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D5.2 Exploitation Requirements and Innovation Design v2

WP5 - Exploitation and Business

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CLARITY Project Overview

Urban areas and traffic infrastructures that are linking such areas are highly vulnerable to climate change. Smart use of existing climate intelligence can increase urban resilience and generate benefits for businesses and society at large. Based on the results of FP7 climate change, future internet and crisis preparedness projects (SUDPLAN, ENVIROFI, CRISMA) with an average TRL of 4-5 and following an agile and user-centred design process, end-users, purveyors and providers of climate intelligence will co-create an integrated Climate Services Information System (CSIS) to integrate resilience into urban infrastructure.

As a result, CLARITY will provide an operational eco-system of cloud-based climate services to calculate and present the expected effects of CC-induced and -amplified hazards at the level of risk, vulnerability and impact functions. CLARITY will offer what-if decision support functions to investigate the effects of adaptation measures and risk reduction options in the specific project context and allow the comparison of alternative strategies. Four Demonstration Cases will showcase CLARITY climate services in different climatic, regional, infrastructure and hazard contexts in Italy, Sweden, Austria and Spain; focusing on the planning and implementation of urban infrastructure development projects.

CLARITY will provide the practical means to include the effects of CC hazards and possible adaptation and risk management strategies into planning and implementation of such projects, focusing on increasing CC resilience. Decision makers involved in these projects will be empowered to perform climate proof and adaptive planning of adaptation and risk reduction options.

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Abbreviations and Glossary

A common glossary of terms for all CLARITY deliverables, as well as a list of abbreviations, can be found in the public document "CLARITY Glossary" available at http://cat.clarityCLARITY-h2020.eu/glossary/main.

Abbreviation/Acronym	Definition
AJAX	Asynchronous JavaScript and XML
BB	Building Block
CBS	Component-Based Software
CC	Climate Change
CCA	Climate Change Adaptation
CKAN	Comprehensive Kerbal Archive Network
CLARITY	Integrated Climate Adaptation Service Tools for Improving Resilience Measure
CRISMA	Modelling crisis management for improved action and preparedness
CS	Climate Service
CSIS	CLARITY Climate Services Information System
DC	Demonstration Case
DoA	Description of Action (Annex 1 to the Grant Agreement)
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
EU-GL	Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient (Document)
EU-MACS	European Market for Climate Services
HTML5	Hypertext Markup Language, version 5
ICT	Information and Communication Technologies
IPCC	Intergovernmental Panel on Climate Change
JSON	JavaScript Object Notation
MCDA	Multi-Criteria Decision Analysis
OGC	Open Geospatial Consortium
PHP	PHP Hypertext Preprocessor
RDBMS	Relational Database Management System
REST	Representational State Transfer
RIA	Rich Internet Application
TC	Test Case
TRL	Technology Readiness Level
US	User Story

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Executive Summary

This report is the second deliverable of Task 5.1 “Exploitation Requirements” of the CLARITY project, funded by the EU’s Horizon 2020 Programme under Grant Agreement number 730355. Task 5.1 intends to make sure that the project partners can recognize realistic exploitation and innovation aspects during the co-design and implementation of CLARITY Climate Service right from the start of the project, when no detailed and focused market study and business model are available yet.

The work foreseen in this task is performed in two stages. The first stage concentrates on the technical perspective and the impact of potential Exploitation Requirements identified on basis of a general and broad assessment of Climate Service market conditions, needs and gaps. Thereby, especially the early results of the EU-MACS (Project ID: 730500. Funded under: H2020-EU.3.5.1.), reported in EU-MACS deliverables D1.1 “Review and Analysis of CS Market Condition” [1], D1.2 “Existing Resourcing and Quality Assurance of Current Climate Services” [2] and D1.3 “Analysis of existing Data Infrastructures for Climate Services” [3] are taken into account. In a second stage, the results of CLARITY’s market analysis and business model (D5.3 “Exploitation and Business Plan v1” [4]) and the proposed technical solutions (D4.1 “Technology Support Plan” [5] and D4.2 “CLARITY CSIS Architecture” [6]) are used to re-evaluate and/or validate the findings of the initial Exploitation Requirements assessment and to concretize innovative aspects of CLARITY products and service.

This document presents the results of the second stage of Task 5.1, that is, the CLARITY Innovation Design (chapter 2) and the validation of the 10 Exploitation Requirements (chapter 3) against the technical offerings and product- and service specifications of WP4 “Technology Support” and WP1 “Co-creation”.

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1 Introduction

The introduction chapter briefly describes the purpose and scope of the task, explains the structure of the document and lists the changes compared to the previous version of the deliverable.

1.1 Purpose and scope

As Innovation Action Project, CLARITY has to deliver innovations that create high impact during and after the lifetime of the project. Innovation in the context of H2020 is understood as the "successful exploitation of new or improved technologies, products, designs, processes, services or solutions, which when used, produce tangible benefits, satisfying needs and wants" [7]. That is, the expected impact of the project is not only to be measured by its scientific contributions, but by the extent of the benefits derived from the innovation and thus relates to the wider societal, economic or environmental cumulative changes over a certain period of time.

The project's exploitation activities involve among others determining the demand for products and services that do not yet exist followed by an assessment of potential innovations and opportunities for their direct or indirect utilisation. While utilisation of project results may take part in research and development activities other than those covered by the project, CLARITY's key exploitation objective is the marketing of operational and sustainable products and services.

Two main categories of innovations provided by CLARITY can be identified:

1) New and improved Climate Services (CS) for integrating resilience to climate change into long-term and large-scale urban infrastructure planning and development activities and
2) a Climate Services Information System (CSIS) that is able to exploit the added value of Climate Services by providing a climate change adaptation platform based on a coherent methodology [1] integrating a marketplace and a community for Climate Services.

The expected impact of the project covers mainly the rapid deployment and market uptake of climate services by demonstrating their added value to the end-users for the decision-making process related but not limited to climate change adaptation.

T5.1 - Exploitation Requirements is a dedicated task established to make sure that the project partners use their best efforts to take measures aiming at ensuring the exploitation of their results. Raising awareness on exploitation possibilities and recognizing valuable and exploitable results is a crosscutting activity that has to be considered during the whole process of climate services co-creation. The task's activities are not isolated and limited to WP5 - Exploitation and Business and are therefore carried out at different levels of the project's overall work plan. Thus, they are helping to establish a sound technological basis for the collaborative exploitation of the project results by influencing topics and decisions regarding technology selection, software architecture, system distribution aspects, user interface design, and others.

Furthermore, in support of the exploitation strategy that will be defined in T5.2 "Exploitation Strategy and Business Plan", this task's activities stimulate concrete measures to ensure that the project results meet real needs and will be taken up by potential users. For this purpose, two instruments were introduced: Exploitation Requirements (chapter 3) and Innovation Design (chapter 2).

As both terms "Exploitation Requirements" and "Innovation Design" are not clearly defined in the fields of requirements analysis or innovation management, the CLARITY team developed an initial concept and approach towards Exploitation Requirements and Innovation Design in D5.1 "Exploitation Requirements and Innovation Design" [8]. The second version of this document extends the Exploitation Requirements approach by validation aspects of the technical implications derived from Exploitation Requirements and applies concept of "Disruptive Innovation" (elaborated by Clayton M. Christensen in [9] and [10]) as the main driver of CLARITY Innovation Design.

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1.2 Intended audience

The target readers of this document are all members of the CLARITY consortium that are involved in the development of CSIS and the related CLARITY Climate Services.

1.3 Structure of the document

The structure of the document and the relationships between the different chapters is as follows:

Chapter 1 (this chapter) introduces the document and explains the overall purpose of this document and its relation to other work packages and deliverables.

Chapter 2 presents the overall CLARITY Innovation Design.

Chapter 3 validates the Exploitation Requirements by reporting on the actual technical implications and the related activities in WP1 “Co-creation” and “WP4 Technology Support”.

Chapter 4 provides the conclusions and a summary on follow-up activities in other work packages.

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2 CLARITY Innovation Design

2.1 Innovation Concepts

"Innovation" has developed into a buzzword in nearly any context and is used in different variants. In this section background and reasoning for the CLARITY project will be provided.

"Innovation" as an economic concept dates back to the beginning of the 20th century. Renowned and influential economist Joseph Schumpeter stated that innovation is a driving force of economic change. He clearly distinguished between "invention" and "innovation": entrepreneurs take leadership roles in translating "inventions" into "innovation" and bring innovations into existence that have the power to create new markets. He minted the term "creative destruction" - established markets sink with the arising of new ecosystems. Schumpeter published his concept yet 1911 in "Theorie der Wirtschaftlichen Entwicklung" (The Theory of Economic Development) [11].

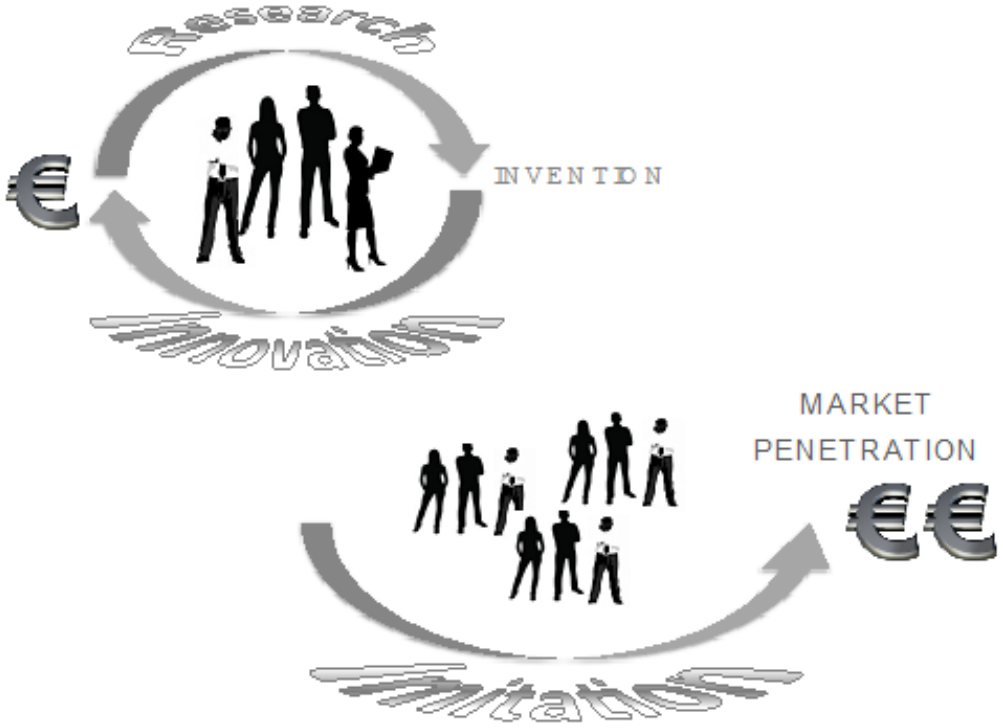

Figure 1: From Invention to Innovation

Money is spent on research and development and (can) lead to an invention. An entrepreneur takes up the invention and translates it into innovation; established markets and business models get obsolete (Figure 1). A temporary monopoly is created that allows abnormal profit rewarding the innovator for his risk taking in developing new products and services. The abnormal profits attract competition and imitators and rivals arise. They help to serve the emerging demand and the prices will decrease.

Schumpeter´s works influenced all successive generations of economists from the entire political spectrum. Contemporary economist Clayton M. Christensen coined the term of "disruptive innovation" [9]. His works is built on the fundament of Schumpeter´s theories and contributes essential further development. He describes the relation between technology and innovation for creating disruptive impact: as only few technologies are intrinsically disruptive the disruptive impact roots in the business model that the technology enables.

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In addition, he claims another two features of disruptive innovations:

- A disruptive innovation starts at the bottom of a market and gives a new population of customer's access to a product or service that was until then only accessible for customers with considerably more money or a superior skill level.
- There is a tendency that disruptive innovations are generated by outsiders of a market and entrepreneurs and not so often by existing market-leading companies.

According to Christensen the established market-leading companies use their (mostly substantial) resources for sustainable innovation - they constantly improve their products and services for their market segments in order to hold competitors at bay and to maintain their (relatively high) profits. As a result, the product- and service performance increases and leads to demanding conditions for use only in a prestigious "premium" segment. In this portion of the market incumbents mostly win.

Challengers enter the bottom of the market. They offer a "good-enough" product or service for an attractive price that is easy to obtain. They turn non-consumers into consumers and attract customers who are focussed on few features or can do with low performance and are not willing to pay for the "premium" without using it. In this portion of the market the entrants mostly win.

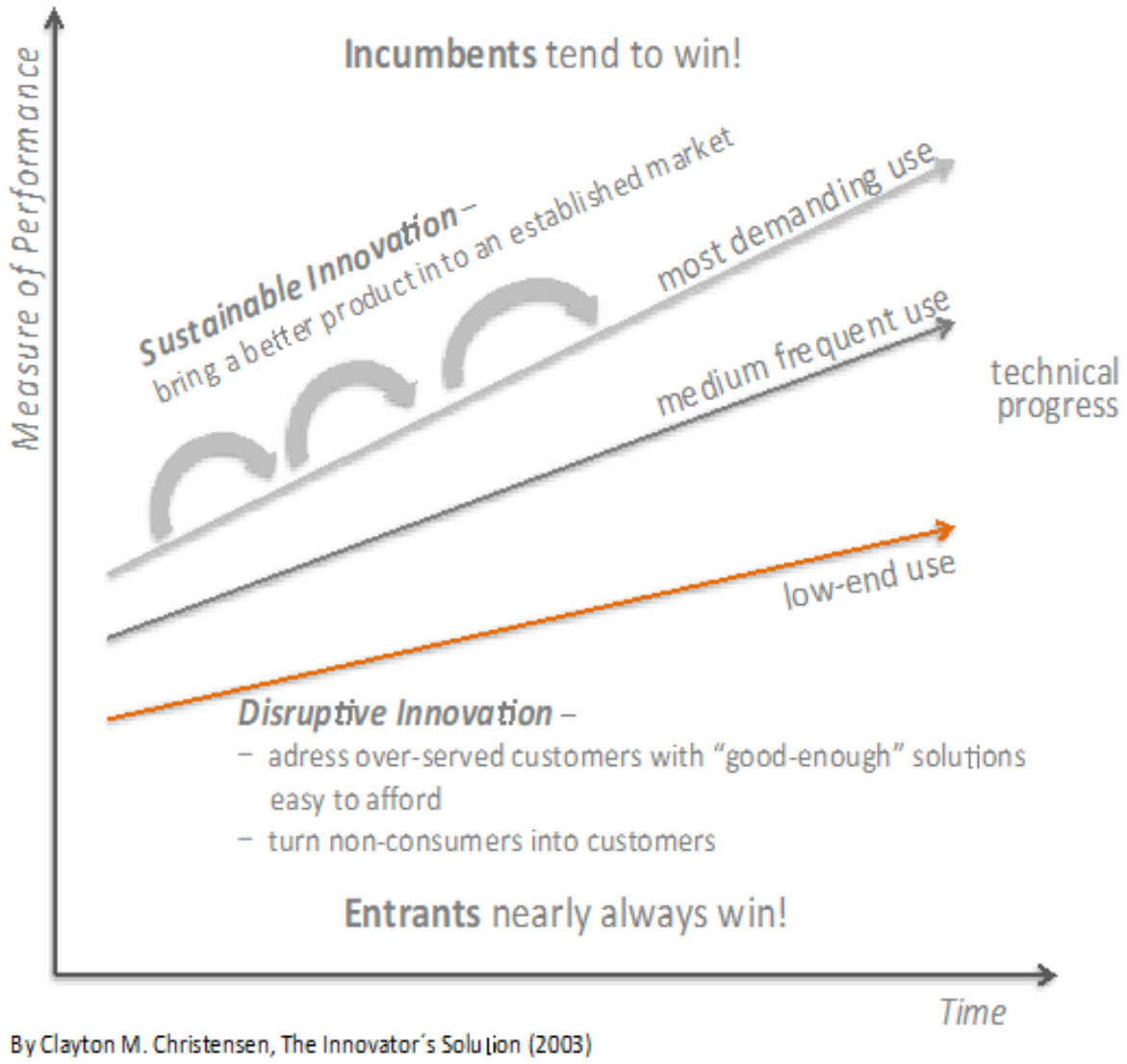

Figure 2: Disruptive Innovation [10]

Over time the performance of an actual innovation will rise and threaten incumbents. At the bottom of the market another innovation challenges and the game starts anew. At the top of the market the force may shift depending on the economic power of the participants (Figure 2).

