Collaborative research and context analysis

CONE – 1st Workshop - Training of trainers

ONLINE | 3 of March 2025

Presenter: Dominika Wróblewska

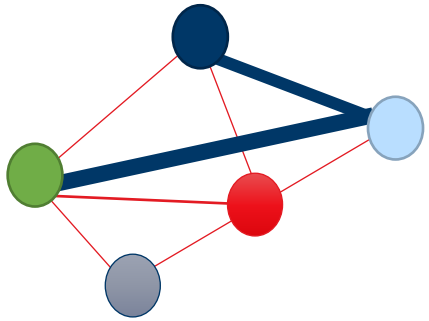
Collaborative research and context analysis in urban planning of resilent cities

Dominika Wróblewska, 2024

Elements and features of the urban space

Urban planning and design for climate resilience

- People
  - Links
  - Dots



Diverse – spatial conflicts.

Resistant –to change, ability to return to its original state.

Limited – space cannot be expanded

Continuous –every part is connected to others, maintaining mutual relationships.

Accessible – space has a public nature, ensuring universal access and freedom to use its resources.

Valuable – methods for assessing the environmental (ecological) and social (cultural) value of space are also continuously evolving.

Dynamic –the variability or development of space, which may result from both natural causes and human activities.

GDAŃSK TECH

RESEARCH UNIVERSITY
EXCELLENCE INITIATIVE

PRESSURE
Urban planning and design for climate resilience

Migration	Pandemics	Climate Change
Social Fatigue	Natural Disasters	Economic Slowdown
Armed Conflicts	Depopulation	Urban Spraw
Technological Development	Vandalism/Terrorism	Poverty

Climate changes

CO2

Mitigation

Adaptaion

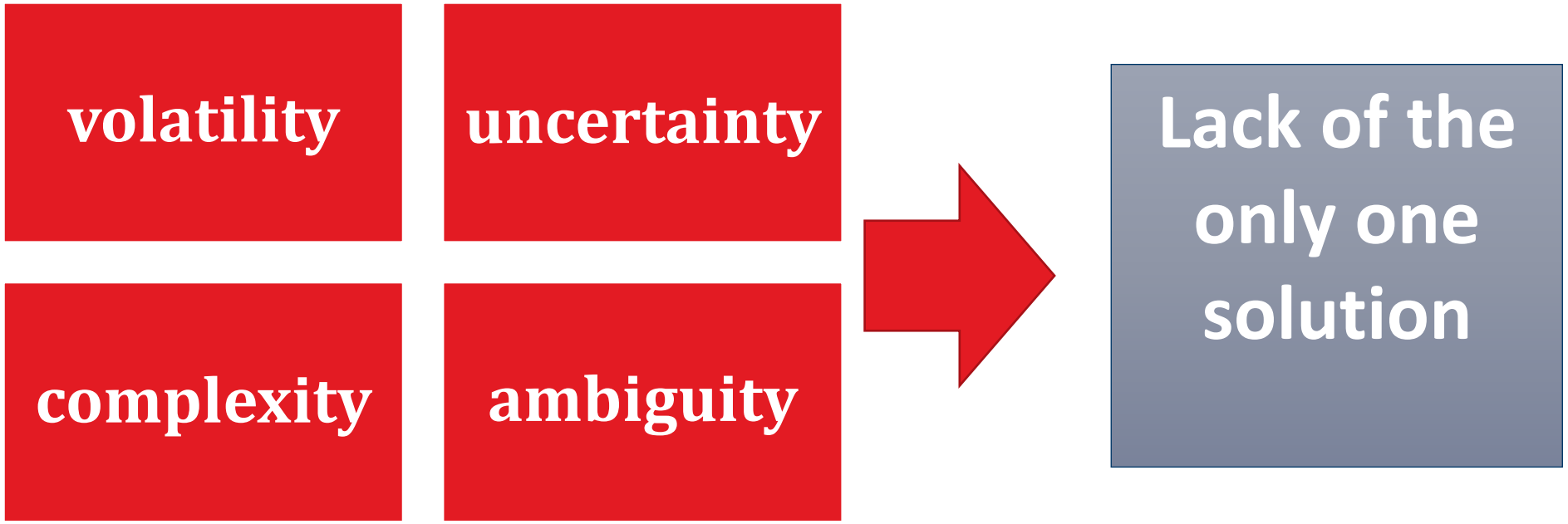
Regeneration

Resilience
Urban planning and design for climate resilience

Urban resilience is the capacity of a city's systems, businesses, institutions, communities, and individuals to survive, adapt, and thrive, no matter what chronic stresses and acute shocks they experience. *{ Arup & Rockefeller Foundation: City Resilience Index}*

As a result, resilience can be ensured for the entire system, regardless of external changes, enabling continued development and goal achievement. In the face of increasing threats and rapid changes, thinking in terms of resilience is crucial for cities, as it highlights the importance of responding effectively to these challenges

VUCA



Strategies for urban planning
Urban planning and design for climate resilience

(1) **Acceptance of changes and uncertainties** that accompany complex systems such as cities, and building resilience to crises by increasing system redundancy, forecasting and modeling its behavior in crisis situations, maintaining the ability of network connections to recover balance after disturbances, and creating conditions for generating knowledge and drawing conclusions from previous crises, in which the resilience triangle can be applied.

RISK, MITIGATION, ADAPTION, FLEXIBILITY

(2**) Creating conditions for rapid regeneration** and renewal after disturbances, which can be supported by building social capital, ecological diversity, and utilizing socio-ecological memory.

ADAPTION, REGENRATION, LOCAL

(3) **Using various types of knowledge**, based on which experiments are conducted, modeling is carried out, and specific information about feedback loops in the system is obtained.

HUBS, LIVING LABS, NETWORKING

(4) **Creating conditions for self-organization**, primarily by shaping multi-level networks of connections and interactions between them.

LOCAL, NETWORKING

Strategies for urban design
Urban planning and design for climate resilience

Diversified infrastructure

Green infrastructure and Nature-based solutions

IT/digital/AI innovation

Decentralized systems and local resilience

Collaboration, awareness and knowledge sharing

Inclusive and equitable design

Mixed-use and dense development

Climate-responsive architecture

Disaster-resilient planning and preparedness

Sustainable mobility and transportation

Urban resilience governance (SDG)

https://www.urbanstrategies.com/expertise/urban-design-guidelines/

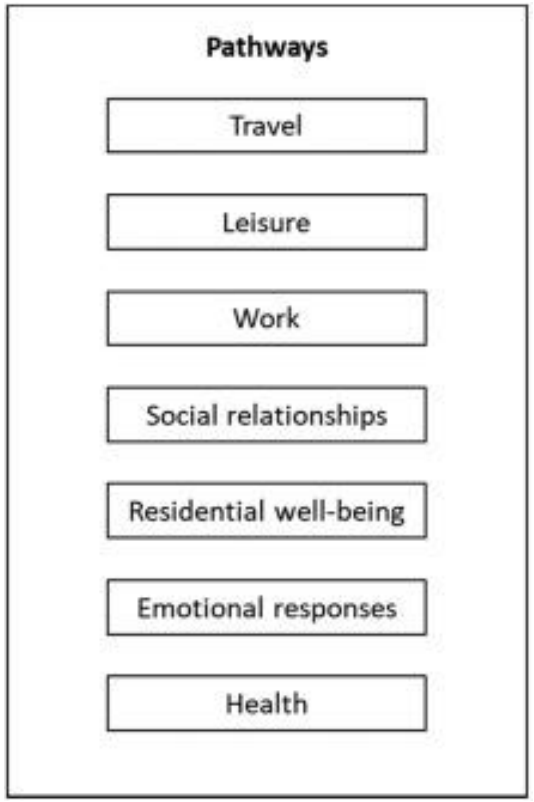
Global → Local

Assessing local environmental and social contexts in urban planning

Every local context around a project is unique and research shows that understanding and adapting to the local context is key for a project to achieve its goals.

Built environment

physical environment: elements of the places and spaces where individuals develop and function on a regular basis, offering opportunities or barriers that influence individual development and behavior.



