



EUROPEAN COMMISSION
SEVENTH FRAMEWORK PROGRAMME

PROJECT FINAL REPORT

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| Scientific representative of the project's coordinator | Peter Petiet - +31 88 8664006 peter.petiet.tno.nl |



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Scientific representative
of the project's coordinator: Mr P. Petiet.



| | |
|--------------------------|---|
| Organisation | TNO – The Netherlands |
| Telephone | +31 88 8664006 |
| E-mail: | peter.petiet@tno.nl |
| Project website address: | http://www.intact-project.eu/ |

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1 Executive summary

Resilience of Critical Infrastructure (CI) to Extreme Weather Events (EWE) is one of the most demanding challenges for both government and society. CI are especially sensitive to EWE. The economic and societal relevance of the dependability and resilience of CI is obvious: infrastructure malfunctioning and outages can have far reaching consequences and impacts. Extreme Weather (EW) is a key phenomenon that can cause severe threats to the well-functioning of CI. The increased frequency and intensity of EW can cause Induced Hazards (IH) such as flooding, drought, ice formation, etc. which present a range of complex challenges to the operational resilience of CI. Moreover, besides a direct effect of EWE and/or IH on CI, this operational resilience is challenged further by indirect, cascading, effects of failure of one type of CI on another type of CI. This increased severity and variability in EWE resulting from effects of climate change, requires CI owners and operators to re-assess their risks and their risk management process. But: how to take (the impact of) climate change into account, how to assess your (future) vulnerability, or, how to identify potential measures for planning, designing and protecting CI?

The INTACT project supports this risk management process. INTACT is an EU FP7 project designed to offer decision support to CI operators and policy makers regarding Critical Infrastructure Protection (CIP) against changing EWE risks caused by climate change. The INTACT Wiki (www.intact-wiki.eu) is the platform in which the knowledge, tools and methods, developed in INTACT are shared with the world. It provides information, references, guidance and experiences on how to ensure continued resilience of CI in the context of changing climate and related EWE. This information is primarily directed at CI operators and policy makers involved with these CI. Amongst other, it contains data on:

- Climate change for the medium-term & long-term period;
- Changes in frequency and strength of EWEs;
- Changes in induced hazards;
- State-of-the-Art tools and methods used in risk assessment;
- Specific vulnerabilities for EWE for specific CI;
- Assessed best practices on mitigation measures;

In order to use this data to determine the future EWE risks to your CI, and to guide the user through this large information source, we have developed a step-by-step method using a general risk management process. This method identifies the main steps comprising ‘good practice’ in decision-making. It recognises the circular nature of risk management, which may require the review of the risk analysis and assessment after implementation of risk reduction control measures. In each of these steps, it is described why which tools/methods are applicable, and how you should use them. With these outcomes, INTACT brings value added to:

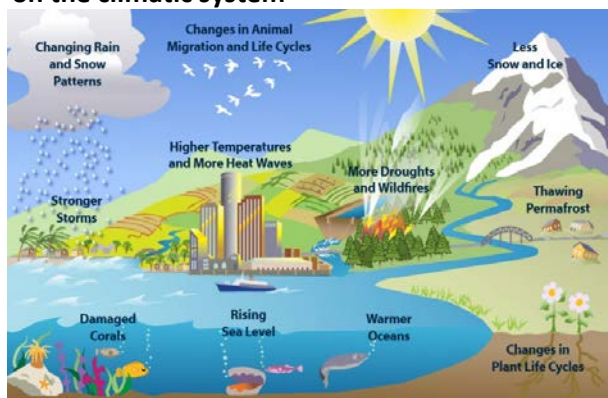
- (Public and Private) Policy planners: to improve their decision-making when taking measures to protect CI against current and future EWE.
- Critical Infrastructure Operators: to improve their awareness, preventive actions, response and recovery options for future EWE and the potential impact to their CI.
- Academia and Scientists: to stimulate a multidisciplinary approach and to create new methodologies and technologies to reduce the vulnerability of CI and to mitigate EW effects.
- Society: to improve both the decision-making in where and how to reduce vulnerabilities and so to further safeguard the security of Europe’s citizens and Europe’s economy.

2 Summary description of project context and objectives

2.1 Changing climate, changing EWE, changing risks on CI

Resilience of Critical Infrastructure (CI) to Extreme Weather Events (EWE), such as heavy rainfall,

Figure 2.1 Impact continued warming on the climatic system



drought or icing, is one of the most demanding challenges for both government and society. Extreme Weather (EW) is a phenomenon that causes severe threats to the well-functioning of CI. The effects of various levels of EW on CI will vary throughout Europe. These effects are witnessed through changes in seasons and extreme temperatures (high and low), humidity (high and low), extreme or prolonged precipitation (for example rain, fog, snow, and ice) or prolonged lack thereof (drought), extreme wind or lack of wind, and thunderstorms.

The increased frequency and intensity of EWE can cause events such as flooding, drought, ice formation and wild fires, which present a range of complex challenges to the operational resilience of CI. The economic and societal relevance of the dependability and resilience of CI is obvious: infrastructure malfunctioning and outages can have far reaching consequences and impacts on economy and society. The cost of developing and maintaining CI is high if they are expected to have a realistic functional and economic life (50+ years). Hence, future EWE has to be taken into account when considering protection measures, mitigation measures and adaption measures to reflect actual and predicted instances of CI failures.

Figure 2.2 Damaged power pylon due to high winds



2.2 (Re)assess impact of EW on CI

Within this context, the EC has formulated and FP7 research topic in 2013 calling for reassessing the impact of EW on CI¹. It called for reassessing regionally differentiated risks, developing a better understanding of factors and the elements to include in risk analysis of societal security, identifying in a systemic way the European and national critical infrastructures that should be re-assessed for extreme weather risks, and reviewing technologies to protect against extreme weather.

2.3 Decision making in the context of business continuity

In considering the enhancement of CI in the event of EWE, the CI operator is faced with a complex physical and technical challenge, to strengthen CI, without introducing unwarranted impacts (cascading) on surrounding CI, properties and on the wider economy and society. The decisions made need to be cognisant of a variety of constraints and need to 'make sense' of a wide range of competing

¹ SEC-2013.2.1-2 Impact of extreme weather on critical infrastructure – Capability Project

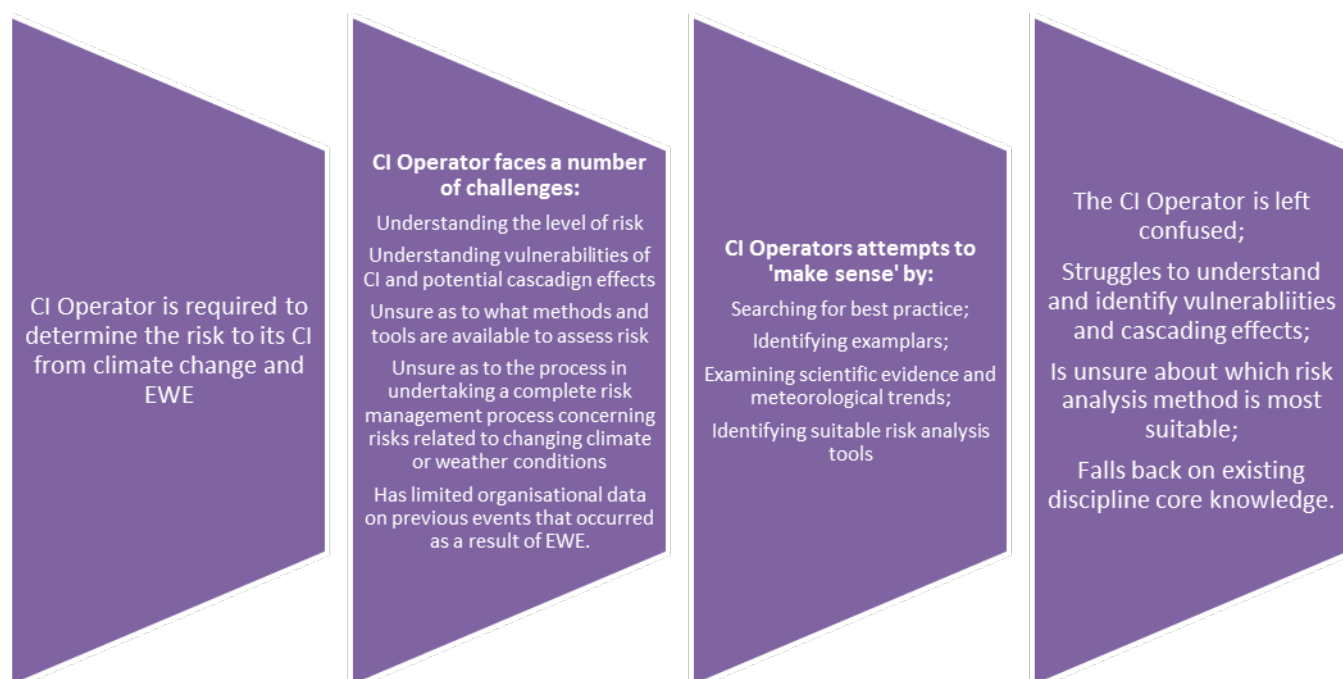
interests and potential solutions. In dealing with this multifaceted scenario, CI operators or decision makers are most likely to fall back on:

- Their own discipline knowledge
 - Strong in terms of applicability to the relevant parts of the challenge – such as where there are current issues and what areas need immediate attention;
 - Weak in terms of different disciplines – such as flood defence design, climate change understanding, vulnerability of CI and the impacts arising from cascading effects.
- Expert advice
 - Strong in reference to the specific problems or aspects addressed;
 - Weak in that it requires advice to be sought, perhaps at considerable additional cost.
- Published design guidance
 - Strong in terms of application to the specific problems or aspects addressed;
 - Weak in terms of full coverage, may be somewhat general, often discipline specific – may be more difficult to find and/or understand.

The challenge is therefore to upgrade the ability of (in this case) the CI operator to locate and prioritise a wide range of potentially relevant information from across disciplines and suitably apply a risk analysis method which will adequately assess the outstanding CI risks and provides the user with a more informed decision making process, which will ultimately help to attain improved resilience of the users CI.

A brief scenario is visualized in Figure 2.3. The case relates to a CI operator who is tasked with undertaking a risk assessment to assess level of risk to CI in the event of EWE. The challenge is to correctly determine the risk to CI from EWE and to identify vulnerabilities and potential cascading effects.

Figure 2.3 The INTACT Challenge

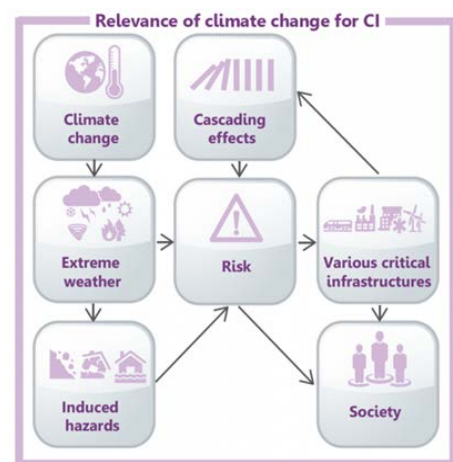


2.4 INTACT main concept

Provided the context and the goal of reassessing the impact of EW on CI, it is crucial to provide a common language and playground, since although it is a multi-disciplinary issue, risk management is treated differently by policy makers, infrastructure operators and other stakeholders from the critical infrastructure protection & resilience, emergency management, and climate change domains.

To this end, INTACT first developed a main concept on how we connect the various domains/ expertise, with risk (management) as key-point (Figure 2.3). It shows that Climate Change (a rather slow changing parameter), affects EW and EWE which can cause a direct risk to CI and (therefore to) society. Then, increased frequency and intensity of EW can cause Induced Hazards (IH) such as flooding, drought, ice formation, etc. which present another range of risk and complex challenges to the operational resilience of CI. Moreover, besides direct effect of EWE and/or IH on CI, this operational resilience of CI is challenged further by indirect, cascading, effects of failure of one type of CI due to EWE and/or IH on another type of CI.

Figure 2.4 INTACT main concept



2.5 INTACT objectives

This context and main concept serves as basis for the overall objective of the INTACT project, which is “to offer Decision Support to CI operators & policy makers regarding Critical Infrastructure Protection (CIP) against changing EWE risks caused by climate change”. The decision support is the crucial instrument to enhance the aspect of business continuity, or, sustained resilience, in order to allow societies and economies to function unimpaired. This overall objective concerns to:

- Assess regionally differentiated risk throughout Europe associated with extreme weather;
- Identify and classify on a Europe wide basis CI and to assess the resilience of such CI to the impact of EWE;
- Raise awareness of decision-makers and CI operators about the challenges (current and future) EW conditions may pose to their CI; and,
- Identify potential measures and technologies to consider and implement, be it for planning, designing and protecting CI or for effectively preparing for crisis response and recovery.

Central is the identification of which components and elements of CI are most critical, and how resilient they are to stochastic and transient EWE and patterns. A major obstacle to resilience planning is the unknown nature of the next major EWE. Careful assessment of potential risk and informed analysis of dependencies between CI can contribute significantly to effective investment in planning and design and inform preparedness actions in the event of failure.

As a consequence, there is an obligation to revisit and reassesses the risk posed to existing CI and to develop practical (evidence based) responses to inform adaptation and resilience enhancement. To facilitate this there is a need to reach consensus on the climate parameters, to address gaps in climate projections alongside other agreed risk-based techniques and to develop a set of validated tools and



datasets tailored to practical needs premised on robust cost-benefit typologies which depict the level of the risk and the severity of impact (social, economic, environmental, etc.) that would result in CI failure.

The INTACT project addresses these challenges and brings together innovative and cutting edge knowledge and experience in Europe in order to develop and demonstrate best practices in protective measures, mitigation measures and adaption measures, as well as crisis response and recovery capabilities.

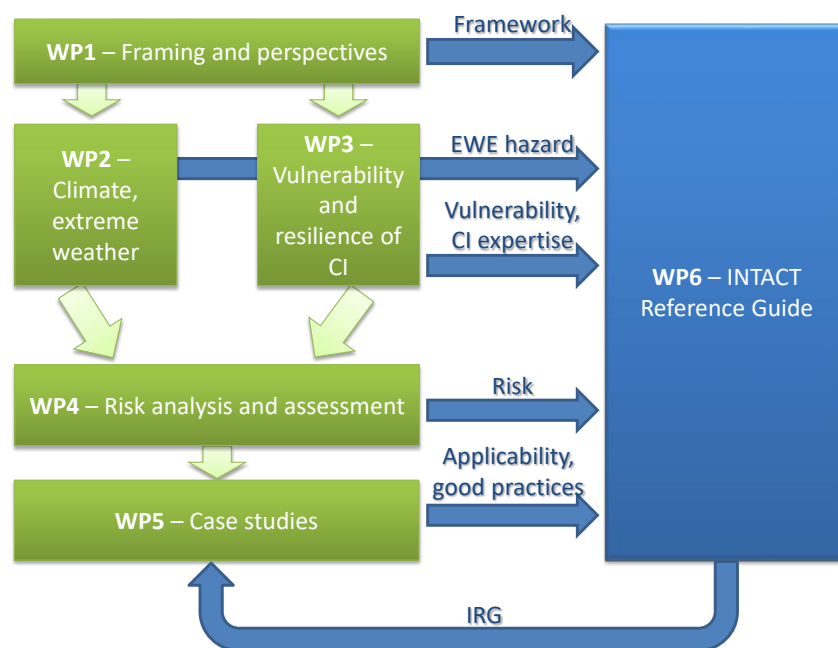
3 Description of the main S&T results/foregrounds

3.1 Introduction: the INTACT project

The INTACT project addresses the resilience of Critical Infrastructure (CI) to Extreme Weather Events (EWE) challenges and brings together innovative and cutting edge knowledge and experience in Europe in order to develop and demonstrate best practices in engineering, materials, construction, planning and designing protective measures as well as crisis response and recovery capabilities. All this culminates in the INTACT Reference Guide, in the form of a publicly accessible Wiki, a decision support system that facilitates cross-disciplinary and cross-border data sharing and provides for a forum for evidence based policy formulation.

As the information contained in the INTACT Wiki is generated in the other WPs of the INTACT project, close cooperation between WP6 and virtually every other WP was established. This is illustrated in Figure 3.1. Further details upon these relationships are provided in INTACT deliverable D6.4.





