seriously contaminated sites that are a risk
- Acceptance of the project: critical suggestions within the formal planning process
- Access to natural green space
- Access to services in rural areas
- Building material recycling and reuse on site
- Built-up land in relation to population
- Business start-ups and closures
- Capital, operation and maintenance costs
- Change in the character of the landscape
- Soil quality
- Soil resource depletion
- Solid wastes to be sent to landfill (or treated)

• The overall level of deprivation • Whether the urban design concept has been developed using different expert opinions	

6.5 Stakeholder Influences

Section 6.5 describes how overall value is essentially a function of the perceptions of stakeholders. The engagement of stakeholders is also crucially important in sustainability assessment. Valuation and sustainability assessment therefore go hand-in-hand with stakeholder engagement.

Stakeholder involvement should be formally included in sustainability assessment for several reasons. Firstly, stakeholder opinions can be an important source of information about particular aspects of sustainability (Therivel 2004). Secondly, inclusive decision making processes improve the robustness of decisions by widening the decision making consensus and so reducing the possibility that decisions will need to be revisited because of objection in the future. Thirdly, inclusive decision making is seen as part of good governance, which may be explicitly included in sustainable development policy (Bardos *et al.* 2011A). The stakeholders at the centre of decision making are generally the project team, comprising the site owner, those being critically affected by a project, the service provider, the regulator and planner. However, other stakeholders can be influential, such as those who might use the site (workers, possibly unions, and other visitors); those who have a financial involvement in the site or the site's ownership (e.g. banks, founders, lenders, insurers); the site's neighbours (adjacent owners and tenants, local communities and councils); and particularly for more complicated problems other technical specialists and researchers (Bardos *et al.* 2011A, Plant *et al.* 2012).

In November 1996, an international group of practitioners and researchers from five continents came together at the Rockefeller Foundation's Study and Conference Center in Bellagio, Italy to review progress on sustainable development assessment and to synthesise insights from practical on-going efforts. The "Bellagio Principles" set out a view on how to assess progress toward sustainable development, which is summarised in Table 7 (Hardi and Zdan 1997). In 2010 Pediatiti *et al.* carried out a meta-analysis of assessment and monitoring tools used for assessing Brownfield regeneration for green space, and found deficiencies in their benchmarking against the Bellagio principles.

Table 7: The Bellagio Principles[22]

Relevance to Sustainability Assessment	Principle
The starting point of any assessment - establishing a vision of sustainable development and clear goals that provide a practical	Assessment of progress toward sustainable development should be guided by a clear vision of sustainable development and goals that define that vision

[22] Summarised from http://www.iisd.org/measure/principles/progress/bellagio_full.asp

Relevance to Sustainability Assessment	**Principle**
definition of that vision in terms that are meaningful for the decision-making unit in question	
Content of any assessment and the need to merge a sense of the overall system with a practical focus on current priority issues,	A holistic perspective: assessment of progress toward sustainable development should: • include review of the whole system as well as its parts • consider the well-being of social, ecological, and economic sub-systems, their state as well as the direction and rate of change of that state, of their component parts, and the interaction between parts • consider both positive and negative consequences of human activity, in a way that reflects the costs and benefits for human and ecological systems, in monetary and non-monetary terms Assessment of progress toward sustainable development should: • consider equity and disparity within the current population and between present and future generations, dealing with such concerns as resource use, over-consumption and poverty, human rights, and access to services, as appropriate • consider the ecological conditions on which life depends • consider economic development and other, non-market activities that contribute to human/social well-being Assessment of progress toward sustainable development should: • adopt a time horizon long enough to capture both human and ecosystem time scales thus responding to needs of future generations as well as those current to short term decision-making • define the space of study large enough to include not only local but also long distance impacts on people and ecosystems • build on historic and current conditions to anticipate future conditions - where we want to go, where we could go Assessment of progress toward sustainable development should be based on: • an explicit set of categories or an organizing framework that links vision and goals to indicators and

Relevance to Sustainability Assessment	Principle
	assessment criteria • a limited number of key issues for analysis • a limited number of indicators or indicator combinations to provide a clearer signal of progress • standardizing measurement wherever possible to permit comparison • comparing indicator values to targets, reference values, ranges, thresholds, or direction of trends, as appropriate
The process of assessment	Assessment of progress toward sustainable development should: • make the methods and data that are used accessible to all • make explicit all judgments, assumptions, and uncertainties in data and interpretations Assessment of progress toward sustainable development should: • be designed to address the needs of the audience and set of users • draw from indicators and other tools that are stimulating and serve to engage decision-makers • aim, from the outset, for simplicity in structure and use of clear and plain language Assessment of progress toward sustainable development should: • obtain broad representation of key grass-roots, professional, technical and social groups , including youth, women, and indigenous people - to ensure recognition of diverse and changing values ensure the participation of decision-makers to secure a firm link to adopted policies and resulting action
Establishing a continuing capacity for assessment	Assessment of progress toward sustainable development should: • develop a capacity for repeated measurement to determine trends • be iterative, adaptive, and responsive to change and uncertainty because systems are complex and change frequently • adjust goals, frameworks, and indicators as new insights are gained • promote development of collective learning and

Relevance to Sustainability Assessment	Principle
	feedback to decision-making Continuity of assessing progress toward sustainable development should be assured by: • clearly assigning responsibility and providing on-going support in the decision-making process • providing institutional capacity for data collection, maintenance, and documentation • supporting development of local assessment capacity

6.6 Combining sustainability considerations with cost benefit assessment to determine overall value

This report suggests a concept of overall value as being the proposition which incentivises investment in a brownfield regeneration project. It has three components:

- Direct financial value
- Tangible wider value
- Intangible wider value.

Existing approaches to CBA can represent direct financial values and tangible wider values and are well established techniques to support choices based on the balance of benefits to costs. However, CBA has serious limitations in terms of identifying the appropriate wider value considerations, and in terms of effectively valuing intangibles externalities. Conversely, sustainability assessment with an appropriate level of stakeholder engagement can identify both tangible and intangible value considerations and rank choices accordingly. Sustainability assessment has major weaknesses in terms of being a convincing basis for financial investment decision making as there is no clear outcome in terms of value. Table 8 compares the strengths and weaknesses of CBA and sustainability appraisal.

Table 8: Brief Overview of Strengths and Weaknesses for CBA and Sustainability Appraisal

CBA	Sustainability Appraisal
CBA has the important strength that different factors in decision making are presented in a single mode, financial cost. This should make it easier to communicate a case for investment, and to compare different project alternatives, particularly to project finders and investors. However, CBA has weaknesses (Therivel 2004): there is no	The strengths of sustainability appraisal or assessment are that (1) it engages (or should engage) a range of stakeholder opinions to provide a consensual understanding of sustainability for a particular undertaking; and (2) it allows for a wide range of sustainability considerations. However, sustainability assessment suffers from a

standard "checklist" of categories so CBA is highly specific to the circumstances and method used for each particular assessment; the valuation procedures for public costs are both highly technical and also subject to serious inherent weaknesses as set out above. Consequently they may not be inclusive of / acceptable to all stakeholders. This problem is exacerbated where contentious "standard values" e.g. for a human life are used in a Cost benefit analysis, or values for transportation or other activities are imported into a remediation Cost benefit analysis from another analysis that may be totally unrelated even to the environmental sector let alone contaminated site management. The link between evidence and assumption may in these circumstances be rather tenuous. Some procedures include a sensitivity analysis step which allows decision-makers to question their judgements and assumptions through the eyes of other stakeholders (Bardos *et al.* 2011A).	number of serious weaknesses which can limit is usefulness in decision-making, at least in the eyes of some stakeholders. • Apparent complexity which is hard to communicate and manage: experience with the *NICOLE Sustainable Remediation Working Group* suggests that some industry and service provider organisations find sustainability assessment complex and difficult to value • Some stakeholders prefer a more financial assessment • Difficulties in distinguishing cause and effect - pressures may be split across several indicators in a way that is unclear, e.g. pressures resulting from changes in road traffic could be: CO_2, emissions to air, as well as social impacts on congestion and safety • Difficulties in managing possible duplications across effects being considered (also related to the point above) • Providing a rationale for prioritisation of sustainability concerns.

Precedents already exist for combined cost benefit assessment approaches which consider both direct costs and wider "sustainability" values in an uncosted way, using MCA techniques (see Section 6.2). However, for these approaches to be usable two extreme stakeholder perspectives need to be reconciled:

- That all factors must be monetised;
- That some factors cannot be monetised.

Without this reconciliation there can be no meeting of minds between, for example an investor and a campaigning group, whatever decision support is provided. Underlying both positions is perhaps a perceived lack of transparency. In one case using a single "value" i.e. money is seen as providing transparency, in particular the possibility of paying for "sustainability" that has no perceived value. In the other case, providing a range of assessments for factors which cannot be properly valued is seen as providing transparency, and avoiding the situation that wider sustainability impacts and benefits are inadequately valued and so are not "paid for".

A further fundamental weakness related to transparency for both cost benefit and sustainability based appraisal methods is a lack of a consistent basis for determining which from a complex range of factors should be considered in determining overall value. While attempts have been made to provide overarching suggestions, the general consensus is that the site specific nature of Brownfield regeneration and the need to balance different stakeholder interests renders a single *prescriptive* list of factors useless (RESCUE 2005, Pediaditi 2010).

HOMBRE proposes that providing transparency is a way forward in resolving this dilemma; providing that all stakeholders recognise that what is derived is a combined approach which on the one hand cannot fully monetise everything, but on the other hand provides a framework for monetisation where this is possible.

Although may seem counter-intuitive, the current difficult economic climate in Europe may provide a rationale for increased Private Sector interest in sustainability, despite the intangible nature of some of its wider value. Intangible corporate assets have a significant impact on shareholder value, often referred to as "goodwill". Goodwill describes identifiable intangible assets acquired in a business transaction, typically the excess of the purchase price of a company over its book value. The value of "goodwill" is currently subject to write-downs across the EU (Reuters 2013). Clear identification of intangible values in the context of sustainable development may be translatable into "goodwill" for businesses involved in regeneration projects, such as reduced project risks and improved reputational value, which may improve the shareholder value of a company. This consideration may be important to those making a financial investment.

HOMBRE's proposal for a way forward in coming to a common understanding of overall value depends on the following:

1) The development of a clear and shared conceptual model for sustainability for a particular site or project
2) The conceptual model can be used as a basis for prioritising which factors are important, related to agreed criteria such as: the services expected from a particular regeneration project; regulatory and corporate limits and policies; other critical limits defined by the local context; and provides an agreed rationale for the verification of project outcomes
3) An iterative approach to developing the conceptual model explicitly considering trade-offs and synergies as part of a design phase and options appraisal
4) The conceptual model could also be used to provide a robust linkage between sustainability appraisal and cost benefit appraisal, using a combined MCA based cost benefit assessment. Such a combined approach could apply monetisation, if desired, to factors considered to be directly financial or economically tangible, and some other form of benchmarking for intangible factors
5) An appropriate level of stakeholder involvement to ensure that outcomes are generally acceptable, an overarching framework for valuation that is also compliant with the Bellagio principles

The most important contributions that HOMBRE can provide are a framework for developing site or project based sustainability models, and a framework for prioritizing which factors are important and how to designate them as "direct financial", "wider tangible" and "wider intangible" components. These frameworks can then be applied to independent MCA / cost benefit assessment, and other economic valuation tools, being collated by the FP7 TIMBRE project (www.timbre-project.eu), which is developing an expert system for Brownfields management (Pizzol *et al.* 2012). Guidance on stakeholder engagement is being developed for "gentle remediation" and soft-end use by the FP7 Greenland Project (www.greenland-project.eu). The remainder of this report is devoted to site conceptual models for sustainability. The next HOMBRE WP5 Deliverable (D5.2) will describe how to apply these models to overall value based decision making use of the expected outputs of the TIMBRE and Greenland projects. This will also exploit an existing decision support framework developed under the REJUVENATE project related to biomass applications, developing it a wider range of soft end-uses scenarios and overall value based decision-making.

Findings for Chapter 6: Valuing costs and benefits from regeneration

For a brownfields regeneration to take place, someone has to be incentivised to invest in it. This likely depends on a *greater* value of the regeneration outcome than the value of the investment made. Within this report the term *overall* value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may be improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns (*direct financial value).* Overall value can therefore be seen as having three components:

- Direct financial value
- Tangible wider value
- Intangible wider value.

Cost benefit assessment describes a process of comparing the likely costs of a project with its benefits and is a form of economic valuation. Where this assessment is based on conversion to strictly monetary terms it is described as cost benefit analysis – CBA. Sustainability assessment (or appraisal) has been described as the process of the process of gaining an understanding of possible outcomes across all three elements (environmental, social, and economic) of sustainable development. Sustainability appraisal is increasingly being used to understand overall value in support of decision making for both Brownfield regeneration projects. This reflects the increasing recognition of the wider potential benefits of Brownfield regeneration to sustainable development.

Overall value is essentially a function of the perceptions of stakeholders. Stakeholder involvement should also be formally included in sustainability assessment to provide a more robust and acceptable assessments, in accordance with the *Bellagio* principles. Valuation and sustainability assessment therefore go hand-in-hand with stakeholder engagement.

