INSuRe

Innovative Nature based Solutions for Reducing hydrometeorological risks

List of participants

Participant No	Participant organisation name	Country
1 (coordinator)	Norwegian University of Science and Technology – NTNU [1]	Norway (NO)
2	Oldenburgisch-Ostfriesischer Wasserverband (OOWV) [3]	Germany (DE)
3	Waterschap Limburg (WL) [3, 4]	The Netherlands (NL)
4	Câmara Municipal de Almada [3, 4]	Portugal (PT)
5	Melhus Municipality [3, 4]	Norway
6	Region of Western Greece [4]	Greece (GR)
7	Municipality of Spiekeroog [4]	Germany
8	Fachleute Naturgefahren Schweiz [5]	Switzerland (CH)
9	Associação de Beneficiários da Lezíria Grande de Vila Franca de Xira (ABLGVFX) [5]	Portugal
10	STATENS VEGVESEN [5]	Norway
11	Bane Nor SF [5]	Norway
12	HIDRA - Hidráulica e Ambiente LDA [2]	Portugal
13	TERRAPRIMA - Serviços Ambientais LDA [2]	Portugal
14	Sociedade Portuguesa de Inovação [2]	Portugal
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19	Powel [2]	Norway
20	Kosmos Education Services [2]	United Kingdom (UK)
21	Laboratório Nacional de Engenharia Civil (LNEC) [1]	Portugal
22	National Technical University of Athens (NTUA) [1]	Greece
23	Swiss Federal Research Institute WSL [1]	Switzerland
24	IWW Water centre [1]	Germany
25	KWR Water B.V. (KWR) [1]	The Netherlands
26	Stiftelsen SINTEF [1]	Norway

R&I [1], Companies [2], Utilities [3], Policy Bodies [4], Sector Organization [5]

Abbreviations

AL	Activity Line	CAD	Clime Adaptive Drainage
DIG	Demonstrators Interest Group	GEOSS	Group on Earth Observations
HMR	Hydro-meteorological Risk	IPCC	Intergovernmental Panel for Climate Change
LSD	Large Scale Demonstration case	NBS	Nature-Based Solutions
SME	Small and Medium-sized Enterprises	CoP	Community of Practice

1. Excellence

The increasing frequency of extreme hydro-meteorological (hydro-met) events is one of the greater challenges faced from climate change. The planning of countermeasures and the development of risk management plans to address this challenge is a vital and ongoing process. However, the development of relevant infrastructures is a very costly and often inefficient method to deal with uncertainty. The adoption of NBS can be a less costly and more sustainable alternative to traditional engineering solutions, while at the same time offering new opportunities through the NBS multiple functions and co-benefits. Planners can look to nature - to restore and develop more sustainable resilient systems, in order to reduce or mitigate the impacts of multiple extreme events.

Land management practices based on an ecosystem view are not new; they have in fact been used by humans for millennia, far longer than the term "ecosystem" has been in existence. Yet it is only in recent years that the prospect of the adoption of cost-efficient, large-scale nature-based interventions has been taken into consideration, especially in relation to events and conditions exacerbated by climate change.

INSuRe will present and demonstrate methods and commercial products for long-term planning and short-term forecasts. This will enable authorities in Europe and worldwide to reduce risks from floods, droughts, landslides, avalanches and storm surges. The INSuRe products comprise tools based on performance analytics, hydrological and geotechnical models and guidelines for socio-economic management for careful planning and for handling crises events. They will be offered by solid commercial INSuRe partner companies that will be supported by research institutes. The involvement of DIG (Demonstrators Interest Group), including a group of non-European follower stakeholders in Africa (Cape Verde and Mozambique), Asia (Nepal and India) and South America (Brazil), will ensure the understanding of diverse needs and contexts beyond Europe, and the dissemination to and outreach far beyond the project LSD geography.

> *INSuRe - Innovative Nature based Solutions for hydro-meteorological Risk reduction - aims to build and demonstrate proof-of-concept for the upscaling and replication of NBS in rural and natural areas as multi-beneficial alternatives to traditional engineering solutions for hydro-met risk reduction. INSuRe will seek to boost largescale implementation and replication of NBS in rural areas by providing an evidence-base on their design, operation, benefits and co-benefits, and by demonstrating an integrated planning strategy based on a roadmap approach together with multi-criteria evaluation and decision-support tools. This will enable land use and infrastructure planners, local authorities and risk managers to:*
> *(i) identify risks and assess local context understanding through a participatory approach involving all stakeholders,*
> *(ii) select, design, implement and monitor NBS based on a holistic evaluation framework of their efficacy, feasibility, benefits and co-benefits,*
> *(iii) integrate NBS implementation into an integrated collaborative strategic planning process to mitigate HMR and overcome barriers, while creating added values for the society (employment and business),*
> *(iv) understand and assess the role and impacts of NBS in creating more risk resilient societies*
> *(v) provide innovative design protocols, governance models and business opportunities.*