Figure 3.1 Relations between WP6 and other WPs



In the next sections, first the main results per work package are described. This closely related the work produced (as described in INTACT deliverables) to the INTACT themes and subsequent aspects, as denoted in Table 3.1. Thereafter the INTACT the main key (exploitable) foreground aspects are further described:

- INTACT Wiki
- Risk management decision framework
- INTACT Education and Training

Table 3.1 INTACT key objectives, strands, target audiences, and outputs

| Indicator/ Colour | Theme | Aspects considered by theme |
|---|-------------------|--|
|  | INTACT objectives | Assess regionally differentiated risk throughout Europe associated with extreme weather; |
| | | Identify and classify on a Europe wide basis CI and to assess the resilience of such CI to the impact of EWE; |
| | | Raise awareness of decision-makers and CI operators about the challenges (current and future) EW conditions may pose to their CI; |
| | | Identify potential measures and technologies to consider and implement, be it for planning, designing and protecting CI or for effectively preparing for crisis response and recovery. |
|  | Stranded Approach | Theoretical advancements |
| | | Practical applications |
| | | Utilisation beyond INTACT |
|  | Target Audience | (Public and Private) Policy planners |
| | | Critical Infrastructure Operators |
| | | Academia and Scientist |
| | | Societal |
|  | INTACT Output | INTACT Consortium |
| | | INTACT Reference Guide |
| | | Risk Management Decision Framework |
| | | Extreme Weather Maps |
| | | INTACT Education Platform |

3.2 Main results per work package

In general the project is executed as planned. The main results can be described as follows:

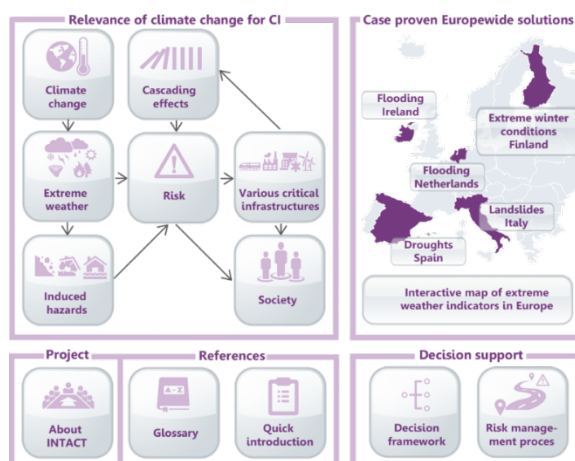
3.2.1 WP1 - Framing and Perspectives

Work Package 1 was designed to fulfil two phases of the project. Initially, WP1 was specifically designed to provide an initial basis for identification of the pertinent issues pertaining to CI and EWEs (Phase one: D1.1). In this regard, Work Package 1, and specifically D1.1 provided the scope and defined the parameters of the INTACT project, providing a definition of the setting within which INTACT focused its efforts. The analysis showed that bringing Climate change and EWEs together with CI will provide a synergy for progressing BSOTA for the INTACT concept and feed into the work conducted by other work packages and forms the basis for the next stages of the development of the INTACT project. Stakeholder engagement was initiated within D1.1 to identify and develop the gap analysis – to set the project in the correct space and setting – to Identify specific key issues that require solutions and the sources they currently utilise to reduce risk and enhance resilience. By mapping the stakeholders in this way it was considered vital that the message will be nuanced to fit what it is these stakeholders need/want to hear, the information emanating from the project and an provide an overall meaningful legacy. Indeed, the identification of these key stakeholders helped ‘pitch’ and channel where INTACT has most relevance and facilitated the assessment of the communication needs (contributions and uses) of the INTACT project; identify the information and materials/resources necessary to maximize its use of and/or contribution to INTACT activities and evaluate where and into which INTACT activities,

input may be most appropriate. This Gap Analysis confirmed that the foremost ‘improvement’ identified was the greater transfer of knowledge which was not fragmented and CI or CI sector specific, with an emphasis on disseminating best practice.

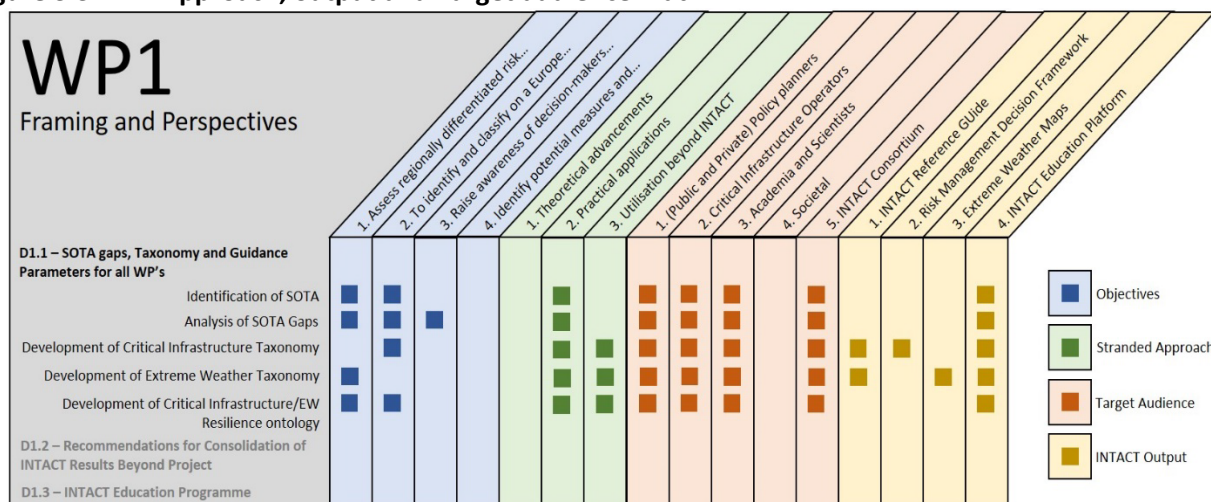
The initial gaps therefore provided a benchmark for the potential of INTACTs legacy, especially pertaining to the enhanced transfer of knowledge within a unified platform which harnesses extreme weather data and projections for evidence based decision making, scientific knowledge pertaining to risk and risk management to provide a fruitful decision support process. Establishing the grounds for the envisioned Knowledge Platform, Tools and Educational outputs established a fertile test bed for success. As the product concept continued to evolve, it became wholly clear that the overarching purpose of the platform is to furnish a community of users with a repository of knowledge relevant to CI and EWEs to inform the investigation/decision process. This is achieved in a number of ways (glossary; CI specific information etcetera). Indeed, this functionality offers potential users enhanced knowledge through best practices from case studies to support decision making, identification of the core steps for risk mitigation and interactive climate maps to assess potential impacts of extreme weather in the future (Figure 3.2). The relevant links between the key segments directs the potential user community to all functionalities which can help to inform the decision making process or area of interest.

Figure 3.2 INTACT Reference Guide (Wiki)



Web link: <http://www.intact-wiki.eu>

WP1 helped establish a common understanding of the key issues and guidance parameters which were to be taken forward in the ensuing Work packages. The development of the hierarchical taxonomies provided a basis and framework for the Work packages and was used as a building block for WP2, WP3, WP4 and WP6. This facilitated the development of a decision support system that integrates cross-disciplinary and cross-border data sharing, to culminate in evidence based policy formulation. Thereafter, D1.1 exploited the knowledge accumulated by identifying potential application areas of INTACT findings and results, developing educational materials and deployment opportunities and the development and use of the INTACT Reference Guide moving forward. The key objectives and outputs and relationship to the identified target audience in terms of results are illustrated in Figure 3.3.

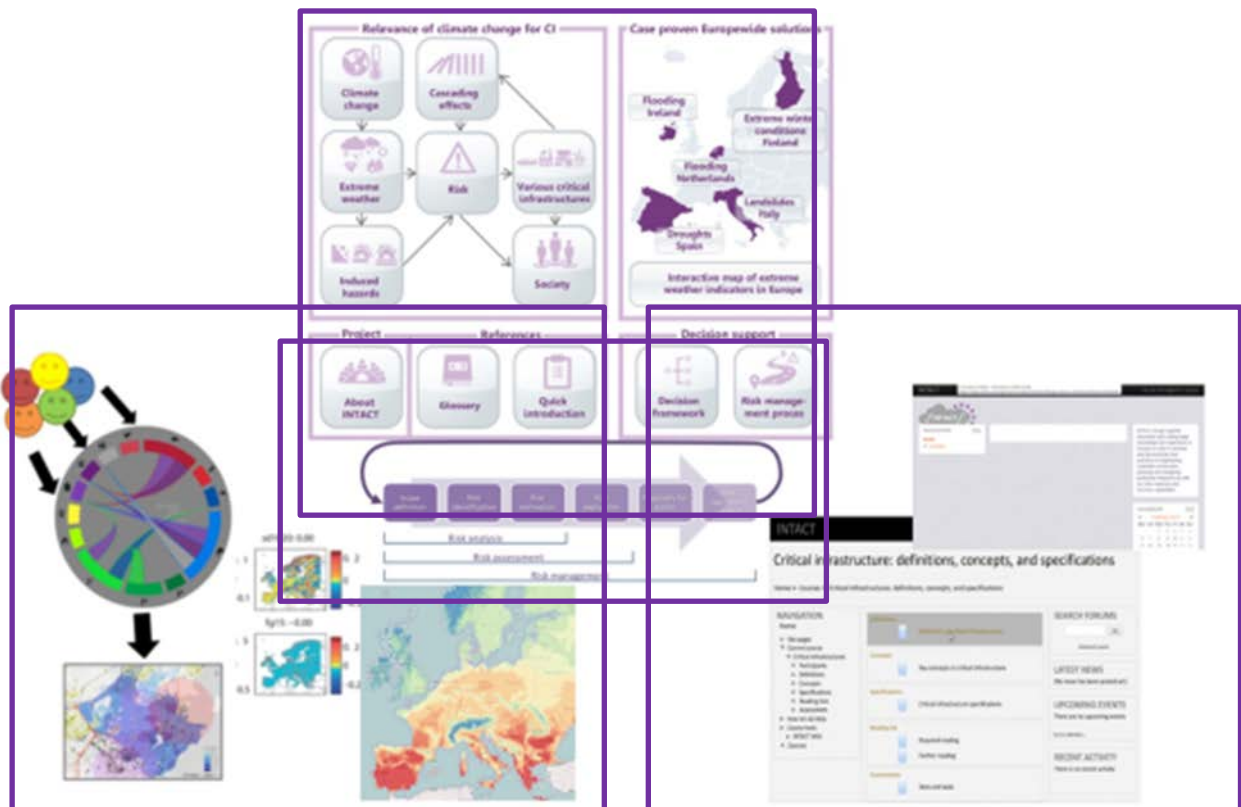
Figure 3.3 WP1 Approach, output and Target audience matrix


More laterally, WP1's objective was to exploit the knowledge accumulated from the INTACT project and identify potential application areas of INTACT findings and results and the development of educational materials and deployment opportunities (Phase 2: D1.2 and D1.3). Specifically, these parameters have been progressed and the viable channels for framing beyond life time impact of the INTACT findings identified within D1.2 and D1.3 respectively.

D1.2 provided an initial platform for the identification of potential avenues for communication, exploitation and dissemination of the INTACT project findings and results. It analysed and presented feasible and potential opportunities for legacy impact to help direct the project results to the appropriate target audience in order to maximize the perceived project potential. The fulcrum of D1.2 was to examine the potential strategies and analysis of the key findings to obtain maximal impact and identification of an exploitable foreground to ensure that the INTACT project 'finds its place' and 'ensures its legacy'. This strategy was premised upon the concept of 'added value' that the INTACT project offers in terms of awareness and knowledge of the nexus between extreme weather and critical infrastructure.

The cornerstone of the INTACT projects findings comprised three core pillars (Figure 3.4), which were designed to meet the gap analysis as furnished D1.1. Therefore, D1.2 used these pillars as a primary foundation to build INTACT's identity by developing a matrix for each work package to identify potential application areas and enhanced knowledge which feed into the respective INTACT project outputs and results and illustrated the association with the key target audience. These are depicted for each of the WPs in this chapter, as shown in Figure 3.3 (WP1), Figure 3.6 (WP2), Figure 3.7 (WP3), etc.

Figure 3.4 Project findings, resources and tools



D1.2 clearly showcases INTACT's added value as a 'one stop shop' for resilience management in light of EWEs (promoting a holistic and integrated decision making process) in an innovative manner which integrates best practice knowledge provides access to decision support tools and methods. The results emanating from D1.2 highlight the collaboration potential between different stakeholders for realizing and achieving risk mitigation. The findings show that the generalized approach adopted by INTACT arguably permits it to be used for a wide range of exercises for wider evaluation purposes, awareness/capacity building and training.

D1.2 seemingly offers the potential to inform and help legislative development. The results of the INTACT project, reflected against current EU legislation indicate how and where INTACT contributes to and benefits from current EU directives. D1.2 showcases the identification and evaluation of the potential application areas of INTACT findings and results in line with current EU directives in relation to design, materials, and codes on protection of CI. Specifically, D1.2 offers a reflection on BSOTA knowledge to support CI protection, particularly when evaluating current EU directives. It offers analysis of the contributions of the INTACT deliverables to the directives and provides examples of further research avenues. In addition, it offers examination for informing standards (areas where standards may be integrated) pertaining to risk management for operational Critical Infrastructure.

D1.2 identifies a number of specific foreground results for potential commercial exploitation. The results clearly demonstrate the usefulness and usability of the INTACT Wiki which supports collaboration between professionals and CI owners/operators. It demonstrates how the project outcomes will ensure long-lasting awareness through the educational structures developed. The various observations obtained from the multidisciplinary stakeholder engagement workshops and

surveys clearly show that the INTACT concept works and importantly the findings pave the way for future exploitation activities relating to the INTACT concept and a rich afterlife.

D1.3 demonstrated the consideration and staged development and process for the creation of the INTACT educational programme. The development of a structured virtual learning environment framework has been specified and tailored to culminate in a 'wide reaching' and facilitatory approach that ensures that the curated knowledge developed within the INTACT project has a tangible education legacy which offers future exploitation potential. D1.3 illustrates that the educational programme ensures a legacy aspect which fosters understanding and transposes knowledge of the holistic resilience perspective; to raise awareness of the need to understand risk and associated trade-offs; to raise awareness of available tools and to promote an integrated, holistic approach to the business of CI resilience.

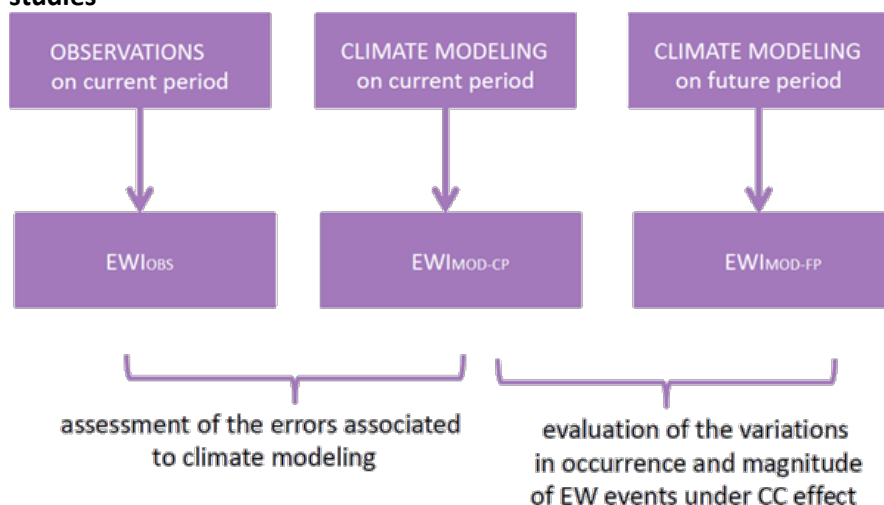
D1.3 reveals that the INTACT virtual learning environment integrates the Wiki as a central repository for knowledge and offers significant feedback flows between the learning platforms and approaches stemming from open source to the formal learning environment. The construction of a Moodle offers an environment which can be hosted within the INTACT Wiki which provides an educational tool within a virtual environment offers key stakeholders and interested parties the ability for both formal and informal 'self-testing' outside of the conventional tertiary learning arena, a key finding which emerged in D1.2 by the INTACT Wiki stakeholder community. It also serves as an interface which can be linked to the formal educational offer, manifesting in a holistic educational package.

3.2.2 WP2 - Climate and Extreme Weather

WP2 developed the knowledge base to provide a quantitative evaluation of the effects of the climate change on the modification of the EWE, having high impacts on CI, through the definition and analysis of the variation of the Extreme Weather Indicators (EWIs). This information was essential for the Wiki to provide the target end user audiences a means to determine how the current extreme weather indicators will change in the future due to climate change. D2.1 (Bucchignani and Gutiérrez, 2015) identified and defined these novel Indicators which culminated in a database which can be utilised at local, regional, national and EU level. This extension allowed for the synthesis and development of a combination of meteorological variables into EWIs in order to better support the management of CI in Europe (Figure 3.6).

