

# Success Factors of Open Urban Data and Urban Data Platforms for Nature-based Solutions

## Key messages

- Nature-based solutions (NbS) are essential measures to address the challenges posed by climate change in urban areas, encompassing a wide range from flooding to heat islands and water shortages. The planning, implementation and monitoring of these solutions should be rooted in accurate and high-quality urban data to foster their efficiency and effectiveness.
- To enhance acceptance and adaptation to local challenges, NbS should be presented to and discussed with citizens and other stakeholders through a co-creation process. This approach allows for the incorporation of ideas and suggestions. Furthermore, continuous monitoring is imperative to assess their impact. The monitoring data should be made publicly available, enabling improvements in future implementations and driving technological progress.
- The successful execution and evaluation of NbS involve several steps: planning, co-creation, participation, construction and/or planting, monitoring, and maintenance. These steps have a higher likelihood of success when integrating open urban data provided by, but also publishing resulting data on, a user-friendly urban data platform based on open standards.
- The establishment of a digital strategy and an urban data platform are recommended, not least to support digital participation systems and significantly enhance co-creation in both the digital and physical realms.

In urban areas, nature-based solutions (NbS) are typically highly visible, audible, and tangible interventions. Yet there is another side to them, which is not immediately apparent but which can profoundly facilitate not only their (co-) planning, but also their (co-) creation, (co-) implementation, (co-) monitoring and (co-) evaluation: open urban data.

Several advantages emerge from utilizing open urban data from the public administration, made available through a centralized and easily accessible urban data platform, to plan NbS interventions and showcase the results digitally, opening up new possibilities across all stages of the NbS implementation process. In that way, an urban data platform is essentially an information hub or communication channel for NbS: while in the initial stages, NbS planning primarily requires urban data to enhance efficiency and effectiveness as well as for co-creation and digital participation, during and after implementation, the stakeholders may transition to the data provision side. They can use the urban

**Urban Data:** encompasses a wide variety of datasets, which may vary in scale, time reference, complexity, and provenance, but have in common that they represent information about urban spaces, such as green areas in the city, biodiversity information, playgrounds and schools, traffic light signals and public transport information, the availability of rental bicycles, cultural events, or weather data. *Open* urban data is publicly accessible, mostly provided by a central administration, and can be searched, used, and analyzed by anyone.

**Urban Data Platform (UDP):** is a comprehensive framework to integrate and interconnect urban data across various urban domains and fields of expertise, such as land use plans, social infrastructure, traffic, and environment efficiently and seamlessly. It empowers users - administration, companies, research, citizens - to access, visualize, configure, analyze, and evaluate data through standardized interfaces and user-friendly web applications and portals in real time depending on their needs. Thus, it facilitates quick decision making and prevents redundant data, additional cost, and duplicate work. A well-established production grade UDP is run by the Free and Hanseatic City of Hamburg (<https://www.en.urbandataplattform.hamburg/>).

data platform to disseminate information about the implemented NbS, the principal project outcomes, and its effects on the environment.

In this brief, we explore potential ways in which NbS processes can benefit from urban data and an effectively implemented urban data platform. We also discuss the challenges that may arise for all stakeholders and provide a real-world example from the Free and Hanseatic City of Hamburg, Germany, to help illustrate theory with practical experiences, and provide a list of resources for further reading.

### Utilizing open urban data (platforms) for nature-based solutions

To demonstrate the practicality and supportive possibilities of utilizing open urban data within the realm of NbS, we examine possible contexts in which such data could be used from three temporal perspectives: pre-greening, during greening, and post-greening. These are each described below in detail.

Pre-greening: Preceding the actual implementation, the existing urban data within an urban data platform can play a significant role in aiding the planning and co-creation of NbS.

