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D4.6 – Resilience Knowledge Hub and Decision Support Platform Part 1

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Executive summary

The demo *D4.6 – Resilience Knowledge Hub and Decision Support Platform Part 1* is the first version of a platform tailored to different user groups focusing on Nature-based Solutions (NbS) as a strategy for hydro-meteorological risk reduction and mitigation. It includes advanced GIS-based mapping tools, browsing successful NbS case studies, and user stories about successful implementations and problems encountered.

The second and final version of the demo, *D4.8 – Resilience Knowledge Hub and Decision Support Platform Part 2*, will be delivered in Month 39 of the project (July 2027).

This demo is meant for building owners and managers, policy-and-decision-makers, industrial stakeholders, and SMEs.

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List of acronyms and abbreviations

AEC	Architecture, Engineering, and Construction
API	Application Programming Interface
BR	Basic Renovation
BRP	Building Renovation Passport
DBT	Digital Building Twin
DHW	Domestic Hot Water
DR	Deep Renovation
DSP	Decision Support Platform
GWP	Global Warming Potential
HTTP	HyperText Transfer Protocol
EPC	Energy Performance Certificate
ETICS	External Thermal Insulation Composite System
EU	Europe Union
GIS	Geographic Information System
HVAC	Heating, Ventilation, and Air Conditioning
KPI	Key Performance Indicator
MR	Major Renovation
NbS	Nature-based Solutions
OGC	Open Geospatial Consortium
PV	Photovoltaic panel
REST	Representational State Transfer
RKH	Resilience Knowledge Hub
SPA	single-page application
UI	User Interface
WBGT	Wet-Bulb Globe Temperature
WFS	Web Feature Service
WMS	Web Map Service
WMS-T	Web Map Service - Time
WP	Work Package

1. Introduction

This deliverable, *D4.6 – Resilience Knowledge Hub and Decision Support Platform - Part 1*, provides the first demonstration of the Resilience Knowledge Hub (RKH) and Decision Support Platform (DSP), is a single, unified platform that integrates diverse Nature-based Solutions (NbS) tools, datasets, and functionalities under one interface. At this stage, the focus is on presenting the conceptual design, key components, and intended functionalities, rather than delivering a fully operational prototype.

This platform represents core outputs of the RETIME project, designed to support building owners and managers, local authorities, and other key stakeholders in making informed decisions on mitigation and adaptation in the face of climate change, especially for hydro-meteorological risk reduction. It aims to integrate data (including spatial data), tools, and knowledge resources of the project into a user-friendly environment that enhances understanding, planning, and action for climate resilience.

The platform concept introduced in this report highlights a modular architecture that integrates hazard information, catalogues of mitigation and adaptation measures, self-assessment tools, and supporting resources such as glossaries and case studies.

This report is structured as follows. *Section 2* outlines the primary aims of RKH and DSP and the specific components of the platform.

By outlining the planned structure, functionalities, and pathways for integration of tools from earlier project work packages (WPs), this deliverable establishes a blueprint for the RETIME platform's evolution.

The second and final version of the demo, *D4.8 – Resilience Knowledge Hub and Decision Support Platform Part 2*, will be delivered in Month 39 of the project (July 2027). Future iterations will refine these concepts into interactive features, expand the datasets and tools available, and engage with pilot sites and stakeholders to ensure practical alignment with user needs through co-design and testing of co-designing and testing the platform.

1.1. Data Driving the Resilience Knowledge Hub

The platform will integrate different datasets as well as RETIME outputs and tools. More specifically, the platform will integrate:

- **Hazard datasets:** publicly available datasets representing hazard-prone areas in Europe and in the pilot areas. These datasets will cover all hazards that the pilot sites are focusing on. The datasets are identified within deliverables *D1.1 – Report on urban vulnerability and risk assessment (multi-risk resilience) methodologies and tools* and *D3.1 – Map of urban vulnerable hotspots in three pilot areas Part 1*.

- **GeoIKP data:** the platform builds on the GeoIKP platform and its data. In particular, suitable NbS case studies will be integrated in the context of adaptation measures.
- **GeoIKP tools:** the backend of the NbS Catalogue, the WebGIS, and the citizen stories tool will be merged into the RETIME platform and its components.
- **Building renovation passport:** the building renovation passport tool will be partly integrated into the self-assessment tool. While mitigation measures will also be added to the measure catalogue for users to browse.
- **Other RETIME outputs:** further RETIME outputs, such as the digital twins, will be merged into the use case examples of the pilot sites to better visualise how these outputs can be applied across different cases.

2. RETIME Resilience Knowledge Hub and Decision Support Platform

This section introduces the RETIME Resilience Knowledge Hub (RKH) and Decision Support Platform (DSP), which aims at improving building owners' knowledge and decision making on mitigation and adaptation of their buildings in the context of changing climate. *Section 2.1* will reflect on the primary aim of this integrated solution, while *section 2.2* dives into the specific components of the platform. At this point, it needs to be noted that this demonstration deliverable is written as a concept for the platform and outlines the future developments to turn this concept into a prototype.

2.1. Aim

The RKH and DSP aim to strengthen climate resilience by equipping AEC (Architecture, Engineering, and Construction) practitioners as well as informed citizens and decision-makers such as building/apartment owners and managers with accessible knowledge and tools to make informed decisions on mitigation and adaptation at city level. By integrating hazard information, nature-based and engineering solutions, renovation pathways, and interactive self-assessment features, the platform fosters capacity building, supports evidence-based planning, and promotes effective action against hydro-meteorological risks and climate extremes.