Subjective well-being

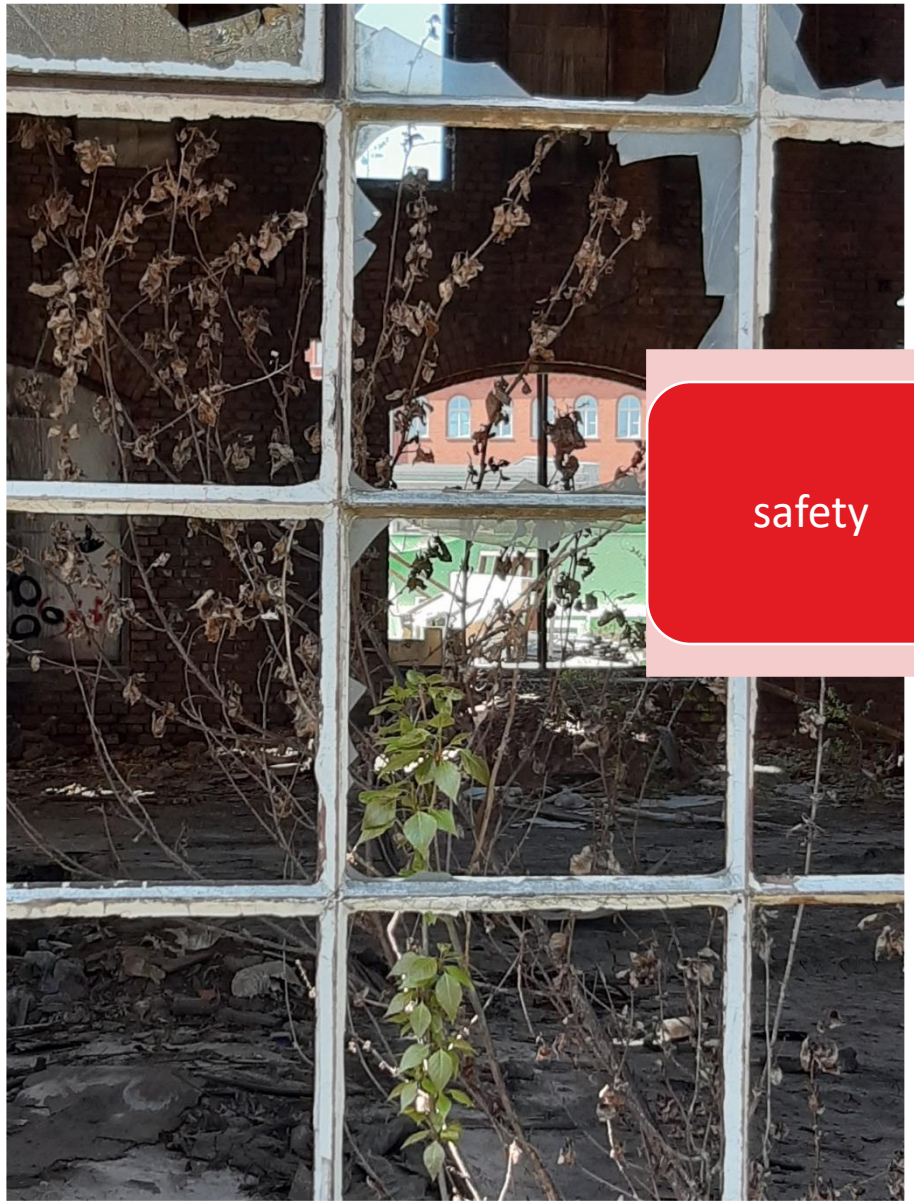
social contexts: the array of social relationships forming the context for an individual's development and behavior, offering opportunities or barriers that influence individual development and behavior.

Model of the pathways linking the built environment to subjective well-being

https://www.sciencedirect.com/science/article/pii/S0264275121001293

People expectations

Urban planning and design for climate resilience



- safety
- opportunity for development
- health
- prosperity
- comfort

Assessing local environmental and social contexts in urban planning

Customized Assessment Frameworks

the assessment process should be adaptable and tailored to the specific needs and circumstances of each city and community

Identifying Key Focus Areas

pinpointing areas where vulnerabilities are most pronounced, such as low-lying regions prone to flooding or areas with high rates of unemployment and violence

Integrating Sustainability and Equity

analyzing urban development through the lens of equity, governance, and sustainability

Use of Technology and Data Analytics

IT,

remote sensing

and other data-driven tools can provide detailed insights into urban dynamics

Scenario Building and Simulation

test the effectiveness of various strategies under different scenarios, ensuring that the chosen resilience measures are robust and adaptable to changing conditions

Collaboration And Engagement

gain an in-depth understanding of local needs, vulnerabilities, and capacities, which are essential for tailoring resilience strategies to specific local conditions.

Physical context

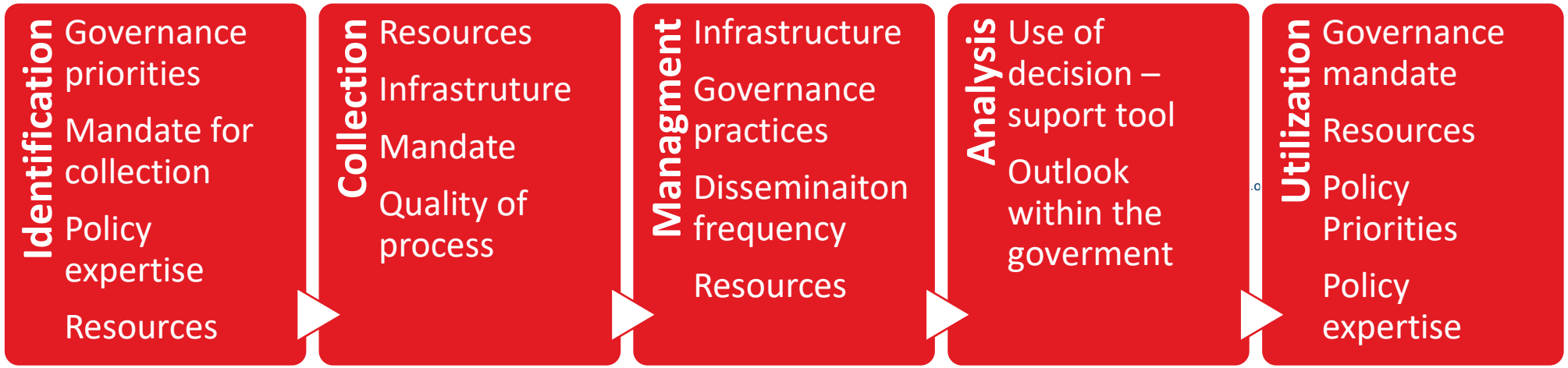
TOPIC	PURPOSE
Location	precinct is situated, highlighting key features, and showing the broad community context
Surrounding area and land use	relationships to the surrounding area including other precincts, centres, features and key infrastructure.
Tenure, ownership, and buildings	functions of buildings and land use in and around the precinct. scale, height, and density of surrounding development land assembly opportunities and constraints to identify influence on development potential.
Environment	climate, soils, vegetation, topography, total water cycle, landscape features, key views, and local character. environmental opportunities and constraints to identify influence on the development.
Physical infrastructure and services	existing and planned infrastructure such as transport networks, energy supply, sewerage, water, and waste systems. constraints to be resolved
People movement	movement network. quality of movement and how people experience travel, opportunities for potential improvements to walkability and cycling. strategic planning by transport agencies

Community context

TOPIC	PURPOSE
People	current and forecast population, demographics and socio-economic characteristics of the precinct and the immediate surrounding area
Housing	housing typologies and reconcile with demand/supply and affordability
Economy	strengths, weaknesses and emerging issues/trends of the precinct's economy including employment and business opportunities.
Culture, values, and identity	communities that will use the precinct to ensure authentic, community driven outcomes values communities have regarding cultural and built heritage, Aboriginal cultural heritage, environmental values, and sense of place.
Social infrastructure and services	current and future capacity, usage and provision of facilities, spaces, services, and networks that support community wellbeing: health-related services, education and training, social housing, justice, and public safety provisions, as well as arts, culture, and recreational facilities.

Data collection

1. Which data exist and at which scale?
2. What kinds of data are lacking?
3. Is the data format convenient or not, when cooperating with other professions in the planning process?
4. Are authorities that work at different spatial scales aware of the need to pool data to improve evaluation and planning at the local scale?
5. Is there data for costs of maintenance of future and existing solutions?
6. Is there data about citizens' perceptions and preferred use of solutions?