- **Information about existing green areas and NbS:** Web applications based on an urban data platform may provide a good and comprehensive visual overview of already existing green areas, flora, and fauna in the city. For example, Hamburg provides the species register<sup>1</sup> and a portal for bathing waters and the current water quality<sup>2</sup>.
- **Identification, evaluation and selection of suitable areas and locations for NbS:** If an urban data platform provides mapping data on measurements such as temperature, precipitation, or air quality, optimal NbS locations, such as very hot and dry or frequently flooded places that would most benefit from NbS, can be identified by combining and overlaying these data sets. Likewise, satellite imagery could reveal particularly dry areas using object detection technologies, and habitat assessment data could indicate areas where protected species reside which may benefit of certain NbS. In this regard, the constant availability of up-to-date urban data and land use plans could significantly expedite the NbS planning workflow for local administrations as well as planning offices and other private companies.
- **Creation of platforms for cooperation and digital co-creation:** Digital and interactive platforms could utilize the openly provided urban data to present and illustrate the issues, challenges, and opportunities for NbS in a planning area. This could foster connections and collaboration among local stakeholders, including residents, to discuss current issues, create solutions and jointly develop ideas for improving the NbS and thus actively contribute and participate in the process. In this context, open urban data can find uses beyond maps and visualisations:
  - **Augmented Reality (AR)** might aid citizens comprehending NbS by explicitly visualizing positive effects on the surrounding environment.
  - **Chatbots** could provide citizens with quick and precise responses to individual questions as well as inform NbS project managers about frequently asked questions about the project.

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<sup>1</sup> <https://geoportal-hamburg.de/artenkataster/>

<sup>2</sup> <https://www.hamburg.de/badegewaesser>

During greening: Throughout the implementation phase, the urban data platform can serve to communicate progress.

- First, an urban data platform could function as an **information hub** for updates on the process. This could entail broadcasting photos to depict the ongoing progress or the provision of progress metrics.
- Additionally, a dedicated **project website** or other online platforms could use the data about the NbS provided on the urban data platform to gather and present even more information, such as feedback from the local media and if and how it influenced the construction, lessons learned during co-creation and co-implementation, details about inauguration celebrations, and suggestions on how citizens can get involved.

Post-greening: Once the NbS has been put into effect, the publication of data on an urban data platform can allow to easily integrate geolocation, description, technical information, and contact addresses in web and smartphone applications for information and promotional purposes while also ensuring transparency in the assessment and evaluation of the NbS impacts.

- Publishing the precise location and additional data of the NbS or an entire network of NbS may facilitate seamless **integration into third party applications**, including outdoor and hiking apps and services.
- Concerning **NbS monitoring**, the publication of monitoring results via an open urban data platform has several beneficial effects: Firstly, open urban data platforms are frequently used by many applications and web portals, which makes the data easily accessible and comprehensible for a broad audience. Also, the dataset might appear in a section - such as "newest datasets" - on the urban data platform information website and pique the interest of users who may not have previously encountered NbS. Secondly, data provision through standardised interfaces ensures easily accessible monitoring data. Available raw data makes published analyses more comprehensible, trustworthy, and traceable for stakeholders. It also improves direct comparability with similar projects in other areas.
- Thinking further, NbS might, especially when very technical systems with multiple sensors are installed, also feed log data into an urban data platform, which could then be used to feed applications for **predictive maintenance**.
- Offering NbS data via an urban data platform through standardized interfaces may facilitate **automatic harvesting of raw data as well as its metadata**. Consequently, datasets can be discovered not only within the platform itself, but also in other metadata portals, possibly encompassing a broader geographical scope. Examples are national and european data portals such as GovData<sup>3</sup> and the official portal for European data<sup>4</sup>.
- Openly providing data via an urban data platform can also enhance the overall **governance** of NbS. Publication of monitoring data, and other documents, such as records of discussions and decision-making processes, fosters transparency and accountability. This, in turn, improves stakeholder and community engagement as well as mass acceptance.