2.2. Main interface components

At this stage of development, the RETIME RKH and DSP take advantage of the already established GeoIKP infrastructure, initially developed under the OPERANDUM project founded under Horizon Europe programme (GA 776848).[1] The GeoIKP serves as a comprehensive environment for exploring, sharing, and co-creating knowledge around NbS. Its use within RETIME was proposed primarily to provide the pilot teams with a functional environment to explore and familiarise themselves with a set of operational tools without replicating tools which has been

[1] OPERANDUM project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776848. OPERANDUM delivered tools and methods for the demonstration and market uptake of Nature-Based Solutions to reduce hydro-meteorological risks. In the OPERANDUM project, site-specific and innovative NBS were co-designed, co-developed, deployed, tested, and demonstrated with partners and local stakeholders in open-air laboratories. More on the website of the project: https://www.operandum-project.eu/

already successfully deployed and validated. This approach enables pilot partners to test existing functionalities, identify concrete needs and priorities for further development, and avoid duplicating already mature tools and components. Accordingly, in the Grant Agreement, RETIME partners committed to integrate and build upon GeoIKP components rather than to develop new ones from scratch.

The GeoIKP offers several core functionalities directly relevant to the RETIME objectives: advanced GIS-based mapping tools, browsing and comparing NbS case studies, reviewing relevant policies and permitting paths, and interacting with citizen-contributed information. Through these, the RKH can showcase a coherent and user-friendly interface that facilitates engagement across different stakeholder groups.

The most relevant elements planned to be used for RETIME are the **NbS Catalogue**, **Policy Catalogue**, and **Interactive Map/Data Catalogue** complemented by the **Citizen Stories** tool, which will support the collection of narratives from local communities and other citizen science activities.

In practice, the integration of GeoIKP components into the RETIME platform will proceed through progressive alignment and interface adaptation. The existing architecture - based on open geospatial standards (OGC WMS, WFS, WMS-T) and REST APIs - facilitates this integration technically. RETIME will extend the Data Catalogue to include new datasets from the project's pilots and models while maintaining full interoperability with the original GeoIKP services. Registered users will be able to save their analyses and interact with specific datasets or NbS entries through the RKH interface.

The following sections dive into the different components of the platform, which encompass elements of the GeoIKP and outputs from the RETIME project, specifically from *WP3 – Cross-scale models and actions for urban vulnerability resilience interventions in real-life and virtual pilots* and *WP4 – Infrastructure Resilience plans and innovative adaptation measures for urban areas at risk*. For instance, the Building Renovation Passport (BRP), developed in *T4.5 – Awareness and advice of building owners driven by adaption pathway approach*, will be a stand-alone web application, but will still be accessible from the RKH environment. As far as RETIME pilot areas are concerned, end-users navigating on the RKH will be redirected to the BRP.

2.2.1. Use Case Examples

To introduce and communicate the tools and functionalities of the platform to the end-users in an easy manner, three use case examples will be applied to each of the pilot sites. These use case examples at building level will have different focus to cover most of the functionalities and tools of the platform: 1) in Lisbon, the key focus will be on monitoring of building conditions in *Bairro da Boavista*; 2) in Žilina focus is on the adaptation of a special needs building towards

future climate extremes considering that the selected building is a social service centre; and 3) Tartu will focus on climate proofing homes by reducing their energy footprint due to their prior experiences in refurbishing apartment houses in the Tähe 2 apartment building.

In order to support RETIME citizen science and to collect user-stories about successful implementations, problems encountered and cookbooks for replication, the GeoIKP **Citizen Stories**[2] tool will be adopted and linked to the use case examples. Citizen science activities focusing on urban resilience will engage residents in sharing their personal experiences, challenges, and solutions through short user stories. These stories will be collected via the Citizen Stories crowdsourcing tool (integrated into the RKH) and linked to spatial information on the map, creating a bottom-up knowledge layer reflecting lived experiences of climate impacts and adaptation actions. This approach reinforces RETIME's inclusive co-design methodology and supports continuous stakeholder interaction.

