Tool for the management of urban-peri-urban relationships

Tool Manual

Version 1

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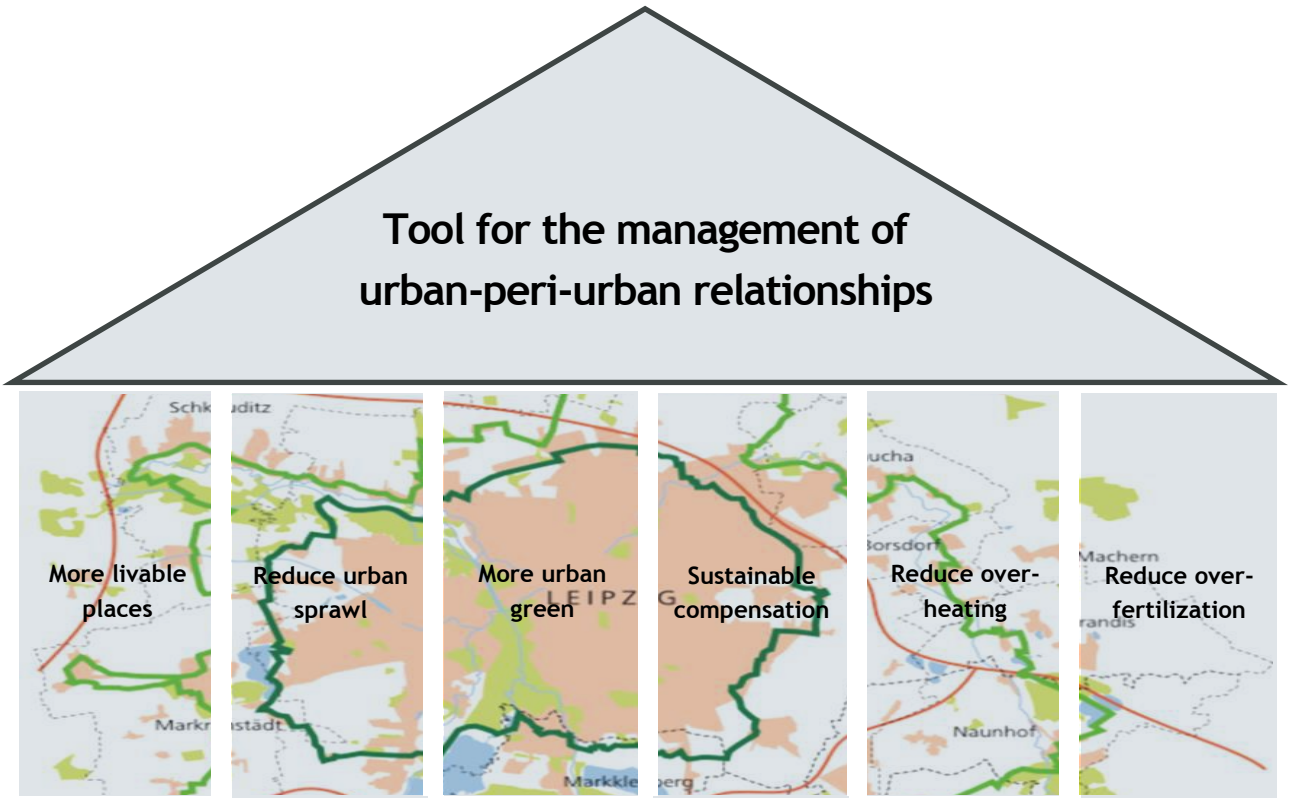
L U M A T O



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1. Introduction and Goals of LUMAT

The LUMAT Project is co-funded by the EU INTERREG VB CENTRAL EUROPE program and involves partners from 7 different countries in Central Europe. The German partners of the consortium have been responsible for the creation of a tool for integrated environmental analysis of soil threats. The tool created is titled “LUMATO” to reflect the LUMAT project goals. The tool is to find direct application in the German pilot region of Leipzig. However the tool is designed in such a way as to also be applicable in other regions in Central European. The opportunities to do so are also described here within.