1.1 Objectives

INSuRe will develop a set of 6 LSDs from North to South Europe, covering different climatic and topographical conditions. They comprise low-land challenges for agriculture and complementary ecosystems services, coastal erosion as well as floods and landslides in mountainous regions. The development and implementation of wise nature based solutions will involve local stakeholders and decision-makers, in a participatory and anticipatory stakeholder driven multidisciplinary approach, considering all the lessons learned, which then can be applied to other parts of Europe and the world.

The INSuRe specific objectives are to:

<u>O1: Development of 6 LSD projects.</u> The LSDs will be developed in rural and natural areas for testing and validating the efficiency and flexibility of implemented and new NBS in reducing and mitigating the effects of extreme hydro-met events. Criteria for the selection of the LSDs is the occurrence of hydro-climatic events, relevant NBS for risk reduction and applicability for upscaling and transfer to other regions. The design and planning of the LSDs will entail a multi-stakeholder participatory process, in order to boost local awareness as to the multiple benefits of NBS in terms of both risk reduction and enhancement of the local environment, and to strengthen the acceptability of solutions to local societies.

<u>O2: Development of a comprehensive comparison framework.</u> NBS - including green, blue, grey and hybrid infrastructure - will be compared, and their anticipated contribution to ecosystem services, including climate change adaptation and mitigation at rural areas, will be assessed. Appropriate and targeted interventions needed to improve resilience and reduce risks of hydro-met hazards, while restoring ecosystems and enhancing socio-economic welfare at the local level, will be identified, taking into consideration natural, physical, socio-economic and institutional attributes of the examined areas.

<u>O3: Identify and assess barriers.</u> The political, economic, social, technical, legal and institutional factors that can influence the implementation of nature-based systems will be identified and assessed. The most significant barriers inhibiting system transition, i.e. those barriers that obstruct the implementation of NBS, will be recognized and instruments and actions that are needed to boost their wider implementation enabled. Focus will be on the most significant barriers, and recommended measures, instruments and actions to overcome these barriers will be derived from the regional experience.

<u>O4: Enable the replication and upscaling of NBS.</u> INSuRe includes studies of cost-effectiveness of the NBS and development of methods for exploitation, replication and upscaling of NBS for different rural areas, functioning under different climate conditions and scales. The project also develops innovative investment strategies and business models focused on the creation of incentives for investments in blue/green infrastructure and ecosystem restoration that will accelerate the implementation of NBS. By establishing a evidence-base (O5) at the sites (O1) on benefits, co-benefits, viability and performance of different NBS according to social, economic, environmental, technical and governance indicators (O2 and O3), as well as strategic planning tools for implementation (O2), INSuRe will strongly promote the replication and large scale implementation of NBS.
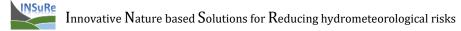
<u>O5: Provide a consolidated evidence-base of the multiple benefits of NBS.</u> Within INSuRe performance specifications, operational requirements and life-cycle costs of the solutions will be developed and made available for end-users and commercialization. The benefits as well as the limits of the solutions under different circumstances (O2,3,4) will be addressed. The evidence source will be a combination of previous projects and the outcomes from the INSuRe LSDs.

<u>O6: Establish long-term sustainable data platforms.</u> INSuRe will develop, apply and validate a set of tools and data platforms to support decision-making processes for planning, design, implementation, operation and long-term maintenance of NBS, and explore linkages with existing initiatives to enhance the outreach of the information gained and lessons learned well past the project completion.

