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SIK-Hub (Spatial information and knowledge hub) - concept note on the development of a decision-support tool in CLEARING HOUSE

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Summary

The SIK-Hub (Spatial information and knowledge hub), formerly online benchmarking tool, is a simple but effective benchmarking tool to compare UF-NBS in different settings along the user demands defined in M4.3. This tool allows a quick assessment of UF-NBS and their environmental, ecological, and social settings based on the visualisation, synthesise, and story-telling of spatial data and information. Thereby, SIK-Hub is not only to be used for comparing different UF-NBS in cities, but will also be useful for facilitating the communication, collaboration, and knowledge exchange or dissemination. The tool is closely linked with IUCN?s Global Standard on Nature-Based Solutions for Societal Challenges, as well as the IUCN Urban Nature Indexes. Potential users have been closely involved in the development of SIK-Hub through a users? evaluation of a mock-up-template of the tool, as well as a corresponding piloting in selected cities (D4.5).

Approval

Date	By
2024-08-02 14:05:49	Dr. Rik DE VREESE (EFI)
2024-08-02 14:07:25	Dr. Rik DE VREESE (EFI)

SIK-Hub (Spatial information and knowledge hub) Concept note on the development of a decision-support tool in CLEARING HOUSE

Deliverable 4.3.

Content

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EXECUTIVE SUMMARY

The SIK-Hub (Spatial information and knowledge hub), formerly online benchmarking tool, is a simple but effective benchmarking tool to compare UF-NBS in different settings along the user demands defined in M4.3. This tool allows a quick assessment of UF-NBS and their environmental, ecological, and social settings based on the visualisation, synthesise, and story-telling of spatial data and information. Thereby, SIK-Hub is not only to be used for comparing different UF-NBS in cities, but will also be useful for facilitating the communication, collaboration, and knowledge exchange or dissemination. The tool is closely linked with IUCN's Global Standard on Nature-Based Solutions for Societal Challenges, as well as the IUCN Urban Nature Indexes. Potential users have been closely involved in the development of SIK-Hub through a users' evaluation of a mock-up-template of the tool, as well as a corresponding piloting in selected cities (D4.5).

KEYWORDS

Sustainable urban development, nature-based solutions, green infrastructure, assessment tool

ABBREVIATIONS

UF-NBS: Urban forests as nature-based solutions

NBS: Nature-based solutions

KEY DEFINITIONS

Urban forests: tree-based urban ecosystems that address societal challenges, simultaneously providing ecosystem services for human well-being and biodiversity benefits. Urban forests include peri-urban and urban forests, forested parks, small woods in urban areas, and trees in public and private spaces.

Urban forestry: the practice of planning and management of urban forests to ensure their health, longevity and ability to provide ecosystem services now and in the future.

Nature-based Solutions (NBS): Nature-based Solutions (NBS) are defined as *"actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"*. (IUCN, 2018)

Urban forests as nature-based solutions: UF-NBS are a subset of nature-based solutions, which build on tree-based urban ecosystems to address societal challenges, simultaneously providing ecosystem services for human well-being and biodiversity benefits. UF-NBS include peri-urban and urban forests, forested parks, small woods in urban areas, and trees in public and private spaces. UF-NBS comprise every measure a city can take to address urban development challenges by deploying tree-based ecosystems. (European Forest Institute, 2018)

Urban tree(s): usually long living woody organism including woody shrubs, usually single stemmed, with the potential to grow at a site in an urban or peri-urban area. This includes roadside trees, trees in squares, parking areas, or in parks and private gardens. Urban trees appear as individual trees, or as groups of trees.

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VERSION HISTORY

Version	Date	Author	Partner	Description
V1.0	13/11/2023	Manuel Wolff	HUB	Initial final draft
V1.1	18/11/2023	Rik De Vreese	EFI	Adapted to CH template
V1.2	20/11/2023	Manuel Wolff	HUB	Final version
V1.3.	01/08/2024	Manuel Wolff	HUB	Revised version, following the comments by the external project reviewers (chapter 5 on current state of implementation and aspirations for further development)

REFERENCE

Wolff, M. (2023). SIK-Hub (Spatial information and knowledge hub) - concept note on the development of a decision-support tool in CLEARING HOUSE (D4.3). H2020 project CLEARING HOUSE, agreement no. 821242. DOI: 10.5281/zenodo.10731987.