The goal of the LUMAT project is to increase the awareness of the ecosystem services provided by natural soils in the processes of planning and implementation of sustainable city development. For this, an integrated, multidisciplinary connection of information from various environmental disciplines is helpful. LUMAT operates on the “Function Urban Area” (FUA) scale; this takes into account the relations between central city areas and the hinterlands in the rural surrounding communities. Various measures are required to address the existing land use conflicts in FUAs; multiple stakeholders are active in FUA regions and have their own unique impact on land use patterns. Through LUMAT, stakeholders are to receive a new understanding and awareness for the important role of soils and the sustainable use of this resource.

In the German pilot area the project is being carried out by the Saxonian State Office for Environment, Agriculture and Geology. The German pilot region for implementation is the Green Ring of Leipzig and the point of contact for this is the established management structure for land management in the territory. The goals of this organization are to steer sustainable land management on the inter-municipal level with the city of Leipzig and 12 surrounding municipalities. The organization is responsible for the creation and implementation of a vision strategy. LUMAT strategies and results aimed for in the region will support the activities of the organization to implement sustainable land use management. New methods for the integration of environmental information are to be created and brought into the existing organizational structures for the protection of soil resources and land.

Sites with threats to the naturally existing ecosystem services of soil (i.e. soil functions) in the Green Ring of Leipzig are to be identified and connected to interdisciplinary environmental information. For this a methodology of a tool was created: LUMATO! Along with important threats of city planning such as brownfields, soil sealing and urban sprawl, also risks of land use are identified and evaluated with the tool. This includes for example the risk of over-fertilization on agricultural land plots or the risk of over-warming on sealed surfaces in urban areas. These topics and the related background information are further described on the following pages. With an integrated analysis of the data, new potentials for the improvement of the ecosystem services from soil are identified.

The tool has been made to cater to the needs of city administrations based upon the example given by the city of Leipzig and the surrounding municipalities. Within LUMATO, recommendations for the revitalization of threatened land are given. The concrete planning of the sites and the implementation of the chosen measures shall only follow through the locally responsible authorities when deemed desirable and will undergo a more detailed analysis.

Functional urban areas are distributed across Central Europe. Their size and importance are dependent upon the scale of their urban area. LUMATO was developed and tested for use in the city-region of Leipzig, yet it is possible to create a LUMATO for other cities and functional urban areas with other priorities and other soil threats as well as other types of background information available. The steps to do so are further described in this document.

2. Stakeholder Management & Creation of the LUMATO

To determine the standard basis of data collection and integration, the existing conditions of the stakeholders (their IT-environment) were analysed along with an analysis of the information available in Germany. A dialog with the stakeholders detailed what organizational structures exist and how data is accessed and edited for environmental management. Discussions also focused on the type of technology that is used in the administration.

A result of these talks was that no new software is desired nor is to be introduced. LUMATO has to be integrated with the existing structure of the city of Leipzig and the systems they use. Standard GIS tasks are established in the administration and these will be available for LUMATO application. The use of georeferenced and visual file formats, such as a shapefile format, are aimed for by the project to reach the implementation of LUMATO in the IT-environment. Other FUA regions should evaluate the potential to use standard GIS applications in their own areas through stakeholder management.

To ensure that the information collected in the LUMAT pilot region of Leipzig could be used for the goal of integrated environmental management and evaluation, a number of steps were undertaken by the German project partners. This included:

1. standardization of environmental data collection methods FUA wide or project area wide,
2. gathering of relevant environmental and soil information,
3. creation of new information as required,
4. connection of the data from various sectors to each other,
5. development and application of an evaluation system,
6. creation of Decision Support Layers for identified stakeholders, and
7. creation of an open system for “Ecosystem Servicing”

An INSPIRE conform georeferenced grid was established in which each cell is 100 x 100 meters large. The various soil relevant information of the LUMAT project are identified and aggregated into grid cells. The integrated INSIPRE grid has many advantages for the implementation of revitalization measures of sites in the context of inter-municipal cooperation.