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<sup>3</sup> <https://www.govdata.de/>

<sup>4</sup> <https://data.europa.eu/en>

## Challenges in implementing an urban data platform

The opportunities of open urban data, not only for the context of NbS, naturally bring forth a few challenges that can momentarily overshadow the positive long-term impacts. An urban data platform is a central hub to access and disseminate urban data. But such a platform does not emerge out of thin air - the organizational and technical establishment of an urban data platform demands considerable effort from the public administration. Built on an essential political will and the commitment of the city's top leadership, this endeavor entails not just the provision of personal and financial resources. It necessitates the creation of an organizational unit that is responsible and accountable for conceptualizing and building such a platform. Additionally, it involves delineating responsibilities and fostering collaboration across a diverse range of administrative departments. On the technical level, it requires actual access to original datasets and their ongoing updates, and even, at times, digitization if they were originally created in analog format. This must be accompanied by scalable data storage solutions, the use of open standards, interfaces, and protocols for data and metadata storage and exchange. Data security must be addressed and, ideally, web portals (e.g. Masterportal<sup>5</sup>) facilitate data search and visualization. A Spatial Data Infrastructure (SDI) addresses all these requirements. Hence, a SDI serves well as core component of an Urban Data Platform. If the project is to extend beyond the prototype stage, the long-term costs associated with operation, support, and ongoing development need to be factored in. However, these costs are quickly balanced by cost savings resulting from efficient and easy data exchange as well as synergies.

While the administration can initiate the UDP with a limited set of open datasets, it can only come to real life when more and more entities from diverse areas of the public administration and potentially also academic partners and private companies are willing to open their data silos and actively share information about the city. Legislative measures can play a pivotal role in this process. For instance, Hamburg's transparency law enacted in 2012 obliges the administration to provide a substantial volume of information, data, and documents online without charge or the need for registration or application. It is important to note that this doesn't encompass data linked to individuals; urban data exclusively pertains to the city. This includes aspects such as maps, urban infrastructure, traffic, education, cultural offerings, services provided by the administration for physical activities, technology, and science.

On the other hand, the UDP truly realizes its utmost potential when the disseminated datasets are actively utilized. For instance, they can be harnessed in online map applications, which could be developed and offered by any interested party, including the administration itself, or in traffic and mobility analyses or more broadly to pinpoint the needs of citizens within the urban environment. To guarantee the applicability for various applications, the urban data platform should provide data through standardized interfaces, for example as advocated by the Open Geospatial Consortium (OGC). Additionally, data that isn't easily discoverable and accessible is data that remains untapped. Hence, adhering to a unified metadata scheme and not only making the raw data available, but also the accompanying metadata in an open metadata catalogue becomes imperative.

## Challenges for urban data in the context of NbS

The utilization of urban data from an urban data platform in co-creation for NbS presents new challenges which might impede the complete realization of the potential benefits. While it is the responsibility of the

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<sup>5</sup> <https://www.masterportal.org/home.html>

administration to ensure easy access to the urban data platform and provide urban data through readable, standardized protocols, complemented by informative and clear metadata and searchable in metadata catalogues, technical proficiency is also necessary on the side of the planners and stakeholders engaged in NbS planning and implementation in order to be able to autonomously and effectively engage with the data. As many of them are not data engineers, they might need to seek assistance from geoinformation experts. This may be compensated by reduced communication efforts with the administration to access the data at all. Upon employing the data in citizen-centered initiatives, one must account for differering levels of digital literacy, the digital divide, and the capacity to comprehend spatial information. The utilization of digital data requires extensive communication, education, and support. Yet, over time, it can result in invaluable advantages, fostering enhanced information sharing and data-driven decisions.

### Recommendations

For cities that are currently in the process of establishing a smart city or urban data platform and intend to leverage it in the context of NbS, we would recommend considering the following areas as initial steps:

- Laying the political groundwork through a digital strategy and/or laws ensuring urban data transparency
- Allocating budget and responsibilities to a dedicated team, department, or organizational unit
- Seeking guidance from administrations that have already succeeded in building an urban data platform
- Prioritizing user requirements, particularly those of NbS stakeholders
- Assessing existing technical infrastructure; leveraging an established geodata infrastructure can be very cost-efficient and thus advantageous
- Implementation of an IT infrastructure connecting existing systems with the urban data platform
- Promote the use of open standards for technical interfaces
- Implement organizational interfaces as well as a city internal UDP consulting unit
- Outlining a systematic process for coordinated integration of datasets into the platform
- Devising a communication strategy encompassing workshops, trainings, and online user resources

In the subsequent box, we describe the Urban Data Platform Hamburg, one of the most advanced production-grade Urban Data Platforms in Europe.