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1 Introduction

The idea of the SIK-Hub (Spatial Information and Knowledge hub) is to develop an interactive online platform demonstrating and visualising CLEARING HOUSE results, to synthesize spatial analysis and knowledge types, and to support collaborations and engagement of a wide range of users. Based on the previously identified user demands (cf. M4.3), the purpose of SIK-Hub is to (Figure 1):

(1) ***deliver a complementary degree of details*** by combining knowledge on different spatial scales and with a different degree of complexity (see section 2),

(2) ***enable multiple interactions*** by allowing for the easy exploitation and dissemination of findings, as well as the engagement, participation and cooperation of multiple users (see section 3), and

(3) ***support decisions of multiple users*** by fostering a better understanding of the various information, different functionalities and knowledge outputs (see section 4).

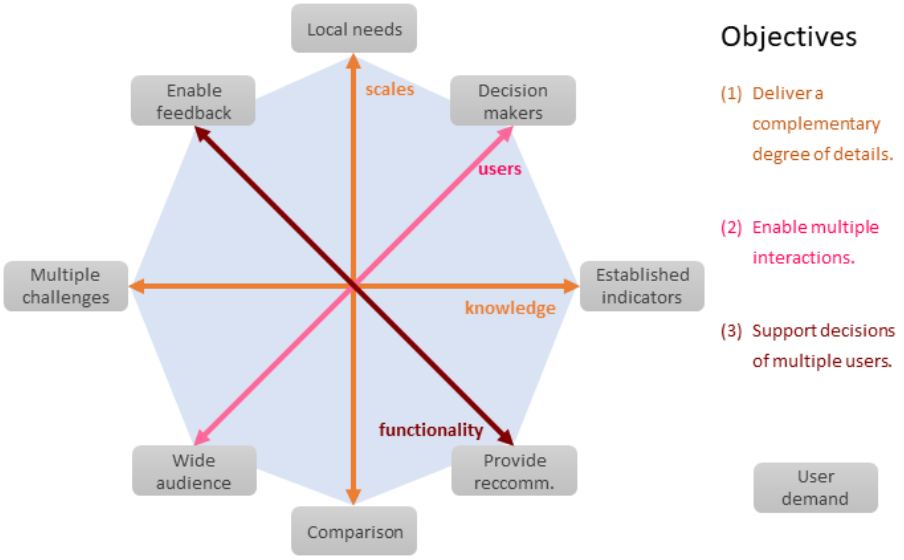

Figure 1: Objectives of the Spatial Information and Knowledge hub (SIK-Hub) derived from various user demands (the exact wording of the user demand is detailed in the annex)**.**

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2 Conceptual frame and types of knowledge

2.1 Architecture

From a ***conceptual perspective***, SIK-Hub is designed across three scales: continental, city, and local (Figure 2). Scale applies not only to a spatial hierarchy, but also to the cause-effect relations with respect to a) the wider context around a socio-ecological system such as a city in terms of climate, forest, and social dynamics; b) the emerging societal challenges of a corresponding system, and c) the complex interactions of socio-environmental traits within such a system (IUCN, 2020).

From a ***thematic perspective,*** SIK-Hub is designed along two categories aligned to the IUCN Global Standard on Nature-Based Solutions (IUCN, 2020), as well as the IUCN Urban Nature Indices (IUCN, 2022): a) nature's contribution to people, especially ecosystem and their health benefits (socio), and b) the habitat status, especially environmental factors, their degradation and biodiversity loss (ecological, Figure 2). This thematic framing allows both, the application of clearly understood and documented indicators within established framings, and the development of local-specific or tailored-based indicators supporting a transparent and inclusive consultation process.

The following section details the rationale for the choice of each scale in line with the tool's objective, as well as the target indicators developed according to the chosen categories.