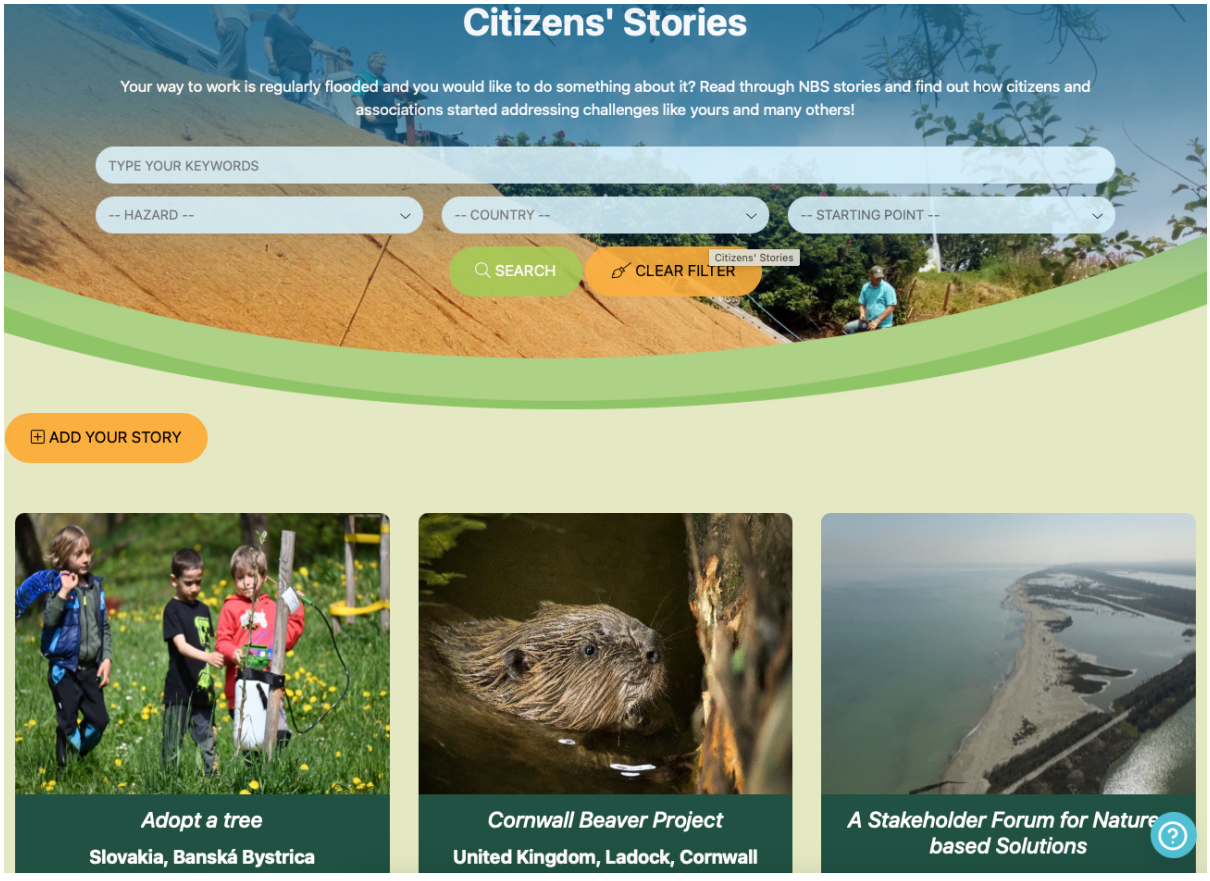


Figure 1. GeoIKP Citizens' Stories interface.

[2] https://geoikp.operandum-project.eu/data/story

2.2.2. Hazard Informer

The Interactive Map is essential component of GeoIKP that RETIME will adapt and extend (Figure 2). This web-based GIS environment allows users to visualise multiple layers of information – hazard datasets, land cover, hydrology, population, and NbS sites – facilitating spatial analysis and decision-making. By clicking on a point of interest, users can access metadata and observational data, compare map layers, and analyse local environmental characteristics. Within RETIME, the map interface will be integrated into the Hazard Informer module and used to visualise pilot-specific datasets, hazard scenarios, and the spatial distribution of NbS and adaptation measures.

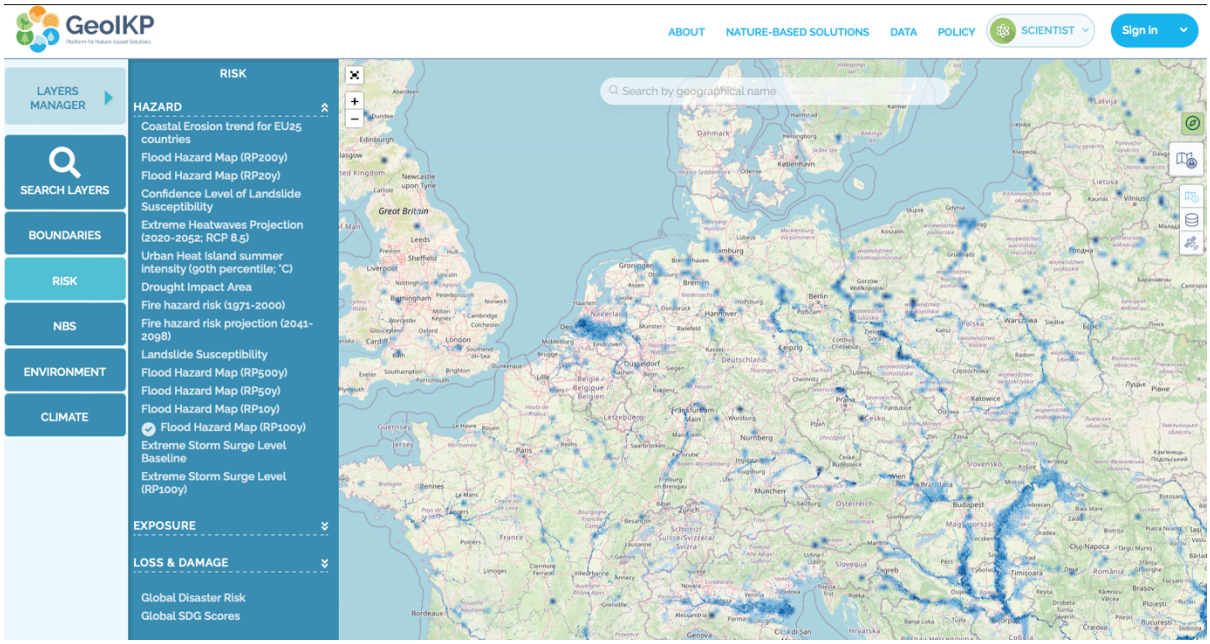


Figure 2. GeoIKP WebGIS interface.

The dataset included in the GeoIKP, developed within H2020 OPERANDUM project, were reviewed by expert users (project internal) and RETIME relevant datasets are directly migrated into this platform. In addition, hazard datasets identified within *D1.1 – Report on urban vulnerability and risk assessment (multi-risk resilience) methodologies and tools* and *T3.1 – Hazard identification in three pilot areas* are being added into the WebGIS. These include local or international hazard datasets for different types of flooding, extreme heat and cold, drought, earthquake, wildfire, landslides, and windstorms. The preliminary list of hazard datasets is outlined in *D3.1 – Map of urban vulnerable hotspots in three pilot areas Part 1*.

2.2.3. Catalogue of RETIME Mitigation and Adaptation Measures

The catalogue includes a list of possible measures that can be taken to either adapt the building stock in the three RETIME pilot sites to different hazards or reduce the buildings energy consumption. For the first one, NbS for buildings and their direct environment will be integrated from the GeoIKP **NbS Catalogue** (Figure 3 and Table 1).[3] For the latter one, measures are shown in Table 2 and target the building energy performance increase while reducing the carbon emissions. The NbS Catalogue enables users to browse Nature-based Solutions implemented around the world, obtain evidence on their effectiveness in reducing hydro-meteorological hazards, and explore detailed information such as intervention types, target hazards, or policy levels. Case studies are crowdsourced and reviewed by experts, ensuring both inclusivity and data quality. The filtering options allow users to search by hazard type, ecosystem, or Sustainable Development Goal target, and the results can be viewed on the interactive map. RETIME will reuse this component to provide access to an existing catalogue of NbS.