- A homogenous data foundation is created with an INSPIRE grid which is then compliant with EU-wide standards. This foundation could potentially then also be used in other areas of Central Europe or on the EU-wide scale.
- An INSPIRE grid contributes to the creation of information that protects the personal information of others. This is achieved because the grid cells do not correspond to the property lines of land parcels. A further detailed analysis to the sites can only be done in this case by the municipality in question.
- A grid creates a good intersection for the collection of interdisciplinary information for a single plot of land. It is only possible to evaluate the potentials for integrated environmental management of a site on the inter-municipal level when also all the environmental relevant information can be properly organized together.

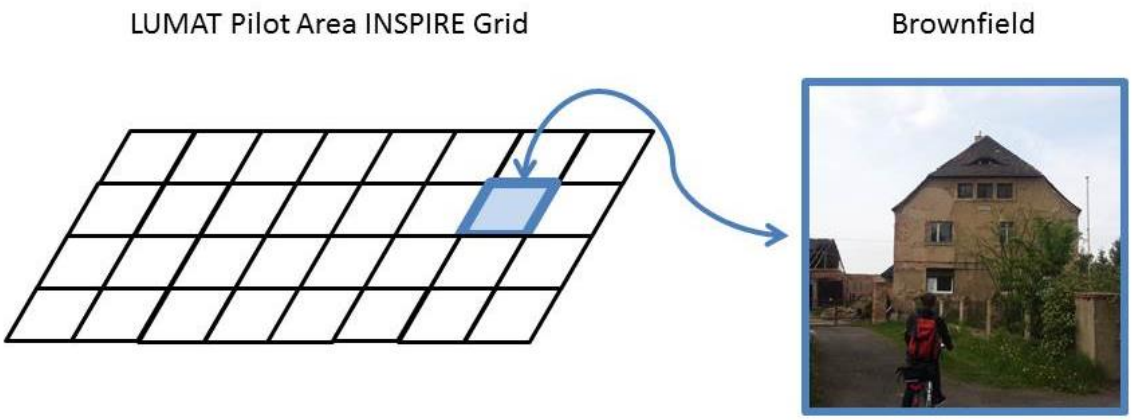

Figure 1. INSPIRE Grid (left) and example of an existing brownfield (right). The information for brownfield revitalization will be included into the GIS grid as attributes. (Image source: LfULG 2018)

The required information for integrated environmental management has been gathered in Leipzig. This included the collection of information on brownfields, soil, water, climate among other topics. Where information was seen to be missing (brownfields), the information was created through on-site mapping and data transfer (see reference Action Plan for the Saxony region). The identified information was included into LUMATO in the form of shapefiles with attribute tables. This information creates the foundation for the data in the tool.

Test shapefiles and exports from the GIS application of the selected information were sent on multiple occasions to the members of the city administration to test the integration of the information into the existing system. Agreement about the FUA-relevant land use conflicts were agreed upon during consultations with stakeholders. An evaluation system was created that was as transparent as possible to also include the stakeholders and allow for them to make adjustments and changes where desired. The final step is the integrated evaluation of the information and the creation of policy recommendations for sustainable management. Decision Support Systems (DSS) were created for the municipalities of the Green Ring of Leipzig with LUMATO. Further developments on LUMATO as well as updates to the information are being done in agreement with the Green Ring of Leipzig.

