URBREATH [101139711]

Systemic Integration of Transformative Technical and Nature-based Solutions to Improve Climate Neutrality of European Cities and Regions and tackle Climate Change: the URBreath Approach

URBREATH

D3.4: Numerical models for the Nature-Based Solutions Version 1

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Document description	This document describes the models addressing NBS-specific physical phenomena and EU generic data and data requested in every front runner city to run the model. The data collected will address both local urban planning, built and natural environment information as well local atmospheric conditions and environmental data. This deliverable is linked to T3.4 and updates of this deliverable are foreseen in M24 (December 2025) and M36 (December 2026).

Document Revision History

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		Modification Reason	Modified by
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2.0	18.12.2024	Submitted to Project Coordinator for quality check	VITO
2.1	19.12.2024	Final version ready for submission	LC

Disclaimer

Executive Summary

Humans use a wide range of services and raw materials produced by ecosystems. These benefits are commonly known as 'ecosystem services' (ESS) or nature benefits and include both products (e.g. drinking water) and processes (e.g. waste decomposition). This deliverable presents the numerical models and frameworks that have been selected and are being configured to evaluate the impact of Nature-Based Solutions (NBS) on urban ecosystem services in Urbreath cities. It details the methodologies and required data and how these models address the requirements of the cities to support the cities in creating more climate robust neighborhoods. The models address key urban metrics, including air quality, heat stress, biodiversity, recreation and water retention and infiltration.

During the first year of the Urbreath project the overview of the interests and requirements of the cities has been made to explore if and how a numerical approach can support them during the planning, implementation, and validation phase of the redesign of local neighborhood plans integrating NBS. The wealth of available models and tools has been matched with these requirements to select the following models and frameworks.

- Nature Value explorer: a pragmatic approach to value ecosystem services including producing, regulating and cultural services;
- Urban climate modelling to evaluate impact of NBS on heat stress;
- Air quality modelling to evaluate impact of NBS on air pollution;
- 3+30+300 to evaluate the availability of trees and vegetation;
- Biotope Area Factor to screen the use of ecologically effective surfaces in urban developments.

For each model the necessary input data have been listed and matched with available datasets. This will be further refined with local data from the involved cities. Future efforts will focus on configuring these numerical models with local data and integrating them into the URBREATH platform and deploying visualizations to enhance accessibility and usability. These developments will support urban planners and policymakers in evaluating and implementing NBS interventions.

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List of Terms and Abbreviations

Abbreviation	Definition
LDT	Local Digital Twin
NBS	Nature-based solutions
WBGT	Wet bulb globe temperature
AQ	Air Quality
ESS	Ecosystem services
UHI	Urban heat island

1 Introduction

The URBREATH project aims at addressing two main challenges within the fields of Urban Regeneration, Resilience, and Climate Neutrality:

Gaps in the prevailing/conventional approach to revitalisation, regeneration, and greening planning about advanced integrated methods and concepts. The prevailing/conventional approach is often simplified to cost/profit criteria which do not often provide the necessary return on investment by failing to attract sustained funding, people, and businesses to regeneration areas.
Lack of consideration of local communities' needs and hence often ending up with solutions (Nature-Based Solutions-NBSs or otherwise) that are imposed on the community, i.e. that are not socially acceptable (such often debated interplay between urban planning and mobility).

A detailed evaluation on NBS impacts helps to overcome both challenges. Within this deliverable we describe the numerical models that the Urbreath consortium aims to integrate into a digital solution to support cities. The ambition is to build a local digital twin (LDT) and apply numerical (and other) models to evaluate the impact of NBSs. The concept of the LDT is presented in D4.1. Through this approach we aim to achieve a more holistic approach for the evaluation of NBS, building on existing components and integration.

The evaluation of NBSs has a strong link with the concept of ecosystem services (ESS). Humans use a wide range of services and raw materials produced by ecosystems. These benefits are commonly known as 'ecosystem services' or nature benefits and include both products (e.g. drinking water) and processes (e.g. waste decomposition) (Jacobs et al. 2010). Along with the growth of the population, the demand for raw materials and services provided by ecosystems also grows. Many have long believed that ecosystem services are free, invulnerable and inexhaustible. But today the impact of human use and abuse is becoming more and more evident: e.g. air and water quality are threatened, oceans are overfished, pests and diseases are expanding beyond their historical limits, deforestation threatens natural protection against erosion, etc.

There is a growing awareness that the services provided by ecosystems are finite and under threat, and that short-term and long-term human interests should be investigated. The concept of considering nature and landscapes as producers of ecosystem services allows us to appreciate the benefits of nature and landscape and provides a framework to bring together and integrate the different social, economic and environmental aspects.

By integration of multiple numerical models into an LDT framework, Urbreath aims to provide helpful insights into these benefits offered by NBSs.

1.1 Purpose and Scope

This deliverable is linked to the activities in the task 3.4 focusing on the development and the implementation of numerical modelling for the nature-based solutions. In this deliverable we describe the numerical models that we aim to integrate and link to an integrated digital solution offered to the Urbreath cities. With this integration we aim to create interoperable, reusable, and flexible components for digital twins targeting the impact of nature-based solutions (NBSs).

1.2 Approach for Work Package and Relation to other Work Packages and Deliverables

Task 3.4 has strong links to other tasks and work packages. In the first year of the project, the needs and requirements from the cities have been gathered, discussed, and described in an iterative way involving all the partners in the consortium. This analysis has been led by WPs 2&5 with the technical support from WP3&4.

The requirements of the cities have been discussed in depth and analysed for a possible technical answer to each requirement. The needs of the cities are documented as use case in deliverable 2.4. This deliverable documents the numerical models that can contribute to realizing the requirements of the described use cases.

Task 3.4 has strong links with other tasks offering model-based analysis and support in WP3:

- Task 3.1 offering AI-based algorithms and tools.
- Tasks 3.2 offering climate modelling, assessment of vulnerability to climate change.
- Task 3.3 offering short-term seasonal weather forecasting.
- Task 3.5 offering socioeconomic modelling support.

The data needs are overseen in task 3.6 Data management and Monitoring. To create an integrated solution, the numerical models will be part of the local digital twin that is foreseen as outcome of WP4.

1.3 Methodology and Structure of the Deliverable

At the end of 2024, the needs and requirements of the cities have been analysed and matched with tools and models to support the cities. The numerical models that are planned to be applied are presented in the chapter 2. The integration of these models into Local Digital Twins (LDT) is discussed as well. Each model relies on necessary input data. These data needs are described in chapter 3.
Lastly, an outlook to the next phase of the Urbreath project is given. This deliverable is foreseen to be updated at the end of year 2 and year 3. It will remain a live document during the project implementation.

2 Tool and model Descriptions

A list of numerical models has been selected to support the Urbreath cities to respond to their requirements linked to their use cases.
The list of models described in this deliverable includes the numerical models. Next to these models, AI models are described in deliverable 3.1; the climate models and weather forecasts models are described in deliverable 3.2 and 3.3.

The data overview is given in the next chapter linking to on-going activities in WP4 and 5.

2.1 Detailed model descriptions

2.1.1 Nature Value Explorer

Ecosystem services are often not entirely appreciated in policy decisions because they are not fully captured in commercial markets nor adequately quantified in terms comparable with commercial services traded in markets. Ignoring the value of these ecosystem services may lead to overexploitation of ecosystems or unbalanced policy and investment decisions.

Because of the importance of these ecosystem services (ESS), the Environment Department of the Flemish has developed Nature Value Explorer with VITO and the universities of Antwerp and Amsterdam to demonstrate the value of ESS in Flanders. The Walloon department DEMNA also started a platform on ecosystem services in Wallonia (WAL-ES). In 2020-2021, VITO and the university of Liège expanded the Flemish Nature explorer with data for Wallonia, so that the tool is now available for the entire country.