Developing disruptive innovations may take longer and the risk is considerably higher than with sustainable innovation development, for example:

- Entrepreneur has mostly no established/proven structures for sales, support, logistics in the market
- Development, trial and refinement of business model; slip-up may cost reputation and threaten the entire innovation process including losing of partners
- Low profits (per unit) jeopardize the financial strategy

Though, it is estimated that there will be a fast market penetration if the innovation is deployed to the market and the impact on newly established markets is higher because of ground breaking novelty in buying or using a product. Within the CLARITY project the approach of disruptive innovation will be adopted.

2.2 CLARITY Innovation Position

The following chart (Figure 3) maps CLARITY project in Christensen´s "Disruptive Innovation" concept:

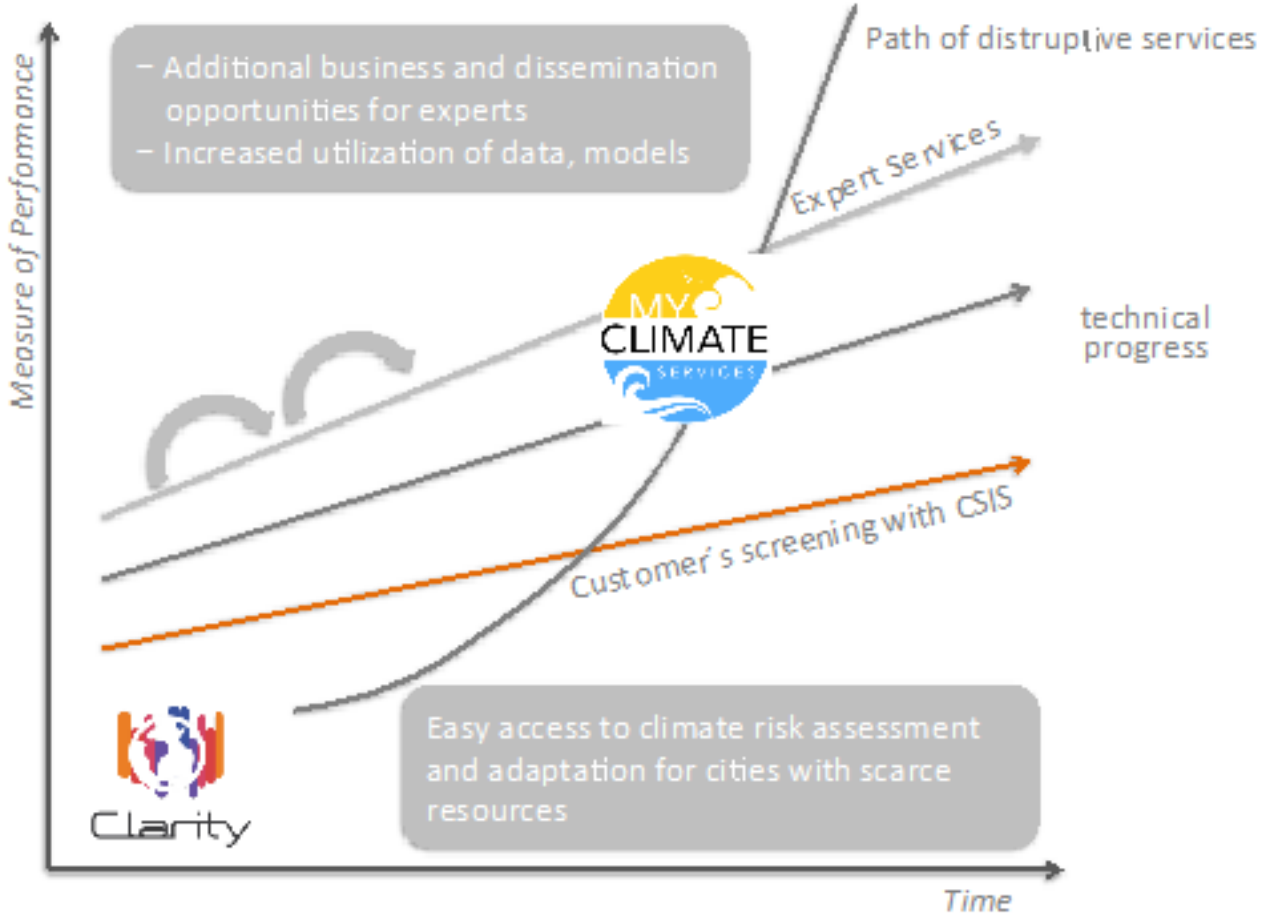

Figure 3: CLARITY Innovation Position

The project addresses the market of Climate Services in its first target segments of cities of any size and providers of road infrastructure (construction and operation).

In CLARITY developed results will enter the bottom of the market. From the **end-users**´ point of view it provides.

Tool or Process	Benefits for End-Users
Web tool CSIS	easy to access, low barrier to make oneself acquainted with "climate services"
for project-/risk managers	low to no skills for climate, climate data and models, knowledge about hazards etc., good to high skills about their project and its goals
featuring climate data from trustable providers	climate risk assessment for specific project location, not only general considerations on several hazards
tool follows a standardized workflow	no relevant information will be missing, user can take his time and gather required information for his project
a report is generated automatically	documentation obligations for project-/risk managers supported; report contains recommendations for further actions and supports decisions
connection with experts relevant for the project	no need to research on their own and require offers
briefing of experts	the provided report is an expert briefing, process for expert study gets more efficient
pre-screening with CSIS is partly for free, the rest is low-priced	small cities can afford the service; experienced users will like the possibility to do some scenarios or use it for project preparation and tender process (non-customers; "good enough" service)

Table 1: Benefits for End-Users

At the top of the market with the highest performance ("premium segment") are renowned climate experts and institutes, who assess climate risks in elaborated studies on project (study) based tariff. Each study is unique, deals also with highly specific questions and takes some time (tailored climate advice).

Their resources are limited and it is not easy to access them for an "unskilled" (in terms of climate services) project-/risk manager; briefing and project definition takes some efforts on both sides. Due to their scarce resources their impact on European cities seen as a whole is not so big.

In the CLARITY project **experts** are highly integrated in the automated pre-screening process within the CSIS. The benefits for them are

Tool or Process	Benefits for Experts
Web tool CSIS	helps to increase knowledge about climate services, how to use them and what they can contribute to an infrastructure project
for project-/risk managers	increased access to customers for their services
featuring climate data from trustable providers	their data and models will be reused, increased spread allows better cost control
tool follows a standardized workflow	better efficiency in project briefing and processing; experts can process more studies due to better preparatory work
a report is generated automatically	n/a for experts
connection with experts relevant for the project	improved acquisition process for experts, their offering, their data; better visibility of experts also for fellow experts, who can join for a

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	project (of course with complementary expertise or the better use of resources)
briefing of experts	more efficiency in offering and preparing a succeeding expert study
pre-screening with CSIS is partly for free, the rest is low-priced	n/a; expert study has to be purchased separately. Work to carry out by the expert can be better planned because expert can build on pre-screening results

Table 2: Benefits for Experts

Experts get access to the medium performance market that they cannot tackle with their existing processes. With experts´ involvement the performance of CLARITY services will move up, if required by the customer case by case. Thereby, one of the key innovations included in CLARITY solution is the usage of "standardised" Data Packages containing all (or part of) the datasets necessary to carry out fast risk screening exercises or even elaborated climate change adaptation studies.

Those Data Packages are created by climate experts and institutes taking also local data and custom modelling into account. Thus, they can be tailored from sectors (urban planning) over segments (cities in southern Europe) down to single customers (city of Naples). The compatibility of such Data Packages with the easy to access and low barrier tools of the CSIS will open new business opportunities for experts in the medium performance market.

The CLARITY marketplace myclimateservices.eu aims to support establishing an entire climate services eco-system. For urban planners, project-/risk managers and the financial sector a service will be the more attractive the better geographical availability is (supported by local data) and the more expertise is available for in-depth analysis.

For experts the service will be the more attractive the more projects and customers they can reach to value their data, models and knowledge. Broad availability and relevance will speed-up market penetration.

With CSIS and the meta-level marketplace CLARITY can bring together "low-performance" services and high-end expert studies, increase the utilization of climate services for all kinds of infrastructure projects and improve the impact of climate services on cities of any size.

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3 Exploitation Requirements

The Exploitation Requirements elicitation process performed in the course of the preparation of version one of this report (D5.1 "Exploitation Requirements and Innovation Design v1" [8]) was based mainly on the assessment of reports on market conditions, initiatives, projects, stakeholder consultations and targeted surveys, and, most notably the first deliverables of the EU-MACS (EUropean MArket for Climate Services) Horizon 2020 project. It has led to the following 10 consolidated Exploitation Requirements from 3 thematic clusters (Table 3)

Thematic Cluster	Exploitation Requirements	
Business objectives	ER01	Develop a viable business ecosystem, business model and secure access to funding
	ER02	Offer free basic Climate Services based on free and open data
Communication and community building	ER03	Demonstrate and communicate the (co-)benefits of Climate Services
	ER04	Establish trust in Climate Services and their providers
	ER05	Co-design Climate Services engaging a community of users, providers, purveyors and researchers
	ER06	Follow a multi-sectoral approach that crosses the boundary of climate sciences
Quality and novelty	ER07	Offer commercial fit-for-purpose tailored Climate Services targeting specific sectors and user groups
	ER08	Consider the role of new regulatory frameworks in stimulating the emergence of Climate Services
	ER09	Provide a user-friendly, intuitive and context-aware discovery and communication infrastructure for Climate Services
	ER10	Use, define and promote open standards for data and services

Table 3: Exploitation Requirements and Thematic Clusters

This chapter gives only a summary of the 10 consolidated requirements and their validity for the project by reporting on their actual technical implications and the related activities in WP1 "Co-creation" and "WP4 Technology Support" (Figure 4). Detailed definitions of the Exploitation Requirements including, among others, the rationale, scope and applicability of the Exploitations Requirement as well as relevant citations from literature assessment and an initial assessment of the expected (technical) implications are presented in the Annex 1 of version one of this report.

A review of additional literature sources that became available after the publication of the first version of this report, including EU-MACS deliverables D1.4 "A multi-layer exploration on innovations for climate services markets" [12] and D4.1 Outlining the urban CS playing field [13], did not led to new relevant high-level Exploitation Requirements or significant updates to existing ones. This is owed to the fact, that the 10 requirements are already the result of a consolidation process that took the findings of more than 20 reports into account.

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However, although there is no need to extend the actual list of requirements, the initial technical implications drawn from the assessment of the requirements are subject to updates and extensions based on their validation against that technical offerings and product and service specifications of WP4 “Technology Support” and WP1 “Co-creation”.

This initial assessment of the Exploitation Requirements identified 10 general topics of technical implications on innovation design whereby most of these implications can be matched 1:1 with requirements (Table 4).

Technical Implications	Exploitation Requirements
Technological infrastructure that ensures long-term sustainability	ER01 - Develop a viable business ecosystem, business model and secure access to funding
Free(mium) generic and basic ICT Climate Services (software and tools)	ER02 - Offer free basic Climate Services based on free and open data
Open standards for processes, data and services	ER03 - Demonstrate and communicate the (co-) benefits of Climate Services ER04 - Establish trust in Climate Services and their providers ER10 - Use, define and promote open standards for data and services
Extended communication	ER03 - Demonstrate and communicate the (co-) benefits of Climate Services ER06 - Follow a multi-sectoral approach that crosses the boundary of climate sciences
Collaboration and co-design infrastructure	ER04 - Establish trust in Climate Services and their providers ER05 - Co-design Climate Services engaging a community of users, providers, purveyors and researchers
Advanced report generation	ER06 - Follow a multi-sectoral approach that crosses the boundary of climate sciences ER08 - Consider the role of new regulatory frameworks in stimulating the emergence of Climate Services
Commercial tailored Expert Climate Services (consulting, advisory, modelling, development, …)	ER07 - Offer commercial fit-for-purpose tailored services targeting specific sectors and user groups
Advanced visualisation and user interaction concepts	ER09 - Provide a user-friendly, intuitive and context-aware discovery and communication infrastructure for Climate Service
Better discovery and matchmaking	ER09 - Provide a user-friendly, intuitive and context-aware discovery and communication infrastructure for Climate Service

Table 4: Exploitation Requirements and related Technical Implications

These topics are considered by the CLARITY consortium through all project activities, in particular during architectural design and co-development of the CSIS and the Climate Services and the selection of concrete background (technologies, software, services …) for the realisation of these products and services.

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The technical implications (open standards, open source, cloud technology, use of best-practices, metadata, engagement of users, efficient communication, user-friendly interface, ...) derived from the Exploitation Requirements are rather generic and could apply to any project that intends to create sustainable and exploitable products and services. They are nonetheless important and need to be addressed by technical and scientific work packages as they translate mainly into technical and functional requirements of Building Blocks and have strong influence on architectural and user interface design (Figure 4).

Additional specific functional requirements regarding the Climate Services domain are identified during the agile co-creation process as described in D4.2 “CLARITY CSIS Architecture” [6] and are documented at the level of Building-Blocks and Mock-Ups. Task 5.2 ensures therefore that not only product features requested by end-users are considered during the product development process but also other aspect that are indispensable for actually creating exploitable products and services.

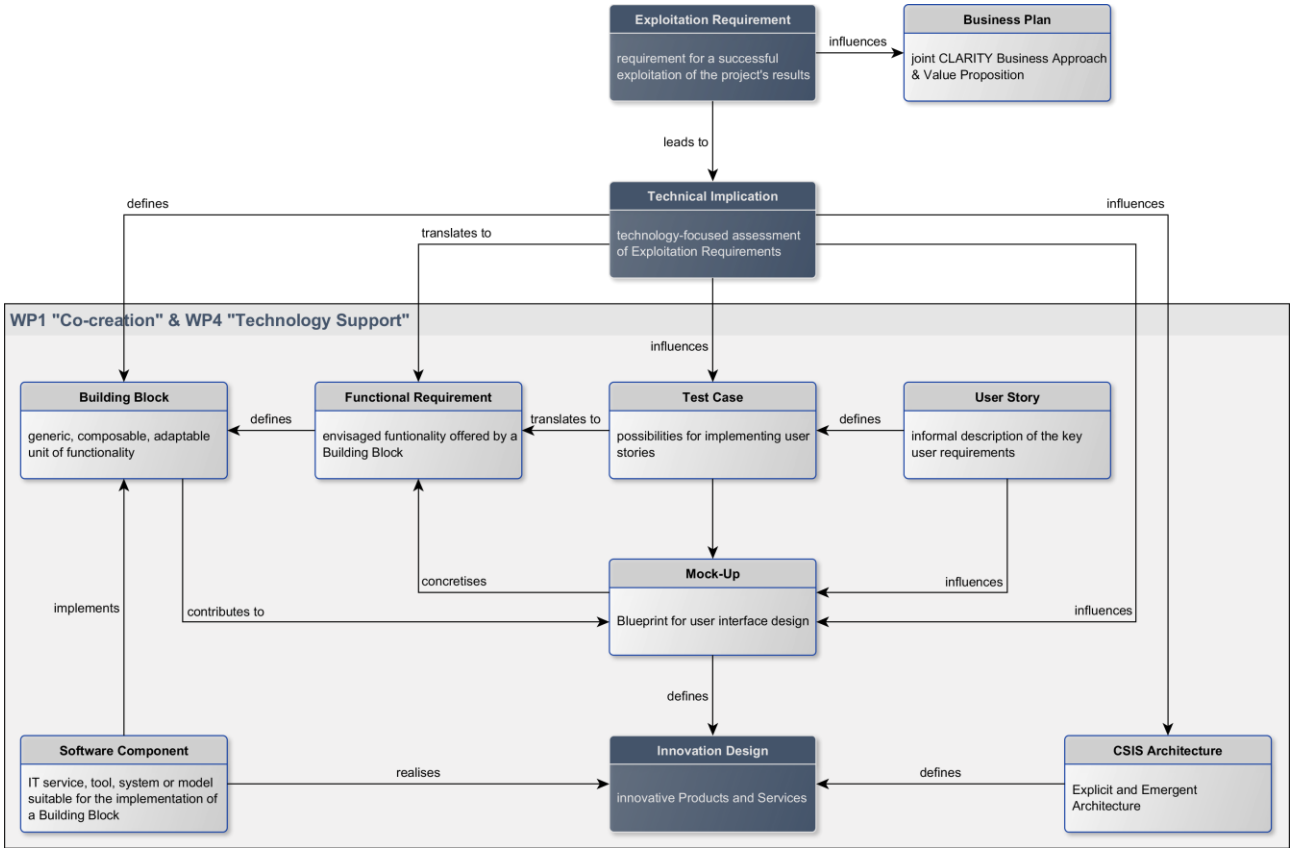

Figure 4: Role of Exploitation Requirements in CLARITY

Consequently, assessing the relevance of an Exploitation Requirements means assessing how the technical implications derived from the requirement influence the overall product development process. The next section explains therefore how the Exploitation Requirements in terms of technical implications are considered at different stages of the product development process.