Existing approaches to CBA can represent direct financial values and tangible wider values and are well established techniques to support choices based on the balance of benefits to costs. However, CBA has serious limitations in terms of identifying the appropriate wider value considerations, and in terms of effectively valuing intangibles externalities. Conversely, sustainability assessment with an appropriate level of stakeholder engagement can identify both tangible and intangible value considerations and rank choices accordingly. Sustainability assessment has major weaknesses in terms of being a convincing basis for financial investment decision making as there is no clear outcome in terms of value. HOMBRE proposes that providing transparency is a way forward in resolving this dilemma; providing that all stakeholders recognise that what is derived is a combined approach which on the one hand cannot fully monetise everything, but on the other hand provides a framework for monetisation where this is possible.

HOMBRE's proposal for a way forward in coming to a common understanding of overall value depends on the following:

1) The development of a clear and shared conceptual model for sustainability for a

particular site or project

2) The conceptual model can be used as a basis for prioritising which factors are important, related to agreed criteria such as: the services expected from a particular regeneration project; regulatory and corporate limits and policies; other critical limits defined by the local context; and provides an agreed rationale for the verification of project outcomes
3) An iterative approach to developing the conceptual model explicitly considering trade-offs and synergies as part of a design phase and options appraisal
4) The conceptual model could also be used to provide a robust linkage between sustainability appraisal and cost benefit appraisal, using a combined MCA based cost benefit assessment. Such a combined approach could apply monetisation, if desired, to factors considered to be directly financial or economically tangible, and some other form of benchmarking for intangible factors
5) An appropriate level of stakeholder involvement to ensure that outcomes are generally acceptable, an overarching framework for valuation that is also compliant with the Bellagio principles

7 Site conceptual models for sustainability

This chapter describes how existing tools and concepts from contaminated land risk assessment have been adapted for use in considering sustainability for Brownfields regeneration projects, in particular the idea of a "sustainability linkage" and a "conceptual site model for sustainability" (or project model). It describes, using a simple example case study provided by C-CURE, how linkages can be combined in a conceptual model and used to support design of integrated "treatment trains" for regeneration of Brownfields to soft end uses, taking into account synergies and trade-offs. It also shows how sustainability conceptual models can be used to support and simplify sustainability assessment, implementation and verification and maintenance. It describes how the sustainability conceptual model is a crucial tool in enhancing and estimating the overall value of a Brownfields regeneration project.

7.1 Developing an approach

HOMBRE's approach on Brownfield regeneration relies on the fact that a well-designed regeneration project can include a range of processes (gentle soil remediation, soil functionality restoration, optimised waste management practices etc.) that simultaneously address i) liabilities related with the site AND ii) a series of specific services that create more value for stakeholders, the environment and finally wider communities. This integrated or holistic approach can also improve the overall sustainability of a regeneration project. HOMBRE's approach on Brownfield regeneration is guided by the objective to provide multiple benefits for both project core stakeholders (landowner, polluter, authorities, whoever is affected by any contamination, planners…) and wider communities around Brownfields (adjacent owners and tenants, local communities and councils).

A conceptual model for sustainability for a site or a project therefore needs to both represent sustainability and also to support decisions such as prioritisations, choosing between trade-offs and different types of use, for example project design, option appraisal and designing or recording verification schemes. It needs to be fairly simple to allow easy deployment and facilitate communication between stakeholders. It needs to be capable of being a basis for determining overall value of projects and to be able to distinguish between project services and wider benefits and impacts. The ideal approach should include:

- The idea that a relatively straight forward conceptual model of sustainability can be defined on a site specific basis (conceptual site model)
- The idea that not all possible impacts / benefits may be manifest at a site and for a sustainability effect to be manifest there needs to be a "pressure", something that can be affected by that pressure – a "receptor", and – crucially – a mechanism by which that pressure exerts and influence on the receptor. All three: pressure, mechanism and receptor need to be present and linked for a sustainability effect to exist (source-pathway- receptor linkage)
- A idea of "significance", that not all effects will be large enough to cause a noticeable benefit or harm (thresholds)
- A idea of prioritisation that allows effects to be ranked in order of their assumed significance.

These ideas have been used widely and successfully in conceptual site models (Nathanail and Bardos 2004) used in risk based land management. Risk based decision-making is now the dominant approach to contaminated land management in Europe, and although not always fully applied, elements of risk based land management as described by Vegter *et al.* 2002 are widespread. The key elements to understanding risks posed by any particular sites are the connections between sources, pathways and receptors, referred to in the UK as pollutant or contaminant linkages (DEFRA 2012), shown in Figure 22.

- A source: chemical contamination present in, on or under land;
- A receptor: something that can be adversely affected by the contamination, such as people, an ecological system, property or a water body; and
- A pathway: a route or means by which a receptor can be exposed to, or affected by, a contaminant.

All three components must be in place for a potential risk to exist.

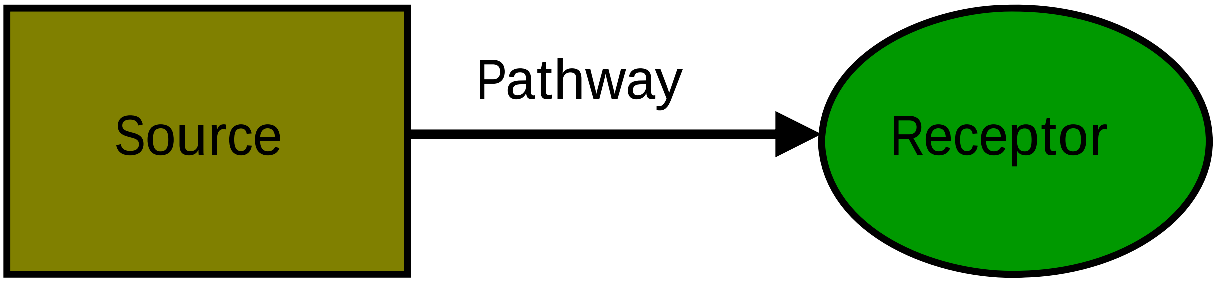


Figure 22: A Contaminant or pollutant linkage

A *conceptual site model* (CSM) is a representation which sets out the critical pollutant linkages of concern for a particular land contamination problem. The CSM crystallises understanding of what needs to be done to achieve risk management, and from this point appropriate remediation techniques for those risk management goals can be chosen. The CSM tends to be drawn up in an iterative way, beginning with all potential pollutant linkages, and as more information becomes available it evolves to describe the significant pollutant linkages and the key site information required to understand them. From this point the CSM may be modified to describe what risk managements steps will be undertaken, and how they should be monitored and verified. The representation of pollutant linkages in a site conceptual model is an important and useful tool in exchanging information and opinions between stakeholders (e.g. site owner, consultant and regulator) and providing effective and transparent decision making (FP5 Welcome Project Report). These models are often schematics, for an example, see Figure 23, and network diagrams may also be used to show common sources, pathways and receptors, see Figure 24 (Nathanail 2013). These network diagrams can be used to target a risk management to maximise the number of linkages broken by a single intervention.

NICOLE (2011) has applied a similar concept of linkages to understanding environmental liabilities for Brownfields, arising from contamination. NICOLE describes a *liability* linkage as having three components:

- A **pollutant linkage**: a contaminant-pathway-receptor relationship, as described above
- A **claim in law:** the laws of the particular Member State or region must be such that the pollutant linkage results or has the potential to result in an environmental liability, and there must be a party in a position to make that claim

- A **liable party**: an individual or an organisation who would ultimately be responsible for the environmental liability.

All three components must be in place for a potential liability to exist. Just as the CSM can be considered as the collection of pollutant linkages for the site, the Conceptual Liability Model can be considered as the collection of liability linkages for the site. The aim is similar which is to provide a clear representation of liabilities, their nature and their ownership; and so provide a shared basis for discussion and decision-making.

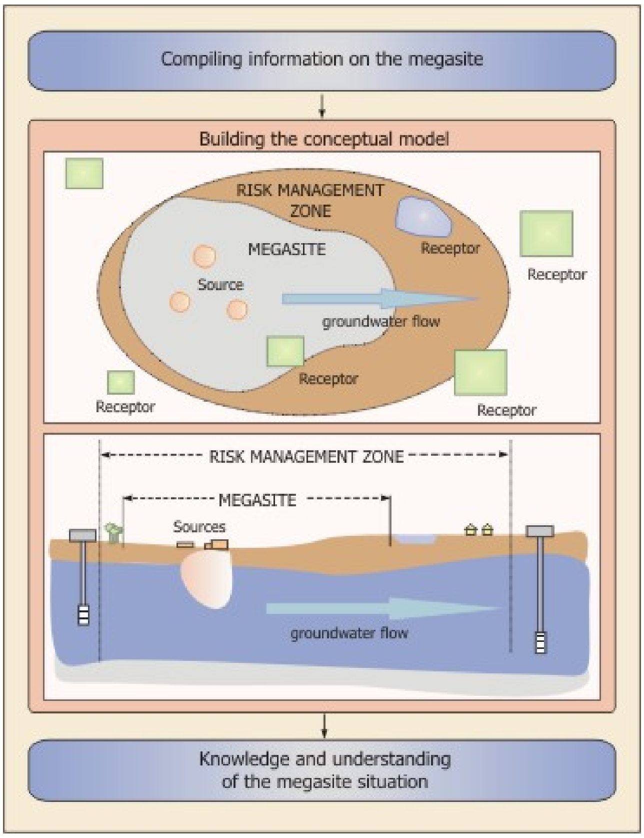


Figure 23: A generalised conceptual site model for megasites. Taken from IMS, WELCOME project FP5

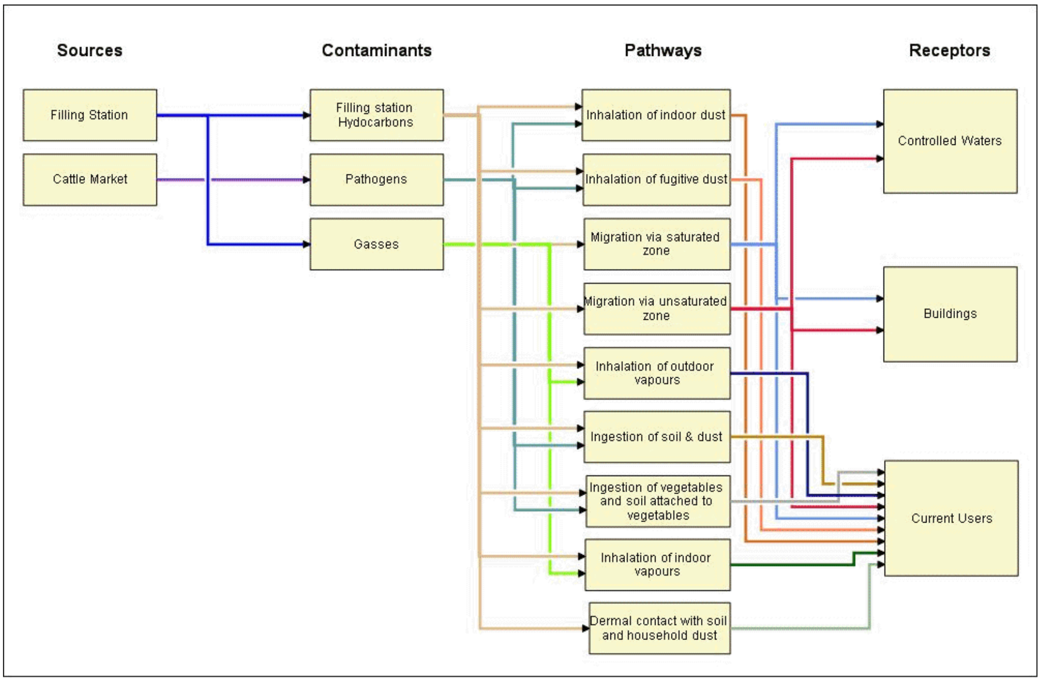


Figure 24: A site Conceptual Model shown as a network diagram, from www.keynetix.com/keycsm

These same ideas of "linkages" and conceptual site (or project) models can be used to provide a tool for crystallising available and relevant information for "sustainability" to help stakeholders recognise, prioritise and deal with the management of the sustainability for a particular site and project, and better understand *overall value*. An iterative approach is most likely, for example to review initial conditions, identify the most pressing sustainability concerns / opportunities, and then describe what services are best suited for a project/site, and how these might best be monitored and verified.

7.2 Case study description

Within this chapter a simple example of a brownfields problem related to soft-end use, with short treatment trains and just two *project services*, has been used to illustrate a site conceptual model for sustainability. The example has been provided by one of the HOMBRE case study partners, C-CURE Limited from its UK LINK funded project: *Development and application of soil and water remediation products derived from agricultural crop residues* (LK0875[23]). The project requirements are for two primary *project services:* a risk management service and a re-vegetation service. However, there are also wide range of stakeholder interests and supplementary sustainability considerations. The example is based on the Parys Mountain site in Anglesey, which has used for copper mining since Roman times. The risk management problem is one of wind blow of copper laden dusts from former settlement ponds during dry periods to adjacent housing (see Figure 25). An additional *project service* required is to support the re-establishment of heather vegetation on the settlement ponds. The historic nature of the site, the nature of its ownership and the fact that a

23 http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=ProjectList&Completed=0&ContractorID=74

third party still owns copper mining rights for the site mean that a wide range of stakeholders have an interest in the site, although the restoration project is being led by the local authority.