The tool is currently available as a stand-alone application for Belgium, presented in the figures below. The tool is freely available online including access to all literature, manuals, and documentation of the methodology to score the impact of NBSs for each ecosystem service.[1]

The tool focuses on pragmatic methods to value ecosystem services. They help everyone (land managers, planners, national and local authorities, non-governmental organisations and active citizens) who wants to map the socio-economic importance of ecosystems. The list of indicator numbers and valuation functions was created based on literature review and empirical research. We refer to the manual for an underpinning of the results.[2] It describes all services included as well as the methodology for the qualitative and quantitative evaluation. The list of ecosystem services valued in this tool can be further extended in the future, as it was not possible to derive quantification functions and a monetary

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[1] https://www.natuurwaardeverkenner.be/

[2] (https://www.natuurwaardeverkenner.be/docs/manual_EN/inleiding

value for all ecosystem services. The Nature value Explorer gives the first exploration of the values for each service included. If a specific ecosystem service proves to be very important or evokes discussions amongst stakeholders, it is advised to use more detailed ecological modelling or to use an economic valuation study specifically developed for the project.

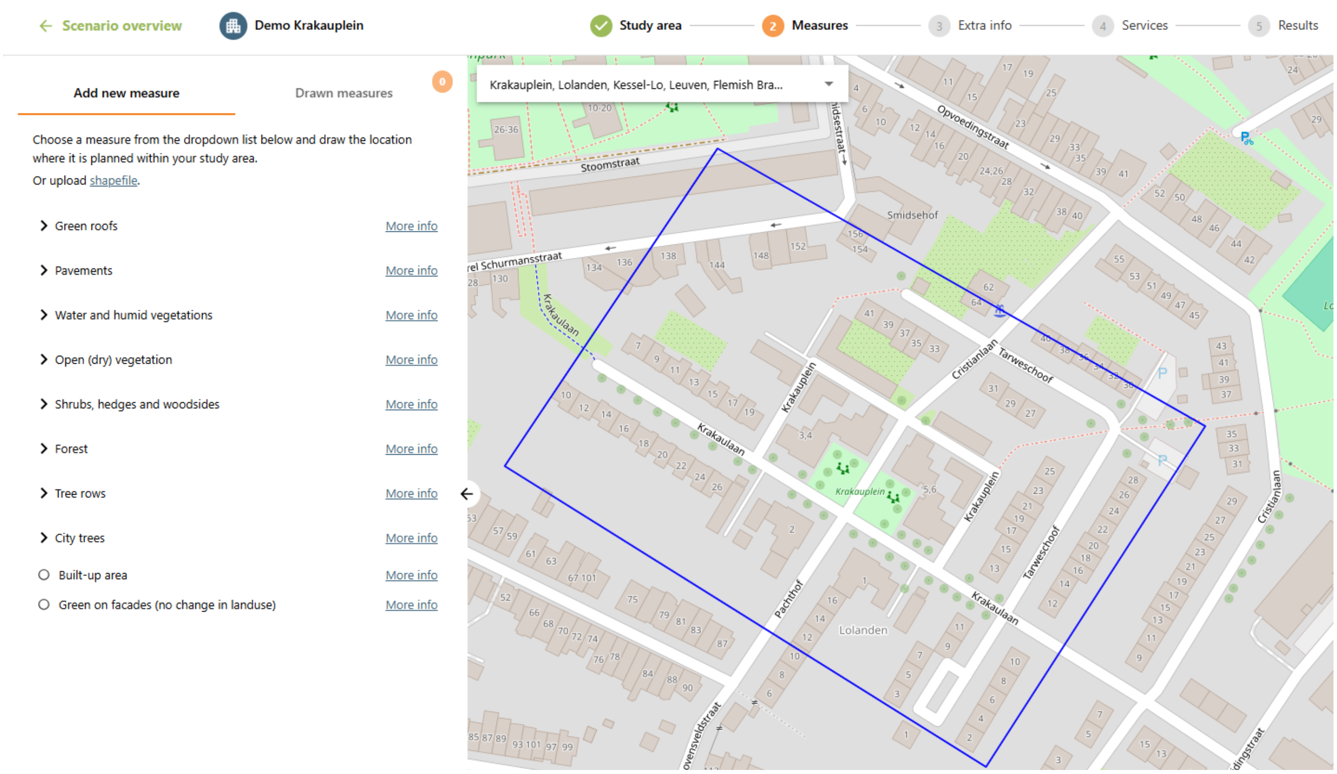

Figure 1: Example of an application of Nature Value Explorer for the Krakauplein case study in Leuven.

Ecosystem services are classically divided into four major groups: producing services, regulatory services, cultural services and support services. Producing services include the provision of products obtained from ecosystems such as genetic resources, food, fibre and raw materials. Regulatory services are those benefits that humans obtain as ecosystems help regulate certain processes such as climate and water quality. Cultural services are those that provide spiritual enrichment, cognitive development, recreation and aesthetic experience. Supporting services are those that are necessary for the provision of all the above services such as soil formation, photosynthesis and the food cycle.