WP2 provided climate change effects for a number of extreme weather indicators relevant for the case studies under various climate change scenarios. These indicators were defined in collaboration with case study stakeholders in the problem exploration phase. WP2 assessed both the absolute and relative change in those indicators. To get an indication of the absolute values of the outcomes of the Regional Climate Models (RCMs) used, the outcomes for the current climate must be compared with observations (see Figure 3.5). This comparison was tried in Italy (De Bruijn and Van Ruiten, 2016, annex III: case study in south of Italy). The indicator values for the selected extreme weather indicators can be found on the INTACT Wiki for all areas in Europe for different climate scenarios. Also the relative changes can be found there. These outcomes can be used to get a first impression of the effect of climate change in any EU region. (See: http://scm.ulster.ac.uk/~scmresearch/intact/index.php/Extreme_weather_maps).

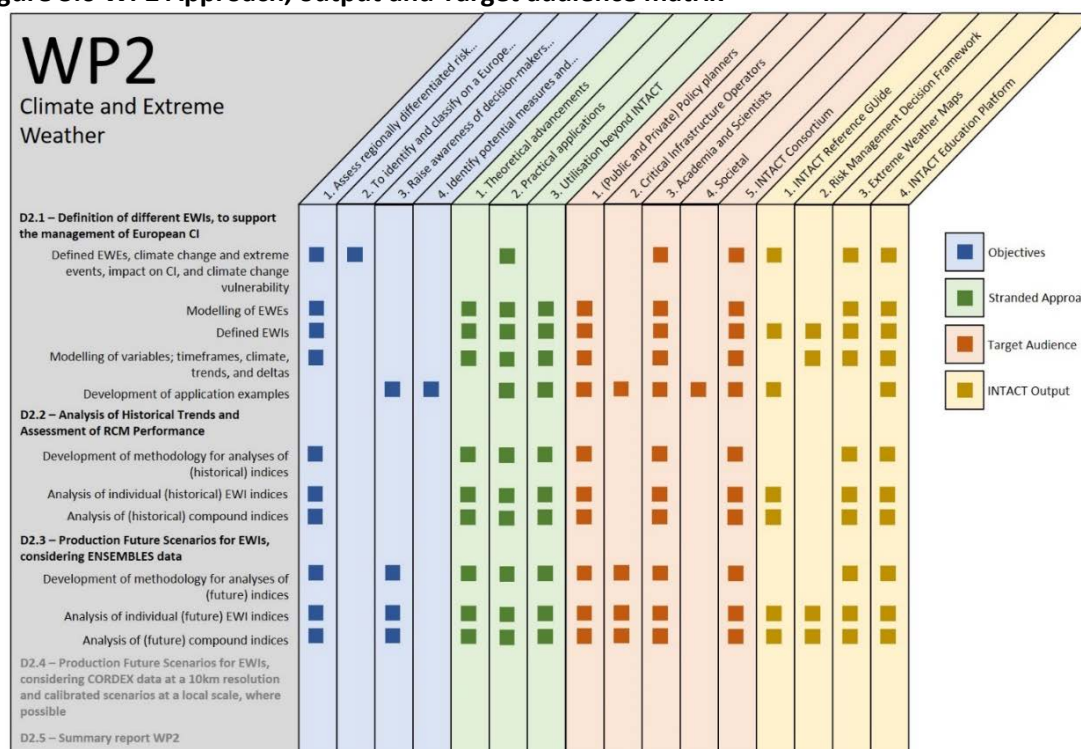
Figure 3.5 Procedure followed in INTACT WP2 to get information on future climates for the case studies



Source: Annex III in (De Bruijn and Van Ruiten, 2016);

The results of D2.2 (Montesarchio and Herrera, 2015) and D2.3 (Gutiérrez and Montesarchio, 2015) furnished theoretical advancement and practical application of the Regional Climate Model (RCM) for enhancing the assessment of regional climate change projections. This has culminated in the provision of estimated and reliable projections to support policy development and operational decision-making. These advancements are evident within the INTACT Wiki, fed into the risk management framework, and are also hosted within the educational programme for research led teaching and continuing professional development.

Figure 3.6 WP2 Approach, output and Target audience matrix



Besides the deliverables, WP2 also submitted various (journal) papers. Summarizing the most important concepts reported in one of the final papers are:

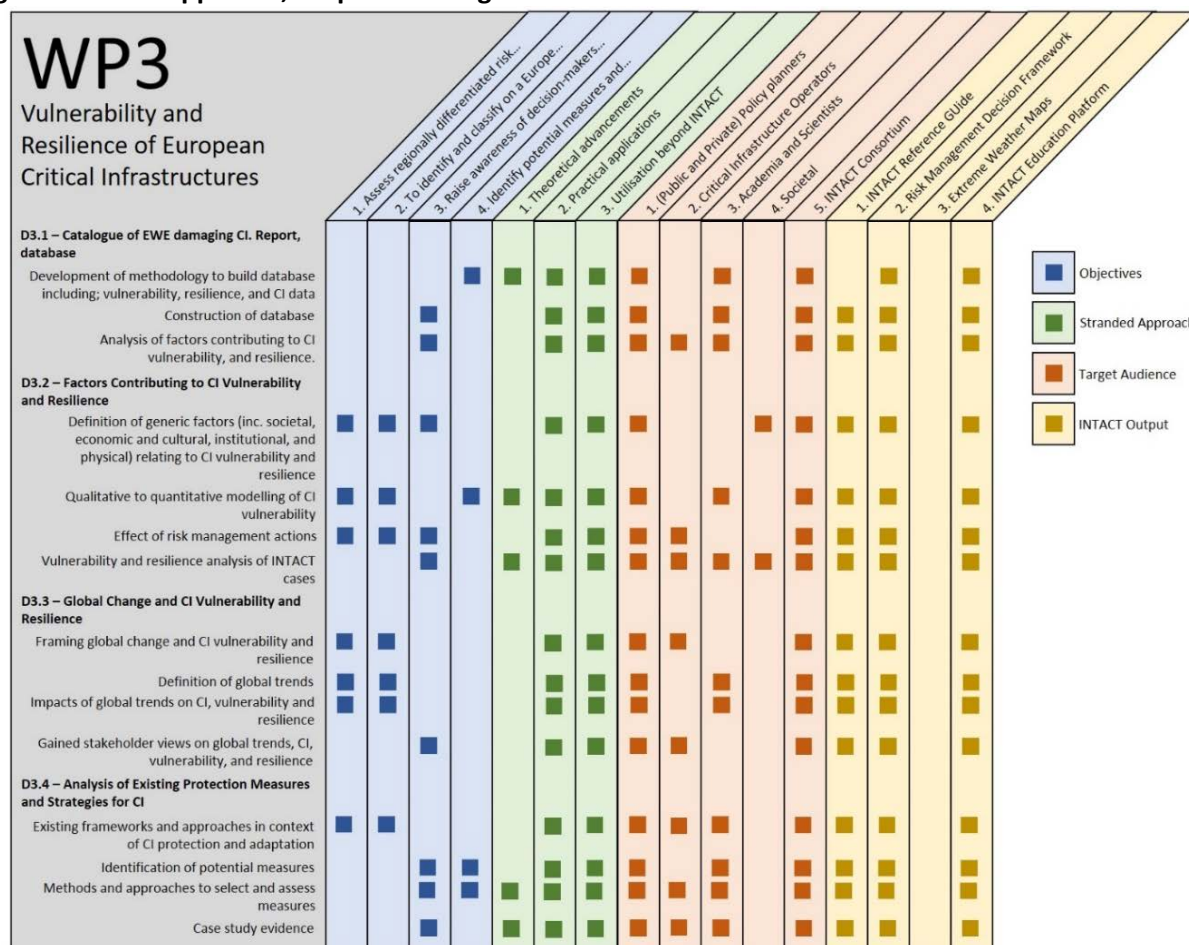
- the modality of interaction with the impact community, including stakeholders and managers, for the appropriate definition of extreme weather indicators affecting their infrastructures.
- The definition, also including examples of implementations, on the correct way to get local information, from the state of art regional climate models and the methods to calibrate the climate change projections, as preliminary and fundamental step to identify future risks affecting critical infrastructures, and then to establish adequate adaptation and mitigation measures.

This last paper, based on the INTACT experience, establishes an important link between climate studies, highlighting that extreme weather events are projected to be more frequent and severe, as a consequence of global warming, and the managers of critical infrastructure, interested in finding information, tools and methods for the evaluation of the future risks affecting the CI of interest.

3.2.3 WP3 - Vulnerability and Resilience of European Critical Infrastructures

WP3 developed knowledge and information relating to the vulnerabilities of CI for EWEs. This information was essential for developing key knowledge content within the INTACT Wiki and specification of the risk management decision framework, thus providing potential end users with a means to determine the impact the changes in EWEs could have for their CI. In developing a methodological framework and associated data catalogue for CI vulnerability assessment and an analysis of CI protection measures, the work package has advancement theoretic and practical knowledge which has strong beyond project life utilisation.

The results derived were tested and refined during the case study workshops to enhance existing scientific work and feed new insights from stakeholder interaction. The outputs provided analysis pertaining to the factors influencing infrastructure vulnerability of different sectors towards a variety of different natural hazards focusing on physical aspects as well as governance aspects/institutional vulnerability in terms of disaster management and the development of vulnerability reducing measures. Figure 3.7 illustrates how the results of WP3 enhance existing SOTA, and where the outputs are hosted within INTACT and which target end-user can avail of the findings.

Figure 3.7 WP3 Approach, output and Target audience matrix


3.2.4 WP4 - Risk and Risk Analysis

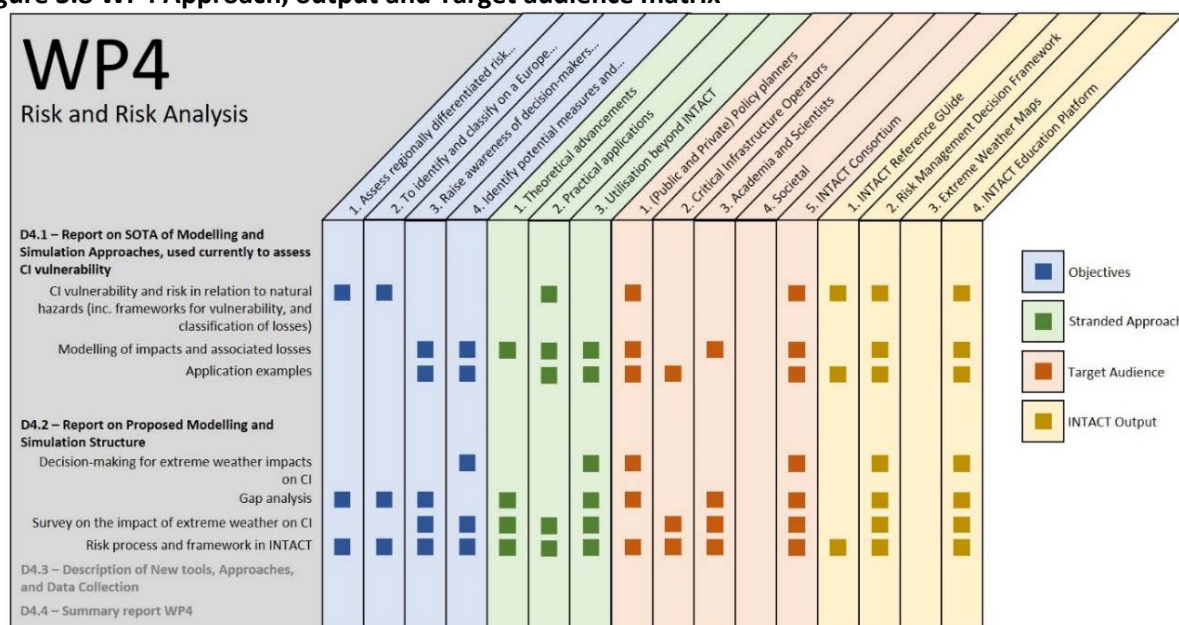
WP4 developed a complementary modelling and simulation structure to support the case study requirements: the INTACT Risk Management Process provides a structured approach to assess the Extreme Weather Events (EWE) impacts on Critical Infrastructure (CI), the resilience and vulnerability of CI to EWE as well as deriving and testing alternative measures and their costs and benefits. Its goal is to support asset owners, operators and authorities with their aim to make reliable, cost-effective, efficient, and transparent decisions.

The risk management process identifies the main steps comprising ‘good practice’ in decision-making (ISO:31000, 2009). It recognises the circular nature of risk management, which may require the review of the risk analysis and assessment after implementation of risk reduction control measures. It comprises a range of tools, data collection protocols, and other assessment methods within an overarching decision-support structure and support the simulation of infrastructure operation, including indirect impacts, and testing of mitigation measures developed with the CI owners and operators. This information was essential in the formation and content analysis for the INTACT Wiki in order to provide the end users a means to determine the relevance of changes in hazard and vulnerability for their CI, and to guide them toward potential mitigation measures. This also provides benefits to the overall

project findings in terms of the applicability of the risk framework (Figure 3.8). The risk management decision framework itself, as (exploitable) foreground is further described in section 3.5.

The final part of WP4 reflected on the success of the application of the modelling framework, in terms of suitability of the models for testing mitigation options and for the decision-making process, feedback from stakeholders, and remaining gaps and recommendations for future development. This critical assessment forms the basis of INTACT deliverable D4.4. This deliverable first considers the application of the risk framework in the various case studies, and reports on the general feedback received from the stakeholders, supplemented by formal responses to a short questionnaire that was used in most of the final workshops.

Figure 3.8 WP4 Approach, output and Target audience matrix



Generally, most stakeholders were familiar with the risk framework, although a smaller number actually followed all of the process steps in their work. One important conclusion from stakeholders' feedback is that identification of risks and developing proposals for actions are the most important steps. Risk estimation and evaluation are not always properly defined as for example, few stakeholders have well defined thresholds for risk. Infrastructure is normally designed to withstand certain design events, defined by their probability (or return period). However, the consequences side of the risk is rarely assessed quantitatively, which complicates the proper evaluation of acceptable risks.

3.2.5 WP5 - Case Studies

Within INTACT there are a number of WPs aiming to develop knowledge and methods (WP1-2-3-4) and one work package (WP5) which combines methods and knowledge across five case studies. The case studies aimed to:

1. Raise awareness and understanding with public and private stakeholders of the risk that EW may pose to their CI,
2. Seek for applicability of the INTACT results, and so to give feedback to other WP's results, and,

3. Seek for and assess protective and mitigation strategies for a variety of regionally different CI/EW combinations.

For that reason, the regions selected for the INTACT case studies are spread over Europe to cover for different climate zones, landscape types and environmental zones, as well as for different CI categories (see Table 3.2).

