D2.2 - Specifications, Architecture

Project name

Asset Level Modelling of RISKs In the Face of Climate Induced Extreme Events and ADAPTtation (RISKADAPT)

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Version	Date	Organisation	Summary of changes
0.1	28/06/2023	RISA	First draft of document structure, introduction, methodology
0.2	15/07/2023	RISA	Modules description
0.3	25/08/2023	RISA	Architecture definition and description.
0.4	17/09/2023	RISA	Architecture definition and description. Technical specifications definition.
0.5	03/10/2023	RISA	Architecture definition and description. Technical specifications definition.
0.6	15/10/2023	RISA	Deliverable ready for internal review.
0.9	24/10/2023	RISA	Deliverable ready for submission.

1.0	27/10/2023	ERRA	Quality reviewed version ready for submission

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List of Abbreviations and Acronyms

Abbreviation	Meaning
BIM	Building Information Model
CAD	Computer Aided Design
CC	Climate Change
CORDEX	Coordinated Regional Climate Downscaling Experiment
CDS	Climate Data Store
CMIP6	Coupled Model Intercomparison Project
Dx.x	Deliverable x.x
DMS	Data Management System
EC	European Commission
EoL	End-of-Life
EPDs	Engineering Demand Paraments
EU	European Union
GA	Grant Agreement
GEOSS	Global Earth Observation System of Systems
GIS	Geographical Information Systems
IDF	Intensity-Duration-Frequency
IPCC	Intergovernmental Panel on Climate Change
IS	Information System
LCA	Life Cycle Assessment

LCC	Life Cycle Cost
MIS	Model Information System
Tx.x	Task x.x
UI	User Interface
UID	Unique Identification
WP	Work Package

Executive Summary

RISKADAPT will provide, in close cooperation with the end-users/other stakeholders, a novel, integrated, modular, interoperable, public and free-of-charge, customisable user-friendly platform (PRISKADAPT), to support systemic, risk-informed decisions regarding adaptation to Climate Change (CC) induced compound events at the asset level, focusing on the structural system. PRISKADAPT will explicitly model dependencies between infrastructures, which, inter alia, will provide a better understanding of the nexus between climate hazards and social vulnerabilities and resilience. Moreover, this project will identify gaps in data and propose ways to fill them, so as to advance the state-of-the-art in asset level modelling by means of utilizing advanced climate science to predict CC forcing on the structure of interest and structural analyses that are customised to the specific structure of interest. The proposed approach considers all major CC induced load effects in tandem with material deterioration, novel probabilistic environmental Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) of structural adaptation measures as well as a new model to assess climate risk that will combine technical with social risk assessments. PRISKADAPT will provide values to a set of indicators for each asset of interest, quantifying primary parameters and impacts, and will deliver all the required information for adaptation decisions in the form of a Model Information System (MIS). PRISKADAPT will be implemented in the case studies of the project pilots that involve specific assets, however, it will permit customisation with local parameters and data, so it can be applied across Europe for CC adaptation decisions involving assets of similar function, that are exposed to multiple climate hazards.

Deliverable 2.2 “Specifications, Architecture” aims to: (a) develop the baseline specification of the system functionalities, to meet the needs identified in T2.1 taking into account existing national and international regulations; (b) describe the modules of the RISKADAPT platform; (c) present the RISKADAPT system architectural specification; (d) identify the interfaces of the internal components and the foreseen interactions between the components, as well as the interfaces for interoperability of the system with RISKADAPT applications, in order to guide the development in a way that will later on enable their integration into the system.

1. Introduction

Deliverable 2.2 “Specifications, Architecture” is one of the two (2) Deliverables of WP2 “User Requirements, Architecture” and is related to T2.2 “Specifications, Subsystem/System Architecture”. This Task deals with the specification and architecture of the integrating, holistic systemic modelling framework (PRISKADAPT) and the subsystems, so as to meet the needs identified in T2.1 with regards to existing national and international regulations, guidelines or standards and best practices.

1.1 Purpose of the deliverable

The aim of this Deliverable is to initially to develop the baseline specification of the system functionalities, to meet the needs identified in T2.1. Further to this, the modules of the RISKADAPT platform’s modules will be identified and the RISKADAPT system architecture will be specified. In doing this, the interfaces of the internal components and the foreseen interactions between the components, as well as the needed interfaces for enabling the interoperability of the system with the RISKADAPT applications will be described.

Attainment of the objectives and explanation of deviations

This Deliverable is related to the RISKADAPT Milestone 3, namely “Requirements/specification of components and system architecture”. This specific Milestone has been fully achieved and as scheduled.

1.2 Structure of the deliverable

The Deliverable has been structured as follows:

Chapter 1. Describes the aim of the RISKADAPT project as well as the purpose, the intended audience and the structure of this document.

Chapter 2. Describes the methodology followed in this Deliverable.

Chapter 3. Presents RISKADAPT’s modules and system architecture.

Chapter 4. Describes RISKADAPT’s technical specifications.

Chapter 5. Summarises the main outcomes of this Deliverable and outlines the future work.

1.3 Intended audience

As the dissemination level of this Deliverable is public, it will be openly available to all stakeholders, such as public authorities, infrastructures’ owners and operators, researchers and technology providers, as well as decision and policy makers interested in a report that presents the specifications and architecture of the RISKADAPT system. This system will enhance resilience via supporting systemic, risk-informed decisions regarding adaptation to CC-induced compound events at the asset level, focusing on the structural system. Moreover, this report will form the basis of the developments that will be conducted in the technical Wok Packages (meaning WP3, WP4, and WP5), so it is of high-interest to all RISKADAPT technical partners.

2. Methodology

This deliverable is linked to T2.2 "Specifications, Subsystem/System Architecture" and aims to present several aspects related to: (a) the detailed technical specifications of the RISKADAPT system; (b) the RISKADAPT platform modules and; (c) the RISKADAPT system architecture (T2.3). Figure 1, along with the next paragraph, outlines the methodological framework that was utilized so as to meet the aim of this Deliverable within the allotted timeframe.

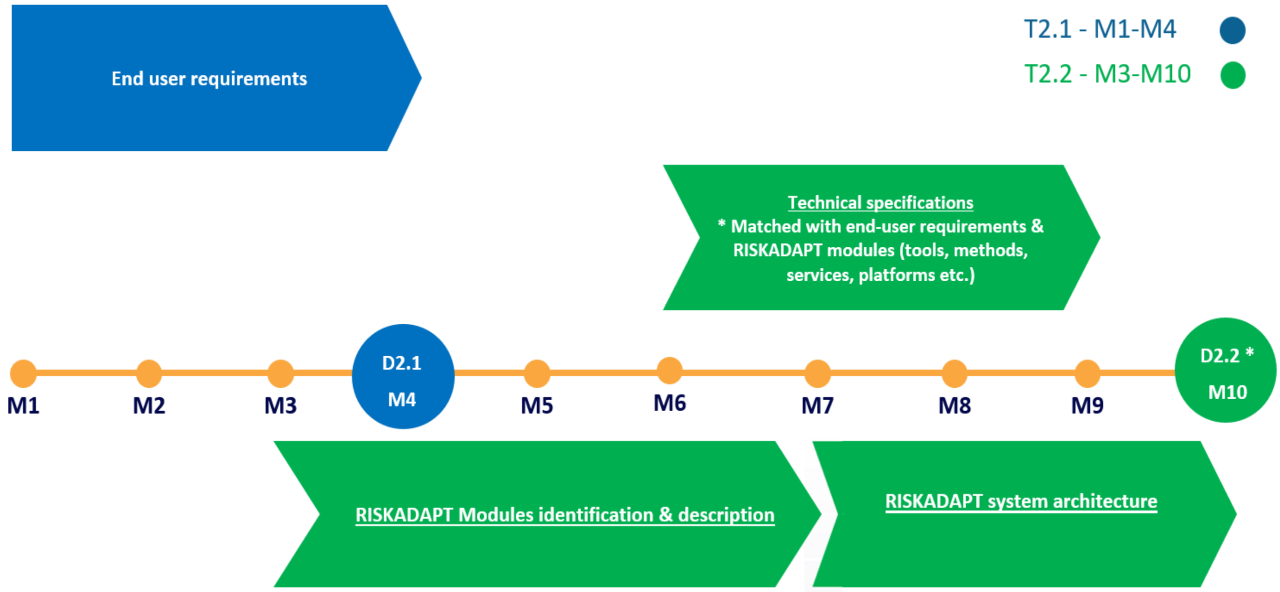

Figure 1: T2.2 methodology and time plan

In particular, bi-weekly and ad-hoc meetings were organised, where all WP2 partners participated actively. During these meetings the partners discussed the progress of the work, as well as clarified issues and risks relevant to T2.2. More specifically, at the beginning of T2.2, a time plan was defined and agreed between the partners. The initial aim was to define the RISKADAPT modules and their interrelations. Based on the aforementioned, technical partners and providers worked on the definition of the technical specifications. The identified technical specifications were consequently matched with the end-users' requirements and the work proceeded with the description of the RISKADAPT modules and the architectural definition. It should be mentioned that the delay in the submission of D2.1 was the main risk identified. To mitigate its impact, partners cooperated and worked carefully, as D2.1 and more specifically the end-users' requirements were an important source of information for this Task.

