Security Sensitivity Committee Deliverable Evaluation

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The evaluation is:

- **The content is not related to general project management**
- **The content is related to general outcomes as dissemination and communication**
- **Diagram path 1, 2. Therefore, the evaluation is Public.**

Decision of Evaluation	**Public**	**~~Confidential~~**
	~~Restricted~~	

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RAIN – Risk Analysis of Infrastructure Networks in Response to Extreme Weather
Project Reference: 608166
FP7-SEC-2013-1 Impact of extreme weather on critical infrastructure
Project Duration: 1 May 2014 – 30 April 2017

D8.9 Exploitation Operational Plan

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1. EXECUTIVE SUMMARY

This document summarizes the work carried out under T8.8 Exploitation policy. The main content of the document is to describe the exploitation strategy developed for the main result of the RAIN project. The work conducted has been structured in five phases:

- Agreeing on the scope, description and limitations of the project's main result(s) and the realization of a SWOT analysis
- Evaluating its market penetration potential by identifying the target market (clients and competitors).
- Agreeing on a high level exploitation model taking into account specific issues such as the exploiting entity Legal form, its governance structure, partnerships policy, regulation of Intellectual Property Rights, etc.
- Developing a high level business case including projections for costs and revenues on a five years horizon using two different scenarios.

2. Introduction

The main result of the project is a systematic risk management framework that explicitly considers the impacts of extreme weather events on critical infrastructure and develops a series of mitigation strategies and tools to enhance the security of the pan- European infrastructure network.

This risk management framework, when used by competent professionals provided with the necessary inputs, allows to:

- quantify the complex interactions between weather events and land based infrastructure systems (i.e. transport, telecoms, energy etc.),
- consider the impact on individual hazards and the coupled interdependencies of critical infrastructure through robust risk and uncertainty modelling,
- consider cascading hazards, cascading effects and time dependent vulnerability
- defines the most suitable technical and logistic solutions to minimize the impact of these extreme events, including novel early warning systems, decision support tools and engineering solutions to ensure rapid reinstatement of the infrastructure network

This holistic risk based decision making framework is the result of the coherent integration of different inputs, generated by the RAIN partners as part of the 6 technical Work Packages (WP) during the course of the project.

3. SWOT analysis

In order to evaluate the project's main outputs and the possibilities to successfully penetrate the relevant markets, a SWOT analysis has been performed with the help of all partners.

A SWOT analysis is a process that identifies the strengths (S), weaknesses (W), opportunities (O) and threats (T) of an organization/product to assess what can and cannot be achieved as well as the potential opportunities and threats.

A SWOT analysis takes information from an environmental analysis and separates it into internal strengths and weaknesses, as well as its external opportunities and threats.

• Strengths describe what an organization/product excels at, allowing decisions on how to gain a competitive advantage.

• Weaknesses are the factors that stop an organization from performing at its optimum level. They reduce progress and give a competitive edge to the competition. Weaknesses must be minimized and improved.

• Opportunities refer to favorable external factors that an organization can use to its advantage. If utilized effectively, opportunities have the potential to create a competitive advantage.

• Threats refer to external factors that have the potential to negatively impact an organization.

The main results of this analysis are summarized below using synthetized sentences. The different points have been identified both by partners of the consortium and by members of the project's Advisory Board (AB).

STRENGHTS

1. The developed framework offers solutions focused on identifying the more efficient infrastructure adaptation and upgrading (more resilience) measures which are more efficient (with respect to cost and time) than new constructions.

2. The team behind the tool/framework is a highly experienced multidisciplinary team that can offer a holistic solution to their clients, including:

    • Expert advice provision (consultancy services) both for land transport and energy/telecommunication infrastructures.

    • Implementation (physical construction works) of the proposed solutions.

    • Taking care of the tool/framework maintenance issues.

    • Detecting market trends, doing research and implementing the necessary technology upgrades to keep up with the market evolution.

3. Adaptability of the approach.

4. Not just an engineering basis, but other aspects are assessed such as social consequences.

5. Development and use of methodologies that don't currently exist.

6. Flexibility (multiple scenarios, countries, EWEs, etc.).
7. Experts in several fields providing inputs.
8. ORT product reaches out to stakeholders.
9. Well-constructed tool with support available from highly qualified individuals (AB).
10. Credibility of outputs due to EU review process (AB).
11. Multi-disciplinary approach combining academic theory with industrial experience (AB).
12. Novelty and progress beyond SOTA (AB).
13. Very comprehensive/extensive approach (AB).
14. Consortium experienced and with international presence (AB).
15. Scalable approach depending on client's needs (AB).
16. Room for further development/improvement (AB).
17. New ideas for the decision making tools area (AB).

WEAKNESSES

1. Organizing the governance and partnership for the RAIN team can be complex due to partners' geographical distribution around Europe, different profiles and legal/tax systems, etc.
2. Quantification of impacts is difficult and time-dependent (especially societal). Therefore, it is not easy to justify investment cost (to increase infrastructure resilience) vs benefits (impact mitigation/prevention).
3. Framework quite general.
4. More integration needed among WPs.
5. Product limited to big clients.
6. Dissemination will need lots of resources.
7. Time efficiency.
8. Difficulty to quantify outputs.
9. Data needed for a solid output is massive and difficult to gather (sometimes nonexistent).
10. Low involvement of the client foreseen in the service (as a data provider).
11. Immaturity as a product.
12. Complexity of each case.
13. Difficulty to show the actual benefits for the client.
14. Potential maintenance issues.

15. Limited potential client base (probably no more than 4 or 5 per country) (AB).

16. Heterogeneity of European infrastructure hinders replicability of the process and gathered data (AB).

17. Can the methodology be properly protected by patents (AB).

18. Hard to apply on a real scenario. The model is mainly theoretical (AB).

19. Complexity, framework is not easy to implement (AB).

20. Data requirements are huge (AB).

21. Very engineer focused (AB).

OPPORTUNITIES

1. Intense weather events are happening with progressively higher frequency.

2. The European infrastructure network (transport and energy distribution) is ageing and a large % of it does not comply with the exigent requirements needed to deal with EWEs.

3. The European infrastructure network is vast, dense and heavily interconnected.

4. Early market penetration being the (amongst the) first to develop a tool of this kind.

5. The EU Adaptation Strategy is focused to promote better informed decision-making by improving knowledge on climate change impacts and is where the RAIN project takes part [18].

6. Economic losses will be highest for the industry, transport and energy sectors [18].

7. Accessibility to several countries only by adapting to national criteria and indicators.

8. The model is easily updated and upgraded, according to data availability.

9. Worldwide application (AB).

10. Publication in non-specialist journals (AB).

11. The infrastructure network is expanding worldwide, potential associated losses to infrastructure disruption are increasing worldwide (AB).

THREATS

1. The area of research is a hot topic which encourages the entry of new competitors.

2. Adversities in market expansion due to possible political and bureaucratic priority of some competitors with similar or worse products in non-European foreign countries.

   Regulations could change in several ways affecting the exploitation of the result, e.g. creation of national agencies for weather related risk management.

3. Weather unpredictability implies high uncertainty of real risk happening (infrastructure failure). This might reduce clients' interest and will to invest.

4. Changes in security thresholds for infrastructures could make our product unnecessary.

5. Overestimation of preventive measures can prevent future clients to hire the service/product.

6. Acceptability of an SME as a supplier and provider of support services (AB).

7. Different tools provided by other EU projects (AB).

Table 1 Summary of SWOT analysis

STRENGTHS	WEAKNESSES
• The developed framework offers solutions focussed on the more efficient to infrastructure adaptation and upgrading (more resilience) which is a more efficient (cost and time) approach than building new ones. • The team behind the tool/framework is a highly experienced multidisciplinary team that can offer a holistic solution to their clients. • Adaptability of approach • Not just engineering base, but other aspects assessed such as social consequences • Development and use of methodologies that don't currently exist • Flexibility (multiple scenarios, countries, EWEs, etc.) • Experts in several fields providing inputs • ORT product reaches out to stakeholders • Well-constructed tool with support available from highly qualified individuals (AB) • Credibility of outputs due to EU review process (AB) • Multi-disciplinary approach combining academic theory with industrial experience (AB) • Novelty and progress beyond SOTA (AB) • Very comprehensive/extensive approach (AB) • Consortium experienced & with international presence (AB) • Scalable approach depending on client's needs (AB) • Room for further development/improvement (AB) • New ideas for the decision making tools area (AB)	• Organising the governance and partnership for the RAIN team can be complex due to partners' geographical distribution over Europe, different profiles and legal/tax systems, etc. • Quantification of impacts is difficult and time-dependant. Therefore, it is not easy to justify investment cost vs benefits. • Framework quite general • More integration needed among WPs • Product limited to big clients (UNIZA) • Dissemination will need lots of resources • Time efficiency • Difficulty to quantify outputs • Data needed for a solid output is massive and difficult to gather • Low involvement of the client foreseen in the service • Immaturity as a product • Complexity of each case • Difficulty to show the actual benefits for the client. • Potential maintenance issues • Limited potential client base (AB) • Can the methodology be properly protected by patents (AB) • Hard to apply on a real scenario. The model is mainly theoretical (AB) • Complexity, framework is not easy to implement (AB) • Data requirements are huge (AB) • Very engineer focussed (AB)
OPORTUNITIES	**THREATS**
• Intense weather events are happening with progressively higher frequency. • The European infrastructure network is ageing and a large % of it does not comply with the exigent requirements needed to deal with EWEs. • The European infrastructure network is vast, dense and heavily interconnected. • Early market penetration being the (amongst the) first to develop a tool of this kind. • The EU Adaptation Strategy is focused in promote better informed decision-making by improving knowledge on climate change impacts and is where the RAIN project takes part. [18] • Accessibility to several countries only by adapting to national criteria and indicators • The model is easily updated and upgraded, according to data availability • Worldwide application (AB) • Publication in non-specialist journals (AB) • The infrastructure network is expending worldwide, potential associated losses to infrastructure disruption are increasing worldwide	• The area of research is a hot topic which encourages the entry of new competitors. • Adversities in market expansion due to possible political and bureaucratic priority of some competitors with similar or worst products in not European foreign countries. • Regulations could change in several ways affecting the exploitation of the result. F.i. creation of national agencies for weather related risk management. • Weather unpredictability implies high uncertainty of real risk happening (infrastructure failure). This might reduce clients' interest and will to invest. • Changes in security thresholds for infrastructures could make our product unnecessary. • Overestimation of preventive measures can prevent future clients to hire the service/product • Acceptability of an SME as a supplier and provider of support services (AB) • Different tools provided by other EU projects (AB)