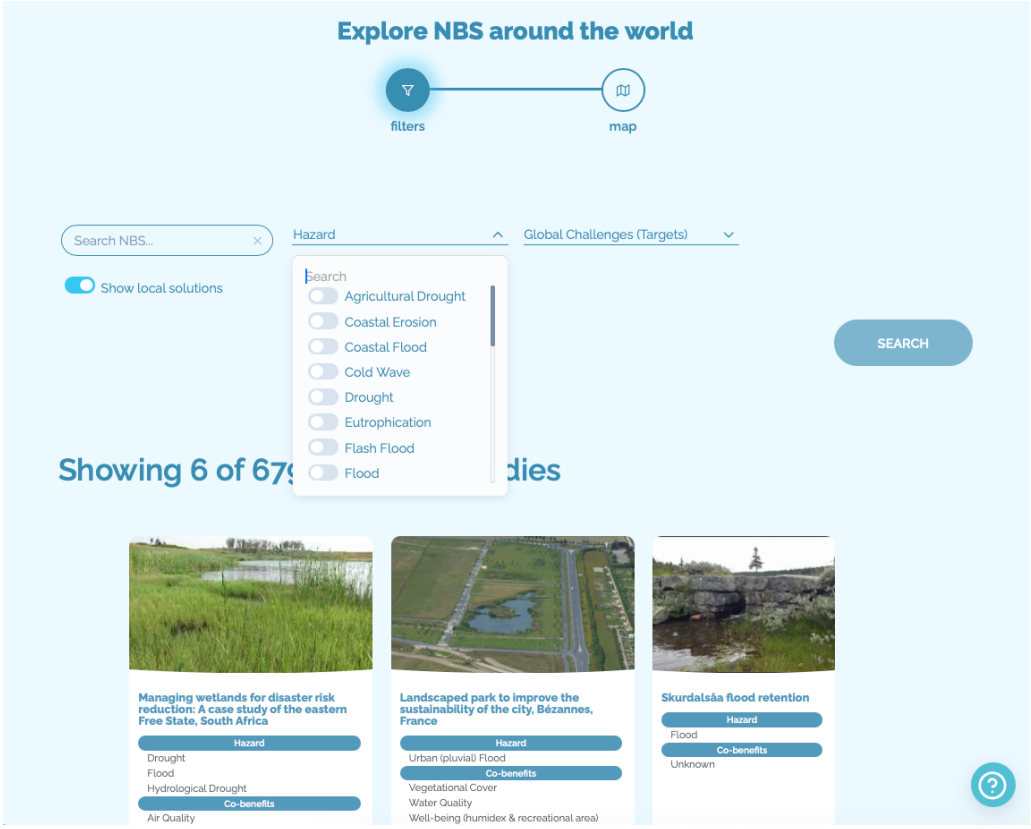


Figure 3. Screenshot of Nature-based solutions (NbS) source in GeoIKP WebGIS

[3] https://geoikp.operandum-project.eu/nbs/explorer

Overall, all measures are categorised by the elements of a building (as outlined in *D1.3 - Report on data specification requirements framework* and *D1.1 - Report on urban vulnerability and risk assessment (multi-risk resilience) methodologies and tools*). Examples of these building elements are shown in Table 1. During the implementation, this list can be adapted and extended when necessary.

Table 1. Examples of building elements for which measures are categorised.

Building system and components	
Foundation/Basement	Inner walls/internal insulation
Façade	Heating system
Roof	Ventilation system
Floor/Ceiling	Cooling system
Openings	Electrical system
Staircases	Hot water system
Elevators & Escalators	Shading or Solar Protection

Adaptation measures: measures such as NbS and other engineering measures with the aim of adapting the building to a changing climate and entailing extremes will be introduced alongside

- a basic definition
- expected impact in terms of hazard reduction
- co-benefits (e.g., improved indoor comfort, energy reduction, CO2 reduction, regulatory compliance, disaster risk reduction)
- installation time (e.g., in months/years)
- price (in €)

Mitigation measures: renovation measures will be structured in different levels (as outlined in Table 2), namely: i) scope and affected element(s) (e.g., for the building envelope: façade, roof or openings); ii) the measures for each element (e.g., for the façade with can insulate from the outside or from the inside, when the exterior cannot be touched like in historic buildings).

Table 2. Structure of energy mitigation measures within the catalogue.

Scope	**Category**	**ID**	**Measure**
Building envelope (E)	Basement	E1	Insulation of basement ceiling or ground floor slab to reduce thermal losses
	Façade	E2	Insulation from the outside
		E3	Insulation from the inside
		E4	Cavity injection

	Roof	E5	Insulation from the outside
		E6	Insulation from the inside
		E7	Insulation of the slab under the roof
	Openings	E8	Addition of secondary glazing
		E9	Installation of shading or solar-control glazing
		E10	Insulation improvement (e.g., Frame or seal enhancement)
		E12	Window replacement
	Shading or Solar Protection	E13	Installation of external shading systems (shutters, overhangs) or other advanced glazing
HVAC System (H)	Heating & Domestic Hot Water (DHW)	H1	Replacement of boilers with high efficiency condensing ones
		H2	Replacement of boilers with heat pumps
		H3	New high efficiency condensing boilers
		H4	New heat pumps
		H5	Change in centralisation & distribution level
		H6	Update of control system in centralised installations
	Ventilation	H7	Installation of mechanical ventilation with heat recovery
	Cooling	H8	New reversible heat pump installation
Renewables (R)	DHW generation	R1	Installation of a solar thermal system to support DHW generation
		R2	Photothermal installation
		R3	Solar thermal to support heat pumps
	Electricity generation	R4	Photovoltaic panels (PV) for aerothermal support
		R5	PV panels for electricity in common areas

Each measure includes a set of products available on the market. For example, the façade insulation from the outside (E1) can be implemented using ETICs (External Thermal Insulation Composite System) or a ventilated façade, with different claddings and insulation thicknesses. Each product will provide the required physical parameters for the energy simulation model,[4] such as thickness, conductivity, efficiency, unitary cost.