#### Real World Example: Free and Hanseatic City of Hamburg

In Hamburg, the Urban Data Platform serves as the primary hub for open urban data, offering a comprehensive collection of over 3.700 datasets, of which more than 540 data sets feature information across various urban domains, such as population and society, health, environment, traffic, science, and technology. Critical political milestones that contributed to this achievement include the city's digital strategy, the Hamburg Spatial Data Infrastructure Law, the enactment of the Hamburg Transparency Law, and the implementation of the *Urban Data Hub* at the Agency for Geoinformation and Surveying. The Urban Data Hub is a central entity responsible for conceptualizing and developing the Urban Data Platform as well as advising the administrative authorities of Hamburg regarding urban data. The datasets are made available through standardized and interoperable interfaces, facilitating their integration into any geodata application. For the public, the most straightforward access point to the Urban Data Platform is Geo-Online (<https://geoportal-hamburg.de/geo-online/>), a web-based geodata portal designed and developed by the Agency for Geoinformation and Surveying as part of the city administration using open source technology (<https://www.masterportal.org/>). Geo-Online empowers anyone to visualize, inspect, combine, intersect, and download both the actual datasets and their accompanying metadata according to their unique requirements.

Both the Urban Data Platform and Geo-Online have already demonstrated their usefulness and success across numerous projects and domains. For instance, they have played pivotal roles in the EU projects *smarticipate* and *mysmartlife*, as well as the social planning tool in Hamburg (CoSI). Over the past years, their value has also been showcased within the scope of the CLEVER Cities project in Hamburg:

1. The data about green spaces and biodiversity in Hamburg played a crucial role in identifying suitable locations for NbS in the project area in Neugraben-Fischbek.
2. Particularly emphasizing the essential aspect of co-creation in CLEVER Cities, the Urban Data Platform furnished the indispensable informational foundation for several participation processes conducted using the digital participation system DIPAS. This wouldn't have been possible without the UDP: the city map and urban data relevant to the planning area were sourced directly from the UDP. This lends plans a tangible quality and empowers contributors to form opinions grounded in current urban data. For instance, the inaugural CLEVER-DIPAS process in Hamburg in 2018 unveiled the project area and invited citizens to propose locations and ideas for green and social enhancements.
3. The heavy rain drainage analysis, which was developed jointly with the local water supplier, Hamburg Wasser, utilized resources from the UDP, including the digital terrain model and land use data.
4. Data created, collected, or generated within CLEVER Cities in Hamburg, including geodata and monitoring data, may also flow into the Urban Data Platform and as such be available for investigation and analysis by any interested party. As an example, the CLEVER project areas, corridors, and active projects in Neugraben-Fischbek were published early in the project, recently supplemented with the biotope mapping of a rainwater retention basin.
5. The CLEVER Cities consortium collaboratively developed and introduced the CLEVER Data Hub (<https://clevercities.eu/resources/clever-data-hub/>), a public open data portal that offers a central search interface for data produced within the context of CLEVER in the local data platforms of the Front Runner cities, thereby enhancing the visibility and accessibility of CLEVER to a wider audience.

**DIPAS (Digitales Partizipationssystem, digital participation system):** Integrated digital system for citizen participation online and on site that operates seamlessly without media disruptions. Empowers citizens to access real-time information about ongoing urban planning projects, view digital maps, aerial photos, 3D models and other geodata from any location using personal digital devices. Additionally, it facilitates participation at events through digital data tables, enabling citizens to provide precise, location-specific feedback, suggestions, and critiques. Developed by the public administration of the Free and Hanseatic City of Hamburg, DIPAS has been made available as open-source software at <https://dipas.org/>.