4. Market Analysis

4.1 TARGET CLIENTS

The project deals with current themes which concern both types of companies/organisations, i.e. private and public, that have the necessity to maintain and protect their infrastructures against extreme weather events. Due to this, the following are pointed out the possible clients interested in the project results.

- Policy makers at national/European level.
- Local authorities/municipalities.
- State owned Infrastructure manager companies [7]. Some of these companies are named below.
- Private companies which have to deal with the maintenance of their constructed infrastructures [8].
- Insurance and re-insurance companies.
- National and International Investment Banks (e.g. EBRD, EIB, ADB).

Table 2 Examples of potential target clients (Utilities companies)

COMPANY	DESCRIPTION
UNION FENOSA	Responsible for the regulated electricity distribution activity of Grupo Gas Natural Fenosa.
TELEFONICA	Telecommunications operator Spain.
ONO	Telecommunications operator Spain.
VIESGO	It is responsible for the electricity distribution activity in Cantabria
UDESA	It is responsible for the electricity distribution activity in Coruña
ELECTRICITÉ DE FRANCE	Utility company (electricity distribution) in France
ENEL	Utility company (electricity distribution) in Italy
EON	Utility company (electricity distribution) in Germany
EIRGRID	Utility company (electricity distribution) in Ireland
IBERDROLA	Utility company (electricity distribution) in Spain
ADIF	Railway infrastructure manager (Spain)

Table 3 Examples of potential target clients (Construction companies)

COMPANY	2014 REVENUE $MIL
ACS(IRIDIUM)	38.707,5
HOCHTIEF	29.299,3
BECHTEL	21,414.0
VINCI	19.679,9
CHINA COMMUNICATIONS CONSTRUCTION GRP. LTD.	15,827.0

SKANSKA AB	14,024.9
STRABAG SE	13,972.0
CONSTRUTORA NORBERTO ODEBRECHT SA	10,199.7
FERROVIAL(CINTRA)	8.365,6
OHL	4.294,1
JACOBS	2,605.7
ACCIONA	2.240,8
ISOLUX CORSAN	2,062.7
AECOM	1,869.0
SACYR	1.570,9

- Consultant companies which require a risk management system to provide more efficient and profitable services such as MCKINSEY&COMPANY, BAIN & COMPANY, BCG, BOOZ&CO., MONITOR, DELOITTE, ACCENTURE, OLIVER WYMAN, L.E.K, THE PARTHENON GROUP.

Furthermore, different companies/entities could be interested part of the results derived from the project, such as:

- Companies that study the evolution of the climate change.
- Universities that which to continue doing research in this area.

4.2 POTENTIAL COMPETITORS

There are different competitors within this kind of research projects. Excluding the large number of private companies, which sponsor this kind of projects, there are some entities with the required capabilities to develop similar results with competitive results.

- Universities.
- Private and public research groups.
- R&D Companies (private and public).
- R&D projects.

Potential competitors can come from three different groups:

- Groups of companies/research centres already offering similar services (risk management of weather events impacting infrastructures).
- Groups of companies/research centres already using similar risk assessment/management framework/tools in other areas willing to move into the infrastructure sector.
- Groups of companies/research centres already investigating the weather evolution and impact on infrastructures willing to develop a similar tool to offer similar services.

In the following some projects, tools with similar scopes to the RAIN project are highlighted as they could become into competitors:

Impact of Climate to Long-Range Transportation Planning, Scenario-Informed Multi-criteria Analysis Tool [1]

LOCATION: USA

DEVELOPERS

- Virginia Department of Transportation(VDOT)
- University of Virginia (UV)
  - Centre for Risk Management of Engineering Systems
  - Centre for Transportation Studies
- Virginia Centre for Transportation Innovation and Research (VCTIR)
- Hampton Roads Planning District Commission (HRPDC)
- Hampton Roads Transportation Planning Organization(HRTPO)

OUTPUT

Website quantitative model that is used to adjust priority setting in the regional long-range transportation plan under a range of climate and climate-related scenarios.

DESCRIPTION

The report describes how anticipated impacts of climate change on transportation infrastructure in the Hampton Roads region of Virginia were assessed via a decision model to help prioritize elements of the region's long range strategic plan. This study is part of a larger effort by the United States Federal Highway Administration (FHWA) to understand the vulnerability of critical transportation infrastructure in several regions.

The risks associated with climate change in Hampton Roads have been well documented in a number of existing reports and outreach efforts carried out by a variety of agencies.

The FHWA has developed a conceptual framework for evaluating this emerging risk. The framework is supported by a quantitative model that is used to adjust priority setting in the regional long-range transportation plan under a range of climate and climate related scenarios.

Four separate types of priority setting are addressed: (1) future transportation projects; (2) existing transportation assets; 3) long-term multimodal transportation policies; and 4) transportation analysis zones (TAZs).

The results in terms of adjusted priorities under the several scenarios are being utilized by the Hampton Roads Planning District Commission (Hampton Roads PDC) as they update the regional long--term transportation plan. The model is being made available via a website, in order that it can be adapted to the situations of other regions.

A Conceptual Tool for Climate Change Risk Assessment [10]

LOCATION: USA

DEVELOPERS:

Paul A. T. Higgins and Jonah V. Steinbuck

Policy Program, American Meteorological Society, Washington, D.C.

OUTPUT

The conceptual tool, as currently developed, is not predictive, however, delineates three quasi-independent factors that contribute to the societal consequences of climate change: how climate changes; the sensitivity of physical systems, biological resources, and social institutions to climate change; and the degree of human dependence on those systems, resources, and institutions

DESCRIPTION

This study develops a new conceptual tool to explore the potential societal consequences of climate change. The conceptual tool delineates three quasi-independent factors that contribute to the societal consequences of climate change: how climate changes; the sensitivity of physical systems, biological resources, and social institutions to climate change; and the degree of human dependence on those systems, resources, and institutions. This conceptual tool, as currently developed, is not predictive, but it enables the exploration of the dependence of climate change risks on key contributing factors. In exploring a range of plausible behaviours for these factors and methods for their synthesis, the authors show that plausible assumptions lead to a wide range in potential societal consequences of climate change. This illustrates that the societal consequences of climate change are currently difficult to constrain and that high-consequence climate change outcomes are not necessarily low probability, as suggested by leading economic analyses. With careful implementation, this new conceptual tool has potential to increase public understanding of climate change risks, to support risk management decision making, or to facilitate communication of climate risks across disciplinary boundaries.

Infusing the use of seasonal climate forecasting into crop management practice in North East Australia using discussion support software (WHOPPERCOPPER) [11,12]

LOCATION: AUSTRALIA

DEVELOPERS:

- Whopper Cropper was developed by the Agricultural Production Systems Research Unit and has drawn on the skills of many research and extension officers (Available online 11 September 2002)
- R.A. Nelson, ABARE, GPO BOX 1563, Canberra, ACT 2601, Australia
- D.P. Holzworth , Agricultural Production Systems Research Unit, CSIRO Sustainable Ecosystems, PO Box 102, Toowoomba, Qld 4350, Australia
- G.L. Hammer, Agricultural Production Systems Research Unit, Queensland Department of Primary Industries, PO Box 102, Toowoomba, Qld 4350, Australia

- P.T. Hayman, Agroclimatology Unit, NSW Agriculture, RMB 944, Tamworth, NSW 2340, Australia

OUTPUT

Whopper Cropper consists of a database of simulation output and a graphical user interface to generate analyses of risks associated with crop management options**.**

DESCRIPTION

Seasonal climate forecasting offers potential for improving management of crop production risks in the cropping systems of NE Australia. But how is this capability best connected to management practice? Over the past decade, participative systems approaches involving simulation-aided discussion with advisers and decision-makers have been pursued. This has led to the development of discussion support software as a key vehicle for facilitating infusion of forecasting capability into practice. The basis of the approach is implementation and preliminary evaluation. The software Whopper Cropper was designed for, and in close consultation with, public and private advisers. Whopper Cropper consists of a database of simulation output and a graphical user interface to generate analyses of risks associated with crop management options. The charts produced provide conversation pieces for advisers to use with their farmer clients in relation to the significant decisions they face.