A range of options were considered to provide risk management and support re-vegetation, each was a simple treatment train with two unit processes: a remediation intervention and replanting. Each had different wider benefits and impacts:

1. No intervention
2. Excavation and removal of settlement pond contents and replacement with "clean soil" followed by replanting with heather
3. Containment and cover followed by replanting with heather
4. Stabilisation using lime followed by replanting with heather
5. Stabilisation using modified charcoal from renewable sources followed by replanting with heather

Interventions also had to manage the low pH and poor soil functionality of the settlement ponds to allow re-vegetation. In 2009 an initial qualitative sustainability assessment to support options appraisal was carried out following the then developing SuRF-UK guidance (CL:AIRE 2010). This assessment did not include treatment train option 2, and did not apply a site conceptual model to sustainability. However the work done is sufficient to develop a simple conceptual model of sustainability for this report.

The sustainability assessment work done should be considered as an initial scoping study carried out by the project design team. It has been prepared to explore possible regeneration options and develop a basis for iterative discussions with additional stakeholders.

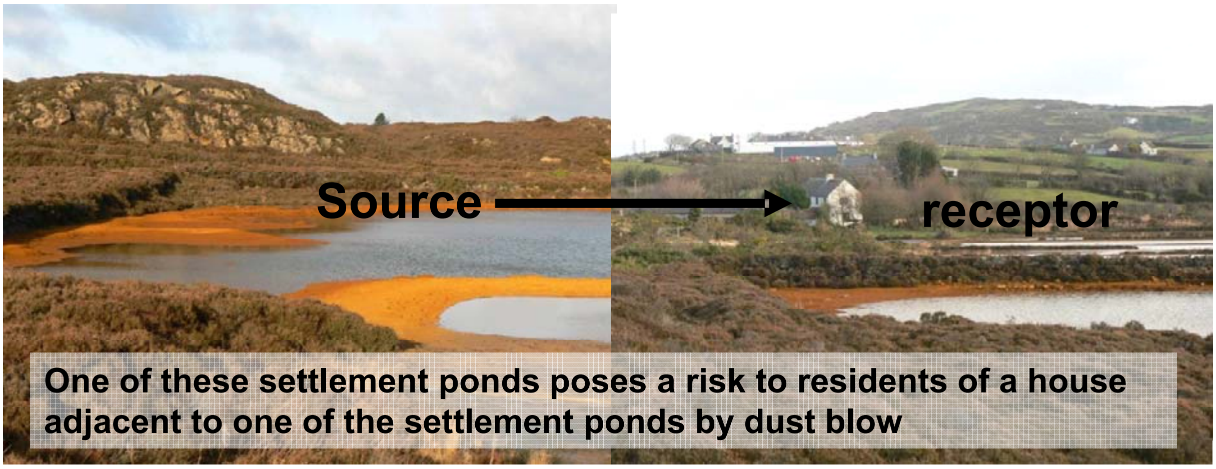


Figure 25: Risk Management Site Conceptual Model for the Anglesey site

7.3 Components of a Conceptual Site Model for Sustainability

7.3.1 The sustainability linkage

A sustainability linkage is proposed as having three connected components (see Figure 26). All three components need to be connected for a sustainability effect to exist:

- A source (pressure or change): this describes a factor that might cause an effect, for example the emission of CO_2 or an increase in road traffic
- A mechanism: this describes how harm or benefit might be brought to a particular receptor, for example the emission of PM10 particulate matter in road traffic exhaust; or

an increase in congestion that causes delay to other road users; or an increased risk of accident from additional vehicle movements

- A receptor which is the constituent of economy, environment or society which could be affected by a change / pressure via a mechanism, for example human beings (i.e. society) via PM10 particulates or increased risk of accidents; or local economy via increased costs of delivery arising from congestion.

If a sustainability linkage exists there is a potential set of connections that can have an effect on sustainability (positive or negative) which can be described in a relatively precise way. This benefit is particularly useful for prioritisation and conceptual site models development.

A range of potential linkages were considered in the Anglesey project sustainability assessment for the environmental, economic and social elements of sustainable development, and this process is discussed in more detail in the text below. Obviously, not all effects are negative, e.g. generation of recyclate, beneficial use of land, job creation, and mitigation of human health effects may all lead to beneficial sustainability linkages. It is also apparent that some linkages are temporary and others are longer term. This is an important distinction and which linkages to consider as relevant in a project depends on how "sustainability" is being perceived by stakeholders. For example, a strictly intergenerational approach may disregard temporary effects, whereas these temporary effects may be very important to stakeholders living within the vicinity of a project. This is an example of boundary setting which is a key initial step in sustainability appraisal, once appraisal objectives have been agreed. Typically boundary setting must consider system and life cycle boundaries, as well as considerations of time and distance (Bardos *et al.* 2011.)

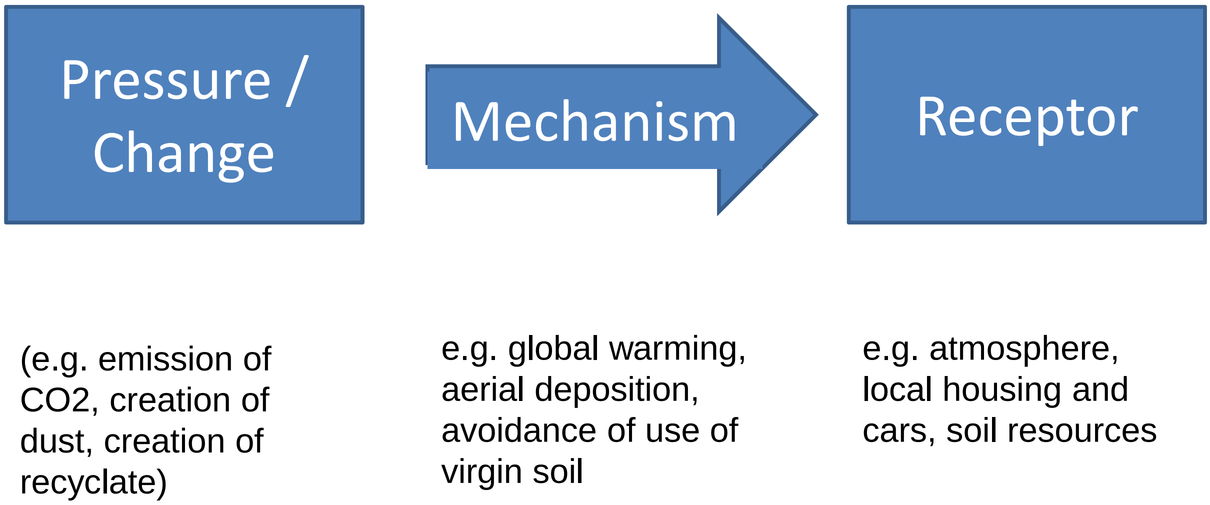


Figure 26: Sustainability linkage

The use of sustainability linkages and a site conceptual model for sustainability has been developed by HOMBRE but is compatible with the majority of international developments listed in Table 4 above. For the Anglesey case study boundaries and indicator guidance from SuRF-UK has been applied. SuRF-UK has provided guidance (CL:AIRE 2011) on what it considers to be an overarching range of themes or overarching categories of sustainable remediation considerations (see Table 9).

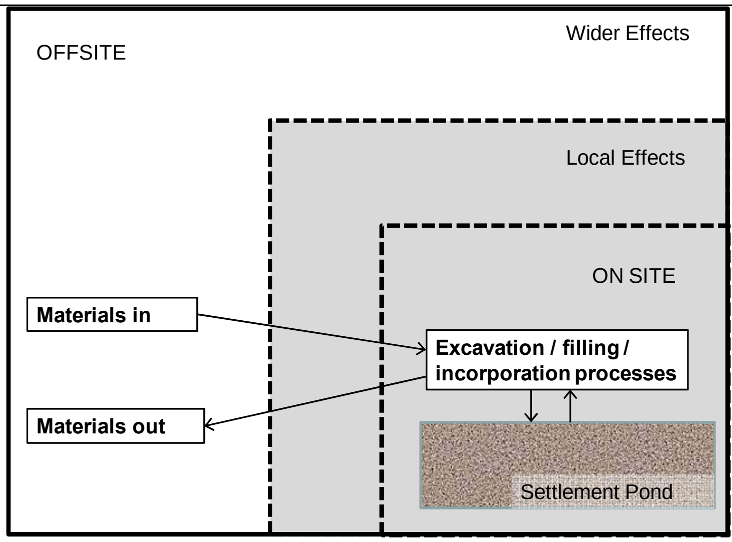
Table 9: Overarching Categories from SuRF-UK (CL:AIRE 2012)

Environment	Social	Economic
Emissions to Air	Human health & safety	Direct economic costs & benefits
Soil and ground conditions	Ethics & equity	Indirect economic costs & benefits
Groundwater & surface water	Neighbourhoods & locality	Employment & employment capital
Ecology	Communities & community involvement	Induced economic costs & benefits
Natural resources & waste	Uncertainty & evidence	Project lifespan & flexibility

The boundary conditions determined for the sustainability assessment are shown in Table 10. Boundaries were drawn up based on their practical appropriateness for the project and its stakeholders. Example considerations were the importance of being able to compare options on a "like for like" basis; the practical and financial considerations of collecting information; and the importance of particular circumstances for different stakeholders (e.g. local vs. distant effects, temporary vs. permanent effects). The overall sustainability model may not be able to include all circumstances that could be seen as significant by all particular stakeholders; but it can "tag" them so that the sensitivity of the decision making to questions such as "should we only consider permanent effects" can be tested.

Table 10: Boundaries Agreed for the Sustainability Appraisal

Boundaries- System	Remediation work for the mitigation of human health risks to a residential property adjacent to disused sediment ponds. Movement of all prepared materials to Parys Mountain site, all operations to treat the sediment pond to fully achieve agreed risk management objectives for the remediation. Removal and disposal of all residues.
Boundaries- Life cycle	What is consumed by a process, the effect of operations – such as their emissions, the impacts of depreciation on capital equipment that will be reused and the effects of its maintenance
Boundaries- Proximity	Local effects are those affecting the sediment pond and its adjacent dwelling

	
Boundaries- Permanence	Temporary effects are those of duration less than or equal to the remediation project operational period

The SuRF-UK categories and the more detailed supporting guidance were used to identify potential *pressures* that might lead to sustainability linkages. The screening of pressures carried out for this example was very simple. Each overarching category was broken down into a series of more explicit considerations. A decision was made on their relevance, and the reason for disregarding any particular factor recorded, as illustrated in 11. It is important to note that the approach taken was one of active exclusion, rather than active inclusion. I.e. the default position was that a pressure was relevant, and therefore to be considered. An explicit reason had to be given for excluding a pressure. This ensures a more rigorous sustainability assessment process, in that factors whose relevance is unclear are still considered.

Table 11: Sample Segment of an Evidence Table Identifying Sustainability Pressures of Possible Relevance at the Parys Mountain Site

Element	Overarching category	Individual Factors	Relevant	Evidence
Environmental	***Emissions to air***	Climate change – emissions of GHG, e.g. CO_2, CH_4, N_2O (as CO_2 equivalents)	yes	
		Acid rain – emissions of no_x, so_x and NH_3 (also relate to air quality)	no	Trivial emissions for all remediation options
		Ozone depletion – emissions of ozone depleting substances	no	Trivial emissions for all remediation options
		(local) air quality – gaseous emissions e.g. Of CO, particulates (PM10, PM2.5), O_3, vocs, trace elements	yes	
Environmental	***Soil and ground conditions***	Changes in chemical status	yes	
		Changes in soil nutrient status	yes	
		Contamination by trace elements, organic compounds, litter, or other undesirable materials	yes	
		Changes in buffering capacity and CEC	yes	
		Changes in pH	yes	

For each pressure possible pathways and targets were identified and used to compile a listing of *complete potential* sustainability linkages (see Table 12). 67 *possible* linkages were identified. While the risk management problem and desired project services were relatively simple, the complicated context of the site and its likely importance to different stakeholders meant that its sustainability context was not so simple. Table 12 shows a segment of this list grouped by SuRF-UK Overarching Categories. An interesting feature even in this segment is that there are shared pressures, mechanisms and receptors. This feature can be exploited to simplify the project / site sustainability conceptual model. This table also identifies pressures created by the conditions prevailing at the site, even in the absence of any treatment train intervention, and changed pressures as a result of a treatment train process. Both need to be incorporated in the sustainability model.