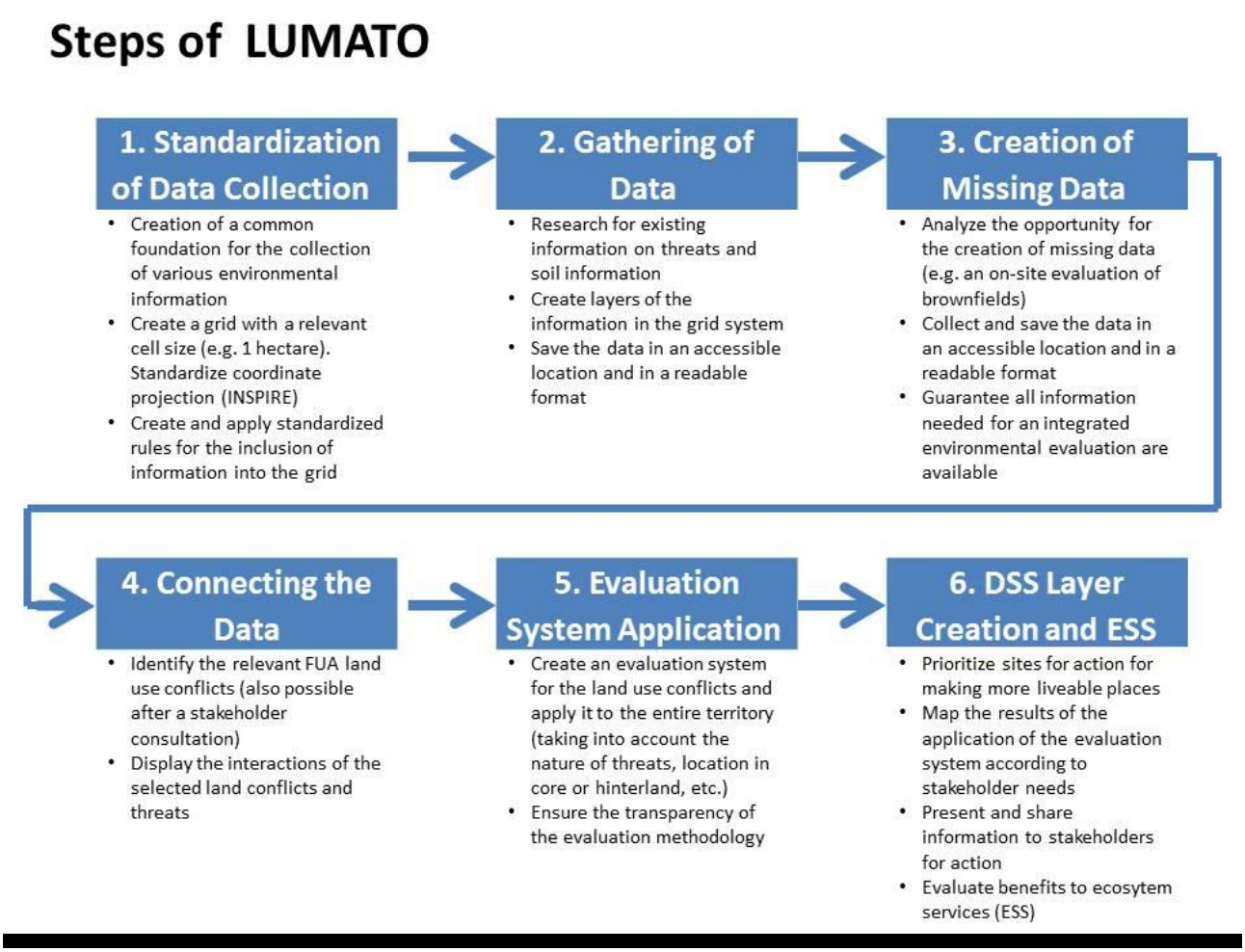

Figure 2. Steps of LUMATO generation (source: LfULG 2018)

2.1. Content of LUMATO for the Revitalization of sites

Soil and soil functions are threatened in functional urban areas by intensive land uses in various manners. LUMATO includes the identification and evaluation of soil threats and the potentials for their revitalization. There are three main layer categories in LUMATO:

- Threats
- Sites of risks
- Area relevant information

The category **"threats"** includes the direct threats to soil[1]: urban sprawl and brownfields. **Brownfields** are built, partially or fully sealed sites, without any current use. These sites are currently abandoned and are in a dilapidated state. Brownfields negatively impact the surrounding community and hinder the ecological system services which are otherwise provided by natural soils: retention of water and materials, evaporation, cooling, habitat formation, among others. The CircUse project provides a common definition of brownfields for Central European nations[2].