Risk assessment tool box [13]

LOCATION: USA

DEVELOPERS: The University of California

OUTPUT: Selection of risk assessment tools

DESCRIPTION

The University of California has developed a selection of risk assessment tools for various purposes for both internal use and for use by everyone. All tools are available to UC employees and the public.

The UCOP Office of Risk Services (OPRS) offers several Excel-based tools intended to support the risk assessment process at each of the UC locations. Each of these tools has been constructed to provide insight from multiple perspectives. The results of any risk management decision will only be as effective as the accuracy of the data provided by the user. Inaccurate data or other information not provided by the user will naturally affect any results, decisions, or recommendations.

These tools are simply a way to assist users in making informed decisions. Final decisions should be made independently by each organization using these tools.

Inventory of Risk Management / Risk Assessment Tools [14]

LOCATION: EUROPE

DEVELOPERS

- ENISA, European Union Agency for Network and Information Security

DESCRIPTION

ENISA has generated an inventory of Risk Management / Risk Assessment tools. A total of 12 tools have been considered. Similarly, to the inventory of methods, each tool in the inventory has been described through a template. The template used consists of 22 attributes that describe characteristics of tools.

The following presents some of the tools identified in the inventory.

MIGRA Tool [16]

LOCATION: ITALY

DEVELOPERS: AMTEC/Elsag Datamat S.p.A.

OUTPUT

The tool consists of 5 major modules: - the knowledge base (providing full ISO 27001:2005 compliance) - the scenario modelling tool - the risk analysis and conformity engine - the what-if engine - the report generator engine. In addition, one installation of the tool can be used to manage multiple companies. Multiple languages are supported (English and Italian currently available).

DESCRIPTION

"MIGRA Tool" is a web application based on the MIGRA methodology (Metodologia Integrata per la Gestione del Rischio Aziendale). It is designed to support security officers (SO) during the whole process of designing and maintaining an effective and cost effective protection system, with reference to both information and tangible assets security. In fact, when adopted, it becomes the core of the organisation Security Management System (SMS), providing the data necessary to make informed decisions about which actions to take, to justify these decisions and to understand their consequences. Functions are provided to perform actions such as:

- generating a model of the organisation suitable for security analysis
- assessing the adequacy and effectiveness of security measures vs. threats and normative or organisational security policy requirements
- identifying and allocating security roles and responsibilities
- consolidating and sharing security know-how about both threats and countermeasures
- performing a qualitative risk analysis
- performing compliance analysis with reference to legislation, rules, standards or internal policies
- providing risk indicators
- performing what-if analysis
- producing management and operational reports

PROJECTS

"Risk analysis of key freight and transit traffic axes taking seaports into account" (RIVA) [2]

LOCATION: EUROPE

DEVELOPERS

- The Federal Highway Research Institute (BASt)
- Laboratoire d'Economie des Transports

OUTPUT

The aim of this project is to develop instruments for identifying, analysing and assessing the risks involved due to projected climate changes. An MS-Excel-based tool was developed, into which standardized collected data as well as data from climate projections were fed

SUMMARY

AdSVIS research programme

The project "Risk analysis of key freight and transit traffic axes taking seaports into account" (RIVA) is the central AdSVIS project. The aim of this project is to develop instruments for identifying, analysing and assessing the risks involved due to projected climate changes.

The project follows up on the ERA-NET ROAD Project RIMAROCC (Risk Management for Roads in a Changing Climate), in which conceptual foundations for consideration of such risks in relation to road infrastructure are drawn up. It has been necessary, however, to further develop this methodology for the complex road network existing in Germany. For this purpose, an MS-Excel-based tool was developed, into which standardized collected data (e.g. situation data) as well as data from climate projections were fed. This tool has, for example, been applied to some 10 percent of the German section of the Trans-European Transport Network (TEN-T).

The evaluation results generated using the RIVA methodology initially enable the climate-related risks to be prioritized. They can, however, also be drawn upon for a comparison with other risks for road infrastructure. The RIVA Project thus provides an important contribution both for the debate on risk management strategies and the decision-making on the measures necessary.

MATRIX (New methodologies for multi-hazard and multi-risk assessment methods for Europe) [19]

LOCATION: EUROPE

DEVELOPERS

- AMRA: Alexander Garcia-Aristizabal, Warner Marzocchi
- ASPINALL: Gordon Woo
- BRGM: Arnaud Reveillere, John Douglas, Gonéri Le Cozannet
- CEABN-ISA: Francisco Rego, Conceicao Colaco
- GFZ: Kevin Fleming, Sergiy Vorogushyn
- NGI: Farrokh Nadim, Bjørn Vidar Vangelsten

- TU-Delft: Wouter ter Horst

OUTPUT

MATRIX is a Seventh Framework Programme Project, focused on multi-risk evaluation and mitigation strategies for natural extreme events and thus, resolves the deficit of planners and policy-makers, and the scientists who inform their judgements and usually treat the hazards and risks related to such events separately from each other, neglecting interdependencies between the different types of phenomena, as well as the importance of risk comparability. The MATRIX ended in 2013.

UNDP United Nations Development Programme [20]

LOCATION: WORLDWIDE

OUTPUT

UNDP works in some 170 countries and territories, helping to achieve the eradication of poverty, the reduction of inequalities and exclusion, build resilience in order to sustain development results.

Within this programme several researches and risk frameworks related with natural extreme weather events risk management, have been studied. For example, “Risk Assessment and Management for Tsunami Hazard”, “Present cost-effective, locally appropriate coastal management and drainage management options contributing to climate change resilience of communities in Fares-Maathoda “, etc.

ESPON 1.3.1. [21]

LOCATION: EUROPE

DEVELOPERS

- **Authors:** Philipp Schmidt-Thomé (editor), Hilkka Kallio, Jaana Jarva, Timo Tarvainen (GTK), Stefan Greiving, Mark Fleischhauer (IRPUD), Lasse Peltonen, Satu Kumpulainen (CURS/HUT), Alfred Olfert, Jochen Schanze (IOER), Lars Bärring, Gunn Persson (SMHI), António M. Relvão (CCDRC), Maria Joao Batista (INETI)
- **Contributing project partners:** Samrit Luoma, Michael Staudt, Tommi Kauppila, Kaisa Schmidt-Thomé, Johannes Lückenkötter, Benedikt Schlusemann, Christian Lindner, Barbro Johansson, Markus Reinke, Luis Martins, Teresa Gil, Jorge Brandao, Susana Machado. Oskari Orenius, Arturo Fernandez-Palacios Carmona, Laurent Tacher

OUTPUT

The project "1.3.1 The spatial effects and management of natural and technological hazards in general and in relation to climate change", which was conducted within the ESPON 2000-2006 Programme.

The approach of the project was to use existing results of hazard research and to combine those in such a way, that the obtained information is comparable over the entire EU 27+2 area. The natural and technological hazards that are relevant for the EU 27+2 area in the ESPON context were selected by specified risk schemes. A so-called spatial filter was applied to ensure that the selected hazards and risks are relevant for spatial planning concerns. Not all hazards are equally relevant. A weighting system, the Delphi method, was used to develop an integrated European hazard map. However, the method was tested in several case study areas. The resulting integrated hazard map shows a pattern of high and very high hazardous areas

ARMONIA [22]

LOCATION: EUROPE

DEVELOPERS

- T6 (Italy, lead partner)
- Institute for Environment and Sustainability Research, Staffordshire University (United Kingdom)
- Geological Survey of Canada (Canada)
- Czech Centre for Strategic Studies (Czech Republic)
- Department of Urban and Regional Planning, Naples University (Italy)
- Geological Survey of Finland (Finland)
- HR Wallingford Ltd (United Kingdom)
- Institute of Spatial Planning, University of Dortmund (Germany)
- Joint Research Centre (European Union)
- Potsdam Institute for Climate Impact Research (Germany)
- Department for Land Use and Urban Planning, Politecnico di Milano (Italy)
- Algosystems SA (Greece)

OUTPUT

The overall aim of the research project ARMONIA (Applied multi Risk Mapping of Natural Hazards for Impact Assessment) is to provide the EU with a new harmonized methodology for producing integrated risk maps to achieve more effective spatial planning procedures in areas prone to natural disasters in Europe. The objectives to be achieved by ARMONIA

- Integration/optimization of methodologies for risk assessment for different types of potentially disastrous events
- Harmonization of different risk mapping processes for standardizing data collection/analysis, monitoring, outputs and terminology for end users (multi-hazard risk assessment)
- Design of a harmonized decision-making tool structure for applying hazard and risk mitigation in spatial planning
- Contribution to the implementation of natural hazard awareness into the improvement of Environmental Assessment policy

In addition, ARMONIA comprises the following steps:

- Analysis of state-of-the-art for spatial planning and mapping of risk from natural hazards;
- Development of a methodology for harmonized integrated maps;
- Development of a harmonized knowledge base of terminology;
- Integration of harmonized risk maps with spatial planning decision processes;

- Implementation, integration and analysis of a case study simulation.