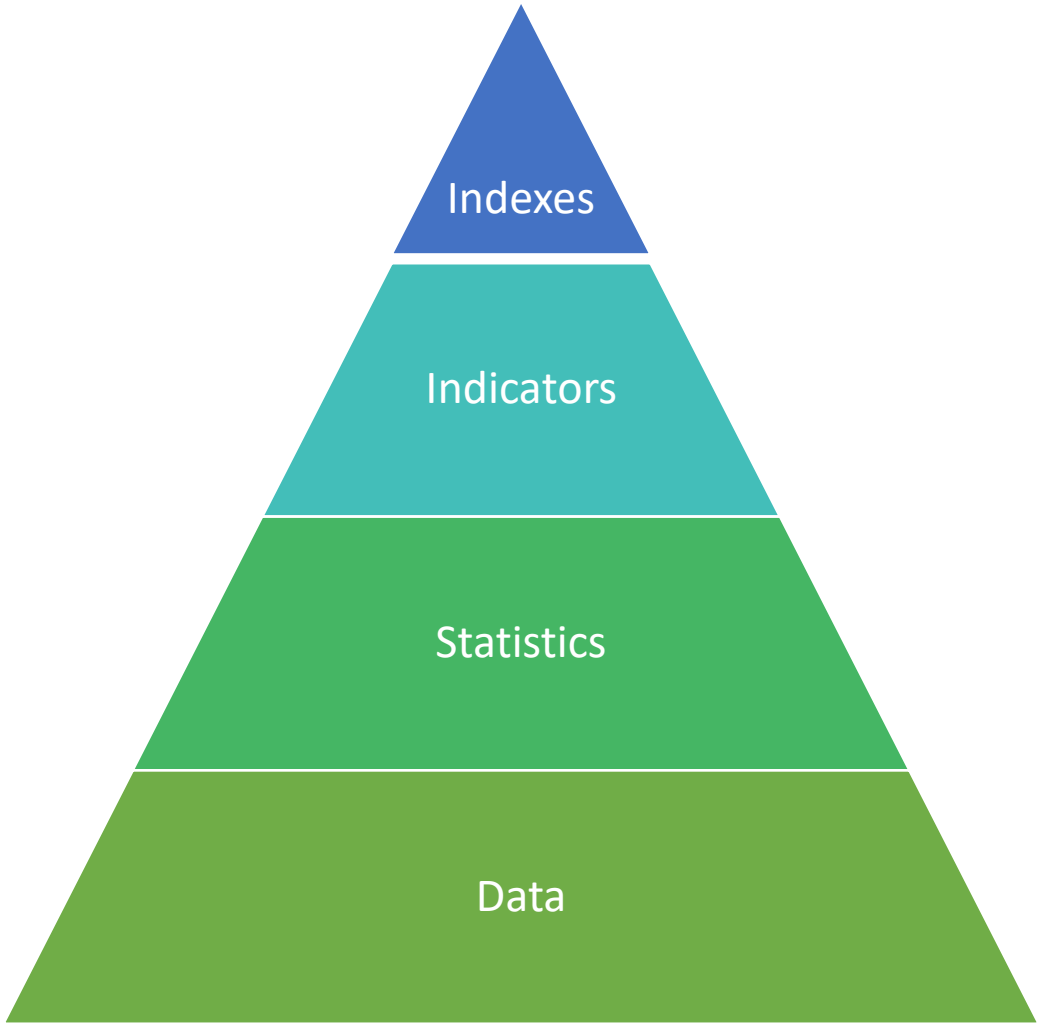


http://www.citiesalliance.org

THE DATA PRODUCTION VALUE CHAIN

Set of data for BGI – Blue Green infrastructure

1. Cadastral (e.g. property ownership, land cover)
2. Technical (e.g. pipes, cables)
3. Geological (e.g. soil layers, stability)
4. Biological (e.g. citizen observations of species, important habitats)
5. Environmental (e.g. environmental monitoring, polluted soil and groundwater)
6. Risks (e.g. flood claims, flood hazard mapping, environmentally hazardous business)
7. Social (e.g. socio-economy, historical buildings)
8. Administrative (e.g. municipal maps for planning)
9. Meteorological (e.g. temperature, precipitation, humidity)



Resources - Remote sensing data collection

Landsat-1, 2, 3, 4, 5, 6, 7	Visible and infrared, thermal	Archives available since 1972	60 m	accessible (NASA), global (cutoffs at specific northern and southern latitudes)	https://earthexplorer.usgs.gov/
PlanetLabs (Dove satellites)	Visible and infrared	Scenes taken daily, high-resolution	0.5–3 m	Private, monthly composites accessible through Norway's International Climate and Forests Initiative Satellite (NICFI) Data Program for the Tropics	https://www.planet.com/nicfi/
Google areal images and high resolution satellite composites	Visible	Composites, temporal archives vary depending on the region	0.15–30 m	Private, global scene composites are available on Google Earth but cannot be downloaded	https://earth.google.com/web/
Amazônia-1	Visible and near infrared	Every 5 days	60 m	Publicly accessible (BSA, Brasil), global but on the catalog only scenes in South America are available	http://www2.dgi.inpe.br/catalogo/explore
Cartosat-3	Visible	Every 5 days, archives available since 2005 (Cartosat-1)	0.25 m	Publicly accessible (ISRO, India), scenes only cover the Indian subcontinent	https://bhuvan-app3.nrsc.gov.in/data/download/index.php