3. RISKADAPT system architecture

The architectural design of the RISKADAPT system closely follows the structure of the project Work Packages (WPs), as explained below and illustrated in Figure 2.

WP3: Climate Data, CC Forcing, Multi-Hazard Modelling (identification/assessment of extreme weather events and forces on structures)

WP4: Multi-Hazard Vulnerability and Adaptation, Structural Resistance Integration in Lifecycle Analyses (assessment of structural damage because of the forces (identified in WP3), assessment of glass window damage in tall buildings under high winds and rain, calculation of icing on electricity lines due to extreme weather, determination of eco-friendly and cost-effective engineering solutions to reduce the above damages)

WP5: PRISKADAPT, MIS and Data Gaps (determine engineering and societal consequences of damage, integrate the above in a platform in the form of a risk-informed decision support system on adaptation measures to extreme weather events, determine a set of metrics quantifying important parameters needed for adaptation decisions)

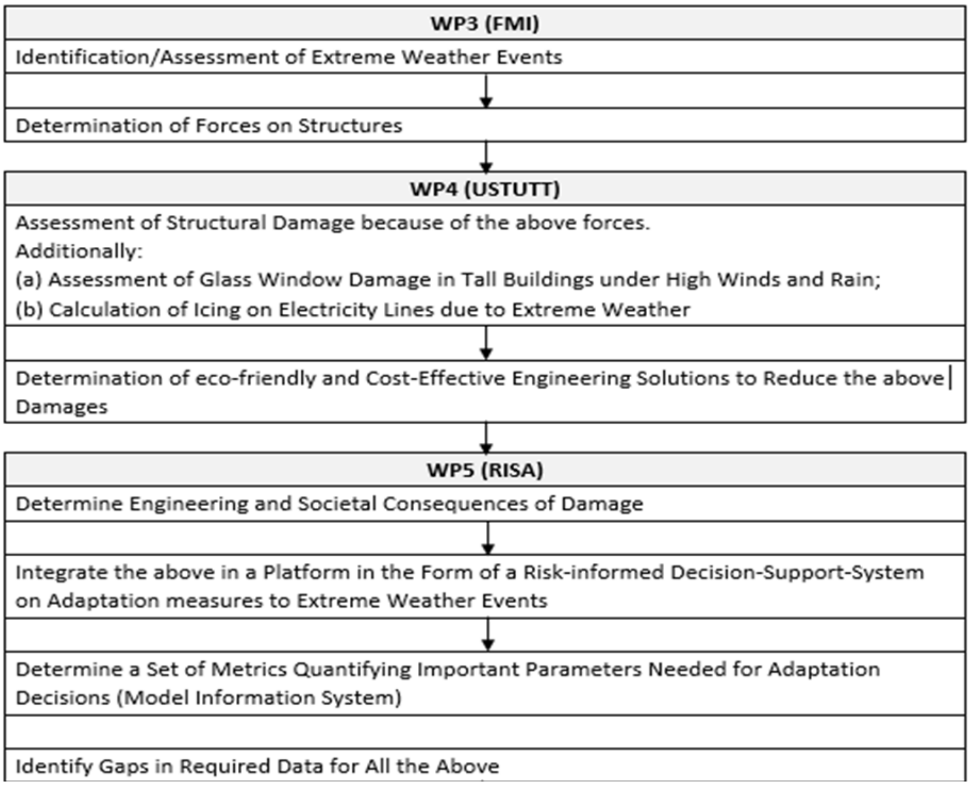

Figure 2. The structure of RISKADAPT project WPs

Each WP is presented in the following paragraphs, along with its internal architecture and data flow, independently as a main element of the RISKADAPT system, and the communications between modules/components are highlighted. Each module/component of the RISKADAPT system elements is responsible for creating detailed and specific datasets and models dedicated to the monitoring of specific hazards, risks or structures. For creating such models, there is a need to collect data from external sources and model results. All elements of RISKADAPT system's architectural design are represented using the symbols present in Figure 3.

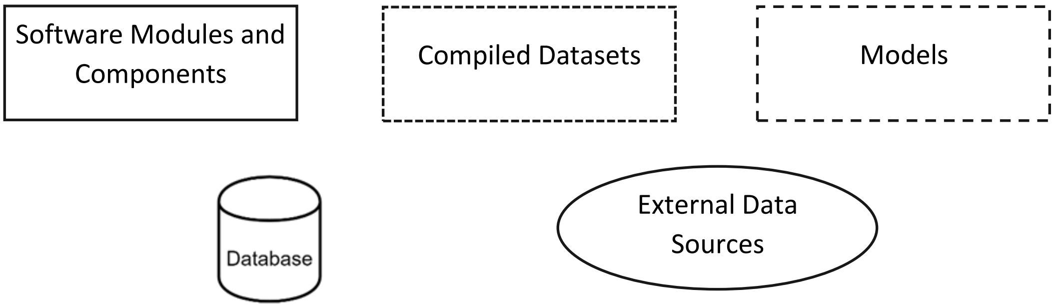

Figure 3. Symbols used for describing the architecture

More specifically, for each element (further to each main aim and description), the relevant modules are identified and for each module the following information is provided:

- Module name: The complete name of the module.
- Module description: A description about the aim and main characteristics of the module.
- Module components: List of components that the module consists of.
- Sources: List of the modules/components that provide data or any other input to the described module.
- Input data: Identification of the input data needed for the module to perform its regular operations.
- Output data: The expected outcome of each module.
- Consumer: Identification of the components/modules that feed from the activities or data produced by the described module.

3.1 WP3 high-level architecture

WP3 provides the climate variables for the present and future climates that provide input to downscaling models, that can used to study the effects on the level of individual assets, such as buildings and bridges. WP3 utilises, as per the input requirements defined in WP2, the available data, especially from Copernicus and GEOSS Services, and analyses them for establishing a scalable use of the developed methods beyond the pilot/target locations. WP3 analyses precipitation, winds and other climatic data derived from existing climate services for the European territory and produces hazard curves across Europe that express the probabilistic regime of climatic hazards. Then, based on climate model projections (especially regional), provides an estimation of how these hazard curves are expected to change in the future corresponding to selected periods relevant to the infrastructure in question.

This WP consists of the following modules:

- Climate data for hydrological analyses, wind and rain forcing and material degradation (T3.1)
- The hydrological module for runoff analysis (T3.2)
- The hydraulic module for water flow loads on bridge structures (T3.2)
- Requirements and specifications for the CC forcing modules (T3.3)

The architectural diagram of the WP3 is presented in Figure 4.

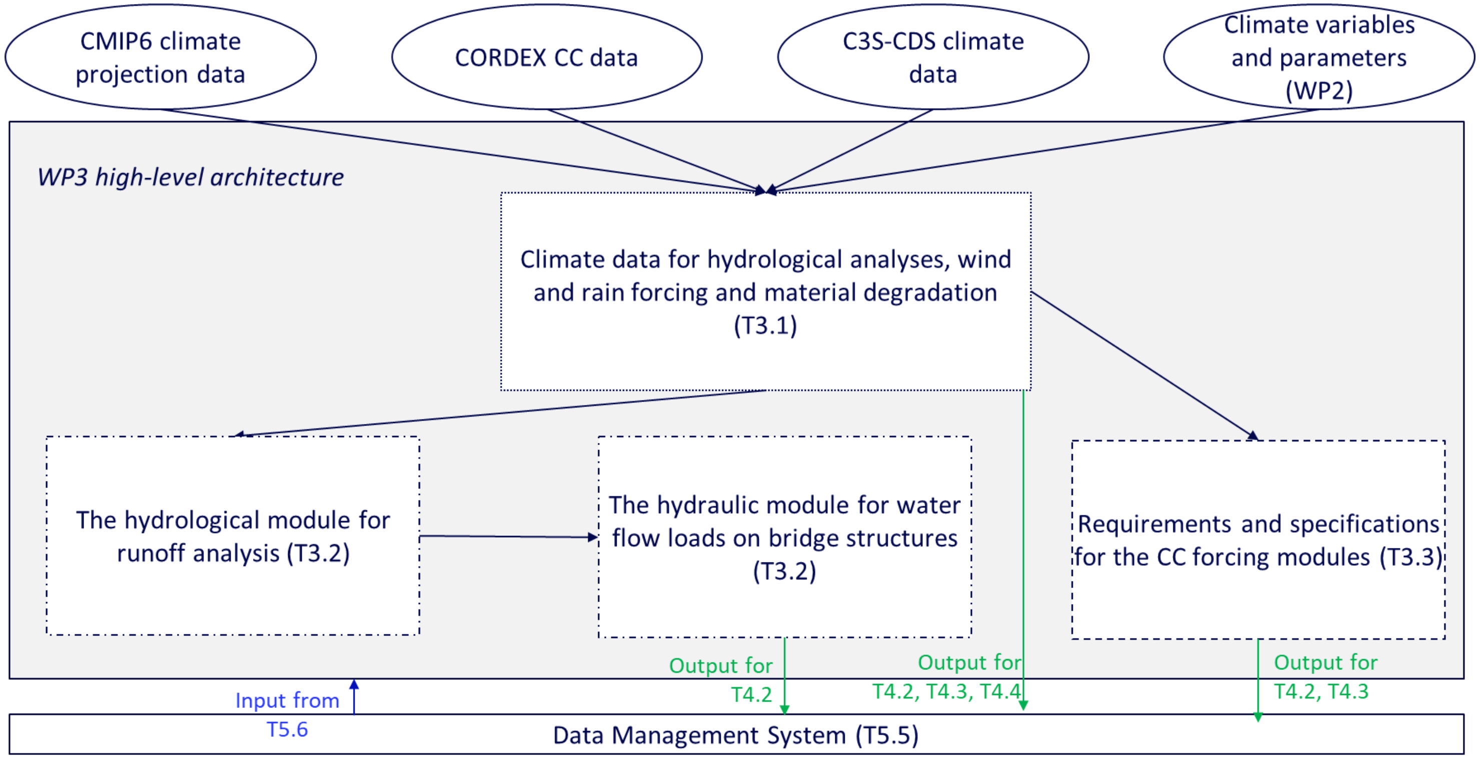

Figure 4. The high-level architecture of WP3

3.1.1 Climate data for hydrological analyses, wind and rain forcing and material degradation (T3.1)

The first module of WP3, namely "Climate data for hydrological analyses, wind and rain forcing and material degradation", is related to the analysis of construction-related meteorological variables, such as wind speed, temperature as well as storms (extra-tropical cyclones), to produce Intensity-Duration-Frequency (IDF) curves that express the probabilistic regime of extreme events occurrence for the present and future periods.