EC-TIGRA: THE INTEGRATED GEOLOGICAL RISK ASSESSMENT [23]

LOCATION: EUROPE

DEVELOPERS

- Consorzio Civita (Italy)
- Aristotle University of Thessaloniki (Greece)
- ENEL.HYDRO SPA (Italy)
- Ente per le Nuove Tecnologie l'Energia e l'Ambiente (ENEA) (Italy)
- FINSIEL CONSULENZA ED APPLICAZIONI INFORMATICHE SPA (Italy)
- INSTITUTO TECNOLÓGICO GEOMINERO DE ESPAÑA (Spain)
- NATIONAL RESEARCH COUNCIL OF ITALY (Italy)
- NORWEGIAN GEOTECHNICAL INSTITUTE (Norway)
- UNIVERSITY OF CAGLIARI (Italy)
- Università degli Studi di Genova (Italy)
- Université de Liège (Belgium)
- Université de Nice - Sophia Antipolis (France)

OUTPUT

The TIGRA aims to be a feasibility project in order to define criteria and procedures for an integrated methodology on risk assessment. For this scope, the objectives will be achieved by focusing and detecting for some European test areas, an "environmental inventory", based on physical and dynamic features of the territory, and a "socio-economic inventory".

WEATHER: Assessment of impacts on Transport Systems and Hazards for European Regions [24, 25]

LOCATION: EUROPE

DEVELOPERS

- FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. (Germany)
- ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (Greece)
- SOCIETE DE MATHEMATIQUES APPLIQUEES ET DE SCIENCES HUMAINES (France)
- KARLSRUHER INSTITUT FUER TECHNOLOGIE (Germany)
- ISTITUTO DI STUDI PER L'INTEGRAZIONE DEI SISTEMI SC (Italy)
- HERRY CONSULT GMBH (Austria)
- AGENZIA REGIONALE PER LA PREVENZIONE, L'AMBIENTE E L'ENERGIA DELL'EMILIA-ROMAGNA (Italy)
- PANTEIA BV (Netherlands)

OUTPUT

The WEATHER project aims at analysing the economic costs of more frequent and more extreme weather events on transport and on the wider economy and explores adaptation strategies for reducing them in the context of sustainable policy design. Its core objective is to "determine the physical impacts and the economic costs of climate change on transport systems and identify the costs and benefits of suitable adaptation and emergency management strategies".

EWENT: Extreme Weather impacts on European Networks of Transport [26]

LOCATION: EUROPE

DEVELOPERS

- TEKNOLOGIAN TUTKIMUSKESKUS VTT (Finland)
- DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV (Germany)
- TRANSPORTOKONOMISK INSTITUTT (Norway)
- FORECA CONSULTING OY (Finland)
- ILMATIETEEN LAITOS (Finland)
- CYPRUS METEOROLOGICAL SERVICE (Cyprus)
- Via donau – Österreichische Wasserstraßen-Gesellschaft mbH (Austria)
- European Severe Storms Laboratory e.V. (Germany)
- ORGANISATION METEOROLOGIQUE MONDIALE (Switzerland)

OUTPUT

"The project addresses the EU policies and strategies on climate change with particular focus on extreme weather impacts on EU transportation system. The goal of EWENT is to estimate and monetise the disruptive effects of extreme weather events on the operation and performance of the EU transportation system. The methodological approach is based on generic risk management framework that follows a standardised process starting from the identification of hazardous extreme weather phenomena, followed by impact assessment and concluded by mitigation and risk control measures.

INTACT: ON THE IMPACT OF EXTREME WEATHER ON CRITICAL INFRAESTRUCTURES [28], [29]

LOCATION: EUROPE

DEVELOPERS

- NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (Netherlands)
- TEKNOLOGIAN TUTKIMUSKESKUS VTT (Finland)
- FONDAZIONE CENTRO EURO-MEDITERRANEO SUI CAMBIAMENTI CLIMATICI (Italy)
- STICHTING DELTARES (Netherlands)
- FUTURE ANALYTICS CONSULTING LIMITED (Ireland)
- DRAGADOS SA (Spain)
- HR WALLINGFORD LIMITED (United Kingdom)

- PANTEIA BV (Netherlands)
- STIFTELSEN NORGES GEOTEKNISKE INSTITUTT (Norway)
- AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (Spain)
- UNITED NATIONS UNIVERSITY (Japan)
- UNIVERSITY OF ULSTER (United Kingdom)
- Teknologian tutkimuskeskus VTT Oy (Finland)
- UNIVERSITAET STUTTGART (Germany)

OUTPUT

INTACT is an EU funded project which has the principal goal of bringing together innovative and cutting edge knowledge and experience from across Europe in order to develop and demonstrate methods and tools that will enable CI (Critical Infrastructures) operators and CIP policy makers to plan for infrastructure resilience and the risks posed to CI taking account of future climate change. The INTACT project aims to realise this through providing guidance how to determine future risks due to climate change, and best practices on protective measures as well as crisis response and recovery capabilities.

INFRARISK: NOVEL INDICATORS FOR IDENTIFYING CRITICAL INFRASTRUCTURES AT RISK FROM NATURAL HAZARDS [30], [31]

LOCATION: EUROPE

DEVELOPERS

- ROUGHAN & O'DONOVAN LIMITED (Ireland)
- EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH (Switzerland)
- DRAGADOS SA (Spain)
- GAVIN AND DOHERTY GEOSOLUTIONS LTD (Ireland)
- PROBABILISTIC SOLUTIONS CONSULT AND TRAINING (Netherlands)
- AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (Spain)
- UNIVERSITY COLLEGE LONDON (United Kingdom)
- PRAK PETER LEONARD (Netherlands)
- STIFTELSEN SINTEF (Norway)
- RITCHEY CONSULTING AB (Sweden)
- UNIVERSITY OF SOUTHAMPTON (United Kingdom)

OUTPUT

INFRARISK is an EU funded project that aims to develop a strategy to ensure that levels of infrastructure related risk due to natural hazards are acceptable. Stress tests are implemented through an operational framework that supports the work of managers, operators, stakeholders and policy makers, providing insight into the impact of extreme natural hazard events and enabling the vulnerability of their infrastructure networks to be assessed.

STREST: HARMONIZED APPROACH TO STRESS TESTS FOR CRITICAL INFRASTRUCTURES AGAINST NATURAL HAZARDS [32], [33]

LOCATION: EUROPE

DEVELOPERS

- EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZURICH (Switzerland)
- ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE (Switzerland)
- BASLER & HOFMANN AG, INGENIEURE UND PLANER (Switzerland)
- CENTRO EUROPEO DI FORMAZIONE E RICERCA IN INGEGNERIA SISMICA (Italy)
- AMRA - ANALISI E MONITORAGGIO DEL RISCHIO AMBIENTALE SCARL (Italy)
- ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA (Italy)
- NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (Netherlands)
- Universite Joseph Fourier - Grenoble 1 (France)
- ARISTOTELIO PANEPISTIMIO THESSALONIKIS (Greece)
- BOGAZICI UNIVERSITESI (Turkey)
- UNIVERZA V LJUBLJANI (Slovenia)
- JRC -JOINT RESEARCH CENTRE- EUROPEAN COMMISSION (Belgium)

OUTPUT

STREST is an EU funded project that aims to develop a rigorous, consistent modelling approach to hazard, vulnerability, risk and resilience assessment of LP-HC (low probability-high consequence) events. It also establishes a common and consistent taxonomy of non-nuclear Critical Infrastructures. Among the most important assessment tools are the stress tests, designed to test the vulnerability and resilience of individual CIs and infrastructure systems. Following the results of the stress tests recently performed by the EC for the European Nuclear Power Plants, it is urgent to carry out appropriate stress tests for all other classes of CIs.

SNOWBALL: LOWER THE IMPACT OF AGGRAVATING FACTORS IN CRISIS SITUATIONS THANKS TO ADAPTATIVE FORESIGHT AND DECISION-SUPPORT TOOLS [34], [35]

LOCATION: EUROPE

DEVELOPERS

- STE GENERALE DE DISTRIBUTION ET DE COMMUNICATION - GE DI COM (France)
- FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V (Germany)
- ISTITUTO SUPERIORE MARIO BOELLA SULLE TECNOLOGIE DELL'INFORMAZIONE E DELLE TELECOMUNICAZIONI ASSOCIAZIONE (Italy)
- UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II (Italy)
- ERNST-MORITZ-ARNDT-UNIVERSITÄT GREIFSWALD (Germany)
- UNIVERSITE CATHOLIQUE DE LOUVAIN (Belgium)
- INEO ENGINEERING & SYSTEMS SNC (France)

- SZKOLA GLOWNA SLUZBY POZARNICZEJ (Poland)
- PELASTUSOPISTO (Finland)
- EVROPROJECT OOD (Bulgaria)
- MAGYAR VOROSKERESZT TARSADALMI SZERVEZET (Hungary)
- INEO DIGITAL (France)

OUTPUT

SnowBall is an EU funded project with the overall objective of increasing preparedness and response capacities of decision-makers, emergency planners and first responders in respect to amplifying hazards in large disasters. It consists in a deep analysis of cascading effects and development of methods to anticipate them; and in a Decision Support System able to display current crisis monitoring and results of simulated decisions integrating cascading effects, thanks to a data collection system, an Events Log Database, Simulators and a Dashboard. SnowBall innovates in its modular approach to crises, its modelling techniques, its agent-supported coupled grid simulations, its generic Events Log Database and tools to follow public behaviour (Emergency Alert, social networks, mobile application).