The Contribution of Remote Sensing and GIS

Land-cover Mapping

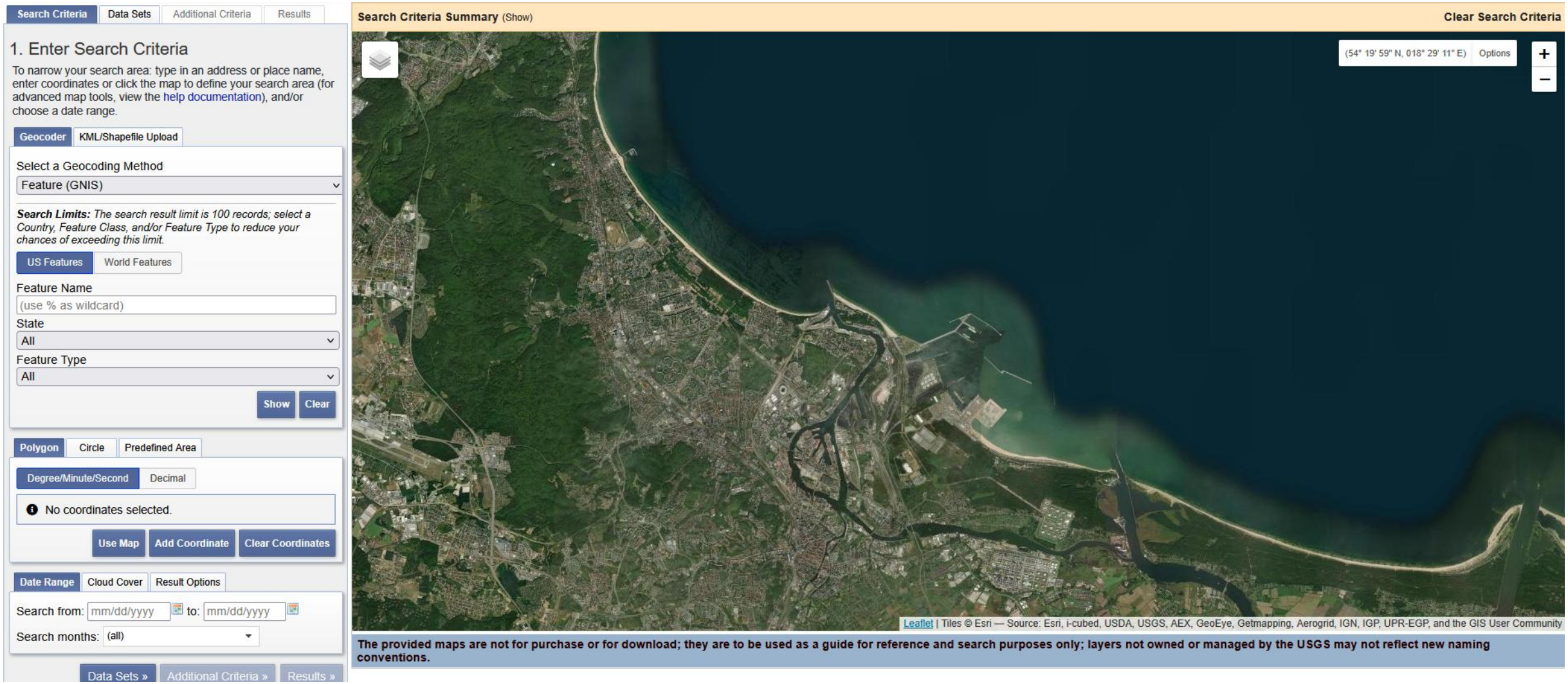
Monitoring Land-cover Change

30 cm of accuracy

https://pixabay.com/photos/united-states-atlantic-coast-night-92351

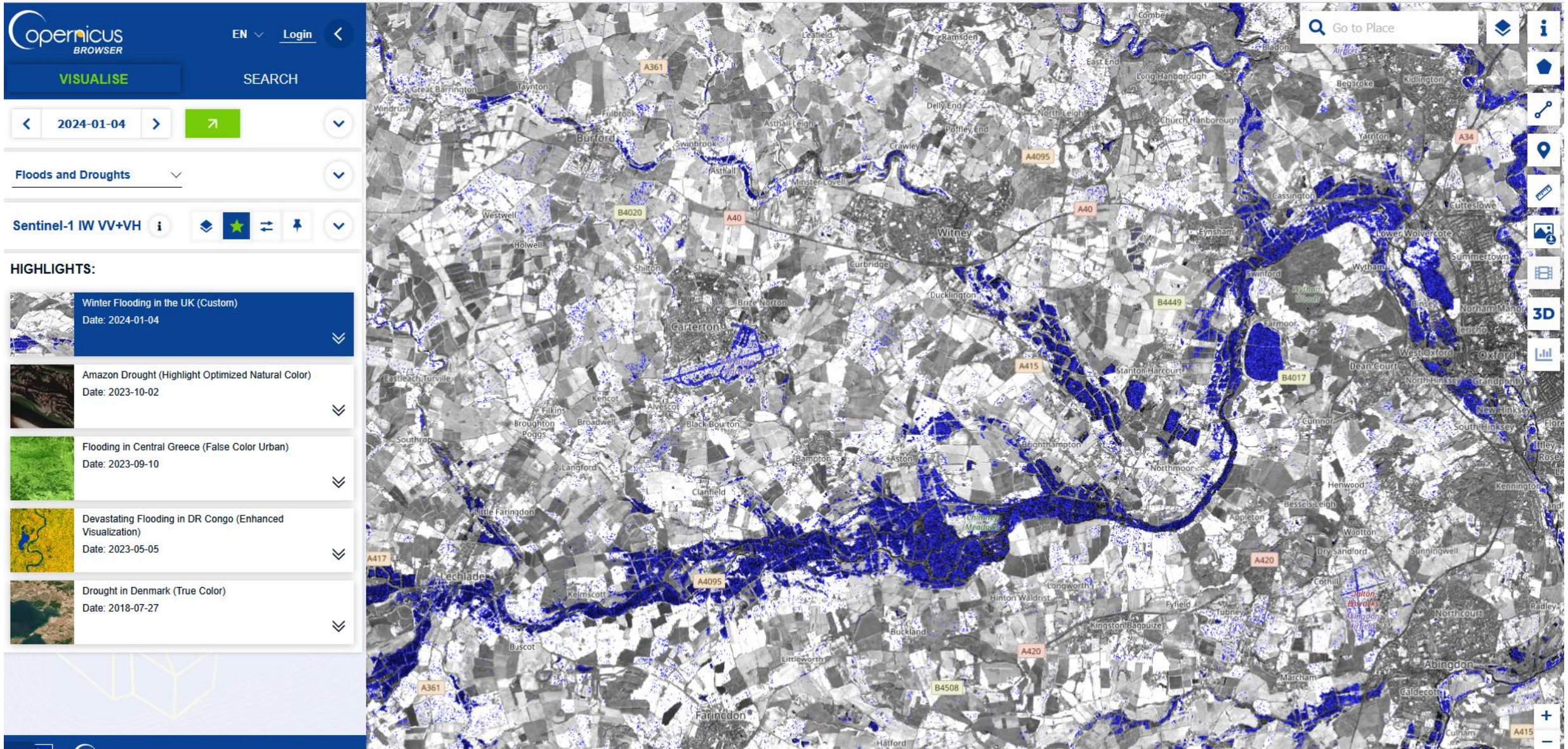
Remote sensing data collection

https://earthexplorer.usgs.gov/



Remote sensing data collection

https://browser.dataspace.copernicus.eu/

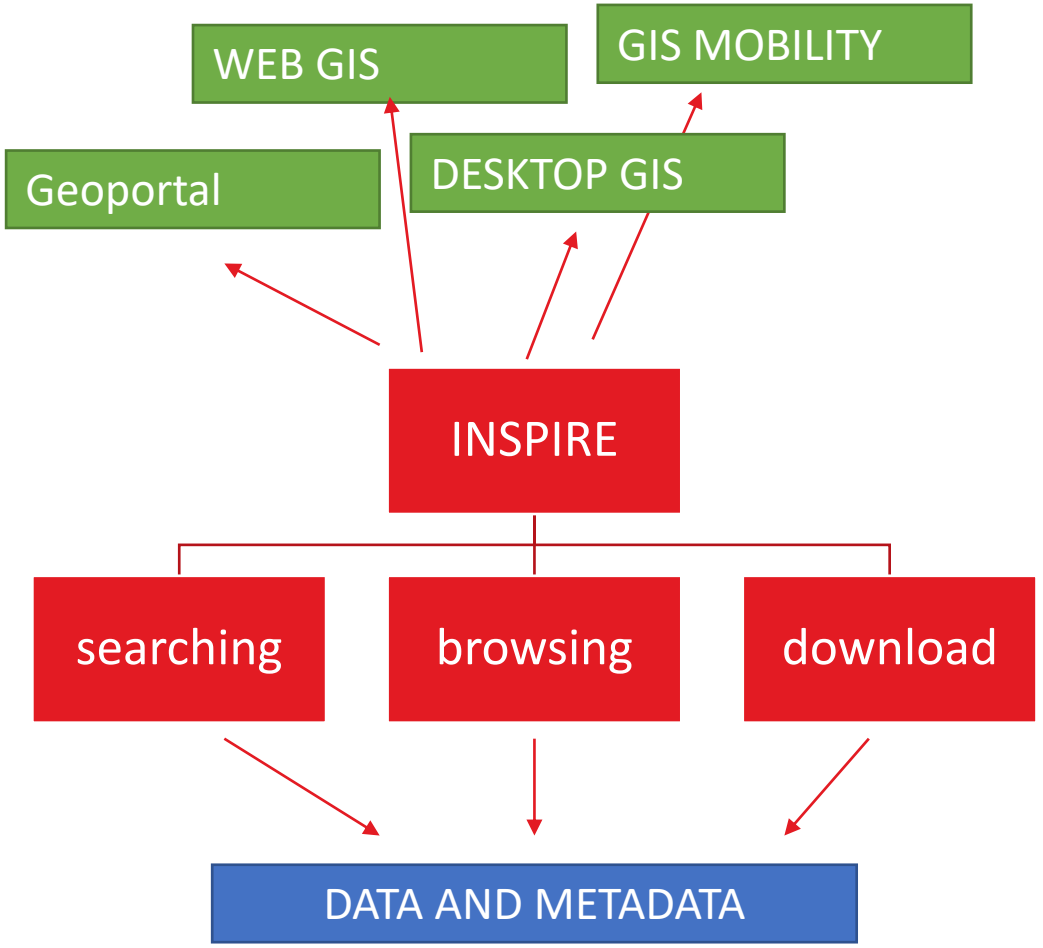


Geospatial data INSPIRE

The INSPIRE Directive encompasses 34 spatial data themes, which are then organized into three annexes. These themes cover a wide range of environmental and geographical information.

Major components:

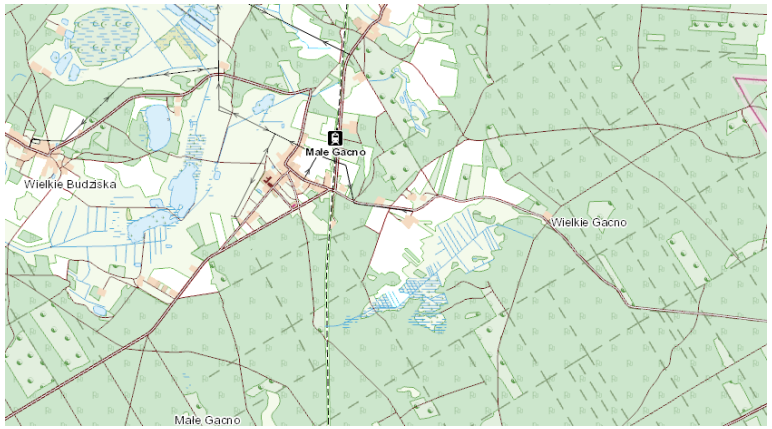
1. **Network services**: Such as discovery, view, and download services that allow users to find, visualize, and access spatial data.
2. **Metadata**: Detailed descriptions of datasets help users understand the data's context and usability.
3. **Data harmonization**: INSPIRE promotes the standardization of data formats and protocols, enabling seamless integration of information from various sources.



European Union

https://inspire-geoportal.ec.europa.eu/

Resources - Geospatial data INSPIRE



https://www.geoportal.gov.pl/

WMS

- Weather patterns and ocean currents
- Geological data (rock types, fault lines)
- Land use information (urban areas, farmland, forests)
- Population distribution
- Transportation networks
- Protected natural sites
- Other

Standardized Formats

IT solutions for data managment/analysis

ICT	Information and communication technologies (System informatyczno – komunikacyjny)
BIM	Building information modeling (System modelowania informacji o budowli/budynku)
GIS	Geografical information systems Systemy informacji geograficznej)
Lot	Internet of Things (wszystko podłączone do internetu)
XR	Virtual reality+ Augmentive reality (wirtualna i rozszerzona rzeczywistość)

IT technologies create a robust framework for resilient urban planning. They allow cities to visualize complex data, simulate impacts, and implement solutions that enhance durability and adaptability. By integrating BIM, GIS, and Digital Twins, cities can not only respond to immediate challenges but also plan for long-term sustainability and resilience, ensuring they are better prepared for future uncertainties

The power of AI and real-time data

IT solutions for creating /managment resilent cities

GPS, mobility patterns, risk managment

Disruptive Technologies for Development Challenge[24]

Developments in smart phone technology have enhanced the availability and practical relevance of people movement data. Mobility patterns, captured through GPS on phones, are increasingly used for urban planning and resilience, from modelling commuting flows to evaluating the impact of urban regeneration investments on local foot traffic. The Disruptive Technologies for Development (DT4D) challenge explored how human mobility data can become a mainstream part of the analytical toolkit for urban and Disaster Risk Management specialists. This can be used to understand where people are when a disaster takes place and how people access services after a disaster. For example, the study tracked how different economic groups accessed hospital facilities during Cyclone Nivar, which struck Tamil Nadu and Andhra Pradesh in India in November 2020.

Digital monitoring: sensors and cameras, real time information, decision -making

Rio de Janeiro's Centre of Operations (COR)[33]

Rio de Janeiro's Centre of Operations (COR) takes advantage of a network of digital sensors and surveillance cameras embedded across the city's infrastructure systems to gather data and information into a single management center. The COR allows emergency services, transport operators, utilities, and other critical service providers to co-locate and receive real-time information about operations across the city, allowing rapid and joined-up decision making and communications throughout the city. This helps to pre-empt shock/stress situations and provides real-time situational awareness during disasters.

Drones, soil maps, maping buildings and dwellings, flood risk

Drones and citizen scientists helping to reduce flood risk[18]

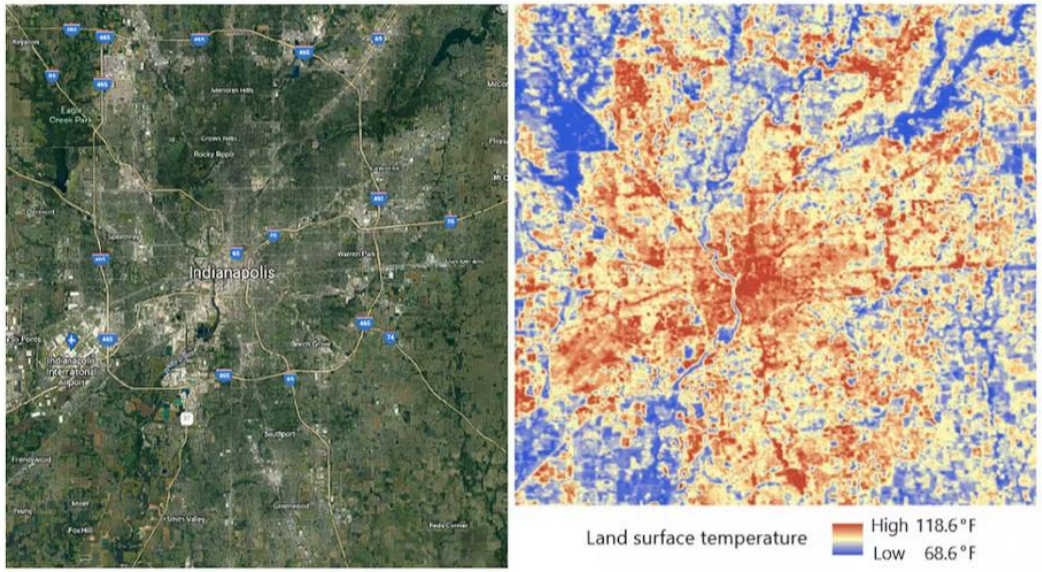
Low-cost digital tools are helping bridge an important data gap as towns and cities continue to grow in an unplanned, unsurveyed manner. In Dar es Salaam, for example, where informal settlements along the banks of the Msimbazi River are vulnerable to flooding during the rainy season, citizen scientists and drones were mobilized to help improve the accuracy of soil maps to better guide urban decision making.