For the present climate, the main focus is on the state-of-the-art C3S Climate Data Store (CDS) reanalysis data and E-OBS in-situ data, both available from the C3S CDS. For the CC data, the focus is on the Coordinated Regional Climate Downscaling Experiment (CORDEX) data as well as on the most recent global climate projection data Coupled Model Intercomparison Project (CMIP6). The above is combined with critical information at the local scale and over extended timescales and contextual site factors from databases in the GEOSS or currently not in GEOSS, including field data, historical records from local environmental agencies and advanced data driven prediction models to provide the required input in terms of loading on structures.

In Table 1, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 1. The sources/input and consumers/output data of the "Climate data for hydrological analyses, wind and rain forcing and material degradation" module

Input Data	**Output Data**
• Climate variables and parameters (WP2). • For the present climate, focus is especially on the state-of-the-art C3S CDS reanalysis data and E-OBS in-situ data, both available from the C3S CDS. • For the CC data, the focus is on the regional CORDEX data as well as on the most recent global climate projection data CMIP6.	• Identification of extreme weather events (e.g., heavy rainfall, wind direction/pressure, extreme temperature) at the location of interest that can induce structural damages to the considered structures. • Determination of the Intensity, Duration, Frequency (IDF) curves of the atmospheric data for all climate change scenarios of Intergovernmental Panel on Climate Change (IPCC). • Development of a package to help users get the IDF curves for similar weather events across Europe. • Provision of variables that affect corrosion of the structural materials (temperature, humidity) for the locations of interest. • Calculation of icing in power lines in the context of corona discharges.
Sources	**Consumer**
• WP2 relative information • C3S-CDS climate data • CORDEX CC data	• "Hydrological module for runoff analysis" (T3.2) • "Requirements and specifications for the CC forcing modules" (T3.3)

• CMIP6 climate projection data	• "Module of structural analysis of the structures" (T4.2) / consumed through the DMS • "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" (T4.3) consumed through the DMS • "Module for estimating the meteorological hazard (i.e., wind speed and direction and ice thickness) for the power transmission line" (T4.4) / consumed through the DMS • "Module for materials degradation" (T4.2) / consumed through the DMS

3.1.2 The hydrological module for runoff analysis (T3.2)

The hydrological module for runoff analysis, will use data provided from the "Climate data for hydrological analyses, wind and rain forcing and material degradation (T3.1)", to provide flood waves (i.e., hydrographs) that are needed for undertaken the hydraulic analysis.

In Table 2, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 2. The sources/input and consumers/output data of the "The hydrological module for runoff analysis"

Input Data	Output Data
• Topography, land use, hydrologic soil groups, precipitation data - for present and future climate conditions (extreme rainfall return levels, typical rainfall distribution, areal reduction factor), local data for calibration and validation (measured discharges and rainfall amounts, return periods of maximum discharges).	• Flood waves (hydrographs) at specified locations.
Sources	**Consumer**
• "Climate data for hydrological analyses, wind and rain forcing and material degradation" (T3.1)	• "Hydraulic module for water flow loads on bridge structures" (T3.2)

3.1.3 The hydraulic module for water flow loads on bridge structures (T3.2)

The hydraulic module for the water flow loads on bridge structures will provide water flow velocities and depths needed to calculate the hydrodynamic loads on the bridge piers. In Table 3, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 3. The sources/input and consumers/output data of the "The hydraulic module for water flow loads on bridge structures"

Input Data	Output Data
• Topography, land use, hydrographs, local data for calibration and validation (measured discharges and water levels, return periods of maximum discharges).	• Extreme hydrodynamic loading of bridge piers in Pilot 1.
Sources	**Consumer**
• "Hydrological module for runoff analysis" (T3.2)	• "Module of structural analysis of the structures" (T4.2) / consumed through the DMS

3.1.4 Requirements and specifications for the CC forcing modules (T3.3)

The "Requirements and specifications for the CC forcing modules" module evaluates the forces acting on the structures due to CC induced extreme events, including pressure forces, drag and lift coefficient due to high wind and wind-driven rain in tall buildings.

In Table 4**Error! Reference source not found.**, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 4. The sources/input and consumers/output data of the "Requirements and specifications for the CC forcing modules"

Input Data	Output Data
• Providing wind data (current, historical or projected considering the climate change). • Providing air temperature data (current, historical or projected considering the climate change). • **Providing rain data (current, historical or projected considering the climate change).**	• Drag coefficient on building facade. • Pressure coefficient on building walls. • Overall pressure field at the building surface.
Sources	**Consumer**
• "Climate data for hydrological analyses, wind and rain forcing and material degradation" (T3.1)	• "Module of structural analysis of the structures" (T4.2) / consumed through the DMS • "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" (T4.3) / consumed through the DMS

3.2 WP4 high-level architecture

WP4 is responsible for (a) identifying structural eco-friendly adaptation options (T4.1); (b) assessing the structural vulnerability of structures (T4.2) and glass windows (T4.3) exposed to extreme events; and (c) assessing icing conditions in relation to corona losses and mitigation measures (T4.4). Through the use of the aforementioned information, LCA/LCC models will be created and will be included in the BIM model (T4.5). Finally, a database that will store information about the used materials/products/transactions and will be linked to the BIM, will be developed (T4.6).

This WP consists of the following modules:

- Library of Low Carbon Structural Adaptation Options (T4.1)
- Module for materials degradation (T4.2)
- Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain (T4.3)
- Module for estimating the meteorological hazard (i.e., wind speed and direction and ice thickness) for the power transmission line (T4.4)
- Module for estimating the risk of power transmission tower and/ or power line (T4.2)
- Module of structural analysis of the structures (T4.2)
- Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs) (T4.2)
- Probabilistic LCA/LCC model development (T4.5)
- Data Base to store information about the used materials/components and transactions (T4.6)

The interconnection of the WP4 modules is depicted in an architectural diagram shown in