[1] For a detailed overview of soil threats in the EU Member States, see the ReCare Hub information center: http://www.recare-hub.eu/soil-threats

[2] See EU Central Europe INTERREG"Circular Flow Land use Management" Project (CircUse). http://www.circuse.eu/index.php?option=com_showdown&typeid=10&Itemid=47

Urban Sprawl describes the expansion of sealed surfaces. The natural qualities of soil on a site of "urban sprawl" are hindered and/or destroyed or are planned to be threatened or destroyed in the foreseeable future. The ecological services of the resource land are disappearing due to urban sprawl. Through soil sealing the reduced ability of the soil to retain water for example are directly visible: water can no longer be filtered into the ground and for this reason becomes runoff. Water is no longer retained on-site. Further negative effects are also caused: the replenishment rate of underground aquifers is reduced, a limited amount of water is left to be available in area. Further, the cooling function is reduced since there is no water available in the soil which can be evaporated off. Brownfields and soil sealing are recognized as two categories/threats in LUMATO due to their direct and negative impacts upon soil and the environment.

"Sites of Risks" are the areas where hazardous consequences for people and the environment may occur if human activities on a site are not adapted to the characteristics of that site. Sites of risks are different from threats in the sense that instead of a direct threat, secondary effects of human activities on sensitive soils (land uses, sealing) can lead to damaging consequences for people and the environment.

In the Green Ring of Leipzig there is a large amount of sites with a very low level of groundwater protection and for this reason they can be categorized as **sites at risk of over-fertilization**. The use of pesticides and fertilizers and other certain types of agricultural uses on these sites in amounts which are not able to be naturally filtered out by the soil will lead to over-fertilization. By consequence, ground water reserves and soils may become contaminated with external elements and chemicals. This can provide a hazard to people and ecosystems.

In the center of the city of Leipzig, an extreme degree of sealing in the urban core may lead to the over-warming of an area. **Sites of over-warming risk** can cause high temperature events to occur which are harmful for residents and visitors. These events are occurring on summer days with little to no wind. These sites of over-warming risks require solutions from city planning. The negative effects of high sealing levels can be mitigated by measures of urban greening directly in these areas. The potentials for urban greening are identified in the LUMATO tool (for example brownfields) as well as other information.

The recognition of **land/soil information** is required for sustainable land management. Various types of environmental information are to be considered for this purpose (flooding hazards, potential soil contaminations, etc.). The threats and sites of risks are to be evaluated based upon the type of sites that they are located on and the ecosystem services that can be improved through the alleviation of the threats.

Location can have various potentials for the sustainable development of a region. Sites in rurally characterized areas, for example, which are further away from a city core (i.e. site in the hinterland) are seen in sustainable land management as sites for important natural and/or agricultural sites. An expansion of settlement structures into outer areas through new planning designations are to be avoided whenever possible to minimize urban development on greenfields. Existing potentials for building sites located inside the settlement structure are to be utilized.

Overview of the content included in the Tool:

- THREATS: brownfields/ urban sprawl (new soil sealing)
- SITES OF RISKS: over-warming / over-fertilization
- INFORMATION: flooding hazard / protection areas / potentially contaminated sites
- LOCATION: settlement area / periphery area / hinterland

3. Creation of the Layers

LUMATO requires a grid layer for each type of information included in the tool. For example, the polygon information of brownfield site delineations in a region is to be transferred into an overlain grid layer. This is done by selecting the grids that are intersected by a polygon of a brownfield in any manner, no matter how much of the grid is actually covered. These grids would be marked as a “brownfield” category and collected into the single layer dedicated for that topic. The target is to create a layer of grid cells with all the affected brownfield cells. This method is applied to all threats and other required information. It is important that the information be current and that the data sources and responsible persons are identified.

