TreesAI

Location-based Scoring (LBS) Methodology

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This report includes a small introduction on the location-based scoring methodology, a description of the project's process and timeline, an initial exploration of the risk that will be assessed in Stuttgart's LBS, a list of the data requirements and further questions to be resolved.

Introduction to Location-based Scoring method

The Location-based Scoring tool was developed by TreesAI to perform Risk-Based Vulnerability Assessment. This helps to evaluate how patterns of risks and potential benefits on natural and human systems are shifting due to climate change. The methodology used by TreesAI to develop a risk score for geographical areas has been adapted from the Impact and Vulnerability Analysis of Vital Infrastructures and built-up Areas Guideline (IVAVIA) (Resin, 2018) that is based on the concepts of risks defined by the IPCC's Fifth Assessment Report.

The overall aim of a risk-based Vulnerability Assessment using IVAVIA is to facilitate the understanding of;

I. **cause-effect relationships** of climate change in a local context;
II. identify **geographical hotspots** of vulnerability and risk and
III. assess what **impact on people, economy and built-up area** under study can be expected now and for the future due to the changing climate.

The Location-Based Scoring (LBS) allows the comparison of areas in the city relative to a specific set of climate risks. Its goal is to score areas of a city in terms of their risk profiles Involved in this stage are the steps:

1. Definition of City Risks
2. Defining the urban indicators
3. Collecting the data and geo-processing it
4. Defining a process for weighting the indicators and aggregating them to a final score
5. Visualising the outcomes

1 | Definition of City Risks (impact chain)

The first step of the onboarding process for a new city is the definition of the main risks that NbS could help mitigate and adapt and that also could damage green infrastructure. This step requires that the hazards and exposed assets or systems are selected.

2 | Impact Chain & Urban Indicators

For each hazard-exposure combination an impact chain is developed. These impact chains describe the cause-effect relationships between the risk elements that contribute to the consequences of a given combination of hazard and the exposed objects. Indicators are sorted into three main categories to identify climate risk; hazard, exposure and vulnerability (coping and sensitivity). The relevant indicators for each domain are defined based on the city's strategic risks, literature, available data and most importantly co-creation workshops with experts and stakeholders.

3 | Data Collection & GeoProcessing

As the LBS is spatially focussed on scoring NbS in relation to where they are mostly needed, using spatial data and GIS software is required. The data collection and geoprocessing of the urban indicators takes up the most time of the project. The result of this step is an input table for the LBS model whereby all spatial units contain values measured for each urban indicator.

Spatial unit: An area bound needs to be defined for the analysis of location-specific attributes, we call these spatial units. Ideally the spatial unit should be to the scale of impact, and to a high resolution, however this relies on the resolution of the data obtained.

4| Normalising, Weighting & Aggregating

To obtain a location score per spatial unit, the different indicators of the risk components are calculated in the LBS Modelling through weighting, normalisation, and aggregation.

Weighting: The weighting of the different indicators allows to prioritise the risk components (hazards, vulnerabilities, exposures). The weights are defined through a survey with a larger group of stakeholders to understand their priorities for investing in NbS.

Aggregating: For aggregating the total domain risk scores and eventually the composite risk score a weighted arithmetic aggregation method is used. With this method, a very high indicator score can directly offset a very low score meaning that indicators can fully compensate each other.

5 | Visualisation of Location-base Score

To present the results of the LBS in spatial data, maps are produced using a Geographical Information System (GIS) and a web-based interface is developed to share a dashboard of results. Maps can very effectively present the geographical comparisons of the climate damages in the city, for either spatial unit. Charts can also be used to both illustrate the combined risks of one hazard or show the risks of one impact chain in the city.

Process Plan & Timeline

The main milestones for the LBS project with Stuttgart are:

Send out LBS Development Plan report which includes

a. Project plan and timeline
b. An initial understanding on climate risks in Stuttgart and an initial framing of the impact chains to further develop in workshops
c. Initial scoping of workshops and stakeholder involvement
d. Data requirements and how they link to the LBS
e. Further questions to resolve

Set-up co creation workshop to complement and finalise the impact chain

Survey to formalise the discussion on the workshop and define the weighting of indicators