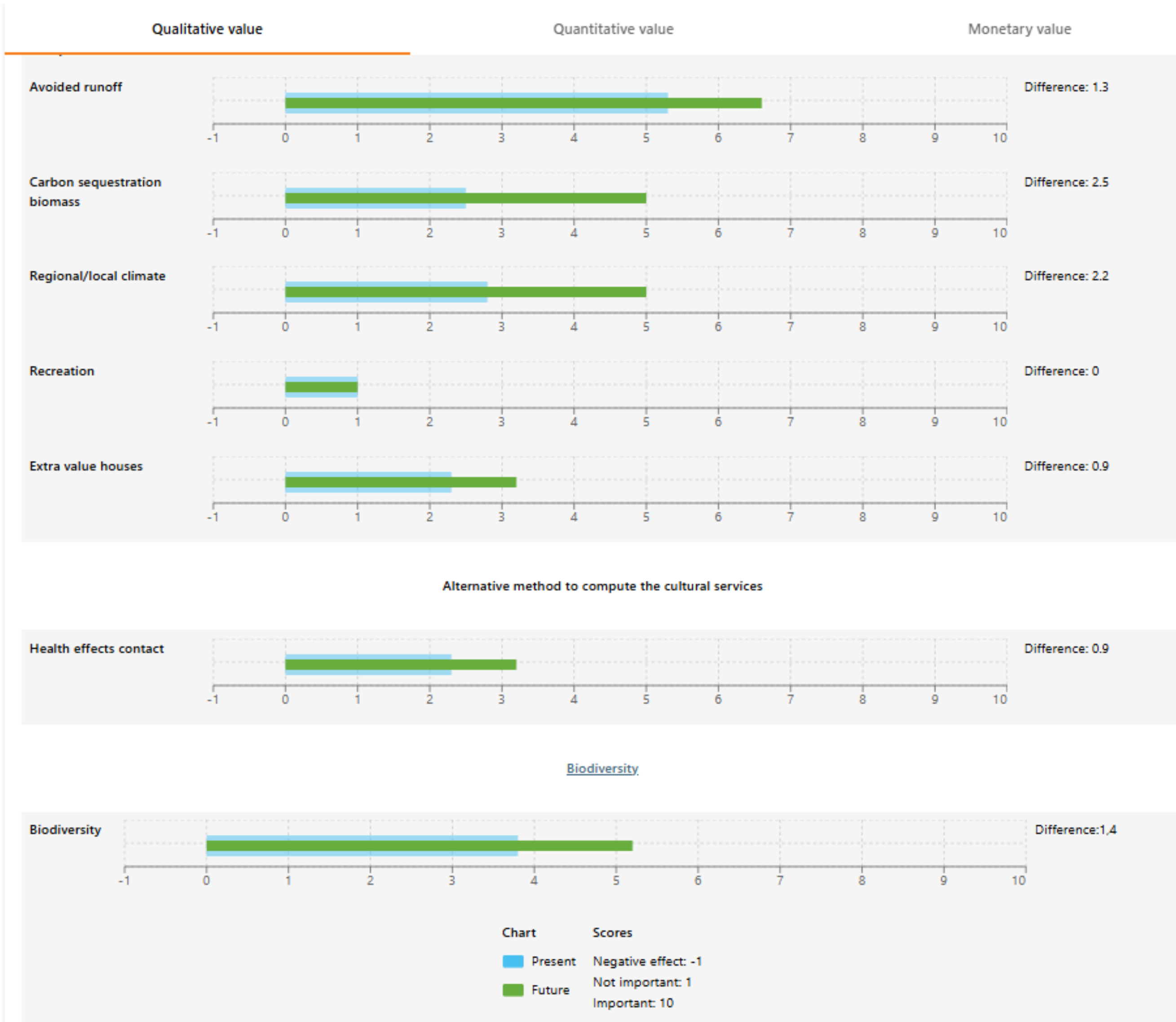

Figure 2: Overview of the evaluation of the qualitative value of nature-based solutions in an urban context using Nature Value Explorer.

Nature Value Explorer provides a step-by-step plan for estimating the effects on ecosystem services when expanding, downsizing or changing urban green spaces, and then depicting their welfare effects. For various ecosystem services, the manual indicates what exactly this service entails and how to value it qualitatively, quantitatively and/or monetarily. It indicates what the starting points are, what input data are needed and where one can find these data. Finally, each ecosystem service is illustrated with an example. These data are based on advancing insights on qualitative, quantitative and monetary valuation of ecosystem services. The following services are currently included.

- Producing services
  - Food production

- Regulatory services
  - Air quality impacts
  - Noise impacts
  - Water retention
  - Carbon capture
  - Urban climate regulation
- Cultural services
  - Recreation
  - Added for real estate
  - Physical and mental health impacts
- Biodiversity

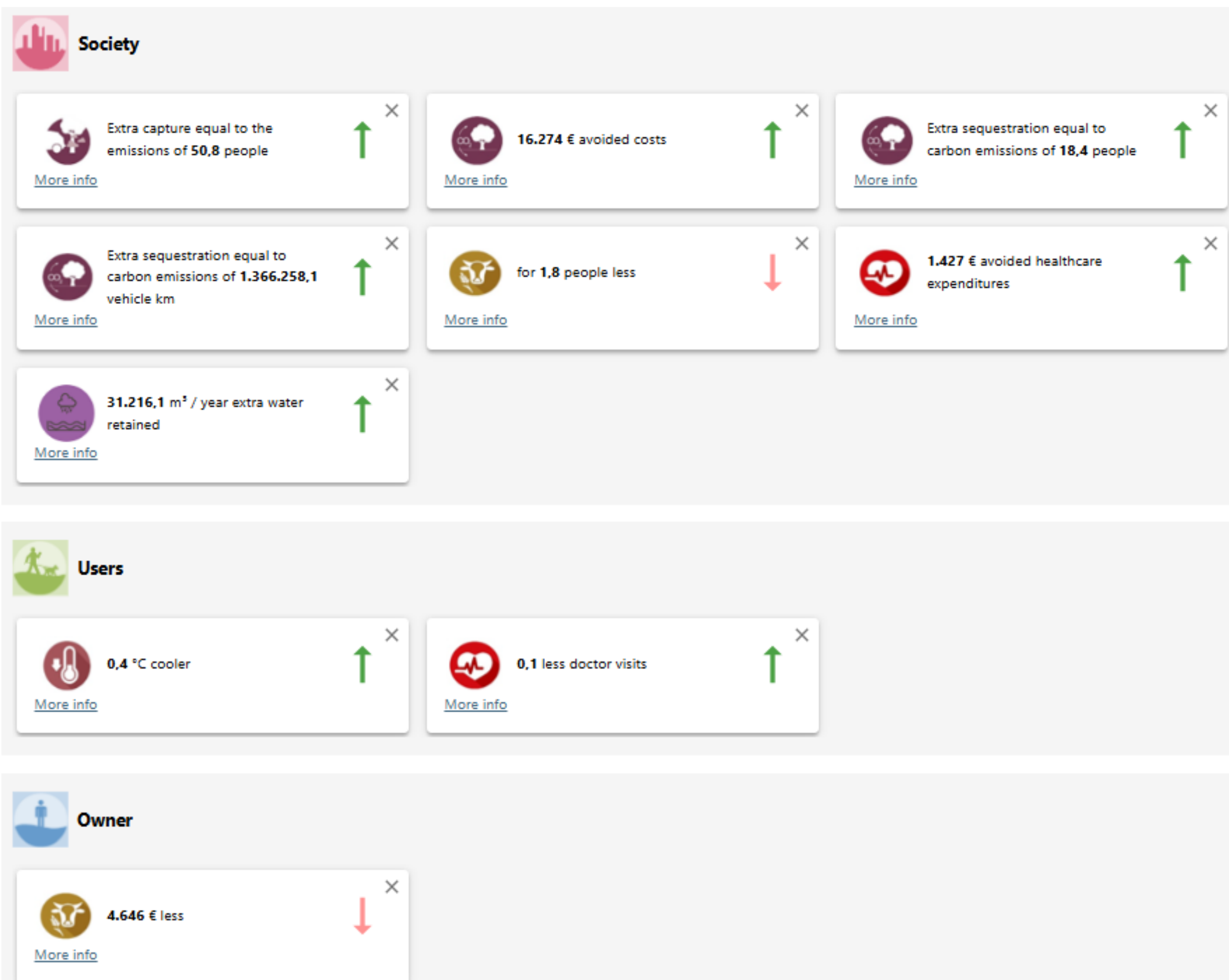

Figure 3: Dashboard presenting the change in ecosystem services for an urban project integrating new nature-based solutions.

2.1.2 Urban climate modelling

UrbClim is VITO's high-resolution urban boundary layer climate model, designed to simulate urban climates at a typical spatial resolution of 100 metres[3]. The model consists of a land surface scheme built on the soil–vegetation–atmosphere transfer framework by De Ridder and Schayes[4] coupled with a 3D atmospheric boundary layer module. UrbClim enables detailed analysis of Urban Heat Island (UHI) effects and air temperature distributions and has been applied to and validated in over 10 cities worldwide[5,6,7,8] The urban heat island effect is the temperature difference between a city and its rural surroundings. The effect is most noticeable at night when cities cool down at a much slower pace due to the modified land surfaces including all buildings and soil sealing.