Table 12: Sample Segment of the List of Possible Sustainability Linkages for the Parys Mountain Site Project, grouped by SuRF-UK Overarching Categories

SuRF-UK Cat	Pressure (t_0) / Change (t_1)	Mechanism	Receptor
ENV1	GHG generation	Emission to air	Atmosphere
ENV1	NOx, SOx from process plant and traffic	Emission to air	Atmosphere
SOC1	NOx, SOx from process plant and traffic	Emission to air	Human health
SOC1	Particulates e.g. PM10	Emission to air	Human health
ENV2	Soil plant nutrient status	Suitability for biological functions	Vegetative cover
ENV2	Soil contamination	Suitability for biological functions	Vegetative cover
ENV2	Soil buffering capacity / CEC	Suitability for biological functions	Vegetative cover
ENV2	Soil pH/redox	Suitability for biological functions	Vegetative cover
ENV2	Soil carbon	Sequestration	Atmosphere
ENV2	Soil condition and WHC	Suitability for biological functions	Vegetative cover
ENV2	Nutrient cycling and other biological functions	Suitability for biological functions	Vegetative cover
ENV2	Soil structure	Erosion	Soil
ENV2	Soil structure	Compaction	Vegetative cover
ENV3	Plant nutrients	Leaching	Surface water
ENV3	Plant nutrients	Leaching	Groundwater
ENV3	Soil pH/redox	Leaching	Surface water
ENV3	Soil pH/redox	Leaching	Groundwater
ENV3	Soil contamination	Leaching	Surface water
ENV3	Soil contamination	Leaching	Groundwater
ENV3	Soil contamination	Flood resilience	Surface water
ENV4	Soil contamination	Suitability for biological functions	Soil ecology
ENV4	Soil buffering capacity / CEC	Suitability for biological functions	Soil ecology
ENV4	Soil pH/redox	Suitability for biological functions	Soil ecology
ENV4	Soil condition and WHC	Suitability for biological functions	Soil ecology
ENV4	Vegetative cover	Change in biodiversity	Local ecology
ENV4	Light / activity / noise	Disturbance	Fauna

7.3.2 Prioritisation and thresholds

The precision of using sustainability linkages allow clearer rationales for both the prioritisation of sustainability considerations, and any applicable thresholds. Importance is easier to determine because the receptor, mechanism of effect and pressure causing it are already described. Furthermore, a common strategy for determining importance (and also prioritisation) can be applied across all linkages. This provides a means of identifying *significant* sustainability linkages. Thresholds are easier to assign because only *significant* linkages need be considered further, and their specific nature allows them to be more transparently connected to particular targets from regulations or public / corporate policy. Clearly, for any assessment of importance, priorities and thresholds to gain acceptance across the stakeholders involved in a project, the overall strategies for determining importance and thresholds needs to be agreed in advance. While assessments will likely be highly site / project specific, four guiding principles can be suggested, as follows.

The assessment of importance and identification of thresholds can be based on four main principles:

1. The **importance** of a sustainability linkage to providing one or more of the **project services** desired of the project: There may be a *direct* relationship between a sustainability linkage and a desired project service such as perhaps biomass production, for example: soil compaction directly affects suitability of soil for plant growth and so affects biomass production – biomass energy is a desired service of the project. Therefore this sustainability linkage is important for the overall value of the project. There may be an *indirect* relationship. For example, soil microbial ecology is likely to be an important

supporting function for plant growth and hence biomass production. Therefore sustainability linkages related to soil ecology would also be important. **Thresholds** can therefore be related to minimums required to deliver the project service, for example the regeneration regime needs to ensure soil pH is managed to a range of 6 to 7.5 based on biomass crop requirements. These *project service sustainability thresholds* provide a link between sustainability appraisal and the technical feasibility and technical option appraisal.

2. The **importance** of a sustainability linkage to **meeting regulatory requirements**: there may be *direct* relationships between a sustainability linkage and a regulatory requirement. Regulatory requirements may operate at national, regional and local level. Local level requirements would include planning conditions. The most obvious examples of this are linkages related to the achievement of the project's risk management requirements. In this case importance reflects both the regulatory relationship *and* a project service relationship. Other types of regulatory relationships might apply to things like noise and dust emissions and criteria linked to regulatory permitting for different kinds of remediation / regeneration processes. There may also be *indirect* relationships resulting from particular policy decisions (see below). **Thresholds** can therefore be related to what is specified in the regulatory requirement.

3. The **importance** of a sustainability linkage to **meeting policy requirements**: These policy requirements may be governmental, set at European, national, regional or local levels. They may be obligatory or they may express preferences. Policy requirements may also be set at a corporate level by particular organisations, for example a corporate policy related to health and safety or climate change. A range of sustainability linkages may have direct relationships to governmental or corporate policies, and these will therefore be regarded as important. **Thresholds** may be related to norms expressed in policy documents, or may need to be agreed in a project specific way related to different policies.

4. The **importance** of a sustainability linkage to **meeting broader stakeholder requirements**: Local issues and particularly strongly held perceptions and views may also be very important developing a more generally acceptable model of sustainability for a site / project. The identification of an unmanageable number of such linkages may be a major fear for stakeholders at the core of a decision. The only way identify these linkages of concern is to ask, but perhaps there is benefit in asking open positive questions in a constructive way, asking broader stakeholder groups about what are the key outcomes they require of a project. These may be outcomes related to benefits or outcomes related to avoidance of loss or harm. It is likely that many outcomes will map directly to linkages already identified under (1) to (3) above. The remaining outcomes identify wider project benefits and impacts of concern for the project. It is quite possible outcomes desired by a broader group of stakeholders may be potentially in conflict with each other and/or the *project services*. This will need to be resolved in due course, but at this stage simply underlines the significance of the sustainability linkage. It is also a possibility that this exercise will identify additional opportunities to improve the overall value of a project, and hence its acceptability. **Thresholds** will be related to desired outcomes. An important wider stakeholder consideration is that some stakeholders may feel that **thresholds** set on the basis of policies, regulations or delivery of project services are not sufficiently stringent and that either additional thresholds are needed for criteria where one does not exist (for example a conservation objective such as protection of

archaeological remains) or that an existing threshold needs to be tightened (for example a biodiversity threshold needs to consider a wider range of categories). However, desired outcomes may be in conflict, so may not be resolvable until an overall model of sustainability has been described and trade-offs and synergies can be analysed in a more rounded way.

All of the sustainability linkages identified in (1) to (4) should be regarded as important or *significant.* It is possible that these significant linkages will need to be prioritised, with the delivery of some outcomes being seen as more important than others. Prioritisation is *subsequent* to the development of the site conceptual model of sustainability, which should encompass all significant linkages. The model is in fact a tool that enables prioritisation decisions by clarifying possible conflicts, trade-offs and opportunities for synergy. However, it should be noted that some of the sustainability linkage thresholds described above are absolute: those related to regulatory thresholds and project services, which determine whether or not a particular process or project approach is viable. Other linkages *may* be more preferential for instance those related to policy or wider stakeholder requirements. Particular policy related thresholds could, however, be absolute, for example those related to project health and safety.

Table 13 shows a segment of the initial significance assessment of pollutant linkages by the service provider on behalf of the site owner. This marked linkages that were related to the delivery of project services, and issues related to regulatory requirements or governmental / corporate policies. In this exercise the service provider did not attempt to second guess wider stakeholder requirements. The number of *significant* sustainability linkages identified by this process was 48, so 19 of the initial set of *possible* linkages were not seen as "important". It is therefore possible that a further iteration of sustainability appraisal involving a larger number of stakeholders will identify additional linkages related to broader stakeholder requirements. Figure 27 illustrates how these linkages might be important to other interests, or if included might have had an impact on the overall value of the project. This underlines the importance of looking at sustainability not as a "must have" project requirement, but as a "want to have" opportunity for improving project overall value and acceptability.

Table 13: Segment of the Identification of Significant Sustainability linkages for the Parys Mountain site

				Site Owner Perspective	
SuRF-UK Cat	Pressure (t_0) / Change (t_1)	Mechanism	Receptor	Desired Service	Other key issue
SOC1	Transport and machinery on site	Accidents	People (health)		***
SOC1	Traffic off site	Accidents	People (health)		**
SOC1	Remediation processes (e.g. deep excavations)	Accidents	People (health)		***
SOC3	Vegetative cover	Appearance	People (culture)	*	
SOC5	Information	Certainty / reliability	People		*
SOC5	Outcome	Certainty / reliability	ALL		*
ENV4	Vegetative cover	Change in biodiversity	Local ecology	*	***
SOC3	Access (for recreation etc)	Closure	People		
ENV2	Soil structure	Compaction	Vegetative cover		*
SOC4	Local policy context (positively!)	Compliance	People		***
ENV5	Resource efficiency	Consumption	People		**
ENV5	Energy efficiency	Consumption / production (net use)	People		**
ECON4	Local economic activities	Cost share / gearing / clustering	Property		
ECON3	Jobs	Creation / preservation / removal	People		
ECON3	Skills	Creation / preservation / removal	People		
SOC3	Archaeological values	Degradation	People (culture)		***
ENV4	Light / activity / noise / vibration / litter	Disturbance	Fauna		
SOC3	Light / activity / noise / vibration / litter	Disturbance (nuisance)	People		***
ECON1	Availability of financial resources	Drawdown / income	Property	*	**
ENV1	GHG generation	Emission to air	Atmosphere		**
ENV1	NOx, SOx from process plant and traffic	Emission to air	Atmosphere		
SOC1	NOx, SOx from process plant and traffic	Emission to air	People (health)		***
SOC1	Particulates e.g. PM10	Emission to air	People (health)		***
SOC1	Soil contamination	Emission to air (dust)	People (health)	*	***
ENV2	Soil structure	Erosion	Soil		*
SOC2	Procurement	Fairness	People		**
SOC2	Disadvantaged groups (householder)	Fairness	People		**
ENV3	Soil contamination	Flood resilience	Surface water	*	
ECON2	Local economic activities	Impact	People		
SOC4	Decision making	Inclusiveness	People		**
ECON4	Local economic activities	Induced investment	People		

SuRF-UK Cat	Pressure (t_0) / Change (t_1)	Mechanism	Receptor	Desired Service	Other key issue
ENV1	NOx, SOx from process plant and traffic	Emission to air	Atmosphere		
ENV4	Light / activity / noise / vibration / litter	Disturbance	Fauna		
ENV3	Plant nutrients	Leaching	Groundwater		
ENV3	Soil pH/redox	Leaching	Groundwater		
ENV3	Soil contamination	Leaching	Groundwater		
SOC3	Access (for recreation etc)	Closure	People		
ECON3	Jobs	Creation / preservation / removal	People		
ECON3	Skills	Creation / preservation / removal	People		
ECON2	Local economic activities	Impact	People		
ECON4	Local economic activities	Induced investment	People		
ECON5	Soil contamination	Institutional controls	People		
SOC3	Traffic off site	Road congestion	People		
SOC4	Well being	Satisfaction / dis-satisfaction	People		
ECON4	Local economic activities	Cost share / gearing / clustering	Property		
ECON2	Knowledge	Innovation	Property		
ECON5	Soil contamination	Institutional controls	Property		
ECON2	Infrastructure	Uplift / discount	Property		
ECON2	Local property values	Uplift / discount	Property		

19 linkages "not priority" of any kind
Some may be of great interest to someone else
Some may have significant value
Some may be both
Of course this is highly context specific

Figure 27: Sustainability linkages seen as important by a service provider and their client may be important in improving overall project value and acceptability

7.3.3 Representation – network diagrams

Developing a site conceptual site model based on linkages allows for duplications to be identified and discarded, and a clearer way for combined effects on a particular receptor from several sources to be understood. An example of a duplication that might occur where linkages are not used might be where say more than one factor being considered are linked to greenhouse gas emissions, and this is not immediately evident. Using sustainability linkages will clarify which pressures are affecting which receptors and how this effect is occurring. Sustainability linkages can then be represented in a site conceptual site model and prioritised analogous to pollutant linkages for risk assessment. Indeed pollutant linkages may form a component of an overall sustainability model.

The example tables above from Parys Mountain illustrate how sustainability linkages can have pressures, mechanisms or receptors in common. A network diagram exploits this to simplify the representation of sustainability, remove duplications, and show common features across linkages that can be used for better sustainability assessment and management (see Box 6). The simple rule of thumb is that each pressure, mechanism and receptor is (as far as possible) only shown **once** in the network diagram, and arrows are used to show how they are interconnected by sustainability linkages.

Figure 28 shows the network diagram derived for the Parys Mountain example. It was constructed simply by repeatedly sorting the spread sheet of linkages so that common pressures, mechanisms and receptors could be identified (see Table 14). The main purpose of Figure 28 is to illustrate the concept of a network diagram. From the point of view of Parys mountain is only a preliminary assessment.

Hence the site conceptual model for sustainability can therefore be used for the same purposes of communication between stakeholders and improving transparency of decision making as is now regular practice for conceptual site models used in risk assessment and management. The conceptual model supports (and develops iteratively) across the phases of decision making and project realisation (as described in Section 7.4), for example:

- Initial design work, including considering synergies, trade-offs and potential losses
- Decision making: sustainability assessment for options appraisal involving stakeholders to support sustainability management
- Implementation, monitoring and verification
- Providing a framework to determine overall value

An important part of the design and decision making processes is considering opportunities for synergies and managing trade-offs (as described in Chapter 5).

Box 6: Sustainability assessment and sustainability management

NICOLE (2011) distinguishes between processes of sustainability assessment and sustainability management, analogous to risk assessment and risk management. A CSM for sustainability could be used iteratively to

- Firstly represent all of the potential sustainability linkages identified,
- Then to represent the linkages determined by stakeholders as significant for a project / site,
- Then to represent options for *management* activities to compare between different scenarios of regeneration and environmental services and subsequently
- To represent agreed activities and describe their verification.

Within each of these steps, several iterations may take place as discussions between stakeholders take place and/or further information becomes available and the CSM is elaborated.