This program has also created an innovative Resilience Academy, where students learn practical digital skills while working to make their countries safer from climate change. Using drones and household surveys, students mapped the whole island of Zanzibar. By digitizing 500,000 buildings, their work increased the previous building register of only 163,000 dwellings.

(8) The World Bank (2019): In Tanzania, Citizen Scientists Help Reduce Flood Risk with Soil Sampling. [Available online].

Remote sensing data analysis

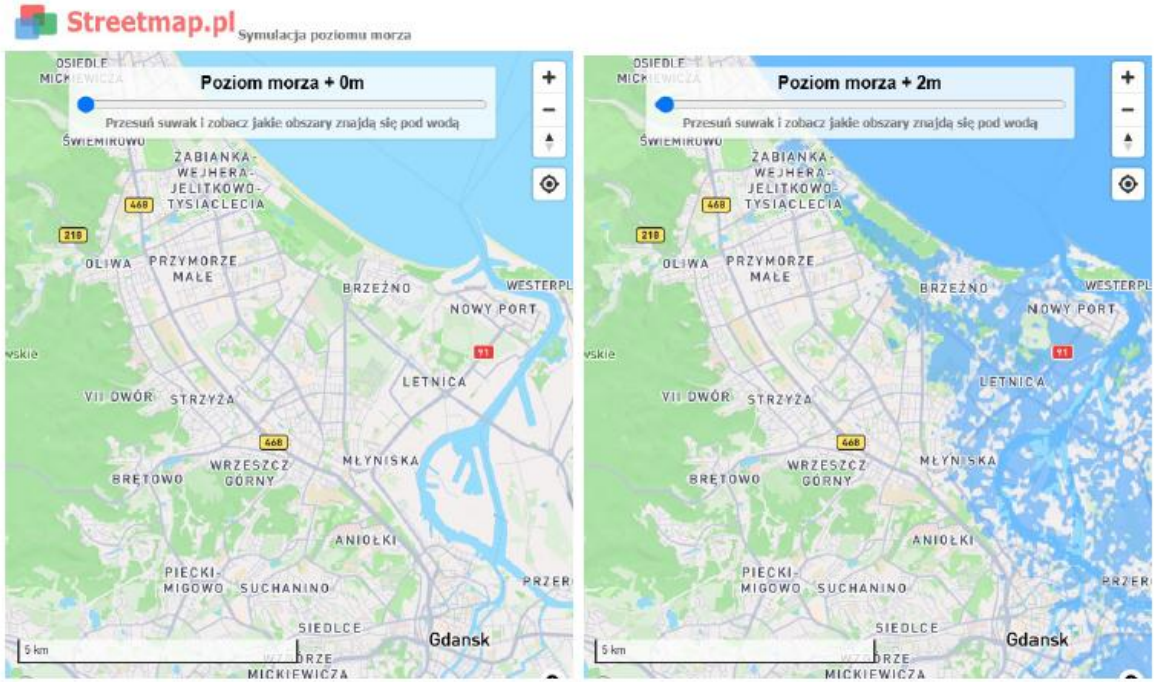
Urban Heat Island



The image on the right shows the surface urban heat island of Indianapolis in July 2019. Note the higher-density built areas in red are much warmer than the cooler, more vegetated areas in blue. NASA/USGS Landsat

https://theconversation.com/landsat-zooms-in-on-cities-hottest-neighborhoods-to-help-combat-the-urban-heat-island-effect-182925

Flooding and sea level rise



https://streetmap.pl/seelevel/#11.18/54.3903/18.6074

Tool for daa managment and analysis - GIS

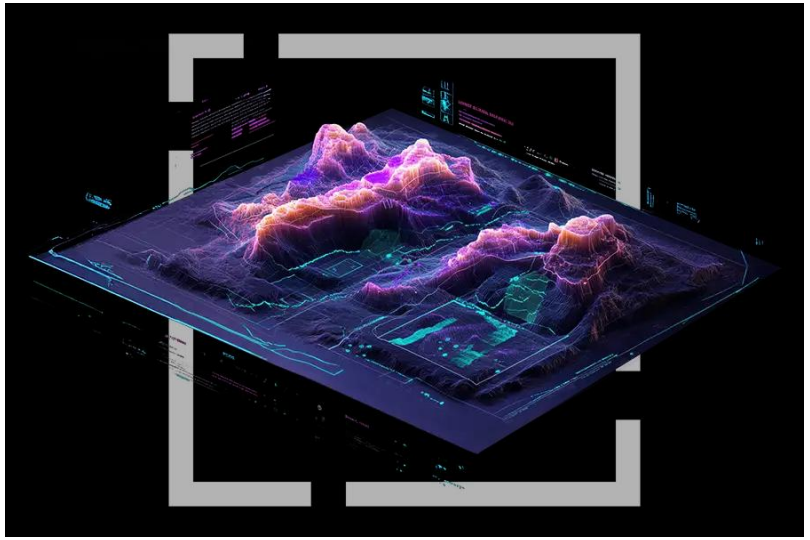
QGIS

Arc GIS Pro

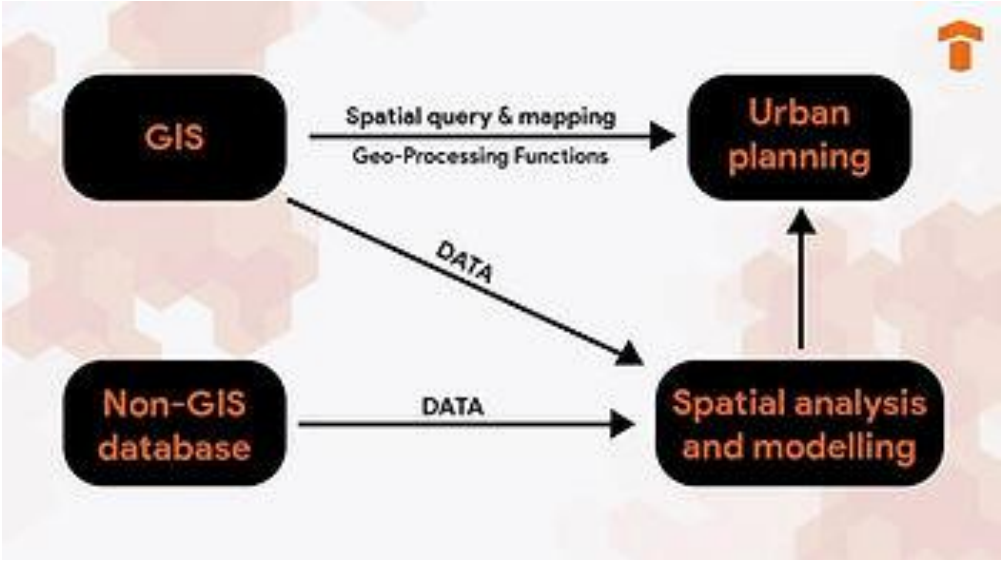
Google Earth Engine

Tool for daa managment and analysis - GIS

Base Management	• A GIS system enables you to share, and make data accessible to help you make decisions
Mapping and Visualization	• Create maps and data visualizations that leverage and present key geographic information
Spatial Analysis	• Perform advanced spatial analysis that provides new insights into trends and patterns on the map
Communication	• Share geographic data and reports across the organization, making it easier to understand spatial information.



Real-Time GIS, GEO AI, 3D GIS



https://www.agsrt.com/post/how-gis-transforms-urban-planning-a-smart-approach-to-sustainable-city-development

Remote sensing data analysis GIS

Building Morphology

Characterization of built-up structures via

1. official building data from administrations
2. openly available building footprints
3. automated or manual generation of footprints
4. use of proxy datasets

Spatial Mapping Unit (Blocks)

Spatial discretisation of blocks through

1. administrative boundaries or parcels
2. derivation from spatial data (buildings or roads)
3. regular spatial grids (e.g. hexagons)
4. manual definition of blocks

Feature Space

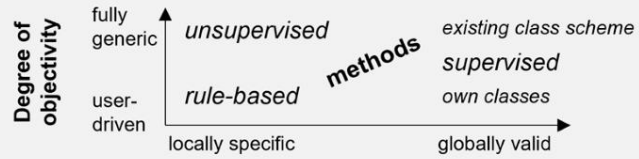
Parameterisation of blocks based on

summarized at the block-level

1. building-related features (size, shape, [height])
2. continuous spatial metrics (density, distance,…)
3. classified metrics (composition of land cover)
4. local parameters (expert-based, region specific)