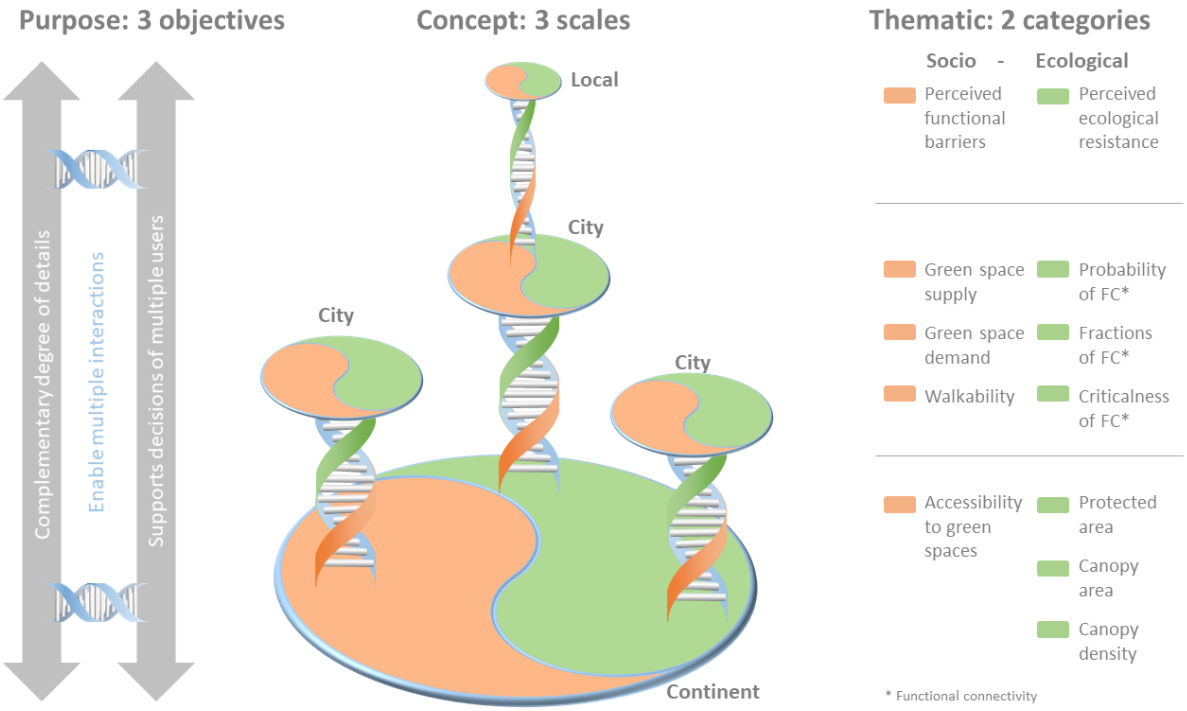

Figure 2: Conceptual frame of the Spatial Information and Knowledge hub (SIK-Hub): 3 scales and 2 categories contrasted to the 3 tool objectives.

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2.1.1 Continental scale

Ensuring a comprehensive comparison: The continental scale ensures a monitoring that covers the entire European territory using raster cells of 1km² instead of administrative or functional boundaries. This prevents a biased comparison which emerges when units of different size are compared, but rather allows to aggregate to all possible levels and for all forms of spatial partitions such as cities or regions (ESPON, 2006). The Degree of Urbanisation is used to classifying the entire territory along the urban-rural continuum (European Commission et al., 2022).

Monitoring forest dynamics, protection, and accessibility: In order to access key dynamics three indicators are used. First, canopy area and density for 2012, 2018, and their change is accessed using high-resolution dataset on tree-cover-density (Copernicus, 2021). Second, IUCN Protected Area Management Categories are used in order to bridge the results to concrete governance responsibilities and processes (UNEP-WCMC, 2016; IUCN, 2020). This provides a comparable and widely accepted standard for classifying protected areas based on their primary management objectives (Dudley, 2008). Third, we estimated the accessibility to green spaces as a proxy for health benefits to humans based on the street network of a city.