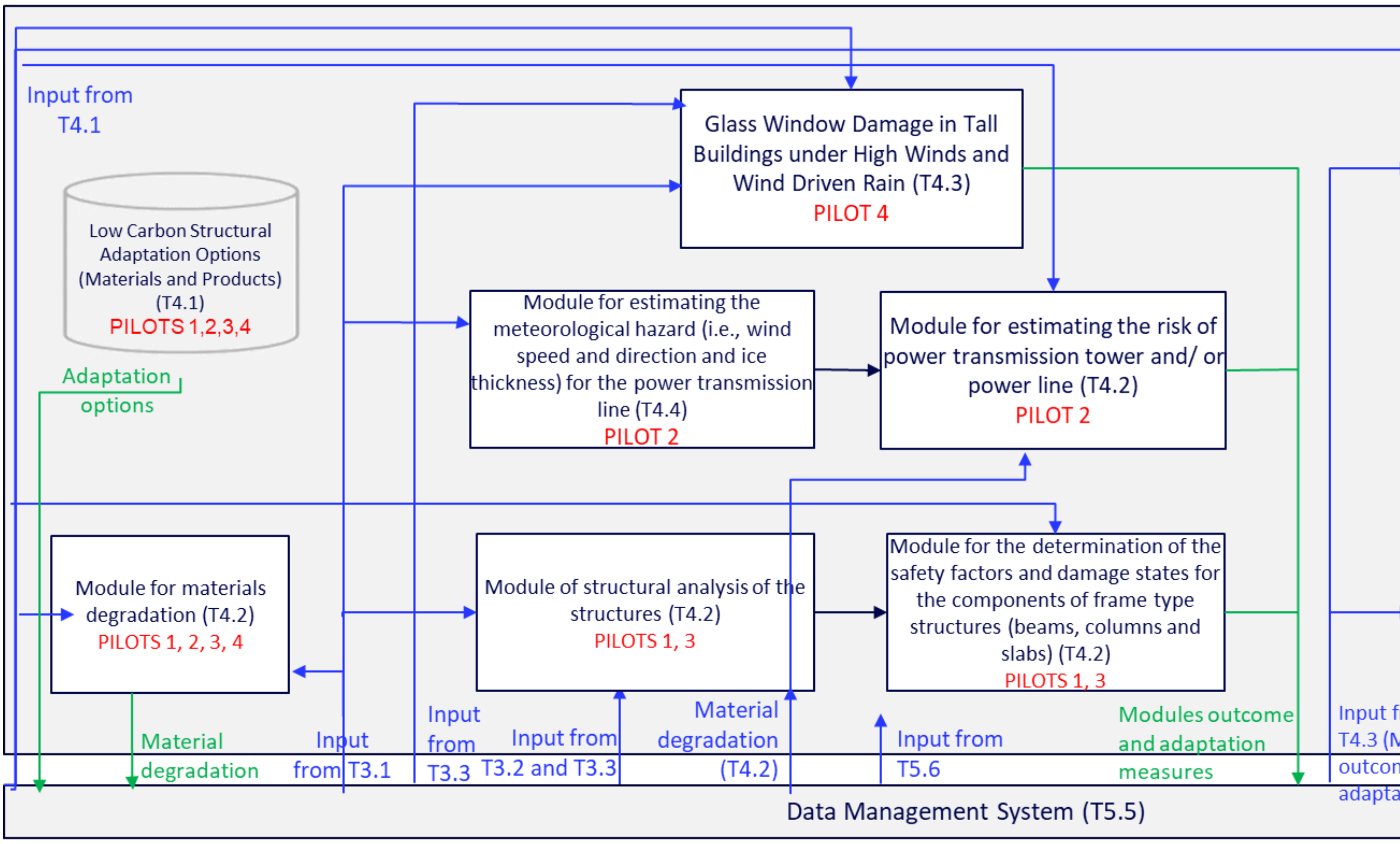

Figure 5. Each module is detailed in Subsections 3.2.1 - 3.2.9.

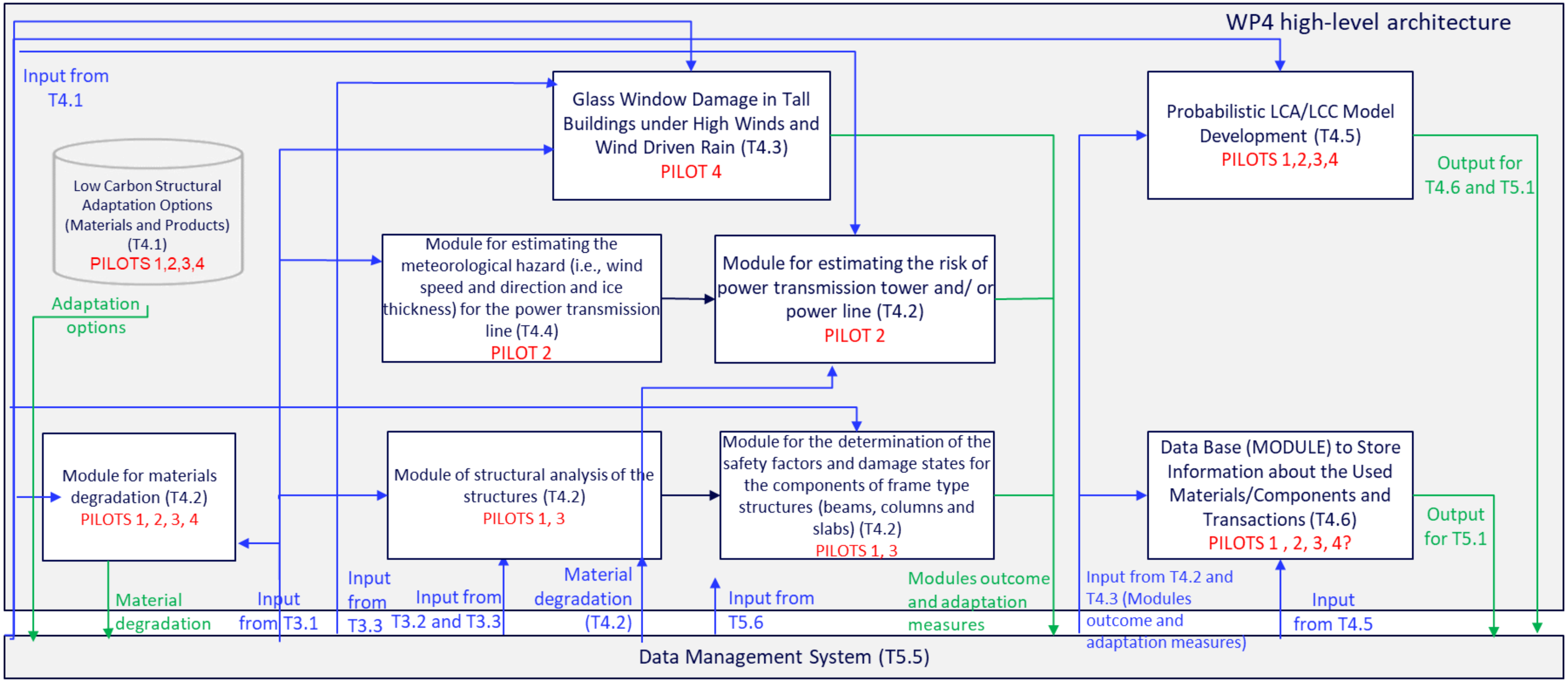

Figure 5.The high-level architecture of WP4

3.2.1 Library of Low Carbon Structural Adaptation Options (T4.1)

The "Library of Low Carbon Structural Adaptation Options" module will provide adaptation solutions (at least 10) based on low-carbon precast concrete elements for buildings and infrastructures. In Table 1, a summary of the sources/input data, as well as the consumers/output data of the module is provided.

Table 5. The sources/input and consumers/output data of the "Library of Low Carbon Structural Adaptation Options" module

Input Data	Output Data
• Material properties (buildings and infrastructures). • Element design (buildings and infrastructures).	• Data for the environmental impact and costs of the adaptation solutions.
Sources	**Consumer**
• Low carbon binders, as an alternative to Portland cement; Better structure design with precast concrete solutions; Recycled aggregates derived from Construction & Demolition Waste; Industrial by-products as part of the concrete composition; Reuse of concrete components; Material mix. High Strength Steel as an alternative to conventional steel; use of Fibre Reinforced Polymer (FRP) plates for strengthening vulnerable members. • Product Engineering Demand Paraments (EPDs) for environmental impacts. • Available market costs.	• "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" (T4.3) / consumed through the DMS. • "Module for estimating the risk of power transmission tower and/ or power line" (T4.2) / consumed through the DMS. • "Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs)" (T4.2) / consumed through the DMS. • "Probabilistic LCA/LCC model development" (T4.5) / consumed through the DMS. • "Module for materials degradation" (T4.2).

3.2.2 Module for materials degradation (T4.2)

The module "Material degradation" will provide estimations of material degradation (e.g., due to corrosion) of concrete and steel by applying appropriate models available in the literature, that also take into account climate change scenarios, where applicable.

In Table 6 a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 6. The sources/input and consumers/output data of the "Module for material degradation"

Input Data	Output Data
• Climate and environmental data. • Materials characteristics.	• Material degradation estimates (e.g., loss of thickness of a steel section).
Sources	**Consumer**

• "Climate data for hydrological analyses, wind and rain forcing and material degradation" (T3.1). • "Library of Low Carbon Structural Adaptation Options" (T4.1).	• "Module of structural analysis of the structures" (T4.2) / consumed through the DMS. • "Module for estimating the risk of power transmission tower and/ or power line" (T4.2) / consumed through the DMS. • "DMS" (T5.5).

3.2.3 Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain (T4.3)

The algorithms developed in T3.3 will be used to assess glass window damage in three cases of high-rise buildings in Hong Kong and to derive vulnerabilities and adaptation measures that will become part of T4.5 and the library in T4.1.

In Table 7, a summary of the sources/input data, as well as the consumers/output data of the aforementioned module are displayed.

Table 7. The sources/input and consumers/output data of the "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" module

Input Data	Output Data
• It receives as a climatological data (T3.1) input the algorithms developed in T3.3, as well as the adaptation options from T4.1.	• Assess glass windows damage and derive vulnerabilities and adaptation measures.
Sources	**Consumer**
• "Climate data for hydrological analyses, wind and rain forcing and material degradation" (T3.1) / consumed through the DMS. • "Requirements and specifications for the CC forcing modules" (T3.3) / input through the DMS. • "Library of Low Carbon Structural Adaptation Options" (T4.1).	• "Probabilistic LCA/LCC model development" (T4.5) / consumed through the DMS. • "Data Base to store information about the used materials/components and transactions" (T4.6) / consumed through the DMS • "DMS" (T5.5).

3.2.4 Module for estimating the meteorological hazard (i.e., wind speed and direction and ice thickness) for the power transmission line (T4.4)

This module will estimate the meteorological hazards (i.e., probability of occurrence of various wind and ice thickness combinations) that may affect the power transmission line. It will also provide assessments of how changes in the meteorological conditions in future climate may affect the risk of damage of the power transmission line.

In Table 8, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 8. The sources/input and consumers/output data of the "Module for estimating the meteorological hazard (i.e., wind speed and direction and ice thickness) for the power transmission line"

Input Data	Output Data
• Climate data.	• It provides information on the current meteorological hazard for the power transmission line and possible changes in that due to climate change. The input will be used by modules that use information on meteorological hazards for power transmission line.
Sources	**Consumer**
• “Climate data for hydrological analyses, wind and rain forcing and material degradation” (T3.1) / consumed through the DMS.	• “Module for estimating the risk of power transmission tower and/ or power line” (T4.2).

