# Sustainable and risk based land management – a briefing about the current state of practice and suggested future direction of travel

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WP3

# WP3 – Sustainable and risk-based remediation

Del 3.1

# Sustainable and risk based land management – a briefing about the current state of practice and suggested future direction of travel

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Information-based Strategies for LAND Remediation

ISLANDR for Soil Health

Date: 31/05/2024

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# Project partners

| | Participant organisation name | Type | Country |
|---|---|---|---|
| 1 | GEOLOGIAN TUTKIMUSKESKUS (GTK) - COORDINATOR | RES | FI |
| 2 | BUREAU DE RECHERCHES GÉOLOGIQUES ET MINIERÈS (BRGM) | RES | FR |
| 3 | STICHTING DELTARES (DELTARES) | RES | NL |
| 4 | ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH) | RES | GR |
| 5 | CHALMERS TEKNISKA HOGSKOLA AB (CHALMERS) | UNI | SE |
| 6 | UNIVERSIDADE NOVA DE LISBOA (NOVA) | UNI | PT |
| 7 | GREENDECISION SRL (GD) | SME | IT |
| 8 | INSTYTUT UPRAWY NAWOZENIA I GLEBOZNAWSTWA, PANSTWOWY INSTYTUT BADAWCZY (IUNG) | RES | PL |
| 9 | In negotiation | | |
| 10 | SUOMEN YMPARISTOKESKUS (SYKE) | RES | FI |
| 11 | SANTERRA | SME | BE |
| 12 | IRN | SME | XK |
| 13 | TEMAS SOLUTIONS GMBH (TEMASOL) (Associate partner) | SME | CH |
| 14 | R3 ENVIRONMENTAL TECHNOLOGY LIMITED (R3) (Associate partner) | SME | UK |

# 1 Introduction

This report, Deliverable 3.1, is produced as part of the Horizon Europe programme's ISLANDR project (see Box 1.1). It is a consultation document about "Sustainable and Risk Based Land Management (SRBLM)", and how this concept will be advanced by the ISLANDR project. It is for sharing with key stakeholders inside and outside the project to both inform them and to collect their feedback with a view to producing a "White Paper" or technical bulletin for widespread communication on SRBLM. In particular, this consultation is intended for the ISLANDR Test Areas (ITAs) and the stakeholder networks NICOLE (primarily site owners and service providers), COMMON FORUM (primarily regulators) and the International Sustainable Remediation Alliance (ISRA).

**Box 1.1: The ISLANDR Project**

The ISLANDR Project (Information-based Strategies for Land Remediation) has 14 partners from around Europe and is funded by Horizon Europe (Grant agreement 101112889) and national contributions from the UK and Switzerland to a total of €6.9 million. ISLANDR aims to promote the delivery of Green Deal objectives, in particular achieving Zero Pollution by reducing soil pollution and enhancing restoration. ISLANDR provides a series of tools and methods to support: (1) the delineation of soil pollution sources, (2) the assessment of risks, (3) the implementation of sustainable and risk-based land management (SRBLM), (4) the inclusion of wider valuation approach in financial and investment cases, (5) closer integration of land contamination and spatial planning decision-making and (6) key policy relevant findings related to the Soil Strategy, proposed soil monitoring law and other areas of policy where soil is a crucial consideration.

ISLANDR is developing a stakeholder-orientated roadmap from the identification of potential problem sites or areas, through site investigation, risk assessment, risk management, investment decision-making, linkage to related decision domains – in particular spatial planning, and into nuanced and targeted policy briefings. It will provide a package of more specific guidance and decision tools in support of this road map. ISLANDR plans to equip practitioners with scalable information depending on their stakeholder role, their (self-identified) skill level and the project stage they are involved with.

SRBLM combines risk assessment with the internationally developing themes of sustainability and resilience, as described in ISO 18504:2017 (ISO 2017). ISLANDR plans to advance SRBLM thinking by reaching a closer integration of land contamination and spatial planning decision-making, the inclusion of a wider valuation approach together with a more thorough understanding of low input remediation approaches from a technological perspective as well as an evidence-based assessment of the risks posed by polluted soils. More specifically, ISLANDR is working on the integration into SRBLM of:

- Circular economy perspective,
- The application of low input remediation techniques (such as nature-based solutions like phytoremediation) particularly for challenging contexts such as dealing with diffuse contamination,

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- The use of holistic concepts of value in driving remediation investment decision-making, for example considering wider sustainability gains and social benefits,
- Specific consideration of soil health, as defined in Box 1.2, related to soil functionality for the site concerned, Through the identification of key soil functions and their consideration regarding the impacts and contributions of remediation strategies.

**Box 1.2 Soil Health**

Soil health has been defined as "the continued capacity of soils to support ecosystem services" and Ecosystem services are understood as the services provided and the benefits people derive from these services, both at the ecosystem and at the landscape scale, including public goods related to the wider ecosystem functioning and societal well-being" (EC, 2021)

*The goal of this consultation document is to promote the development of a shared understanding of the current state of practice for sustainable and risk-based land management and collect a wide range of stakeholder opinions about how this might be advanced to be more inclusive for considerations of soil health, low input remediation techniques and wider concepts of value. The report sections consider:*

- *SRBLM in a nutshell*
- *Circular economy perspective*
- *The potential for low input remediation*
- *Wider concepts of value and their use in investment decisions*
- *The consideration of soil health*
- *ISLANDR next steps.*

A particular focus for ISLANDR is for sites where reuse and/or remediation is *challenging* as it is stalled for economic reasons, types "B" and "C" as defined by CABERNET in 2006 (Ferber *et al.* 2006). Brownfield sites can be divided into three broad categories based on the financial ease with which they can be reused. This is called the "ABC" model, see Figure 1.1. For some sites, there is a strong financial feasibility driving redevelopment, for example, because the property value is high, referred to as "Type A". For sites referred to as "Type B", the Private Sector financial case is marginal, but redevelopment could be facilitated by a public funding intervention such as an investment fund. In some cases, there is no direct viable financial case for redevelopment, referred to as "Type C". If Type C sites are to be restored, this generally falls to public budgets. However, public funding is not a given, and if provided, it may only be sufficient for minimal actions to mitigate risks to health (for example preventing access). Thus B&C sites may be stalled and remain as degraded land for the long term, with consequent deleterious environmental, economic, and social impacts on their surroundings. The development of a strategy and investment case that can support the restoration of these

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sites whether public, private or mixed funding, given the tendency to relatively narrow cost-benefit analysis, remains an enormous challenge.

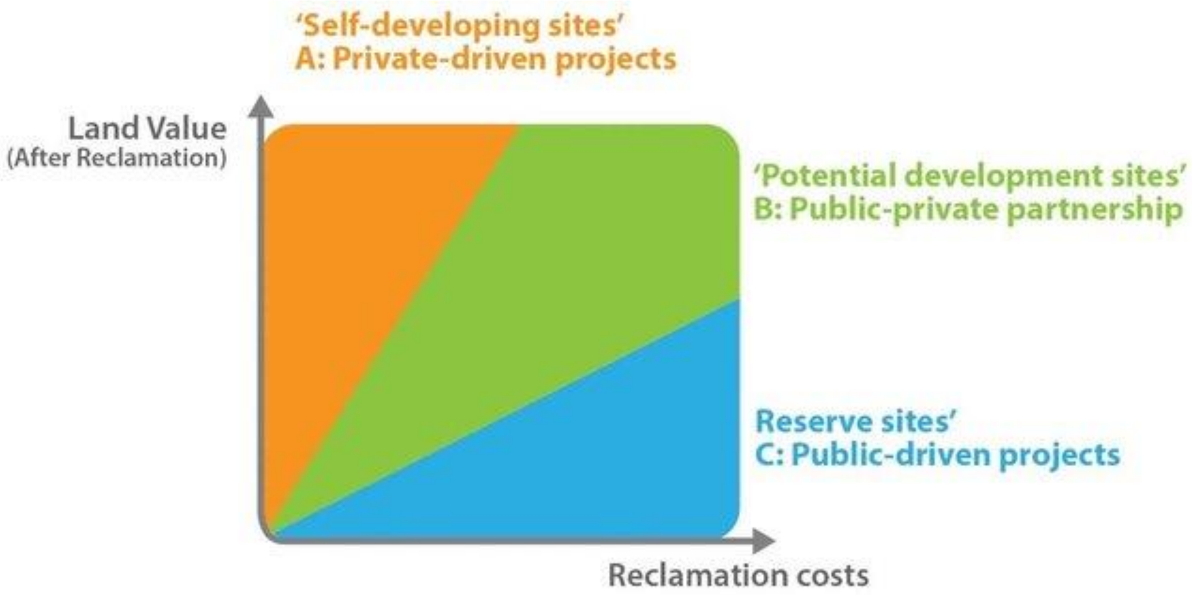


**Figure 1.1: CABERNET ABC model for Brownfield sites (taken from Ferber *et al*. 2006: Sustainable Brownfield Regeneration).**

# 2 Sustainable and risk-based land management (SRBLM)

Risk assessment is used in most countries as a tool to set contaminated site management priorities and to design individual site remediation strategies. Risk assessment is a formalised process of evaluating the consequence(s) of a hazard, for example the presence of potentially toxic elements, and their likelihoods/probabilities. In other words, risk assessment for contaminated sites is a process for understanding the likely level of harm from land contamination, and how likely that harm is to happen (Bardos, 2024). Figure 2.1 shows this relationship in a qualitative way.