5. EXPLOITATION STRATEGY

5.1 EXPLOITATION MODEL

Several possibilities for the exploitation of the RAIN project's main result have been assessed. For instance, a possibility would be to sell the developed risk based decision making framework/tool as a standalone product for the clients to use. That would imply some extra work in terms of providing it with robustness and a user friendly interface. Partners could then exploit (sell) the result independently so no post-project entities would have to be created, thus facilitating the exploitation of the result. However, support solutions for software maintenance would have to be thought of. This possibility is not developed further since this approach doesn't maximize the exploitation possibilities of the tool/framework.

It's been agreed by partners that the best way to exploit the main outcomes of this project is by offering innovative consultancy services for clients, mainly energy, telecoms and transport infrastructures managers although these could be extended to consider other infrastructures e.g. water distribution networks. A consultancy firm/vehicle would have to be created through the association of all/some of the project partners. The multidisciplinary entities partnering in this solution would allow offering a holistic service that would include, for any given scenario (infrastructure network), the following:

- A complete extreme weather analysis focusing on the most probable extreme weather events that could happen in the following X years.
- A multi-criteria risk based decision making framework/tool that will factor in those climate events and the criticality of the elements identified in the scenario to provide a risk profile for the scenario, presented as a failure probability distribution function.
- **A report evaluating the impacts of the different weather events on the scenario.** These impacts would be evaluated from several points of view (societal, security, economic, etc.) and the outcomes of these evaluations would be translated into measurable indictors such as repair costs, loss of live, time losses for infrastructure users, etc.
- This previous analysis will serve as a decision support system for the consultancy company to suggest to the client the most suitable technical and logistic solutions to minimize the impact of extreme weather events on any infrastructure network, ensuring the quickest possible reinstatement of the network.
- In case the client wishes to materialize (all or any of the suggested) mitigation solutions, this firm would be able to carry out the necessary works.

The RAIN consortium is made of a multidisciplinary group of companies and research centres who could easily fulfil the several roles needed to offer the aforementioned holistic service. A consultation was done to the different partners within the consortium and the following table reflects how each partner would contribute to the different tasks which make up this service.

Table 4 Summary of capabilities within the consortium to offer a holistic consultancy service to clients.

Services portfolio	Partners														
	TCD	ESSL	UNIZA	TU-DELFT	GDGEO	DRA	FUB	ROD	HI	ISIG	PSJ	FMI	IPTO	AIA	YOU
EWEs assessment focusing on the most probable extreme weather events that could happen in the following X years.				■	■		■					■			
Identification of the most critial/vulnerable infrastructure elements according to the identified EWEs	■		■	■		■		■	■		■		■	■	
Risk profile assessment factoring in EWEs and CI elements in the scenario. (Failure probability distribution functions) Assessment of vulnerability & resilience	■		■	■		■		■			■			■	
Impact evaluation and cuantification (of the impact of the EWEs on the scenario). Impacts to be evaluated from several points of view (societal, security, economic, etc.) and translated into measurable indicators such (repair costs, loss of live, time losses for infrastructure users, etc.)	■		■	■		■		■	■	■	■		■	■	
Selection of the most suitable technical and logistic solutions to prevent/ minimize the impact of extreme weather events on the infrastructure network. (New assessment taking into account prevention/mitigation actions so an evaluation investment vs cost can be done)	■		■	■	■	■		■	■	■	■		■	■	
Construction works to materialize (all or any of the suggested) prevention/ mitigation solutions (including Project Management)					■	■		■			■		■		

5.2 LEGAL FORM

Regarding the legal form, several possibilities have been identified:

On the one hand, one of the possibilities is to form a **joint venture (JV)**, which is a business arrangement in which two or more parties agree to pool their resources for the purpose of accomplishing a specific task. This task can be a new project or any other business activity. In a joint venture (JV), each of the participants is responsible for profits, losses and costs associated with it. However, the venture is its own entity, separate and apart from the participants' other business interests.

On the other hand, a second possibility is to form a **European Economic Interest Grouping (EEIG)**, which is a type of legal entity designed to make it easier for companies in different countries to do business together, or to form consortia to take part in EU programs. Its activities must be ancillary to those of its members, and, as with a partnership, any profit or loss it makes is attributed to its members. Thus, although it is liable for VAT and employees' social insurance, it is not liable to corporation tax.

In the table below, the main both legal forms are compared.

Table 5 Comparison between JV and EEIG

	Joint Venture (JV)	European economic Interest Group (EEIG)
definition	business entity created by two or more person or organization to share the expense and profit of a particular business project	association between companies or other legal bodies, firms or individuals from different EU countries who need to operate together across national frontiers.
types	• contractual joint ventures • joint ventures partnership • joint venture companies	
capital sharing prerequisite	yes	no
operation limitations	anywhere	only in the EU
number of members	at least 2	at least 2 members from different Members States of the Community
employees	no limit	less than 500
corporation tax	yes	no
liability	limited liability	unlimited liability

Furthermore, another possibility is to create a spinoff, which is an independent company through the sale or distribution of new shares of an existing business or division of a parent company. A spinoff is a type of divestiture. Businesses wishing to streamline their operations often sell subsidiary businesses (not core businesses) as spinoffs.

5.3 GOVERNANCE

Taking into account the size of the consortium which could potentially be formed to offer the aforementioned services, some governance principles should be considered.

Some key principles and how they can be put into practice, including model governance arrangements, are described below. The expectations and needs of all partners will need to be considered and it is not necessarily expected that all significant partnerships should fully apply or adopt all these measures. However, their relevance to each partnership should always be considered.

- **Shared understanding**: Partners should formally agree and record how a partnership operates, including structure, purpose and aims, activities, roles and responsibilities, membership, regulatory framework and exit strategy.
- **Accountability**: Partnerships should account for actions through reporting, meetings, oversight and scrutiny of performance and regulatory compliance, openness and engagement, and complaints and redress procedures.
- **Decision-making**: There should be clearly allocated roles, responsibilities, accountabilities and open and transparent processes, such as records of delegated authority and key decisions and effective scrutiny.
- **Value for money**: Costs and benefits should be understood to ensure arrangements provide value for money over alternative arrangements.
- **Corporate governance processes**: Good governance contributes to delivering high-quality, cost-effective services through effective systems and process for managing issues, such as risk (including insurable risk), performance, finance and information.
- **Standards of conduct and leadership**: High standards should be agreed to govern the way the partnership works, to ensure the needs of all partners are met, to identify conflicts of interest and to resolve disputes.

5.4 REGULATION OF IPR (INTELLECTUAL PROPERTY RIGHTS)

For each of the identified results, partners should make clear if they are bringing information based on their own experience (Background), or are developing new information (Foreground) resulting from their involvement in the specific result development.

In order to anticipate any eventualities or conflicts, the Consortium Agreement (CA) specified from the beginning of the project how to handle patent issues among the partners. Where issues are not covered by the Consortium Agreement, the default EU IPR guidelines can be used. To summarize, prior knowledge and know-how (background) will belong to each of the involved partners.

Partners were required before the beginning of the project, under the CA, to make such information available to the consortium. New knowledge developed during the project (foreground) has been shared by those directly involved in the development. Other consortium partners have been/will be allowed access to the knowledge developed under agreed conditions. In all cases the interest of the industrial partners is to be given priority in order to enhance exploitation of project results.

Basic premises:

- Each partner shall have the ownership of their development (foreground), as well as their current knowledge, tools, software, etc. (background) protected.
- As a result, each partner shall have the right to exploit the knowledge outside the consortium.
- Any partner can join an activity with another partner as long as the IPR state that they are eligible to do it.
- In relation with the previous point, any partner can exploit specific IPR of their own and IPR of other partners only when a specific agreement is in place with the IPR owner.
- Partners should be encouraged to look for synergies with other partners for the definition of new business opportunities, commercialization of results and other activity relevant for the benefit of the consortium.

IPR'S ON BACKGROUND INFORMATION (B)

Background information refers to all information brought to the project from existing knowledge, owned or controlled by project partners in the same or related fields of the work carried out in the research project.

In this case, no partner has declared any specific background information.

IPR'S ON FOREGROUND INFORMATION (F)

Information including all kind of exploitable results generated by the project partners or 3rd parties working for them in the implementation of the research project.

In order to identify the partners contributing to the different results generated in each WP, a consultation was carried out. The table below shows the partners which have contributed to the main (partial) results which constitute the principal components of the risk analysis framework.