3.2.5 Module for estimating the risk of power transmission tower and/ or power line (T4.2)

This module will estimate the risk of the power transmission tower(s) and/or the whole power line for various high wind and/or icing extreme events. In doing this, the fragility of the tower (i.e., probability of failure for specific wind and ice thickness combinations) and the meteorological hazard (i.e., probability of occurrence of a specific wind and ice thickness combination) will be combined.

Components:

a) Component for estimating the wind force acting on the transmission tower and the conductors/earth wires that support it.

b) Component for estimating the fragility of a transmission tower for various combinations of wind and ice thickness.

In Table 9, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 9. The sources/input and consumers/output data of the “Module for estimating the risk of power transmission tower and/ or power line”

Input Data	Output Data
• Module for the estimation of the meteorological hazard (i.e., probability of occurrence of wind speed and ice thickness, meteorological variables). • Power line configuration (e.g., location, span lengths, etc.) and tower drawings with the corresponding specifications (e.g., tower geometry, steel class, conductor/earth wire types) provided by FINGRID. • Adaptation options.	• Risk of the tower and or power line (i.e, probability of failure).
Sources	**Consumer**

• "Module for estimating the meteorological hazard (i.e., wind speed and direction and ice thickness) for the power transmission line" (T4.4). • "Library of Low Carbon Structural Adaptation Options" (T4.1). • "Module for materials degradation" (T4.2) / consumed through the DMS.	• "Probabilistic LCA/LCC model development" (T4.5) / consumed through the DMS. • "Data Base to store information about the used materials/components and transactions" (T4.6) / consumed through the DMS. • "DMS" (T5.5).

3.2.6 Module of structural analysis of the structures (T4.2)

The aim of "Structural analysis of the structures" module is to determine the internal forces (axial forces, shear forces and bending moments) due to the external loading (permanent vertical and transversal loads). The output of this module will offer the necessary input for assessing the vulnerability of the structures in the RISKADAPT Platform.

The scope of this module is to: (a) model the structures; (b) apply the loading system according to either the Eurocodes or the National rules and regulations; and (c) perform the analysis to estimate the internal forces.

The added value of this module is to determine the safety factors and consequently the damage states to be used in the rehabilitation module.

In Table 10, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 10. The sources/input and consumers/output data of the "Module of structural analysis of the structures"

Input Data	Output Data
• The geometrical model which can be imported from a CAD software. • The dimensions and the mechanical characteristics of the materials for the entire geometrical domain. • The boundary specific conditions and the physical definitions of the contour laws. • The verification of the results either by using equilibrium conditions or theorems of energy conservation. • The data of the heavy wind loads as the loading system.	• The expected outcome are the internal forces (shear, axial and bending moments) to be compared with the maximum allowable according to the structural engineering principles.
Sources	**Consumer**
• "Climate data for hydrological analyses, wind and rain forcing and material degradation" (T3.1) / consumed through the DMS.	• "Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs)" (T4.2).

• "Hydraulic module for water flow loads on bridge structures" (T3.2) / consumed through the DMS. • "Requirements and specifications for the CC forcing modules" (T3.3) / consumed through the DMS. • "Module for materials degradation" (T4.2) / consumed through the DMS.	

3.2.7 Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs) (T4.2)

This module is composed from a certain number of numerical equations. The output of this module will define the structural vulnerability of the structures. The scope of this module is to: (a) model geometrically and dimensionally the main structural components; (b) apply the output of the FEM analysis; and finally (c) find out the safety factors to be interrelated to the damage states.

The value added by this module is to determine the safety factors and consequently the damage states to be used in the rehabilitation module.

In Table 11, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 11. The sources/input and consumers/output data of the "Module for the determination of the safety factors and damage states for the components of frame type structures"

Input Data	Output Data
• The dimensions and the mechanical characteristics of the materials. • The laws (e.g. diagram, equation etc.) governing the stresses versus deformation.	• The safety factors, damage state and the adaptation measures.
Sources	**Consumer**
• "Library of Low Carbon Structural Adaptation Options" (T4.1). • "Module of structural analysis of the structures" (T4.2).	• "Probabilistic LCA/LCC model development" (T4.5) / consumed through the DMS. • "Data Base to store information about the used materials/components and transactions" (T4.6) / consumed through the DMS. • "DMS" (T5.5).

3.2.8 Probabilistic LCA/LCC Model Development (T4.5)

In this module, a framework for lifecycle analyses of the adaptation options is established and relevant environmental/economic information is collected. Based on this, probabilistic lifecycle modelling is set up. The framework is enriched through the inclusion of further internal and external sources of LCA/LCC uncertainties. The analyses are provided according to current standards (ISO 14040; ISO 14044; EN15804; EN15978). Performed analysis of uncertainties covers a variety of factors such as lack of data, future scenarios, frequency of repairs and maintenance measures, decarbonisation trends, climate targets.

Moreover, LCC includes micro- and macroeconomics functions, to be specified in each context. For each selected uncertainty, its consequences in terms of CC and environmental impacts are considered and included in the probabilistic LCA framework: the methodology exploits sampling methods such as the Monte Carlo simulation, which provide min./max./mean impacts. Lastly, the probability of occurrence for the environmental impacts is derived.

In Table 12, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 12. The sources/input and consumers/output data of the "Probabilistic LCA/LCC Model Development" module

Input Data	Output Data
• Adaptation options from T4.1. • Assessments of structural damage and other relevant information from T4.2 and T4.3. • Decarbonisation trends, climate targets, discount rate, price increase rate provided by internal research.	• It will provide probabilistic time dependent LCA/LCC models to be included in the BIM model integrating structural, economic and environmental assessments under different CC-induced extreme weather events.
Sources	**Consumer**
• Library of Low Carbon Structural Adaptation Options (T4.1). • "Module for estimating the risk of power transmission tower and/ or power line" (T4.2) / consumed through the DMS. • "Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs) (T4.2)" / consumed through the DMS. • "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" (T4.3) / consumed through the DMS.	• "Data Base to store information about the used materials/components and transactions" (T4.6) / consumed through the DMS. • "TPRISKADAPT" (T5.1) / consumed through the DMS. • "DMS" (T5.5).

3.2.9 Data Base to Store Information about the Used Materials/Components and Transactions (T4.6)

A database linked to the BIM and IoT is created that includes a sort of materials'/components' 'passport' with information on their properties/interventions/transactions to provide a comprehensive picture of life-cycle costs and End-of-Life (EoL) value and facilitate reuse. In Table 13, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 13. The sources/input and consumers/output data of the "Data Base to Store Information about the Used Materials/Components and Transactions"

Input Data	Output Data
• Assessments of structural damage and other relevant information from T4.2 and T4.3. • The LCA/LCC models that will be included in the BIM model from T4.5.	• All the collected data in IFC format are transmitted to the PRISKADAPT.
Sources	**Consumer**
• "Module for estimating the risk of power transmission tower and/ or power line" (T4.2) / consumed through the DMS. • "Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs) (T4.2)" / consumed through the DMS. • "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" (T4.3) / consumed through the DMS. • "Probabilistic LCA/LCC model development" (T4.5) / consumed through the DMS.	• "TPRISKADAPT" (T5.1) / consumed through the DMS.

3.3 WP5 high-level architecture

WP5 concerns the modelling of the social consequences and adaptation measures, as well as the development of TPRISKADAPT, an MIS and PRISKADAPT that will integrate all the aforementioned information. Finally, enhanced visualization will be generated by assimilating information from available PRISKADAPT sources (e.g., as-built drawings), fused and raw data from all measurements (e.g., climate data, inspection results, monitoring) and simulation results. Data gaps will be also identified and discussed.

This WP consists of the following modules:

- TPRISKADAPT (T5.1)
- Social risks and impacts (T5.2)
- Total risk assessment and management (T5.3)
- PRISKADAPT (T5.4)
- Model Information System (T5.7)
- DMS (T5.5)
- User Friendly Frontend Interface with Enhanced Visualisation (T5.6)

The WP5 modules are interconnected following the architectural diagram displayed in Figure 6. The modules are detailed in Subsections 3.3.1 - 3.3.7.