2.1.2 City scale

Accounting for multiple needs and challenges of cities: The city scale refers to 805 European cities within their administrative territory with a population of at least 50,000 inhabitants in 23 European Economic Area (EEA) member states and the United Kingdom as defined by the Urban Audit delineation (Eurostat, 2020). This enables not only the comparison of cities, but also to account for the individual challenges of them which emerges from the complex socio-ecological heterogeneity within them e.g. with respect to landscape configuration, fragmentation and human demand for UF-NBS.

Modelling intra-urban socio-ecological interrelations: In recognising that both social and biophysical landscape characteristics influence who experiences which ecosystem services and to what extent, this scale integrates the concepts of networks into an ecosystem services framework. The fragmented landscape of cities affects movement of people (walkability), and wildlife (connectivity). Based on high-resolution tree-cover-data (TCD 2018), land use data (Urban Atlas 2018), and Open Street Map data, six indicators are modelled displaying walkability and connectivity (Figure 2).

2.1.3 Local scale

Identify gaps and flaws in 'our' city: The local accounts for the multiple perspectives on certain challenges from a citizens-science perspective. The way citizens engage with and benefit from UF-NBS traits largely depends on the way citizens perceive and evaluate selected traits. Consequently, accounting for the perception of beneficiaries provides a complementary lens to monitoring or modelling approaches in order to estimate the societal demand for UF-NBS (Verhagen et al. 2017).

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Capturing perceived socio-ecological traits in cities: This scale captures the assessment and mapping of perceived socio-ecological traits in selected locations of case study cities. The associated key topics account for perceived ecological resistance of trees against climate threats, as well as functional barriers of accessing urban green spaces. The LOUPE application (Scheuer et al., 2022) is used in order to develop surveys adapted to both the thematic focus and the local sites.

2.2 Types of knowledge

In line with the objectives outlined above, SIK-Hub combines different types of knowledge which essentially determine the options for interaction (see section 3) and the functionality of the tool (see section 4). The tool combines data and information (Table 1). ***Data*** is understood as spatial explicit quantitative facts which apply to either one of the three spatial scales (continental, city, local), and can refer to monitored (e.g. by obtaining and editing secondary data), modelled (e.g. by using proxies and tools for manipulating input data), or perceived data (e.g. by displaying citizen science observations). ***Information*** refers to qualitative information either with or without a spatial reference such as interpretations of (synthesised) data, narratives of a particular challenge or a specific case, guidelines in the form of scientific papers and other reports. Information allows a deeper understanding and investigation of the presented material as well as the replication of data processing following tool principles (see section 3.2). In targeting a wide range of potential users (see section 3.1), SIK-Hub combines three ***sources*** of data and information for which Table 1 provides examples.

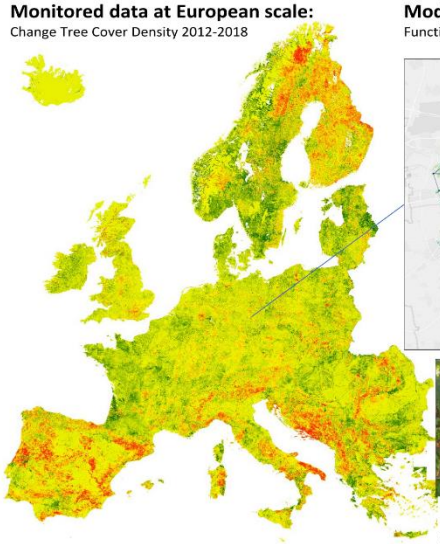
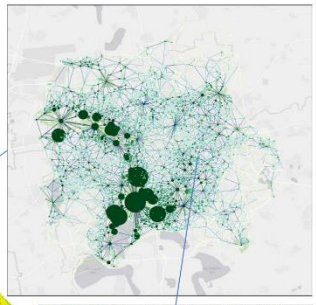
Source	Data	Information
Provided (by developers)	**Monitored data at European scale:** Change Tree Cover Density 2012-2018  **Modelled data at City scale:** Functional connectivity of tree canopy patches  **Perceived data at Local scale:** Observed ecological resistance of trees 	**Interpreation and narratives:** Storylines and storymaps  **Guidelines:** Scientific and other reports 
Obtained (by partners)	• Tree inventory • Cadastre data	• Development concepts • Thematic initiatives
Shared (by users)	• Classified observation • Geolocation	• Opinions • Qualitative feedback

Table 1: Examples of different types and sources of knowledge provided, obtained, and shared by SIK-Hub.