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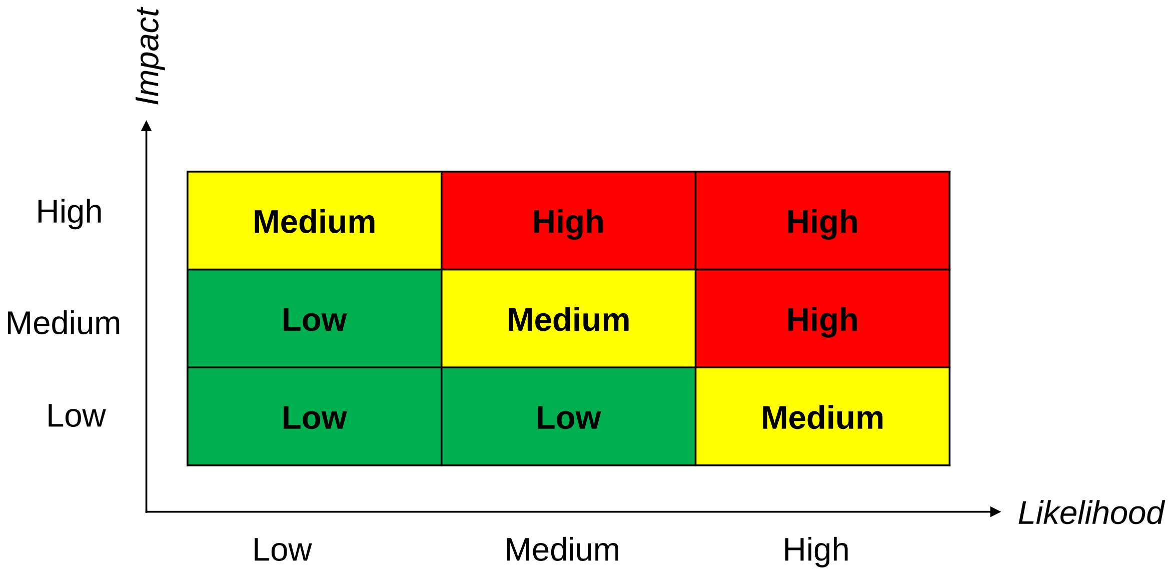


**Figure 2.1 A simplified risk matrix, risk as a consequence of impact and likelihood (figure from Bardos 2024)**

The risk assessment process is based on a series of steps.

- Hazard identification – to identify hazards that have the potential to cause harm;
- Hazard characterisation - to analyse and evaluate the risk potential for that hazard for example considerations of toxicity and pathways, also known as exposure assessment;
- Risk estimation - to estimate the level of risk to different receptors; and
- Risk evaluation - to determine the likely significance (seriousness) of those risk levels.

These steps are carried out based on an understanding of:

- Sources: the presence of hazardous substances and their locations
- Receptors: entities that are vulnerable to these hazards, for example, humans, bodies of water, ecology, building foundations, and of course soil health (although this is currently rarely specifically considered as a receptor)
- Pathways: the routes by which hazards could reach receptors, for example, in air as a vapour, or dissolved in water.

Risks exist when a receptor is connected to a source of a hazard via a pathway, as illustrated in Figure 2.2. These connections are often described as S-P-R linkages, or in some countries "contaminant linkages" or "pollutant linkages".

Multiple linkages may exist on a site. If one or more of these are estimated to have an unacceptable level of risk, then risk management is necessary. Risk management describes interventions that are made to mitigate risks from the hazards identified. Risk management

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interventions (for example contaminated site remediation) break linkages (see Figure 2.2). The linkage may be broken by removal of a source or rendering it harmless, by preventing it from moving along a pathway, or by intervening at the level of the receptor, for example a zoning regulation to restrict the range of possible land uses to (say) "industrial". An overall remediation strategy for a contaminated site therefore needs to address the totality of the S-P-R linkages assessed to be problematic.

Information about S-P-R linkages can be combined in conceptual site models (CSMs), which are diagrammatic representations of these linkages for a particular site, supported by brief written comments (ISO 2019). CSMs are used to communicate site investigation, risk assessment and risk management information and are iteratively developed along a site management trajectory from initial desk study, site investigation, risk assessment and management and subsequent verification of any remediation work undertaken, for example see Figure 2.3.

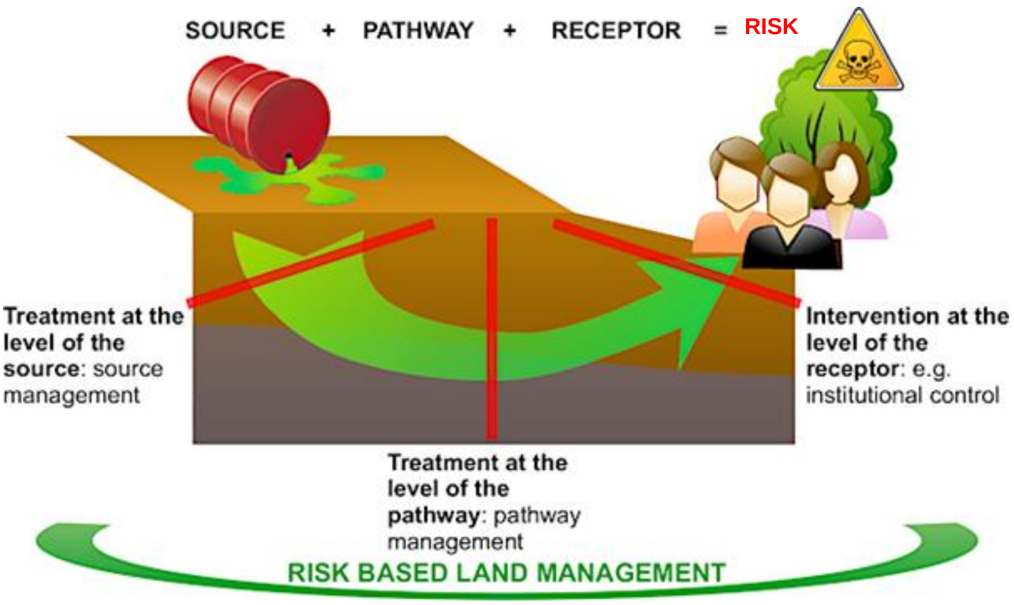


**Figure 2.2 Risk based land management (adapted from Tack and Bardos 2020)**

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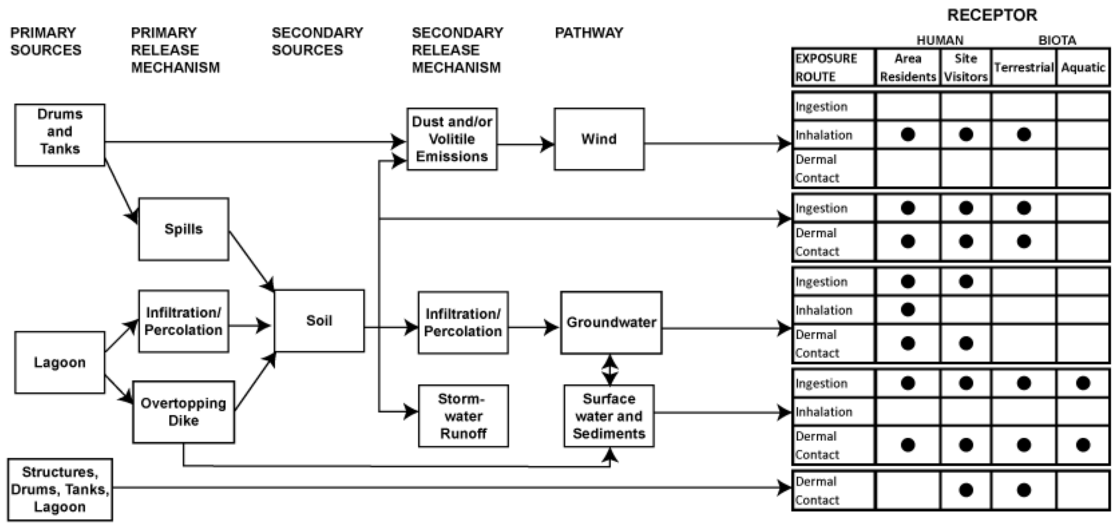


**Figure 2.3 Example pathway receptor network diagram, taken from US EPA (2011)**

"Sustainable Development" has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987). In September 2015 the United Nations has set 17 sustainable development goals (SDG) with an explicit concern over land degradation (United Nations, 2015).