Additionally, with the aim to ease the generation of alternative renovation scenarios, a set of predefined renovation packs are included in the energy simulation module at different level of intervention (basic, major, and deep) and different costs. Some potential examples of

[4] An Energy Plus simulation model is created from the BIM model and different parameters (e.g., insulation thickness or conductivity are parametrically changed for each alternative simulation according to the available solutions in the catalogue).

intervention for each structural system or facility and the aggregated interventions (involving a combination of different components) are defined for each level of intervention in Table 3.
These packs can be aligned with the targeted renovation roadmap in each pilot site at building level to provide representative combinations of measures for typical building retrofit cases. End-users can quickly evaluate potential energy savings, cost impact, and CO_2 reductions without needing to configure each measure at separate components. In this way, they can also compare different renovation strategies and identify the most suitable pathway for staged building upgrades.

Table 3. Examples of renovation packs divided per level of intervention (basic, major, and deep).

Level of Intervention	Description	ID	Renovation packs	Detailed information
Basic renovation (BR)	Minimal efficiency interventions, targeting either just the building envelope or just the HVAC system, with limited cost	BR1	E2+E5	Only opaque envelope
		BR2	E2+E5+E10	Only envelope (opaque + windows)
		BR3	H1	Only HVAC (higher efficiency)
		BR4	H2	Only HVAC (lower efficiency, change to heat pumps)
Major renovation (MR)	Improvements in the building envelope and to HVAC system for energy savings and to comply with current building codes	MR1	E2+E5+H1	BR1+BR3 = Opaque envelope + higher efficiency HVAC
		MR2	E2+E5+E11+ H1	BR2+BR3 = All envelope + higher efficiency HVAC
		MR3	E2+E5+E11+ H2	BR2+BR4 = All envelope + heat pumps
Deep renovation (DR)	Comprehensive interventions, both involving envelope and HVAC improvements and advanced renewable energy-related systems for reaching high sustainability standards or near-zero energy consumption	DR1	E2+E5+E11+ H1+H7+R2	MR2+H7+R2 = All envelope + higher efficiency HVAC + ventilation + solar for DHW
		DR2	E2+E5+E11+ H2+H7+R4	E1+E5+H7+R4 = All envelope + heat pumps + ventilation + PV panels for electricity

This catalogue will be highly leveraged by components such as the BRP, whose 'roadmap' functionality will be based on the mitigation and adaptation measures that the end-user is picking up to plan the building's step-by-step renovation.

2.2.4. Building Renovation Passport and Self-Assessment Toolkit

Despite being developed as a separate web platform, the BRP will be accessible through the RKH – likely leveraging the latter's WebGIS interface. This application shall provide users with recommendations to help make their buildings more resilient to climate change, either by enhancing energy efficiency or by taking action against future climate-related hazards. The BRP will therefore guide users through mitigation and/or adaptation processes. Whereas the mitigation pathway focuses primarily on increasing the energy performance of the building (the main target of the BRP), the adaptation pathway focuses more on hazard related tasks (*T3.1 - Hazard identification in three pilot areas* and *T3.3 - Exposure and vulnerability database*) and the integration of elements from the GeoIKP.
Figure 4 shows how the combined effort of RETIME tasks will provide the BRP with suggestions regarding mitigation and adaptation measures that can be implemented. This approach, referred to as 'self-assessment toolkit', will also be based on the end-user's inputs on the RKH and BRP's interfaces.

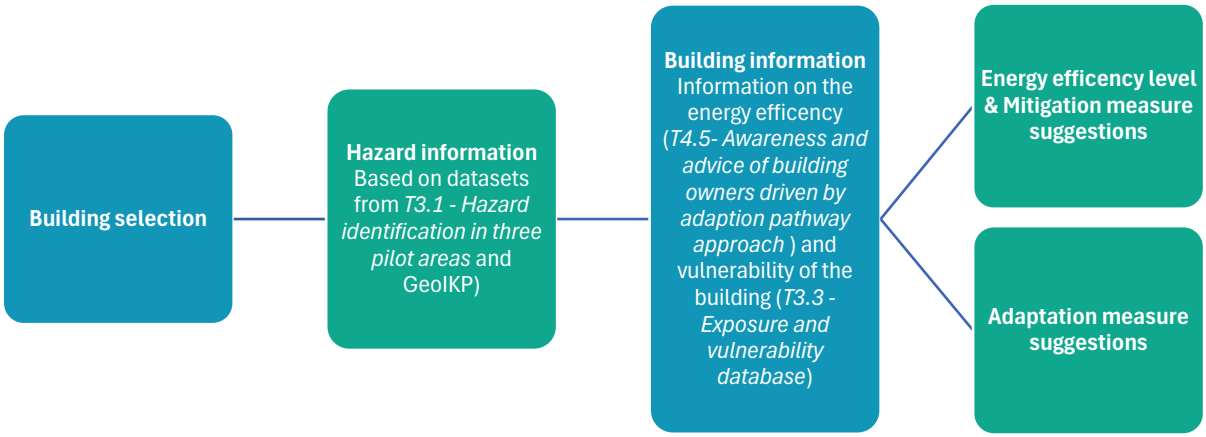


Figure 4. Self-assessment toolkit approach.