Table 14: Example of sorting of sustainability linkages from Parys Mountain (by mechanism)

SuRF-UK Cat	Pressure (t_0) / Change (t_1)	Mechanism	Receptor
SOC1	Transport and machinery on site	Accidents	People (health)
SOC1	Traffic off site	Accidents	People (health)
SOC1	Remediation processes (e.g. deep excavations)	Accidents	People (health)
SOC3	Vegetative cover	Appearance	People (culture)
SOC5	Information	Certainty / reliability	People
SOC5	Outcome	Certainty / reliability	ALL
ENV4	Vegetative cover	Change in biodiversity	Local ecology
SOC3	Access (for recreation etc)	Closure	People
ENV2	Soil structure	Compaction	Vegetative cover
SOC4	Local policy context (positively!)	Compliance	People
ENV5	Resource efficiency	Consumption	People
ENV5	Energy efficiency	Consumption / production (net use)	People
ECON4	Local economic activities	Cost share / gearing / clustering	Property
ECON3	Jobs	Creation / preservation / removal	People
ECON3	Skills	Creation / preservation / removal	People
SOC3	Archaeological values	Degradation	People (culture)
ENV4	Light / activity / noise / vibration / litter	Disturbance	Fauna
SOC3	Light / activity / noise / vibration / litter	Disturbance (nuisance)	People
ECON1	Availability of financial resources	Drawdown / income	Property
ENV1	GHG generation	Emission to air	Atmosphere
ENV1	NOx, SOx from process plant and traffic	Emission to air	Atmosphere
SOC1	NOx, SOx from process plant and traffic	Emission to air	People (health)
SOC1	Particulates e.g. PM10	Emission to air	People (health)
SOC1	Soil contamination	Emission to air (dust)	People (health)
ENV2	Soil structure	Erosion	Soil
SOC2	Procurement	Fairness	People
SOC2	Disadvantaged groups (householder)	Fairness	People
ENV3	Soil contamination	Flood resilience	Surface water

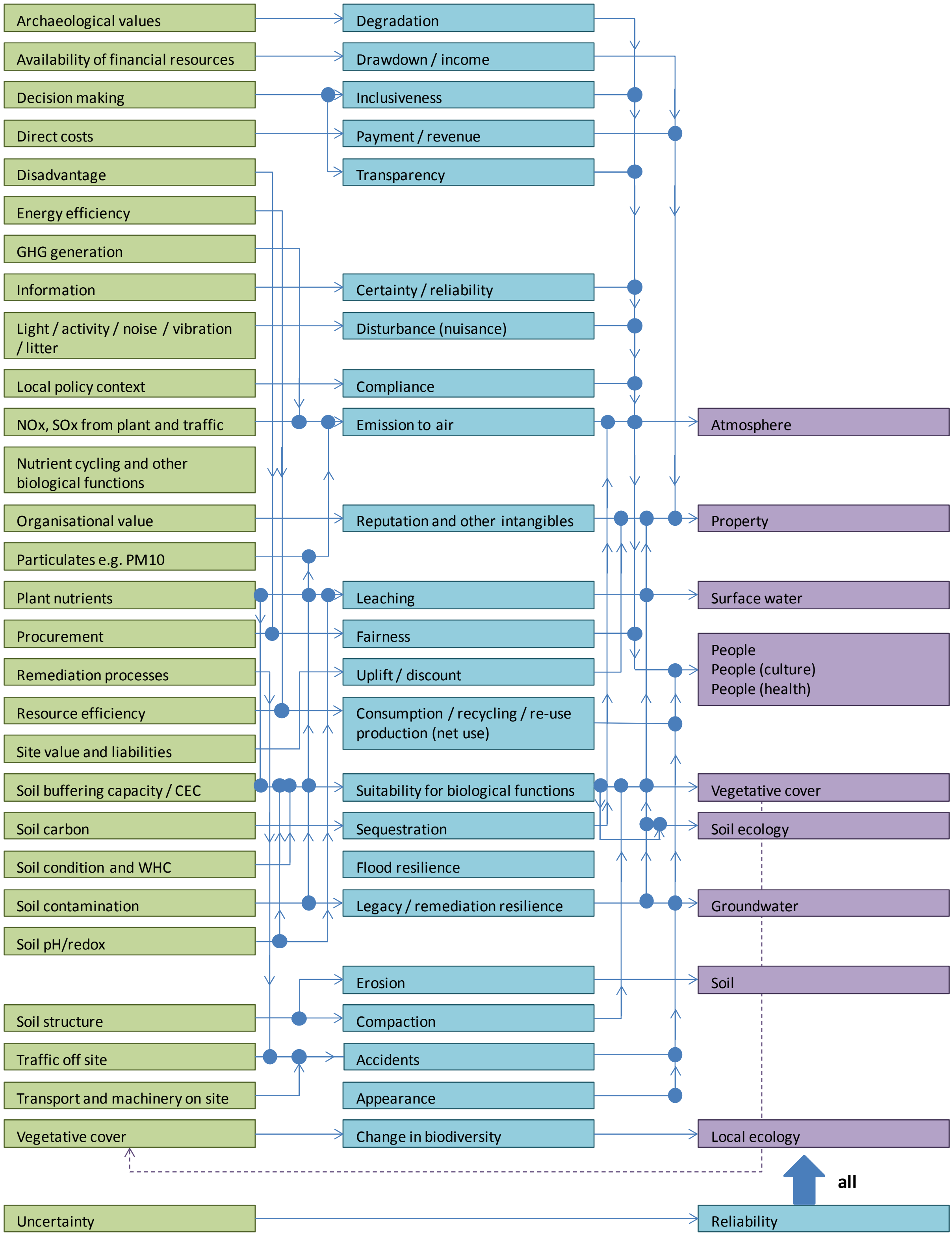


Figure 28: Parys Mountain Site Conceptual Model for Sustainability (Network Diagram)

7.4 Applications of sustainability site conceptual models

Figure 29 sets out the typical stages in the emergence and realisation of a Brownfields regeneration project. There is a period of initial design work which includes the first exploration of what might make a viable project and setting of aims. These aims are then made manifest in an initial project design, or set of options for further consideration. There then follows the transformation process in which the initial ideas are developed further with stakeholders and decisions are made on a final project configuration, which is then implemented. Aftercare follows implementation, when the restored site is maintained and there is some process of verification that the project outcomes meet the project aims. This is something of an oversimplification, particularly for soft end-uses, and stages may vary in nature and sequence. For example, the processes of objective setting, design and decision making may all involve significant dialogue between stakeholders and be iterative nature, for instance objectives may be altered as a result of design work. In addition, the transformation and aftercare processes may also overlap, particularly where longer term gentle remediation approaches are being used to manage contamination issues. In some cases, particularly for soft re-uses, the land-use may be an interim one, so a further transformation may take place in the future. Nonetheless, all projects will pass through a series of stages and a site conceptual model for sustainability can assist each stage and will develop and change as the regenerate progresses.

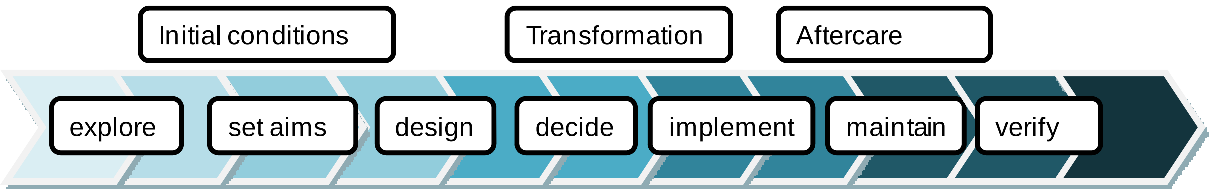


Figure 29: Emergence and realisation of a brownfields regeneration project

7.4.1 Initial design work

A proposal Brownfields regeneration project will include a number of possible project services that together add value and make a case for investment. This investment may be from the Private or Public sectors or both. Different groups of investors will have different agendas. Some examples of different soft regeneration project agendas are:

- A community led initiative to provide a green infrastructure project, such as woodland or a conservation area (National Urban Forestry Unit 2001)
- A joint public / private sector initiative to improve the attractiveness and value of a new built development by also transforming its surroundings (Bardos *et al.* 2001)
- Re-use of brownfield land for renewable energy production (Bardos *et al* 2011).

This report has described a *project service* as a benefit that a project is designed to provide e.g. manage risks and grow biomass. Project services contribute to sustainability, but do not necessarily encompass all of the sustainability benefits and impact of a project. In the Parys mountain example the project services required were: risk management for the householders' exposure and re-vegetation with heather. However, an initial screen of sustainability linkages found a much wider conceptual model of sustainability for the site with a range of potential effects on different receptors (atmosphere, water, property, people, soil and ecology) as shown in Figure 28. Figure 30 shows an overall representation of the project services and wider effects.

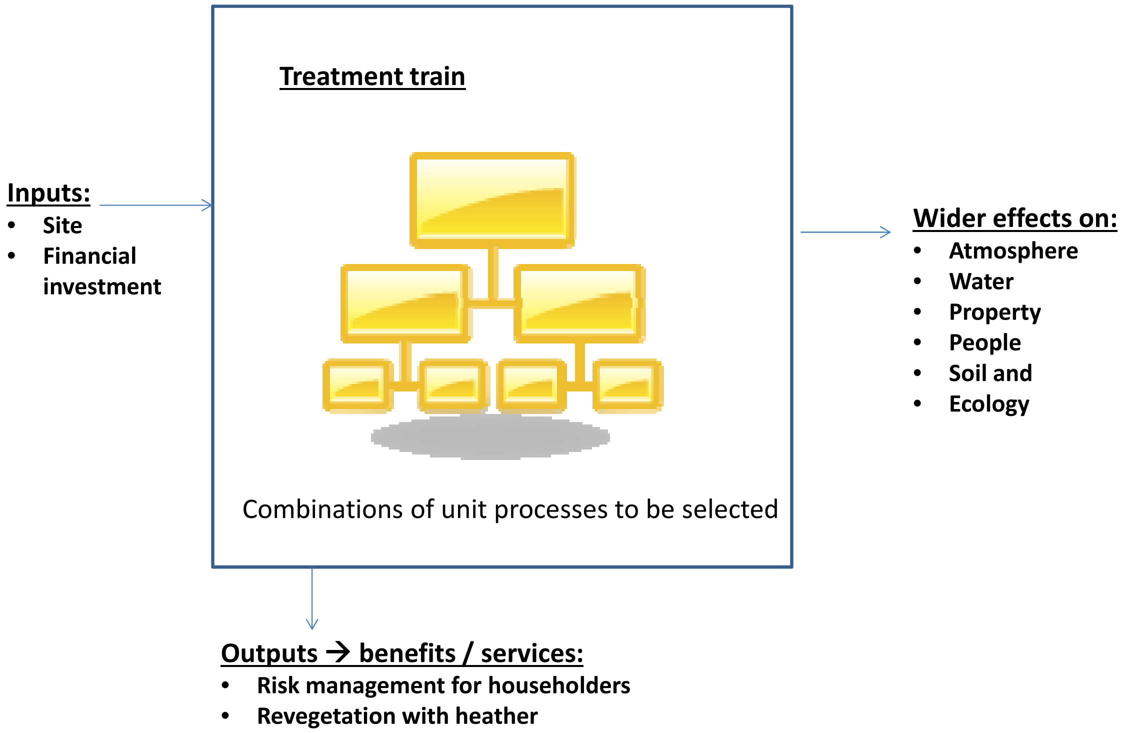


Figure 30: Services and Wider Effects for the Parys Mountain Initial Assessment: a conceptual service model

The project services define the investment case for the brownfield regeneration project at least initially. However, the wider effects can have an impact on value, this may be economically tangible or intangible, but still add value for the investment case via "goodwill", or impose costs, for example pollution control measures, as described in Chapter 6. It is therefore important for the design process to take a holistic view of sustainability, rather than one solely related to the expected project services, to improve the *overall* value of the project. During this process additional project service opportunities may be identified and included as direct project services. In the case of Parys Mountain, an additional project service that might have emerged from considerations of wider effects during such an iterative approach could have been resilience of the regeneration solution to flooding.

The conceptual model of sustainability crystallises both the importance of the project services to achieving sustainable development *and* the wider effects in an integrated way, which can be summarised in a network diagram. A conceptual model for project services, such as Figure 30, identifies the key outputs (services) from the project and the projects wider effects. An iterative approach to developing the conceptual models for services and sustainability means that design can be improved, for example by:

- Identifying opportunities for project services that directly support investment decisions (including mitigation of potential costs)
- Considering trade-offs and synergies between different project services and their wider effects (discussed in more detail below)

- Identifying opportunities for good management practice and policies that improve the overall performance of a project (for example related to operating hours, noise etc.)24.
- Engaging with stakeholders

During this process sustainability assessments should become more refined and reliable as more detailed information becomes available and as design becomes more complete.

Stakeholder engagement increases the chances of recognising additional project services and more correctly understanding the wider effects that might affect a project's acceptability or require some form of mitigation. For some community led projects such engagement may begin at a very early stage. For other projects stakeholder engagement may proceed in stages, refining design sequentially and at each stage presenting a more concrete set of options.