Assignment of Classes

Feature-based assignment of classes with



Validation & Cartography

Validation

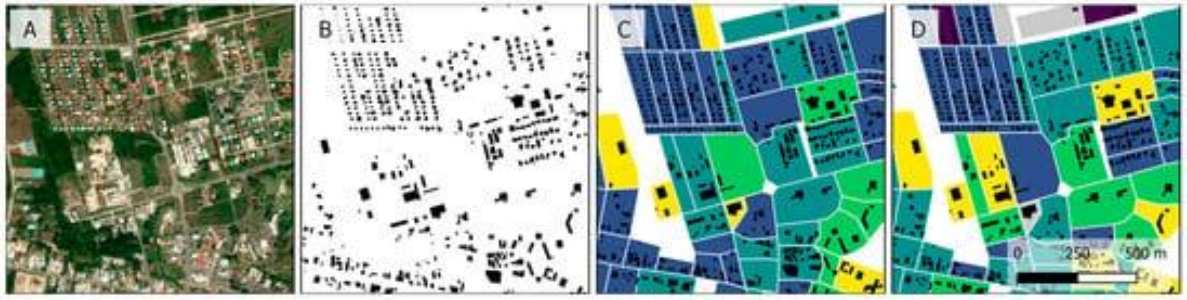
1. test for plausibility (field checks)
2. hard measures by indepdendent reference data

Cartographic presentation

1. Symbology, colors, communication

Braun, A.; Warth, G.; Bachofer, F.; Schultz, M.; Hochschild, V. Mapping Urban Structure Types Based on Remote Sensing Data—A Universal and Adaptable Framework for Spatial Analyses of Cities. Land 2023, 12, 1885. https://doi.org/10.3390/land12101885

Remote sensing data analysis GIS

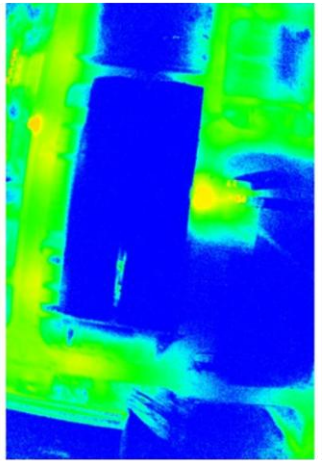


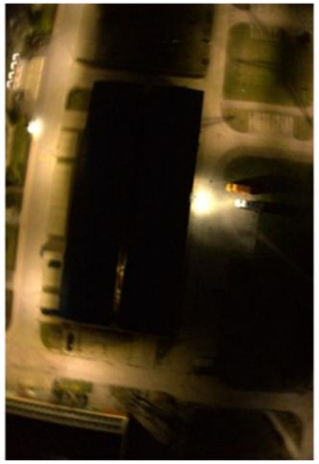
Example for zonal statistics for the city of Belmopan, Belize. (**A**) Satellite image; (**B**) building footprints; (**C**) average building size; (**D**) standard deviation of building size (from blue (low) to yellow (high)).

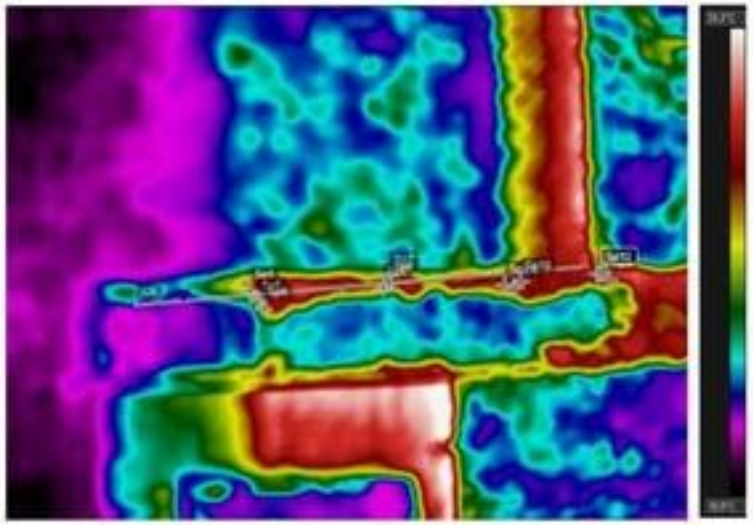
Different representations of buildings as input for urban morphology studies. (**A**) Satellite imagery (city of Tübingen, Germany); (**B**) polygon footprints as provided by the cadastral office of the city administration; (**C**) raster blocks as retrieved from official topographic maps (scale 1:25,000); (**D**) centroid points of buildings digitized from the satellite image.

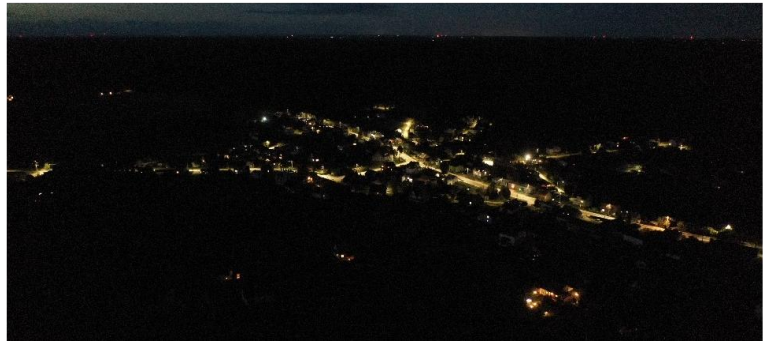
Braun, A.; Warth, G.; Bachofer, F.; Schultz, M.; Hochschild, V. Mapping Urban Structure Types Based on Remote Sensing Data—A Universal and Adaptable Framework for Spatial Analyses of Cities. Land 2023, 12, 1885. https://doi.org/10.3390/land12101885

unmanned aerial vehicles, digital photogrammetry, and photogrammetry









temperature.

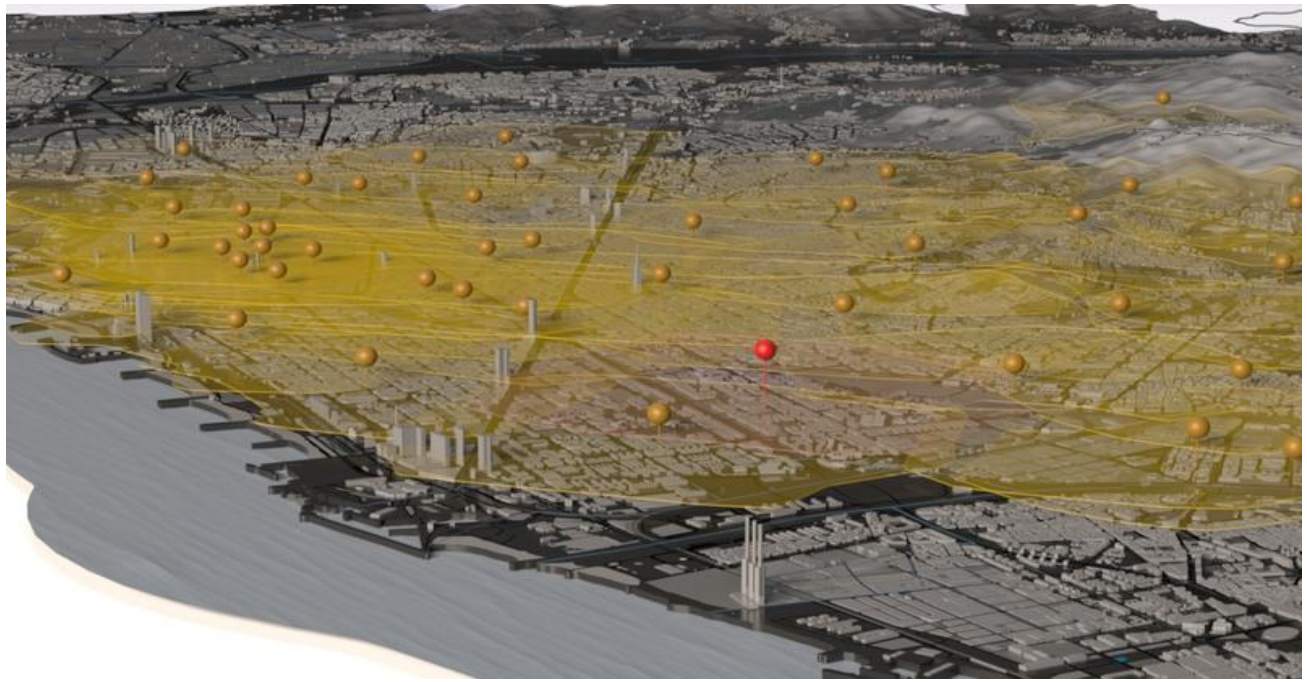
Elkadi, H.; Seifhashemi, M.; Lauwerijssen, R. Thermographic Analysis of Green Wall and Green Roof Plant Types under Levels of Water Stress. Sustainability 2024, 16, 8685. https://doi.org/10.3390/su16198685

IT solutions for building scenarios

Barcelona's DIGITAL TWINS like those created thanks to the Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC-CNS) are being used to validate future initiatives in the city.
The different models, which simulate the city of Barcelona in aspects including mobility, accessibility, urbanism, health, etc., will serve as a starting point for making political decisions.

The MareNostrum supercomputer also allows for more comprehensive analysis of data, such as *trends in gentrification, the availability of public services, and the presence of infrastructure needed by the elderly or disabled*.

https://www.tomorrow.city/discover-the-alternative-barcelona-europes-first-digital-twin/



the library network, with an emphasis on the new Gabriel García Márquez Library.