Since mid-to-late 2000s a growing interest for sustainable remediation has emerged in initiatives from several international and national organisations as well as other initiatives from networks and forums (Rizzo *et al.* 2016). The sustainable remediation ISO standard, ISO 18504:2017, is based on a large body of work across many countries (ISO, 2017). The standard describes and summarises an increasing global consensus that the overall benefit of risk management/remediation should be positive, also considering its wider impacts, and that decision-making should be inclusive and transparent (see Figure 2.4).

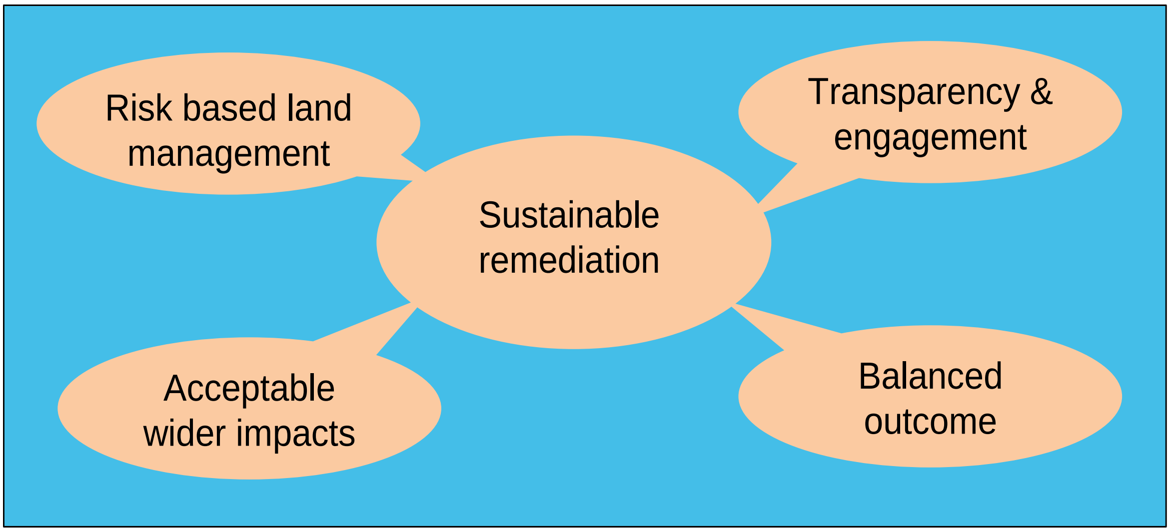


**Figure 2.4 Sustainable Remediation, courtesy of r3 environmental technology ltd.**

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The “sustainable and risk-based land management” concept (SRBLM) brings in “sustainability” as an additional decision dynamic for risk management decisions (Bardos, 2024), which is the maximisation of sustainability gains, and the minimisation of sustainability losses (see Figure 2.5). SRBLM can influence decision-making at several points across the lifecycle of an individual site or for a portfolio of sites: from the very inception of a project, during the planning of the future land use and how the site will be redeveloped and the planning of how the site will be restored, comparing remedies for individual S-P-R linkages and for considering the aftercare and long-term stewardship of a site.

There is an important cross-over between spatial planning and SRBLM as spatial planning decisions determine land use, which in turn determines the source-pathway-receptor linkages that define risk assessment outcomes and risk-management needs. Different spatial planning choices across a land area may lead to substantial sustainability gains, for instance by the *avoidance* of S-P-R linkages, or by the creation of opportunities for interim land management solutions that favour longer-term and lower input remediation choices such as nature-based solutions (NbS).

The development of sustainability as a consideration in site decision-making and increasing opportunities to value wider social, economic and environmental benefits (for example via social return on investment approaches) creates an opportunity for a more holistic approach to cost-benefit assessment for the *challenging* sites that are ISLANDR’s focus. Moreover, the use of “low input remediation techniques” creates an opportunity for remedies for these challenging sites that both lower costs and deliver, or can be associated with the delivery of, a range of wider services such as renewable energy and feedstocks, wider ecosystem service delivery and social benefits related to public amenity. A wide range of low input remediation interventions are available (see Section 4).

It is important to recognise that this *tendency* towards lower inputs and wider benefits does not mean that a “low input technique” is automatically the most sustainable approach. The most sustainable approach is critically dependent on project and site-specific factors, as illustrated in Figure 2.6. Other remediation alternatives may be a more sustainable choice depending on the site circumstances, for example:

- If local waste heat is available then a thermally based *in situ* remediation could be a sustainable choice, at least in terms of energy balance.
- A phytoextraction-based system could be less sustainable because of the risk of transmission of metal contamination along biomass value chains.

These are simply examples, the overall sustainability of *any* project needs to be understood on the basis of site-specific sustainability assessment, and not on the basis of simple assumptions that one technique is better than another.

The “sustainability” concept behind SRBLM cannot be complete without considering soil health. The fast-emerging concepts and methodologies for assessing soil health all converge in considering soil functions as keystones for the provision of ecosystem services that are dependent on soil ecosystems. However, although the recent European Soil Framework Directive suggests indicators to evaluate soil health and although several countries already consider the risk towards ecosystems in their site assessments, many questions persist on the methodologic approaches to use. Taking the concept further, the next step is to integrate the consideration of the risk of remediation methods on soil functionality in regard to the future use of a site. Also, the contribution of soil health by delivering ecosystem services to the remediation process, such as natural attenuation and to the redevelopment of sites, such as climate adaptation should be better identified and taken up in the accounting for wider values of the remediation and redevelopment.

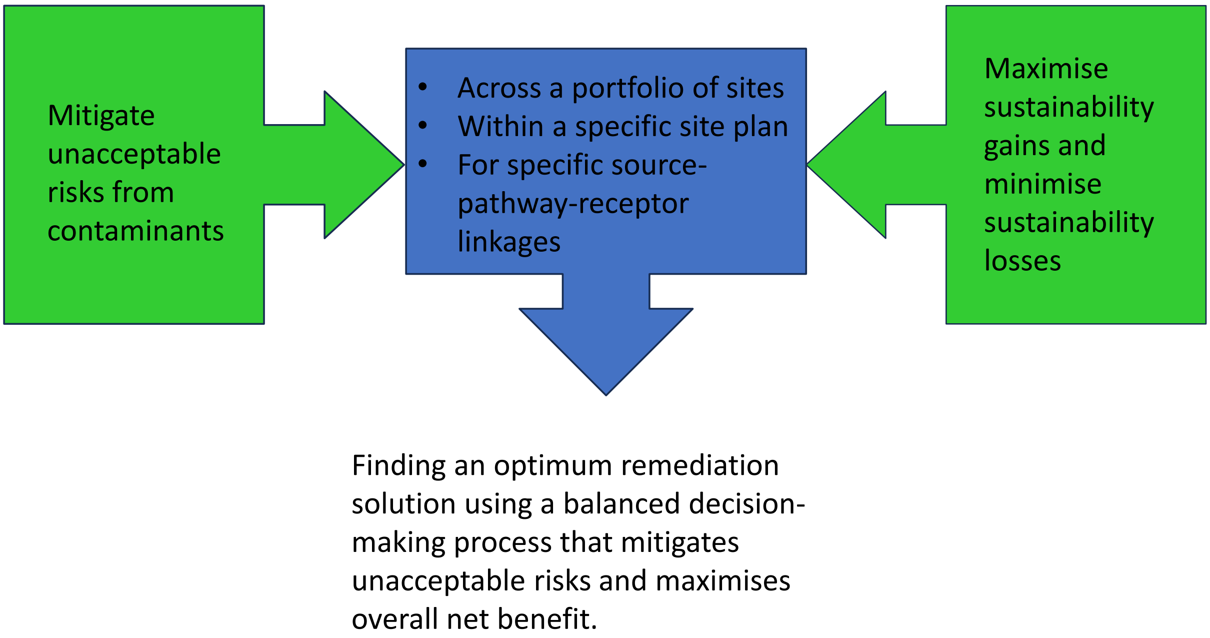


**Figure 2.5 Sustainable and risk-based land management (Bardos 2024)**

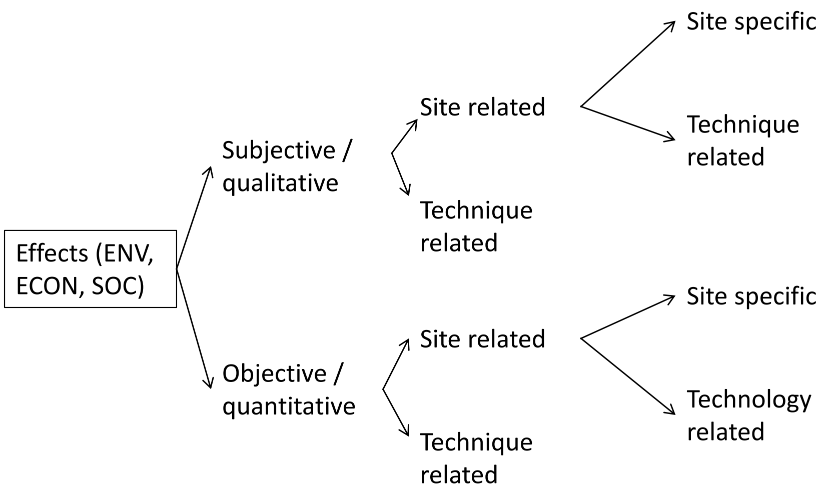


**Figure 2.6 Sustainability considerations, sites and techniques (from Bardos 2024).**

It is important to be clear that sustainability is **not** tradeable against risk management objectives. In other words, it is not a valid argument to suggest that a risk management target threshold (such as a requirement for a maximum soil contamination level) should be

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relaxed to reduce the carbon costs of the remediation process. This kind of trade-off would lead to a receptor still being at an unacceptable risk of harm. The purpose of remediation is to mitigate this risk. Accordingly, sustainability assessments of remediation technologies consider, as alternatives to be assessed, only those that allow the mitigation of unacceptable risks.