Identifying opportunities for synergy, avoiding and managing trade-offs (as described in Chapter 5) are crucial to maximising the overall value of a regeneration project. These might occur between desired project services, and also between project services and wider effects. Consider a project looking at establishing biomass and green infrastructure for renewable energy on former coal spoil heaps at an abandoned mine, where the green infrastructure also serves the purpose of improving the attractiveness to businesses of commercial properties located at the hub of the former mine workings.

- Between project services
  - Synergy: risk management of surface contamination and biomass cultivation
  - Trade-off: biomass production and open space green infrastructure
- Between services and wider effects
  - Synergy: biomass cultivation and soil functionality
  - Trade-off: biomass and green infrastructure versus previous informal uses by local stakeholders

One would imagine that potential net losses between project services would be rare because attempting to develop two wholly antagonistic project services would not be compatible with viable aims for a project. For instance, in this example, perhaps a biomass only solution would not improve the attractiveness to businesses of commercial properties: hence the development of a "mosaic" including green infrastructure. However, this gives rise to a "trade-off" in that alternative risk management strategy necessary for green infrastructure areas.

A potential net loss between services and a wider effect implies that the project service simply cannot be delivered as originally conceived on a particular site. For example, a net loss might be that the removal of surface water by a particular kind of biomass plantation is sufficient to cause the loss of an attractive surface water feature on the site. In this case potentially the biomass production is put at risk, as well as the negative impact on the surface water feature, which in turn reduces the attractiveness of the commercial development. In this scenario a form of biomass with a lesser requirement for water, or some form of grey water recharge from the commercial development might need to be considered.

A particularly significant consequence of trade-offs and synergies is how they affect the investment case for the regeneration project. Synergies imply an improvement in overall value and net losses imply a reduction in overall value. The impact of a trade off on overall value is more uncertain, but typically implies a cost. This may be a direct financial cost, for

[24] SuRF-UK is developing guidance on good management practices for supporting sustainable remediation over 2012-13

example the cost of dealing with surface contamination for green infrastructure areas in this example. It may be a tangible economic cost, for example, reduced scope for marketing of biomass. It may be an intangible cost, for example, an undesirable impact on bird populations. These intangibles will affect the *goodwill* held by a project; this may have a particularly important impact on investments being made for non-commercial purposes, for example, from public funding.

The use of sustainability linkages, and relating them to project services, provides a transparent basis for understanding these trade-offs, synergies and potential net losses, and any thresholds that are them consequently agreed for particular sustainability linkages, as described in Section7.3.2). Regeneration is a process of transforming a site from a starting condition ($state_0$) to a regenerated state ($state_{transformed}$). A regeneration project is carried out to *change* sustainability linkages in a project, mitigating negative effects, seeking opportunities for positive effects. Hence project services comprise the *removal* of unwanted $state_0$ sustainability linkages, as well as the introduction of additional beneficial linkages. The transformation process will include a variety of processes, which will carry their own wider effects, modifying or adding sustainability linkages. The conceptual site model for sustainability therefore will change over time.

The conceptual site model for sustainability therefore supports a process of "optioneering", where different regeneration and service interventions may be compared and considered to develop a series of variants of the service and sustainability models describing interim or final strategy options for more detailed evaluation with a wider group of stakeholders. The optioneering process allows different treatment train configurations to be refined and compared for the soft endues regeneration process. Its output is likely to be a series of treatment train configurations, and possibly a range of potential project services across each of these options. These can then be taken forward for more detailed consideration, and valuation / sustainability assessment. Where this involves widening the scope of stakeholder engagement it is quite possible that their additional information and interests may result in a further iteration of aspects of the design stage.

It is also more than likely that stakeholder opinions will already need to be sought during the optioneering process. This is of course inevitable for a community led regeneration approach, but important even for a site-owner led initiative. For example, the site owner and consultants will need to be certain that processes used in treatment trains are viable, that project services will have real end-uses, and that they meet regulatory and policy requirements.

Deliverable D5.2 will show the use of site conceptual models for optioneering in more detail, including considering trade-offs, synergies and losses.

7.4.2 Decision making: sustainability assessment for options appraisal involving stakeholders

The design process for treatment train development for soft end uses described above incorporates sustainability considerations, and indeed stakeholder dialogue. Its interim or final outputs will need a process of evaluation to ensure that any choices between alternative treatment train approaches maximise overall value. Sustainability assessment is crucial to developing the over-arching framework necessary to understand overall value, as described in Chapter 6.

It is possible also that treatment trains will be compared against a “no intervention” strategy, to ensure that there is a general overarching set of benefits. In the Parys Mountain example the no intervention strategy did turn out to be the least sustainable approach based on a simple qualitative sustainability assessment carried out by the service provider. In addition several key regulatory and service thresholds (as defined in Section 7.3.2) could not be met by a “no intervention” strategy, so it was also shown to be “non-viable” for managing the site.

The benefits of a site conceptual model for sustainability appraisal are:

1. A diagrammatic approach provides clarity, documenting and illustrating sustainability objectives (project services), boundaries, the scope of what is to be considered as part of “sustainability”, the overall framework that underpins the assessment approach, how uncertainties such as differences in stakeholder opinions will be considered, and in reporting. The network diagram for the site conceptual model for sustainability developed for the Parys-Mountain site reduced complexity from a spread-sheet with 48 individual sustainability linkages, to a diagram that identified 29 pressures but included all linkages.
2. This process of making the model, in particular a network diagram, eliminates duplications in sustainability considerations because the diagram does not multiply connections between pressures, mechanisms and receptors. Only single connections are shown.
3. Integration is possible with risk management contaminant linkages
4. The model avoids the consideration of irrelevant possible pressures on sustainability because only pressures that are linked via a mechanism to a receptor qualify. A network diagram also clearly shows where a particular pressure has multiple sustainability effects via different mechanisms and receptors;
5. Simplification of the sustainability assessment: assessment criteria / indicators can be limited to the common pressures identified in the network diagram as these are representative of all sustainability linkages (in the case of Parys Mountain this would mean a reduction from 48 individual assessments for significant sustainability linkages to 29 common “pressures”).
6. Providing a rationale for thresholds that are clearly described and linked to both sustainability and project services, and hence to the overall value of the project.
7. The conceptual model provides a framework for how qualitative and quantitative information can be combined to provide an overall representation of sustainability at a site; and as it develops through iterations identifying which linkages are most in need of and capable of quantitative evaluation (a tiered approach).

The use of a sustainability model also helps stakeholders discuss different concerns as

- Linkages can be assigned or “tagged” in different ways, in particular related to boundaries for time and distance (as described Section 7.3.1)
- Additional linkages can be included / excluded for sensitivity testing purposes (for example to investigate the impact of different stakeholder opinions on comparisons of options)
- Different thresholds can be considered for sensitivity testing purposes (for example to investigate the impact of different stakeholder opinions on comparisons of options).

Of particular interest to some stakeholders may be considerations of time or distance. Some sustainability linkages may be related to local effects, and some may be related to temporary effects for example:

- Distinguishing local from global effects (by reference to the receptor), e.g. dust from processing and traffic (depending on distance travelled) from GHG emissions
- Effects which are temporary during a particular operational phase of a project from those which are permanent, or longer term
- Considering a strictly formal view of intergenerational sustainability, e.g. by disregarding effects that have a duration less than 20 years, and indeed possibly an intergenerational view of services from a regeneration project if this is a factor in incentivising investment

It is hard to say whether all stakeholders will want to make these kinds of distinctions, but the sustainability model the considerations to take place, and their impacts on decision-making (e.g. choice of regeneration approach) compared in a transparent way.

The outputs from a CSM for sustainability could include:

- Providing a rational, transparent and robust set of reasons for why the stakeholders of a particular project have decided what "sustainability is"
- Identifying in a logical way what sustainability objectives are important (in a way that can also encompass and include risk management needs)
- Providing a rationale for indicator selection and sustainability assessment, which can readily use current guidance documents (e.g. SuRF-UK framework, or NICOLE), for example to identify possible pressures on sustainability.

Sustainability is not an absolute and objective measurement. To be useful the sustainability assessment approach has to be acceptable –as far as possible- to the stakeholders which will be bound by or affected by the decisions made using it. The acceptability of the assessment approach will be critically dependent on an appropriate level of stakeholder engagement, to ensure that all key parties can be confident that decision making is transparent, and that rationales are clearly discussed (even if not all stakeholders agree with particular outcomes).

Deliverable D5.2 will show the use of site conceptual models in sustainability assessment for decision support in more detail.

7.4.3 Implementation and maintenance including monitoring and verification

There are three ways in which a site conceptual model for sustainability can assist implementation:

- Identification of good management practices to improve benefits and reduce negative impacts during the project implementation process;
- Providing a rationale for verification of sustainability
- Identifying mitigating actions or maintenance requirements if project services or sustainability outcomes are not met

SuRF-UK has begun work on "best management practices" which have the objective of encouraging sustainable thinking and decision-making across all land contamination management activities, in particular those that do not necessarily need a formal assessment[25].

[25] www.claire.co.uk/surfuk

The concept encompasses simple actions that might improve outcomes during the operation of a project, which offer "quick wins" at low cost, for example:

- Avoid mixing top soil and subsoil during stripping
- Do not strip soils during adverse weather conditions
- Segregate stockpiles to optimise reuse potential
- Avoid over compaction (use tracked equipment)
- Prevent contamination of clean soils.

These practice suggestions, which can be readily implemented, link good site management practice to particular SuRF-UK headline categories (as shown in Table 9 above) - in the case of these bullets to "ENV5, Natural resources and waste". This concept is obviously also very useful for Brownfield regeneration more generally. For regeneration projects, best management practices would be used to improve sustainability pressures identified in the conceptual model, for example, the "soil structure" pressure shown in Figure 28 above.

The site conceptual model for sustainability can also provide a clear rationale for maximising the effectiveness of monitoring and verifying "sustainability" as a project is implemented, and targeting any consequent maintenance requirements. It can provide a means of showing how monitoring the narrowest range of verification indicators can provide the greatest benefit in terms of sustainability linkages covered. The means of achieving this is by focusing monitoring mechanisms and receptors, and selecting indicators on this basis.

An example of this from Parys Mountain is shown in Figure 31. In this example a single mechanism "suitability for biological functions" mediates a number of pressures for a particular receptor the required vegetative cover by heather. In this situation the easiest component of the sustainability linkage to monitor is the receptor rather than the mechanism, i.e. the growth of the heather. If the heather is growing as desired then the thresholds for a wide number of linkages have been achieved. In addition, linkages supporting soil microbial ecology will also have been achieved (in so far as its supporting service for heather is concerned). Hence the simple monitoring of heather cover provides reassurance that a wide range of sustainability linkages are being managed "correctly" and their contribution to the *overall value* of the project is being achieved.

If monitoring indicates that the expected project services / sustainability outcomes are not being delivered (i.e. verification is not achieved), then reviewing mechanisms and, where necessary, the pressures that they link to provides a means of rigorously identifying where project failures have taken place and some form of intervention (mitigation) is necessary. For example, at Parys Mountain, if the heather growth is not as desired then the conceptual model indicates the via the connected sustainability linkages where additional monitoring and investigation is necessary. At Parys Mountain failure in maintaining vegetative cover encompasses one or more of three mechanisms: leaching (of plant nutrients); compaction (of soil structure) and suitability for biological functions. It is likely that the two easiest mechanisms to consider will be compaction and leaching, the former by site inspection and the latter by a simple soil nutrient status test. In parallel it will be necessary to monitor pressures connected with "suitability for biological functions" via a range of soil analyses. On the basis of this additional monitoring mitigation measures can be identified, for example to deal with problems of compaction or mitigate pH.

The benefit of the use of the sustainability conceptual model is that it targets effort and so reduces the cost of investigating verification failures and project maintenance.