SWOT – tool for the barier analysis

URBAN LAND
internal context

URBAN LAND
external context

- characteristics of the city that give it an advantage over others in the area for particular criteria

- external chances to better achieve stated objectives

- characteristics that pla the city at a disadvantage relative to others in the area for particular criteria

- external elements that could cause trouble for the city

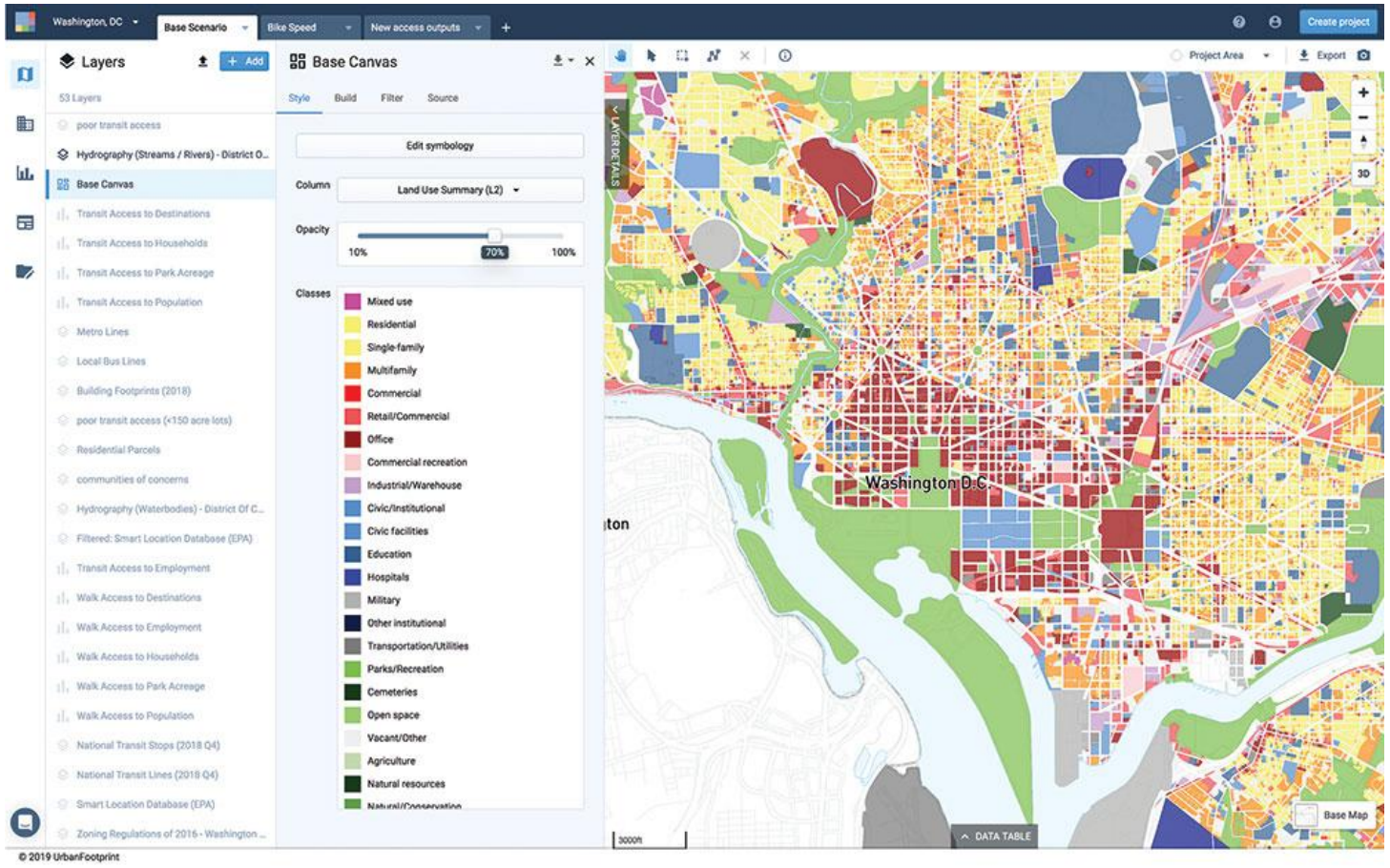
SWOT Conclusions

S-O | W-O strategies – Strategies to pursue **opportunities** that are a good fit for the site's strengths and overcome the site's **weaknesses**.

S-T | W-T strategies – Strategies that use **strengths** to reduce vulnerability to external **threats** and establish a defensive plan to address weaknesses.

UrbanFootprint tool

UrbanFootprint **excels in evaluating land use patterns comprehensively in the effort to create dynamic and resilient cities**.
Urban planners are able to get insight into the potential balance between various land uses by carefully examining the allocation of spaces for residential, commercial, and recreational activities.
By maximizing the use of existing space, encouraging mixed-use neighborhoods, and reducing urban sprawl, this research opens the way for more effective and coherent urban settings.



Case study - Envision Utah used UrbanFootprint to build and analyze multiple land use scenarios and present their potential impacts to the community

https://urbandesignlab.in/top-10-software-tools-for-quantitative-research/

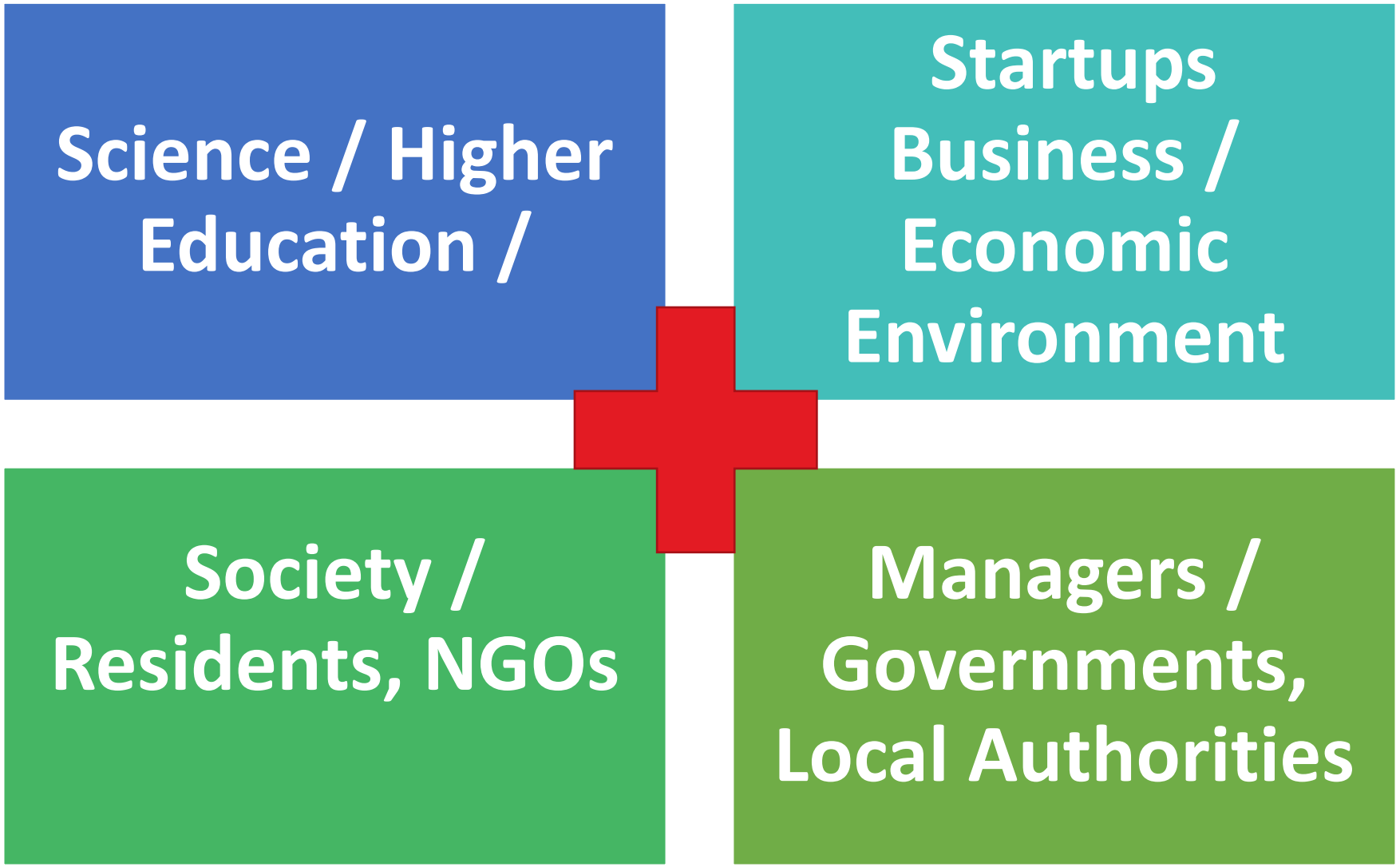
Collaboration and engagement

HUBS
LIVING LABS
SIM CITY

GDAŃSK TECH

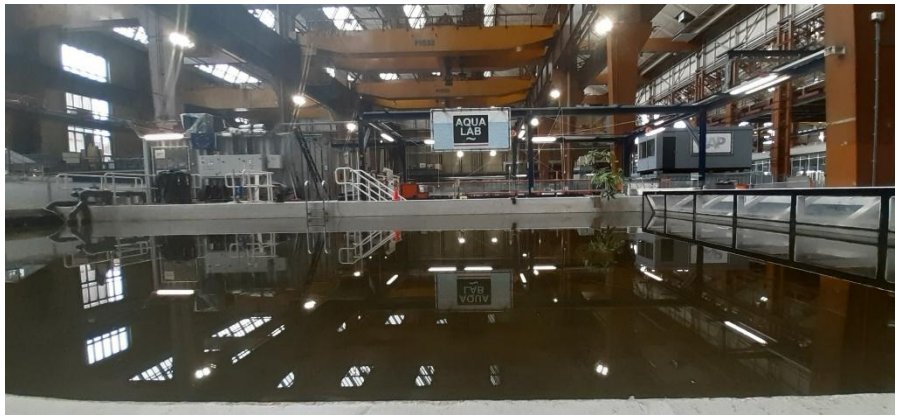
RESEARCH UNIVERSITY
EXCELLENCE INITIATIVE

Collaboration and Knowledge Sharing



Collaboration and Knowledge Sharing - HUBS
RDM - Rotterdam University of Applied Science, Rotterdam

RDM Rotterdam is an innovation hub located in a former shipyard complex in the Port of Rotterdam. It is a unique place where education, business, and port authorities collaborate on the development of new technologies and solutions for smart ports and the maritime industry. RDM (Research, Design, Manufacture) functions as an innovation lab, bringing together technical universities, startups, and companies that test and implement pioneering concepts related to automation, sustainability, and port logistics.