## Conclusions

In summary, we see many possibilities and ways through which the utilization of urban data in the context of NbS can significantly bolster and streamline the planning phase, for example to identify the best spots and to intensify digital co-creation and participation and can even serve as a communication channel during and post-implementation. The digital integration with an urban data platform<sup>6</sup> augments project visibility, not only for regional entities but for a wider array of stakeholders, thereby augmenting transparency across the board. Moreover, other NbS projects may benefit from public monitoring and evaluation data over the long term. The use of open urban data is an effective way to expedite the development and realization of NBS projects, fostering collaboration among disparate stakeholders to tackle intricate challenges. To fully harness the advantages of an Urban Data Platform, open urban data should be conveniently and digitally accessible via standardized and interoperable interfaces and protocols. The data should be described by meaningful metadata presented in a standardized format. Additionally, the public administration should equip citizens with tools to promptly view and use the data, eliminating the necessity for technical expertise. In Hamburg, the incorporation of the CLEVER Cities project data into the Urban Data Platform guarantees their future availability, ensuring that they are accessible online and usable by anyone. This accessibility extends not only regionally but also internationally through the CLEVER Data Hub.

Looking towards the future, the notion of utilizing urban data within the realm of NbS could be expanded into the domain of urban digital twins. Essentially, the concept of the Urban Digital Twin is similar to that of a construction kit, where the building blocks are combined anew for each problem. An urban digital twin consists of multiple components: geo base data, specialized data, an application environment to render the technology accessible, and analytical tools to work with the input data. Envisioning an urban digital twin for the NbS context, the first component would encompass urban data, such as fundamental maps and orthophotos, while other components could contain data and tools which might be necessary for the detection and monitoring of NbS, including trees, weather data, a tool for heavy rain drainage impact analysis, a tool to detect sealed surfaces from orthophotos, and a tool for citizen participation. In the application component, predictive functionalities could be integrated to illustrate diverse scenarios detailing the effects of interventions on their surroundings. After implementation, the resulting monitoring data could also be integrated into the city's urban data platform.

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<sup>6</sup> <https://www.en.urbandataplatform.hamburg/>

**Resources:**

- Website of the Urban Data Platform Hamburg: <https://www.en.urbandataplattform.hamburg/>
- UDP Cockpit: <https://geoportal-hamburg.de/udp-cockpit/#/>
- Geo-Online / Geoportal Hamburg: <https://geoportal-hamburg.de/geo-online/>
- Masterportal: <http://masterportal.org/>
- Metadata Catalogue: <https://metaver.de/portal>
- DIPAS: <https://dipas.org/>
- CLEVER Data Hub: <https://clevercities.eu/resources/clever-data-hub/>
- Heavy Rain Drainage Analysis:  
[https://clevercities.eu/fileadmin/user\\_upload/City\\_Publications/drainage-analysis-for-heavy-rainfall-neugraben-fischbek.pdf](https://clevercities.eu/fileadmin/user_upload/City_Publications/drainage-analysis-for-heavy-rainfall-neugraben-fischbek.pdf)
- Hamburg's Transparency Law: <https://www.hamburg.de/transparenzgesetz/>
- OGC: <https://www.ogc.org/>
- Schubbe, Nicole, et al. "Urbane Digitale Zwillinge als Baukastensystem: Ein Konzept aus dem Projekt Connected Urban Twins (CUT)." ZfV-Zeitschrift für Geodäsie, Geoinformation und Landmanagement zfv 1/2023 (2023). Available online: [https://geodaesie.info/images/zfv/148-jahrgang-2023/downloads/zfv\\_2023\\_1\\_Schubbe\\_et-al.pdf](https://geodaesie.info/images/zfv/148-jahrgang-2023/downloads/zfv_2023_1_Schubbe_et-al.pdf)



**AUTHORS:** Bianca Lüders, Free and Hanseatic City of Hamburg

**CONTACT:**

Email: [info@clevercities.eu](mailto:info@clevercities.eu)

Website: [www.clevercities.eu](http://www.clevercities.eu)

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