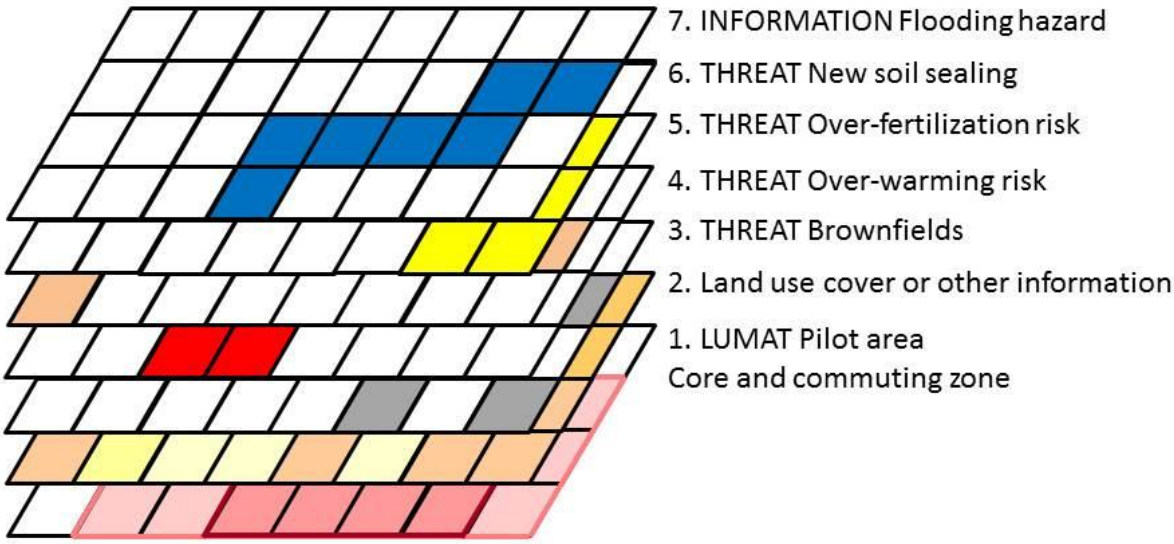

Figure 3. Compiling of the layers in LUMATO for integrated environmental management (Source: LfULG 2018)

3.1. Threat: Urban Sprawl and Soil Sealing

In LUMAT the environmental qualities of natural soils are recognized with the concept of ecosystem services. The creation of the layer Urban Sprawl combines the information of sites that are planned to be altered by human activity in the near future and therefore a change in the ecosystem services can be expected. The sealing of soil resources hinders soil from carrying out ecosystem services and the extent of this should be reduced whenever possible.

3.2. Threat: Brownfields

Brownfields are represented by urban built-up sites which are no longer in use. These sites are no longer needed and can be revitalized for sustainable land management. The potentials to revitalize brownfields are manifold and can be studied in connection to the type of land categories present in the area. The context in which the brownfield is located can often have an important factor in the type of revitalization which is desired (flood hazard zone, extreme temperatures due to excessive soil sealing, etc.).

3.3. Site of Risks: Over-warming (through excessive soil sealing)

Excessive soil sealing can lead to harmful heat effects to take place during warm summer days in Central Europe. This is exacerbated by a lack of urban green in city cores. Sealed soil is no longer able to evaporate water. The surrounding temperatures cannot be naturally regulated through evaporation cycle and the additional provision of shade. These sites must be addressed by revitalizing natural soil processes.

3.4. Sites of Risk: Over-fertilization

The permeability of soil varies greatly from site to site. It is largely dependent upon the physical characteristics present. Despite the wide variation, land is often used in similar manners, even when this may prove harmful to the environment. One consequence may be the filtration of harmful elements such as pesticides and fertilizers into ground water reserves on sites which do not have the natural capacity to retain water and/or the materials deposited on the sites. As a result, there is a risk of the contamination of soil and water resources.

3.5. Location: Settlement, Periphery & Hinterland Areas

The location of a site often has impacts upon the potentials for sustainable land management. Threats in the hinterland are to be dealt with in a different manner than threats in city center areas. The potential uses of the sites for sustainable land use management are different and should be recognized as such.

3.6. Land Relevant Information

Sustainable land use can build upon the connection to a wide range of environmental information from different sectors. These are to be integrated in LUMATO for integrated environmental management. These layers are to be stakeholder relevant, and may include for example:

- Flooding hazard sites
- Protected sites (landscape, nature, water, etc.)
- Sites of agricultural land use
- Sites of (potential) soil contamination

3.7. Integration of the Data

All the categories mentioned above will be transformed into the grid foundation of the LUMATO. Each threat and information will receive a dedicated layer. This will make integrated environmental management possible. Each cell can be combined with cells of other layers to evaluate the decision of sustainable action. This makes it possible to create Decision Support System for the entire FUA region. Because the data from all the disciplines has been integrated into a homogenized format, the geographical comparison can take place quickly (see Figure 3).