# 3 A circular economy perspective for land remediation

A circular economy for land is a major policy goal in most countries, with many compelling arguments for encouraging the reuse of previously used land rather than greenfield developments. For example, the EU seeks a net land take of zero in < 30 years (i.e., no net land take by 2050). Brownfields are sites where the previous use has discontinued and reuse has stalled, which may be for a variety of reasons. The redevelopment and restoration of these sites is an opportunity for land "recycling", so reducing land take from greenfield areas (see Figure 5.1).

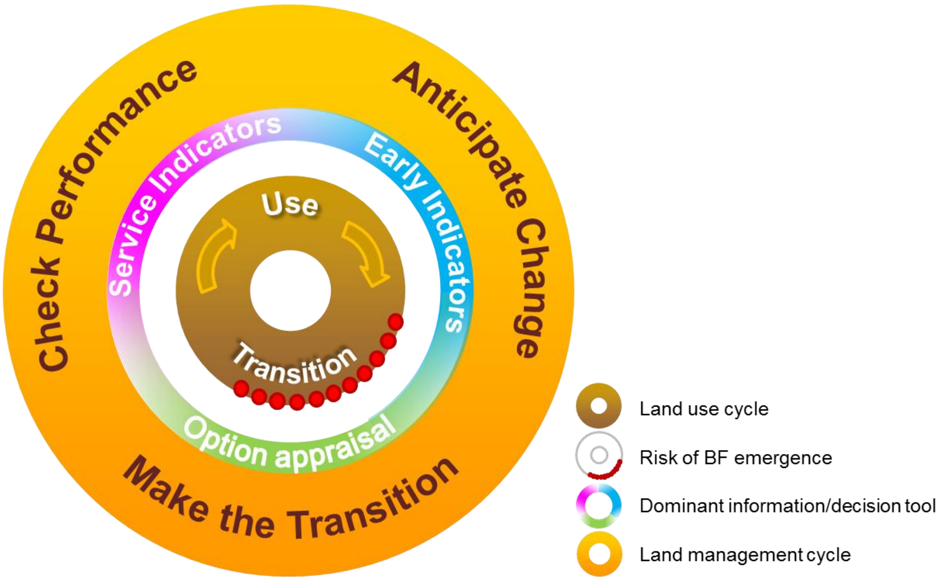


**Figure 3.1 Circular land management (FP7 HOMBRE Project, Van Gaans & Ellen, 2014)[1]. Red dots indicate where there is potential for the emergence of new brownfield sites.**

The circular economy perspective is also very relevant in the context of the use and generation of resources by land-use including contaminated sites management, or example taking into account:

[1] https://www.zerobrownfields.eu/content.aspx?wp=3&p=227

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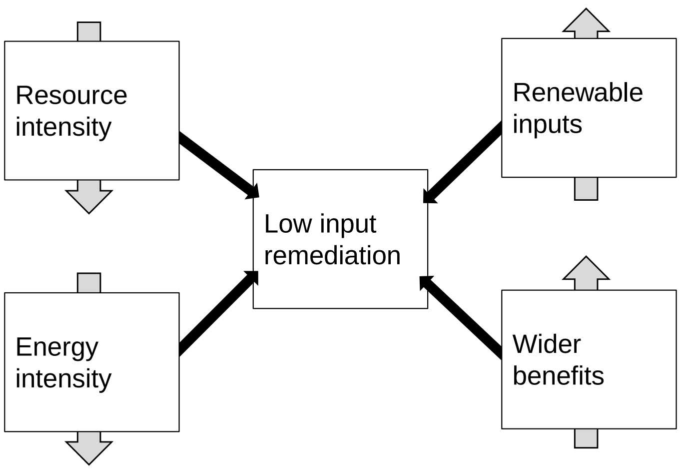
- Natural soil is essentially a non-renewable resource because of the length of time required for soil formation on bedrock so where soil is excavated in projects it should be fostered as resource and brought back into use to avoid extraction of virgin materials such as topsoil or aggregates, which is under discussion in a separate ISLANDR activity and will be reported on in detail by the end of 2024[2].
- The resources and energy consumed and created by remediation processes, where low input remediation, such as phytoremediation, offer particular opportunities as they are relatively frugal in their use of resources and energy and provide biomass which can be used for energy or biofeedstock.

# 4 The potential for low input remediation techniques

Low input remediation techniques describe a "family" of techniques which are generally considered to need lower inputs of energy and materials and also offer wider benefits than conventional remediation technique, including the capacity to generate renewables (see Figure 4.1).

Many available remediation techniques, for example, those based on pumping, thermal processes, soil washing, and such like, are resource- and energy-intensive. Therefore, given the importance of reducing the use of non-renewable resources and fossil carbon energy, there is an increasing interest in remediation techniques where materials and energy demands are low, i.e., *low input remediation techniques*. These low demands may be because inputs are supplied by natural processes such as photosynthesis, or because renewable energy (such as from photovoltaic systems) or renewable resources (such as biochar) are exploited. These low-input techniques typically come with other advantages, in particular the potential for generating renewables (such as biomass) and wider benefits such as the preservation of soil functionality, as summarised in Table 4.2. The concept includes and expands on remediations considered as NbS and "Gentle Remediation Options" (Bardos, Pizzol *et al* in preparation).




[2] ISLANDR D5.1, Defining barriers and potential solutions for reuse of contaminated land and soils

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**Figure 4.1 Schematic illustration of the benefits of applying low input remediation.**

**Table 4.1 Examples of low input remediation techniques (Bardos, Pizzol, *et al.* in prep).**

| In or close to practical deployment | Emerging techniques undergoing research and development |
|---|---|
| • *In situ* stabilisation using biochar or other renewable inputs<br>• Various forms of *in situ* bioremediation<br>• Natural attenuation and natural source zone depletion<br>• Electrokinetics using renewable energy<br>• Phytoremediation variants<br>    o Phytoextraction<br>    o Rhizofiltration (engineered wetlands)<br>    o Phytovolatilisation<br>    o Phytostabilisation<br>    o Phytocontainment<br>    o Phytoexclusion<br>• Various forms of permeable reactive barriers | • Mycoremediation<br>• Phytodegradation / rhizodegradation<br>• Enhanced Phytoremediation<br>• Bioelectrochemical remediation |

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**Table 4.2 Examples of potential wider benefits from low input remediation, depending on the technology and other site interventions (developed from Bardos *et al.* 2016).**

| Level 1 | Level 2 | Examples |
|---|---|---|
| Risk mitigation of contaminated land and groundwater | Biosphere (including human health) | Human health protection |
| | | Protection of ecology |
| | Water resources (hydrosphere) | Surface water treatment and protection |
| | | Groundwater treatment and protection |
| Soil improvement | Fertility | Managing nutrient and micronutrient availability to support vegetation |
| | | Improving soil biological functionality |
| | | Improving soil condition to support desired plant/crop |
| | Soil structure | Improve soil resilience |
| | | Providing vegetative cover |
| | | Mitigation measures for soil erosion and land sliding |
| Water resource improvement | Water resource efficiency and quality | Reuse of water resources |
| | | Recovery of water resource |
| | | Improved quality of surface water on-site or in the vicinity |
| | Flood and capacity management | Retention of runoff/surface water storage |
| | | Flood mitigation (incorporating mitigation of severe weather events) |
| | Rehabilitation of water | Rain/drainage water (including sustainable drainage) |
| | | Contaminated leachate/drainage treatment and reuse (landfill leachate, acid mine drainage, etc.) |
| Provision of green infrastructure | Enhancing ecosystem services | Protection of habitat and biodiversity (where existing and for protected sites) |
| | | Developing new habitats and increasing biodiversity |
| | Enhancing local environment | Improve urban soundscapes and air quality |
| | | Limiting visual intrusion by landscaping (buildings, transport links etc) |

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| Level 1 | Level 2 | Examples |
|---|---|---|
| | | Urban climate management (such as mitigation of urban heat island effect) |
| Mitigation of human induced climate change (global warming) | Renewable energy generation | Energy for on-site use |
| | | Energy for off-site use |
| | | Supply to an integrated energy mix |
| | Renewable material generation | Biofeedstock (for biofuel/gas/plastics) |
| | | Reuse of organics |
| | Greenhouse gas mitigation | Reduced GHG emissions |
| | | Carbon sequestration |
| Other socio-economic benefits | Amenity | Open space |
| | | Leisure |
| | | Education |
| | | Improved health and wellbeing |
| | | Access (footpaths, cycle routes) |
| | | Tourism |
| | | Community centre |
| | | Views and viewpoints |
| | | Framing built developments |
| | | Grazing |
| | Economic assets | Job generation |
| | | Land value recovery over time |
| | | Area value uplift |
| | | Interim land management |

There are significant obstacles limiting the practical deployment of many low input remediation techniques:

- Their performance may not be well benchmarked against more conventional remediation approaches.
- They are not necessarily perceived as offering the same risk management performance, for instance, because they take significant time to remove a source term.
- They are not as well understood by many stakeholders, which creates uncertainty in their deployment.