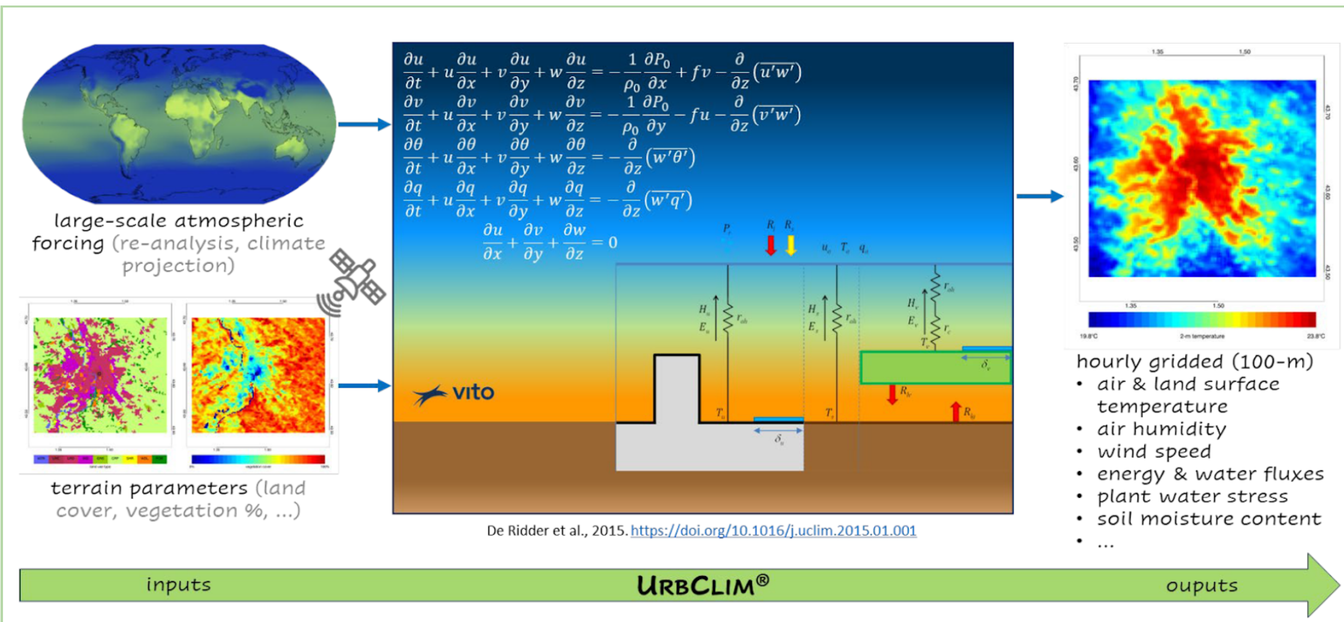

Figure 4: Schematic representation of the UrbClim model.

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[3] De Ridder K, Lauwaet D, Maiheu B. UrbClim: A fast urban boundary layer climate model. Urban Climate. 2015;12:21-48.

[4] De Ridder K, Schayes G. The IAGL Land Surface Model. J Appl Meteorol. 1997;36:167–182.

[5] García-Díez M, Lauwaet D, Hooyberghs H, Ballester J, De Ridder K, Rodó X. Advantages of using a fast urban boundary layer model as compared to a full mesoscale model to simulate the urban heat island of Barcelona. Geosci Model Dev. 2016;9:4439–4450.

[6] Lauwaet D, De Ridder K, Saeed S, Brisson E, Chatterjee F, van Lipzig NPM, et al. Assessing the current and future urban heat island of Brussels. Urban Climate. 2016;15:1–15.

[7] Lauwaet D, Hooyberghs H, Maiheu B, Lefebvre W, Driesen G, Van Looy S, De Ridder K. Detailed urban heat island projections for cities worldwide: dynamical downscaling CMIP5 global climate models. Climate. 2015;3:391–415.

[8] Zhou B, Lauwaet D, Hooyberghs H, De Ridder K, Kropp JP, Rybski D. Assessing seasonality in the surface urban heat island of London. J Appl Meteorol Climatol. 2016;55:493–505.

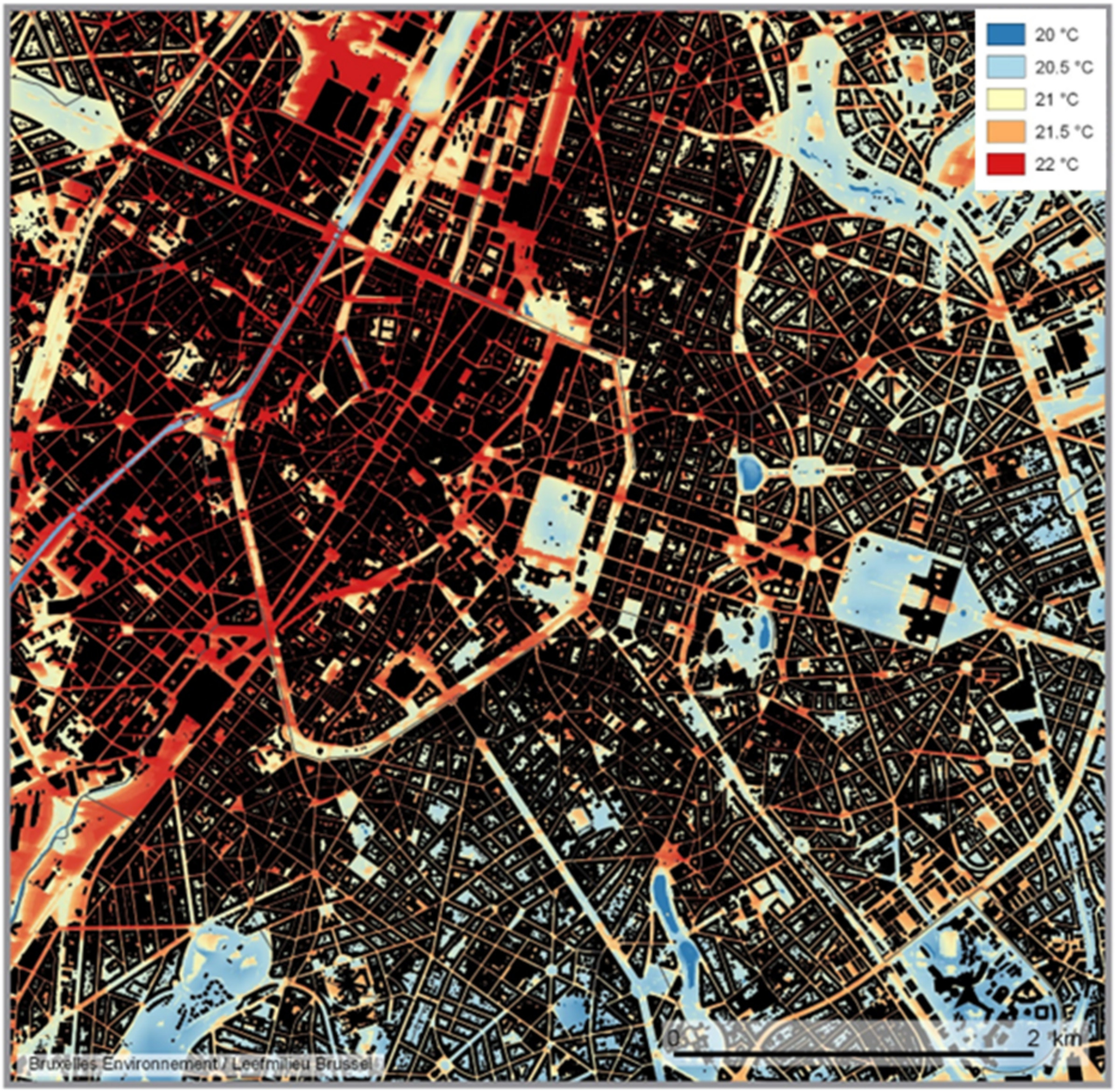

Figure 5: Example of a detailed daily mean WBGT map for the city center of Brussels during a typical hot day.

UrbClim outputs provide valuable spatial data on urban air temperatures and the UHI effect, which are relatively stable over short distances. However, air temperature alone is insufficient to fully quantify heat stress. Factors such as radiation load (shortwave and longwave), humidity, and wind speed play a critical role in human thermal comfort. To address this, VITO has developed a methodology to calculate the Wet Bulb Globe Temperature (WBGT), a comprehensive heat stress indicator, at metre-scale resolution by combining UrbClim outputs with detailed radiation calculations using 3D data on buildings and vegetation[9]. This enables the computation of several heat stress indicators, such as - among others - the number of heatwave days, exceedances of health threshold values, heat-related mortality and lost working hours. These capabilities make UrbClim an ideal tool for heat stress analysis, offering clear and impactful results for identifying vulnerable urban areas. More information on the urban climate modelling can be found at https://climasys.vito.be/en.