(blue boxes indicate functions where the user requires to provide input and green boxes represent outputs from the platform provided to the user).

Within the BRP, end-users will leverage the 'roadmap' functionality to simulate renovation scenarios over a long-term time horizon. Each scenario will be made up of multiple steps, which together will lay out a staged building renovation roadmap. Every step will feature one or multiple renovation measures, that can be both mitigation and adaptation-based (Figure 5).

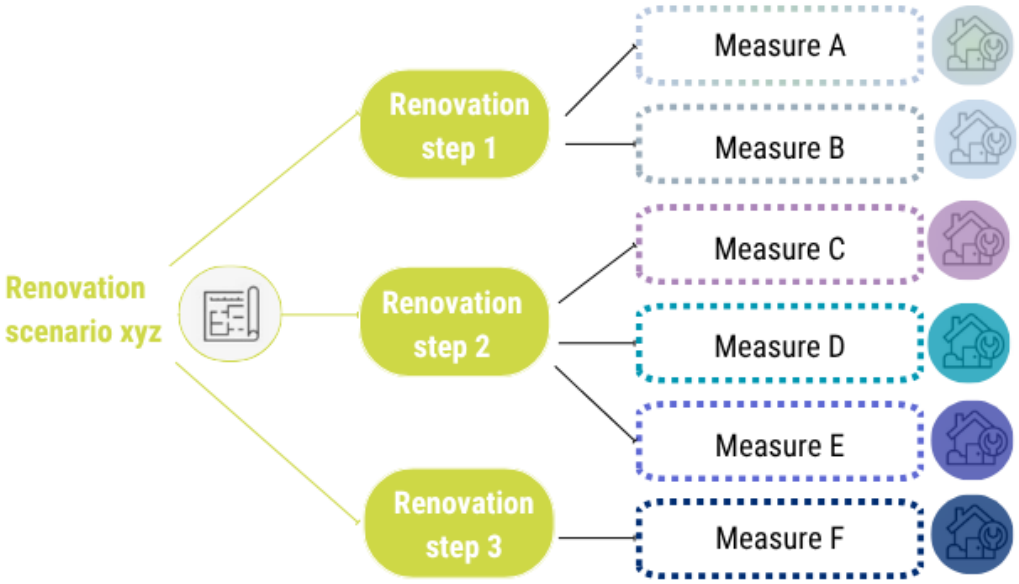


Figure 5. Example chart of renovation scenarios with the suggested RETIME measures.

End-users, whether they are building owners, administrators, or construction companies, will set up a renovation scenario undertaking a multi-step procedure through the BRP 'roadmap' functionality, whose full logic is shown in Figure 6.

In terms of visual output, this is a straightforward multi-step procedure. Each BRP UI enables end-users to configure preferences or select specific options (while remaining consistent with the BRP's building renovation logic) before proceeding to the next interface. At the end of the process, a set of indicators is displayed on the BRP UIs, summarizing the results of the renovation scenario simulation.
Scenarios depend on the project on which the end-users is enabled (e.g. building block, building or flat). They will first choose which building component they aim at improving (e.g., roof, windows/doors), before selecting the year in which implementing the specific renovation action – thus outlining a preliminary roadmap. Users will later associate each shortlisted renovation action to a specific mitigation or adaptation measure, out of multiple options available, based on specific indicators that help them make comparisons and take informed decisions (e.g.,

price, performance). As described in *section 2.2.3*, BRP users will be ideally given the possibility to pick up energy or hazard-focused measures based on the RETIME catalogue's options.

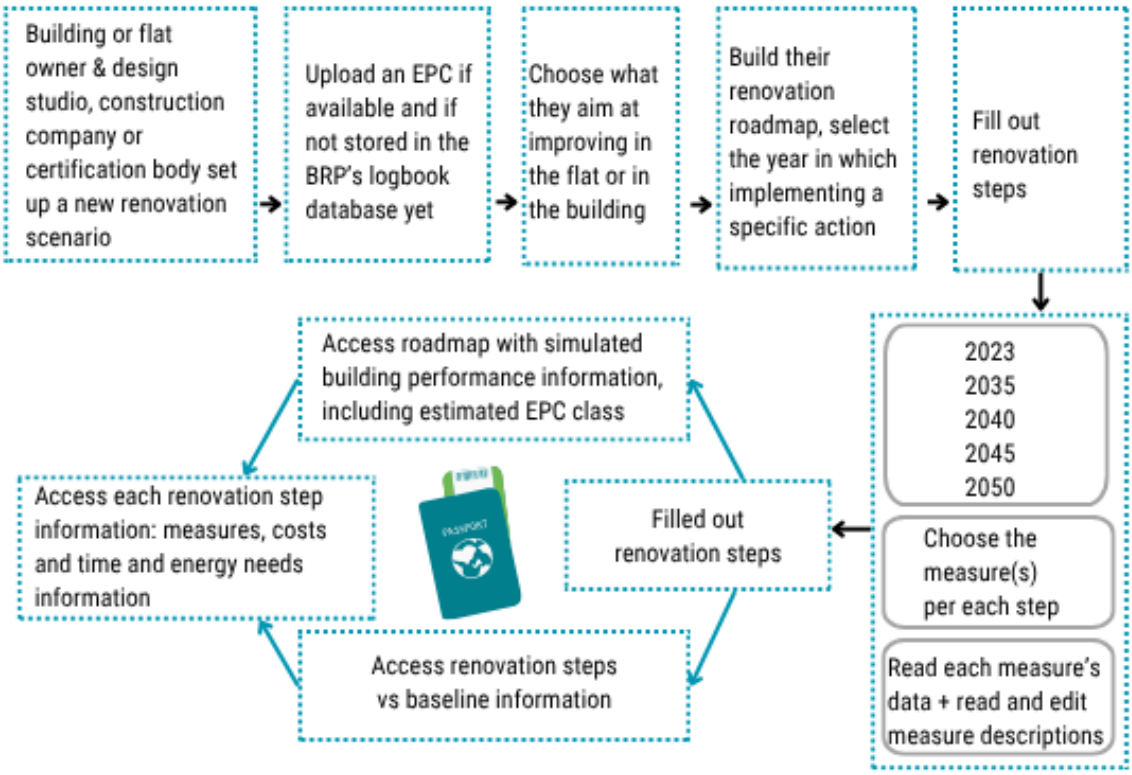


Figure 6. Functionalities of RETIME Building Renovation Passport roadmap.