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- The opportunities they offer for wider benefits related to soil health or the creation of renewables or landscape improvement are not routinely given economic or financial values in the development of site management plans.
- Very often remediation options appraisal takes place towards the end of a site management decision pathway, i.e. *after* the planning of the future land use at the site and the detailed layout has been determined and *after* the risk management objectives this layout depends on have been set. By this stage, many of their advantages no longer exist.
- For development sites, often the remediation and the redevelopment of a site are considered in a disjointed way, so that potential opportunities from a low input remediation technique such as providing a parallel sustainable urban drainage system are not considered and the opportunity to create enhanced value is missed.

A key focus of interest for ISLANDR is in addressing these key challenges.

# 5 Wider concepts of value and their use in investment decisions

The wider benefits and services that can be provided by remediation, and in particular by low input remediation approaches, may help change the economic considerations for *challenging* sites if they can be valued. The potential for societal benefits, such as improvements to community health from providing open space or recreational areas, or increased soil health and increased provision of ecosystem services, may also widen the pool of potential investment interests to include public funders interested in supporting these wider "societal benefits". For more effective design and implementation, a structured process for engaging stakeholders—including local communities, businesses, regulators, and investors—ensures their concerns and interests are considered in the prioritization process. The repurposing of brownfield sites for renewable energy production is now widespread in the USA[3] and a developing activity in Europe, for example in the Kosovo ISLANDR Test Area[4] (see Box 5.1). Less well understood is how this land re-use strategy can be linked with long-term risk management and wider nature-based solution benefits such as the improvement of habitat and soil health, although this synergy is of increasing interest (Semeraro *et al.* 2020).

Increasingly both the Private and the Public Sectors are acknowledging the need to take sustainability aspects into account in investment decisions for brownfield sites, especially where they will have a long-term stewardship for the site in question. Some of the wider benefits generated by remediation, not least by low input remediation, and redevelopment of sites can be included as externalities in cost-benefit analyses. This direction of travel towards taking a wider economic perspective could be accelerated by a better definition and valuation of the wider sustainability gains and losses for projects, particularly at the project planning stage and the development of the value proposition and investment case for a brownfields project. The development of a Green Deal economy also creates multiple opportunities for new economic activities in renewable resources and energy. Low input remediation linked to

[3] https://www.epa.gov/re-powering
[4] http://kek-energy.com/kek/kek_greenland/


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plants can also support biomass for energy such as biofuels or for biofeedstocks or renewable fibres. Use of land space for photovoltaic systems (and indeed battery storage facilities) can be integrated with ecological benefits with remediation exploiting NbS. Social return on investment assessment of the social benefits from providing public amenities on degraded land has been found to be potentially substantial by the pioneering work of Land Trust in the UK[5]. Other pioneer project examples include the trials for the rehabilitation of industrial and marginal land to produce bioplastic feedstock in Italy[6] and the development of a new park as a "green lung" in Manchester as part of a larger housing and commercial development[7]. Cross-cutting these options is the improvement of ecosystem services, increasing, e.g., biodiversity, carbon sequestration, and water quality, while also promoting climate adaptation and resilience.

**Box 5.1 Solar4Kosovo - Photovoltaic Plant[8]**

The electricity sector in Kosovo is almost entirely dependent on coal-fired power plants (97%). This investment project will install a solar photovoltaic plant of up to 100 MW capacity on former ash dump fields near 'Kosovo A' thermal power plant. This first large-scale solar photovoltaic plant in Kosovo will increase installed capacities tenfold from 10.1 MW to 110.1 MW. As a result, the share of solar power in the energy mix of Kosovo will increase from 0.2% to 2.3%. The plant is expected to be completed in 2027, and to produce around 152 GWh of electricity and save 152,000 tonnes of $CO_2$ annually.

Funding sources of Solar4Kosovo: WBIF EU grant: EUR 32.8 m, KfW loan: EUR 29 m, EIB: EUR 32.7 m, Beneficiary contribution: EUR 10 m. Estimated investment: EUR 104.5 m.

Considering the sustainability gains or losses of different remediation approaches could influence the decision on *how* a brownfield site is restored, with greater potential for wider sustainability gains the earlier this consideration takes place within the overall land re-use strategy decision-making (Figure 5.1). For example, a remediation approach for a diffuse contaminated site that also generates a usable biomass and/or ecological improvements could add a sustainability gain for the site. As another example, consider a brownfield site proposed for reuse for retail with landscaped parkland that includes an area with immobile and biodegradable wastes in the subsurface in the unsaturated zone well above the water table. If the contaminated area is planned for the retail development the contaminated soil will be excavated, creating a remediation requirement. If the contaminated area is planned to be in the parkland location, then the remediation solution can be one of isolation and natural attenuation, so the need for remediation is avoided, which is a sustainability gain. Obviously, this is a simplified example, and the location of the retail will depend on other issues such as accessibility. However, the overall principle that greater sustainability gains are possible if "sustainable remediation" is considered during overall site development planning and design

[5] https://thelandtrust.org.uk/who-we-are/policy/public-health-and-wellbeing
[6] https://www.matrica.it/article.asp?id=25&ver=en
[7] https://lcrproperty.co.uk/manchester-opens-its-first-new-park-in-100-years-setting-a-new-blueprint-for-sustainable-development/
[8] https://wbif.eu/storage/app/media/Factsheets April 2024/WBIF CLEAN ENERGY Factsheet April 2024.pdf

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and not left to the point where the site configuration and its various risk management requirements are fully defined. Additional sustainability gains may be possible if a portfolio of sites can be managed as a single package.

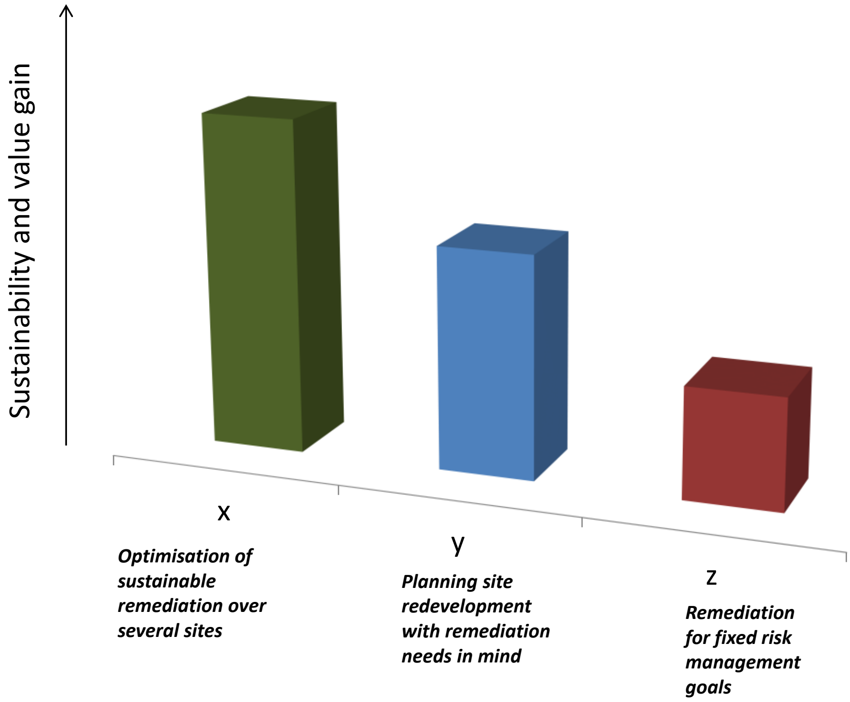


**Figure 5.1 An “xyz” model for early planning in sustainable remediation demonstrating the potential of higher gains the earlier sustainable remediation is considered (Bardos 2024).**

# 6 The consideration of soil health

The EU soil strategy was first elaborated in 2006 and relaunched in 2021 as a plan for the achievement of more sustainable soil management by 2030[9], which is supported by a proposed Directive on Soil Monitoring and Resilience[10], currently under negotiation. The Soil Strategy is a “key deliverable of the EU biodiversity strategy for 2030. It will contribute to the objectives of the European Green Deal. Healthy soils are essential for achieving climate neutrality, a clean and circular economy and halting desertification and land degradation. They are also essential to reverse biodiversity loss, provide healthy food and safeguard human health”. Also, the European Soil Mission aims at leading the transition towards healthy soils by 2030, by setting up Living Labs and a research program.