3.1 Develop a viable business ecosystem, business model and secure access to funding

3.1.1 Description

The main objective of Exploitation Requirements elicitation and assessment is to make sure that the co-design process is able to produce products and services that are actually fit for exploitation. The development of a viable business ecosystem and business model is a key factor to exploit the outcomes after the end of the project.

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In addition, governments, development agencies and other stakeholders have to take into account not only the direct outcomes of new Climate Services, but also the value of socioeconomic benefits that will be provided by the aforementioned services. Therefore, public institutions should seek to acquire adequate financing in order to secure access to funding. To justify the funding needed, the business model should also analyse socioeconomic benefits to demonstrate how the benefits of new services are significantly larger than the cost to produce them and thus helping public bodies to take funding decisions to invest in Climate Services.

The climate service platform could be funded either by public money, or, by revenues from private business, or by a mix thereof, e.g. through public-private partnerships. The CLARITY activities should target new customer segments, so that private funding of Climate Services could increase in relation to public funding, which is significantly higher than private funding today.

Likewise, the funding of Climate Services could be direct, by end-users of a service or indirect, by some other interested party – resulting in a free of freemium service from the point of the view of the end-users. In order to provide both free and commercial Climate Services it is necessary to take into account how to update and improve these products and services (in terms of funding) - i.e., the design of incentives to operate, maintain and develop products and services beyond the project runtime.

3.1.2 Impact and Validation

In general, securing the long-term maintenance of the CLARITY platform (CSIS, marketplace, community) through institutional funding, development projects or commercial exploitation of Climate Services is a matter of CLARITY's overall business objectives, which are addressed in detail in task T5.2 "Exploitation Strategy and Business plan". Therefore, this Exploitation Requirement can be considered a "meta-requirement" that covers all other requirements that must be met to allow for a successful exploitation of the project's results. D5.3 "Exploitation and Business Plan (v1)" laid already the foundations for a joint CLARITY business approach for individual or collaborative exploitation of project results within an ecosystem where actors of the supply- and demand-side of Climate Service can connect and collaborate. Accordingly, general activities performed under consideration of this "meta-requirement" are listed in Table 5.

General Activities	Work Package / Task
Development of the business model that considers the mutual interest of key business partners to participate in the attractive ecosystem and analysis of funding sources to assure the exploitation of the project outcomes.	WP5 "Exploitation and Business"
Description of the products and services offered by project partners to meet the needs of the customers including the identification of target customer segments and relationships, key partners and activities, and the cost structure and revenue streams.	WP1 "Co-Creation" and WP2 "Demonstration & Validation"
Update of the business model during the project lifespan including the expected outcomes for the project partners.	WP5 "Exploitation and Business"
Development of an exploitation strategy that includes a market analysis, exploitable results, potential user groups, suppliers and enabling means and tools for exploitation actions.	WP5 "Exploitation and Business"
Development of Scientific Support based on Data and Services with established funding and networks (e.g. Copernicus, ECMWF).	WP3 "Science Support"

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Investigate cooperation with existing climate services / marketing platforms (Copernicus Data Store, Risk Data Hub, Climate Knowledge Hub) to bundle capacities, jointly use resources and to increase visibility.	WP3 “Science Support” and WP4 “Technology Support”

Table 5: General Activities regarding ER01

In terms of technical implications, long-term sustainability of the CSIS can be achieved by the provision of a technological infrastructure that ensures maintainability and extensibility beyond the end of the project. Besides the implications initially identified in first version of this report, additional new technical topics are considered from exploitation point of view. Corresponding activities are summarized in Table 6.

Technical Implications	Ongoing Activities
Adopt state of the art cloud and container technology “Docker” to be able to transfer the complete CSIS to new hosting environment.	The corresponding Docker Image build specifications (“Dockerfiles”) are published in CLARITY’s source code repository on GitHub (https://github.com/clarity-h2020).
Maximise the usage open source software for the implementation of Building Blocks to avoid licensing costs.	WP4 selected suitable open source products for nearly all Building Blocks. The respective technology choices are reported in the Technology Support Plan (D4.1 [5] and D4.2).
Provide a development environment and continuous integration system that eases common software maintenance tasks.	This is covered by the specification of the CLARITY Development Environment in D1.1 [14] and the infrastructure provisioning on the CLARITY Development Server.
Develop procedure / instruction manuals of the components developed for training core personnel in the future.	This will be covered by the D6.x “CLARITY Guideline” documents and by auxiliary code documentation (Issues, Wikis, “readme” files, .etc.) in the respective GitHub source code repositories.
Consider the need of testing environments, running in parallel to the production environment, also for training core personnel in the future.	In addition to the testing framework specified in D1.1 [14], advanced end-to-end testing environment like cypress.io (https://www.cypress.io/) will be used.
Design software in the best way to allow technology transfer to another third party or another team of persons (not involved during the project).	This includes for example code quality and code documentation. SonarQube (https://www.sonarqube.org/).
Re-use existing open source data for the development of CSIS (Copernicus Land Monitoring Services, Urban Atlas, SWICCA, EURO-CORDEX).	EURO-CORDEX and Urban Atlas will be used on European level as well as for expert studies, selection of (climate change/ hazard/ risk) indices in process.
Algorithms to translate climate hazards to local level and risk assessment are based on concepts and models developed in previous projects	E.g. re-using and extending the concepts and models from former FP7 project CRISMA.

Table 6: Technical Implications and ongoing Activities regarding ER01

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

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Building Blocks	Software Components
Container Engine and Cloud Infrastructure	Docker, Kubernetes, EGI (European Grid Infrastructure)
Integration and Development Platform	GitHub, Jenkins, Sonatype Nexus, SonarQube, Selenium-Grid, Gulp, Apache Maven, cypress.io

Table 7: Building Blocks and Software Components regarding ER01

3.2 Offer free basic Climate Services based on free and open data

3.2.1 Description

It is expected that any exploitable project result will in one way or another depend on the usage of the climate data offered by Upstream Climate Services (climate data services). CLARITY intends therefore to provide customized Downstream Climate Services to various stakeholders and customers by combining existing global and regional climate change related data (essential climate variables, economic/societal indicators, etc.) with other customer specific local and site-specific data, in line with CLARITY Objective 2 ("Maximize the re-use and tailoring of existing data, technologies and services"). Thus, for the long-term success of the project it is essential to base the CLARITY Downstream Climate Services on such reliable and trustworthy Upstream Climate Services that can continuously combine observations of the climate system with the latest scientific findings and achievements. However, the climate data that is freely available for research or educational purposes isn't freely available for commercial use. Therefore, CLARITY should provide both free basic generic Climate Services based on free and open-access data and at the same time offer fee-based services based on commercial data and highly customized and tailored Expert Climate Service based on high-quality and local data. Thereby, the purpose (from a business perspective) of offering free Basic Climate Services is to stimulate capacity building at the level of final users, thus increasing the overall CLARITY community and stimulating the uptake of commercial Expert Climate Services.

3.2.2 Impact and Validation

The requirement of providing free basic Climate Services has led to the specification of ICT Climate Services as a core concept of the CLARITY CSIS Architecture's conceptual Innovation Design: "ICT Climate Services are (partially) free, simple, ready to use, online ICT tools (software). Thereby, most complexity is hidden from the end-user to provide an easy-to-use product, for which no or just minimal knowledge of climate change science or technical skills is needed." [6]. The main properties of such ICT Climate Services are summarised in Figure 5.

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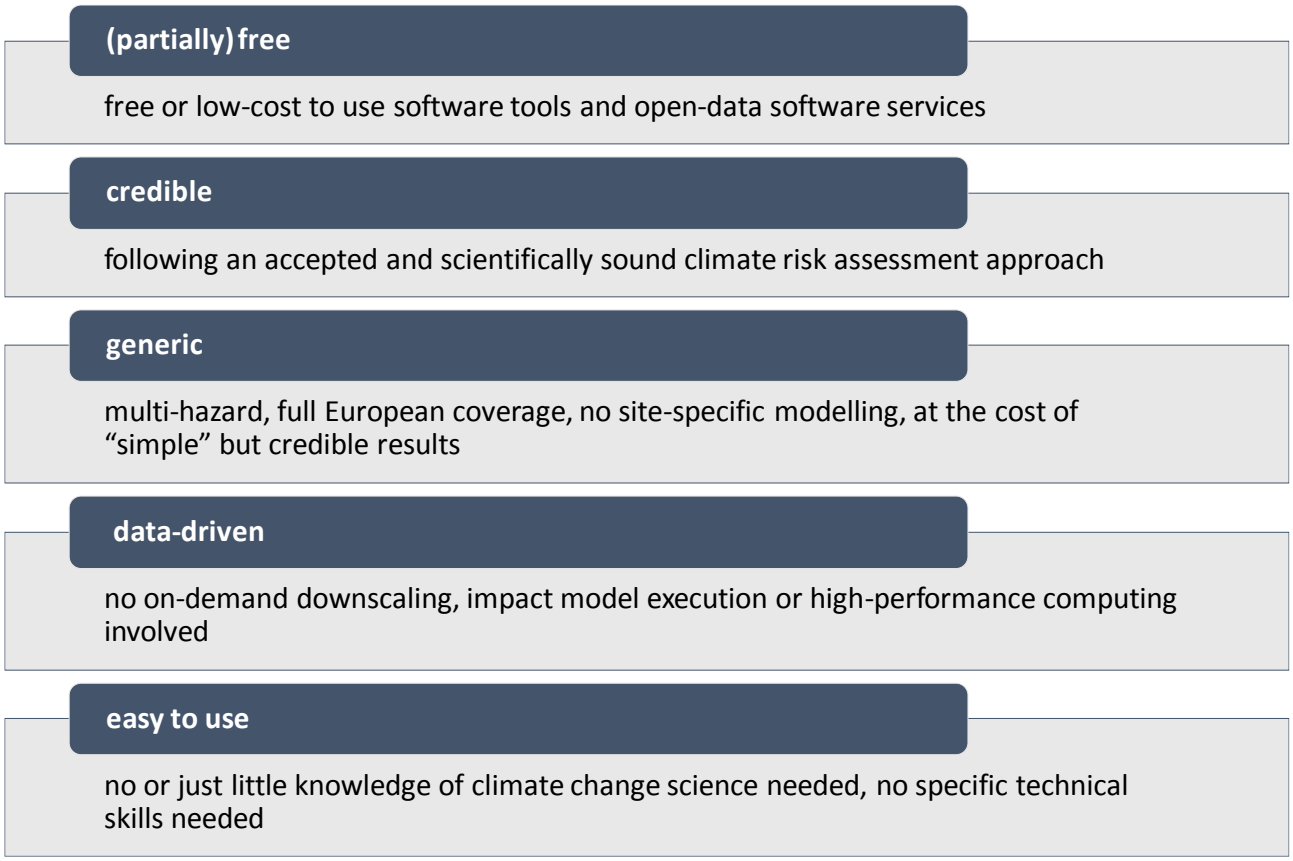

Figure 5: Main Properties of ICT Climate Services [6]

The first version of this report identified five main types of (free) and basic ICT Climate Services that fit within the scope, objectives and work plan of the CLARITY project (Table 8).

ICT Climate Services	Work Package / Task
ICT Climate Services for basic and strategic assessment of infrastructure projects that offer basic risk analysis, screening and pre-feasibility studies and a proposal for common adaptation options.	Conceptual foundations, input climate data and (impact) models: WP2 and WP3; technical realisation in WP4.
ICT Climate Services for scenario management that implements the EU-GL workflow and the CLARITY standard methodology, respectively.	T4.3 "Scenario Management
ICT Climate Services for local and individual Multi-Criteria Decision Support Analysis supporting different decision strategies.	T4.5 "Scenario Analysis, Decision Support and Report Generation"
Catalogue of adaptation options for ICT Climate Services	T3.4 "Adaptation Strategies and Decision Support"
Collection of data from open data sources used for ICT Climate services (Copernicus, EURO-CORDEX, SWICCA).	T3.2 "Climate Intelligence"

Table 8: Initially envisaged ICT Climate Services

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Figure 6 shows a Mock-Up[1] of the ICT Climate Service for basic and strategic assessment of infrastructure projects. This service covers the scope of a pre-feasibility analysis as anticipated by the EU-GL methodology (high-level application of EU-GL Modules) and is the main generic CS product developed by CLARITY.

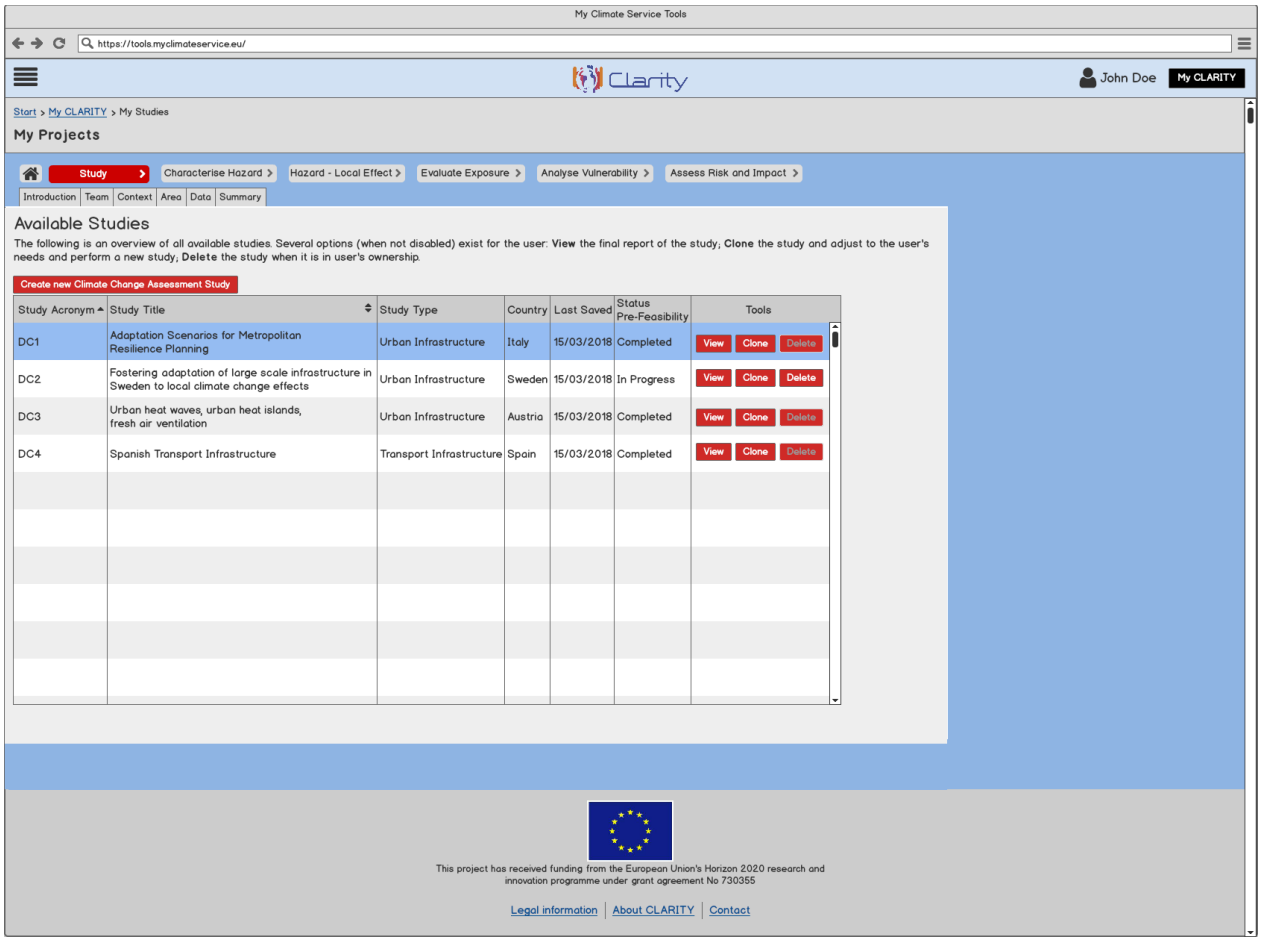

Figure 6: ICT Climate Services for basic and strategic assessment Mock-ups

While the inherent complexity of a tailor-made Climate Change Adaptation Studies that has to be performed for the four CLARITY Demonstration Cases (D2.1 "Demonstration and Validation Methodology" [15]) demands for sophisticated types of Expert Climate Services (see chapter 3.7), the CLARITY Demonstration Case workshops nevertheless identified additional generic ICT Climate Services that could be provided by CLARITY (Table 9).