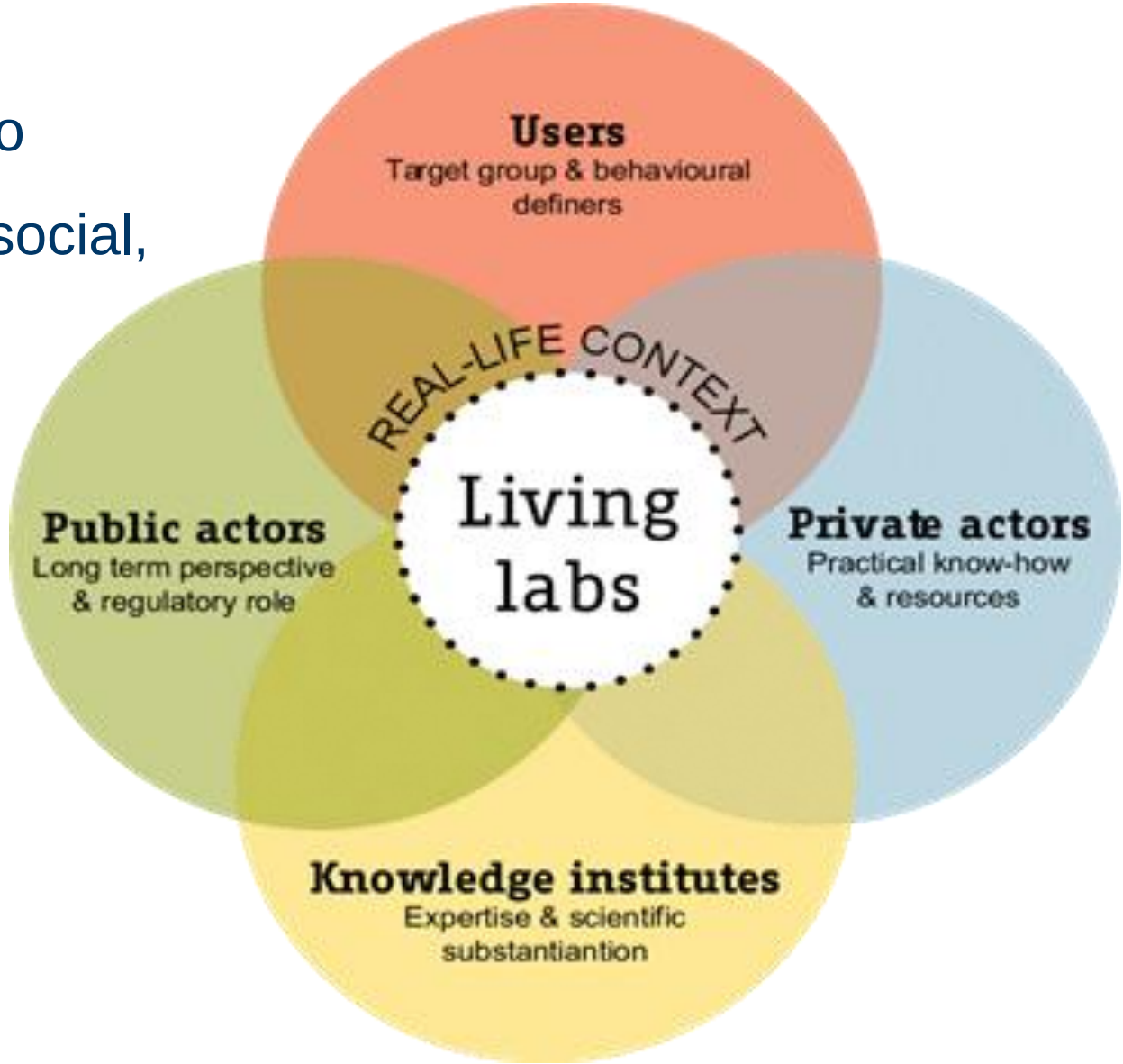
Education

Innovaiton

Business

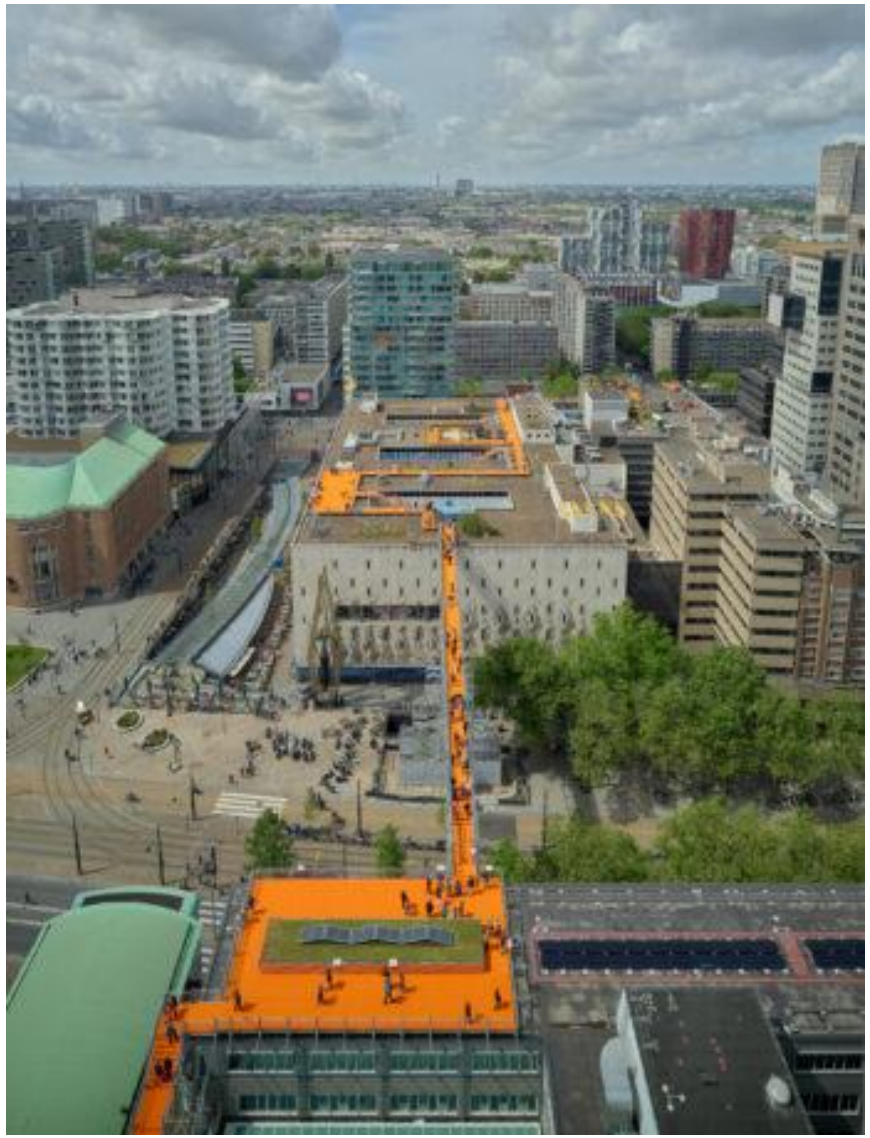
Collaboration and Knowledge Sharing - Living Labs

Living labs are an innovative approach to creating and testing new technological, social, and environmental solutions in **real-life conditions.**



Collaboration and Knowledge Sharing - Living Labs
Architecture Days, ROOFTOP DAYS, Rotterdam

The ultimate goal of the city is to transform over 929,030 m² of flat rooftops into multifunctional roofs with greenery, water retention systems, and solar panels. It is a slow process that may take 25 years, but in the end, perhaps the Dutch saying will lose its meaning – and rooftops will become places where people truly want to be..



[Photo: Ossip van Duivenbode/courtesy Rotterdam Partners]

Collaboration and Knowledge Sharing - Living Labs
Architecture Days, ROOFTOP DAYS, Rotterdam

Renewable Energy
Biodiversity
Water Management
Recreation
Art
Education

Collaboration and Knowledge Sharing - Living Labs
The Green Village, TU Delft

Business

University

Citizens

Research

Education

Place to work and live

Innovaiton

employment

New projects

New networking

Collaboration and Knowledge Sharing - Living Labs
Hanze University of Applied Sciences, Groningen

100+

Living Labs

500+

Strategic partners

400+

Graduate companies

Implementation of the solutions in the city

SIM CITY – tool for building undestanding, awarness

SimCity (*https://www.ea.com/pl-pl/games/simcity*)

SimCity's digital environments replicate the urban complexity found in real life and let users create, construct, and oversee their own cities. Players are encouraged to consider the complex problems that urban planners and policymakers deal with on a regular basis in this interactive environment. Users may see how their choices in zoning, infrastructure, and public services affect the health and development of their virtual metropolises because to the simulation's responsive mechanics.

https://urbandesignlab.in/top-10-software-tools-for-quantitative-research/

GDAŃSK TECH

Thank You

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