[9] https://environment.ec.europa.eu/topics/soil-and-land/soil-strategy_en
[10] https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_3637; https://www.euronews.com/green/2024/04/11/soil-protection-law-survives-plenary-vote-but-considerably-weakened

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The strategy,proposed Directive and Mission are underpinned by the concept of "soil health". **Soil health** has been defined as "the continued capacity of soils to support ecosystem services" where ecosystem services are understood as the services provided and the benefits people derive from these services, both at the ecosystem and at the landscape scale, including public goods related to the wider ecosystem functioning and society well-being" (EC, 2021), which is very closely aligned with concepts of soil functionality. Soil health depends on the biological, chemical, and physical properties of soil which underpins its function.

**Soil ecosystem services** depend on the functional processes and properties of the soil. A clear distinction is made between ecosystem functions and ecosystem services. Ecosystem functions are the ecological processes that result in the supply of ecosystem services. Ecosystem services are the benefits that people obtain from ecosystems, either directly or indirectly(figure 6.1). Changes in ecosystem functions influence the potential supply of ecosystem services. (Van der Meulen & Maring, 2018) (Soil) ecosystem services can contribute strongly to obtaining societal challenges and needs e.g. de Global Sustainable Development Goals (SDGs) (Figure 6.2).

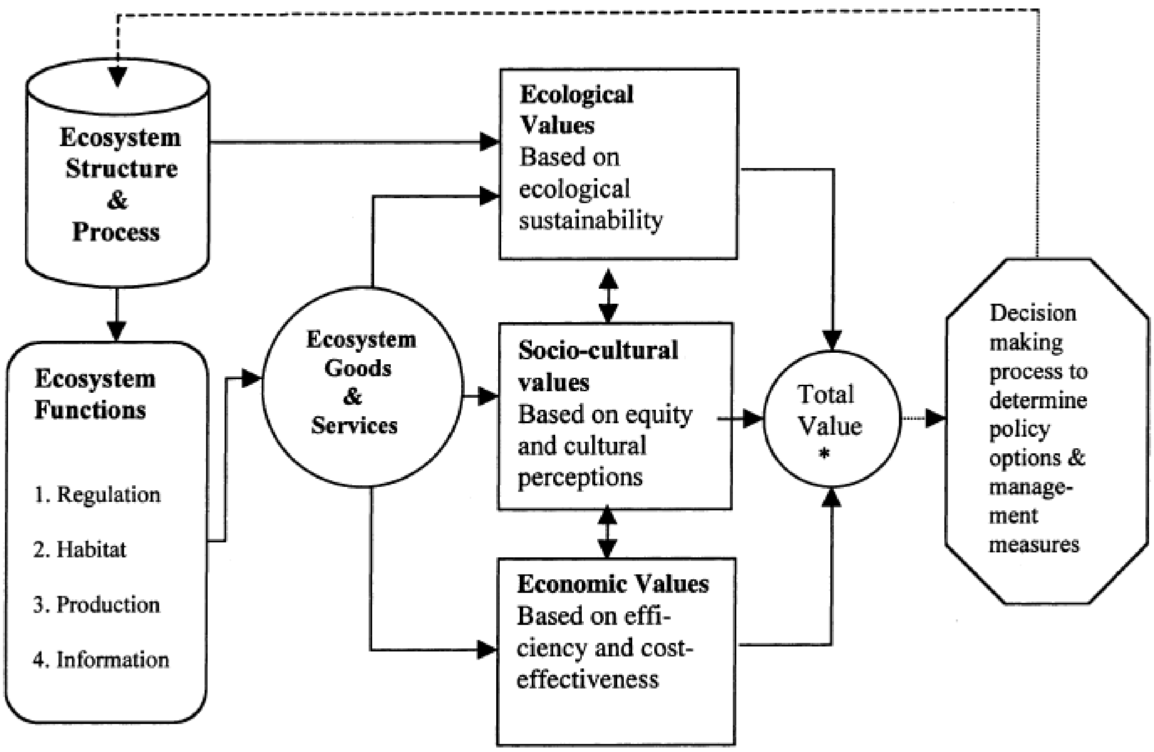


**Figure 6.1 Framework for integrated assessment and valuation of ecosystem functions, goods and services, De Groot et al., 2002**

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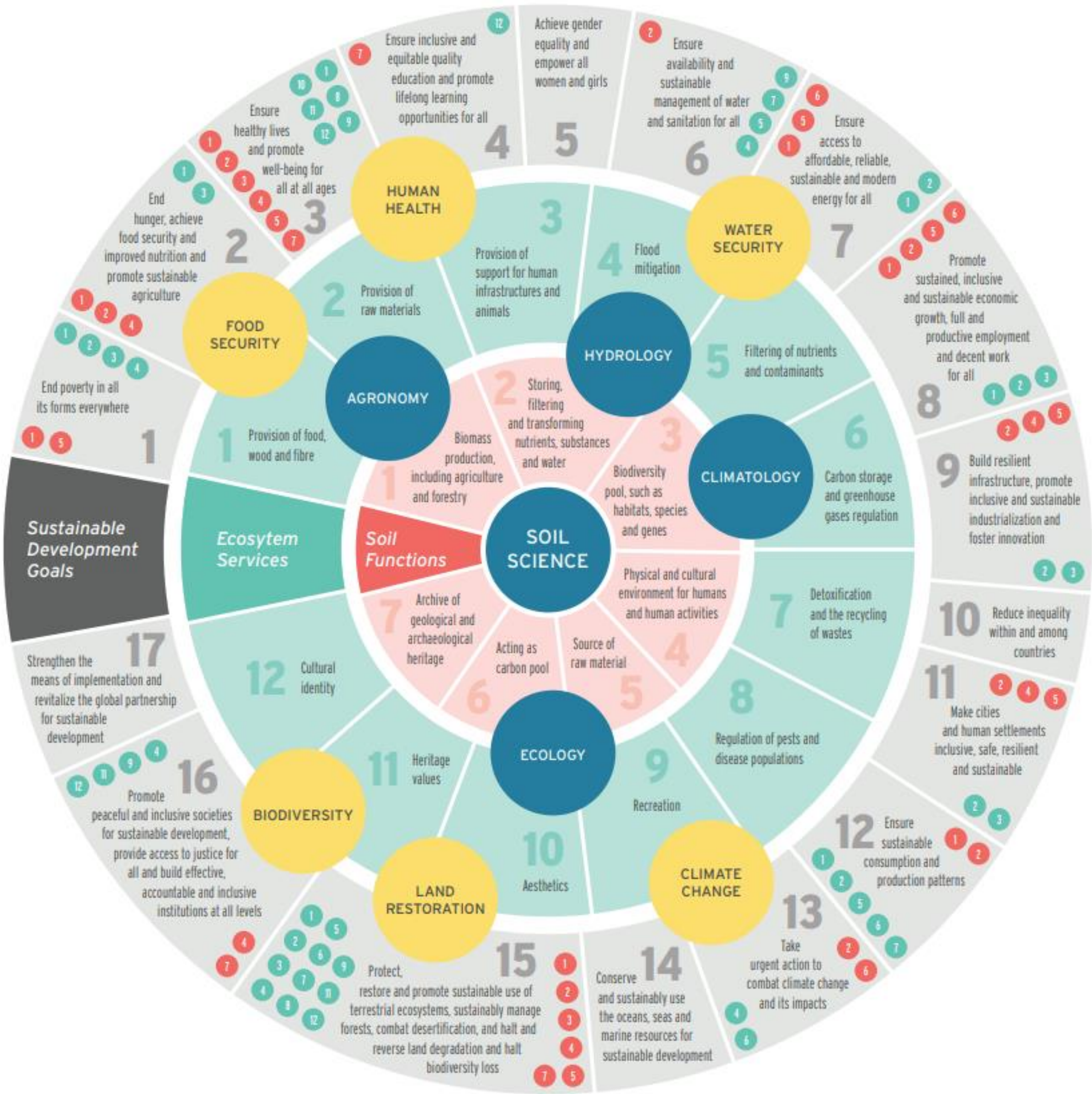


**Figure 6.2. Soil functions support provision of ecosystem services that contribute to the achievement of multiple SDG's as defined by the United Nations. (Keesstra et al., 2016).**

Soil functions are the result of interactions between biotic and abiotic soil components. Three main categories of functions are generally distinguished:

- Hydrogeomorphological functions: these include all functions related to the water cycle (retention, water infiltration/water table recharge, runoff slowdown, soil stabilization against erosion);
- Biogeochemical functions: all purification functions (recycling and retention of organic matter, elimination of pollutants, retention of particles), as well as carbon sequestration and fertility;
- Biological functions: these include habitat support functions and ecological connectivity.