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3 Usefulness of the tool

3.1 Interaction options for multiple users

SIK-Hub is developed as an interactive platform that seeks to account for the needs of different key users. Accordingly, the tool provides passive and active options for interaction which a) vary according to the key user group (Table 2), and b) request adapted technical solutions of the tool itself (see section 4.2). The different interaction options and their technical functions are not exclusive to specific user groups but are mostly available to everybody.

Passive interaction options are facilitated through the interactive use of the tool across spatial scales, case studies, and indicators. The visualisation via interactive maps allows a customer based scaling across different degrees of spatial coverage and content richness that allows a user-friendly and easy to understand way to navigate through the information of the tool. For selected localities, storylines are provided which describe how to read the multi-criteria results in a problem-centric manner. In addition, and where appropriate, scientific papers are made available which provide method guidance on how to obtain and process data with corresponding tools. This fosters the capacity building of residents and stakeholders, allows for evidence-based decision making processes, and accounts for the different needs of users with respect to information complexity and data skills. In addition, and based on the tool's conceptualization, SIK-Hub can be used by project partners complementary to existing tools (e.g. IUCN Urban Nature Indices[1]), or to detect data uncertainties and knowledge gaps pushing the joint development of advanced indicators (e.g. within Network Nature's cross-Horizon project Task Force 2: Integrated Assessment Framework[2]).

Active interaction options are facilitated through communication, collaboration, and knowledge exchange or dissemination among human actors. For example, residents should be motivated to actively engage either with the material provided, or the localities which have been studied. An interactive block on the webpage enables users to provide feedback to any observations they have made by either screening though the maps, or in by in-situ observations. Users can also upload small pictures which demonstrate their individual visual access to trees in line with the 3-30-300 rule on promoting health and well-being through urban forests (Konijnendijk, 2023).[3] With respect to the partners which have been active in the development of SIK-Hub inside and outside of CLEARING HOUSE, the tool provides the opportunity of developing joint policy guidelines based on multiple and complementary tools and platforms used by the partners. The joint use of existing and currently developed platforms fosters the development of advanced project ideas, analytical interests, and new thematic lenses using the synergies between the partners and their tools. Finally, as the tool uses freely available data and processing software (e.g. Open Street Map, QGIS), the evidence can easily be

[1] https://iucnurbanalliance.org/content//uploads/2022/11/IUCN-Urban-Nature-Indices_15-Nov-2022.pdf
[2] https://networknature.eu/networknature/nature-based-solutions-task-forces
[3] https://iucnurbanalliance.org/promoting-health-and-wellbeing-through-urban-forests-introducing-the-3-30-300-rule/

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updated upon the availability of recent data, or reproduced using different spatial scales or analytical methods. As the spatial classifications used by SIK-Hub have been obtained from supra-national bodies such as EUROSTAT, JRC (Joint Research Centre of the European Commission), Copernicus programme, and IUCN (e.g. World Database on Protected Areas), the tool can easily be extended by the mentioned data sources or related data providers (e.g. European Territorial Observatory Network ESPON). Finally, upon interests of city officials, the LOUPE tool (Scheuer et al., 2022) for accessing citizen science knowledge can also be applied in other cities with the corresponding results being available within SIK-Hub.

Key users	**Passive interaction** (informing and decision-support)	**Active interaction** (communicating and disseminating)
Residents	• Explore various spatial and thematic layers • Use storylines for a better understanding of indicators and their processing	• Provide feedback on tool results, or complementary information based on individual in-situ observations • Upload pictures for assessing the visual accessibility
Decision makers	• Obtain evidence for supporting decisions • Apply comparisons across scales and themes	• Foster cooperation between policy bodies, planning sectors, or administrative levels, • Engagement platform to support collaboration, initiatives, and public participation
Project partners and researchers	• Use indicators as complementary to their tools • Detect data uncertainties and knowledge gaps	• Develop joint policy guidelines based on multiple and complementary tools and platforms • Use tools to develop advanced project ideas, analytical interests, and thematic lenses
Developers	• Using tool for developing scientific output • Provide technical and output-related support	• Temporal update based on publicly available data • Extension of tool by spatial scales or indicators

Table 2: Different interaction options for key users.