ICT Climate Services	Demonstration Case
Green Area Factor - model and tool for impact of vegetation for urban areas.	DC2 “Fostering adaptation of large scale infrastructure in Sweden to local climate change effects”.
Indicator tool for hazard characterisation	DC2 “Fostering adaptation of large scale infrastructure in Sweden to local climate change effects” and DC4 “Spanish Transport Infrastructure”.
Catalogue of adaptation options	All Demonstration Cases.

Table 9: Initially envisaged ICT Climate Services of Demonstration Cases

[1] Mock-Ups offer a visual preview of the envisaged products and services.

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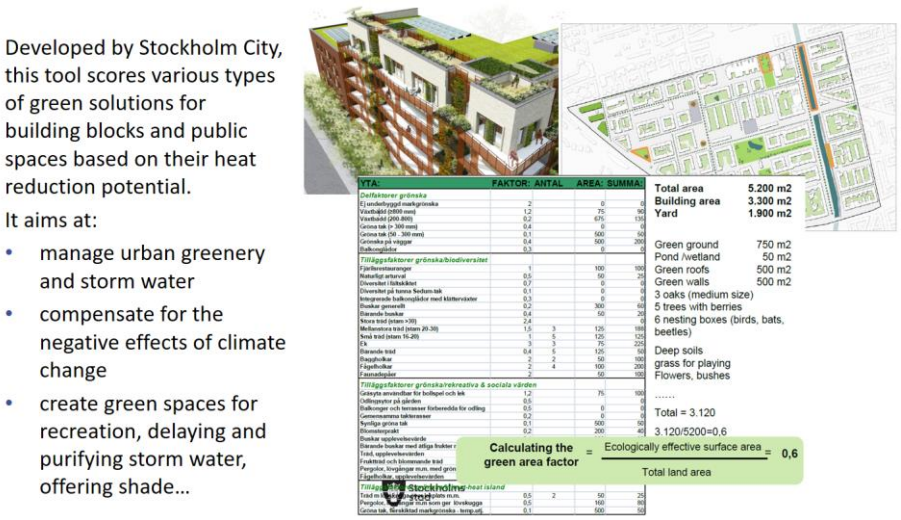

Figure 7: Green Area Factor Tool ICT Climate Service

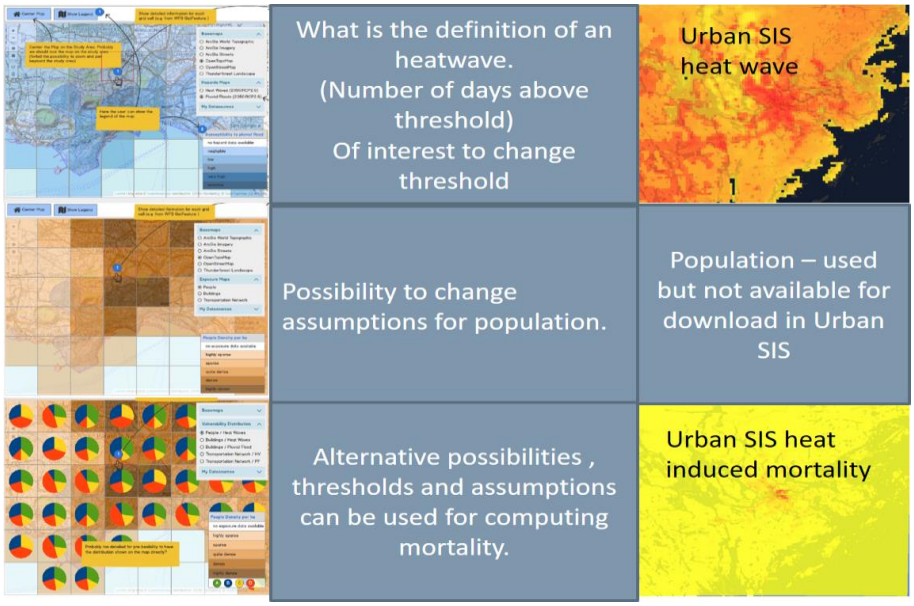

Figure 8: Hazard Indicator Tool ICT Climate Service

The tools shown in Figure 7 and Figure 8 represent additional distinct exploitable results and are therefore described in more detail in CLARITY's Exploitation and Business Plan [4].

To be able to offer such generic Climate Service that rely on freely available climate data, reliable, credible and quality assured Upstream Climate Services, like the C3S (Copernicus Climate Change Services) and EURO-CORDEX data services, must be integrated into CSIS. Therefore, it must be ensured that these data services are both technically and legally usable for scientific as well as commercial exploitation. Although C3S is currently under development and will be fully operational by 2018, there exist several proof of concept sectoral information system (e.g. SWICCA - Service for Water Indicators in Climate Change Adaption (http://swicca.climate.copernicus.eu/) and UrbanSIS - Climate Information for European Cities (http://urbansis.climate.copernicus.eu/), that can be used in CLARITY for providing both free ICT and commercial Expert Climate Service. The open data licensing schema allows exploitation of C3S data both for free and commercial purposes. Technically, the integration of C3S SWICCA and UrbanSIS climate data into CLARITY Data Repositories does not pose any problems as the data is freely available as download (netCDF Format) and via THREDDs data servers.

Regarding other (upstream) Climate Data Services like EURO-CORDEX, there might arise issues regarding the commercialisation of CLARITY Expert Climate Services. Some datasets can be used freely for research or non-commercial use, but have to be purchased for commercial use. Another issue that has not to be underestimated is the heterogeneity and lack of standardisation of climate data. While most climate data services offer NetCDF files, the actual data model encoded in NetCDF file format differs from dataset to dataset. Besides climate hazards at pan-European scope also data on infrastructure projects, elements at risk, etc. so all elements that are needed to perform an out-of-the box pre-feasibility (high-level application of EU-GL) have to be collected and processed by CLARITY. This includes also simple (impact) models at some kind of matchmaking (Scenario Transferability) to relate elements at risk to (generic) adaptation options. The main challenge is thereby in obtaining the appropriate data that can be used free of charge for the basic services. For climate hazard information this might be rather unproblematic but for other types of data where no authoritative providers like C3S, etc. are available, it could pose a real risk. Accordingly, concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 10.

Technical Implications	Ongoing Activities
Heterogeneity of climate data and models is an issue that has not to be underestimated.	WP2 and WP3 data harmonisation activities will define the standard format specifications for Hazard, exposure, Impact, etc. data used within the CSIS. WP4 will implement and adopt these specifications in CLARITY Data Package standard and the related tools.
Appropriate data (Hazard, Exposure, ...) both for the general pre-feasibility study (ICT CS, Table 8) as well as Demonstration ICT- (Table 9) and Expert CS (chapter 3.7) is needed.	WP2 and WP3 performs the necessary data collection and creation activities, WP4 provides the IT infrastructure for data storage and processing.
Technology support has to provide Data Repositories that are not only able to store several Gigabytes of climate data but also provide standardised machine-level access (OpenDAP, WMS) to other ICT services and (impact) models. In order to reduce the storage capacity, a service data-broker may be used; this service would offer access to data stored by servers external to CSIS in an easy and transparent way for the user.	WP4 offers a spatial data infrastructure currently consisting of GeoNode (http://geonode.org/)and Rasdaman (http://www.rasdaman.com/). Other services like OpenDAP THREDDS Data Server (https://www.unidata.ucar.edu/software/thredds/current/tds/) can be deployed as needed.
Partially free but rather generic ICT Climate Services have to be implemented and offered through the CSIS. In order to be able to generate measureable benefits for external stakeholders, the services have to be provided as simple, ready to use and open-data-driven (open-source) software tools.	WP1 and WP4 activities currently concentrate on the implementation of the CSIS Mock-Ups for basic and strategic (pre-feasibility) assessment of infrastructure projects (Figure 6). Other types of ICT CS (Figure 7 and Figure 8) will addressed in WP2 once the CSIS and the CLARITY Marketplace are operational.
Data-driven ICT CS should not depend on costly site-specific modelling, individual model execution, and high performance computing or expensive local climate data.	WP2, WP3 and WP4 make a combined effort to produce Data Packages for the general pre-feasibility analysis and for the four Demonstration Cases. See also chapter 3.10.2.

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ICT Services should be user friendly and simple, so that no or just little knowledge of climate change science or specific technical skills are needed to use them.	User Interfaces of ICT CS (Mock-Ups) are designed together with end-users and validated during workshops. See also chapter 3.9.2.
The role of the CSIS is recognized as to bridge the gap from supply driven (Upstream) Climate Services to demand driven (Downstream) Climate Services by offering (partly) free basic and generic ICT Climate Services and to help end-users to identify and discover their need for fit-for-purpose commercial Expert Climate Services.	CLARITY's Exploitation and Business Plan [4] identified corresponding interference & value Streams and business opportunities related to ICT CS (e.g. membership business).

Table 10: Technical Implications and ongoing Activities regarding ER02

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 "Technology Support":

Building Blocks	Software Components
Data Repository	GeoServer, GeoNode, ERDDAP / THREDDS, Rasdaman

Table 11: Building Blocks and Software Components regarding ER02

3.3 Demonstrate and communicate the (co-) benefits of Climate Services

3.3.1 Description

A major barrier relevant to the uptake of Climate Services is that added value of Climate Services is often unclear and difficult to measure. Climate Services generate economic and social value only if the society and/or economy benefit from decisions and actions taken as a result of the information provided by Climate Services. Unfortunately, climate change adaptation in general and Climate Services in particular are likely to merely be seen as an additional cost factor by the relevant stakeholders and not as an opportunity. Especially in the private sector, the need to reduce risks and saving costs in the long term by using Climate Services is related to the lack of understanding on how these services can sustain productivity and reduce losses. Thus, businesses are currently geared to the free use of such services but would be willing to pay for them in the presence of demonstrable benefits, in particular the economic benefits (i.e. avoided future costs).

In order for CLARITY CSIS and the related Climate Services to be successful, CLARITY as a whole has to demonstrate that using Climate Service(s) brings tangible benefits, and that these benefits surpass the initial investment in those services. Communicating and demonstrating the (co-)benefits of Climate Services should therefore aim at influencing the perception of the added value of Climate Services by the potential users, especially their capacity of receiving, combining and interpreting climate and non-climate information and using them in decision-making process.

3.3.2 Impact and Validation

Two different aspects of realistic demonstration of the benefits of CLARITY Climate Service have been envisaged in the first version of this report:

1. Demonstration on local / institutional / sectoral level by internal stakeholders (WP2) that present the results of the project-internal co-design process (WP1, 2, 3 and 4); and
2. "hands-on" demonstration on aggregate/general level by offering ready-to-use tools (ICT Climate Service) to external stakeholders.

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This translates in the main to the project internal and external usage of basic generic ICT Climate Services and the project internal usage of tailored Expert Climate Services and thus corresponds to usage and presentation of CLARITY Climate Services CSIS / Marketplace and the Demonstration Cases.

Therefore, the following recommendations regarding the demonstration of benefits were given for the CSIS and the Demonstration Cases.

CSIS	Demonstration Cases
Follow a common methodology that is supported by tools (ICT Climate Services) that are able to generate data-driven insights, e.g. in the form of (standardised) indicators that can be easily visualised (chart, diagram) on https://myclimateservices.eu/.	
Allow external end-users ("potential customers") to draw benefits from the usage of certain (free) ICT Climate Service.	Design the Demonstration Cases so that they give a good impression of the benefits.
Clearly identify and advertise benefits in the CSIS.	Add information on socio-economic benefits in the information used for the Demonstration Cases.
Produce tangible results that manifest as reports, data, etc.	Initiate workshops and stakeholder activities to reach the desired set of stakeholders and give a good demonstration of benefits.
Use a modern and appealing visual presentation that exploits the possibilities of state-of-the art data visualisation techniques (e.g. https://beta.prepdata.org/, https://www.weadapt.org/).	

Table 12: Recommendations for the CSIS and the Demonstration Cases regarding ER03

Accordingly, the CSIS Mock-Ups use a series of charts and maps for effectively communicating benefits of the services (Figure 10) and the CLARITY Demonstration Cases are showcased on myclimateservices.eu (Figure 9).

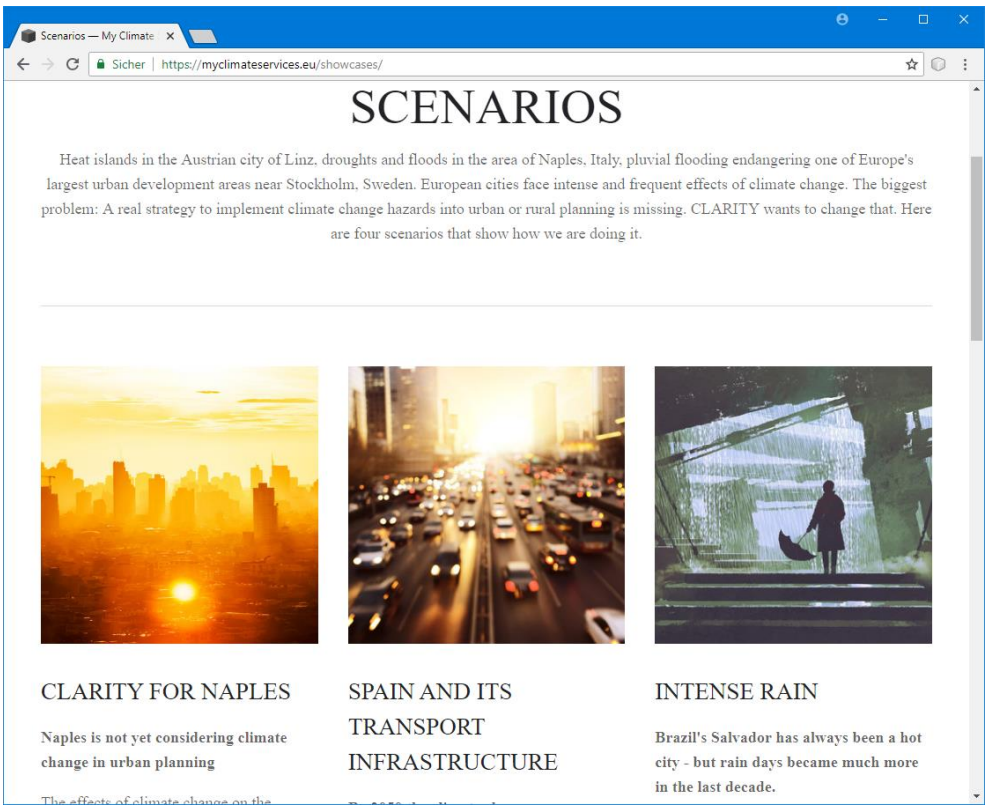

Figure 9: CLARITY Demonstration Cases showcased on myclimateservices.eu

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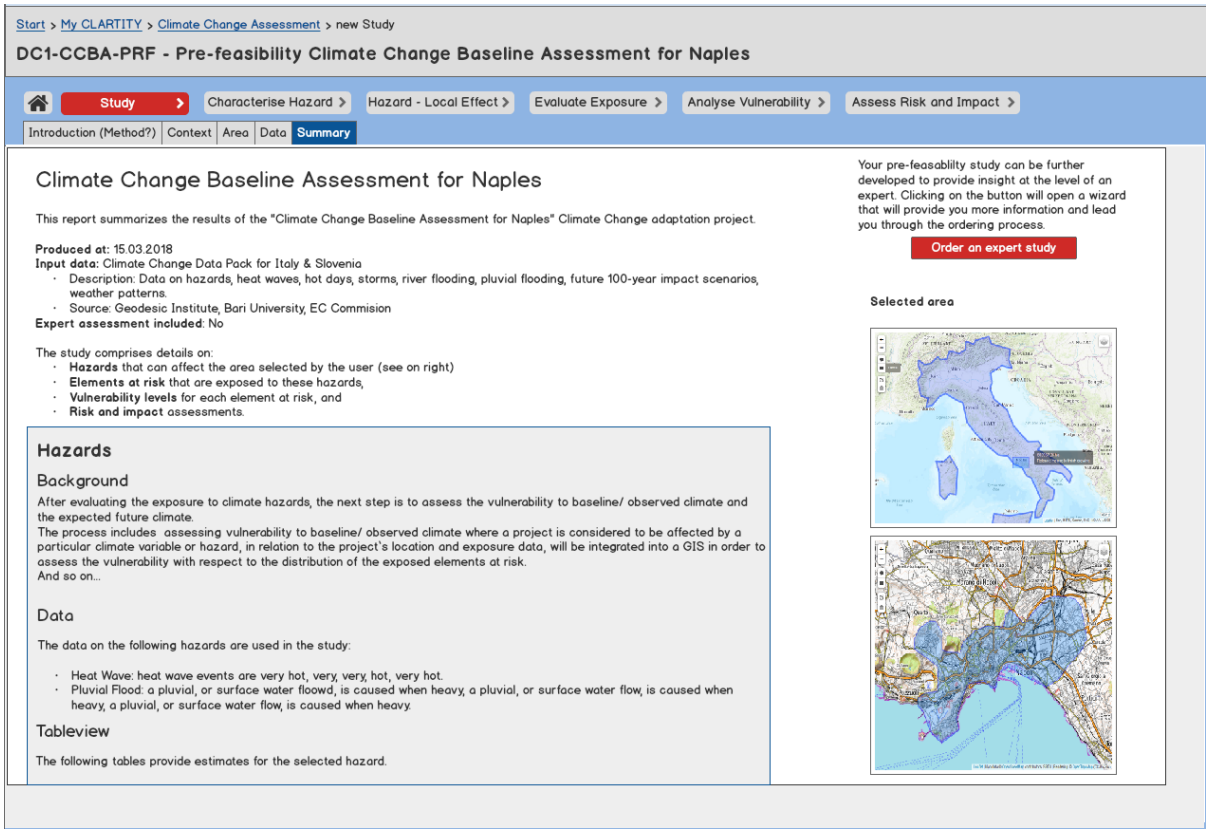

Figure 10: Mock-up covering ER03 (Final Report)

Further general activities performed under consideration of this Exploitation Requirement are listed in Table 13.