Table 6 Compilation of foreground declaration by partners

Foreground declaration (inputs to the Risk Analysis Framework)		Partners														
		TCD	ESSL	UNIZA	TU-DELFT	GDG	DRA	FUB	ROD	HI	ISIG	PSJ	FMI	IPTO	AIA	YOU
WP2	Analysis of the most significant Severe Weather Hazards in Europe and definition of critical intensity threshold levels.							X					X			
WP2	Assessment of the predictability of severe weather with current state-of-the-art forecasting systems through the revision of present state of risk monitoring and early warning systems					X		X					X			
WP3	Methodology to identify potential critical infrastructure elements	X		X	X	X	X				X	X				
WP3	Methodology for measuring societal vulnerability due to failure of those critical land transport infrastructure elements.	X		X						X	X	X				
WP4	Methodology to identify potential critical infrastructure elements in power grids / telecommunication networks to assess the impact of the selected Extreme weather events on those networks													X	X	
WP4	Software tool prototype to assess the impact of selected Extreme weather events on power grids and telecommunication networks														X	
WP5	Mathematical models and algorithms to enable the operation of the Risk analysis framework				X				X		X					
WP6	Methodology to assign failure probability values for critical infrastructures	X			X		X		X					X		
WP6	Probabilistic methodology for quantifying the economic, societal and security impact of CI failure due to extreme weather events for both single and multi-mode risks.			X	X				X	X	X				X	
WP6	Validation of the R.A.F through two specific use cases.	X			X				X		X					
WP7	Assessment of current engineering solutions to increase redundancy and minimiZe the impact of EWEs.	X				X	X							X	X	
WP7	Definition of appropriate remediation/mitigation strategies to increase the safety and reliability of the network.	X		X		X	X			X		X		X	X	
WP	Project management to guide steps											X				

5.5 PROJECTIONS FOR COSTS AND REVENUES ON A FIVE YEARS HORIZON.

A high level exercise has been done with the objective of estimating projections for costs and revenues on a five-year horizon in case a company was created to offer the consultancy services describe before I this document.

Two different scenarios have been considered. One of them includes the whole consortium has members of the company which offers these services. The second one just includes a reduced group of partners, covering all the necessary profiles (DRAGADOS, TCD, YOURIS, TU DELFT, ESSL and AIA).

A simplification of a real cost-benefit analysis has been done for obvious reasons. The different assumptions taken and the process followed are explained below.

The potential consulting company (RAIN JV) would have three business areas, namely the Consultancy area, the software (framework/tool) development area and the marketing area. The first two areas would be divided into different divisions. Consultancy would include (Climate / weather analysis, Transport infrastructure risk and impact assessment, Telecommunications / Energy infrastructure risk and impact assessment, scenarios modelling and societal risk and impact assessment). The software department would include two divisions, one for maintenance and one for software upgrades. The marketing area would cover all marketing and business development tasks.

The figure below summarizes this structure.

Table 7 Structure of the RAIN JV

RAIN JV Structure	
Consultancy	Weather/climate analysis
	Transport infrastr. risk&Impact assessment
	Telco/energy infrast. risk&Impact assessment
	Scenario modelling
	Social risk/impact assessment
Framework / tool	Maintenance
	Upgrade / update
Marketing	Marketing

Most of the resources needed for this company to provide its services come in the form of person months. The resources for each of the areas when offering the consultancy services to one client during one year have been assessed by partners. The PM costs for each different partner have been taken from the DOW.

Table 8 Estimation of resources needed for the consultancy services

Partners roles and resources (PMs) distribution for the first client during the first year								
	Consultancy services					Framework / tool		Marketing
	Weather/climate analysis	Transport infrastructure	Telecomm/ energy infrast.	Scenario modelling	Social risk/ impact	Framework upgrade	Software maint.	Marketing
DSA		1						
TCD		1		1				
ESSL	1							
UNIZA		1						
TU-DELFT				1		0,2	0,1	
GDG		1						
FU-BERLIN	1							
ROD		1						
HI					1			
ISIG					1			
PSJ						0,2	0,1	
FMI	1							
YOURIS								1
IPTO			1,5					
AIA			1,5					
16,6	3	5	3	2	2	0,4	0,2	1

Once the PM costs have been inserted, the cost and resources structure for the company is as follows:

Table 9 Distribution of costs

Resources structure			Overall %
Consultancy	90%	Weather/climate analysis	18,07%
		Transport infrastructure	30,12%
		Telecomm/ energy infrast.	18,07%
		Scenario modelling	12,05%
		Social risk/impact	12,05%
Framework / tool	4%	Maintenance	2,41%
		Upgrade / update	1,20%
Marketing	6%	Marketing	6,02%

Cost structure			€ per area
Consultancy	€ 162.025,11	Weather/climate analysis	€ 34.272,14
		Transport infrastructure	€ 61.361,89
		Telecomm/ energy infrast.	€ 29.400,00
		Scenario modelling	€ 20.097,77
		Social risk/impact	€ 16.893,31
Framework / tool	€ 6.416,42	Upgrade / update	€ 4.277,61
		Maintenance	€ 2.138,81
Marketing	€ 10.400,00	Marketing	€ 10.400,00

Another category of costs is the product/service development costs, mostly incurred during the project duration. The costs considered for the development of the risk analysis framework are also taken from the DOW. Since 50% of those costs are provided by the EC, the real investment required from partners has been half of the total project budget. The financing cost for this investment is assumed to be amortized with an annual interest rate during 5 years.

Other costs such as framework/tool maintenance and update, marketing tasks and travel expenses have been considered:

- The framework/tool maintenance and update costs are proportional to the number of clients
- Marketing costs depend on the expected clients for the following year with fixed minimum amount each year.
- Infrastructure costs are a % of the consulting costs.
- Travel expenses are defined as the combination of the number of clients, number of travels per year and client and an average cost for each trip.

Other variables taken into account for the 5 year scenarios are:

- Expected number of clients for each year.
- Real number of clients each year.
- Price to charge each client for the services provision.
- Corporation tax (country dependant)

An excel sheet has been developed where all the % given to each cost are customisable. By modifying all the customizable costs and other variables, different scenarios can be projected (pessimistic, realistic and optimistic) for the cost-benefit analysis.

Scenario 1

One of the many scenarios that can be generated can be seen below. In this case, the RAIN JV is formed by all 16 partners and the target pursued is to engage 18 clients after 5 years. The resources estimation presented before for this case is rather optimistic (16,6 PMs per client per year) but this scenario has been developed to exemplify the approach followed.

Table 10 instantiates one of the many possible costs and revenues projections for the five years after the consolidation of the RAIN JV. In this scenario, for the clients' engagement curve presented on the blue row, the price per client (green row) has been calculated so that after 5 years the annual balance is close to the break-even point.

In terms of market uptake, this a very pessimistic scenario in which only 6 clients are engaged after 5 years. However, the RAIN JV would stop losing money and become self-sustained with that number of clients at a price of 275.150€ per client per year. (Profit after taxes of 3,68€)

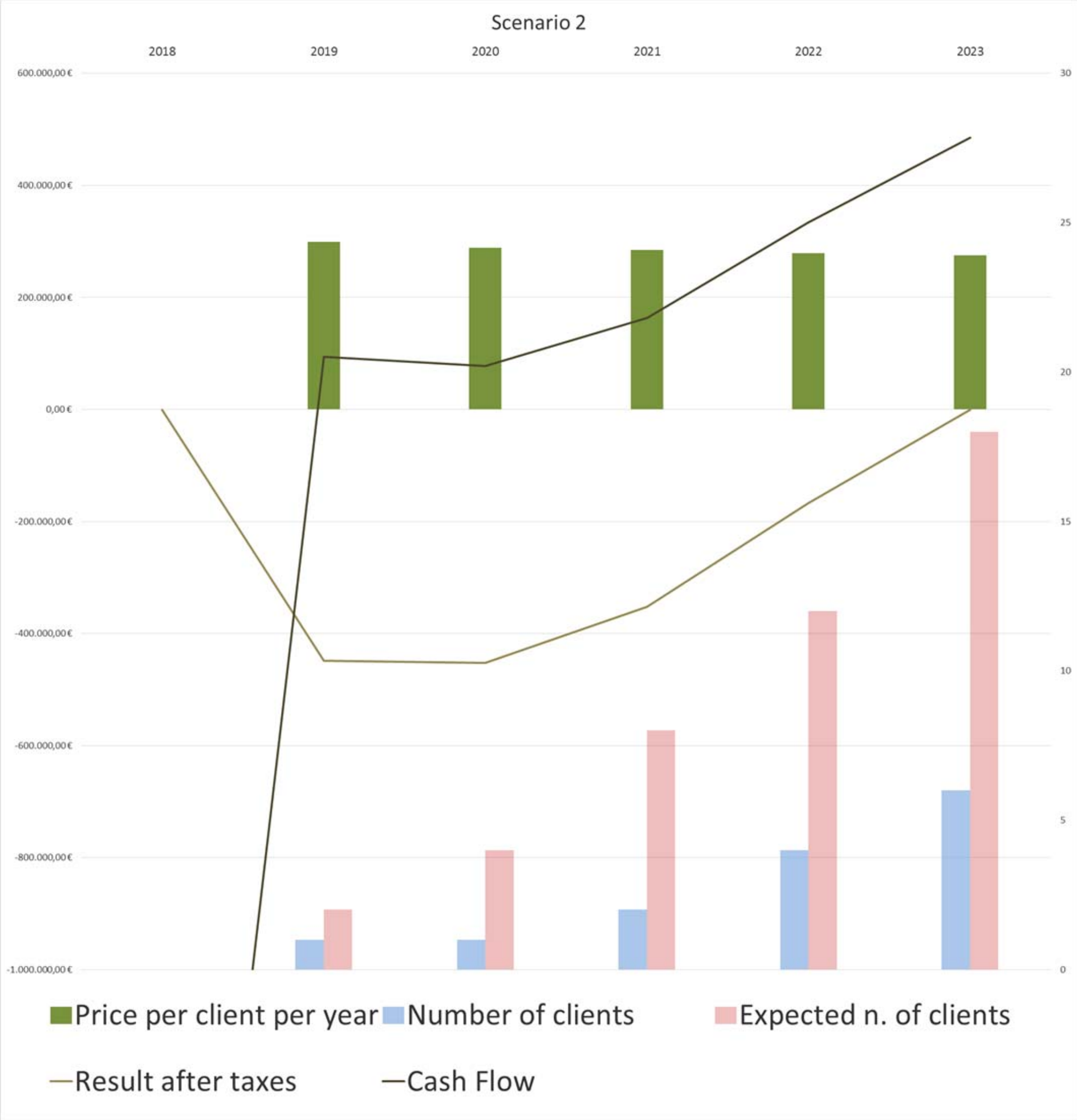
Table 10 5 years cost projection for a specific scenario