Once the scenario is fully set up, end-users will be redirected to a summary interface where renovation steps can be compared among each other and, if feasible, against the building's baseline. Key Performance Indicators (KPIs) expected to be considered for this analysis will be:

- investment (€);
- energy consumption (kWh/y);
- energy savings (%);
- CO_2 emissions (kg/y);
- CO_2 savings (%);
- return period (y).

Considering that end-users can configure as many staged renovation scenarios as they want, the BRP web application will also feature an interface where simulated roadmaps can be compared. Registered users will be able to save in the BRP database each renovation scenario's inputs and outputs for future use and adjustments (e.g., modifying variables to explore how simulation

results are affected). Specific KPIs will, therefore be considered to compare different simulated roadmaps, likely:

- total investment;
- energy savings;
- CO_2 savings;
- return period (of the investment);
- targeted Energy Performance Certificate (EPC) class.

When the BRP is accessed from the RKH, the following actions will be required:

Registration: To save the following inputs and outputs, the user will need to register to the RKH platform. This way, the user can always recover the assessment and recommendations provided.

Building selection: The first step of the user will be to select a building of interest from a map interface.

Hazard information: After selecting a building, hazard likelihoods are indicated to the end-users based on the datasets stored in the Hazard Informer. The hazard datasets are static but will be replaced if updates are available. This will help the user to consider not only mitigation but also targeted adaptation measures in the following steps. The hazard datasets are currently static because the platform aims to demonstrate the integration and visualization of hazard information rather than operate as a real-time monitoring service. Using static datasets simplifies the initial implementation and testing phase. However, the system architecture allows for updates or replacement of datasets once new or improved data become available.

Building information: The end-users asked to provide specific inputs about the building to assess existing vulnerabilities and the energy performance improvement potential (country specific)[5]. In the latter case end-users will be redirected to the BRP web application (e.g., through the Single Sign-On schema), where they will also pick up which measures to install – based on the catalogue outlined in *Section 2.2.3*. The granularity of the building information will depend

[5] Each nation in fact features its own energy ratings, but a simplification grouping all the European Energy Performance Certificate (EPC) levels (which likely does not distinguish residential from non-residential buildings) can be leveraged for a preliminary EPC class assessment – assuming that the BRP renovation tasks are undertaken.

on the privacy level of the data, with the possibility of integrating official data sources across the three RETIME pilot sites.

Energy efficiency level & Mitigation suggestions: Based on the user's inputs on the BRP (*T4.5 - Awareness and advice of building owners driven by adaption pathway approach*), the self-assessment Toolkit will calculate the country-specific targeted energy performance. In the process to set up a long-term roadmap, intermediate renovation steps will be outlined, including the installation of one or more measures (such as façade insulation, double-glazed windows). The draft idea behind the BRP is that each selected measure will be associated to a description highlighting the benefits of the choice and one or more indicators (e.g., price) – as in the measures catalogue. The mitigation actions will be mainly energy focused. When a step-by-step renovation scenario is configured by an end-user, its results and those of its intermediate steps will be shown on the BRP interfaces in the form of detailed KPIs. This Energy Simulation module is currently focused on selected buildings in the three RETIME pilot sites and extension to other usages is also envisaged.

Adaptation measures: Using the building information provided by the user, the building vulnerability for specific hazards can be assessed by the RKH. The assessment will be indicator-based, drawing on *T3.3 – Exposure and vulnerability database* and *T1.1 – Urban multi-risk resilience assessment approaches and methodologies*, as well as using the input data supplied by the user.[6] Based on the vulnerability of the building, measures will be suggested to the BRP, reflecting NbS (integrated from the GeoIKP) and engineering solutions. The BRP will therefore aim at showing the staged renovation scenario's KPIs considering the installation of adaptation measures too.

2.2.5. RETIME Glossary

As a support for understanding different elements of the platform, the RETIME glossary developed as part of the deliverable *D1.1 - Report on urban vulnerability and risk assessment (multi-risk resilience) methodologies and tools* will be integrated into the DSP. This will be done either as a stand-alone page or directly integrated into the different tools of the platform. The latter would show a '?' next to technical words; thus, the user can quickly look these words up by hovering over the '?'. This will further support the glossary itself as new technical words can be identified and added to the glossary. In parallel, user guide will be available to all end-users,

[6] The final list of indicators for flooding and extreme heat hazards will be presented in the final version of the demo *D4.8 - Resilience Knowledge Hub and Decision Support platform Part 2*.

which will enable exploring all the platforms components in depth and guide through the platform.

2.2.6. RETIME Policy Catalogue

In parallel, the **Policy Catalogue** provides access to an extensive collection of policy documents relevant to NbS planning and implementation. Through search, filtering, and linkage to related case studies, users can identify policies and legal frameworks influencing the deployment of NbS at local, national, and European levels. This functionality will support RETIME's objective of connecting scientific and technical knowledge with governance and policy mechanisms that enable resilience planning. This component will build upon the existing Policy Catalogue available in the GeoIKP platform. RETIME will further utilise and extend the current functionalities and datasets under the GeoIKP environment to ensure consistency and interoperability.