General Activities	Work Package / Task
Develop demonstrators showing the benefits of the CSIS and CLARITY CS, respectively.	WP2 “Demonstration & Validation”
Validate the benefit demonstrators from socioeconomic perspectives and assess the current and potential socio-economic impact of CLARITY.	T5.3 “Social Innovation Assessment”
Communicate project results to new stakeholders.	WP6 “Dissemination and Community Building”
Perform workshops with new stakeholder to advertise the benefit of CLARITY CS.	T2.3 “Demonstration”
Compare adaptation costs and consequences of the expected impact and costs (including damages and other impacts) in the case of applying or not applying adaptation measures.	T3.5 "Economic and Societal Impact"
Identify and quantify the associated socio-economic cost of each adaptation measure applying multi-criteria analysis.	T4.5 "Scenario Analysis, Decision Support and Report Generation"
Calculate, analyse and visualize climate scenarios with and without adaptation measures to demonstrate benefits	T3.4 “Adaptation Strategies and Decision Support”
Scientific dissemination and media coverage to increase visibility, reach scientific communities and potential users.	T6.4 “Scientific Dissemination”, T6.2 “Media Production and Publishing”

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DC workshops to engage all stakeholders within the CLARITY project, to demonstrate benefits and integrate feedback.	T2.3 “Demonstration”

Table 13: General Activities regarding ER03

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 14.

Technical Implications	Ongoing Activities
Dissemination experts should formulate and communicate these benefits for end-users, e.g. in form of online presentations and infographics (http://www.visualisingdata.com/resources), e.g. https://www.slideshare.net/ECFoundation/presentations. Thereby, relevant technologies for information visualisation (e.g. http://selection.datavisualization.ch/) have to be selected and integrated.	The demonstration cases and the related CLARITY Climate Services and associated benefits are being showcased on myclimateservices.eu (Figure 9). New visualisations and articles will be added as soon as concrete outputs of Climate Services are available.
The architecture has to distinguish between (internal) custom Expert Climate Service that are tailored to the CLARITY Demonstration Cases and (external/public) generic ICT Climate Service that are also directly usable by external stakeholders.	This is a concept of the CLARITY CSIS Architecture’s conceptual Innovation Design, see also chapter 3.2.2.
ICT Climate Services have to produce tangible outputs for end-users, e.g. reports and data in standard formats like SHP, NetCDF, PDF, ODF, etc. and Expert Climate Services by external stakeholders should be easily integrated with generic ICT Services of the CSIS through a "data-driven" architecture.	The specification of standardised “Data Packages” which include the results of a complete climate adaptation study in standardised format is an ongoing activity in WP2 and WP4. See also chapter 3.10.2.
There is a strong need for an (meta-) information model for case studies (CLARITY Demonstration Cases) that is linked with the information models for Climate Services (marketplace offer) and their providers (Service Portfolio) and through indirection also with climate data and models, tools (provenance). This allows also for demonstrating the benefits of Upstream Climate Services (e.g. Copernicus C3S) by means of Case Studies (e.g. CLARITY Demonstration Cases).	A comprehensive data model for CS providers and their Portfolio has been defined for the CLARITY Marketplace. References to Demonstration Cases for showcasing concrete (usage of) Climate Services have been foreseen. A detailed data model for showcases is under preparation.
Integration of mapping or GIS tool in CSIS to visualize model results (e.g. to visualize effect of adaptation options).	See Table 15.

Table 14: Technical Implications and ongoing Activities regarding ER03

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

Building Blocks	Software Components
Scenario Transferability Component	AIT Climate Twins Prototype, Flamingo 4, MapServer

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Data Dashboard	Rich Internet Application (React), Drupal Module , ckan, GeoNode
Data Package Export and Import Tool	Rich Internet Application (React), Drupal Module
Data Repository	GeoServer, GeoNode, ERDDAP / THREDDS, Rasdaman
Marketplace	Drupal 8, Drupal Commerce

Table 15: Building Blocks and Software Components regarding ER03

3.4 Establish trust in Climate Services and their providers

3.4.1 Description

Potential Climate Service customers are first and foremost interested in products of neutral and reputable providers that deliver salient, objective, credible and defensible results, even "in light of the irreducible uncertainty about future climate change" [16]. It is therefore essential for the success of Climate Services to transparently report and inform on their characteristics and provision, both in relation the origin, quality and uncertainty of the underlying models and data as well as the methodological approach and processes which created them.

To establish trust in Climate Services and their providers, quality assurance and control as well as certification have to be addressed. However, widely accepted objective measures of the quality of Climate Services do not exists, complicating the validation or verification of the Climate Service quality. On the one hand, this highlights the need to develop standards, and on the other hand the need for transparency. The latter includes the standardization of data and methods, and the inclusion of version history and metadata so that users can track the decision for suggesting climate change adaptation measures, and trace it back to the underlying data and models. Also robust data, and providing services based on state-of-the-art science contribute to a defensible analysis and product.

As an additional measure for establishing the trust relationship between the users and providers of the climate services, CLARITY platform will support the direct user/provider interactions and consultations, rather than attempting to completely replace such interactions by technology and formalism.

3.4.2 Impact and Validation

The first version of this report noted, that this Exploitation Requirements is relevant for the project as a whole as it covers both the process as well as the actual outcome of the project. This leads to the following general activities for enabling users to assess the added value that CLARITY Climate Services offer to their business:

General Activities	Work Package / Task
Make available clear information regarding the data sources, generation methods, version history and metadata.	T2.2 “Demonstrator-specific data collection” and T3.2 “Climate Intelligence”
Use of standards both for the components of the Climate Service and for the interfaces to access the information.	WP2 “Demonstration and Validation” and WP3 “Technology Support”
Make the project visible and transparent throughout all project stages, discussing with other climate experts and getting in contact with the huge climate community in order to make them understand about CLARITY’s aim and proceedings.	WP7 “Project Management” and WP6 “Dissemination and Community Building”

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Let end-users objectively rank the adaptation scenarios according to explicitly stated decision objectives of the different stakeholders, taking into account key performance indicators including those related to uncertainties.	T3.4 “Adaptation Strategies and Decision Support”, T3.5 “Economic and Societal Impact” and T4.5 “Scenario Analysis, Decision Support and Report Generation” establish a scientifically sound and defensible standard methodology based on EU-GL
Establish a scientifically sound and defensible standard methodology based on EU-GL that considers the existing results produced and published by the EC and by other related projects.	WP3 “Science Support”
Enable interaction between users and experts during the production process.	DC workshops enable the interaction/discussion between all stakeholders within CLARITY, feedback from users can be incorporated into future dissemination efforts
Provide scientific publications through a peer review process, use stablished methodologies and data sources for Climate Services.	T6.4 “Scientific Dissemination”

Table 16: General Activities regarding ER03

In the Mock-Ups, showing information regarding the data sources contained in a CLARITY Data Package is considered an important feature that has to be implemented in the CSIS (Figure 11). See also chapter 3.10.2.

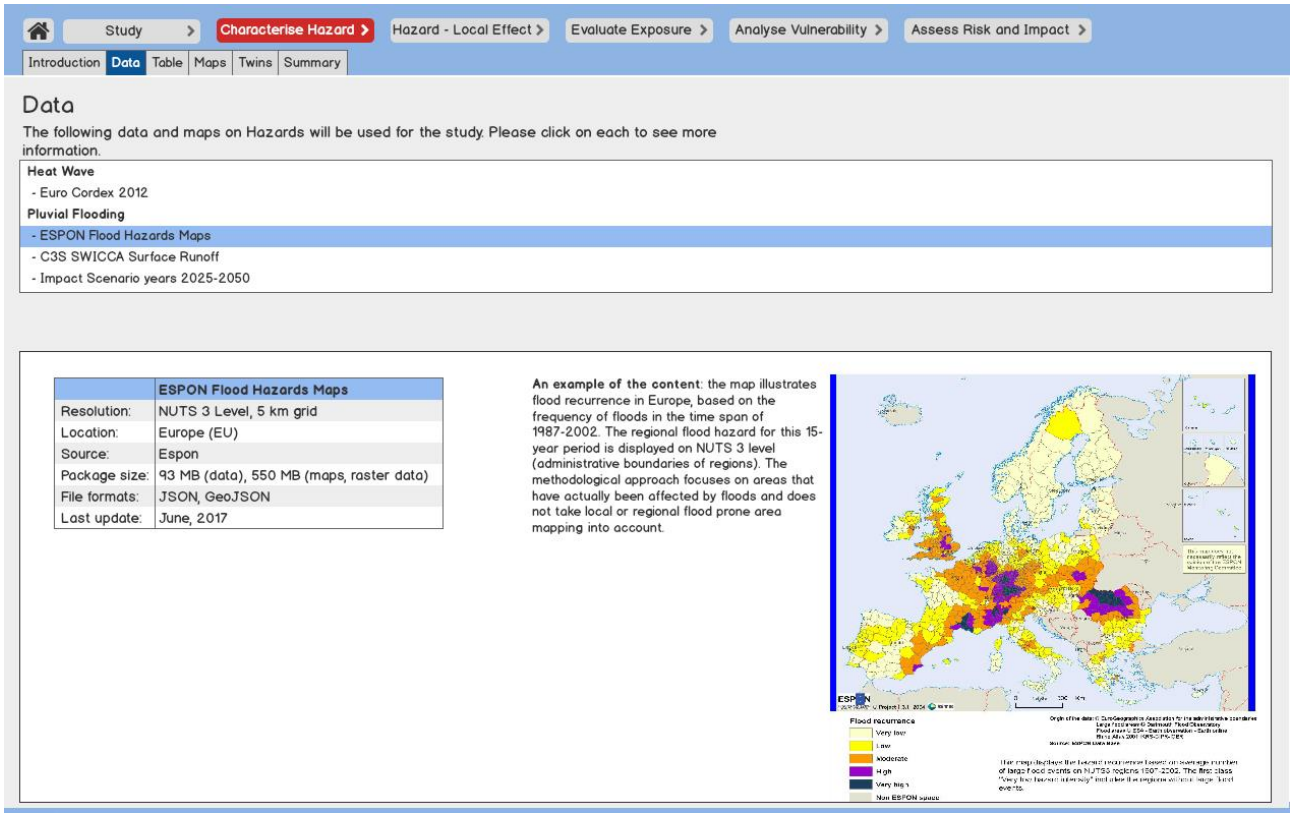

Figure 11: Mock-up covering ER04 (Meta-Data)

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 17.

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Technical Implications	Ongoing Activities
Users must be able to record the decisions that lead to the implementation of climate change adaptation measures and to trace them back to the underlying data and models.	This is being addressed in the CSIS by recording information on all steps performed by the user and the respective data used and produced and including them in a final report that can be printed by the user (see also Figure 10).
Quality assurance and uncertainty of the underlying data and models as well as provenance information (about the process (model) and input data which created the data) must communicated properly throughout the whole planning process.	The meta-data of the original information source of CLARITY Data Packages are disclosed transparently in the CSIS. Currently, it is foreseen to use the ckan (https://github.com/ckan/) for this purpose.
Uncertainty should be quantifiable, e.g. derived from statistical properties and could be considered as an indicator that can be transformed (normalised) to criteria.	Possibilities for visualising uncertainty in geographic settings by using different opacity level of map layers to provide an indicator for uncertainty (see https://truth-and-beauty.net/projects/ukko) are being explored.
Climate Service providers have to disclose information on which data or methods they used to develop their Climate Service and how they dealt with uncertainties. Furthermore quality assurance reputation, neutrality and trustworthiness must be easily recognizable in the Climate Service Catalogue / Marketplace.	This is being considered in the Service Provider Portfolios in the Marketplace. This includes among others (moderated and verified) feedback from Climate Service users ("customer ratings"), links to scientific publications, talks, etc. and Case Studies (Demonstration Cases) that are available in the CSIS. See also chapter 3.3.2.
Data processing and climate analysis needs to follow established scientific procedures to provide information, if possible based on already published results or including standardized methods for climate analysis.	This is being considered in T3.2 in processing of climate and hazard data for ICT and expert studies, taking into account ensemble of models and different climate scenarios for future projections to account for possible variability and uncertainties in projections.
Enable interaction between potential users and experts.	Organisation of workshops for DC and external stakeholders.

Table 17: Technical Implications and ongoing Activities regarding ER04

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 "Technology Support":

Building Blocks	Software Components
Catalogue of Elements at Risk and Adaptation Options	AIT EMIKAT
Catalogue of Data Sources and Simulation Models	CKAN, ckanext-spatial, ckanext-geoview
Scenario Management	Drupal 8, Drupal Module, cids Integration Base, RESTful Web Services API
Multi Criteria Decision Analysis Tool	CRISMA Multi Criteria Decision Analysis (MCDA) Tools, AngularJS

Table 18: Building Blocks and Software Components regarding ER04

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3.5 Co-design Climate Services engaging a community of users, providers, purveyors and researchers

3.5.1 Description

Developing, planning, constructing and operating (urban) large-scale infrastructure projects involves multiple disciplines and expertise as well as stakeholders with different roles and interest. User and beneficiaries of Climate Services are not a homogenous group or from a single discipline. Therefore, for Climate Service development and establishment of a co-design approach it is necessary to engage a large community of researchers, providers, purveyors and end-users. This multidisciplinary community needs to be fostered on regional and European level, encourage cooperation among scientific sectors, providers and purveyors and engage end-users from public and private sectors in order to co-design and deliver fit-for-purpose services. Community consultations will help to build mutual trust of different stakeholders as well as to reveal end-user challenges (e.g. tight timelines and budgets), their expectations and clarify how they will use the services in their respective projects - thus leading to "communities of practice" and trusted relations along value chains.

Commercial and societal success of Climate Services is driven by users as integral and equal partners in design and build-up of Climate Services as well as their engagement in the community. In order to reach the main relevant target groups, "good practices" need to be communicated sector-specifically and multiplicators have to be integrated.

3.5.2 Impact and Validation

CLARITY by itself follows a co-design approach that intends to establish and foster multidisciplinary collaboration (including sharing of technical infrastructure). Moreover, this particular Exploitation Requirement is already represented in many of the objectives in the CLARITY workplan: "Climate Service development will be facilitated by a bottom up approach with integral stakeholder and end-user involvement (user-centred design). CLARITY Climate Services will be co-developed by city planners, consultants and providers of the climate intelligence and end-users from urban and regional planning as well as infrastructure providers." (DOW, Objectives O3 and O5)

The most relevant general activities performed under consideration of this Exploitation Requirement are listed in Table 19.