**Soil ecosystem functions** result from the interactions between biotic and abiotic soil components enabling soil to function as a vital living system and to provide ecosystem services. There are 6 soil functions that are prevalent at the site level: carbon storage and dynamics, nutrient supply to plants, water retention and infiltration, habitat for biodiversity, pollutant retention and degradation and physical stability. At a bigger scale in time and space they can include the contribution to air quality, climate regulation or even pedogenesis.

The consideration of soil health and thus soils ecosystem functions (and the difficulties to do so) in current spatial land management and choice of remediation strategies is still understudied.

The Mission Soil implementation plan (EC, 2021) lists 8 objectives for achieving good soil health by 2050

- reduce desertification ;
- preserve soil organic carbon stocks;
- stop soil sealing and increase the reuse of urban soils;
- reduce soil pollution and improve soil remediation;
- prevent erosion;
- improve soil structure to enhance soil biodiversity;
- reduce the EU's overall soil footprint;
- improve society's understanding of soil.

Mission Soil also defines poor soil health as corresponding to "soils poor in organic matter for their type, compacted or contaminated by chemicals such as nutrients, heavy metals, biocide remnants, hormones and medicines at concentrations higher than those allowed by health regulations or plant requirements."
Although contaminated land has no healthy soils, it still has functioning soil functions and can deliver valuable ecosystem services that offer value for the site and its transition to new use and a cleaner state.

Soil (chemical, physical and biological) quality is highly site specific and moreover may evolve over time. The functioning can also be improved by gentle remediation strategies that use the natural system and spatial planning strategies considering the spatial diversity and allow for e.g. temporal, interim uses. However, the improvement of soil health will be gradual, and takes time. . By bringing together, in an early stage, the planning and remediation experts, and by working on a collaborate plan for the site's future, both the remediation strategy and the redevelopment towards new uses can be combined. This evolution should be built into spatial planning strategies which foresee several interim stages of reuse with an overall pattern towards extending the multifunctionality of an area as part of a long-term risk management vision. A stepwise approach also encourages actors to start working on the transition towards soil health when realistic goals (both in of terms of effort and in terms of time to reach the (interim and final) goals) are set.

# 7 ISLANDR Next Steps

ISLANDR’s ongoing work focuses on improvements to:

(1) the delineation of soil pollution sources,

(2) the assessment of risks,

(3) the implementation of sustainable and risk-based land management (SRBLM),

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(4) the inclusion of wider valuation approaches in financial and investment cases,

(5) closer integration of land contamination and spatial planning decision-making and

(6) key policy-relevant findings related to the Soil Strategy, proposed soil health law and other areas of policy where soil is a crucial consideration.

Responses to this consultation document will be used to better focus these efforts with a view to providing a roadmap (see Figure 7.1) for different stakeholders dealing with contaminated land, to support an expansion of the scale and pace of bringing *challenging* sites back into a productive and useful land-use cycle, avoid a linear (cradle to grave) exploitation of soil resources and improve soil health. This roadmap, due in mid 2026 will focus on the nexus between low input remediation, soil health and wider values to develop better policy and investment cases for the sustainable and risk-based management of *challenging* sites. The roadmap distinguishes the different phases of remediation and redevelopment of these challenging sites, it considers the main activities for the different actors. Within each of these activities, it will connect to 'building blocks' that support these activities. These building blocks can be individual, more detailed resources such as:

- a scheme for including soil health as a receptor in conventional contaminated site risk assessment practices and models
- a template for developing investment cases that include wider values for site rehabilitation
- Guidance for soil-inclusive planning
- Remediation appraisal tools

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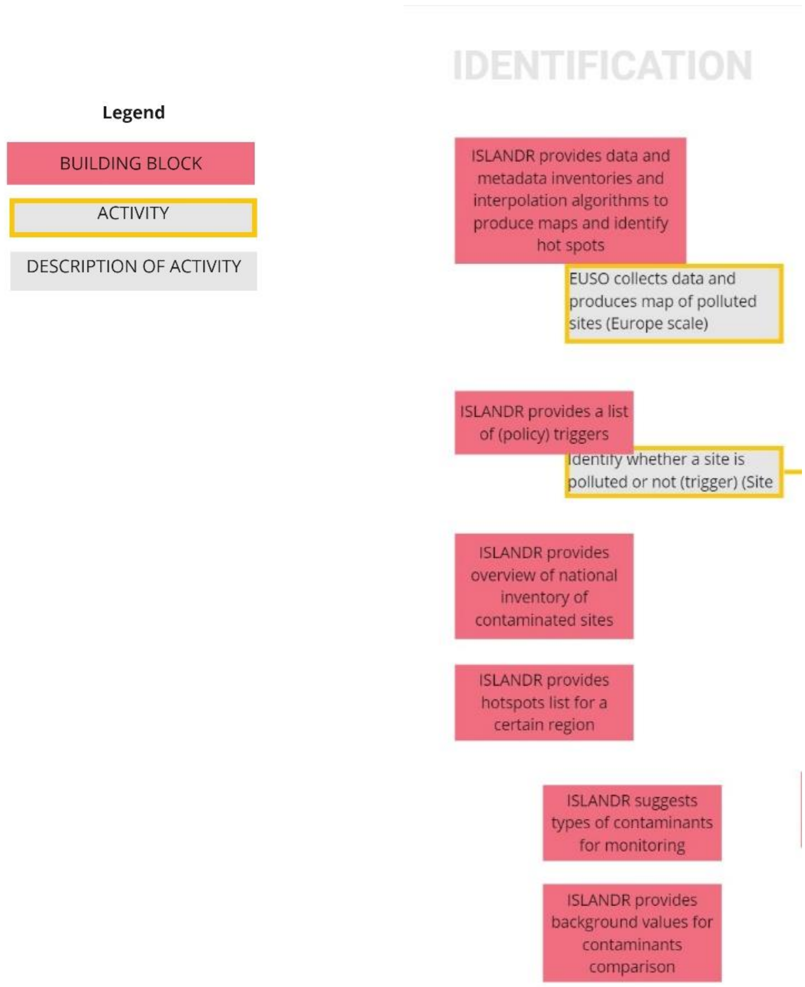
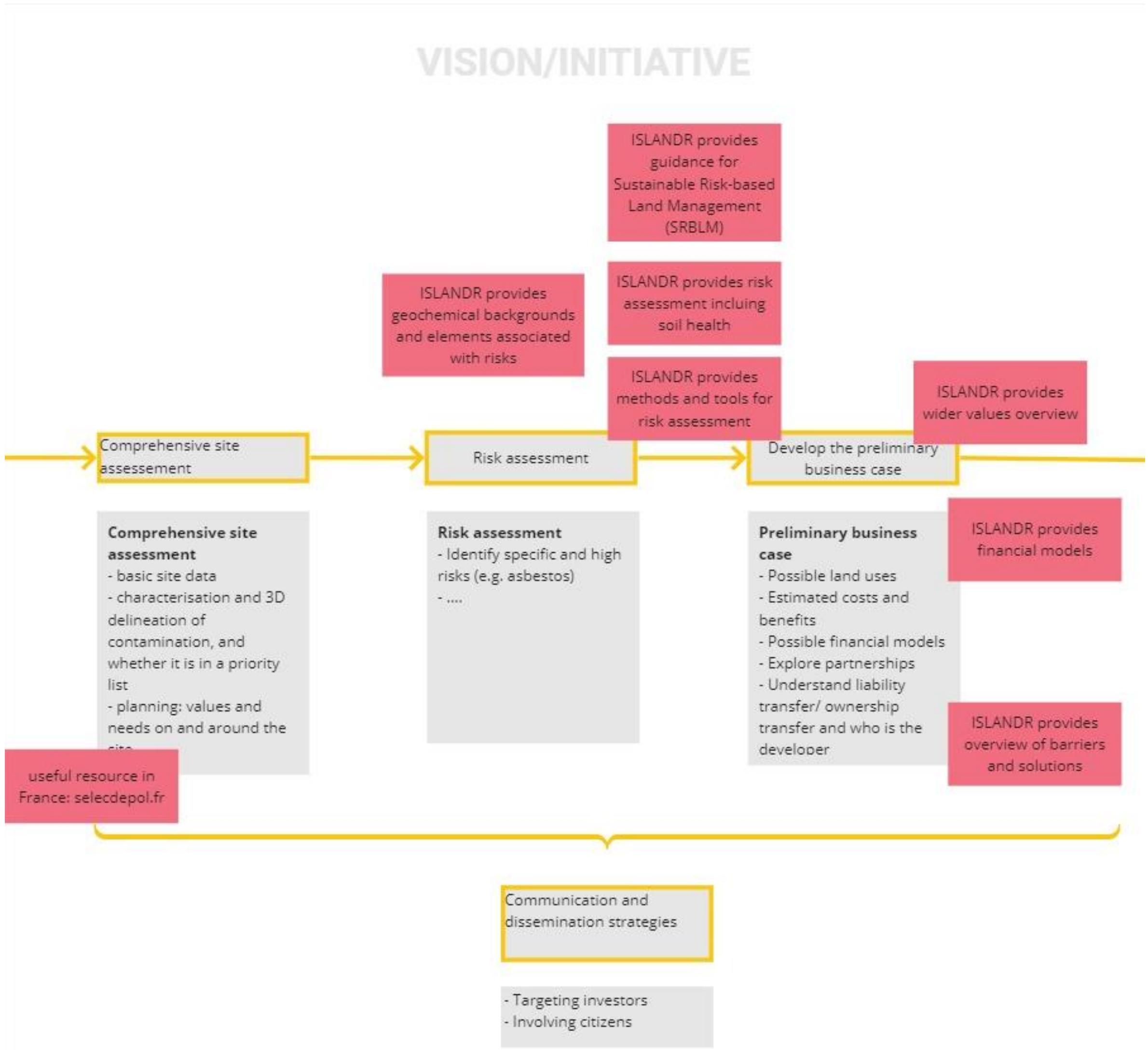
**Figure7.1 Draft visualisation of the roadmap. Yellow-lined boxes are the activities, pink boxes are the 'building blocks'**