2.3. System Architecture

The RETIME Resilience Knowledge Hub and Decision Support Platform will be designed as a modular, service-oriented web application following open standards. The architecture follows a service-oriented approach, where each functional component operates as an independent service communicating through well-documented Representational State Transfer (REST) and OGC APIs, as shown in Figure 3. This ensures flexibility, maintainability, and scalability of the system while enabling integration with other RETIME components such as the Digital Building Twin (DBT) and the Building Renovation Passport (BRP).

The platform follows the best practices in web GIS domain and uses open geospatial standards (such as WMS, WFS, WFS-T) to distribute spatial datasets and ensure interoperability with external systems like the Copernicus Data Store or the Risk Data Hub.

All services will be containerised and deployed on a Linux environment, orchestrated through Docker, and served via Nginx HTTP reverse proxy. This deployment strategy ensures easy replication, efficient scaling, and robust performance in pilot and production environments.

The architecture is divided into four main layers:

- presentation,
- application,
- geospatial services, and
- catalogues with supporting analytics.

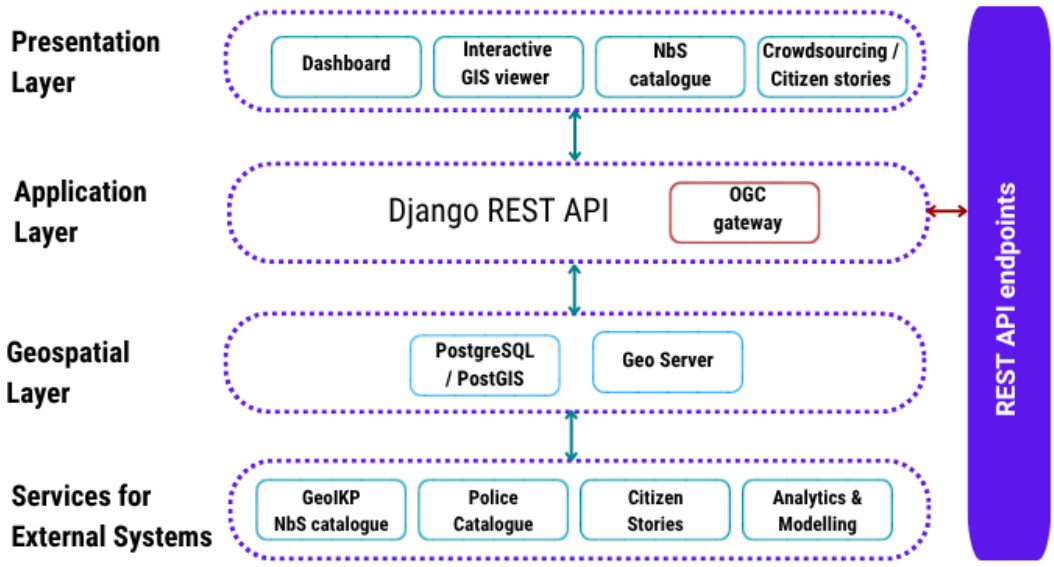


Figure 7. RETIME Resilience Hub and Decision Support System Architecture.

At the presentation layer, a React single-page application (SPA) provides an intuitive user interface. This interface includes dashboards for key indicators, an interactive WebGIS viewer (*section 2.2.2*), catalogue for NbS and policy measures (*section 2.2.3*), and a citizen engagement module for crowdsourcing activities (*section 2.2.1*). Users will be able to explore data, visualize scenarios, and interact with spatial layers seamlessly through this responsive interface.

The application layer is powered by Django and the Django REST Framework. It implements all business logic, manages user authentication and authorization, and exposes RESTful endpoints for each system component. The backend also supports background processes such as data ingestion, sensor integration, and decision-support computations. Asynchronous tasks and resource-intensive analytics will be managed through Celery workers connected to a Redis or RabbitMQ queue.

The geospatial services layer combines PostgreSQL with the PostGIS extension and GeoServer. PostGIS serves as the main spatial database, storing all vector and raster datasets, including case studies, interventions, and citizen-contributed information. GeoServer publishes these layers through OGC-compliant services (WMS, WFS, and WMTS), ensuring that all geospatial content is available to both internal and external systems.

Finally, the catalogues and analytics layer manage structured knowledge repositories (such as the NbS Catalogue, Policy Catalogue, and Citizen Stories) while also supporting analytical tools and models that generate insights and recommendations.

All system components will be deployed as Docker containers, ensuring reproducibility and simplifying maintenance. The architecture includes containers for the Django backend, React frontend, GeoServer, PostgreSQL/PostGIS, and auxiliary services such as Celery workers and Redis queues. Nginx will function as the reverse proxy and static file server, routing API requests to Django, geospatial requests to GeoServer, and serving the React frontend.

In this production environment, database replication and automated backups will ensure resilience, while Celery workers can be scaled horizontally to handle increased analytical workloads. GeoServer will be equipped with GeoWebCache for efficient tile caching, improving map rendering performance. Continuous integration and deployment pipelines will automate building, testing, and versioning of the Docker images, ensuring smooth updates with minimal downtime.

3. Conclusions

This deliverable has presented the conceptual foundation for the RETIME Resilience Knowledge Hub and Decision Support Platform, outlining its purpose, architecture, and planned components. As a first realise of a demo, it illustrates the intended direction of development rather than a fully functional tool.

The next steps will focus on progressively translating this concept into a functional prototype, building on parallel activities within RETIME and integrating advanced tools from the GeoIKP platform. Future development will include the integration of hazard datasets, expansion of the mitigation and adaptation measures catalogue, refinement of the Building Renovation Passport into the self-assessment toolkit, and design improvements to ensure a user-friendly interface. Close collaboration with pilot sites and stakeholders will guide the creation of tailored use cases, ensuring that the platform responds to real-world needs.

Ultimately, by iteratively refining functionalities and engaging end-users throughout the process, the platform will evolve into a robust decision support environment that enables effective climate adaptation and mitigation actions, thereby contributing to the wider objectives of RETIME.