General Activities	Work Package / Task
Involved partners, technical as well as end-users in requirements specification and co-design of the CLARITY services.	WP1 “Co-creation”
Let stakeholders and end-user drive the development of the Demonstration Cases with input on their needs and carry out the work jointly by end-users as well as researchers and technicians.	WP2 “Demonstration and Validation”
Perform workshops with a larger group of stakeholders during the project that ensures that requirements and design of the system wider set of end-users.	T2.3 “Demonstration”
Foster community building across the whole value chain and improve communication methods (including sales skills for Climate Service providers).	WP6 “Dissemination and Communication”

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Develop a methodology through interaction between experts of different fields taking into account end-user requirements and user-oriented data analysis.	WP3 “Science Support”

Table 19: General Activities regarding ER05

Community-building and co-creation aspects are reflected in the CSIS Mock-Ups by the possibility to form teams that collaboratively work on a Climate Change Adaptation Study (Figure 12). This includes also the involvement of external experts from the CLARITY Community and Marketplace (https://myclimateservices.eu/).

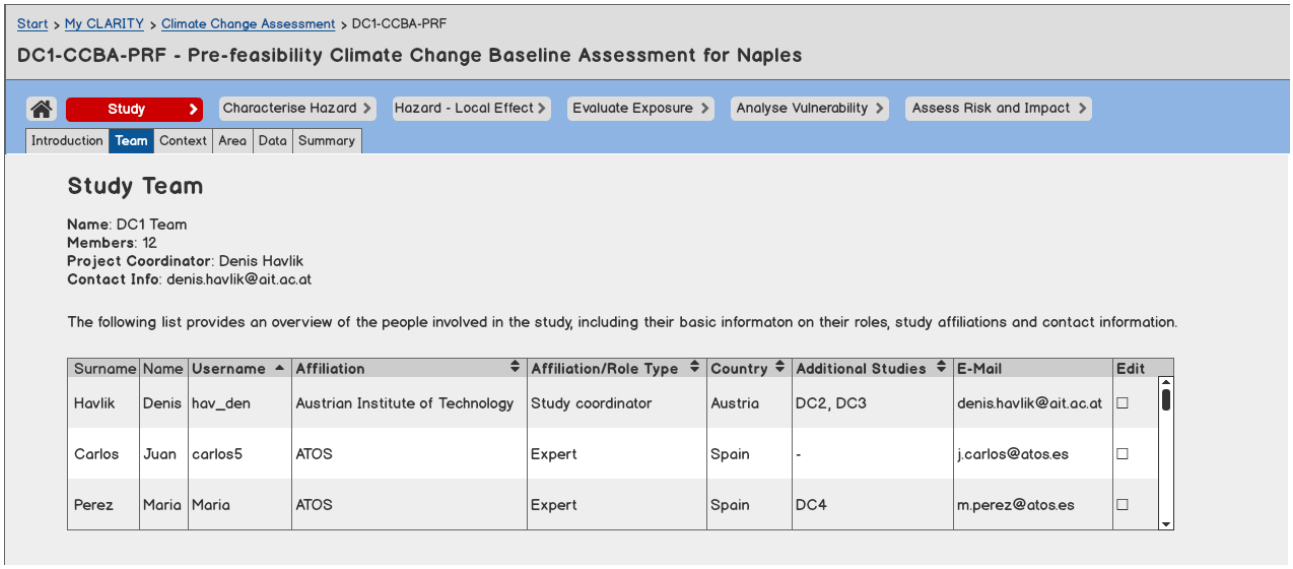

Figure 12: Mock-up covering ER05 (Collaboration)

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 20.

Technical Implications	Ongoing Activities
Follow an iterative rapid prototyping approach that delivers early results with limited functionality as basis for validation and further refinement.	This is achieved by providing Mock-Ups to end-users at an early stage of the co-design process before the actual implementation starts. The tool “Balsamiq Mockups” (https://www.balsamiq.com) is used for this purpose (see also Figure 6).
Provide an easy-to-use technical collaboration platform that incorporates non-it expert users in the agile software development process and allows them to receive direct feedback from software architects and developers.	CLARITY uses a GitHub Management Project (https://github.com/clarity-h2020/csis/issues) which provides a simple yet powerful ticket system that connects users and developers and thereby supports also traceability and quality assure.
Allow external stakeholders participating in co-design of Expert Climate Services to easily request and exchange information needed to perform a climate adaptation study.	WP4 provides for example secure cloud storage facilities that are suitable for exchanging confidential and private data.
Provide possibilities to disseminate (possibly anonymized and aggregated) study results as case study or as input to other Expert Climate Services.	At least parts of the final report (see Figure 10) can be made public and be used as input for Scenario Transferability to find similar studies and projects.

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Integrate the CLARITY community with the marketplace be able to involve also new stakeholders (e.g. data providers) during all phases of the co-design process.	Technical facilities to connect different Drupal Systems (CSIS, Marketplace, CLARITY website) are being implemented.
Define input/ output specifications and data requirements for different modelling tools and check availability from data providers.	Identify data requirements, compatibility issues regarding input and output formats needed for each modelling step (WP2, WP3).

Table 20: Technical Implications and ongoing Activities regarding ER05

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

Building Blocks	Software Components
Scenario Management	Drupal 8, Drupal Module, cids Integration Base, RESTful Web Services API
Data Repository	GeoServer, GeoNode, ERDDAP / THREDDS, Rasdaman
Marketplace	Drupal 8, Drupal Commerce

Table 21: Building Blocks and Software Components regarding ER05

3.6 Follow a multi-sectoral approach that crosses the boundary of climate sciences

3.6.1 Description

Developing, planning, constructing and operating (urban) large-scale infrastructure projects involves multiple disciplines and expertise as well as multiple stakeholder roles and interest. Consequently, the users that would be willing to pay for Climate Services are rather heterogeneous in terms of sectors, disciplines as well as actual needs.

General and generic Climate Services therefore may not adequately address the needs and expectations of the relevant target groups. Furthermore, climate data alone is not sufficient for the provision of targeted Climate Services but has to be integrated with local and other relevant data to address the specific needs of the users. Therefore, pictured barriers can be tackled by establishing and fostering multidisciplinary collaboration (including sharing of technical infrastructure) and community building across the whole value chain.

In order to be able to provide valuable Climate Services for a wide variety of end-users from different sectors and disciplines, CLARITY has to follow a multidisciplinary approach that encompasses multiple sectors and domains, crosses the boundaries of climate science and facilitates the integration of both climate and non-climate information into an open knowledge infrastructure.

3.6.2 Impact and Validation

The first version of this report noted, that this exploitation requirement especially concerns the architecture of CSIS as a whole, starting from the co-creation process of the CSIS itself until the ongoing operation of the CSIS and the services it provides for end-users. Multiple experts from different sectors have to work together to provide the best and valuable results for end-users which again might work in a variety of sectors and therefore have to base their decisions on a wide range of factors from a multiple of fields of study.

General activities performed under consideration of this Exploitation Requirement are listed in Table 22.

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General Activities	Work Package / Task
The WP3 methodology was developed through interaction between experts of different fields.	WP3 Science Support, T3.1 “Scientific Background”

Table 22: General Activities regarding ER06

This has already been anticipated in the setup of the project. General activities performed under consideration of this Exploitation Requirement are therefore considered in the whole work plan of the project. Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 23.

Technical Implications	Ongoing Activities
CLARITY must provide a multidisciplinary framework where users and producers of Climate Services within different sectors are not only able to exchange data but also to enrich climate with additional sector specific information.	This topic is being addressed by the Scenario Transferability Component (Figure 13) where projects and their (Hazards, Elements at Risk Adaptation Options, etc.) can be assessed across sectors.
Merge essential climate data obtained from Upstream Climate Services with other sources of non-climate data and integrate these data with various kinds of modelling and assessment tools to provide tailored adaption strategies.	The Catalogue of Elements at Risk and Adaptation Options intends to provide both a wide range of elements at risk which are related to many different sectors (e.g. road infrastructure, buildings, social, etc.), as well as a wide range of adaptation options.
It might be that not all sectors are fully dealt with at the beginning; therefore, a community-driven mechanism by which the gaps are being filled is suggested.	The Catalogue of Elements at Risk and Adaptation Options enables users to provide their own Hazard Conditions (“local effects”, Figure 13) elements at risk and suggest their own adaptation options, which then might be assessed by experts. Thereby, such user provided content have to follow the same quality and transparency standards as being used for essential climate data.
In order to provide pinpointed information for all relevant parties, indicators need to cover a wide variety of topics (climate, air quality, financial, social, etc.).	A weighing system for indicators (automatic per type of end-user or end-users set the weighting factors according to their preferences) is planned to be implemented for the Multi Criteria Analysis and rank different scenarios.
It should be possible to generate “extended focus reports” which addresses certain sectors (climate, adaptation, financial, people, etc.) in more detail.	This depends on the availability and diversity of sector specific information in the CSIS is currently being investigated.
The CLARITY methodology encompasses a complex modelling chain using information from different sectors that need to be provided in a uniform and standardized format.	Identify data requirements, compatibility issues regarding input and output formats needed for each modelling step.

Table 23: Technical Implications and ongoing Activities regarding ER06

In the Mock-Ups, scope of the Scenario Transferability concept is extended beyond basic climate indicators so that end-users are able also discover “twin” regions within other sectors e.g. where the probability of certain hazards is similar to their actual project region (Figure 13). It is planned, that this concept is also applied to the Catalogue of Elements at Risk and Adaptation Options so that the end-user’s project being assessed can be matched to other projects that share the same elements at risk (covering a variety of sectors).

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The same could be true for adaptation options. By the use of Scenario Transferability, end-users can search for and find other projects with the same proposed or already implemented adaptation options, in order to investigate further and learn from the experiences already made.

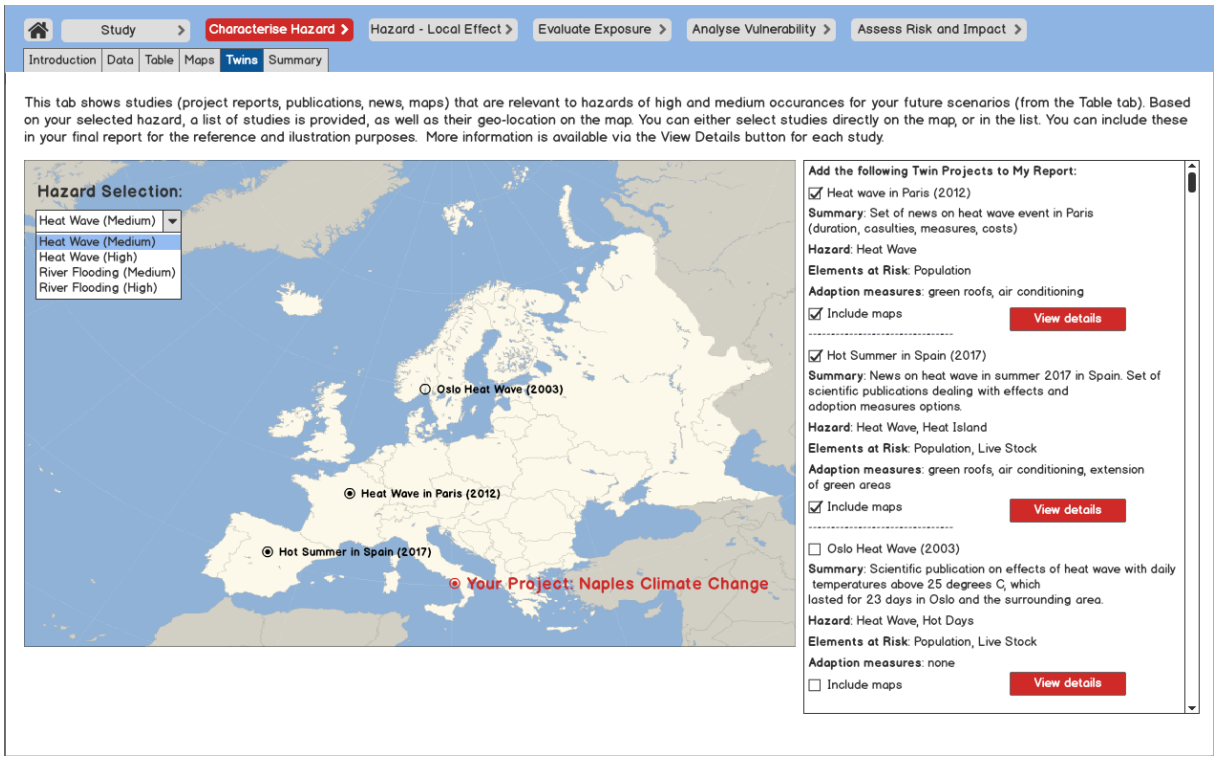

Figure 13: Mock-up covering ER06 (Scenario Transferability)

Figure 13 shows an example how sector specific local effects (e.g. hill shade and building albedo for the urban planning sector) is considered in the current Mock-Ups.

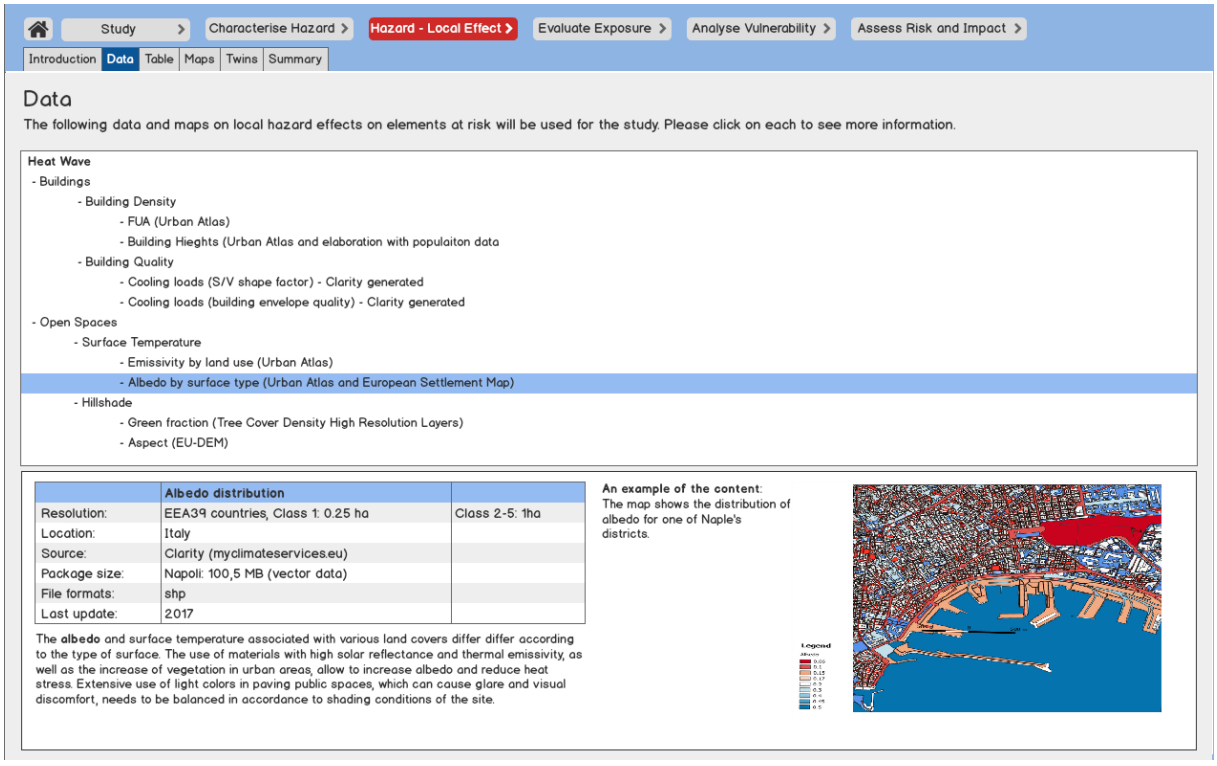

Figure 14: Mock-up covering ER06 (Hazard Local Effects)

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Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

Building Blocks	Software Components
Catalogue of Elements at Risk and Adaptation Options	AIT EMIKAT
Scenario Transferability Component	AIT Climate Twins Prototype, Flamingo 4, MapServer
Scenario Management	Drupal 8, Drupal Module, cids Integration Base, RESTful Web Services API
Multi Criteria Decision Analysis Tool	CRISMA Multi Criteria Decision Analysis (MCDA) Tools, AngularJS
Report Generation	Drupal 8, Drupal Module, eCharts

Table 24: Building Blocks and Software Components regarding ER06

3.7 Offer commercial fit-for-purpose tailored services targeting specific sectors and user groups

3.7.1 Description

At present, potential demand for Climate Services is not fully developed because, in many cases, the services offered do not match the services requested. The CLARITY exploitation process, offering fit-for-purpose tailored services, targeting specific sectors and user groups, can allow eliminating the actual distance between suppliers and users, focusing on the real demand.

In order to design and develop the novel services that better match the users’ needs, the users must be able to better understand and judge the features of Climate Services, assess whether or not they fit their needs, and clarify if and how they can be adopted in their planning and investment decisions.