3.2 Tool principles

Based on the multiple interaction options SIK-Hub seeks to facilitate, certain principles can be derived both for the technical implementation as well as for the handling of information.

First, in line with the data management plan of CLEARING HOUSE (D6.2), the technical implementation follows the stated ethical aspects as well as the ***FAIR principles***:

- Findable: Hosting relevant project results on a central hub allows users to easily find data collected or produced by the consortium by accessing either the hub's URL, or via the CLEARING HOUSE webpage as well as other related websites (e.g. by the European Commission). The features of SIK-Hub will further allow to easily navigate through the different types of data and knowledge offered within the platform.

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- Accessible: All data and information offered are accessible via visualisation, interpretation, and storytelling. It is intended that large parts of the data and information can further be downloaded for the individual purpose of the user. However, this needs to be decided case-wise due to the different nature of sources and knowledge types (see section 2.4 and the data management plan of CLEARING HOUSE D6.2).
- Interoperable: Standard vocabulary and libraries for metadata as well as references to the data sources and processing are used on a case-by-case basis to make the data interoperable between researchers, institutions, organisations, countries, etc.
- Re-use: Data and information which can be re-used is offered via download for the individual purpose of the user. Data generated through interviews and surveys will not be re-used directly due to privacy concerns but, if integrated into the hub, will be (pseudo)anomised.

Second, SIK-Hub largely supports ***open access principles*** with respect to both the used data as well as processing strategy. In particular, the monitored and modelled data rely on publicly available data sources p(e.g. Open Street Map, Copernicus programme). Downloading the edited or original data in combination with the openly provided guidelines allow an easy reproduction of results. However, especially data and information which are obtained from partners, or have been collected via citizen science tools might not or only be available upon request due to license and data protection issues. As for the software used to edit data and information within SIK-Hub, freely available processing software has largely been used (e.g. R, QGIS). For the reasons given in section 4, the hub itself is hosted, however, on a commercial software. Still, the functions of the hub are freely available and accessible (see section 4.2). For a long-term solution, the team of Humboldt-Universität zu Berlin (HUB) explores options to migrate the tool to an open access software. This step seems to be most promising after the different features have been tested within CLEARING HOUSE.

4 Technical platform and functionality

4.1 Technical implementation

SIK-Hub will be implemented in an ArcGIS environment based on five considerations.

- It allows a ***quick implementation*** of various features, e.g. when compared to a command-line-based solution, and is, consequently, most promising in setting up a ready-to-use system until the end of the project.
- The ***flexible design*** of different features and functions allows to be constantly contrasted to the user demands and quickly adapted as required and needed.
- The ***variety of features*** offered is most promising for the indicated objective of the tool as they stretch from advanced visualisation features to analytical elements, data sharing options, and the gathering of user feedback.

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- As ArcGIS is ***already licensed*** by Humboldt-Universität zu Berlin, no additional costs need to be covered by the project.
- As the license is ***continuously hosted*** by Humboldt-Universität zu Berlin, SIK-Hub will be available and accessible also beyond the lifetime of CLEARING HOUSE in accordance with the interaction options outlined above (section 3.1).

4.2 Functionality and features

Based on the promotion of interaction options and following the detected principles for the implementation (see section 3), SIK-Hub provides six functionalities which serve the three tool objectives to a different extent as Figure 3 details.

(1) Navigate through data and information: This function allows all users to explore the data and information which is stored in SIK-Hub via pre-defined categories, a key-word search, and a tailored filtering of the search. Data and information of SIK-Hub itself can be approached and downloaded, as well as open accessible data related to the thematic framing (see section 2) e.g. derived as web-based maps. Therefore, the feature *ArcGIS Hub* is used.

(2) Visualise data: This function allows an easy and quick visual inspection of the provided data across different scales and themes (see section 2) by zooming in/out or (de)activating layer. Furthermore, this function allows a quick visual demonstration for supporting public outreach or sectoral collaboration. Therefore, the feature *ArcGIS Experience Builder* is used.