			SCENARIO 2					
			Expected n. of clients	2	4	8	12	18
	Asumptions to play with		Number of clients	1	1	2	4	6
			Price per client per year	299.000,00 €	289.000,00 €	285.000,00 €	279.000,00 €	275.150,00 €
STARTING YEAR	2018		2018	2019	2020	2021	2022	2023
			year n	year n+1	year n+2	year n+3	year n+4	year n+5
INVESTMENT								
Product Development	50%		2.387.223,76 €					
TOTAL INVESTMENT			2.387.223,76 €	- €	- €	- €	- €	- €
EXPENSES								
Consulting expenses				171.025,11 €	171.025,11 €	342.050,22 €	684.100,43 €	1.026.150,65 €
Weather/climate analysis				34.272,14 €	34.272,14 €	68.544,27 €	137.088,55 €	205.632,82 €
Transport infrastructure				61.361,89 €	61.361,89 €	122.723,79 €	245.447,57 €	368.171,36 €
Telecomm/ energy infrast.				29.400,00 €	29.400,00 €	58.800,00 €	117.600,00 €	176.400,00 €
Scenario modelling				20.097,77 €	20.097,77 €	40.195,53 €	80.391,07 €	120.586,60 €
Social risk/impact				16.893,31 €	16.893,31 €	33.786,62 €	67.573,25 €	101.359,87 €
Trips/meetings per client per year	3	3.000,00 €		9.000,00 €	9.000,00 €	18.000,00 €	36.000,00 €	54.000,00 €
Maintenance and update expenses				7.165,00 €	7.165,00 €	7.913,59 €	9.410,75 €	10.907,92 €
Maintenace expenses		15%		4.919,26 €	4.919,26 €	5.560,90 €	6.844,18 €	8.127,47 €
Update expenses		5%		2.245,75 €	2.245,75 €	2.352,69 €	2.566,57 €	2.780,45 €
Marketing expenses	2.000,00 €	15%		17.520,00 €	24.640,00 €	38.880,00 €	53.120,00 €	74.480,00 €
Other expenses				8.942,08 €	8.942,08 €	17.884,15 €	35.768,31 €	53.652,46 €
Infrastructure costs	5%			8.942,08 €	8.942,08 €	17.884,15 €	35.768,31 €	53.652,46 €
TOTAL OPERATING EXPENSES			- €	204.652,19 €	211.772,19 €	406.727,96 €	782.399,49 €	1.165.191,02 €
Amortizations				477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €
Product Development				477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €
Financial expenses				65.472,66 €	51.807,66 €	37.727,02 €	23.218,11 €	8.267,90 €
TOTAL FINANCIAL EXPENSES				542.917,41 €	529.252,41 €	515.171,78 €	500.662,87 €	485.712,65 €
TOTAL EXPENSES				747.569,60 €	741.024,60 €	921.899,73 €	1.283.062,36 €	1.650.903,68 €

Table 11 5 years revenues projection for a specific scenario

REVENUES								
COST PER CLIENT PER YEAR				747.569,60 €	741.024,60 €	460.949,87 €	320.765,59 €	275.150,61 €
Revenues per year				299.000,00 €	289.000,00 €	570.000,00 €	1.116.000,00 €	1.650.900,00 €
TOTAL OPERATING REVENUES				299.000,00 €	289.000,00 €	570.000,00 €	1.116.000,00 €	1.650.900,00 €
BALANCE								
RESULT BEFORE TAXES				- 448.569,60 €	- 452.024,60 €	- 351.899,73 €	- 167.062,36 €	- 3,68 €
Profit /Loss before taxes			- €	- 448.569,60 €	- 452.024,60 €	- 351.899,73 €	- 167.062,36 €	- 3,68 €
tax base for corporation tax			- €	- 448.569,60 €	- 900.594,20 €	- 1.252.493,93 €	- 1.419.556,28 €	- 1.419.559,96 €
Corporation tax (15%)	15%		- €	- €	- €	- €	- €	- €
RESULT AFTER TAXES			- €	- 448.569,60 €	- 452.024,60 €	- 351.899,73 €	- 167.062,36 €	- 3,68 €
CAH FLOW								
PROFITS AFTER TAXES			- €	- 448.569,60 €	- 452.024,60 €	- 351.899,73 €	- 167.062,36 €	- 3,68 €
(-) Initial investment			- 2.387.223,76 €	- €	- €	- €	- €	- €
(+) Investment amortization fixed assets			- €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €
(+) Financial expenses			- €	65.472,66 €	51.807,66 €	37.727,02 €	23.218,11 €	8.267,90 €
CASH FLOW			- 2.387.223,76 €	94.347,81 €	77.227,81 €	163.272,04 €	333.600,51 €	485.708,98 €

Table 12 Cost and revenues chart for the 5 year projection for the same scenario



Scenario 2

This second scenario is more realistic, since only a reduced number of companies join together to constitute the RAIN JV after the project conclusion. The partners selected (DRAGADOS, TCD, ESSL, TU-DELFT, IPTO and AIA) cover the whole portfolio of services which are considered to be necessary for the RAIN JV to engage clients with its business proposition. The resources estimation by the partners involved is much higher, especially for the software department and the scenario modelling department. The final distribution is the following:

Table 13 Resources estimation for the RAIN JV in this second scenario (only 6 partners)

Partners roles and resources (PMs) distribution for the first client during the first year								
	Consultancy services					Framework / tool		Marketing
	Weather/climate analysis	Transport infrastructure	Telecomm/ energy infrast.	Scenario modelling	Social risk/ impact	Framework upgrade	Software maint.	Marketing
DSA		5						
TCD		3		3	2			
ESSL	4							
UNIZA								
TU-DELFT	4			6		6	2	
GDG								
FU-BERLIN								
ROD								
HI								
ISIG								
PSJ								
FMI								
YOURIS								3
IPTO			1,5					
AIA			5	3	2	2	2	
53,5	8	8	6,5	12	4	8	4	3

The cost and resources structure for this scenario is the following:

Table 14 Distribution of costs for the second scenario

Resources structure			Overall %
Consultancy	72%	Weather/climate analysis	14,95%
		Transport infrastructure	14,95%
		Telecomm/ energy infrast.	12,15%
		Scenario modelling	22,43%
		Social risk/impact	7,48%
Framework / tool	22%	Maintenance	14,95%
		Upgrade / update	7,48%
Marketing	6%	Marketing	5,61%

The projection of costs and revenues for the next 5 years (with the same market uptake than in the previous scenario) can be seen below:

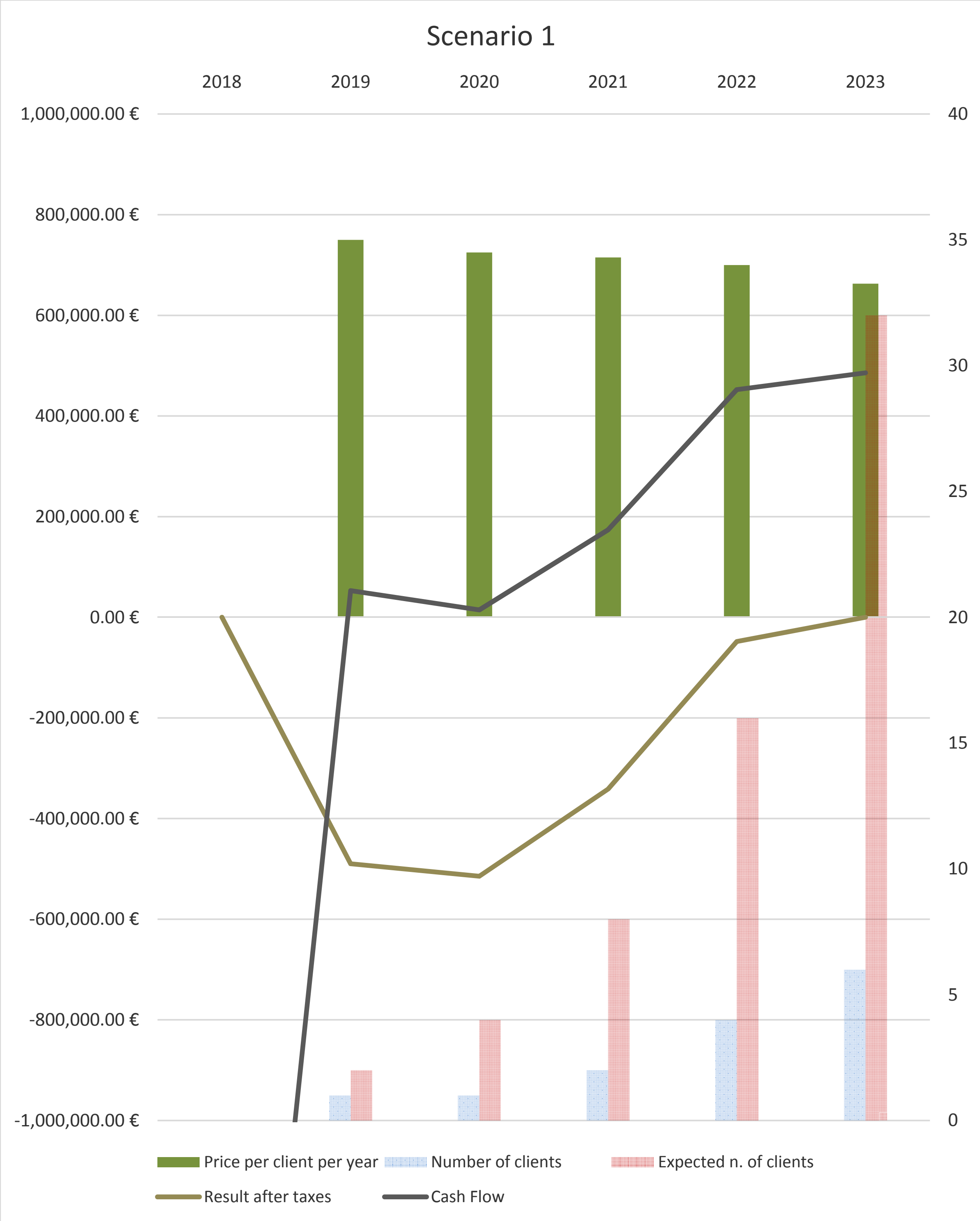
Table 15 5 years cost projection for a specific scenario

			SCENARIO 3					
	Asumptions to play with		Expected n. of clients	2	4	8	16	32
			Number of clients	1	1	2	4	6
			Price per client per year	750.000,00 €	725.000,00 €	715.000,00 €	700.000,00 €	663.000,00 €
STARTING YEAR	2018		2018	2019	2020	2021	2022	2023
			year n	year n+1	year n+2	year n+3	year n+4	year n+5
INVESTMENT								
Product Development	50%		2.387.223,76 €					
TOTAL INVESTMENT			2.387.223,76 €	- €	- €	- €	- €	- €
EXPENSES								
Consulting expenses				471.766,70 €	471.766,70 €	943.533,40 €	1.887.066,80 €	2.830.600,20 €
Weather/climate analysis				78.832,28 €	78.832,28 €	157.664,57 €	315.329,13 €	472.993,70 €
Transport infrastructure				98.129,09 €	98.129,09 €	196.258,18 €	392.516,35 €	588.774,53 €
Telecomm/ energy infrast.				68.600,00 €	68.600,00 €	137.200,00 €	274.400,00 €	411.600,00 €
Scenario modelling				160.385,94 €	160.385,94 €	320.771,87 €	641.543,75 €	962.315,62 €
Social risk/impact				47.819,39 €	47.819,39 €	95.638,78 €	191.277,57 €	286.916,35 €
Trips/meetings per client per year	3	6.000,00 €		18.000,00 €	18.000,00 €	36.000,00 €	72.000,00 €	108.000,00 €
Maintenance and update expenses				149.757,76 €	149.757,76 €	166.058,67 €	198.660,50 €	231.262,33 €
Maintenace expenses		15%		110.722,81 €	110.722,81 €	125.164,92 €	154.049,13 €	182.933,34 €
Update expenses		5%		39.034,95 €	39.034,95 €	40.893,76 €	44.611,37 €	48.328,98 €
Marketing expenses	2.000,00 €	15%		44.560,00 €	57.920,00 €	84.640,00 €	138.080,00 €	244.960,00 €
Other expenses				30.921,18 €	30.921,18 €	61.842,35 €	123.684,71 €	185.527,06 €
Infrastructure costs	5%			30.921,18 €	30.921,18 €	61.842,35 €	123.684,71 €	185.527,06 €
TOTAL OPERATING EXPENSES			- €	697.005,64 €	710.365,64 €	1.256.074,43 €	2.347.492,01 €	3.492.349,59 €
Amortizations				477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €
Product Development				477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €
Financial expenses				65.472,66 €	51.807,66 €	37.727,02 €	23.218,11 €	8.267,90 €
TOTAL FINANCIAL EXPENSES				542.917,41 €	529.252,41 €	515.171,78 €	500.662,87 €	485.712,65 €
TOTAL EXPENSES				1.239.923,05 €	1.239.618,05 €	1.771.246,20 €	2.848.154,87 €	3.978.062,24 €

Table 16 5 years revenues projection for a specific scenario

REVENUES							
COST PER CLIENT PER YEAR			1.239.923,05 €	1.239.618,05 €	885.623,10 €	712.038,72 €	663.010,37 €
Revenues per year			750.000,00 €	725.000,00 €	1.430.000,00 €	2.800.000,00 €	3.978.000,00 €
TOTAL OPERATING REVENUES			750.000,00 €	725.000,00 €	1.430.000,00 €	2.800.000,00 €	3.978.000,00 €
BALANCE							
RESULT BEFORE TAXES			- 489.923,05 €	- 514.618,05 €	- 341.246,20 €	- 48.154,87 €	- 62,24 €
Profit /Loss before taxes		- €	- 489.923,05 €	- 514.618,05 €	- 341.246,20 €	- 48.154,87 €	- 62,24 €
tax base for corporation tax		- €	- 489.923,05 €	- 1.004.541,10 €	- 1.345.787,30 €	- 1.393.942,17 €	- 1.394.004,41 €
Corporation tax (15%)	15%	- €	- €	- €	- €	- €	- €
RESULT AFTER TAXES		- €	- 489.923,05 €	- 514.618,05 €	- 341.246,20 €	- 48.154,87 €	- 62,24 €
CAH FLOW							
PROFITS AFTER TAXES		- €	- 489.923,05 €	- 514.618,05 €	- 341.246,20 €	- 48.154,87 €	- 62,24 €
(-) Initial investment		- 2.387.223,76 €	- €	- €	- €	- €	- €
(+) Investment amortization fixed assets		- €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €	477.444,75 €
(+) Financial expenses		- €	65.472,66 €	51.807,66 €	37.727,02 €	23.218,11 €	8.267,90 €
CASH FLOW		- 2.387.223,76 €	52.994,36 €	14.634,36 €	173.925,57 €	452.507,99 €	485.650,41 €

Table 17 Chart for the 5 year projection



6. CONCLUSIONS

The systematic risk management framework developed within the project is a new approach towards the problem of helping infrastructure managers to take decisions about how to best protect their assets against the impacts of the constantly evolving weather. There seems to be many other similar initiatives which might become competitors on the medium term, but that shows as well that there is a market need to be solved, which provides room for market penetration for partners within the consortium which want to offer the services described in the document. Besides, the SWOT analysis carried out with the help of RAIN partners and the Advisory Board members lead us to think that the timing for the exploitation of this development is right, since it is a problem which is being considered at several levels.

It seems that no partner within the consortium has the necessary know-how to be able to exploit the whole potential of this framework. Therefore, it seems unavoidable that partners join efforts once RAIN is finished in order to be able to exploit its main outcomes. The complexity of the consortium of partners which have collaborated in the development of the RAIN risk management framework is a great difficulty when it comes to defining a clear exploitation strategy. Partners have different profiles, governances, economic interests and target markets, so elaborating a clear joint strategy for all the partners is hardly feasible. For that reason, several simplifications have been considered and the most plausible scenario is one where partners form a joint venture (RAIN JV) to co-ordinately offer the services described in this document. This JV, where partners have complementary roles, simplifies governance and unites interests.

The developed scenarios lead to think (bearing in mind that the costs estimations are merely estimations) that it would be feasible to offer solid services to infrastructure managers with a sensible price. It needs to be considered however that, as in all R&D projects, the project’s main results could still benefit from some finer tuning and further validation of the tool and methodologies through more case studies. That would provide the framework with more robustness, which is a must before engaging with real clients.

It is recommended that core partners keep track of each other and arrange discussions once RAIN is finished on how to move forward with the exploitation of this framework, either as a holistic service (all the services mentioned in the document) or focussing on the exploitation of only a part of those services.

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