Within the Urbreath project, the Urbclim model is applied to model the urban climate for the Urbreath cities, starting with the frontrunners. The model has been set up using the output of the climate models set up in T3.2 (deliverable D3.2).

2.1.3 Air quality modelling

Several air quality (AQ) models can be applied to assess or forecast air pollution levels in EU cities. To respond to the air quality interests of the Urbreath cities, we plan to build on existing AQ models and applications.

As part of the proof-of-concept digital twin solutions offered by the Horizon project DUET[10], air quality models have been integrated into a digital twin architecture. Urbreath will build on this previous integration to make steps towards a more robust model coupling and integration with other models to evaluate the impact of NBSs. VITO integrated the FASTRACE traffic emission model and the QUARK air quality model to evaluate mobility choices for air quality impact. The models have been described by Degraeuwe et al.[11] and applied to build stand-alone tools to evaluate road traffic contributions to NO_2 concentration in Europe. This application[12] can also be applied for a first screening of the air quality situation in the Urbreath cities and check the contribution of different sectors including road transport and NFR (Nomenclature for reporting) sectors. The figure below shows an overview for Cluj-Napoca.

The QUARK and FASTRACE models can be coupled to a digital twin architecture. An overview of the current model coupling is given in the figure below. The next step is a more robust model coupling avoiding direct links but have a full integration of each component. More insides in the models and existing applications are available on https://atmosys.vito.be/en.

VITO's QUARK model (Quick Urban AiR quality using Kernels) is a kernel-based model derived from a Gaussian plume model. A kernel is the annual average pollutant concentration around a road segment. Such kernels can be calculated for different orientations of the road (from North-South to East-West in

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[9] Lauwaet D, Maiheu B, De Ridder K, Boënne W, Hooyberghs H, Demuzere M, Verdonck ML. A new method to assess fine-scale outdoor thermal comfort for urban agglomerations. Climate. 2020;8(1):6. doi:10.3390/cli8010006.

[10] https://www.digitalurbantwins.com/

[11] Degraeuwe B. et al., A source apportionment and air quality planning methodology for NO2 pollution from traffic and other sources, Environmental Modelling & Software, 176 (2024), 106032, https://doi.org/10.1016/j.envsoft.2024.106032

[12] https://no2sourceapportionment.concawe.eu/

steps of for example 15°) and for meteorological conditions across the EU. A database of these kernels can be used to quickly model local traffic contributions to air pollution levels. Similarly, it can be applied for other sectors.

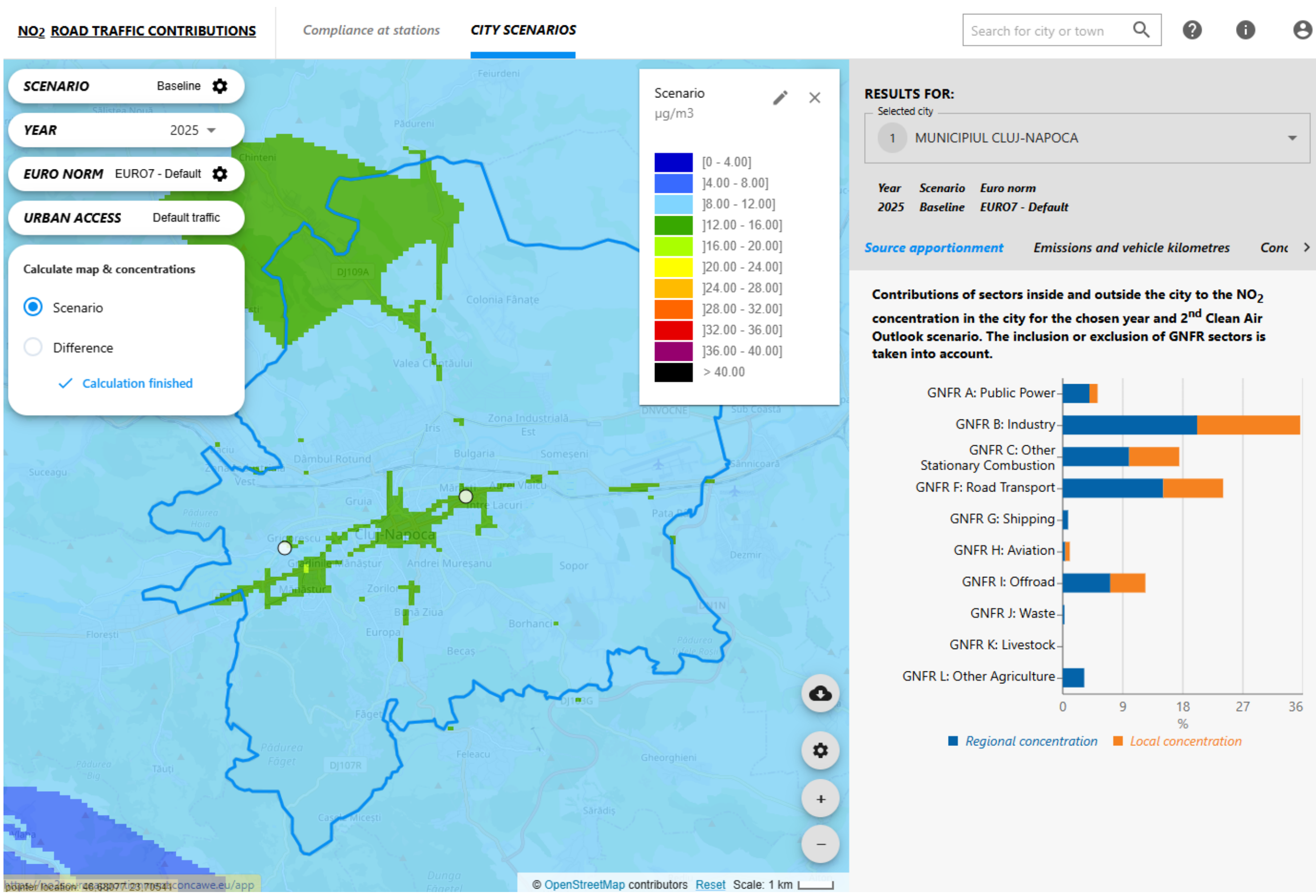

Figure 6: Analysis of air quality situation for Cluj-Napoca using using NO_2 source apportionment viewer yielding insights per sector and split between local and regional contributions.

FASTRACE (Hooyberghs et al., 2022)[13] is a software tool developed by VITO to calculate spatially disaggregated emissions from road transport, starting from country specific vehicle fleet data, COPERT emission factors (Ntziachristos et al., 2020)[14] and traffic intensities at the street level. FASTRACE calculates the emission per vehicle type and per road segment.

[13] Hooyberghs H. et al., Validation and optimization of the ATMO-Street air quality model chain by means of a large-scale citizen-science dataset, Atmospheric Environment, 272 (2022), 118946, https://doi.org/10.1016/j.atmosenv.2022.118946.

[14] Ntziachristos, L., and Z. Samaras. "EMEP/EEA air pollutant emission inventory guidebook 2019: 1. A. 3. bi-iv road transport 2019." Luxembourg: European Environment Agency (2019).