(3) Analyse data: This function allows spatial analytics using interactive data visualizations. By combining spatial and thematic filters across different layers, a tailored-based detection of locations relevant for a particular challenge as well as the thematic comparison of several spatial units such as cities is possible. Interactive tables and summary graphs allow a real-time scoring and benchmarking. Therefore, the feature *ArcGIS Experience Builder* is used.

(4) Explore information: This function allows to access information related to a particular thematic challenge, a specific location, or a particular use case as shared by users. It provides a short narrative in combination with a map or other multimedia content, as well as references to further material within and outside of SIK-Hub (e.g. guidelines, scientific papers, official documents etc.) that allows a deeper understanding of the material. Therefore, the feature *ArcGIS Story Maps* is used.

(5) Upload data and information: This function allows to add, manage, and showcase data and information by authorised stakeholders. This function is in particular valuable in order to fill detected knowledge gaps e.g. for developing complementary storylines or storymaps, or to enable a deeper and tailored analysis of the material (e.g. intersect the data with own zoning plans). Therefore, the feature *ArcGIS Hub* is used.

(6) Share feedback, data, and information: This function allows a straightforward and intuitive form-based collection of user feedback with respect to the presented data and information within SIK-

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Hub, and/or for a specific location. Users can also upload small files displaying their opinion such as pictures of specific localities and challenges. Therefore, the feature *ArcGIS Survey 123* is used.

Figure 3: Functionalities and features of the Spatial Information and Knowledge hub (SIK-Hub) contrasted with the 3 tool objectives, knowledge source, and interaction options.

4.3 User interface and outputs

The user interface is accessible via a central URL. All functions and features can be approached on this master interface, as Figure 4 shows. SIK-Hub provides various possibilities for output and outreach:

- Export of lists for selected or detected features from the visualisation and analysis feature (*ArcGIS Experience Builder*),
- Download of data and information from the data storage feature (*ArcGIS Hub),*
- Explore further materials and data sources via the data storage (*ArcGIS Hub)* and story map feature (*ArcGIS Story Maps),*
- Enable the engagement of a wider audience or a specific community via the participation feature (*ArcGIS Survey 123),* and
- Foster the cooperation and evidence-based decision making via the visualisation (*ArcGIS Experience Builder)* and analysis feature (*ArcGIS Experience Builder*).