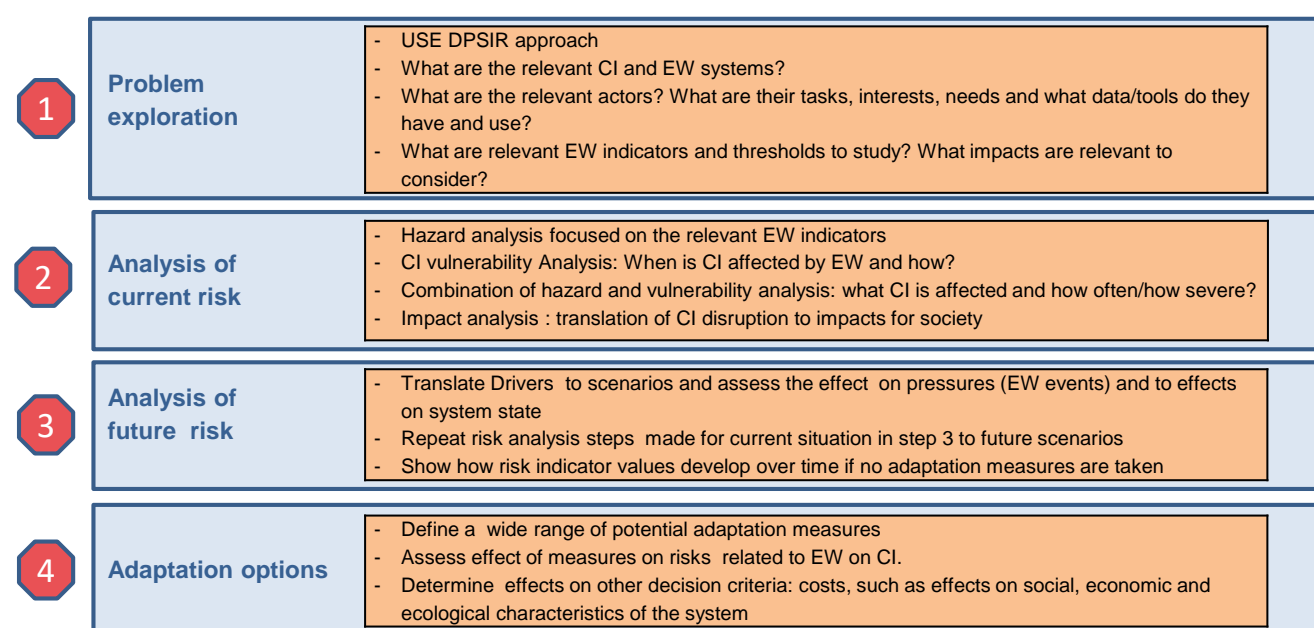
Table 3.2 Overview of the 5 case studies

| Case | Country | Hazard | CI considered | Lead partner |
|------|-------------|---|--|--------------|
| A | Ireland | Flooding (heavy rainfall/storms) | Combination of CI (Transport, power and water utilities) | FAC |
| B | Netherlands | Storm, flooding, rainfall, other relevant EWE | Transport (roads, railroads, pipelines, navigation) | DELTA RES |
| C | Italy | Rainfall, Landslides | Transport | CMCC |
| D | Finland | Snow storm, severe winter conditions | Electricity distribution network | VTT |
| E | Spain | Heat waves, droughts | Networked infrastructure | DRAGADOS |

In order to analyse **if** and **what** measures should be taken to reduce the vulnerability of CI to EWE and to increase society's resilience, a framework was adopted in all case studies (INTACT Deliverable D5.1 (De Bruijn & Van Ruiten, 2015)). The framework is similar to most policy analysis frameworks and consists of four steps (see Figure 3.9):

1. Problem exploration;
2. Analysis of current risk;
3. Analysis of future risk if no changes in policies or operations occur;
4. Adaptation options.

Figure 3.9 Overview of the steps taken in the case studies



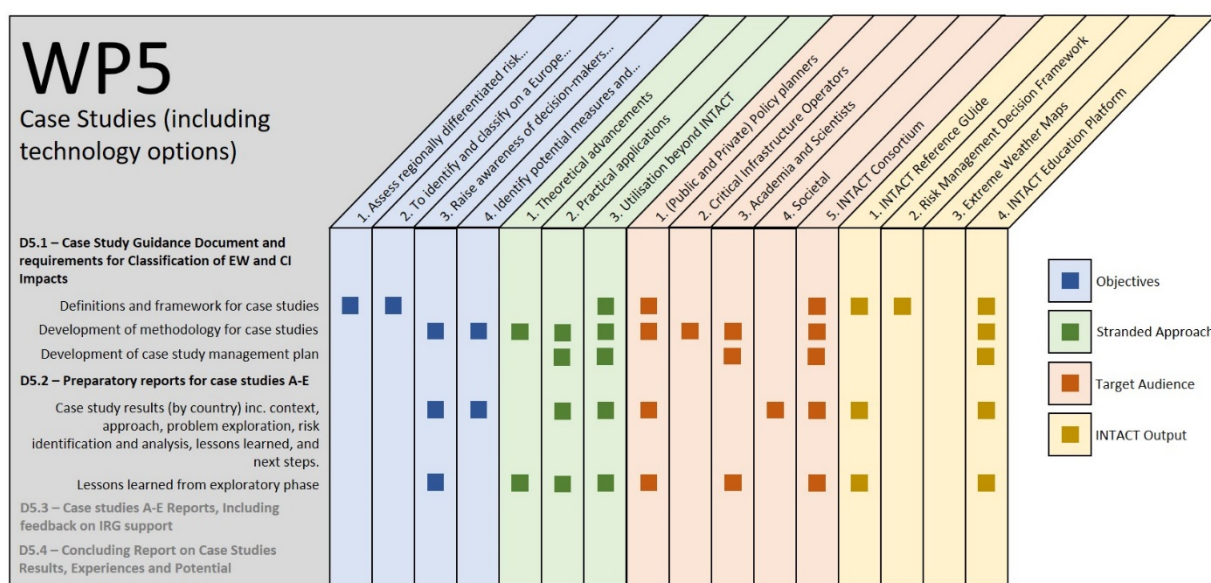
These steps correspond with the risk framework which was provided by WP4 (previous section and section 3.5). The first phase ‘problem exploration’ covers the step ‘scope definition’ of the framework below. The second phase ‘risk analysis of current risks’ and the third phase ‘analysis of future risk’ together cover the steps ‘risk identification’ and ‘risk estimation’ of the risk framework. The fourth phase ‘adaptation options’ covers the step ‘risk evaluation’ and ‘proposal for actions’ of the risk framework.

WP5 iteratively tested the risk assessment method and the other information contained in the Wiki on its applicability and user-friendliness. The results of these tests were further used to enhance both theoretical and practical knowledge and development of the Wiki and the associated information and methods contained. As conclusions, the framework steps and supporting tools were successfully applied in the case studies. They may also support other areas to assess the vulnerability of their CI to EWE and identify adaptation measures. The Storyline approach, CI tool, the event tree analysis and risk framework are all applicable to many cases. In all cases, methods which use collaborative learning, or modelling, knowledge exchange and which allow the use of existing information were selected.

These measures result in a comprehensive interdisciplinary overview of the problems and solutions and the roles and responsibilities of stakeholders. Detailed quantitative mono disciplinary methods were found less feasible for these CI vulnerability analyses. Methods assessing indirect effects are lacking. There are now tools such as Circle which structure expert input, but there are no easily applicable methods or knowledge to address indirect effects, costs of disruptions for companies and so on.

These findings with regards to the user experiences gained within the test cases tests were also incorporated into the Wiki to provide the end user community with best practice examples of the application of the methods developed, raise awareness and the ability to apply the results to assess protective and mitigation strategies for a variety of regionally different CI/EW combinations (Figure 3.10).

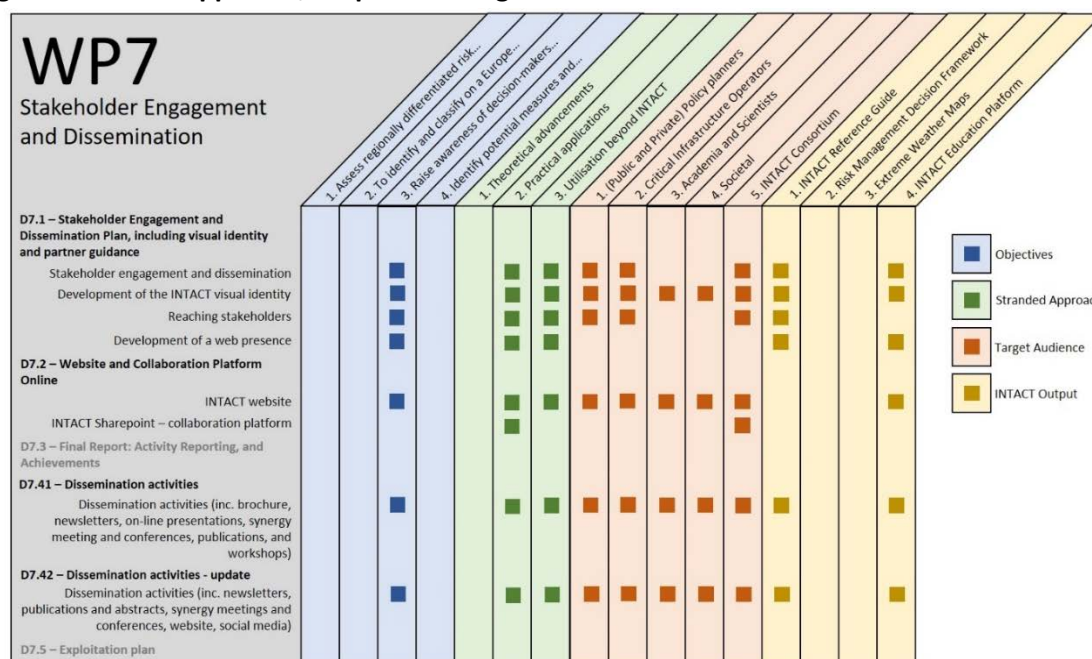
Figure 3.10 WP5 Approach, output and Target audience matrix



3.2.7 WP7 - Stakeholder Engagement and Dissemination

Work package 7 is an essential feature of the project in terms of conveying the INTACT ‘message’ as it is principally concerned with the communication, education and dissemination of the key outcomes of the INTACT project and the benefits offered by INTACT to public and private end-users and stakeholders - essential for driving key stakeholder interest in the INTACT results (Figure 3.12).

Figure 3.12 WP7 Approach, output and Target audience matrix



3.3 Platform foreground

The innovation in the INTACT knowledge platform (INTACT Wiki), Risk Management Decision Framework and associated tools produced within the project have the capacity to underpin academic and commercial activity and other tangible forms of return on investment (through training or consultancy). The INTACT framework presents an innovative structure to assist users through the Wiki, including decision support i.e. risk management process stages. The framework has the potential to inform educational and consultancy activity arising from INTACT.

3.4 INTACT Wiki

The INTACT Wiki is the platform in which the knowledge, tools and methods, developed in INTACT are shared with the world. On it, you can find information, references, guidance and experiences on how to ensure continued resilience of critical infrastructures in the context of changing climate and related extreme weather events. This information is primarily directed at operators of critical infrastructures and policy makers involved with these critical infrastructures and can be used in various ways.

The Wiki contains a large amount of interconnected information that attempts to cover the needs of a wide range of potential users. In order to support users looking for a specific type of information, we provide several entry points that direct them to the various sections of the Wiki that would be of most interest to them.

The Wiki is an online interactive repository that contains guidance for enhancing the resilience of CI, from planning, design to construction and operation. End users can find information about the following aspects and their interrelations:

- Terminology and its use in risk management, resilience, critical infrastructure protection and meteorology;
- Individual CI sectors;
- A universal method to assess and reduce climate-related risks in CI;
- Scientifically based predictions on climate change and extreme weather indicators at each European location;
- A list of helpful tools to support climate adaptation process of CIs;
- A list of protection measures and strategies that can be used to enhance the resilience of CIs;
- Experiences and best practices with the INTACT methods gained by application of the risk method in cases.

In order to support users looking for a specific type of information, the Wiki provides several entry points that direct users to the various sections of the Wiki that would be of most interest to them e.g. decision support, relevance of climate change for CI, and case studies.

3.4.1 Added value of the INTACT Wiki

In recent years, a number of risk management tools and methods guidance documents have been developed which seek to address issues around CI resilience. There is also existing information on climate change predictions around Europe. Yet, the existence of such tools is often not widely known and building awareness around the availability of such resources is a key area which INTACT can contribute to. In addition, the availability of a platform offering combined scientifically based climate change forecasting on a Pan-European scale, together with defined Risk Management Process, and listing a wide range of risk assessment tools and methods is unique. This is a unique resource that the INTACT Wiki (and INTACT as a project) can provide, thereby supporting asset owners and operators and authorities with their aim to make reliable, cost-effective, efficient, and transparent decisions.

This INTACT Wiki brings many existing risk management tools, risk management related terminology, climate change data and protection measures and strategies together, situating their use within a wider resilience context and promoting their use in an integrated manner.

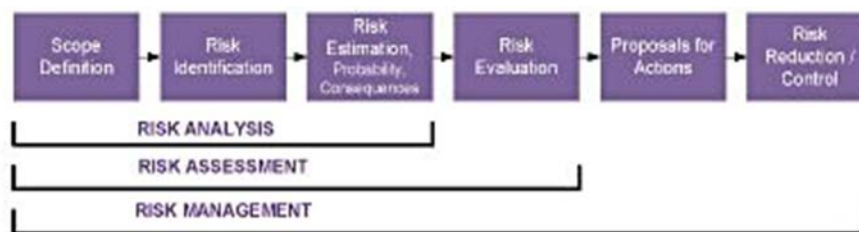
3.5 Risk management decision framework

In order to use all data in the Wiki to determine the future EWE risks to your CI, and to guide the user through the large information source (depending on the type of CI and EWE that are of interest to the user) we have developed a step-by-step method using the risk management process developed by the International Electrotechnical Commission²³ (Figure 3.13).

² IEC/ISO 31010:2009 "Risk management - Risk assessment techniques", 2009.

³ IEC 60300-3-9:1995 "Dependability management - Part 3: Application guide - Section 9: Risk analysis of technological systems". 1995.

Figure 3.13 The process of risk analysis, risk assessment and risk management according to IEC 60300-3-9



The risk management process identifies the main steps comprising ‘good practice’ in decision-making. It recognizes the circular nature of risk management, which may require the review of the risk analysis and assessment after implementation of risk reduction control measures. The steps of the process are:

- Scope definition:
 - Determines the scope of the risk assessment in terms of the CI, the information needed and the type of approach, timeframes and scales to be considered;
- Risk identification
 - Explores and classifies the main hazards and vulnerabilities taking into account cascading effects;
- Risk estimation
 - Assesses the risk magnitude using available models and taking into account uncertainties;
- Risk evaluation
 - Assesses the magnitude of risk considering the particular context of the CI;
- Proposals for action
 - Provides guidance on the possible mitigation measures to reduce the estimated risk;
- Risk reduction control

The INTACT Risk Management Process provides guidance to users on different methods and tools available for each step in the process. There are also tools that cover more than one step in the process and these can be used to scope out the issues surrounding EWE impacts on a particular CI, as well as identifying and estimating the level of risk. To facilitate the recording of the different steps of the risk management process, a record sheet is provided to end-users which is aimed to be used as a check list. This check list will ensure that the main aspects of the Risk Management Process are considered and recorded by the user. These may be reviewed at a later stage and contribute to best practice document management control. The list of methods and tools does not intend to be prescriptive in which methods to use but offers the user a broad range of methods and tools which to consult when estimating risk.

3.5.1 Added value of the Risk Management Process

The added value of the Risk Management Process and can be summarised in the following points:

- Risk assessment is indispensable in order to identify threats, assess vulnerabilities and evaluate the impact on CI and CI related assets or systems, taking into account the probability of the occurrence of these risks. The availability of a broad range of risk assessment tools and

methods on one platform increases the options and usability of the platform, enhancing its value to users.

- The ability to use sub-steps as stand-alone solutions for users who require specific information or tools, and do not wish to follow the complete Risk Management Process offers additional flexibility to the user.
- The provision of a record sheet / check-list allows users to record the steps taken which can be reviewed at a later stage and can contribute positively to good document control practice within an organisation.
- The platform is easy to use with each step of the Risk Management Process clearly outlined for the end user to follow, and a range of potential applicable methods and tools outline in each step in the process.
- It offers a resilience approach that can help end users better prepare for, respond to and management CI in the event of EWE.

3.6 INTACT Education and Training

The role of the INTACT Educational Programme is to provide a viable mechanism to propagate the holistic vision of INTACT to its intended audience (and auxiliary multidisciplinary audience) and to continue to build usage of and confidence in the INTACT project concept and products beyond the lifecycle of the INTACT project. We provided a rationale and development path for the design and specification of the INTACT concept and key knowledge emanating from the deliverables which can be incorporated into a robust educational programme pertaining to the resilience of Critical Infrastructure as a consequence of climate change.

3.6.1 INTACT Virtual Learning Environment (VLE)

The selection of a multimedia interface of virtual learning environment (VLE) or Digital Learning Environment (DLE) was borne out of the wide consideration of the actions, activities and structures commonly associated with knowledge centres (such as the INTACT wiki), which are generally premised on certain key activities: networking, research, education / training, and knowledge dissemination. As the INTACT wiki is a virtual version of this concept, developing a VLE is ripe for the interaction with the Wiki ('hub' or 'portal'). In this regard, the integrated education environment adopts a web enabled approach which has the utility to triangulate and incorporate the various elements of the project wiki, tools and deliverables to culminate in varying degrees of educational attainment and dissemination. This offers the ability to 'educate and train' multidisciplinary stakeholders and future policy makers and provides the wider public interested in CI/EWEs with a user friendly approach to accessing knowledge and the INTACT project findings and results. This also facilitates both direct and virtual networking and is a robust and sustainable method to host a 'community of interest' in urban resilience.