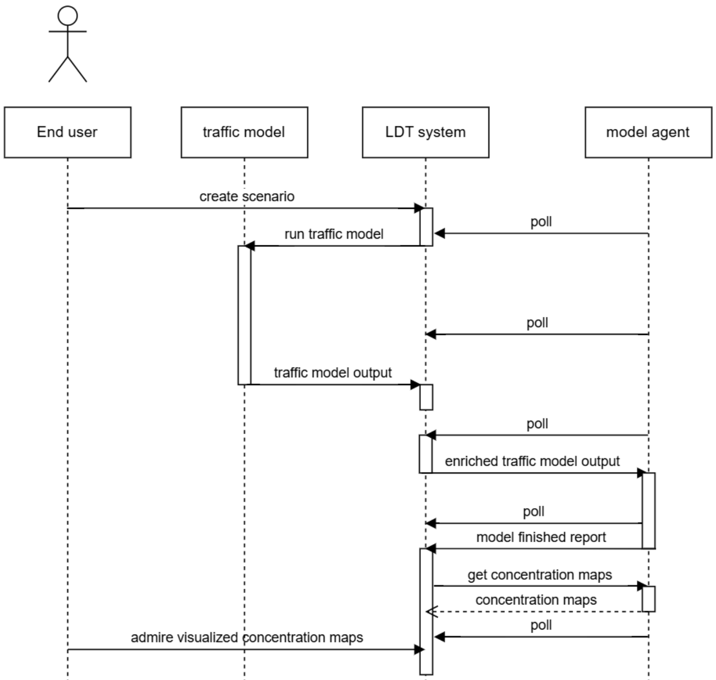

Figure 7: Schematic overview of air quality model integration in LDT flow scheme.

2.1.4 3+30+300

The Nature based solutions institute (https://nbsi.eu/) has introduced the 3+30+300 rule a few years ago as a concept for developing urban forests and creating greener and healthier cities. The rule states that all residents should be able to see 3 large trees from their home, live in a neighbourhood with at least 30% tree canopy (or vegetation) cover, and be no more than 300 metres from the nearest public green space that allows for multiple recreational activities. Konijnendijk published a paper presenting this approach and the scientific basis.[15]

In the urban paragraph of the deal on the EU Nature Restoration Law, reads that member states shall achieve an increasing trend in the total national area of urban green space till a satisfactory level is reached. Green standards can help to define this satisfactory level. The 3+30+300 rule is one of these standards. The 3+30+300 rule emerges as a transformative concept, emphasizing the essential role of green spaces in human lives, particularly for mental well-being. Moving forward, it is crucial to consider not only the quantity but also the quality and use of green spaces to maximize their benefits.[16]

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[15] Konijnendijk, C.C. Evidence-based guidelines for greener, healthier, more resilient neighbourhoods: Introducing the 3–30–300 rule. J. For. Res. 34, 821–830 (2023). https://doi.org/10.1007/s11676-022-01523-z

[16] https://platformurbangreening.eu/inspiration/beyond-concrete-the-transformative-impact-of-the-3-30-300-rule-on-urban-living/

Currently many cities and regions look at implementing this rule as new indicator or standard for urban green, such as Flanders[17]. An example of an implementation for Belgium is available as open data offered by Datalab[18]. The figure below shows the surrounding of the case in Leuven (Krakauplein).

Figure 8: Example of the implementation of the 3+30+300 rule for Leuven by Datalab.

Within Urbreath we look at the integration of these indicators into the digital twin offering starting from existing toolboxes such as the green visibility index.[19,20]
Firstly, it can be applied to evaluate the current situation in the Urbreath cities. Next, we aim to evaluate new designs for access to urban green.

2.1.5 Biotope Area Factor (BAF)

The Biotope Area Factor (BAF)[21] is a tool used to measure the absorbent properties of a surface. It has been initiated by Berlin and other cities in and outside the EU. The concepts of the BAF have been

[17] https://www.natuurenbos.be/groennormen

[18] https://thedatalab.be/330300/

[19] https://github.com/VITO-RMA/green-visibility-index

[20] Vervoort P., Vanderheiden S., Hambsch L., Poelmans L., Vandermoere F., Loots I., Greenness visibility in urban living environments as pathway to promote health and well-being: Mapping spatial differentiation in Flanders (Belgium) based on viewshed analysis, Nature-Based Solutions, 6, 100187 (2024). https://doi.org/10.1016/j.nbsj.2024.100187

[21] https://ugl.sg/wp-content/uploads/2021/01/20191002_biotope_area_factor.pdf

clearly described for the application in an urban context by the urban development department of Berlin[22] and its application in Canada:

"*To calculate this BAF indicator, one need only determine the relationship between the ecologically effective surface area and the total surface area of a lot. Over the last three decades, this factor has been incorporated into the urban planning practices of several cities so that under-used spaces such as walls and roofs can be better integrated into greening policies. The BAF is particularly valued because it offers a flexible approach to reconciling densification and greening policies. Given the problem of heat islands, which affect the health of the most vulnerable, this innovative measure provides a way to improve air quality and increase access to cooler spaces in the city. With regard to the built environment, it helps solve the problem of urban flooding by lowering the degree of soil sealing*."

The calculation can be performed in different cities using essentially the same formula:

$$BAF = \sum_{i=1}^{N} \frac{active\ surface_i \times value\ factor_i}{Total\ surface}$$

The example below demonstrates the flexibility of the model. In this calculation, the individual parts of a plot of land are weighted according to their "ecological value".

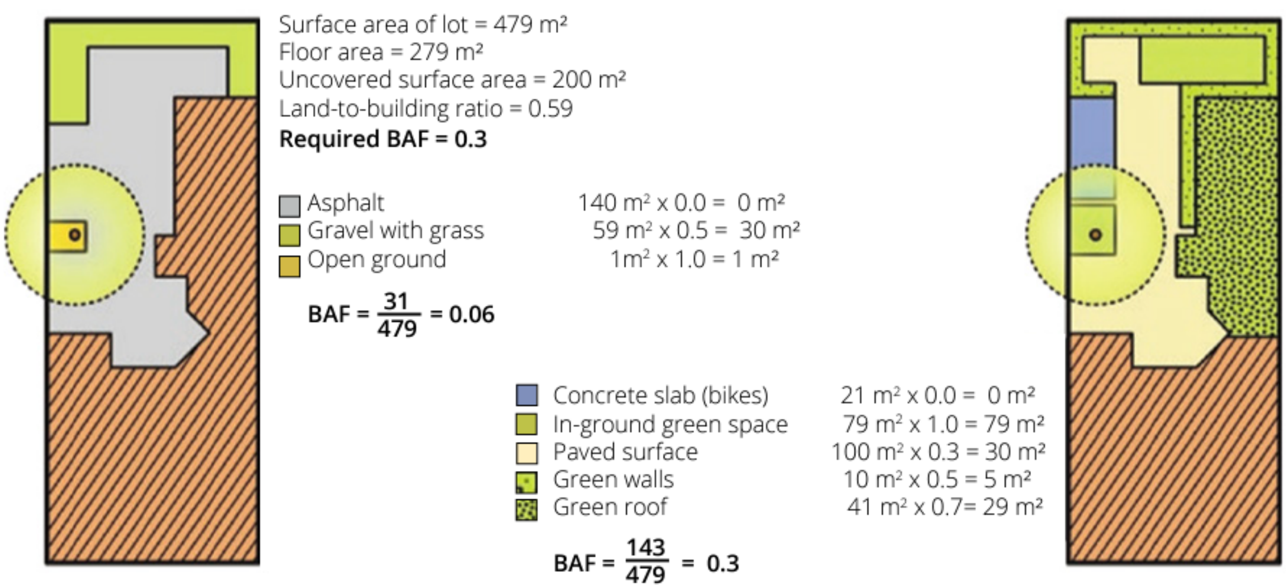

Figure 9: Example of the application of BAF, reproduced from *Co-designing the active city – participatoryplanning.ca.*[21]