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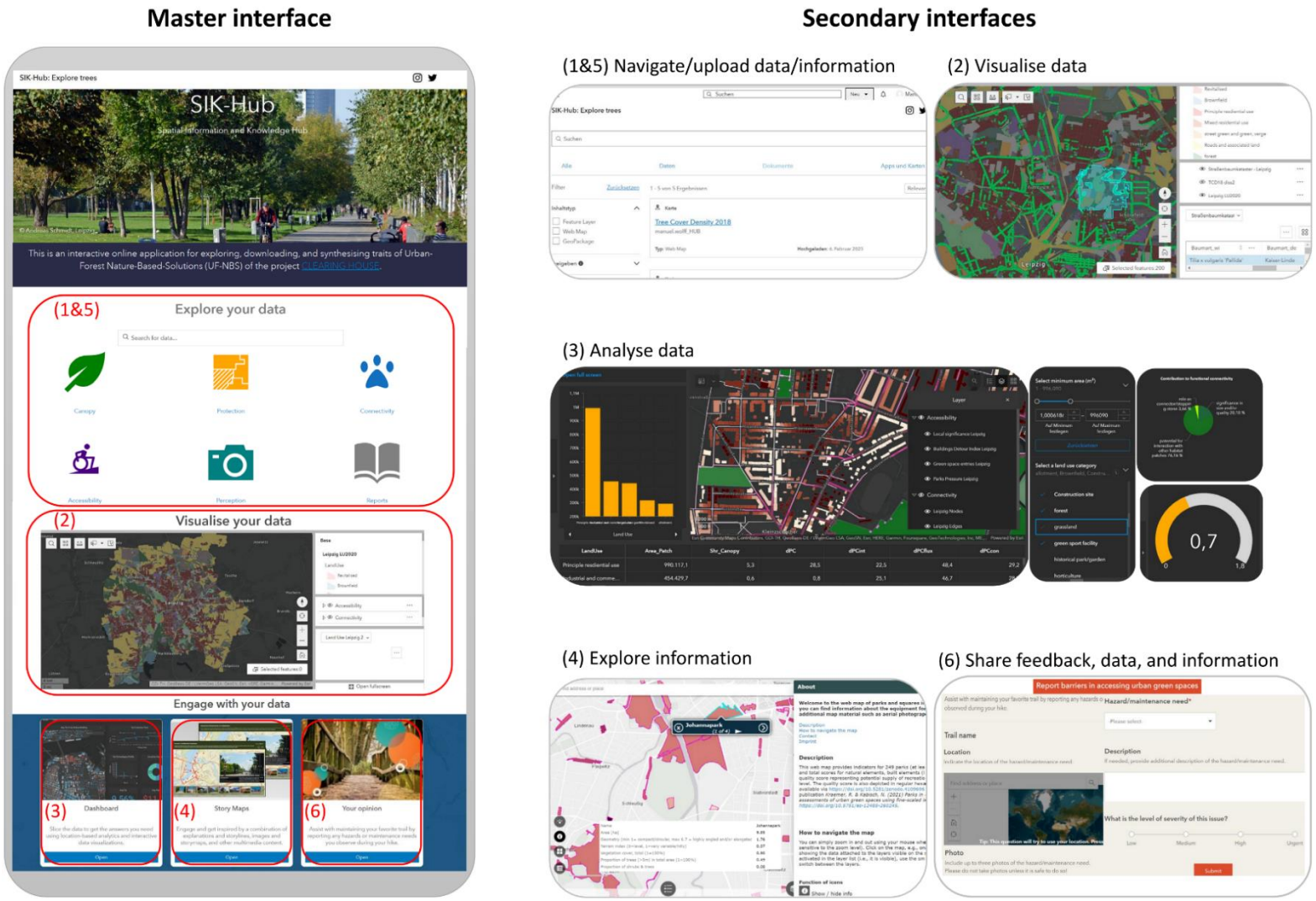

Figure 4: Demo user interface with functionalities.

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5 Current state and implementation

By the end of the project, SIK-Hub was optimized for delivering complementary information on the city level covering all six European case studies (see chapter 2.1). The data on continental scale was modelled and could easily be implemented. The data collection for the local level (namely perceptual data derived by PPGIS methods, see D3.6) was delayed in almost all case studies. There have been efforts in channeling the methods for producing information on continental and city scale to the Chinese partners. Unfortunately, until the projects end no comparable information could have been produced covering Chinese case studies. Nevertheless, SIK-Hub in its current state provides the different types of knowledge outlined in chapter 2.2 providing the basis for different forms of interaction as described in chapter 3. In fact, within the project life span, the tool could have been tested in the city of Barcelona, Brussels, and Leipzig. This was also enabled by all features being functional by the end of the project, except feature 6 (share feedback, data, and information; see chapter 4). Given a new project context after CLEARING HOUSE, it is intended to a) add the last missing feature into the tool, b) extent the provided amount of data and information within the tool (modelled data but also story maps), and c) explore pathways in which the tool can effectively be used for informing and stimulating urban projects. There are no other commitments for its completion. SIK-Hub is released and publicly accessible via the CLEARING HOUSE project webpage or under https://sik-hub.hub.arcgis.com/.

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Annex

List of identified user demands with respect to the Spatial Information and Knowledge hub (M4.3. Workshop synthesising users' demands for application and benchmarking tool conducted)

- Provide comprehensive and comparable data (positive competition, encourage twinning, leader, and follower cities),
- Provide detailed and local specific information,
- Provide well-known and established indicators for different aspects/general situation,
- Account for multiple needs and challenges of cities and city regions combining quantitative and qualitative data,
- Provide direct support for decision makers,
- Option to identify the gaps/flaws in 'our' city based on multiple perspectives of a wider audience,
- Option to develop suggestions and recommendations based on analysis,
- Option to continuously feedback for optimizing the tool / enrich information, direct users to further material.

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