A scoping Investigation of various approaches currently used in the educational setting is exhibited in Table 3.3. Review of these platforms enabled the selection of the most appropriate structure and 'vehicles' in order to deliver on a truly integrated VLE to meet the needs and demands for a holistic educational and learning based approach.

Table 3.3 Current VLE based platforms

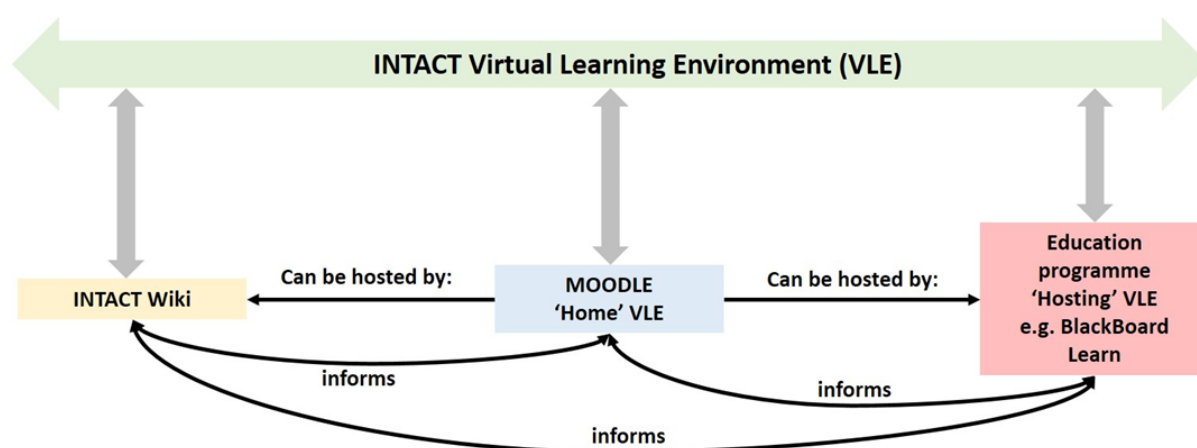
| Platforms | What it offers | Who it's for | Selling points | Paid for? |
|---------------------------|--|---|--|-----------|
| BLACKBOARD LEARN | Various services, including a wide range of embedding options for materials, and assessment formats | Academic staff and students | Customization options, social learning and options for distance learning | Yes |
| PEARSON ECOLLEGE | Various services, including Pearson Learning Studio, which offers a learning management system and cloud computing for educators | Higher education and K-12 schools internationally. | Customization options, social learning and options for distance learning | Yes |
| SAKAI | Two software products: The Collaboration and Learning Environment and the Open Academic Environment. These products support online communities of shared education and research | Academic institutions and individuals | Emphasis on personalization and connectivity. Over 350 educational institutions worldwide use the Collaboration and Learning Environment for managing education and research | Yes |
| LORE | An online platform for school courses allowing teachers and students to manage their work and share information | Primarily teachers and students but open to professional use as well | Ease of use and further student engagement with the course material | Yes |
| GOINGON.COM | An online academic interface to support teacher-student networks. Provides services such as online classrooms, forums and research sharing | Anyone in the sphere of education | The simple interface allows easy engagement and connectivity with school resources and peers | Yes |
| MYEDU | Web applications for educational purposes. These applications include class schedules, a GPA calculator and a degree timeline among many other things | College students | A free service that integrates many educational services into a single system. Myedu helps students plan out their academic career and is available at 800 colleges | No |
| INSTRUCTURE CANVAS | Canvas is a learning management system that provides many services to track student progress within one interface. Examples of these services include Speed-Grader, online quizzes and assignment submission | Mainly for teachers and administrators but open to students | Free for teachers. Canvas provides a time saving way to keep classrooms organized | No |
| MOODLE | Open source software for online courses and websites. It was originally an acronym for “Modular Object-Oriented Dynamic Learning Environment.” | Teachers and institutions with abilities to host installation. Course can be made available to the public | Free and customizable. Moodle has attracted its own ecosystem of developers, users and Moodle-based services | No |

Bringing in these supporting structures therefore permits the INTACT VLE to have the capacity to underpin a robust and sustainable platform via its ability to support the INTACT wiki repository of high quality curated relevant material, structured via the design and adoption of a thematic framework, enabled via a learning/educational functionality.

This potential functionality offers interested end-users (interested parties and practitioners) a medium which can interact with the wiki repository of knowledge directly and the more insular university VLE

platforms (Figure 3.14). The tiered and hierarchical nature offers a bi-directional educational learning integration and feedback loops between the various project outputs. Figure 2 below gives a visual depiction and indication of the way in which organisations of different types – public sector, private sector (both non-technical and technical stakeholders) educational and research organisations – will be able to interact with each other – utilising elements of the wiki, tools and deliverables and indexing this with the formal educational programmes being developed (modules) and the more open source/quasi open source, all creating the basis for an ongoing, vibrant resilience learning environment.

Figure 3.14 INTACT Virtual Learning Environment



The INTACT VLE has the ability to host various teaching resources. These resources can take the form of different media, allows learning materials to be disseminated in other ways, and also allow for students' knowledge to be assessed, and by different means, as exhibited in Table 3.4.

Table 3.4 VLE as a teaching resource

Media

MS Office and other documents

Websites

Sound (.mp3 .wav etc) and movies (.mov .mp4 etc)

Dissemination

Distance Learning (through video conferencing)

Blogs

Chat rooms

Recorded lectures, tutorials, and seminars

Assessment

Quizzes

Tests – multiple choice, multiple answer, written, fill-in-the-blanks, and hot-spot type questions

Surveys

Submission of reports

Electronic presentations

3.6.2 INTACT Moodle

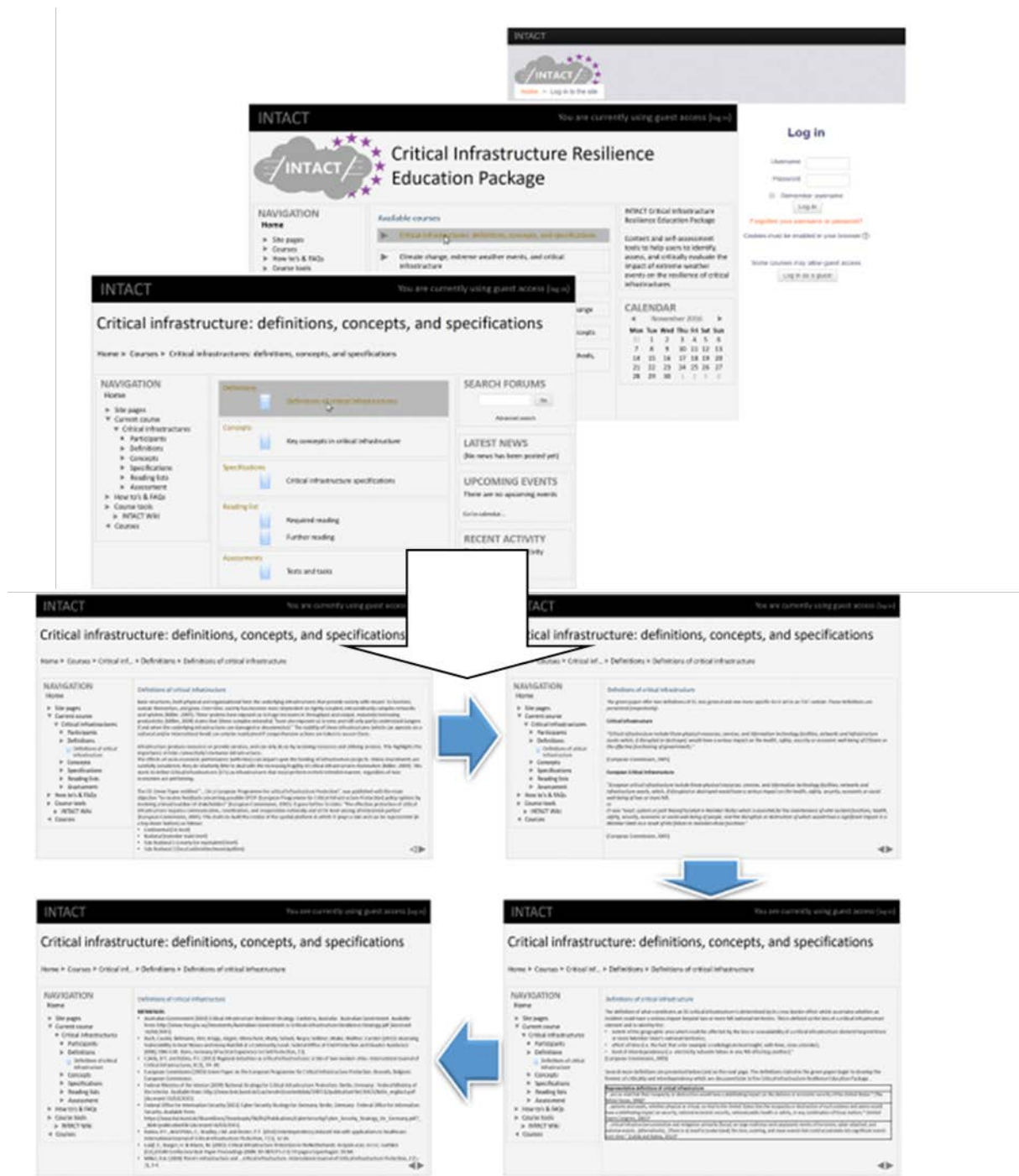
Adopting a Modular Object-Oriented Dynamic Learning Environment (Moodle) 'gateway' provides an intuitive link to the INTACT platform and associated tools which is a free open-source learning management system or e-Learning platform that serves educators and learners across the globe. It provides a medium in order to control the VLE platform and the associated integration with the Wiki and formal education programmes. Indeed, the Moodle offers a hybrid platform between the more formal educational institutions VLE and the completely open source wiki environment and bridges the knowledge gap as it is an open source/access vehicle offering 'enhanced' materials and connects/facilitates the learning continuum from the casual interested user (of the Wiki) through to a committed accredited learning setting. The INTACT Moodle can be observed by following the link provided:

<http://scmserv3.scm.ulster.ac.uk/web/moodle2>

The Educational service draws on key elements from Project Deliverables (D1.1; D3.5 etc.) and additional material not utilised for the formal Deliverables. The Educational service is delivered via the Moodle (Figure 3.15). This Virtual Learning Environment is accessible via the Project Platform, which also hosts the Educational programme content (as a crucial 'orientation' tool). This INTACT VLE provides a number of free to use Reusable Learning Objects. Whilst this material is constantly being augmented it is intended to launch the service with a number of key modules which are indexed to for example, critical infrastructures, definitions, concepts and specifications.

Pertinently, in addition to set of modules which allow the users to utilise aspects of the tools and deliverables the educational service functionality consists of content and self-assessment tools to help users further to assess and 'self-test' at the end of their user experience, as the Educational Service provides the facility to host educational material and also to provide online testing facilities – this provides the opportunity for users of the Education service to interact with the material and then undertake online self-assessment to determine their level of understanding of the material. This will also allow the issuing and recording on the system of completion of a module by the Community member. Whilst these modules will not be credit bearing (initially) it will be possible to issue CPD module completion certification which will be of great value to the professionals who will use the service and who are generally expected to undertake at least 24 hours of CPD per annum. This provides further avenues for knowledge enhancement for both accredited and non-accredited professional development, and exploitation and educational reach of the INTACT project.

Figure 3.15 Example of the INTACT Moodle education service



Moreover, it offers avenues for future exploitation and educational reach, and serve to orient the user both into the Urban Resilience SOA milieu, and also as a potential rout to more formal CPD and Educational modules and programmes which are under consideration by the academic Partners directly, and other partners indirectly. The Educational service provided is a critical aspect of the INTACT Community VCE. This element operationalizes the objectives of the Project relating to the continuing impact of INTACT on urban built environment policy, policy evaluation and how and where this influences and advances curriculum development, training and CPD activity.



3.6.3 Blackboard Learn (Ultra)

Blackboard Learn is a virtual learning environment and course management system which features course management, customizable open architecture, and scalable design that allows integration with student information systems and authentication protocols. It provides powerful and easy-to-use systems for educational instruction, communication, and assessment. In terms of functionality, Blackboard Learn provides users with a platform for communication and sharing content and has a suite of benefits including: (1) increased availability, (2) quick feedback, (3) improved communication, (4) tracking, and (5) skill building and can be accessed from the internet at anytime and anywhere. A key construct of the Blackboard facility is that it can be incorporated and utilised in the delivery of hybrid courses as a supplement to other digital environment learning systems and web-based distance learning. The Blackboard Learning System can also be used as a supplement to other digital environment learning systems are the primary instructional tools. In this regard, any materials (textbooks, video libraries, animated tutorials, and internet interactions available through storage resources) can be interwoven during the didactic sessions. In this didactic format, Blackboard can be used independently of its course cartridges as an interactive, out-of-class access site to present learning units, post assignments, provide pre-lecture assessments in the form of quizzes and question pools, exchange files within the digital drop box, create and archive discussion boards for specific lecture blocks or topics, post grades confidentially, and provide evaluation tools. In this setting, Blackboard provides an interactive instructional medium which can be interwoven into the INTACT Wiki and INTACT Moodle which complements the resources and tools available.

4 The potential impact

INTACT's added value is its role as a 'one stop shop' for resilience management in light of EWEs (promoting a holistic and integrated decision making process) in an innovative manner which integrates best practice knowledge provides access to decision support tools and methods.

Using a Business Model Canvas approach, the consortium partners developed a 'pathway to market' for the INTACT project outputs. The proposals varied and incorporated consultancy, research, education and knowledge creation opportunities for exploitation. To validate these proposals, stakeholder opinion was sought as a means of validation. This feedback received from stakeholders as potential 'future customers' proved very valuable to the final Exploitation Plan.

The project has been successful in collating a comprehensive and pragmatic knowledge base with situational awareness (through the incorporation of case studies) and education and teaching support modules that support policy and practice on CI resilience by identifying best practice tools and methods that are applicable throughout Europe and beyond.

- It is envisaged that INTACT will be exploited and developed within educational programmes to develop and enhance educational courses, in areas such as disaster resilience; infrastructure engineering; environmental protection and resilience.
- The ability to contribute to further RDI has also been identified. Groups of cooperating partners would be built depending on the individual business opportunities.
- Partners who have developed technical tools are committed to seeking opportunities to deploy the tools, either as part of an INTACT package, as standalone deployments or as integrated extensions of existing client planning, operational asset management and business intelligence systems. INTACT partners, particularly the academic partners, are planning to use the knowledge gained during INTACT project for teaching and further research opportunities.
- The consortium proved to be an effective working group and the partners are open to developing further cooperative projects together, including participation in future Horizon 2020 programmes.

As already described in the previous Chapter, the three main key exploitable foreground aspects concern:

- INTACT Wiki
- Risk management decision framework
- INTACT Education and Training

The other exploitation opportunities concern 'consultancy' and 'Research and Technological Development'. These opportunities will be shortly described in the next sections. An overview of the potential avenues of the exploitable foreground is exhibited in Table 4.1. This is further elaborated in the final (sub)sections where each partner elaborates some more about this exploitable knowledge and/or ideas for possibilities of INTACT in the future. Further information on exploitation is described in section B, B2: Overview table with exploitable foreground.

Table 4.1 Overview of example exploitable foreground

| Type of exploitable foreground | Description | Product/measure | Sector |
|---|--|---|--|
| General advancement of Knowledge | INTACT Wiki (web facing interface) | Access to INTACT knowledge and tools/maps | <ul style="list-style-type: none"> • Local government • Higher Education (Moodle) • Public • Industry/Companies |
| Commercial exploitation (R&D) | Risk management decision framework | <ul style="list-style-type: none"> • Integrated platform with Wiki • Professional CPD | <ul style="list-style-type: none"> • Higher education • Local/Regional government • Industry • Public • RTD • CPD training |
| General advancement of Knowledge / Commercial exploitation (R&D) | Virtual Learning Environment platform: Educational content & learning material | <ul style="list-style-type: none"> • Standalone e-platform • Integrated platform with Wiki • Consultancy • Courses offered to professionals | <ul style="list-style-type: none"> • Higher education • Local/Regional government • Industry • Public • RTD • CPD training |
| Commercial exploitation (R&D) | Data/Tools (Circle/Interactive maps) | As part of Wiki: best practice informative tools; downloadable data | <ul style="list-style-type: none"> • Industry • Policy • Higher Education |

4.1 Consultancy Services

The use of the INTACT platform prototype as a support tool for consulting and advice is regarded as one of the most feasible exploitation strategies for the complete INTACT platform, in at least the short term following the closure of the project. These services would take advantage of the platform and tools, either as a whole or individually. It is envisaged that INTACT consortium partners will utilise the results of INTACT in their respective consultancy work. For example, PANTEIA proposes to use results for consultancy relating to e.g. European Commission in the TEN-T corridors. FAC also proposes to use the INTACT findings to inform on new Horizon 2020 related projects and in relation to national and regional consultancy related work.