[22] https://www.berlin.de/sen/uvk/en/nature-and-green/landscape-planning/baf-biotope-area-factor/calculating-the-baf/

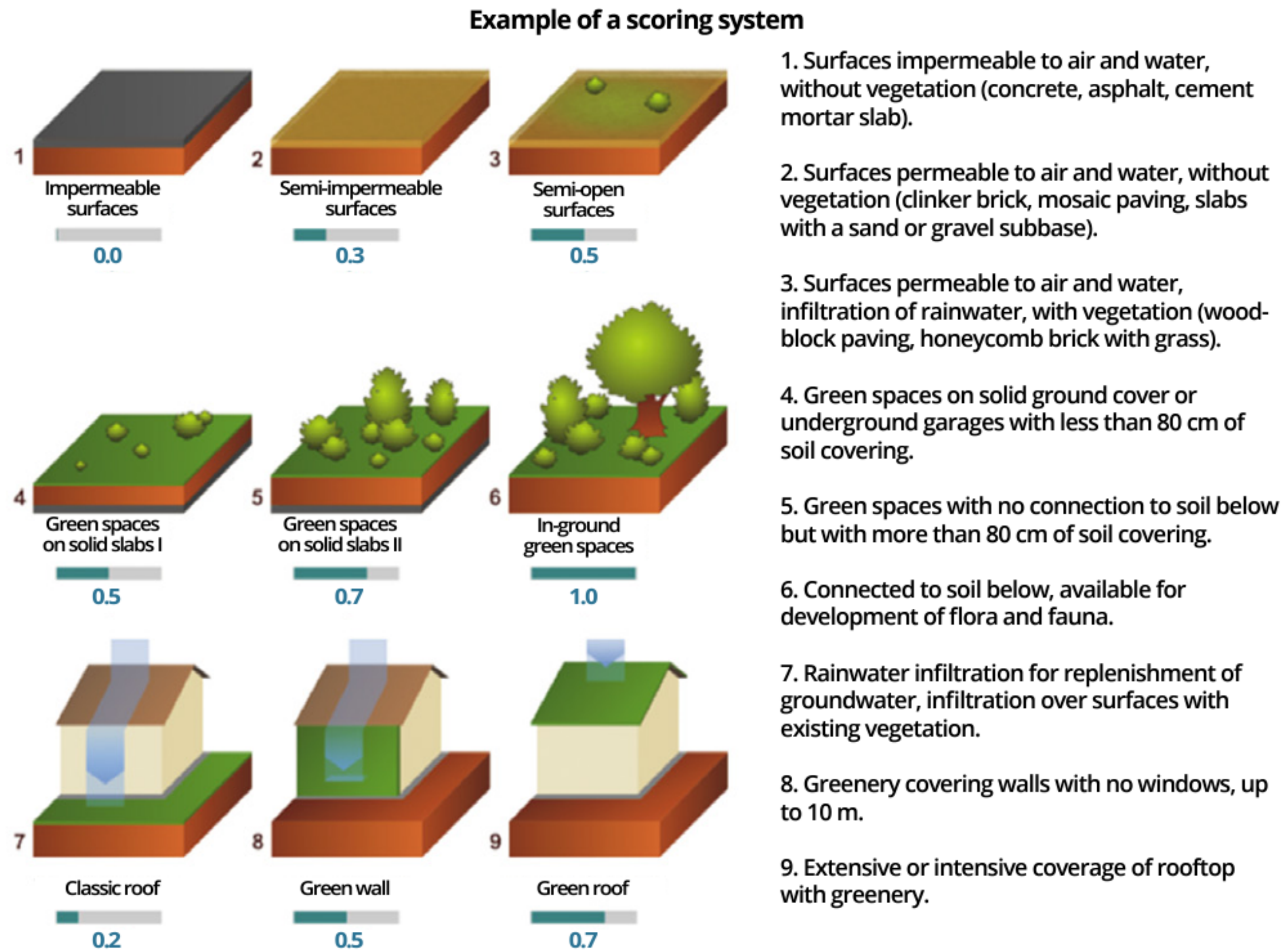

Figure 10: Overview of the BAF scoring system, reproduced from *Co-designing the active city – participatoryplanning.ca.*[21]

2.2 Current Development Status and next steps

For each of the numerical models the next steps are described in the table below.

Table 1: Overview of selected numerical models and their respective status of use in the project and planned next steps.

Tool	Status	Next Steps
Nature Value Explorer	The approach to evaluate ecosystem services of NBSs is fully developed and applied in a stand-alone application for Belgium.	• Design of EU-version • Building of EU-version using EU-generic data • Integrate (aspects of) the framework into the LDT and analyse use of local data

Urban climate modelling	VITO is modelling the urban climate for the front runner cities starting from the output of FIC's climate model (task 3.2).	• Present current and future urban climate information including heat stress maps to FR cities. • Integrate the maps into LDT • Analyse options for follower cities
Air quality modelling	Stand-alone air quality models and applications and proof-of-concept integration of AQ model into digital twin.	• Test integration of air quality model into Urbreath LDT for a data rich environment • Analyse option for integration of local data
3+30+300	The concept is defined and has been tested for Belgium.	• Create a separate script to calculate the 3 indicators starting from EU-wide remote sensing data • Integration as re-usable model into LDT • Adapt for use of local data
Biotope Area Factor	Well known concept that can easily be applied for back-of-the-envelope calculations.	• Test for pilot areas • Test integration to calculate BAF for current state • Re-usable model integrated into LDT

Of the selected numerical models, we do not foresee an integration of the urban climate model. This proofs too complex given the model complexity and computational demands.

3 Data Needs and Data Analysis

3.1 Data requirements and analysis for Nature Value Explorer

The following data are needed to set up Nature Value Explorer for an urban environment. The tool relies on raster data at a sufficiently high-resolution to differentiate in an urban context. The concept can work with any resolution, but the quality of the analysis improves with availability of higher resolution data. The current version used in Flanders relies mainly on 10x10 m² raster data. Processing of data from other data formats can be included.

The following maps are the strict minimum to configure the tool.

- Land use map
- Vegetation map / Urban green inventory
- Air quality maps: annual average particulate matter concentrations (PM_{10} and $PM_{2.5}$)
- Population density map / number of inhabitants
- Annual average rainfall data

Possibly soil texture information can be added, but due to soil disturbance often less relevant in an urban context.

Additional data requirements need to be addressed if we want to value the impact of NBSs on recreation.

- Presence of heritage or cultural / historical landscapes
- Visual pollution
    - Presence of wind turbines or high-voltage network lines
    - Analysis of buffering of visual pollution by trees (can be added on demand)
- Noise levels
- Trail network and trail density
    - This is based on open street maps but can be refined with local data if available

For each dataset, an EU generic dataset or remote sensing database is proposed if local data proof to be unavailable or not suited.

3.2 Data requirements Urban Climate modelling

To operate UrbClim, the following meteorological and terrain datasets are applied:

- ERA5 Reanalysis Data: Provides meteorological inputs for conducting historical reference simulations, typically a recent 10-year period, allowing for statistically robust heat stress indicator maps.
- Future climate projections: usually coming from IPCC global climate model ensembles under different SSP scenarios, provided in collaboration with Urbreath Task 3.2 Climate Modelling and Assessment of vulnerability to climate change
- Imperviousness and Building Height: from local sources or Copernicus datasets
- Land Cover Data: from local sources or Copernicus datasets
- Monthly Vegetation Cover: Sentinel-2 data or other local datasets

- GLO-30 Copernicus Digital Elevation Model: A global DEM with a 30-metre resolution is included to account for terrain effects

The urban climate modelling has been initiated with these datasets.