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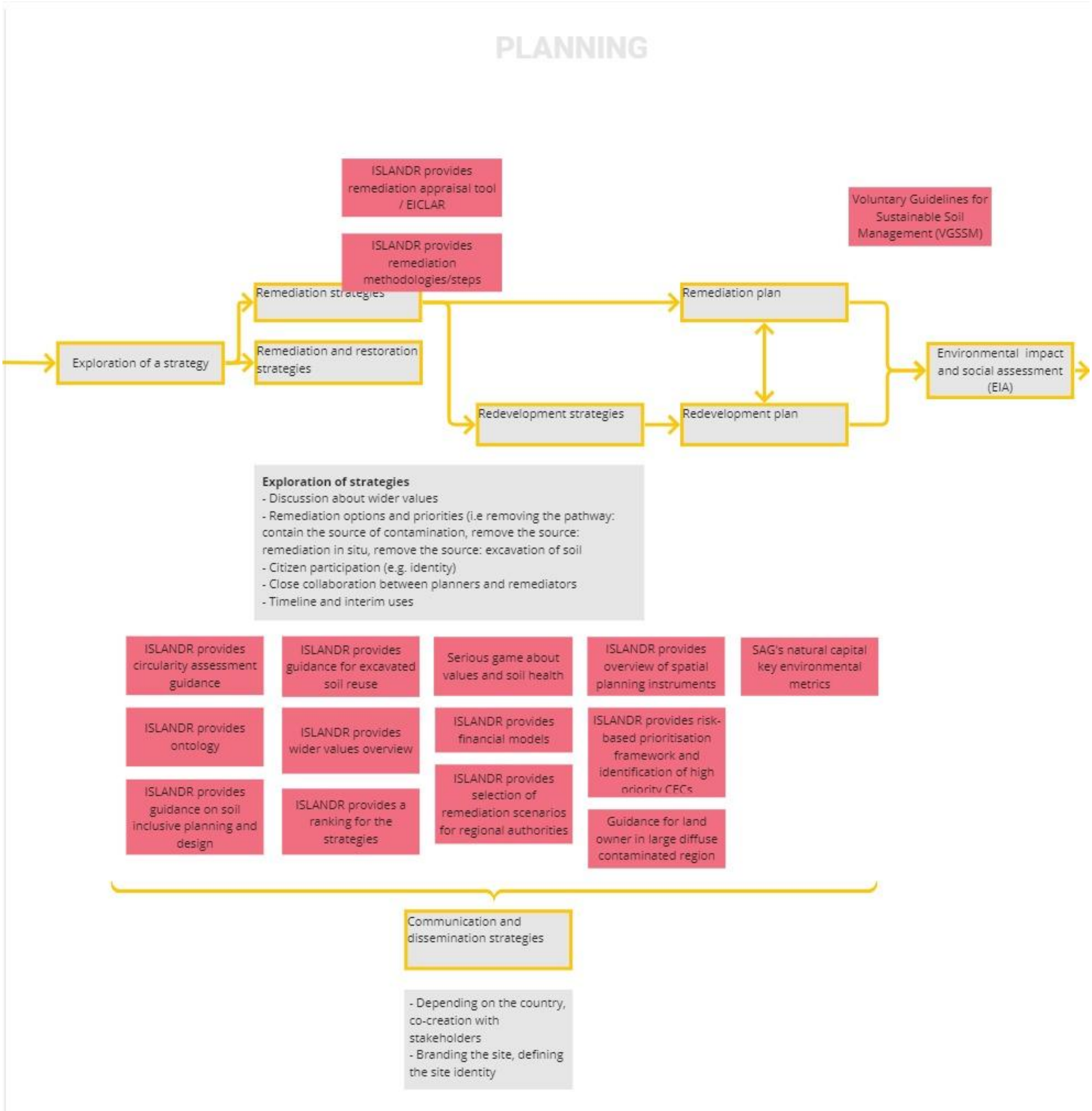


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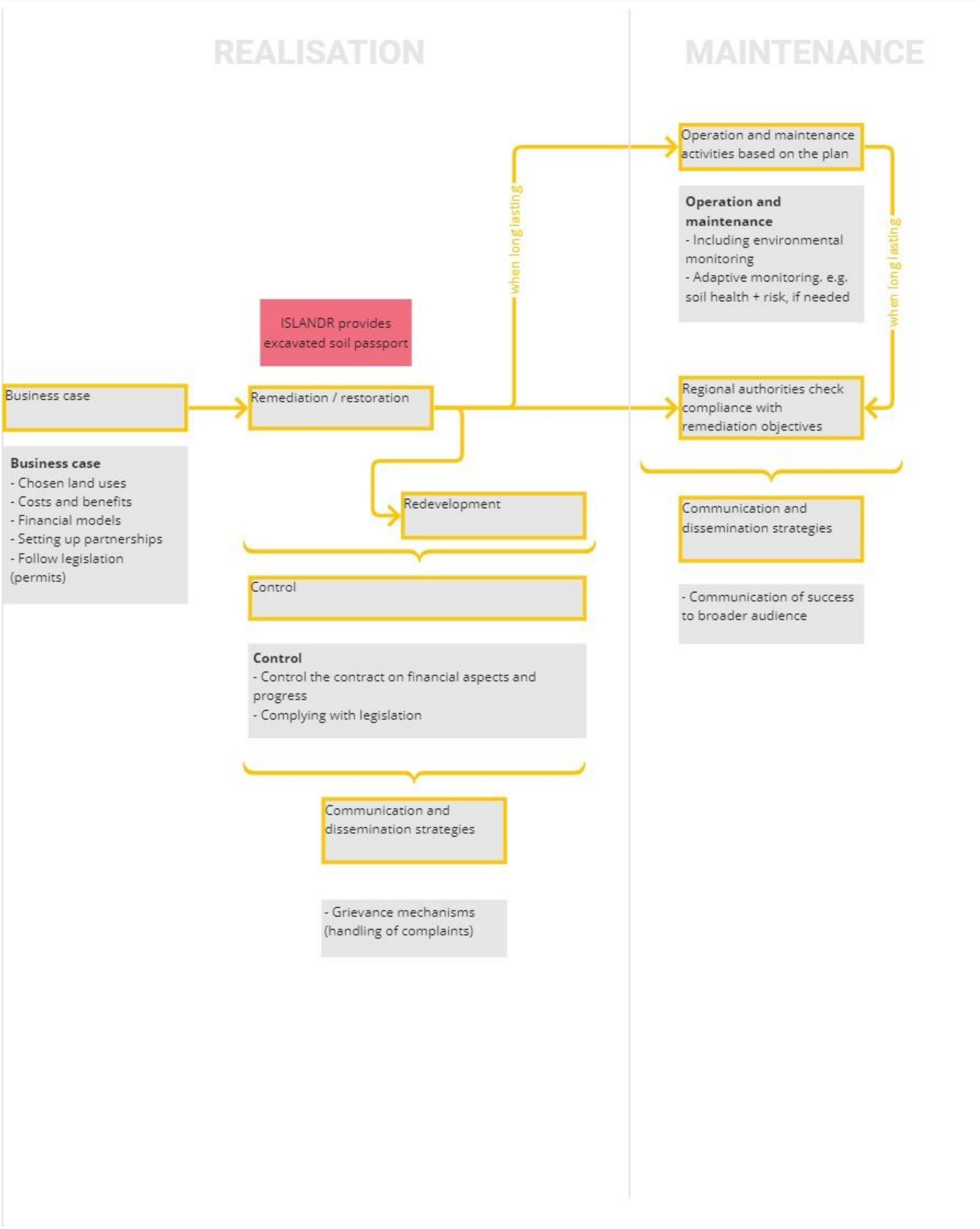


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