Last round to show results and reiterate

Work Packages	Outputs	Sep	Oct	Oct	Oct	Oct	Nov	Nov	Nov	Nov
1.Project initiation: developing impact chain (qualitative risk assessment)										
Define the hazard and exposure combinations	*DML to send out **LBS Plan Report***									
Determine main stakeholders and partners	*Workshop invitation to all stakeholders*									
Co-creation Workshops on Impact Chain	*Impact chains defined co-creatively*									
Survey to define the weighting of indicators	*Table with weights for all indicators*									
2.Implementing Location-based Scoring (quantitative risk assessment)										
Data Collection	*all data requirements obtained*									
Data Management and Geoprocessing	*all data processed to the defined spatial resolution*									
Run LBS model	*final risk scores per impact chain*									
Data Visualization	*maps, charts and diagrams completed*									
Final LBS Report and Dashboard	*PDF report and online dashboard*									

Co-Creation workshops

For each hazard-exposure combination shown above, an impact chain is developed. The impact chains are refined in a co-creation workshop with domain experts. Two sets of online co-creations sessions are to be conducted.

1. To identify the urban indicators and discuss the weighting of each
2. To evaluate the results and discuss any necessary iterations.

An example of an impact chain is shown in Fig. 2.

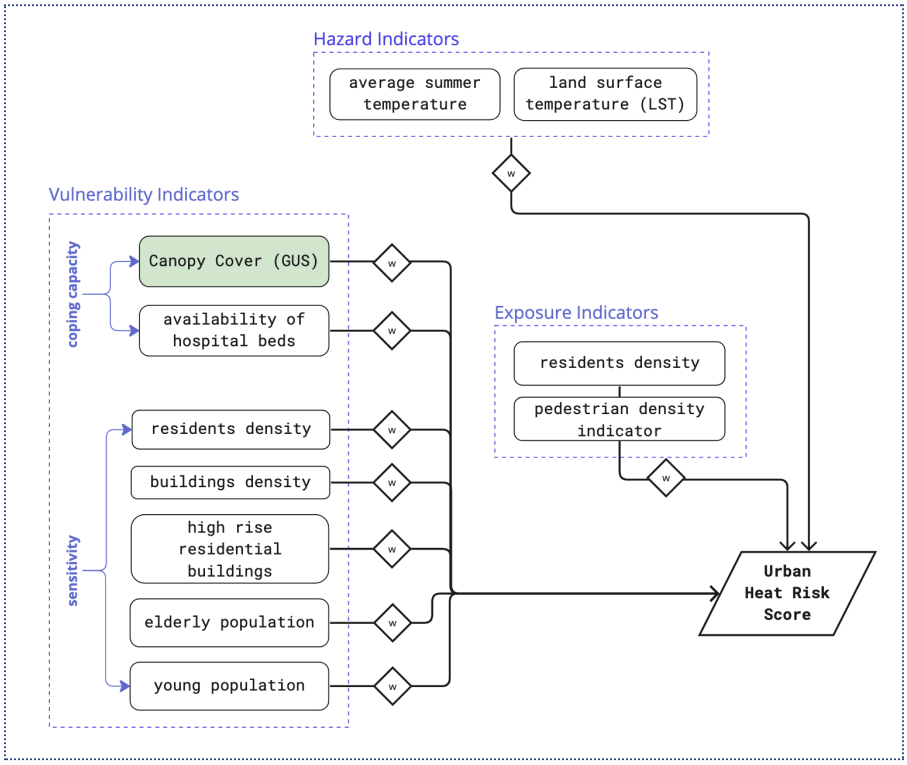

Fig 2. Example of Heat to Population Health impact chain

Stakeholders involved in Impact Chain Workshop:

https://www.stuttgart.de/organigramm/

Committee built of city departments and external institutions and private companies

City departments:

- Policy Department on Climate Protection, Mobility and Housing
- Economic Development Department
- Department of Equal Opportunities (OB-CG)
- Fire Department
- Office for Sport and Exercise
- Social welfare office
- Health Department
- Environmental Protection Agency

- Office of Urban Planning and Housing
- Civil engineering department
- Garden, cemetery and forestry office
- Climatology City Department

Private Companies:

- Health Insurance companies
- Property Damage Insurance companies

External Consultants

- Social Institutions
- University
- Transportation Companies

Weighting of Indicators

Weights are assigned to all indicators included in the impact chain. These weights will be based on the results of a survey conducted with several experts with expertise ranging from health and livability, to transport and infrastructure. The survey will be set up in such a way that the participants rank indicators of the various impact chains on the potential relative damage cost each indicator can face in case one of the climate hazards occurs. This way, the potential costs of climate change is embedded in the risk assessment in the form of weight.