CLARITY co-creation process and public consultations aim to eliminate or at least shorten the distance between suppliers and users and to assure the work focuses on the real demand and result in fit-for-purpose tailored services, targeting specific sectors and user groups. Besides integrated and tailored information, provided on appropriate temporal and spatial scale and sectoral assessments, such Expert Climate Service have to take the social needs, which influence business activities and public decision making, into account.

3.7.2 Impact and Validation

This requirement is clearly related to the overall Climate Service co-creation process that results in the provision of tailored Expert Climate Services, which are dealing with the detailed versions of the EU-GL modules and the CLARITY Modelling Methodology, respectively. In the same manner as ER02 “Offer free basic Climate Services based on free and open data” has led to the specification of ICT Climate Services as a core concept of the CLARITY CSIS Architecture’s conceptual Innovation Design (see chapter 3.2.2), this requirement has led to the specification of Expert Climate Services: “An Expert Climate Service is an individual and professional consulting and advisory service that can be provided as joint venture activity of operational, technical and industry specialists. It can be considered a tailored and fit-for purpose "micro" Climate Service that is co-created according to individual user needs and thus a commercial service that users are willing to pay for.” [6]. The main properties of such Expert Climate Services are summarised in Figure 15.

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commercial

paid professional consulting and advisory services

credible

following an accepted and scientifically sound climate risk assessment approach

individual

project-specific scenarios, custom data and model integration, custom micro-climate modelling, detailed climate risk & adaptation studie

scenario-driven

(off-line) scenario analysis and site-specific numerical modelling (calibration and execution)

collaborative

joint venture activity of operational, technical and industry specialists

Figure 15: Main Properties of Expert Climate Services

In the Mock-Ups, Expert Climate Services are currently represented by the possibility to invite external experts to participate in A Climate Adaptation Study (Figure 12). Such Experts would prepare local data ("off-line") and then feed the data back into the CSIS (data-driven approach) as shown in Figure 16.

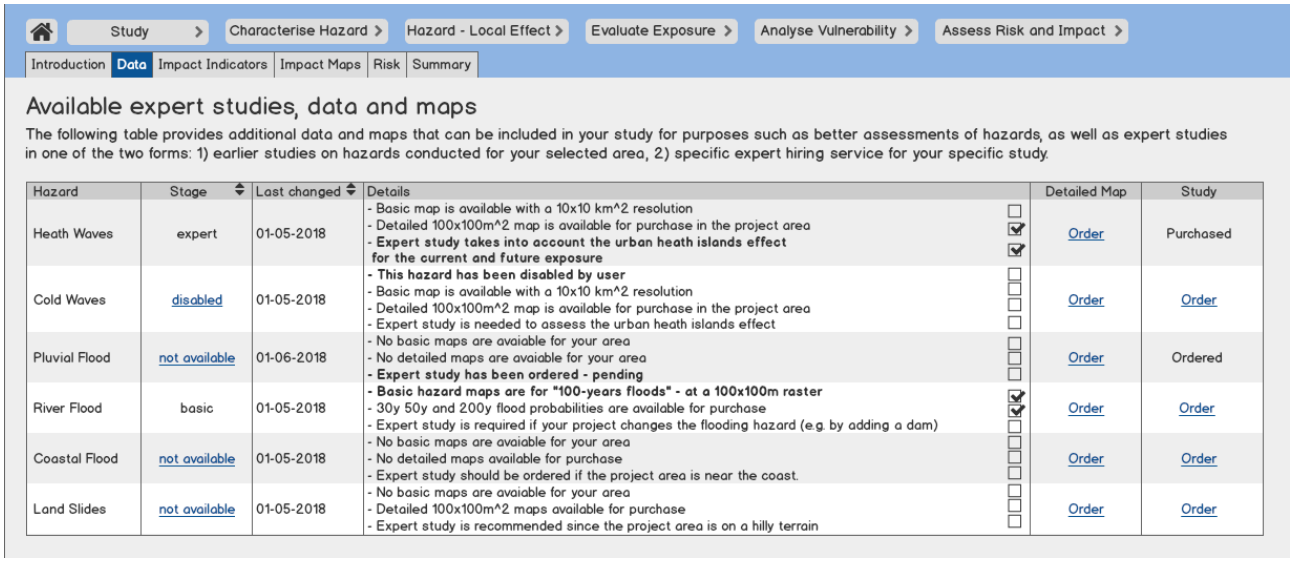

Figure 16: Mock-up covering ER07 (Expert Studies)

As already, mentioned in chapter 3.2.2, the CLARITY Demonstration Cases demand for sophisticated types of Expert Climate Services tailored to their specific needs. The initial Exploitation and Business Plan [4] identified therefore several Expert Climate Services that have to be provided by CLARITY in the context of the implementation of the Demonstration Cases (Table 25).

Expert Climate Services	Demonstration Cases
Expert service for assessment of climate change adaptation measures.	DC1 “Adaptation Scenarios for Metropolitan Resilience Planning”
Model for risk assessment considering/including climate change effects.	DC1 “Adaptation Scenarios for Metropolitan Resilience Planning”
Processed Data (compiled as Data Packages)	DC1, DC2, DC3, DC4
Consulting and expert service analysis of economic, societal impact.	DC1 “Adaptation Scenarios for Metropolitan Resilience Planning”
Expert service user-tailored for large scale investments.	DC2 “Fostering adaptation of large scale infrastructure in Sweden to local climate change effects”
Expert services with scope to the management of multiple flood hazards with a special emphasis on situations where many datasets are available.	DC2 “Fostering adaptation of large scale infrastructure in Sweden to local climate change effects”
Expert service and consulting including climate modelling on local scale.	DC3 “Urban heat waves, urban heat islands, fresh air ventilation”
Modelling of urban microclimate.	DC3 “Urban heat waves, urban heat islands, fresh air ventilation”
Expert service tailored for transport sector and urban infrastructure management.	DC4 “Spanish Transport Infrastructure”

Table 25: Initially envisaged Expert Climate Services of Demonstration Cases

General activities performed under consideration of this Exploitation Requirement are listed in Table 26.

General Activities	Work Package / Task
Modelling activities for Expert Climate Services (Table 22).	WP3/ T3.2 “Climate Intelligence”

Table 26: General Activities regarding ER07

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 27.

Technical Implications	Ongoing Activities
Provide easy technical facilities for external data and service providers to join the CLARITY Community & Marketplace and to offer their Climate Services.	The Marketplace will provide functionalities for creating Service Provider Profiles and Service Portfolios and to link them with other relevant information available in the CSIS.
Provide easy technical facilities for external service providers to develop their Climate Services according to CLARITY conceptual and technical standards.	A standard format for CLARITY Data Packages is being specified that enables external Experts to benefit from CSIS functionality for workflow integration, data visualisation, decision support, report generation, etc. See also chapter 3.10.2.
Provide data repositories for secured and controlled access and technically integrated them into the CSIS Infrastructure.	Data Repositories in support of CLARITY’s data-driven approach towards Expert Services are made available by WP4 “Technology Support”.

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Allow users to discover and possibly order Expert Climate Services directly from within the CSIS while performing a pre-feasibility assessment.	Service Providers Service Portfolios and a Service Provider Catalogue is implemented as part of CLARITY Marketplace and integrated with the CSIS.
Allow specific data collection for Expert Climate Services e.g. for microscale modelling	Specific data collection is carried out for each DC

Table 27: Technical Implications and ongoing Activities regarding ER07

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

Building Blocks	Software Components
Data Repository	GeoServer, GeoNode, ERDDAP / THREDDS, Rasdaman
Marketplace	Drupal 8, Drupal Commerce
Data Package Export and Import Tool	Rich Internet Application (React), Drupal Module

Table 28: Building Blocks and Software Components regarding ER07

3.8 Consider the role of new regulatory frameworks in stimulating the emergence of Climate Services

3.8.1 Description

Under new EU regulatory frameworks, companies and public administrations participating in the elicitation of new (or maintenance of existing) infrastructure projects, are likely to be required to demonstrate that their project plans are climate-change resilient. For example, the vulnerability of urban and transport infrastructure to climate change and its effects depend upon a variety of factors, including the type of infrastructure in question, its location, design, age, relative usage and the particular climate change risks to which the infrastructure might be subject. Furthermore, resilience of such infrastructure to the effects of climate change depends, at least in part, upon the applicable existing EU and national regulatory frameworks and the extent to which those frameworks foster adaptation to climate change by reducing or eliminating the risk of harm or damage now or in the future.

These regulatory frameworks address the risks that climate change poses for such infrastructure, not just in the short to medium term, but also for the whole duration of the life of the infrastructure. Besides, they also need to address the considerable uncertainties associated with climate change, including the location, nature, timing and severity of climate change impacts or events that may occur. At present, infrastructure planners and stakeholders lack tools that can support them in assessing and assuring the compliance of their projects with such EU and national regulatory aspects.

CLARITY Climate Services should support these actors by methodological and transparent means in the assessment and documentation of the possible risks that climate change poses in their projects as well as what adaptation measures can be applied to mitigate their impacts.

3.8.2 Impact and Validation

The first version of this report noted, that there is a lack of tools that can support infrastructure planners and stakeholders to check and meet compliance of their projects with EU and national regulatory aspects. CLARITY Climate Services can support these actors in the assessment and documentation of possible vulnerabilities and risks of climate change in the project as well as what adaptation measures are to be applied to mitigate its impacts.

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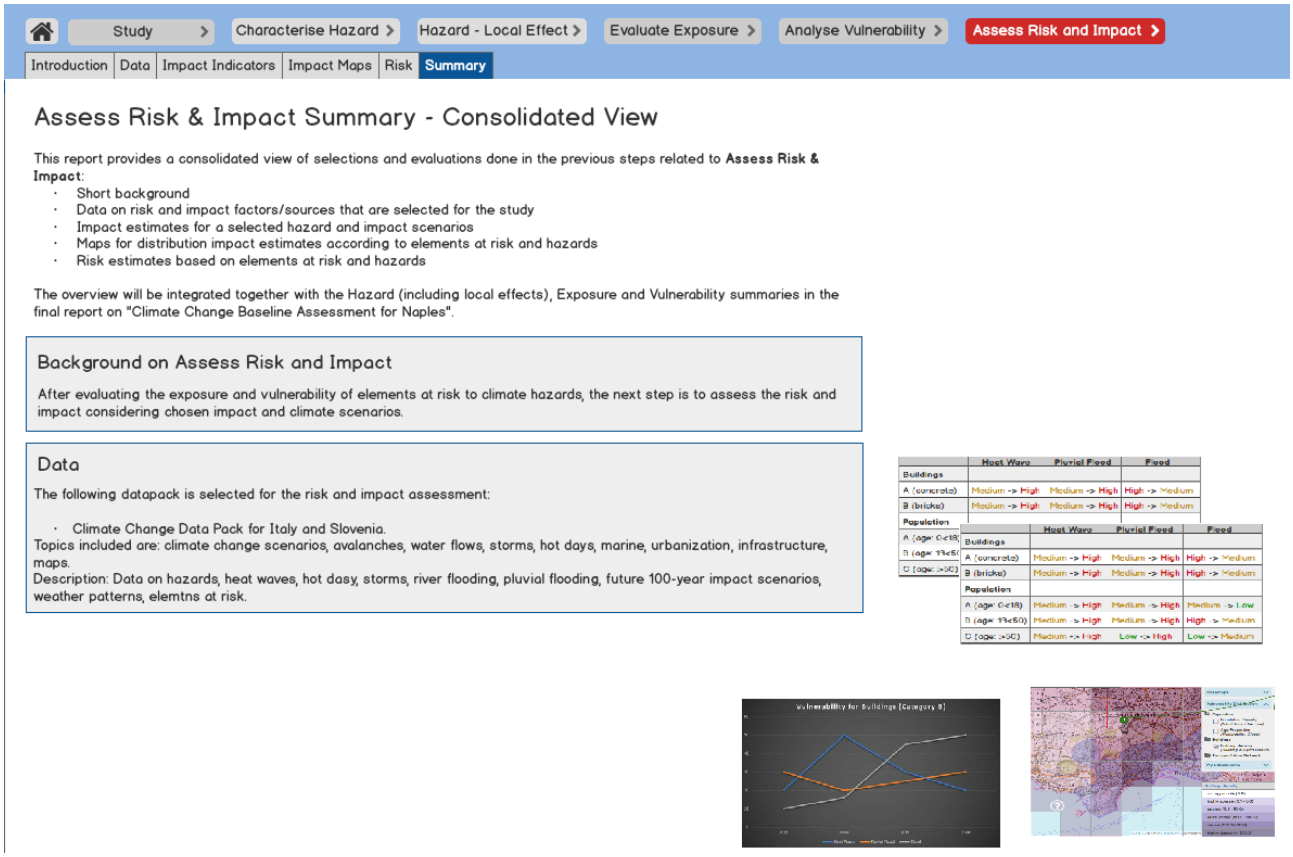

Figure 17: Mock-up covering ER08 (Summary Report)

General activities performed under consideration of this Exploitation Requirement concern mainly report generation feature of the CSIS as the overall architecture and implementation follows the CLARITY Modelling Methodology that is based on guidelines [17] and thus EU regulatory frameworks.

The final result of a climate adaptation study is a report that should be (semi-) automatically generated. Report Generation can be fed by a Data Package, a Reporting Template and should then be able to output a report following a specific structure. This is already reflected in the Mock-Ups (Figure 10 and Figure 17). Content validation is, however, non-trivial. Therefore Report Generation functionality will be limited to structural aspects of reports.

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 29.

Technical Implications	Ongoing Activities
Implement template-based Report Generation has to be implemented based on free and open source software.	Jupyter Notebook (http://jupyter.org/) has been evaluated but seems too complex for our purposes. Currently, it is planned to implement a solution based on Drupal 8 built-in features.
Simple templates for different types of reports have to be defined.	This requires an assessment of regulatory frameworks and their requirements such as for example also the methodology for tracking climate adaptation finance of Multilateral Development Banks. Currently only a default template for EU-GL [17] has been developed as part of the Mock-Ups (Figure 10 and Figure 17).

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Semi- automatic Report Generation depends on well-defined input that can validated, aggregated and visualised. Therefore, technical standards for the respective input formats (Data Packages) have to be defined and communicated to external stakeholders that want to use CLARITY Report Generation functionality for their Expert Climate Services.	This is being addressed as part of the specification of the CLARITY Data Package standard (see also chapter 3.10.2).
All datasets included in the Data Package that are provided together with the accompanying report document must enclose the corresponding metadata records so that external parties are aware of who, when, how (including information about the uncertainty) and for what purpose the data was produced.	It is planned to use the ckan meta-data catalogue not only for storing information about the data that is contained within a CLARITY Data Package but also about the data (e.g. climate intelligence) that was used to produce the actual data.

Table 29: Technical Implications and ongoing Activities regarding ER07

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

Building Blocks	Software Components
Data Package Export and Import Tool	Rich Internet Application (React), Drupal Module
Report Generation	Drupal 8, Drupal Module, eCharts

Table 30: Building Blocks and Software Components regarding ER08

3.9 Provide a user-friendly, intuitive and context -aware discovery and communication infrastructure for Climate Services

3.9.1 Description

Current slow uptake of Climate Services is, at least partially, caused by deficiencies in existing Climate Services portals. In particular, the key barriers to user uptake are related to some portals not being designed with the user in mind, non-intuitive and inconsistent complex navigational schemes and search functionalities, information and service presentation that exceed the knowledge of a novice or non-expert user and unclear definitions of the actual Climate Service offers. To maximise impact and uptake of CLARITY Climate Services, the CSIS has to provide user-friendly, intuitive and context-aware discovery and communication mechanisms.

To increase user experience and usability for non-experts, the user interfaces of the CSIS platform should not presuppose any specific technical skills or deep knowledge of climate change science. Usability in this context also means hiding the complexity of the underlying scientific and technical infrastructure and finding an intuitive and easy way to present an information and service offer that is both relevant and valuable for the specific end-user (while at the same time recalling that this information has to be provided within the service, see also ‘Establish trust in Climate Services and their providers’ in chapter 3.4). This goes hand in hand with an improved (visual) presentation of information, products and services and context-aware discovery functions.

3.9.2 Impact and Validation

Being able to present a relevant and valuable service offer demands for a new information and service discovery approach. The CLARITY Community encourages users to register and create user profiles that contain sector information, professional background, etc. At each step (“module” in EU-GL terminology) the CSIS, has to present information on suitable fit-for-purpose local and sectoral information or providers such

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taking those user profile information into account. When linked to the Marketplace such a discovery approach that recommends relevant content opens new exploitation possibilities.