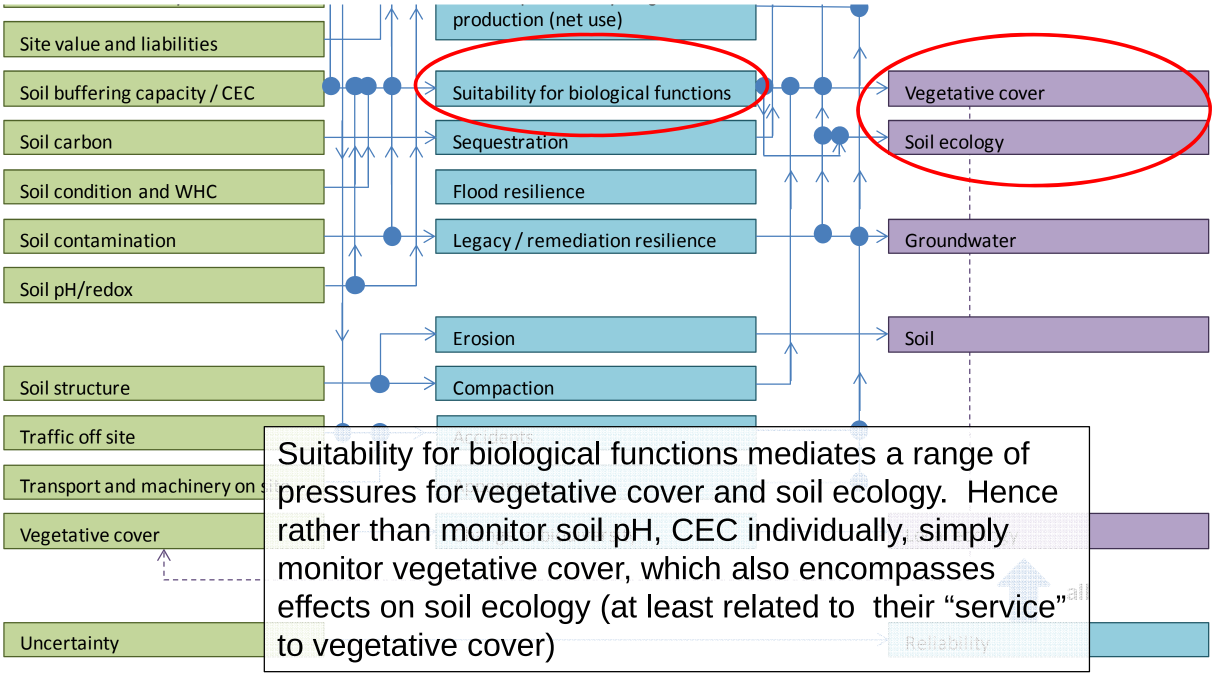


Figure 31: Using a Site Conceptual Model of Sustainability to Determine Verification Needs

7.4.4 Providing a framework to determine overall value

The importance of the site conceptual model of sustainability for overall value is twofold. Firstly, its use during optioneering in the design stages of the project identifies opportunities for maximising value by exploiting synergies, optimising trade-offs and avoiding net losses. Secondly, it provides a framework for assessing the components of overall value (direct financial value, tangible economic value and intangible values) both for selecting the treatment train approach likely to yield the greatest overall value for the smallest investment; and for monitoring outcomes to verify that the expected overall value is being achieved.

The use of a conceptual model facilitates a holistic view of sustainability which may highlight additional project service opportunities that improve overall project value. It also more clearly identifies the different investments required *in addition* to financial investment, for example community support and acceptance. It therefore provides a more balanced case for a project proposal, especially where public money is one of the funding sources, but also where *goodwill* is important to investors (for example their reputation or the ease and speed of project delivery). The conceptual model identifies both the project services which are the value drivers that incentivise financial investment in a project, and also the wider effects which may improve or reduce value, depending on effect and circumstance.

The use of sustainability linkages and relating them to project services allows clarity in identifying directly costable elements of costs and benefits (i.e. considerations with a direct financial value or tangible economic outcome) and intangible elements which may nonetheless have a significant bearing on the overall value of a project. This provides a rationale for an evaluation approach that might be acceptable to a broad range of stakeholders, for example combining monetary evaluations where appropriate with a broader MCA based ranking for intangible value. Investors can then take their own view of the likely usefulness or financial value of the "goodwill" they can derive.

The monitoring and verification of outcomes described in Section 7.4.3 supports the demonstration that the overall project value has been achieved. Where outcomes are suboptimal, the conceptual model can be used to efficiently identify where problems are occurring and how these might be remedied.

Findings for Chapter 7: Site conceptual models for sustainability

Ideas of "linkages" and conceptual site models widely used in contaminated land risk assessment can be used to provide a tool for crystallising available and relevant information for "sustainability". The aim is to help stakeholders recognise, prioritise and deal with the management of the sustainability for a particular site and project, and better understand *overall value*. An iterative development of such a conceptual model is likely reviewing initial conditions, identify the most pressing sustainability concerns / opportunities, project design, option appraisal, understanding overall value, implementation, verification and maintenance.

A sustainability linkage is proposed as having three connected components:

- A source (pressure or change): this describes a factor that might cause an effect, for example the emission of CO_2 or an increase in road traffic
- A mechanism: this describes how harm or benefit might be brought to a particular receptor, for example the emission of PM10 particulate matter in road traffic exhaust; or an increase in congestion that causes delay to other road users; or an increased risk of accident from additional vehicle movements
- A receptor which is the constituent of economy, environment or society which could affected by a change / pressure via a mechanism, for example human beings (i.e. society) via PM10 particulates or increased risk of accidents; or local economy via increased costs of delivery arising from congestion.

All three components need to be connected for a sustainability effect to exist. If a sustainability linkage exists there is a potential set of connections that can have an effect on sustainability (positive or negative) which can be described in a relatively precise way.

A common strategy for determining importance (and also prioritisation) can be applied across all linkages. This provides a means of identifying *significant* sustainability linkages, and any applicable thresholds. The assessment of importance and identification of thresholds can be based on four main principles:

5. The **importance** of a sustainability linkage to providing one or more of the **project services** desired of the project: **Thresholds** can therefore be related to minimums required to deliver the project service.
6. The **importance** of a sustainability linkage to **meeting regulatory requirements**. **Thresholds** can therefore be related to what is specified in the regulatory requirement.
7. The **importance** of a sustainability linkage to **meeting policy requirements,** corporate or governmental. **Thresholds** may be related to norms expressed in policy documents, or may need to be agreed in a project specific way related to different policies.
8. The **importance** of a sustainability linkage to **meeting broader stakeholder requirements**: Local issues and particularly strongly held perceptions and views may

also be very important developing a more generally acceptable model of sustainability for a site / project. **Thresholds** will be related to desired outcomes. However, desired outcomes may be in conflict, so may not be resolvable until an overall model of sustainability has been described and trade-offs and synergies can be analysed in a more rounded way.

Sustainability linkages can be combined using a network diagram to provide a more simplified representation than tables of linkages. The simple rule of thumb is that each pressure, mechanism and receptor is (as far as possible) only shown **once** in the network diagram, and arrows are used to show how they are interconnected by sustainability linkages. Hence the site conceptual model for sustainability can therefore be used for the same purposes of communication between stakeholders and improving transparency of decision making as is now regular practice for conceptual site models used in risk assessment and management.

The conceptual model supports (and develop iteratively across the phases of decision making and project realisation:

- Initial design work, including considering synergies, trade-offs and potential losses
- Decision making: sustainability assessment for options appraisal involving stakeholders to support sustainability management
- Implementation, monitoring and verification, maintenance
- Providing a framework to determine overall value

The importance of the site conceptual model of sustainability for overall value is twofold. Firstly, its use during optioneering in the design stages of the project identifies opportunities for maximising value by exploiting synergies, optimising trade-offs and avoiding net losses. Secondly, it provides a framework for assessing the components of overall value (direct financial value, tangible economic value and intangible values) both for selecting the treatment train approach likely to yield the greatest overall value for the smallest investment; and for monitoring outcomes to verify that the expected overall value is being achieved.

The next HOMBRE WP5 Deliverable (D5.2) will describe how to apply conceptual site (project) models for sustainability to value based decision making.

8 Conclusions

The concept of "circular land management" underpins HOMBRE's thinking and is structured around the following key principles: avoiding new Brownfields, recycling existing Brownfields and compensating the effects of land consumption. The goal of HOMBRE within circular land management is to reduce the consumption of greenfield land and the production of Brownfield land. This can be achieved by maintaining land in productive use as far as possible, but where it falls out of use, to make sure its transition to a new land use is as rapid as possible. The return to use of land could be for built redevelopment, or for soft end uses such as urban green space. A possible intermediate scenario is that there may be an interim soft use, prior to longer term re-establishment into the land cycle.

HOMBRE's overarching aim is to develop new approaches to improve Brownfield regeneration in terms of performance and sustainability in a holistic way and show new opportunities to generate more value for private and public investors. At the core of HOMBRE's approach is the use of intelligent and holistic suite of technologies (treatment trains), management measures and land use to deliver optimized benefits for targeted beneficiaries, i.e. delivering "*project services*". Thus, from HOMBRE's perspective, project services from BF regeneration are fundamental as they multiply the chances to regenerate BF and provide new opportunities for economy, environment and society.

In WP5 the term *"project service"* is used to express the benefits obtained by specific beneficiaries or "receptors" (i.e. nature, people or society). Project services are delivered through the implementation of processes during the regeneration of Brownfields and the maintenance of specific land uses. Project services are the basis upon which value can be created that will leverage a Brownfield regeneration, by provide benefits that make the investment in regeneration worthwhile to specific constituencies or beneficiaries who will support it.

The exact choice of project services and the most efficient way in which they can be delivered determines the usefulness and hence the value of a regeneration project. Project designs will likely need to consider a range of synergies, trade-offs and potential net losses:

- Synergy describes the simultaneous enhancement of more than one service, for instance, because improving the value of one service can enhance the value of another service (for example non-food crops can help managing risks associated to soil contamination on a site as well as providing resources for bio-energy production)
- A trade-off refers to the increase of the provisioning of one service that is accompanied by the simultaneous decline of another service at the same location
- A loss describes a situation where two project services are incompatible, and trying to deliver both will result in poorer performance for both.

The role of different stakeholder interests has an enormous impact on analysis of synergies, trade-offs and losses because relative values may be very different for different stakeholder groups for any particular project service or wider impact.

From a conceptual point of view, HOMBRE's overarching strategy on leveraging value creation from BF regeneration is shown in Figure 32.

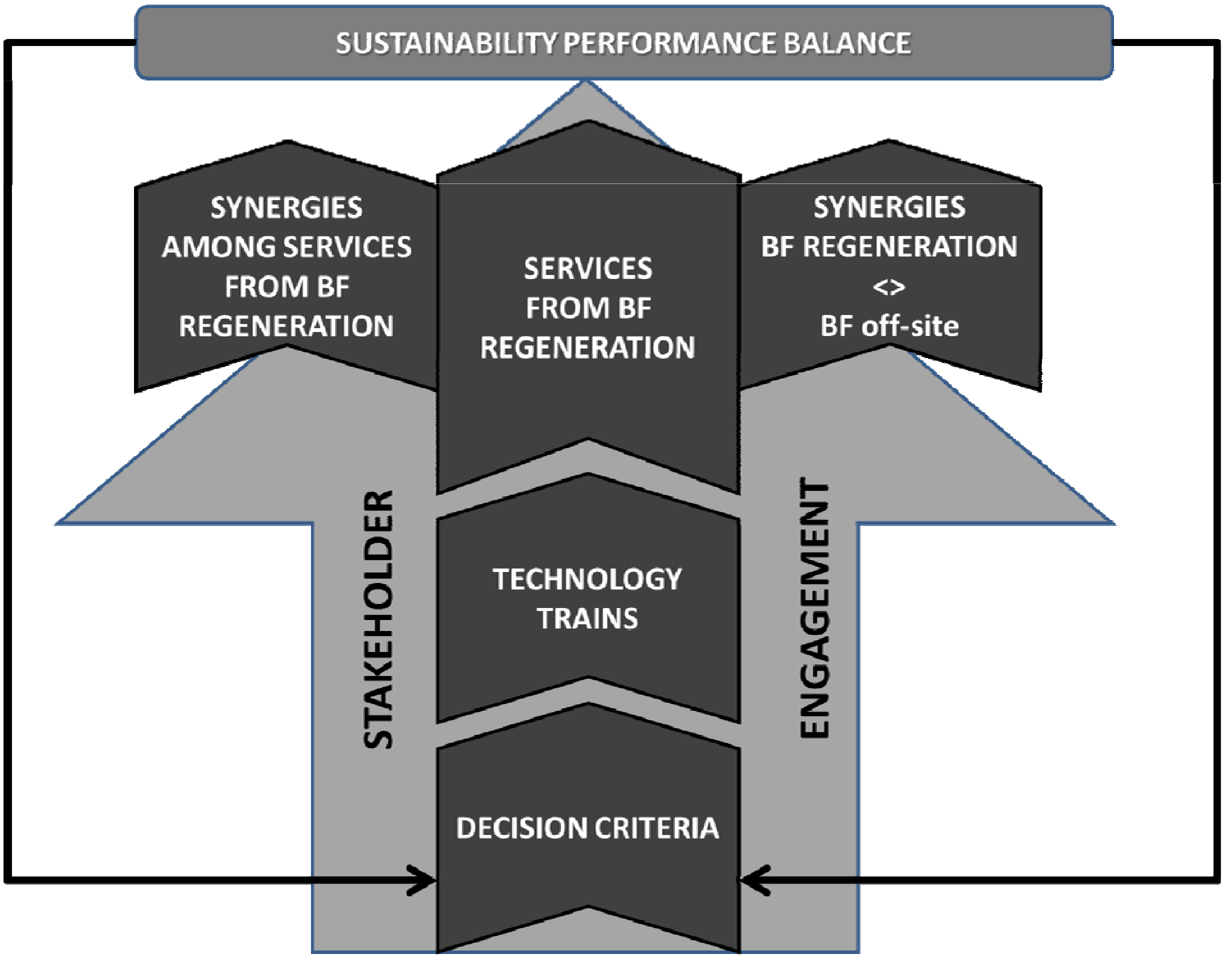


Figure 32: HOMBRE Concept

For a brownfields regeneration to take place, someone has to be incentivised to invest in it. This likely depends on a *greater* value of the regeneration outcome than the value of the investment made. Within this report the term *overall* value is taken to be the incentivisation for Public and or Private investment in brownfields regeneration, which may be improvements in wider environmental, social or economic value, as well as improvements in direct monetary returns (*direct financial value).* Overall value can therefore be seen as having three components:

- Direct financial value
- Tangible wider value
- Intangible wider value.