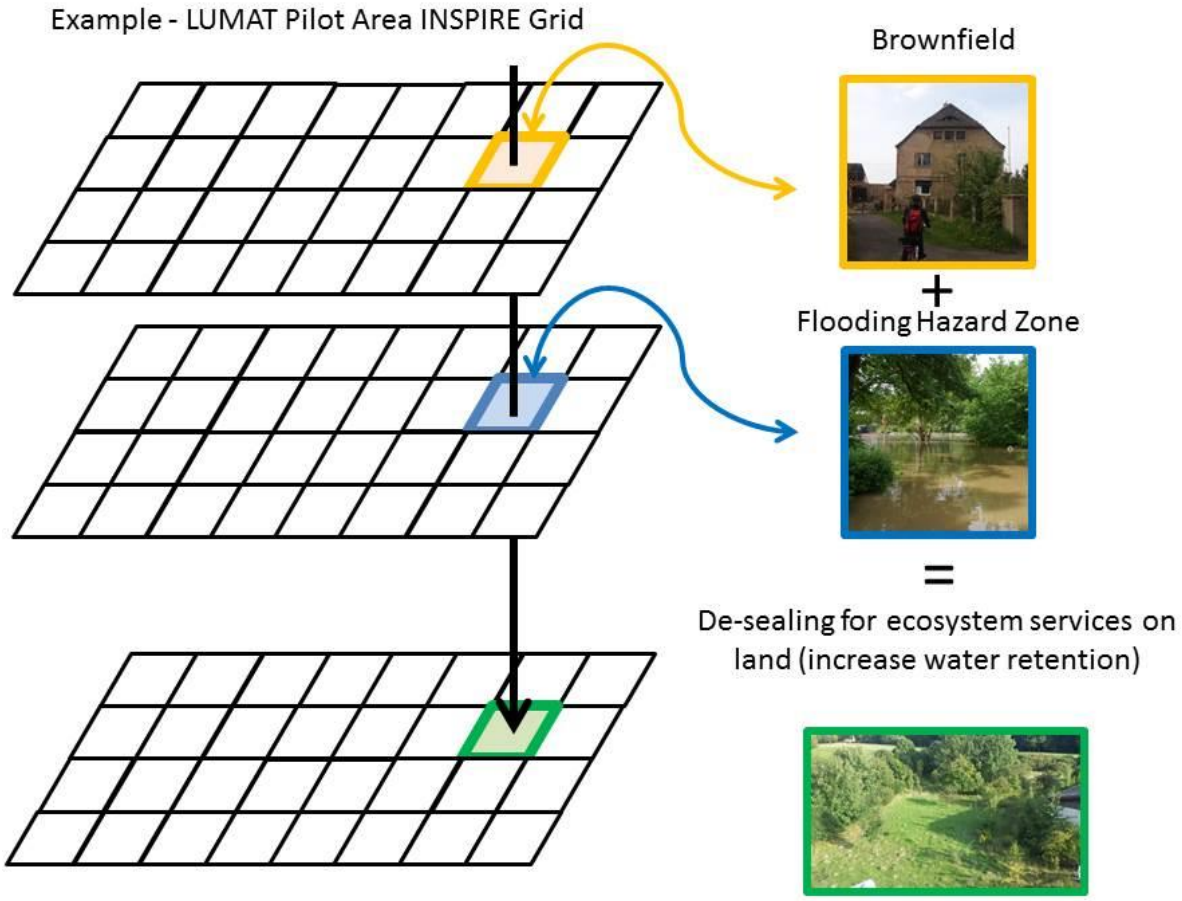

Figure 4. Example of revitalization to increase ecosystem services.

4. Creation of LUMAT Decision Support Layer

LUMATO gives an initial evaluation of sites for making places more livable through the creation of Decision Support Systems. The role played by soil to improve ecosystem services is qualitatively recognized here. Soil information coupled with information from other environmental disciplines allows for integrated environmental management and for new conclusions to be reached. The location dependent evaluation is also planned for in the design of LUMATO; rural areas are to be evaluated for different measures than sites located in the main city areas. For example in cases of new soil sealing, compensation for building structures and the consumption of land should be directed to sites that are suitable for de-sealing: brownfields in hinterland areas.[3]

[3] It is not desired to define new planning evaluations which are static in nature. Policy is recommended according to the principle of subsidiary – the local decision makers are the ones with the final word about the realization of compensations projects.