3.3 Data requirements Air quality modelling

The scheme below shows the overview of the data and models used to create high resolution maps for the region of Flanders. This combines the impact of local emissions from traffic, other local emissions such as industry, emissions outside the modelling domain via the background concentrations, meteorology and the local built environment.

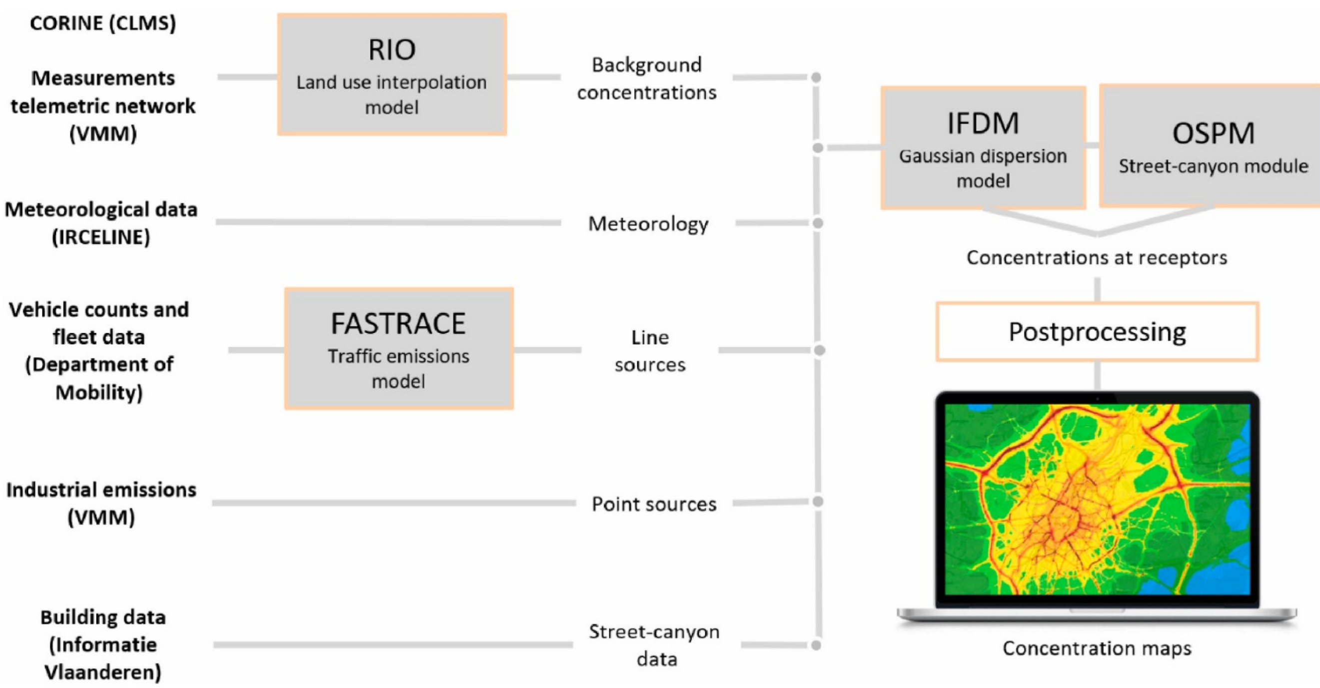

Figure 11: Flow chart of the ATMO-Street model chain used to create high-resolution air quality maps for the Flemish region (reproduced from Hooyberghs et al.)[23]

- Background concentrations can be provided from a local model (such as the RIO model applied in Belgium) or CAMS reanalysis map for the EU provided by ECMWF.[24]
- Meteorology can be provided by a local meteo provider providing assimilated meteo model data or meteo measurements or ERA5 reanalysis meteo.

[23] Hooyberghs H., De Craemer S., Lefebvre W., Vranckx S., Maiheu B., Trimpeneers E., Vanpoucke C., Janssen S., Meysman F., Fierens F., 2022, Atmospheric Environment 272, 118946

[24] https://ads.atmosphere.copernicus.eu/datasets/cams-europe-air-quality-reanalyses?tab=overview

- To evaluate the impact of road traffic and road traffic scenarios, traffic intensities on the road network are needed as either annual totals or peak hour traffic intensities. EU generic data can only give a rough first estimate. EU Traffic Data Mapper is given such EU wide estimates (Degraeuwe et al. 2024).[11] Local mobility data can further refine the air pollution maps.
- Fleet data are combined with traffic intensities to calculate traffic emissions. COPERT provides for the EU27 detailed vehicle fleet data as well as necessary emission factors.[25]
- To include the local impact of the built environment, a street canyon module like OSPM can be applied.[26] It relies of the combination of the traffic network and building data to process the necessary parameters to describe street canyons. Deliverable 4.1 includes the full overview of all the available data to describe and visualize the buildings in all Urbreath cities and the available level of detail (LOD1/2/3).

3.4 Data requirements 3+30+300

The 3+30+300 evaluation scheme requests the calculation and aggregation of the 3 underlying indicators. For each indicator necessary input data need to be provided.

- To calculate indicator '3' at least a dataset with all trees in a city is needed. Either point locations of trees in an inventory or remote sensing data providing an overview of trees or tree crowns can be applied. A first estimate can be made by directly calculating the number of trees in a buffer area. A more refined analysis applies a viewshed analysis taking into account the presence of buildings and other objects. This can be achieved taking into account a Digital Terrain Model (DTM) containing the terrain elevation and a digital surface model (DSM) providing surface heights including natural and built features. The following datasets are requested.
    - A map indicating the location of trees (vegetated) areas
    - A Digital Terrain Model (DTM)
    - A Digital Surface Model (DSM)
- To calculate indicator '30' a 30% tree canopy cover needs to be evaluated. This requests a tree canopy map. The same data as for indicator '3' can be applied.
- To calculate indicator '300' an overview of publicly accessible green needs to be available. Either this is available, or an accessibility analysis can be made using for example the Openstreet maps network. Using such a network, the distance to public green can be calculated as distance over the network.
    - Public green space
    - Road network including soft mobility, either Openstreet map or other local data.

[25] https://copert.emisia.com/

[26] https://envs.au.dk/en/research-areas/air-pollution-emissions-and-effects/the-monitoring-program/air-pollution-models/ospm/description-of-the-ospm-model

3.5 Data requirements Biotope Area factor

The biotope area factor aims to inform users on the permeability and absorbent properties of a current or future plan for an urban domain. These calculations rely on the availability of sufficiently high resolution land cover and land use information datasets as a starting point. Users either need to upload this information themselves or this can be provided for a city or region.
The necessary land use and land cover information is identical to Nature Value Explorer. Typically, these 2D datasets don't inform on greening at building level such as type of green roof or vertical greenery. Users should refine the information starting from an available overview from public datasets.

4 Conclusions

This deliverable outlines the progress made in the selection and configuration of numerical models to evaluate the impact of Nature-Based Solutions (NBS) on the urban environment and local ecosystem services including heat stress, air quality, water retention and infiltration, recreation and ecological impact. The initial phase of the project included the matching of available tools and models to the requirements of the cities.

For each selected model and tool, an overview of necessary input data is documented starting from mostly available EU wide generic data and further refined with local data.

Next steps include configuration and uptake of each tool for the Urbreath cities starting with the front-runners. Simultaneously the integration of these tools as components in the Local Digital Twin takes a start. The results of this process will be reported in the next version of this deliverable.

These steps will support the development of an actionable tool that enable stakeholders to assess the potential effects of NBS interventions effectively. Finally, special focus will be given on integration, visualization, and deployment, during future phases of the project. This will ensure the models are accessible, practical, and relevant to urban planning and decision-making processes.