Overall value is essentially a function of the perceptions of stakeholders. Stakeholder involvement should also be formally included in sustainability assessment to provide a more robust and acceptable assessments, in accordance with the *Bellagio* principles. Valuation and sustainability assessment therefore go hand-in-hand with stakeholder engagement.

Existing approaches to CBA can represent direct financial values and tangible wider values and are well established techniques to support choices based on the balance of benefits to costs. However, CBA has serious limitations in terms of identifying the appropriate wider value considerations, and in terms of effectively valuing intangibles externalities. Conversely, sustainability assessment with an appropriate level of stakeholder engagement can identify both tangible and intangible value considerations and rank choices accordingly. Sustainability assessment has major weaknesses in terms of being a convincing basis for financial investment decision making as there is no clear outcome in terms of value. HOMBRE proposes that providing transparency is a way forward in resolving this dilemma; providing that all stakeholders recognise that what is derived is a combined approach which on the one hand cannot fully monetise everything, but on the other hand provides a framework for monetisation where this is possible.

Ideas of “linkages” and conceptual site models widely used in contaminated land risk assessment can be used to provide a tool for crystallising available and relevant information for “sustainability”. The aim is to help stakeholders recognise, prioritise and deal with the management of the sustainability for a particular site and project, and better understand *overall value*. An iterative development of such a conceptual model is likely to include reviewing initial conditions, identify the most pressing sustainability concerns / opportunities, project design, option appraisal, understanding overall value, implementation, verification and maintenance.

A sustainability linkage is proposed as having three connected components:

- A source (pressure or change): this describes a factor that might cause an effect,
- A mechanism: this describes how harm or benefit might be brought to a particular receptor,
- A receptor which is the constituent of economy, environment or society which could affected by a change / pressure via a mechanism.

All three components need to be connected for a sustainability effect to exist.

Sustainability linkages can be combined using a network diagram to provide a more simplified representation than tables of linkages. The conceptual model supports (and develop iteratively across the phases of decision making and project realisation:

- Initial design work, including considering synergies, trade-offs and potential losses
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The importance of the site conceptual model of sustainability for overall value is twofold. Firstly, its use during optioneering in the design stages of the project identifies opportunities for maximising value by exploiting synergies, optimising trade-offs and avoiding net losses. Secondly, it provides a framework for assessing the components of overall value (direct financial value, tangible economic value and intangible values) both for selecting the treatment train approach likely to yield the greatest overall value for the smallest investment; and for monitoring outcomes to verify that the expected overall value is being achieved.

The overarching conclusions of this report are to reiterate HOMBRE’s overall goal to add value during regeneration and after regeneration. This added value may even be enough to facilitate regeneration where it would otherwise be stalled. The approach suggested here of considering project services in an overall site conceptual model of sustainability to broaden opportunities for regeneration design and better determine overall value combines a range of existing concepts from work related to ecosystem services, sustainable development and stakeholder engagement, tools used in risk management and cost benefit assessment.

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Annex 1

Draft document (fiche) for data compilation on regeneration techniques.

TECHNOLOGY		**Status of application**	
Technique name		**Robustness, verification**	
		Ref. country - Project	

TECHNIQUE DESCRIPTION – FUNCTIONING PRINCIPLES – EXISTING VARIANTS OF THE TECHNIQUE

APPLICABILITY TO CONTAMINANTS AND SOIL CONDITIONS

Organic contaminants	Inorganic contaminants	Adequate soil conditions

	Gravel	Sand	Silt	Clay	
Texture	☐	☐	☐	☐	
g/cm3	< 1	< 1,2	< 1,4	< 1,6	< 1,8
Bulk density	☐	☐	☐	☐	☐
GW table					
pH					
Soil O.M.					
N., K., P.					

ADEQUATE CLIMATE CONDITIONS

Mean annual temperature [º C]

Mean annual precipitations [mm]

Resilience / capacity to respond to changing climate conditions (humidity, temperature)

Bad ☐ Acceptable ☐ Good ☐

POTENTIAL ADVANTAGES	**LIMITATIONS**

INPUTS

Materials (seeds, sprouts, pesticides, organic and inorganic soil amendments, origin of materials, natural resources or recycled materials, also water abstraction) – [T/ha/year] [L/ha/year]	**Machinery on site + transport dependency (energy consumption)**	**Operation and maintenance efforts**	**Costs (major cost items)**

Costs (major cost items) – % of total costs:

	<30	<50	>50
hours	☐	☐	☐
material			
………	☐	☐	☐
………	☐	☐	☐
………	☐	☐	☐
energy	☐	☐	☐
others			
	☐	☐	☐
	☐	☐	☐

OUTPUTS / POSITIVE (+) AND NEGATIVE (-) IMPACTS

Contaminant fate

Accumulation	roots ☐	leaves ☐	stems ☐
Degradation	☐		
Stabilization	☐		
Bioavailable	☐		
Mobilization / release	☐		
Volatilization	☐		
others	☐		

Soil

	improved / ↑	worsen / ↓	? / =
Chemistry	☐	☐	☐
Respiration	☐	☐	☐
Buffering capacity	☐	☐	☐
Permeability	☐	☐	☐
Fertility	☐	☐	☐
Compaction	☐	☐	☐
Water holding capacity	☐	☐	☐
Org. carbon	☐	☐	☐
Others			
	☐	☐	☐

Air

Green house gases Emissions	
CO2 absorption	Y / N
Other effects	

Waste

Possible emissions to water

Contaminants	
Dissolved org. carbon	
Others	

Generated goods / wastes

good or waste	Direct value (Y/N) or valorisation opportunity

Neighbourhood

	duration of impact: short	medium	long	cyclic
noise	☐	☐	☐	☐
vibrations	☐	☐	☐	☐
transport nuisance	☐	☐	☐	☐
dust	☐	☐	☐	☐
pollen	☐	☐	☐	☐
others				
	☐	☐	☐	☐

Community involvement ? …………….Y / N

Visual impact – landscape

Item + / -	duration of impact: short	medium	long	cyclic
	☐	☐	☐	☐
	☐	☐	☐	☐
	☐	☐	☐	☐
	☐	☐	☐	☐

short: < 6 months medium: < 3 years long: > 3 years

Ecology

Introduction of alien species

Yes ☐ No ☐

impact	(-)	(+)	? / none
local fauna	☐	☐	☐
local flora	☐	☐	☐
ecological structures and functions	☐	☐	☐
………………………	☐	☐	☐

CONTRIBUTION TOWARDS SERVICES (*)

service	comment	TIME SPAN: short	medium	long	cyclic
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐

short: < 6 months medium: < 3 years long: > 3 years

Sources – Reference information	

Each of these effects has a specific time span on which it becomes relevant. Maybe we could indicate in a qualitative way (short term, medium term, long term) the time span for a technique to perform positive effects.
A possible classification could be:

- Short term: less than 1 year
- medium term: less than 2-3 years
- long term: over 3 years

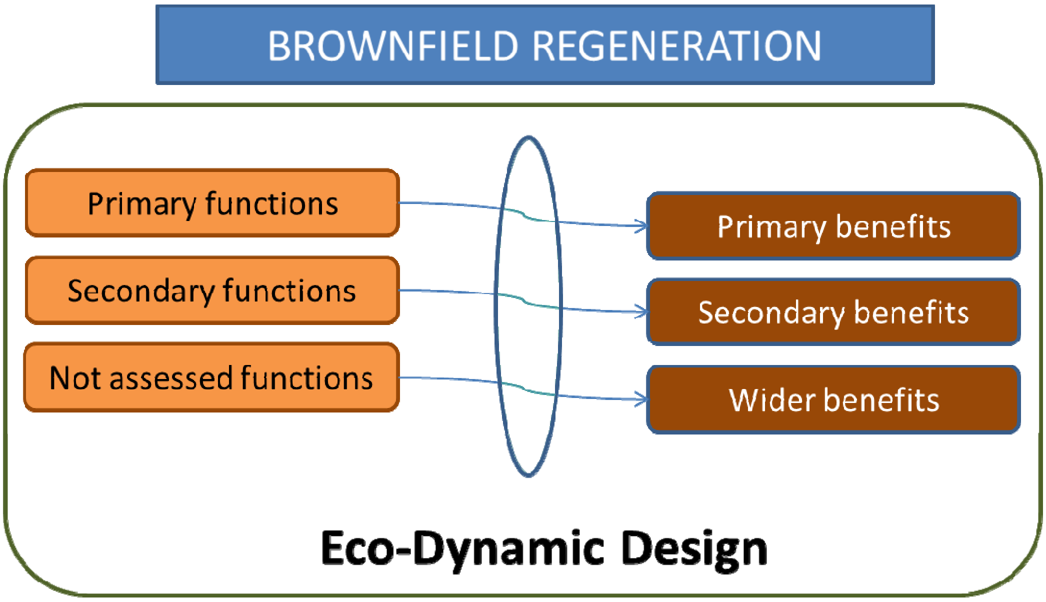
(*): relevant contribution to disposal, productive, consumer, regulation, cultural services. Specify shortly how the technique, as standalone technique, or when combined with other techniques can contribute to the identified service.

Annex 2

Identification and use of synergies in practice - Principles of Eco-Dynamic Design

An illustrative example of integrated planning approach can be taken from the eco dynamic design (E.D.D.) concept. This concept, based on methods proposed by the Building with Nature program (www.ecoshape.nl) contains generally accepted approaches like stakeholder involvement and brainstorm techniques. This is the same approach as HOMBRE is aiming at. EDD strives to use environmental dynamics into spatial development, not only for mitigation of negative effects (primary goal to reach Brownfield regeneration), but also for achieving additional positive effects on natural value, soil, water, air quality, recreational values and environmental perception (services that serve stakeholders within both the EDD as the HOMBRE approach). With the application of the EDD concept for Brownfield regeneration the BF owner determines the primary function or service, but will be searching for synergies with other functions (secondary). The primary benefit serves the BF owner, while secondary benefits serve local and regional stakeholders. Note that secondary benefits can be equally important as primary benefits to reach successful BF regeneration (because of additional value, social support, legal admissibility, etc.)

The figure below shows a schematic view on the EDD approach. It shows the primary BF re-functioning with the BF owner, resulting in primary benefits These are reached by applying the appropriate techniques for soft re-use (possibly through the implementation of a combination of technologies, i.e. treatment trains). It also shows the secondary functions (meaning: secondary for the BF owner, but equally important for major project sustainability) resulting from the stakeholders (local and regional) participation. EDD facilitators will investigate the possibilities to combine the secondary functions with the primary soft re-use techniques applied for the BF owner (multi-functionality leading to additional values). Next to these secondary functions, the assessment of wider benefits will be defined and explained to the BF owner and stakeholders (i.e. CO_2 fixation, heat island reduction, air quality improvement, etc. ;awareness of these benefits will increase overall value of BF regeneration).



Holistic approach of BF regeneration with Eco-Dynamic Design

Using natural dynamics is comparable to the approach of ecosystem services (see section 4.1). Certain aspects of the ecosystem that supply services can be exploited optimally when they are mimicried or engineered (for example: flow through velocity in artificial wetlands resulting in optimal water sanitation, or certain microbial activity resulting in stabilization of soft soils).

Characterization and key principles of Eco-Dynamic-Design:

- Surplus of values and services: what can nature/society do for the Brownfield regeneration and vice-versa?
- Use self-designing and self-regulating ability of natural systems (saves costs!)
- Ecosystem: from large to small. What are the regional (or national) needs? In this way a solution becomes part of the greater whole.
- Ecosystem: from small to large, a small-scale solution can be utterly important for the greater whole. A mind-shift is needed that small-scale techniques or land uses can indeed cause great solutions.
- Surplus values for society and surrounding instead of mitigation.
- Segregation>Integration: Experts of various disciplines and organisations together in all project phases. The sooner the better.
- Tell the story. Share results with stakeholders and society. Tell the story behind the design of the Brownfield.

In line with HOMBRE's approach, stakeholder participation is an essential component in EDD processes. It supports assessing needs on regional scale and to inventory solutions on local scale subsequently, and it helps securing public endorsement and commitment. Most of these local and regional needs for specific services may be secondary to the BF owner, but can be relevant when these can be enhanced through designed processes in the course of Brownfield regeneration (via treatment trains and well-designed land-use) techniques. It will lead to social support/acceptance, economic viability and/or legal willingness, increasing the chance to successful sustainability. These secondary functions and benefits may well be comparable with interim use during Brownfield regeneration. Knowledge and expert input from different disciplines and organizations in all project phases is essential in eco-dynamic design processes for the projects to be successful. Working together with ecologists, hydrologists, geologists, materials scientists, planners, landscape designers, developers and stakeholders often gives new insights with clear benefits for integrated planning and sustainability. This is because the existence of many ecosystem services and their potential value are often unknown to designers and spatial plan developers, whereas scientists are often unaware of economic or social drivers.

Resumed, Eco Dynamic Design benefits are the following:

- Supports decision making in spatial development in line with nature dynamics.
- Helps exploiting best value of services provided by multifunctional natural ecosystems and integrate these in processes (land planning, environmental planning, BF regeneration, habitat restoration, green infrastructure development) aimed at benefiting society's (stakeholders) needs
- Provides a platform for stakeholders from different disciplines to collaborate and find consensus on best acceptable options to reach planned objectives, resulting in sustainable re-use of Brownfields.