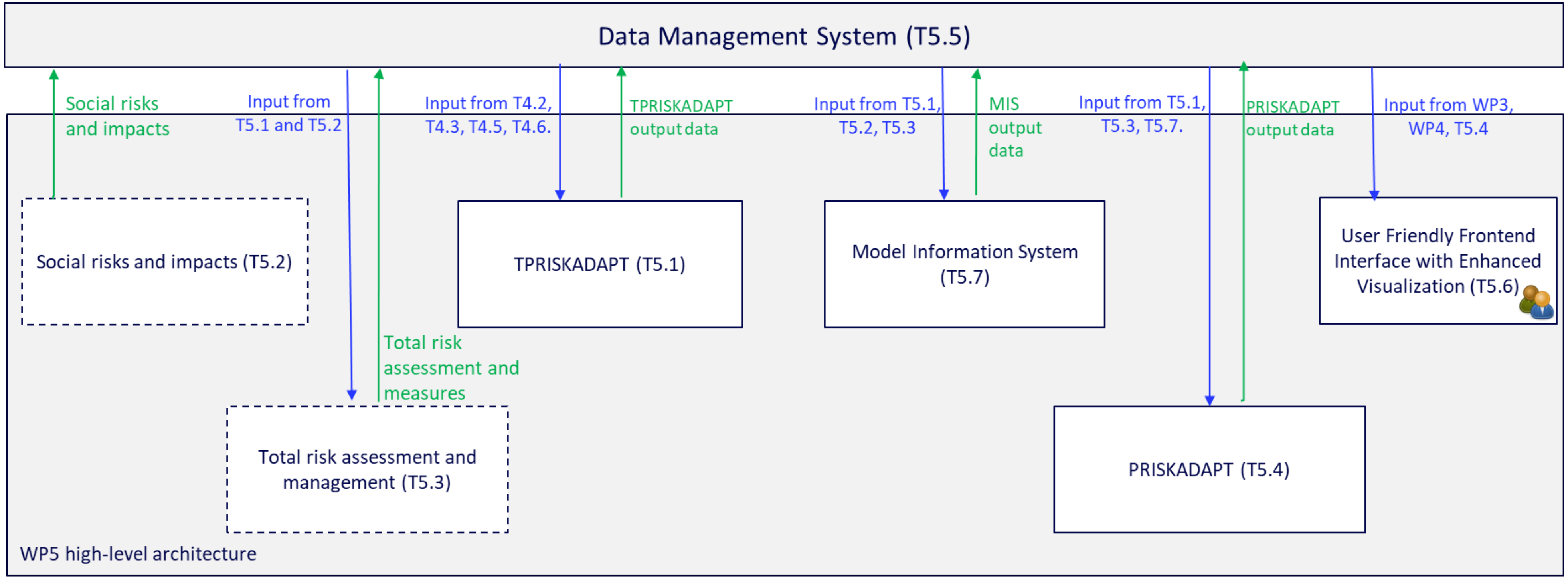

Figure 6. The high-level architecture of WP5

3.3.1 TPRISKADAPT (T5.1)

TPRISKADAPT is a module related to the technical/engineering consequences and adaptation solutions. It will include authoring tools to design the logic of the module interdependences in terms of functional flow block-diagrams and will have all the necessary controls so as the users can use it in its entirety or with their own CC forcing/structural/LCA/LCC models. It will also have CC forcing/civil engineering/BIM/LCA/LCC models to create new end-to-end analyses or to enhance existing ones. Moreover, it will include modelling of various single/multi-hazards' scenarios on structures, and will implement sustainable engineering adaptation strategies to minimise their consequences on the environment and society based on technological risk analyses.

TPRISKADAPT will be expandable (to accommodate future modules, such as for instance modules on other extreme events, e.g., earthquakes or landslides), interoperable (across technologies/borders), and designed to be accessed by non-expert/expert users with user-friendly features.

In Table 14, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 14. The sources/input and consumers/output data of the "TPRISKADAPT"

Input Data	Output Data
• Materials information. • LCA/LCC models results. • Capacity loss, engineering impacts and adaptation solutions. • Scenario per structure.	• The safety factors, damage state and the adaptation measures per structure. • LCA/LCC models results.
Sources	**Consumer**
• "Glass Window Damage in Tall Buildings under High Winds and Wind Driven Rain" (T4.3) / consumed through the DMS. • "Module for estimating the risk of power transmission tower and/ or power line" (T4.2). / consumed through the DMS. • "Module for the determination of the safety factors and damage states for the components of frame type structures (beams, columns and slabs)" (T4.2) / consumed through the DMS. • "Probabilistic LCA/LCC model development" (T4.5) / consumed through the DMS / consumed through the DMS. • "Data Base to store information about the used materials/components and transactions" (T4.6) / consumed through the DMS / consumed through the DMS. • "DMS" (T5.5).	• "Total risk assessment and management" (T5.3) / consumed through the DMS. • "PRISKADAPT" (T5.4) / consumed through the DMS. • "Model Information System" (T5.7) / consumed through the DMS. • "DMS" (T5.5).

3.3.2 Social risks and impacts (T5.2)

A spatial microsimulation model will be developed in order to estimate the geographical distributions of the relevant socio-economic indicators in the affected regions (including estimates of the distribution and variation of income of industries due to likely CC induced damage to the assets of interest). It will be based on a socioeconomic model that maps and connects all different domains that are affected, identify local vulnerability, exposure, resources, services and capacities, as well as considers other relevant issues (e.g. existence of emergency response plans, climate change adaptation plans etc.). The model will provide a basis that can be applied (following parameterisation) to other European regions.

In Table 15 a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 15. The sources/input and consumers/output data of the "Social risks and impacts" module

Input Data	**Output Data**
• Social impacts. • Economic impacts. • Information about vulnerability and exposure of people and assets of interest. • Information about Emergency and Prevention Plans and CC Adaptation Plans.	• Social risks and impacts, including vulnerability exposure and CC adaptation and resilience.
Sources	**Consumer**
• Qualitative and quantitative investigation of Pilots. • Secondary data derived from literature review, documents review and media analysis. • Primary data derived from in-depth interviews and surveys.	• "Total risk assessment and management" (T5.3) / consumed through the DMS. • "Model Information System" (T5.7) / consumed through the DMS. • "DMS" (T5.5).

3.3.3 Total risk assessment and management (T5.3)

By using the relevant input, the "Total risk assessment and management" module will assess the environmental impact, other than the embodied impact in construction materials, and provide estimates of intangible impacts. It will assess total (technical and social) risk and evaluate combinations of social and technological measures. The work will be modular, interoperable and expandable to include additional social impacts in the future.

In Table 16, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 16. The sources/input and consumers/output data of the "Total risk assessment and management" module

Input Data	**Output Data**

• Capacity losses, engineering impacts and solutions (T5.1). • Socioeconomic impacts and solutions (T5.2). • Information about vulnerability and exposure of people and assets of interest.	• Provide total (social and technological measures) and risk assessment information.
Sources	**Consumer**
• "TPRISKADAPT" (T5.1) / consumed through the DMS. • "Social risks and impacts" (T5.2) / consumed through the DMS. • "DMS" (T5.5).	• "Model Information System" (T5.7) / consumed through the DMS. • "PRISKADAPT" (T5.4) / consumed through the DMS. • "DMS" (T5.5).

3.3.4 PRISKADAPT (T5.4)

The PRISKADAPT module: (a) evaluates technical adaptation options in terms of engineering indicators including safety, GHG emissions, construction cost/duration and status of the asset during construction and (b) provides indispensable input to social 'impact chains' in terms of residual capacity and downtime.

For scenarios/structures/adaptation measures not covered in TPRISKADAPT, the user will be able to use external structural models and input the pertinent results to benefit from the upstream service (CC loading) and the downstream services (risk analyses) of the RISKADAPT; or use customized CC forcing, and customized structural models and use only the downstream services.

This module integrates and chains capacity losses and engineering adaptation solutions (T5.1) with modelling of social impacts and solutions (T5.2) and total risk assessment (T5.3), including required simulations for the pilots and combinations of social and engineering adaptation solutions that will be evaluated in terms of a set of primary parameters and indicators that will be decided and estimated in T5.7. The decision stakeholders will be able to input values to determine the local value of the above indicators and also to attribute weights to the impacts of interest. Then, the PRISKADAPT will determine the level of risk.

Furthermore, it provides the simulation environment, through the enhanced visualization environment (T5.6), that will be used to run end-to-end adaptation support services for the test cases in the pilots, while it will be usable throughout EU for similar assets under CC threats with local parameters and data. PRISKADAPT provides direct access to predefined 'what-if' scenarios, providing risk- based planning capabilities, risk management and adaptation strategies propositions.

In Table 17, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 17. The sources/input and consumers/output data of the "PRISKADAPT"

Input Data	Output Data
• PRISKADAPT will integrate and chain capacity losses and engineering adaptation solutions (T5.1) with modelling of social impacts and solutions (T5.2) and total risk assessment (T5.3), including required	• PRISKADAPT will determine the level of risk; provide the simulation environment to run end-to-end adaptation support services for the test cases in the Pilots.

simulations for the pilots and combinations of social and engineering adaptation solutions that will be evaluated in terms of a set of primary parameters and indicators that will be decided and estimated in T5.7. The decision stakeholders will be able to input values determining the local value of the above indicators. Furthermore, they will be able to attribute weights to the impacts of interest.	
Sources	**Consumer**
• "TPRISKADAPT" (T5.1) / consumed through the DMS. • "Total risk assessment and management" (T5.3) / consumed through the DMS. • "Model Information System" (T5.7) / consumed through the DMS. • "DMS" (T5.5).	• "User Friendly Frontend Interface with Enhanced Visualisation" (T5.6). • "DMS" (T5.5).

3.3.5 Model Information System (T5.7)

The RISKADAPT MIS will comprise indicators that will provide all the needed information to enable comparison between different adaptation solutions. The engineers in the consortium will finalise the choice of engineering indicators, while social scientists from RUG will lead in the development of social indicators as described under Objective 6.

In Table 18, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 18. The sources/input and consumers/output data of the "Model Information System"

Input Data	**Output Data**
• Capacity loss and solutions (T5.1). • Socioeconomic impacts (T5.2). • Social and technological risk assessment data -(related information from T5.3).	• Indicators that will provide all the needed information to enable comparison between different adaptation solutions.
Sources	**Consumer**
• "Total risk assessment and management" (T5.3) / consumed through the DMS. • "TPRISKADAPT" (T5.1) / consumed through the DMS. • Social risks and impacts (T5.2) / consumed through the DMS.	• "PRISKADAPT" (T5.4) / consumed through the DMS. • "DMS" (T5.5).