Approach

The INTACT project offers several streams for consultancy. The consortium partners will seek to maintain engagement with stakeholders identified in the INTACT project, and to develop new and ongoing strategic engagement with both private and public stakeholders, using the knowledge obtained during the course of the project and utilising the project outputs including the Wiki and Risk Management Process.

Benefit

INTACT will be used as a resource for informing local/regional/national government for enhancing resilience on infrastructure. This will provide new enterprise opportunities for consortium partners.

4.2 Research and Technological Development

Consortium partners propose to continue to pursue collaborative research opportunities across research institutes and build upon the INTACT brand and exploit the findings for further research opportunities, primarily through national research programmes and EU level programmes, for example, PANTEIA will use it for Horizon 2020 and TEN-T Corridors research projects. This will include scientific and built environment educational exploitation. INTACT consortium partners, particularly the academic partners within the consortium (University Ulster, University of Stuttgart) largely propose to use the knowledge gained during the INTACT project for further research and teaching.

A number of partners (HR Wallingford, FAC, VTT, NGI, TNO) also plan to exploit the INTACT project findings in research, publications, conference presentations etc.

4.3 Partners' future use of INTACT results

4.3.1 TNO

Exploitable foreground

TNO will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | |
| Consultancy | |
| Research and Technological Development | X |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|--|--------------------|
| Exploitation | Present the INTACT platform to target market audience at meetings, workshops and Conferences. | M1-M36 |
| Partnerships | Seek opportunities to partner with relevant organisations involved in designing and/or implementing CI resilience interventions e.g. CI providers, Policy makers, National and local government, Planning Authorities, Emergency response units etc. | M1-M36 |
| Networking and Exploitation / Business Collaboration Opportunities | Using the expertise developed during the INTACT project and our extended professional network that has been facilitated by the project, TNO will seek related exploitation opportunities to build on the INTACT project results and to exploit them for further research and development projects. | M1-M36 |

4.3.2 CMCC

Exploitable foreground

CMCC will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | X |
| Consultancy | X |
| Research and Technological Development | |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|--|--------------------|
| Exploitation | The INTACT WIKI could be fruitfully used to display a “happy-ending” attempt to bridge the gap between scientific community and stakeholders. In this perspective, it could be used as basis to “export” in other contexts. In different contexts, assessments about “adaptation capacity” of territories, organisations and infrastructures to face with climate changes are increasingly in demand; in this perspective, tools and approaches developed within the Project for “Risk Management Process” represent the perfect completion of usual activities usually carried out by CMCC primarily aimed, up to now, to assess variations in weather forcing or hazard under the effect of CC | M1-24 |
| Partnerships | Thanks to INTACT Project, solid collaborations with different partners have been established. They permitted to develop tools, approaches and simulation chains that could obtain great interest in other (also geographical) contexts | M1-M36 |
| Networking and Exploitation / Business Collaboration Opportunities | The Project permitted increasing networking and collaborations at local scale; in the specific, the tools adopted have made easier the communication between researchers, policymakers, CI maintainers. As the relevance that such partnerships has acquired in these years in numerous funding opportunities (at National and European scale), such contacts could be widely exploited in next years | M1-24 |
| Awareness | The tools developed within the Project will be widely used to increment awareness about the treated topics (climate changes, improvement of resilience of CI); it could take place in special way during the several occasions in which CMCC researchers are called to give speeches or presentations | |

4.3.3 DELTARES

Exploitable foreground

Deltares will be involved in the exploitation (commercial, education etc.) of the following products (where ‘X’ is inserted):

| Title | |
|--|---|
| INTACT Wiki | |
| Risk Management Process | X |
| INTACT Education and Training | X |
| Consultancy | X |
| Research and Technological Development | X |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|--|--|
| Exploitation | Course material based on the INTACT cases The case study experiences will be translated in course material for professionals working on CI risks such as CI owners, operators, researchers, and government employees. | Most work ready from additional INTACT budget. 1 Month extra to finalise |
| Partnerships | This work adds to the work being done in WP1 of INTACT, which provides course material for students. Integration with educational tools. | 2 months |
| Networking and Exploitation / Business Collaboration Opportunities | A course will be organised with a selection of INTACT partners. It can be combined with a relevant conference on this topic | 2 months |

4.3.4 FAC**Exploitable foreground**

FAC will be directly involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | |
| Consultancy | X |
| Research and Technological Development | |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|--|--------------------|
| Exploitation | Present the INTACT platform (Wiki) to target market audience at meetings, workshops and conferences to share knowledge and practical solutions to interested and relevant bodies on improved CI resilience measures. Relevant target audience include Local Government (Policy Makers, Planners and Engineers), CI asset operators (public and private), Scientific and research communities. INTACT research will also be exploited through consultancy and new research development initiatives and new project development opportunities. | M1-M36 |
| Partnerships | Seek strategic opportunities to partner with relevant public and private organisations involved in designing and/or implementing CI resilience interventions e.g. CI providers, Policy makers, National and local government, Planning Authorities, Emergency response units etc. | M1-M36 |
| Networking and Exploitation / Business Collaboration Opportunities | Using the expertise developed during the INTACT project and our extended professional network that has been facilitated by the project, FAC will seek related exploitation opportunities to build on the INTACT project results and to exploit them for further research and development projects. There is potential for networking | M1-M36 |

| | | |
|------------------------|---|--|
| | and exploitation opportunities with both public and private bodies. | |
| Other (Please specify) | FAC will use INTACT research findings and the Wiki in its future CI and urban resilience projects and in our own knowledge and expertise development in the future. | |

4.3.5 DRAGADOS

Exploitable foreground

DRAGADOS will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | |
| Consultancy | X |
| Research and Technological Development | |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|--|--------------------|
| Exploitation | Results of INTACT project will be use internally to improve the works carried out by the company. | M1-M36 |
| Partnerships | Seek opportunities to continue working in the field of the CI affected by climate change with involved partners from different countries. | M1-M36 |
| Networking and Exploitation / Business Collaboration Opportunities | The network created during the project development will contribute to assure future collaboration in other business or research opportunities. | M1-M36 |

4.3.6 Ulster University

Exploitable foreground

Ulster University will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | |
| INTACT Education and Training | X |
| Consultancy | X |
| Research and Technological Development | |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--------------|---|--------------------|
| Exploitation | The INTACT Wiki offers several avenues for future exploitation, namely pertaining to scientific, research and educational exploitation. In line with Ulster University's research strategy, exploitation through delivering research projects with 'real life' impact for transposing knowledge | M1-36 |

| | | |
|--|--|-------|
| | beyond academic capacity will be undertaken. Scientific exploitation will be developed using INTACT results through presentations in conferences and meetings. The INTACT concept will be exploited and developed within the educational programme to develop and enhance educational courses, including MSc in Disaster Resilience; MSc in Infrastructure Engineering; MSc GIS; MSc Safety Engineering and MSc Disaster Management; Environmental Protection and Resilience. INTACT findings will be used in a number of modules within the interactive learning environment with additional aspirations to develop accredited training programmes for professionals for continued professional practice. | |
| Partnerships | Ulster will seek to develop ongoing strategic engagement with both private and public entities to encourage bi-directional learning and exploitation of the INTACT product. This will encompass interactive demonstrations and dissemination of INTACT in public forums with the view to enhancing knowledge whilst simultaneously ensuring INTACT as a concept is enshrined within private/sector strategic directions. | M1-36 |
| Networking and Exploitation / Business Collaboration Opportunities | Ulster's research strategy is to continue to pursue collaborative research opportunities across a suite of research institutes. Ulster will endeavour to build upon the INTACT brand and exploit the findings for further research opportunities, primarily through national research programmes and EU level programmes. | |
| Other (Please specify) | INTACT will be used as a resource for informing local/regional/national government for enhancing resilience on infrastructure. A number of the Ulster project team sit on government panels and bodies. | |

4.3.7 HR Wallingford

Exploitable foreground

HR Wallingford will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | X |
| Consultancy | X |
| Research and Technological Development | X |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--------------|---|--------------------|
| Exploitation | Present the INTACT platform to target audiences at briefings, workshops and conferences, as well as publish additional journal papers | M1-M36 |
| Partnerships | Look to continue the collaboration with INTACT partners to further exploit selected project outcomes. Seek to work with consultants and other stakeholders who are delivering | M1-M36 |

| | | |
|--|---|--------|
| | CI interventions to include INTACT outputs in their solutions. | |
| Networking and Exploitation / Business Collaboration Opportunities | Promote the INTACT project outputs as part of existing professional networks, such as the UK CIRIA infrastructure resilience network. Look for research and development opportunities to provide for further exploitation of the outputs with new partners. | M1-M36 |
| Education and Training | Use material from the INTACT Wiki and the teaching module from WP1 as part of the Floods and Coastal Engineering degree programme at Brunel University | M5-M36 |

4.3.8 PANTEIA

Exploitable foreground

Panteia will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | |
| INTACT Education and Training | X |
| Consultancy | X |
| Research and Technological Development | |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|---|--------------------|
| Exploitation | Panteia will use the results of INTACT in their consultancy work. Examples are work for the European Commission in the TEN-T corridors Furthermore, the knowledge of INTACT will be exploited by doing education via guest lectures. | 36 months |
| Partnerships | Panteia will liaise with the INTACT partners where possible to keep the wiki alive. Results that stem from the exploitation and which are interesting for the wiki, will be shared | 36 months |
| Networking and Exploitation / Business Collaboration Opportunities | Panteia will keep on disseminating the results of INTACT, as related to the exploitation of the results in different projects. The results allow us to build further partnerships. | 36 months |

4.3.9 NGI

Exploitable foreground

NGI will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|----|
| INTACT Wiki | X* |
| Risk Management Process | X* |
| INTACT Education and Training | |
| Consultancy | X |
| Research and Technological Development | X |

* indirect through consultancy

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|---|--------------------|
| Exploitation | Seek opportunities to apply the INTACT wiki as part of consultancy projects for e.g. CI providers, Norwegian municipalities, Planning Authorities, Emergency response units etc. | M1-M36 |
| Partnerships | | |
| Networking and Exploitation / Business Collaboration Opportunities | The extended professional network of NGI developed within the INTACT project provide extended exploitation opportunities, e.g. to apply for commercial or research projects together with INTACT partners. NGI will seek related exploitation opportunities to exploit the INTACT project results for further research and development projects. Specifically, the INTACT results will be applied and further developed within the research based innovation project "Klima2050". | M1-M36 |

4.3.10 VTT

Exploitable foreground

VTT will be involved in the commercial exploitation of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | |
| Consultancy | |
| Research and Technological Development | X |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|---|--|--------------------|
| Exploitation | VTT's press release (both in Finnish and in English) regarding INTACT results will be released after INTACT project has been ended. VTT will use the results of INTACT project in further national and international projects dealing with infrastructure protection, electricity distribution, risk management vulnerability and risk analyses, multi-criteria decision-making, cost-benefit analysis and asset management. Present the INTACT wiki and Risk Management Process to target market audience at meetings, workshops and Conferences. | M1-M36 |
| Partnerships | Seek opportunities to partner with relevant companies to accelerate the commercialization the methods developed, tailored and applied in the Finnish case study in INTACT. | M1-M36 |
| Networking and Business Collaboration Opportunities | Results of the Finnish case study are aimed at decision makers and experts who are involved in the crisis management (preparedness, mitigation, response and recovery) related to the winter extremes. The main target groups are: | M1-M36 |

| | | |
|----------------------|---|--------|
| | <ul style="list-style-type: none"> authorities at distinct levels (municipalities, ministries, hospitals, military, national emergency supply agency, meteorological institute etc.), emergency organisations (rescue services, emergency medical services, police, fire service, emergency response centre etc.), private parties (electricity transmission companies, enterprise which takes care of the functioning of the nation-wide high-voltage grid, infrastructure owners and operators etc.) and non-governmental voluntary organizations (The Finnish Red Cross, contractors etc.). <p>Examples of options for collaboration in the context of INTACT results:</p> <ul style="list-style-type: none"> Direct sales A joint development project (e.g. with infrastructure owners and operators, public decision-makers, private companies) Co-operation (e.g. with technology providers and ICT companies) | |
| Other (Please state) | <p>Boosting the use of the risk management process and wiki, for example in the fairs and via VTT's national and international networks and alliances.</p> <p>Further discussions on co-operation possibilities with the partners met in the conferences during INTACT -project are in progress.</p> | M1-M36 |

4.3.11 University Stuttgart

Exploitable foreground

USTUTT will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | |
| Risk Management Process | |
| INTACT Education and Training | X |
| Consultancy | |
| Research and Technological Development | X |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--------------|---|--------------------|
| Exploitation | Present and use the INTACT Education and Training outcomes at lectures, conferences and workshops. | M1-M36 |
| Partnerships | <p>Cooperation with relevant organisation conducting research in the field of CI resilience</p> <p>Cooperation with relevant persons teaching in the field of CI resilience</p> | M1-M36 |

| | | |
|--|---|--------|
| Networking and Exploitation / Business Collaboration Opportunities | Building on the aforementioned partnerships USTUTT seeks to initiate further project proposals that address CI resilience. In this context USTUTT will contribute knowledge and experiences developed in the scope of the INTACT project. | M1-M36 |
|--|---|--------|

4.3.12 CSIC

Exploitable foreground

CSIC will be involved in the exploitation (commercial, education etc.) of the following products (where 'X' is inserted):

| Title | |
|--|---|
| INTACT Wiki | X |
| Risk Management Process | X |
| INTACT Education and Training | |
| Consultancy | X |
| Research and Technological Development | |

Timetable for the use within the next 3 years after the end of the project

| Activity | Brief description of the activity | Timescale (months) |
|--|--|--------------------|
| Exploitation | Present the INTACT platform to target market audience at meetings, workshops and Conferences, as well as publish additional journal papers. Seek consultancy and new research development initiatives and new project development opportunities. | M1-M36 |
| Partnerships | Seek partnership with relevant organizations interested in Extreme Weather Indices (EWIs) and/or involved in designing and/or implementing CI resilience interventions both from the private sector and from national and local government. The INTACT WIKI could be fruitfully used for this purpose. | M1-M24 |
| Networking and Exploitation / Business Collaboration Opportunities | Seek opportunities using the expertise developed during the INTACT project to partner with relevant organisations involved in designing and/or implementing CI resilience interventions in the framework of funding opportunities (at National and European scale). | M1-M36 |



5 Address of public website

www.intact-project.eu

6 Project logo, diagrams or photographs

6.1 Project logo



6.2 Project Website

The project website has been developed and is up to date, and is maintained by PANTEIA:

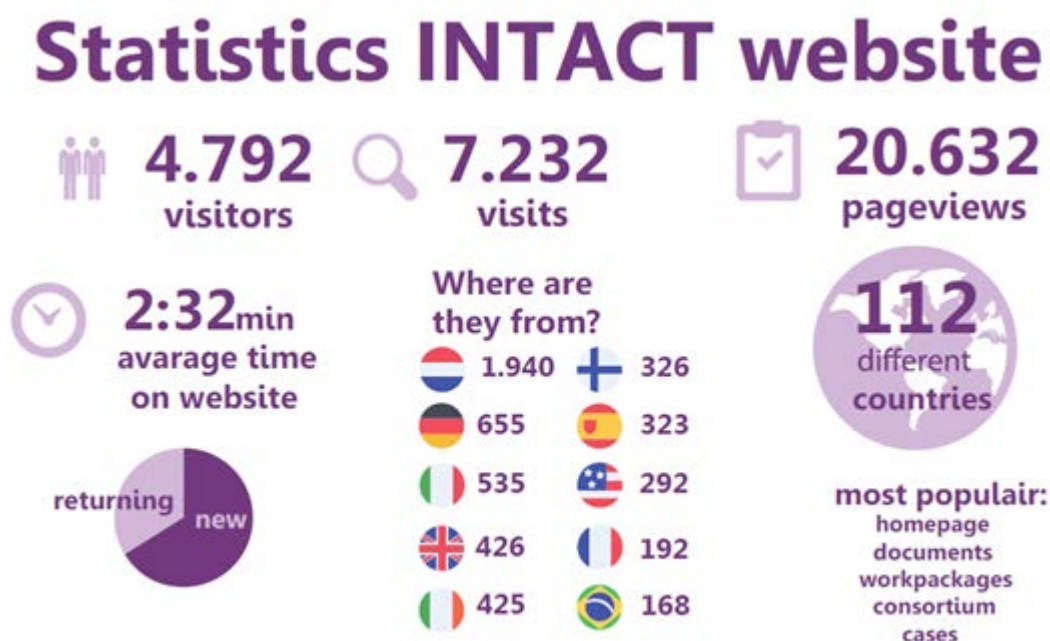
- <http://www.intact-project.eu>;

All information developed within the INTACT project is available through the INTACT Reference Guide (IRG), in the form of a publicly accessible Wiki, and is maintained by ULSTER:

- <http://www.intact-wiki.eu>;

Some statistics of the INTACT website are shown in the infographic of Figure 6.1.