Geodata Requirements

Carbon Flood & Water Management Heat Island effect

Data Requirements	Description or Example	Format	Priority	data flow
Land Surface Temperature (LST)	**Map** - *LST specifically refers to the temperature of the Earth's land surface. It is typically measured remotely using satellite imagery or ground-based sensors.*	raster (GeoTIFF)	must have	LBS1
Air temperature	**Map** - *The measurement of the temperature of the air, typically taken at a specific height above the ground surface.*	raster (GeoTIFF) or vector (shp)		LBS1
Electricity consumption for cooling	**Map / List** - *Electricity consumption data related to cooling systems, such as air conditioning units, can indicate the demand for cooling in urban areas.*	vector (shp) or csv		LBS3
Ground cover	**Map** - *provide data about the distribution of different land cover types, such as impervious surfaces (e.g., buildings, roads), vegetation, and water bodies.*	raster (GeoTIFF) or vector (shp)	must have	LBS3
Slope Map	**Map** - *a slope map depicts the steepness or gradient of the terrain's surface. It provides information about the rate of change in elevation across the landscape.*	raster (GeoTIFF) or vector (shp)	must have	LBS1
Air Quality PM1.0 and PM2.0	**Map** - *provides information about the concentration levels of these specific airborne particulate pollutants in a given area or region*	raster (GeoTIFF)	must have	LBS1

Extreme Historic Rainfall Event Map	**Map** - *information that represents rainfall accumulation in an event of exceptionally high and unusual amount of rainfall.*	raster (GeoTIFF) or vector (shp)		LBS1
Flood Risk Map	**Map** - *geographical representation that provides information about the likelihood and potential severity of flooding in a specific area*	raster (GeoTIFF) or vector (shp)	must have	LBS1
Hydro basin and sub-basin geometry	**Map** - *geographical representation that displays the delineation and geometry of sub-basins within a larger river basin or watershed. These maps are used to understand the structure and characteristics of sub-basins, which are smaller drainage areas or sub-divisions of a larger river basin*	vector (shp)		LBS1
Land-use map	**Map** - *Land zoning data reveals how land is legally designated and regulated. It includes zoning classifications such as residential, commercial, industrial, recreational, or mixed-use zones.*	vector (shp)	must have	LBS2 & LBS3
Building Footprint	**Map** - *that displays ground area and includes information on height and uses of buildings is needed to calculate areas with higher UHIE intensity.*	vector (shp)	must have	LBS2 & LBS3
Noise Pollution	**Map** - *geographical representation that displays information about the levels of noise pollution or environmental noise in the region.*	raster (GeoTIFF)		LBS1
Residential Population data	**Map / List** - *population data is needed to identify higher concentrations of residential populations and their socio-economic differences. The indicators include age, average income, health conditions, etc. Please make sure there is some spatial field such as district or sub-district name.*	vector (shp) or csv	must have	LBS2 & LBS3
Social Multiple Deprivation index	**Map / List** - *A dataset that combines various socioeconomic and demographic factors to assess social vulnerability. It includes variables such as poverty levels, educational attainment, minority populations, and housing conditions.*	vector (shp) or csv		LBS3
Vehicular traffic	**Map** - *By analyzing traffic data, such as traffic counts or congestion levels, in relation to temperature measurements, we can assess the impact of vehicular heat on UHIE intensity.*	vector (shp) or csv		LBS3
Green Infrastructure data				
Tree Inventory	**Map / List** - *that defines the DBH, species, height, age, locaiton per tree*	shp or csv		GUS1
Landsat Satellite Data or GI (NDVI)	**Map** - *NDVI is a vegetation index calculated using the near-infrared (NIR) and red bands of the electromagnetic spectrum captured by Landsat satellites.*	raster (GeoTIFF)	must have	LBS 3
HQ Canopy cover map	**Map** - *extent of vegetation cover provided by the canopies of trees, shrubs, or other vegetation in a particular area. It provides insights into the density and coverage of the vegetation canopy within a given region.*	raster (GeoTIFF) or vector (shp)	must have	GUS 1 & LBS 3
Map of Open Green Spaces	**Map** - *the distribution and accessibility of green spaces, parks, woodlands and other open spaces*	vector (shp)	must have	LBS 3
Biotype, Biodiversity and Green Corridors	**Map** - *distribution and classification of different biotypes or ecological communities within a specific area or region.*	vector (shp)		GUS 1 & LBS 3
Planned Green Infrastructure projects	**Map / List** - *that describes the upcoming or potential green infrastructure and NBS projects in the city.*	pdf or csv		-

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