• "DMS" (T5.5)	

3.3.6 DMS (T5.5)

The DMS collects, stores and manages heterogeneous data that was obtained from variable sources in the project and makes them available to all the applications and services in the platform. Data sources include available information systems (climate, GIS, models and analysis results), utility resources (IoT sensors, satellite, devices and services) and also other external information. The DMS is based on open data standards offering the needed flexibility of adaptation. It implies that data follows open formats (e.g. JSON-LD) and non-relational databases are being used to store all the produced data.

In Table 19, a summary of the sources/input data, as well as the consumers/output data of the module are displayed.

Table 19. The sources/input and consumers/output data of the "DMS"

Input Data	Output Data
• Data sources include available information systems (climate, GIS, models and analysis results), utility resources (IoT sensors, satellite, devices and services) and also other external information.	• All requested data
Sources	**Consumer**
• WP3 modules. • WP4 modules. • WP5 modules.	• WP3 modules. • WP4 modules. • WP5 modules.

3.3.7 User Friendly Frontend Interface with Enhanced Visualisation (T5.6)

Enhanced visualization will show physical damage caused by disaster events of interest to the asset of interest and how this change based on the timing of the event because of material deterioration as well as during the implementation of the various adaptation options. All this information is depicted in a 3D visualization environment, showing, e.g.:

- the damage produced by an extreme event
- the damage severity in, using for instance, green/yellow/red colour coding,
- performance with and without specific adaptation measures
- expected impacts (e.g., economic, environmental pollution, unemployment caused by asset unavailability)
- how impacts can change during implementation of the various adaptation options
- the affected geographic areas.

The frontend will also support customised views for the users:

- additional information in an appropriate format related to the user expertise/type. For instance, for structural engineers' information on structural analyses in technical terms (e.g. safety factors),
- the same information in simple terms, for users that do not have an engineering background,

- language used is fine-tuned to the user's conversational characteristics and familiarity with ICT tools as a function of age, and
- explanation of the used terms.

Table 20 provides a summary of the sources/input data, as well as the consumers/output data of the module.

Table 20. The sources/input and consumers/output data of the "User Friendly Frontend Interface with Enhanced Visualisation"

Input Data	**Output Data**
• Available PRISKADAPT sources (e.g. as-built drawings). • Fused and raw data from all measurements (e.g. climate data, inspection results, monitoring, etc.). • Simulation results.	• Requested by end-users information will be displayed to the interface.
Sources	**Consumer**
• "PRISKADAPT" (T5.4) / consumed through the DMS. • WP3 input. • WP4 input.	• End-users will visualise the relevant information.

3.4 RISKADAPT high-level architecture

The analysed high-level architectures of WP3, WP4, WP5 and WP6 (as presented respectively in Figure 4,

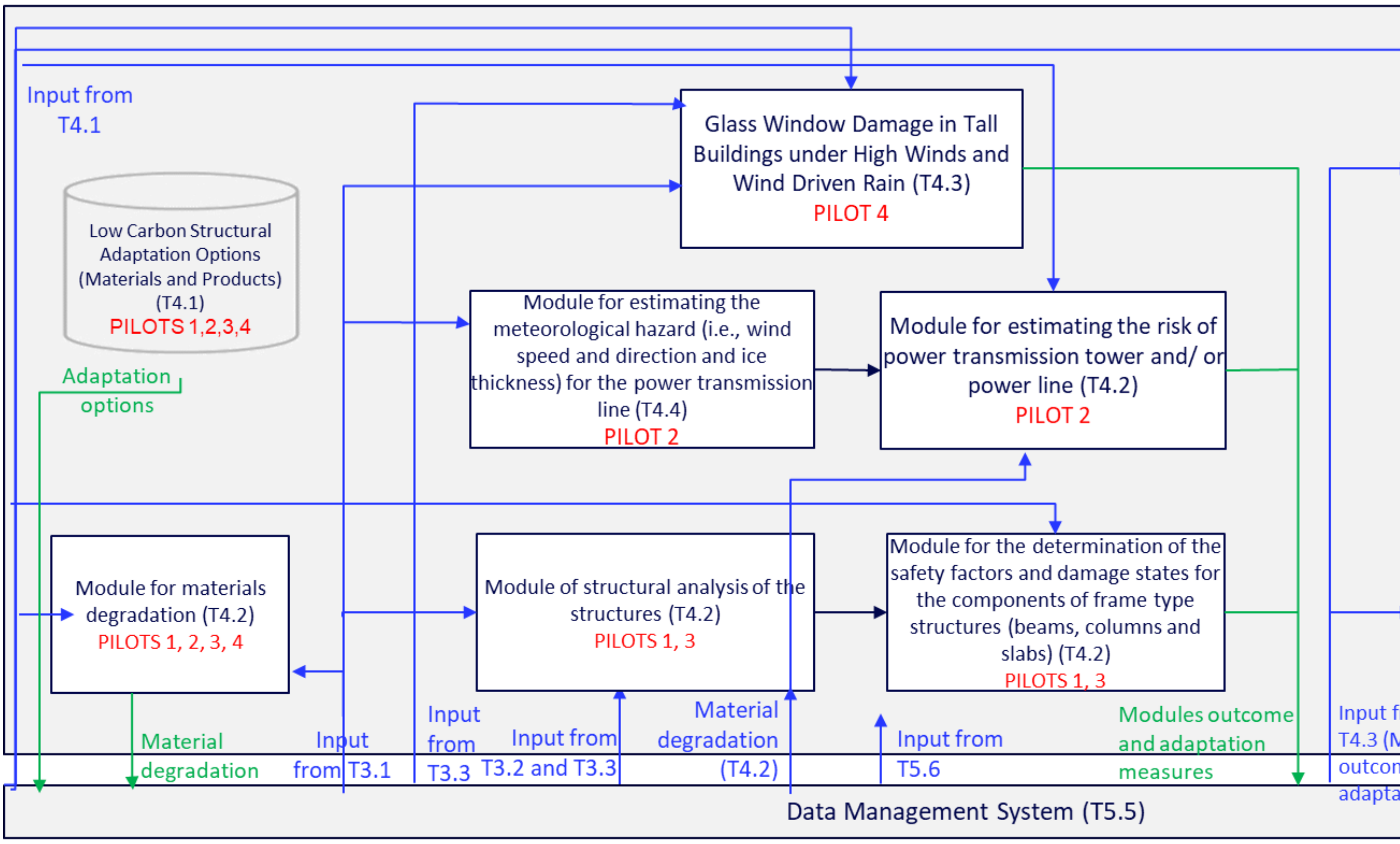

Figure **5**, Figure 6) can be consolidated in a single architecture that is displayed in Figure 7. It should be mentioned that the architecture might get updated /extended, as the project evolves.