Figure 6.1 Statistics on INTACT website (at the end of the project)



6.3 Project brochure

In the 1st period the INTACT brochure has been finalised and serves as a quick introduction factsheet to the project. It presents a distinctive identity for the INTACT project, informs the stakeholders on the expected project outcomes and the activities which will lead to the final product.

6.4 Project video

INTACT Video

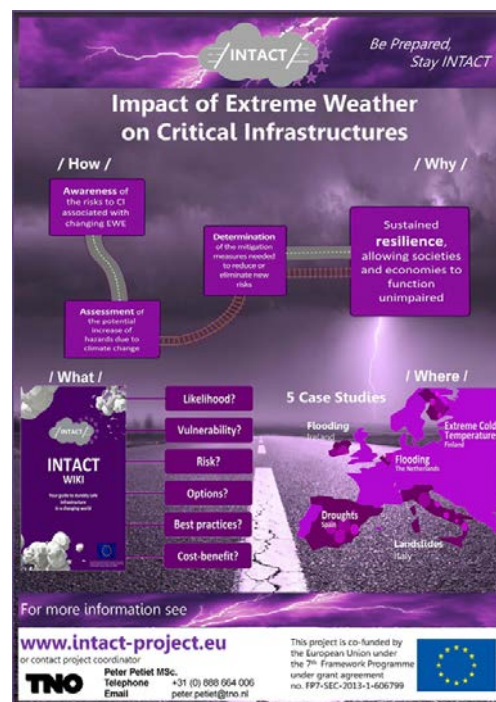
Future Analytics has developed a video presenting the INTACT project. It can be viewed on the INTACT Website:

http://www.intact-project.eu/intact/assets/File/INTACT_Final.1_qtp.mp4

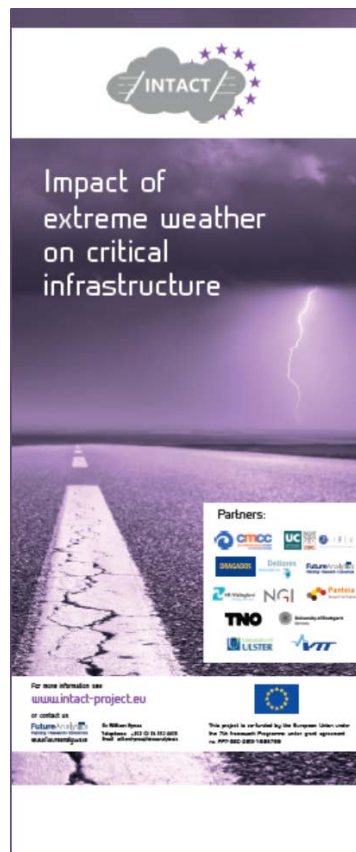
It can also be viewed on the INTACT Youtube Channel:

<https://www.youtube.com/watch?v=qel2AxVdZ9U>

6.5 Project Poster



6.6 Project Banner



6.7 Project Newsletters

The INTACT newsletters have informed the target group on the project progress, the results as well as the upcoming activities (a ‘sneak preview’). The newsletters have been published every six months on the website and were sent out electronically to different stakeholders related to the project. The newsletters covered different themes as the project progressed, such as on case studies and a wrap up at the end of the project:

- No 1 – Start up INTACT
 - <http://panteia.m13.mailplus.nl/archief/ mailing-464157.html>
- No 2 – Request for support
 - <http://panteia.m13.mailplus.nl/archief/ mailing-475220.html>
- No 3 – Risk Framework
 - <http://panteia.m13.mailplus.nl/archief/ mailing-487884.html>
- No 4 – INTACT wiki
 - <http://panteia.m13.mailplus.nl/archief/ mailing-505951.html>
- No 5 – Case study results
 - <http://panteia.m13.mailplus.nl/archief/ mailing-523603.html>
- No 6 – Final INTACT results
 - <http://panteia.m13.mailplus.nl/txt534619/ mBw42gdt9tdEsEn>

The newsletters have been sent out to the different stakeholders and other interested parties. Up to the end of the project, the number of contacts that the newsletters were sent to amounted to approximately 220, after the End Event this will increase as they will also receive the final newsletter in which the results are given of the End Event.

6.8 Project Twitter account

Twitter (Figure 6.2) has been used for direct information, for example by including comments and pictures from the sites, commenting events and related topics as well as more traditional dissemination, such as posting upcoming events. The Twitter account of the INTACT project: @Intact_eu.

Figure 6.2 Twitter impression



By the end of the project we had 107 followers on Twitter. INTACT made 152 Tweets. The number of tweets is approximately 1 per week during the project. The number of followers on Twitter is shown in Figure 6.3. As can be seen, the number of followers gradually increased.

Figure 6.3 Development of number of followers on Twitter

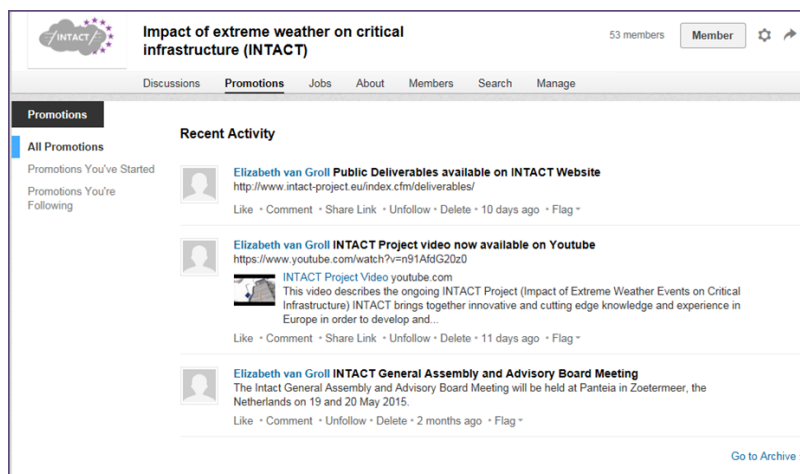


6.9 Project LinkedIn account

The LinkedIn account connected the consortium members, the case studies stakeholders as well as any other stakeholder interested in the project outcomes. The main activities in LinkedIn involved: connection with other projects and stakeholders, dissemination of workshops and events, news with project results and discussions on relevant topics.

The LinkedIn account of the INTACT project: INTACT (see screenshot in Figure 6.4). LinkedIn Group: <https://www.linkedin.com/groups/Impact-extreme-weather-on-critical-8173422>

Figure 6.4 LinkedIn impression



By the end of the project we had 67 members on LinkedIn, and INTACT supported 7 project related discussions on LinkedIn. The number of LinkedIn discussions is relatively small, due to the fact that most discussions were held face-to-face with stakeholders during workshops.



7 Use and dissemination of foreground

7.1 Table of dissemination activities and Scientific (peer reviewed) publications

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|--|--|---------------------|---|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Article | Deltares | 'Vulnerability to flooding of the critical infrastructure in Cork'. Published in the R&D Highlights of Deltares 2017. | | | Scientific community | All |
| Article | TNO | 'Risk management support on critical infrastructure protection against extreme weather events', by Peter Petiet | November 16 - 2016 | European CIIP Newsletter, Volume 10, Number 3 | Scientific community, Policy makers | All |
| Dissemination and Networking Presenting INTACT project | CMCC/CIRA (Guido Rianna) | The Fourth Italian Workshop on Landslides will take place in Naples on November, 23-25, jointly organised by the Seconda Università di Napoli and the Università di Napoli Federico II. Naples, Italy; | 23-25 November 2015 | Naples | Scientific community | IT |
| Dissemination and Networking Presenting INTACT project Input/ Feedback from Stakeholders | VTT (Riitta Molarius, Kari Mäki, Minna Räikkönen, Kim Forssén) | Finnish case study workshop: Risk analysis | 16 December 2015 | | Stakeholders | FI |
| Dissemination and Networking Presenting INTACT project Feedback from Stakeholders | All INTACT partners | INTACT Mid-project external stakeholder workshop | 14 January 2016 | Brussels | Stakeholders | EU |
| Dissemination and Networking Presenting INTACT project | CMCC/CIRA (Paola Mercogliano, Guido Rianna, | Italian case study workshop | 29 February 2016 | Naples | Stakeholders | IT |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|---|---|---------------|--------|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Input/ Feedback from Stakeholders | Fabio Ciervo, Nicola Zollo, Alfredo Reder) NGI (Marco Uzielli) | | | | | |
| Dissemination and Networking Presenting INTACT project Input/ Feedback from Stakeholders | FAC (/ HRW/ DELTARES/ USTUTT) | Irish case study workshop | 9 March 2016 | Cork | Stakeholders | IE |
| Dissemination and Networking Presenting INTACT project Input/ Feedback from Stakeholders | DELTARES (Thomas Bles) PANTEIA (Jan Kiel) TNO (Tara Geerdink, Albert Nieuwenhuijs) | Port of Rotterdam 2nd case study workshop | 5 April 2016 | Delft | Stakeholders, Policy makers | NL |
| Dissemination and Networking Presenting INTACT project Input/ Feedback from Stakeholders | DRAGADOS (Elena Martín) HRW (Marta Roca), DELTARES (Sandra Gaytan) | Spanish case study workshop | 20 April 2016 | Madrid | Stakeholders | ES |
| Dissemination and Networking Presenting INTACT project Input/ Feedback from Stakeholders | VTT (Kari Mäki, Minna Räikkönen, Kim Forssén, Riitta Molarius) HRW (Andy Tagg) | Finnish case study workshop: Measures | 23 May 2016 | | Stakeholders | FI |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|--------------------------|---|------------------|---|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Dissemination and Networking | HRW (Andy Tagg) | Community of Users meeting | 14-15 March 2017 | Brussels, BE | Stakeholders, Policy makers | UK |
| Meeting summary | CMCC (Paola Mercogliano) | 'Adaptation of Structural Design to Climate Change' DG GROW workshop | 11 December 2015 | Brussels | Policy makers, Scientific community | EU |
| Newsletter 1 | PANTEIA | First Newsletter with focus on the planned activities during the project | March 2015 | Website and distributed to mailing list | Scientific community, Policy makers, Civil society, Media | All |
| Newsletter 2 | PANTEIA | Second Newsletter with focus on the progress made and next steps in the project | July 2015 | Website and distributed to mailing list | Scientific community, Policy makers, Civil society, Media | All |
| Newsletter 3 | PANTEIA | Third Newsletter with focus on Decision Support module | 7 January 2016 | Website and distributed to mailing list | Scientific community, Policy makers, Civil society, Media | All |
| Newsletter 4 | PANTEIA | Fourth Newsletter with focus on INTACT Wiki (Reference Guide) | May 2016 | Website and distributed to mailing list | Scientific community, Policy makers, Civil society, Media | All |
| Newsletter 5 | PANTEIA | Fifth Newsletter with focus on the Case Studies | December 2016 | Website and distributed to mailing list | Scientific community, Policy makers, Civil society, Media | All |
| Newsletter 6 | PANTEIA | Sixth Newsletter with focus on the Final Event | March 2017 | Website and distributed to mailing list | Scientific community, Policy makers, Civil society, Media | All |
| Oral presentation | CMCC | 'An experience of knowledge co-production for setting up landslide risk management processes in a critical infrastructure: the case of Campania Region (Southern Italy)' by Rianna, Roca Collell, Uzielli, van Ruiten, Mercogliano, Ciervo, Reder | | EGU, Vienna | Policy makers | AU |
| Oral Presentation | Guido Rianna | European Geosciences Union General Assembly | 24-28 April 2017 | | Scientific community | All |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|--|---|-------------------|--|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Oral presentation – synergy | Peter Petiet (TNO) | Community of Users meeting Focus on natural hazards and a side event with a focus on climate extreme events. | 22-23 June 2016 | | Scientific community, Policy makers | EU |
| Oral presentation – synergy | William Hynes (FAC) | STREST Final Workshop | 16 September 2016 | | Stakeholders | EU |
| Oral presentation – synergy | Peter Petiet (TNO) | FORTRESS workshop | 20 September 2016 | Tiel, NL | Stakeholders, Policy makers | EU |
| Oral presentation – synergy | Peter Petiet (TNO) | DOMINO II event | 21 September 2016 | Tiel, NL | Scientific community, Policy makers | EU |
| Oral presentation – synergy | Albert Nieuwenhuijs (TNO) | European Transport Conference | 7 October 2016 | Barcelona, ES | Scientific community, Policy makers | All |
| Oral Presentation – synergy | Albert Nieuwenhuijs (TNO), HRW (Andy Tagg) | Joint conference / DRMKC meeting | 16-17 March 2017 | Brussels, BE | Scientific community | EU |
| Panel discussion | TNO | TNO assisted at a RAIN workshop at TU Delft | 4 April 2016 | Delft, TNO | Scientific community, Policy makers | EU |
| Panel member, and oral presentation – synergy | Peter Petiet (TNO) | INFRARISK Final Conference | 29 September 2016 | Madrid, ES | Scientific community, Policy makers | EU |
| Poster | TNO | ‘Impact of Extreme Weather on Critical Infrastructures’ (2015). Authors: P. Petiet. | 2015 | Presented at CRITIS 2015 conference; | Scientific community, Policy makers | All |
| Poster Presentation | PANTEIA | ‘Impact of Extreme Weather Events on Critical Infrastructures’ (2016). Authors: J. Kiel. | 18 -21 April 2016 | Warsaw, TRA 2016 | Scientific community, Policy makers | All |
| Poster presentation | NGI | Approaches for assessment of vulnerability of critical infrastructures to weather-related hazards | 22 April 2016 | European Geosciences Union General Assembly, | Scientific community | All |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|----------------|---|----------------------|---|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| | | | | Vienna, 17–22 April 2016 | | |
| Poster presentation | VTT | ‘Factors of Vulnerability and Resilience in Energy Systems’. Authors: K. Mäki, K. Forssén, M. Räikkönen | 14-15 June 2016 | CIREW Workshop 2016 Helsinki | Scientific community | All |
| Presentation | DELTA/RES/ FAC | ‘Flood vulnerability of critical infrastructure in Cork, Ireland’ (2016). Authors: K.M. de Bruijn, L. Cumiskey, R. Ní Dhubháda, M. Hounjet, W.H. Hynes. | 17 – 21 October 2016 | Presented at FLOODRisk 2016 Lyon, FR | Scientific community | EU |
| Presentation | TNO | ‘Resilient risk management strategies for critical infrastructure within cities’ (2016). Authors: T. Geerdink. | 10-13 May 2016 | Adaptation Futures 2016 International Conference; | Scientific community | All |
| Presentation | TNO | ‘Knowledge gaps in risk management for critical infrastructure: insights from four case-studies’ (2016). Authors: T. Husby | 10-13 May 2016 | Adaptation Futures 2016 International Conference | Scientific community | All |
| Presentation | DELTA/RES | During the presentation of Thomas Bles about the ROADAPT project, short notice was given to the INTACT case study ‘port of Rotterdam’. | 18 April 2016 | Warsaw, TRA 2016 | Scientific community, Policy makers | All |
| Presentation | DELTA/RES | Presentation ‘Functioning of ports from a climate change perspective’ | 29 April 2016 | Brussels, Benelux workshop CLIMATE ADAPTATION AND TRANSPORT & MOBILITY IN THE BENELUX AND SURROUNDING AREAS | Scientific community, Policy makers | EU |
| Presentation | USTUTT | Influences of Global and Regional Change on the Resilience of Critical Infrastructures | 10-13 May 2016 | Adaptation Futures 2016 International Conference | Scientific community | All |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|---------------------------------------|--|---------------------|---|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Presentation | TNO | Title: 'Risk management support on CIP against changing EWE risks' | 22-23 May 2016 | 4 th CoU on Natural Hazards, Brussels | Scientific community | All |
| Presentation | USTUTT | 'Aufbau eines Evaluierungssystems für den Umgang mit Infrastrukturausfällen anhand von 'Best und Worst Practice' Beispielen' (Development of an evaluation system for infrastructure failures by using best and worst practice examples) - Presentation of INTACT framework during meeting for KIRMin project | 20 July 2016 | KIRMin - Kick Off Meeting, Köln | Scientific community | DE |
| Presentations & Paper | Guido Rianna | World Landslide Forum 2017 Ljubljana (Slovenia) | 30 May -2 June 2017 | Ljubljana | Scientific community | All |
| Presentation included INTACT Results so far | TNO | Workshop on Innovations in Climate Services By KNMI | 2-4 November 2015, | Hotel Zuiderduin, Egmond aan Zee, The Netherlands | Scientific community, Industry | NL |
| Presentation Meeting for KLARIS project | USTUTT (Benedikt Rilling, Anna Goris) | 'Systemmodell ausgewählter heutiger Infrastrukturen und Extremereignisanalyse' (System model of selected present infrastructures and EWE) (Presentation of INTACT framework and case study examples) during meeting for KLARIS project ('Notwendigkeiten und Möglichkeiten zur klimaresilienten und zukunftsfähigen Ausgestaltung von nationalen und grenzübergreifenden Infrastrukturen') | 12 November 2015 | Berlin | Scientific community, stakeholders | DE |
| Publication of results of case study | DELTARES | The Port of Rotterdam case study will be published in the DELTARES R&D Highlights 2015, our annual showcase of projects. This topic is also published on our website, see: https://www.DELTARES.nl/app/uploads/2015/04/PB_Impact-of-Extreme-Weather-on-the-Port-of-Rotterdam.pdf | Spring 2016 | Internet | Stakeholders, Policy makers | NL |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|------------------------------|--|----------------------|--|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Publication | PANTEIA/ TNO/ DELTARES | ‘A Decision Support System For The Resilience Of Critical Transport Infrastructure To Extreme Weather Events’ (2016). Authors: J.Kiel, P. Petiet, A. Nieuwenhuis, T. Peters, K. van Ruiten. | 18-21 April 2016 | Published on Proceedings of 6th Transport Research Arena, April 18-21, 2016, Warsaw, Poland. | Scientific community, Policy makers | All |
| Publication | NGI/FAC | ‘Impact of extreme weather on critical infrastructure: the EU-INTACT risk framework’. Authors: A. Tagg, M. Räikkönen, K. Mäki, M. Panzeri. | 17 – 21 October 2016 | Presented at FLOODRisk 2016 Lyon, FR | Scientific community | EU |
| Publication | NGI | Probabilistic modeling of vulnerability of road infrastructures to floods | 17 – 21 October 2016 | Presented at FLOODRisk 2016 Lyon, FR | Scientific community | EU |
| Publication | DELTARES/ PANTEIA | ‘EU-INTACT-case studies: Impact of extreme weather on critical Infrastructure’ (2016). Authors: K. van Ruiten, T. Bles, J. Kiel. | 17 – 21 October 2016 | Presented at FLOODRisk 2016 Lyon, FR | Scientific community | EU |
| Publication | VTT | ‘A holistic approach for assessing impact of extreme weather on critical infrastructure’ Authors: M. Räikkönen, K. Mäki, M. Murtonen, K. Forssén, A. Tagg, P. J. Petiet, A. H. Nieuwenhuijs & Michael McCord | 25-27 May 2016 | Conference: Risk Analysis, http://www.wessex.ac.uk/conferences/2016/risk-analysis-2016 Crete | Scientific community | EU |
| Publication | TNO | Information published in ‘Security Research Projects Catalogue 2015’ | 2015 | | Scientific community – Industry – Civil society – Policy makers – Media | All |
| Publication | DELTARES | Deltares Publication, R&D Highlights 2015 INTACT Project pp. 18,19. | 2015 | Delft | Scientific community | NL |
| Publication | CMCC | ‘Future trends of snowfall days in northern Spain from ENSEMBLES regional climate projections’ (2015). Authors: M.R. Pons, S. Herrera, J.M. Guitiérrez; | 2015 | Published on Climate Dynamics Journal. | Scientific community | All |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|-------------|---|-----------------|--|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Publication | CMCC | ‘Variations in landslide frequency due to Climate Changes through high resolution Euro-CORDEX Ensemble’ by Rianna, Reder, Villani & Mercogliano | | World Landslide Forum 4, Lubiana (Slovenia) | Scientific community | All |
| Publication | VTT | ‘Resilience of Finnish electricity distribution networks against extreme weather conditions’ | March 2016 | Kim Forssén: Master’s thesis. | Scientific community | FI |
| Publication | CMCC | ‘Extreme temperature and precipitation events over Italy Assessment of high-resolution simulations with COSMO-CLM and future scenarios’ (2016). | 2016 | Authors: A.L. Zollo, V. Rillo, E. Bucchignani, M. Montesarchio and P. Mercogliano. Published on International Journal of Climatology | Scientific community | All |
| Publication | NGI | Assessing the risk posed by natural hazards to infrastructures’ (2016). Authors: U.M.K. Eidsvig, K. Kristensen, and B.V. Vangelsten. | 2016 | the Journal Natural Hazards and Earth System Sciences (NHES); | Scientific community | All |
| Publication | VTT | ‘Enhancing the Resilience of Electricity Networks by Multi-stakeholder Risk Assessment: The Case Study of Adverse Winter Weather in Finland’ Authors: Molarius, R., Räikkönen, M., Forssén, K. & Mäki, K. | February 2017 | Journal of Extreme Events - Early Access. World Scientific (2017) No: February, 25 p. DOI: 10.1142/S2345737616500160 | Scientific community | All |
| Publication | VTT, TNO | Creating stakeholder value through mitigation measures in the context of disaster management. Infrastructures 2017 Authors : Räikkönen, M; Molarius, R.; Mäki, K.; Forssén; K; Petiet, P. J.; Nieuwenhuijs, A. H. | tbd in May 2017 | Infrastructures 2017, No. X, Vol. X, pp. xx-xx | Scientific community | All |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|------------------|---|-----------------|--|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Publication | | 'VESTNICK - of Almaty University of Power Engineering and Telecommunications Risk management process for extreme weather event impacts' Authors: Marta Roca Collell and Andrew Tagg. | 2016 | | Scientific community | All |
| Publication | USTUTT | 'An Integrated Critical Infrastructure Risk and Resilience Concept in the Context of Extreme Weather Events and Global Change' (2017). Authors: M. Schwab, C. Berchtold, A. Goris | | Journal of Extreme Events, Online Ready | Scientific community | All |
| Publication | VTT | 'Resilience of Electricity Distribution Networks against Extreme Weather Conditions' Authors: Forssén, K., Mäki, K., Räikkönen, M. & Molarius, R. | | ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part B: Mechanical Engineering - Early Access. ASME (2017). DOI: 10.1115/1.4035843 | Scientific community | All |
| Publication | NGI & CMCC/ CIRA | 'Temporal evolution of landslide risk for the municipality of Nocera Inferiore, Italy under the effect of climate changes' Authors: Uzielli, M., Rianna, G., Mercogliano, P., Ciervo, F., & Eidsvig, U. | August 2017 | 8 th Conference of the International Society for Integrated Disaster Risk Management (IDRiM 2017), Reykjavik (Iceland) | Scientific community – Industry – Civil Society – Policy Makers | All |
| Publication | VTT | 'Resilience of Finnish electricity distribution networks against extreme weather conditions'. Authors: K. Forssén, K. Mäki. | 14-15 June 2016 | CIREN Workshop 2016 Helsinki | Scientific community | All |