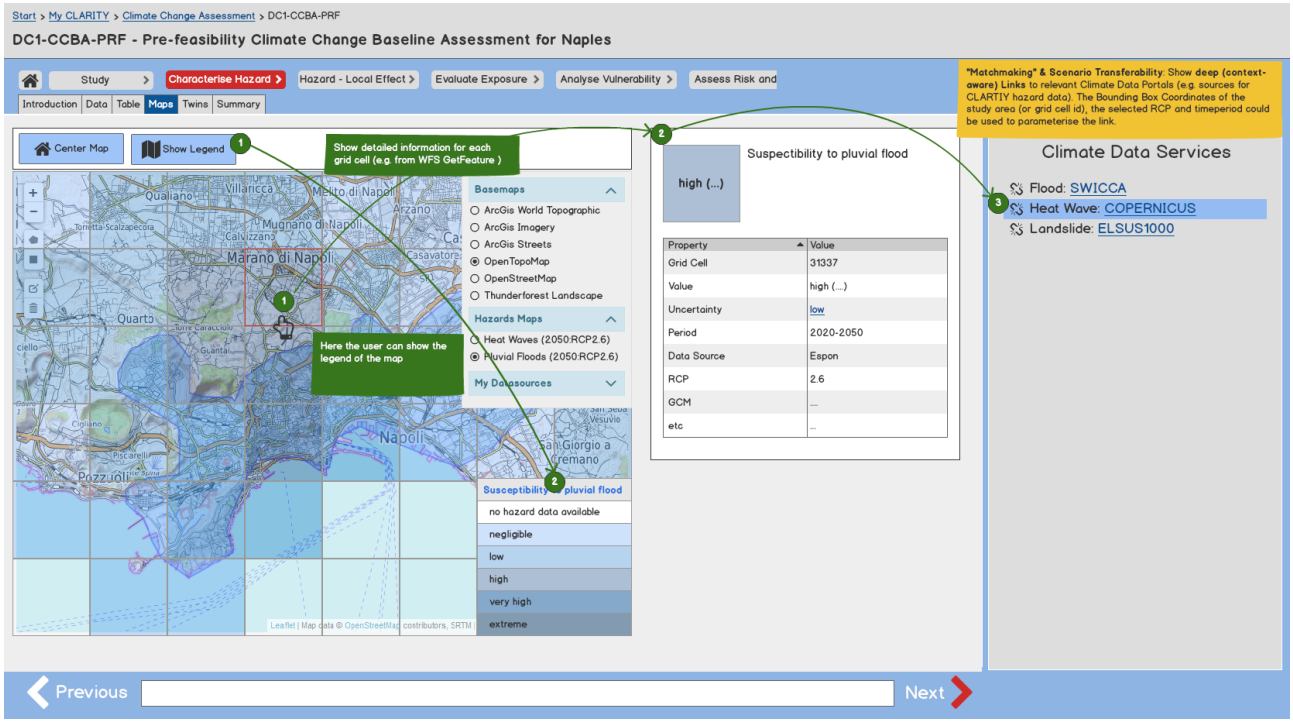

Figure 18: Mock-up covering ER09 (Discovery)

The Mock-Up in Figure 18 shows how links to relevant climate data portals that take the context of the user into account (hazards, spatial location, etc.) could be included in the user interface of the CSIS.

General activities performed under consideration of this Exploitation Requirement are listed in Table 31.

General Activities	Work Package / Task
Collect end-user requirements in terms of discovery, visualization and reporting needs.	T1.2 “Climate Services Requirements” and T5.4 “Climate Service Marketplace”
Implementation and integration of the different building user interface components involved that cover this requirement.	T1.3 “Climate Services Co-creation”, T1.4 “Climate Services Industrialization” and Support and WP4 “Technology Support”

Table 31: General Activities regarding ER09

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 32.

Technical Implications	Ongoing Activities
ICT Climate Services that allow direct user interaction should be developed according concepts for usability and for human computer interaction with help of state-of-the art technologies for user interface design.	CLARITY ICT CS are developed as lightweight web applications rather than heavyweight and complex desktop applications. The Mock-Up process allows user interface developers to react on direct feedback received from end-users.

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A good balance between scientific accuracy and simplicity has to be found that hides complexity from non-(climate change and risk management)experts but still signals credibility to experts.	This is considered in CSIS user interface design. For example, CSIS users are not be forced to make a choice for a specific emission scenario or circulation model. Nevertheless, this particular information has to be given in the provenance information of the respective Climate Services
'Machine-learning' practices could be used to leverage the transition from data to information (data communication) and identify implicit relationships, which in turn improve the overall discovery process.	Automatic discovery (matching) based on user input, e.g. during pre-feasibility study, is part of the Scenario Transferability concept. This is currently being implemented for Hazards (Hazard Twins, see Figure 13).Other possibilities are being investigated.
The source code of the various visual modules to be implemented/integrated in the CIS web client(s) must be tested against the different browser flavours available in the market (i.e., Firefox, Chrome, Safari, Internet Explorer) in order to ensure that they run smoothly and free of incompatibilities in each them.	Plugins for the Jenkins (https://jenkins-ci.org/) Continuous Integration service like Selenium (http://www.seleniumhq.org/) allowing carrying out such automated tests will be used in the development phase.
Discovery and matchmaking (Scenario Transferability) should not be limited to the CSIS (Marketplace) but also provide links to partner portals like Climate-ADAPT (http://climate-adapt.eea.europa.eu/) or Upstream Climate Services like SWICCA (http://swicca.climate.copernicus.eu/). Thereby, contextual information (e.g. spatial location, climate hazard, sector, ...) should also be used (e.g. by means of HTTP GET parameters or deep links) to direct the user to relevant information (e.g. guidance documents) and data (provenance).	This is currently not being considered in the current Scenario Transferability concepts but might be addressed in the future as it provides interesting opportunities also for community building and dissemination activities.
The different steps proposed by EU-GL should be presented to the user in a “story” manner, allowing him to go back and forth, assessing in a visual manner (i.e. maps, graphs, tables) the consequences of the decisions he/she makes in each step.	As shown in the Mock-Ups (Figure 6) the CSIS includes a step-by-step wizard that guides the user through the EU-GL modules.
Reporting Generation should enable the user to easily access and download draft and final reports packages at the end of the project assessment process. Such report packages should include automatically generated documentation (with embedded supporting tables, graphs and maps of the study area) together with all the datasets (Data Package) used in the study in order to be further used in other stages of the planning project.	It is expected that this information can be collected mainly from the Drupal 8 backend, a custom report generation module can then be developed that integrates the different data sources to generate a consolidated report.

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Implement in the interface contact mechanisms from clients, either for support, questions, or request of services.	This will be considered in the next version of the Mock-Ups.
Design and implement functionality to collect customer satisfaction, and maybe analyse this information (automatic report).	This will be considered in the next version of the Mock-Ups.

Table 32: Technical Implications and ongoing Activities regarding ER09

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 “Technology Support”:

Building Blocks	Software Components
Scenario Management	Drupal 8, Drupal Module, cids Integration Base, RESTful Web Services API
Scenario Transferability Component	AIT Climate Twins Prototype, Flamingo 4, MapServer
Report Generation	Drupal 8, Drupal Module, eCharts

Table 33: Building Blocks and Software Components regarding ER09

3.10 Use, define and promote open standards for data and services

3.10.1 Description

The usage of open standards is not only a basic requirement for achieving technical interoperability of products and services and for facilitating collaboration between producers and consumers of those services but also brings considerable economic benefits. Accordingly, standards "help businesses to enhance the quality of their products and the efficiency of their processes", "play a vital and often invisible role in supporting economic growth through their role in boosting productivity and innovation" and "facilitate innovation by creating the environment for the development of new products" [18]. Therefore, the development of the CLARITY CSIS and CLARITY Climate Services, respectively, must be accompanied by the usage, definition and promotion of open standards for data, protocols and services from the very beginning of the projects. On the one hand, this includes technical interoperability and information exchange standards which refer to the structure, content, format and semantics of data used and produced by Climate Services. Here, special attention has to be paid to the compatibility of these standards to existing infrastructure and tools of actual end-users and potential providers of Climate Services. On the other hand, this includes also standards for service provision and quality assurance procedures. In particular, CLARITY has to face the challenge of integrating climate change research results, risk and impact assessment concepts and decision support tools into a well-defined standards-based service offer under the umbrella of the de-facto standard methodology for climate proofing of vulnerable investments.

3.10.2 Impact and Validation

While the project does not aim to pursue the lengthy and complex process of producing a de jure standard, CLARITY aims at establishing the technical and conceptual specifications developed during the course of the project as consortium recommendations or even as de facto standard (by reusing and adapting whenever relevant already existing and well-established standards). CLARITY will identify and if possible adopt the current standards relevant to the scientific and technical domains of project.

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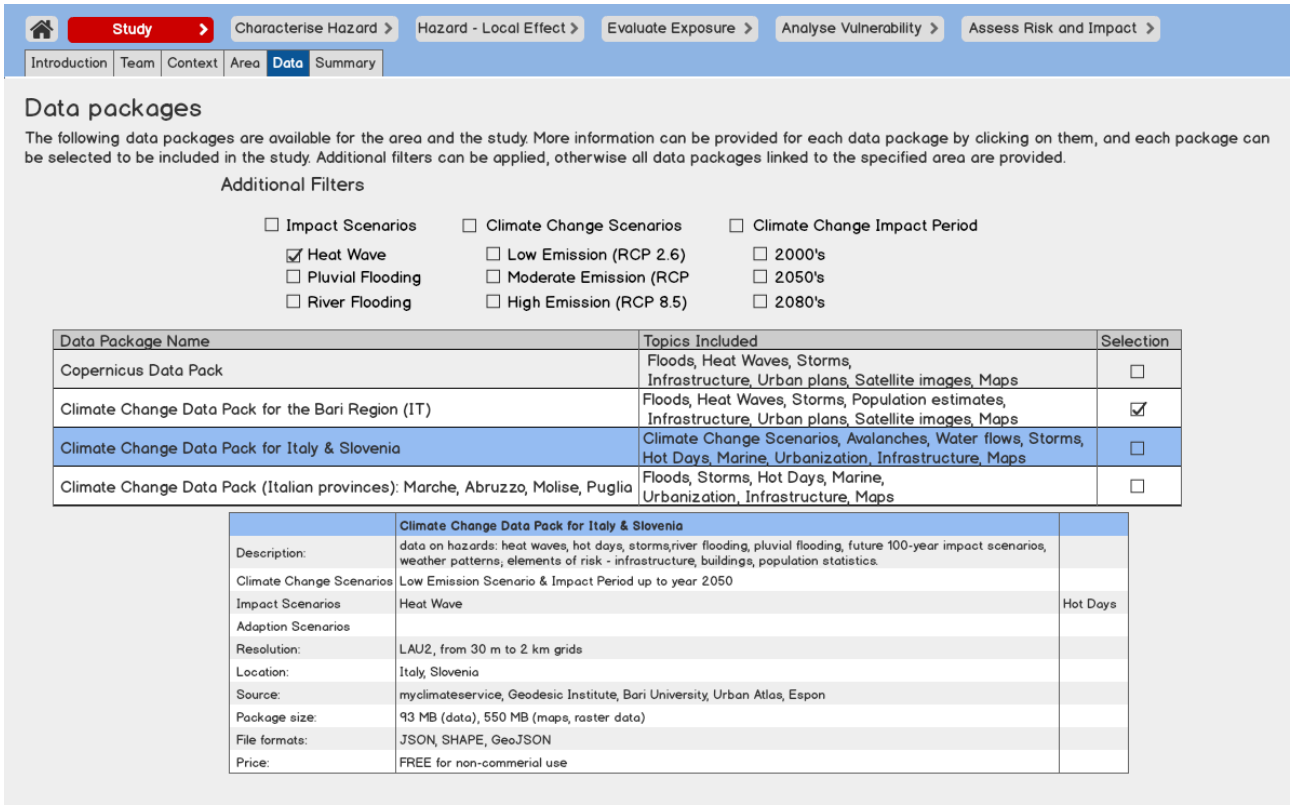

Figure 19: Mock-up covering ER10 (Data Packages)

As described in the CSIS Architecture [6], CLARITY follows a data-driven approach that builds upon standard data formats like Data Packages and OGC Geo Packages. Complex local model execution, like downscaling or urban climate modelling, is performed "offline" as join-venture activity of it-specialists and model experts. Such experts deliver their results as CLARITY Data Package to ensure technical interoperability to the CSIS and thus the Climate Services Ecosystem. A Data Package can either reside inside the CSIS as Virtual Data Package (distributed among several physical data stores, metadata stored on ckan) if the provider of the Expert Climate Service uses the CLARITY CSIS to provide its service, or as concrete file (Serialized Data Package) if the provider works offline. Figure 11 and Figure 19 show the usage of such Data Packages in the CSIS Mock-Ups.

General activities performed under consideration of this Exploitation Requirement are listed in Table 34.

General Activities	Work Package / Task
Identify and adopt the technical standards that are related to climate information (use standardized formats e.g. NetCDF for climate data).	T2.1 “Data requirements definition”, and T2.2 Demonstrator-specific data collection
Identify and adopt standards regarding processes and methods (e.g. disaster risk management concepts, INSPIRE metadata collection).	T3.1 “Scientific Background” and T3.2 “Climate Intelligence”
Verify that format, interface and report standards are met, as well as collaborating with WP3 partners in order to define and validate that the established methodologies are met in the operation of the services.	T2.4 “Validation”

Table 34: General Activities regarding ER10

Concrete technical implications and corresponding activities related to this Exploitation Requirement performed under consideration of these issues are listed in Table 35.

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Technical Implications	Ongoing Activities
The CLARITY Modelling Methodology that is developed in WP3 based on EU-GL combining the concepts of IPCC AR5 and the risk assessment community has to manifest in technical specifications and concrete technical solutions.	The CSIS that is currently co-developed in WP1 and WP1 is the reference implementation of the CLARITY Modelling Methodology.
A simple standardised format for Indicators that are relevant for the Multi Criteria Decision Support has to be defined. Technically, (Impact) model output must be transformed (e.g. by an aggregation or **Indicator Function**) into a standardised **Indicator Set** so that the Indicators can easily be compared or visualised by the respective tools.	This activity will be addressed in T4.5 "Scenario Analysis, Decision Support and Report Generation"

Table 35: Technical Implications and ongoing Activities regarding ER10

Technical Implications derived from this Exploitation Requirement influenced the functional requirements and the technology choices of the following Building Blocks in WP4 "Technology Support":

Building Blocks	Software Components
Data Package Export and Import Tool	Rich Internet Application (React), Drupal Module
Scenario Management	Drupal 8, Drupal Module, cids Integration Base, RESTful Web Services API
Multi Criteria Decision Analysis Tool	CRISMA Multi Criteria Decision Analysis (MCDA) Tools, AngularJS

Table 36: Building Blocks and Software Components regarding ER10

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4 Conclusion

As Innovation Action Project, CLARITY has to deliver innovations that create high impact during and after the lifetime of the project. The activities performed in T5.2 “Exploitation Requirements” raised awareness on exploitation possibilities among all project partners and helped the technical and scientific partners that are not directly involved in business development activities to discover further opportunities for creating valuable and exploitable results.

The first version of this report identified 10 consolidated Exploitation Requirements from 3 thematic clusters and described concrete technical measures and opportunities that will positively influence CLARITY’s exploitation objective. Those technical implications are being considered by the CLARITY consortium through all project activities, in particular during architectural design and co-development of the CSIS and the Climate Services, respectively.

The second version of this report validated the relevance of the Exploitation Requirements and their potential impact against the technical offerings and product and service specifications of WP4 “Technology Support” and WP1 “Co-creation”, concretised innovative aspects of CLARITY products and service and developed a concept for Innovation Design.

CLARITY's Innovation Design builds upon the concept of "Disruptive Innovation" and aims at transforming non-consumers of Climate Services into consumers. It furthermore intends to also attract customers who are focussed on few features or can do with less sophisticated products and services. While CLARITY addresses the market of Climate Services in its first target segments of cities of any size and providers of road infrastructure (construction and operation), CLARITY products and services will enter the bottom of the market and attract new customers that are not (yet) willing to pay for premium or expert services without using it. On the other hand, it allows also experts to get access to the medium performance market that they cannot tackle with their existing highly sophisticated products and services by providing a marketplace (myclimateservices.eu) that aims to support establishing an entire climate services eco-system.

The validation of Exploitation Requirements' technical implications and related topics of innovation design highlighted the noticeable and ongoing influence of this task on the overall product development process and the related activities in WP1 “Co-creation” and “WP4 Technology Support”. Moreover, the Innovation Design aspects will be developed further into business models in WP5 "Exploitation and Business".

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