DSS 1: Sustainable Land Use on Brownfields

The locations of brownfields in central urban areas or rural hinterlands area have differing potentials. The sites serve different users in different situations. LUMAT recommends the following planning evaluation:

- ***Brownfields in Core Urban Areas - Revitalization - from built to urban green solutions***. The first option of revitalization can be a built solution which can reduce development pressures on greenfields in the region. If there is no demand for the construction of the site, urban green should be considered a viable alternative.
- ***Brownfields in Periphery - Urban Green - from urban green to built solutions***. Periphery sites often provide a boundary between the city and the surrounding green infrastructure and are often under construction pressure. It is suggested to first consider urban green uses on these sites to maintain the connection of green infrastructure and minimize sprawl. If not possible, then the construction of these sites is a second option which is favored over construction in the hinterland.
- ***Brownfields in Hinterland – Green Spaces - sites for compensation measures***. These sites are located away from the existing settlement structures and cannot be seen to be sustainable locations for urban uses; green uses are to be pursued on such sites.

DSS 1 combines information about planned soil sealing as well. By displaying both the brownfields and the planned urban expansion sites on the same map, it is possible to compare brownfield potentials for the compensation of new soil sealing (quantitative comparison).

DSS 2: Achieve Cooling through Urban Green

Overwarming of urban areas on hot summer days with a lot of sunshine through excessive soil sealing can be alleviated through creating urban green sites in areas at risk of over-warming. Brownfield sites are often located in these areas at risk due to their size and (often) core location. Developing urban green in city structures has measurable impacts on the reduction of the maximum temperature experienced[4]. DSS 2 displays the potential sites of cooling functions through creating urban green structures on brownfields that are within ~100 meters of a sites of overwarming risk, creating a possible “oasis effect”.

DSS 3: Raising the Water Retention in Flood Hazard Zones

One ecosystem service provided by natural soils is the regulating function of water retention, for example after rain or a flooding event. Unused and sealed brownfield sites in flood zones must be removed for the purpose of increasing water retention. This is for the protection of the people in the vicinity of the site and can be expected to have positive impacts on the flood zone in general. The more land that is able to be de-sealed in this context, the greater the expected benefits can be.

DSS 4: Reduce the Distribution of Harmful Substances on Sites of Risk

Soils have a wide range of filtering capacities due to physical characteristics of the soil, among other factors. The awareness for this is often missing in the wider public and is not taken into account when deciding the location of land uses. In the case of agricultural land uses, the use of pesticides and fertilizers on soils with a high permeability rate of water should be considered for the cessation of harmful agricultural practices due to the potential for the contamination of water resources.

DSS 5: Compensation Site for Soil in Protected Zones

Information about the location of protection zones for nature, landscapes and water resources are displayed in DSS 5 along with the neighboring brownfields. Protection zones should be expanded upon by

[4] Source: Jutta Böhm, Christa Böhme, Arno Bunzel, Christina Kühnau, Detlef Landua and Markus Reinke Urbanes Grün in der doppelten Innenentwicklung. Bundesamt für Naturschutz. 2016. Page 209

de-sealing brownfield sites which are in spatial proximity to these areas. Stakeholders should consider the revitalization of these brownfields for the purposes of improving natural capital.

5. LUMATO for Evaluation of Ecosystem Services

Further down the road, the incorporation of information that is currently available regarding the evaluation of ecosystem services could find its application into LUMATO. This would allow for stakeholders to concretely understand the measurable benefits they can expect through the carrying out of the revitalization strategies on threatened sites presented in the LUMATO DSS. Decision makers would receive further justifications needed to undertake sustainable land use. The improvement of the environment and making the places more livable for the citzens in Central Europe are key to this strategy; support and justifications can come from the tool in a quantitative manner. Each decison or planned action on a threatened site should be descriped by ecosystem services to reach public awareness raising.