| LIST OF DISSEMINATION ACTIVITIES | | | | | | |
|---|--------------------|--|-------------------|--|---|---------------------|
| Type of dissemination Product (=presentation, conference, workshop, publication, flyer, poster, etc.) | Main leader | Title | Date | Place | Target Audience (Scientific community – Industry – Civil society – Policy makers – Media) | Countries addressed |
| Publication | CSIC | On the Credibility of Regional Climate Models to Reproduce Extreme Precipitation; Casanueva, A., Herrera, S., Gutiérrez, J.M., Fernández, J. | Sept. 2017 | EVAN 2017 | International Conference on Advances in Extreme Value Analysis and Application to Natural Hazards | All |
| Publication preparation | VTT | Preparation and submitting of a journal paper based on the results of the Finnish case study focusing on the CBA of measures. Authors: M. Räikkönen, K. Mäki, K. Forssén, R. Molarius et al. | Tbd | | Scientific community | All |
| Publication preparation | USTUTT | 'Global and Regional Changes in Risk Research: Impacts on Critical Infrastructures' (2017). Authors: A. Goris, B. Rilling | | Under review for the Journal of Extreme Events | Scientific community | All |
| Sessions | Jan Kiel | European Transport Conference – organization of different parallel sessions on the topic of extreme weather and infrastructure | 7 October 2016 | Barcelona, ES | Scientific community, Policy makers | All |
| Workshop | PANTEIA | Case Study Workshop | 20 May 2016 | PANTEIA, Zoetermeer, the Netherlands | Stakeholders | NL |
| Workshop | Peter Petiet (TNO) | Outcome of 'Knowledge-sharing workshop' EU projects on mitigating cascading effects during crises, | 20 September 2016 | Tiel, NL | Stakeholders | NL |
| Workshop | Deltares, Panteia | Port of Rotterdam 3rd case study workshop | 22 September 2016 | Delft, NL | Stakeholders | NL |



8 Section B

8.1 B1: List of applications for patents, trademarks, registered designs, etc.
if applicable

| B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC. | | | | | |
|--|------------------------|--------------------------|--|---------------------------------|---------------------------------------|
| Type of IP Rights | Confidential YES/NO | Foreseen embargo date | Application reference(s) (e.g. EP123456) | Subject or title of application | Applicant (s) (as on the application) |
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8.1 B2: Overview table with exploitable foreground

| B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND | | | | | | | | | |
|--|--|--|------------------|-----------------------------|--|---|--|---|--|
| N O. | Type of exploitable foreground | Exploitable Foreground (description) | Confid ential | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application | Timetable for commercial use or any other use | Patent or other IPR exploitation (licenses) | Owner & Other Beneficiary(s) involved |
| 1 | Commercial exploitation of R&D results | Consultancy opportunities and future research and development project opportunities | Y | None | The use of the INTACT platform prototype as support for consulting and advice is regarded as one of the most feasible exploitation strategies for the complete INTACT platform in at least the short term following the closure of the project. These services would take advantage of the platform and tools as whole or separately. Partners to use the results of INTACT in their respective consultancy work. For example, Panteia proposes to use results for consultancy relating to e.g. European Commission in the TEN-T corridors. | Generally applicable to CI owners and operators, Local Government, Planning, Policy Makers, Designers and Engineers | May 17 | N/A | All Consortium Parties |
| 2 | Dissemination of R&D results | INTACT Wiki | N | May-17 | An INTACT Wiki has been developed to help support CI operators and owners and policy makers in terms of balance issues of CI resilience with strategic design. The use of the Wiki contains guidance advice for enhancing the resilience of CI through risk identification at the planning, design and operation stages. End users apply the Risk Management Process to assess the level of risk and vulnerability to their respective CI. End users also use a record form to document risk process applied. The guidance is summarised from a range of existing risk assessment and management tools and methods guidance material and is presented with links to more detailed information. There is also Pan-European climate change | Built environment professionals i.e. CI Owners and Operators, Policy Makers, Local Government Planners, Engineers, Designers, Education Professionals | May 17 | Free of charge ⁴ | All Consortium Parties |

⁴ It is proposed that this tool is most beneficial to users when provided free of charge. Despite the innovative nature of the Wiki, the consortium believes that imposing a cost would discourage wider use of the Wiki in favour of more traditional research methods which will not provide the holistic and integrated vision for resilience which the Wiki offers.



| B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND | | | | | | | | | |
|--|--------------------------------------|---|-------------------|-----------------------------|--|---|--|---|--|
| N O. | Type of exploitable foreground | Exploitable Foreground (description) | Confid- ential | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application | Timetable for commercial use or any other use | Patent or other IPR exploitation (licenses) | Owner & Other Beneficiary(s) involved |
| | | | | | data available for reference in anticipating the impacts of climate change on end users regions. Some consortium partners will disseminate the results through conferences. | | | | |
| 3 | Dissemination of R&D results | VTT's press release (both in Finnish and in English) regarding INTACT results | N | May 2017 | Information on Wiki (Climate Change Data, Risk Management Process, etc.) and especially on the Finnish case study | Authorities at distinct levels ⁵ Emergency organisations ⁶ Private parties ⁷ Non-governmental voluntary organizations | May 2017 | N/A | VTT |
| 4 | Knowledge Creation | Education and Training | N | May-17 | (1) The INTACT Wiki (Climate Change Data, Risk Management Process, etc.) will be used as a teaching and training tool. (2) Project results will serve as the base for presentations that will form part of a seminar and other lectures (including guest lectures at universities). | Built environment education - third level students (undergraduate, post-graduate) and professionals (as part of Continuous Professional Development). | Aug 17 | It will be exploited in the course of normal university business ⁸ . It will also form the basis of wider avenues for consultancy and CPD training. | UU, USTUTT, Panteia. |
| 5 | Knowledge Creation | Education and Training | N | May-17 | Present the INTACT Wiki and Risk Management Process to target market audience at meetings, workshops and Conferences. | Experts in safety and security of critical | From May 2017 | It will be exploited in the course of | VTT, FAC |

⁵ Such as municipalities, ministries, hospitals, military, national emergency supply agency, meteorological institute etc.

⁶ Such as rescue services, emergency medical services, police, fire service, emergency response centre etc.

⁷ Such as electricity transmission companies, enterprise which takes care of the functioning of the nation-wide high-voltage grid, infrastructure owners and operators etc.

⁸ Such as postgraduate teaching modules, research, publications, etc.



| B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND | | | | | | | | | |
|--|--|---|-------------------|-----------------------------|--|--|--|---|---|
| N O. | Type of exploitable foreground | Exploitable Foreground (description) | Confid- ential | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application | Timetable for commercial use or any other use | Patent or other IPR exploitation (licenses) | Owner & Other Beneficiary(s) involved |
| | | | | | | infrastructures and asset management | | normal research institute business ⁹ | |
| 6 | Knowledge Creation | Further national and international R&D&I project opportunities. | Y | None | INTACT Wiki, risk management process, exploitation of the results and findings of the Finnish case study, Information dealing with infrastructure protection, electricity distribution, risk management, vulnerability and risk analyses, multi-criteria decision-making, cost-benefit analysis and asset management. | Authorities at distinct levels, asset owners and operators, emergency organisations, technology providers | From May 2017 | N/A | VTT |
| 7 | Research and developmental exploitation of the project results | Current and future research and development projects/opportun- ities. | N | May-17 | INTACT Wiki, Risk framework, knowledge an methods from the INTACT deliverables | Scientific community | From May 2017 | N/A | All Consortium Parties |
| 8 | Research and Technological Development | Knowledge creation | N | May-17 | Wiki as a knowledge platform: project results will be used for other national projects (e.g. KLARIS, KIRmin) and will also be discussed with regional planning authorities | Research | From May 2017 | It will be exploited in the course of projects and project proposals. | USTUTT |
| 9 | Dissemination of results (presentation at CIRIA workshop) | INTACT Wiki and case study results | N | Mar-17 | INTACT risk process and associated tools | CI operators, consultants, policy makers | From March 2017 | Future use of certain tools (e.g. Circle) may require input or licensing from other project partners | HRW plus other partners for any follow- on work |

⁹ Such as research, publications, conference presentations etc.



| B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND | | | | | | | | | |
|--|--|--|-------------------|-----------------------------|--|--|--|---|--|
| N O. | Type of exploitable foreground | Exploitable Foreground (description) | Confid- ential | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application | Timetable for commercial use or any other use | Patent or other IPR exploitation (licenses) | Owner & Other Beneficiary(s) involved |
| 10 | Commercial exploitation of R&D results | Commercial exploitation of R&D results | Y | None | Direct sales, company assignments on risk analyses and related to the situational awareness | Generally applicable to CI owners and operators, technology providers, emergency organisations, national and local authorities | From May 2017 | N/A | VTT |
| 11 | Teaching | INTACT Wiki content | N | May-17 | HR Wallingford are part of a consortium that will be delivering degree programmes at Brunel University on "Flood and Coastal Engineering" for the Environment Agency. As part of the Foundation, BSc and MSc courses, HR Wallingford will utilise some of the outputs from INTACT as part of the teaching material | University students (who will take up employment in flood risk management roles in EA and elsewhere) | From September 2017 | N/A | HRW |