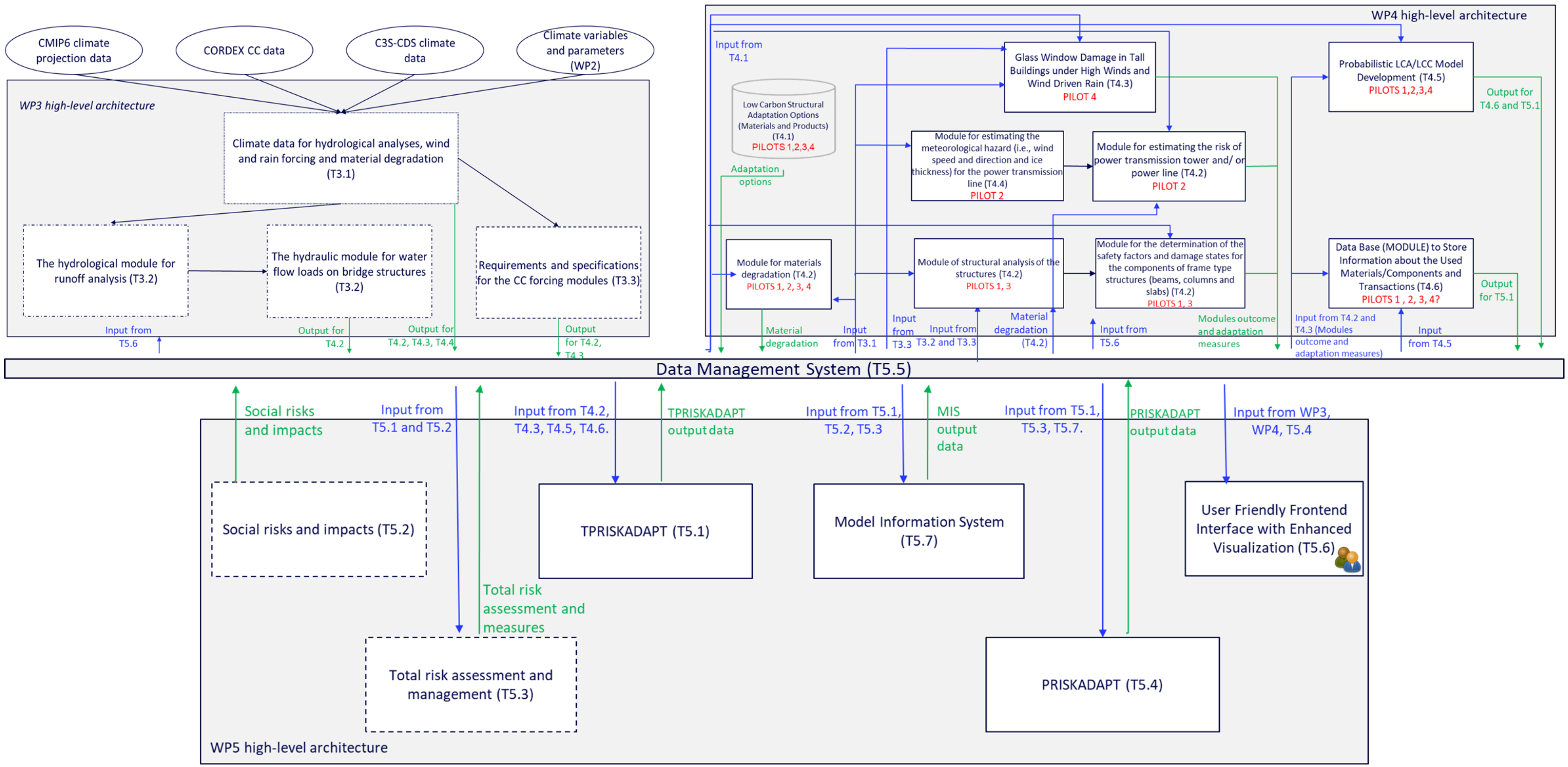

Figure 7. RISKADAPT high-level architecture

4. RISKADAPT system technical specifications

Based on the end-users' requirements (as they have been defined on D2.1), technical partners/providers as well as end-users identified technical specifications and matched them with the users' requirements (see Table 21). The technical specifications might get updated, as the project evolves and gets more mature.

Table 21. Description of the RISKADAPT technical specifications, their relative WP, end-user requirements and responsible partner(s)

UID	System Requirement Description	Relative end-user requirement(s)	Relative WP(s)	Relative Pilot(s)
1	CC-Force: Climate data shall be provided on the standard form (UNIBO)	FR-1, FR-2, FR-3	WP3	Pilot 1, Pilot 3
2	Data-1: Data shall be provided in a commonly accepted format. (Data Providers)	FR-1, FR-2, FR-3, FR-4, FR-5, FR-6, FR-7, FR-8, FR-9, FR-10, FR-11, FR-12, FR-13, FR-15	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
3	DMS-1: DMS SHOULD be based on open data standards. (RISA)	FR-1, FR-2, FR-3, FR-4, FR-5, FR-6, FR-7, FR-8, FR-9, FR-10, FR-11, FR-12, FR-13, FR-15	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
4	DMS-2: All users shall be authorised and authenticated in order to use the platform. (RISA)	FR-19. FR-21	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
5	DMS-3: Administrators shall be able to manage user accounts. (RISA)	FR-20	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
6	DMS-4: DMS should integrate in a flexible and efficient way multiple services. (RISA)	FR-14, FR-15, NFR-4, NFR-6, NFR-7	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
7	DMS-5: DMS should be able to collect and store several types of data and metadata. (RISA)	FR-1, FR-2, FR-3, FR-4, FR-5, FR-6, FR-7, FR-8, FR-9, FR-10, FR-11, FR-12, FR-13, NFR-3	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
8	DMS-6: DMS should store data and metadata and allow historical lookup and display through the UI. (RISA)	FR-1, FR-2, FR-3, FR-4, FR-5, FR-6, FR-7, FR-8, FR-9, FR-10, FR-11, FR-12, FR-13, NFR-3	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
9	DMS-7: DMS should provide the data/output to all connected modules to a commonly accepted format. (RISA)	FR-14, FR-15, NFR-4	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4

UID	System Requirement Description	Relative end-user requirement(s)	Relative WP(s)	Relative Pilot(s)
10	DMS-8: DMS should be able to accept, store and retrieve input from all connected modules if this is deemed necessary. (RISA)	FR-14, FR-15, NFR-4	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
11	DMS-10: DMS shall restore the "lost" data upon communication recovery. (RISA)	NFR-1, NFR-2	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
12	DMS-11: DMS should ensure secure communication, data transactions and data storage. (RISA)	NFR-1, NFR-2	WP3, WP4, WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
13	DMS-12: The APIs of the DMS allow the extraction and pushing of information from all sources. (RISA)	NFR-4, IR-6	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
14	DMS-13: DMS should provide the capacity losses and socioeconomic impacts (RISA)	FR-17, FR-18	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
15	DMS-14: DMS should store data and metadata resulted from the Total Risk Assessment. (RINA)	FR-17	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
16	DMS-15: DMS should provide the Total Risk Assessment outputs to the MIS. (RISA)	FR-18	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
17	DMS-16: DMS should store data and metadata resulted from the MIS. (RINA)	FR-18	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
18	Hydraulic model-1: Data shall be provided in a commonly accepted format. (ULFGG)	FR-11, FR-14, FR-23, NFR-5	WP3	Pilot 1
19	Hydrological model-1: Data shall be provided in a commonly accepted format. (ULFGG)	NFR-5	WP3	Pilot 1
20	LCS-1: The LCS database will contain all information on precast low-carbon solutions that will be implemented. (BIBM)	FR-13	WP4	Pilot 1, Pilot 3
21	LCS-2: The LCS database will contain all information on FRP plates and high-strength steel solutions will be implemented. (TECNIC)	FR-13	WP4	Pilot 2
22	LCS-3: The LCS database will contain all information on glass	FR-13	WP4	Pilot 4

UID	System Requirement Description	Relative end-user requirement(s)	Relative WP(s)	Relative Pilot(s)
	window solutions that will be implemented. (HKU)			
23	LCS-4: The LCS database will provide information to all consuming modules. (BIBM)	FR-13, IR-3, IR-4, IR-6	WP4	Pilot 1, Pilot 2, Pilot 3, Pilot 4
24	PRISK-1: PRISKADAPT ensures that you have an ecosystem of modules working with one another. It connects modules, pushes or pulls data from them (via the DMS), and orchestrates and executes workflows (on demand or on schedule) among them. (RISA)	NFR-4, IR-6	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
25	UI-1: Climate data shall be presented on the UI. (ERRA)	FR-1, FR-2, FR-3, FR-4, FR-5, FR-6, FR-7, FR-8, FR-9, FR-10, FR-11, FR-12, FR-13, FR-15, FR-24, FR-25	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
26	UI-2: An intuitive UI shall be made available to the end-users (ERRA)	FR-24, FR-25, FR-26, IR-2, UR-1, UR-2, UR-3, UR-4, UR-5, UR-6, UR-7, UR-8, UR-9, UR-10, UR-11, UR-12, UR-13, UR-14, UR-15, UR-16	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
27	UI-3: Information will be depicted to users using specific icons, colours, graphs per type of information (ERRA)	FR-24, FR-25, FR-26, IR-3, IR-4, UR-1, UR-2, UR-3, UR-4, UR-5, UR-6, UR-7, UR-8, UR-9, UR-10, UR-11, UR-12, UR-13, UR-14, UR-15, UR-16	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
28	UI-4: All requested by end-users' data shall be presented on the UI (ERRA).	FR-24, FR-25, IR-1, IR-3, IR-4	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
29	UI-5: Forecast data (calculated by the other RISKADAPT modules) shall be presented on the UI (ERRA).	FR-24, FR-25, IR-1, IR-4	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
30	UI-6: Predictions regarding the structures, hazards, risks and other info shall be presented on the UI (ERRA).	FR-24, FR-25, IR-1, IR-3, IR-4	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4

UID	System Requirement Description	Relative end-user requirement(s)	Relative WP(s)	Relative Pilot(s)
31	UI-7: UI shall be able to present to the users an overview of the current situation (ERRA).	FR-24, FR-25, IR-1, IR-3	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
32	UI-8: Data shall be presented to the UI in high-resolution for critical, important and high impact (based on the end-users needs and input) assets, buildings and structures. (ERRA)	FR-27, IR-1, IR-3, IR-4	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
33	UI-9: The UI shall support customised views for the users and shall allow additional information in an appropriate format related to the user expertise/type. (ERRA)	IR-5	WP5	Pilot 1, Pilot 2, Pilot 3, Pilot 4
34	A BIM-IFC file will be created with the materials and adaptation solutions. (Tecnic)	NFR-8	WP4	Pilot 1, Pilot 2, Pilot 3, Pilot 4
35	UID1+UID2 (Pilot 3): Module for the assessment of the horizontal loading systems (Tecnic)	FR-1, FR-7, FR-15	WP4,	Pilot 1, Pilot 2, Pilot 3

5. Conclusions

Deliverable 2.2 - "Specifications, Architecture" is one of the two (2) foreseen Deliverables of WP2 and is related to Task 2.2, namely "Specifications, Subsystem/System Architecture". In this report, the modules of the RISKADAPT platform and the data exchanges are defined and the RISKADAPT system high-level architectural specification is described. Moreover, the technical specifications are defined and matched with the end-user requirements (as those have been defined in D2.1). The architecture definition and technical specifications will form the basis of the developments that will be conducted in the technical Work Packages (meaning WP3, WP4, and WP5). At this point it should be mentioned that they (architecture and technical specifications) might need to be updated, as the project evolves and becomes more mature.