1.2 Relation to the work programme

Table 1 - INSuRe approach to challenges and identification of relevant ALs

SC5-08-2017: Specific Scope element in the text of the call	How the requirement is addressed in INSuRe Activities
"Develop, demonstrate and deploy innovative systemic and yet locally attuned nature-based solutions…"	6 LSD projects will be developed in rural areas, including sensitive ecosystems in mountainous and coastal areas. NBS will be applied for the reduction of HMR and enhancement of natural capital. AL1
"Develop a comprehensive framework for the comparison of green and blue/grey/hybrid hydro-met risk prevention and reduction solutions…"	INSuRe will implement an indicator-based framework assessing the contribution of different NBS to watershed vulnerability reduction and resilience building, under climate and land use change scenarios addressing different levels and combinations of frequency, intensity, spatial extent, duration, and timing of extreme hydro-met events. Through this, INSuRe will ensure that the most suitable nature-based solutions will be identified, highlighting their respective socio-cultural and environmental benefits. AL2
"Identify and assess barriers related to their social and cultural acceptance and policy regulatory frameworks and propose ways to overcome them"	The political, economic, social, technical, legal and institutional factors of the external environment, likely to influence the implementation of NBS, will be identified through the mapping of local stakeholder perceptions, using the PESTLE framework. Informed by this inventory of barriers, "Communities of Practice" (CoP) will be set up and strongly contribute as co-creators in the cases. In these communities all the relevant stakeholders discuss the technological progress in its social, cultural and policy context, paying attention to both barriers and opportunities. AL3
"Develop methodologies, tools and best practices enabling the replication and up-scaling of nature-based solutions in different contexts"	Best practices, protocols and standards regarding planning, design, operation and maintenance of NBS will be developed to boost their replication and wider penetration to the market. Innovative investment strategies and funding mechanisms focusing on public-private partnerships and aiming at multi-stakeholder involvement and collaboration will be developed, by exploring different methods and approaches, such as co-creation, crowd-sourcing and crowd-funding. AL4 and AL5.
"Provide a consolidated evidence base on co-development, performance standards, cost effectiveness, … multiple benefits of NBS…"	The outcome of the LSD projects together with the planned cross-cutting activities of INSuRe will provide a strong evidence base of the potential of NBS to be applied in a coordinated context involving public authorities, commercial companies, knowledge providers and society. AL6
"Establish long-term sustainable data platforms considering existing initiatives and alternative options…"	INSuRe will develop a data management policy and a data management plan in line with the current EU policy and link to an open access data repository to publish evidence on practices and lessons learnt regarding implementation and use of NBS to mitigate the HMR. References to IPCC, GEOSS, Copernicus and INSPIRE.

1.3   Concept and approach

INSuRe will provide demand-driven solutions for a range of specific hydro-climatic challenges in Europe that focus on different geographical scales and are usable by a diverse spectrum of end-users. Through 6 LSDs INSuRe addresses several climatic regions and a combination of risks representing challenges for citizens, environment and economy. The NBS comprise methods to support long-term planning as well a short-term warning solutions by analyzing current performance and related risk and the effect of counteracting NBS measures. Activity lines that cross-cut the cases will ensure optimal exploitation of competences and exchange of knowledge across the cases, secure consistent handling of information and

results, and enhance synergies between the cases. The activity lines will address upscaling and transferability to other regions, as well as the uncertainty of the climate projections and the effectiveness in risk reduction of the NBS measures. These measures will be built, in addition to the technical performance, to also take into account relevant socio-economic factors, financing and policy contexts as well as the new scenarios of land use. To ensure the establishment of sound management strategies able to cope with future climate challenges, all solutions built in INSuRe will be validated by a range of end-users and decision makers, through their dynamic and participative interaction with researchers. Already available proven adaptation strategies from earlier projects (see page 9) will be used to establish a catalogue of measures and solutions ("inspiring tools") as a starting point.

Table 2 - LSD Sites Risk and Impacts classified in; 1 - to a high degree, 2 - to some degree, 3 - to a low degree

			GR	CH	PT		NL	DE	NO
	Identification of LSD Sites Landscape type		Lagoon	Mountain	Coast, Shore	Shore, Agri	Agri	Coast, Shore (Agri)	Mountain/Valley FloodPlains
Hydromet Risks		Floods			1	1	1	1	1
		Droughts			2	1	1	2	3
		Land Slides		1	2				1
		Storm surges			2			3	-
		Sea Level Rise	1		2	2		2	
		Avalanches		1					1
Impacts on human & society		Rural settlements & Infrastructure		1	1	1		1	1
		Environment & Agriculture & Public Safety		1	1	1	1	2	2
		Recreational activities and tourism	1	1	1	2		2	2

The 6 LSD Sites in INSuRe

Almada and Lezíria, Portugal. The LSD is composed of two sites sharing the proximity of the Tagus River and estuary at the greater Lisboa Metropolitan area. Increased HMR are expected due to sea level rise and storm surges, extreme rainfalls, floods and droughts. The sites represent a rich, wide and relevant evidence of different HMR. The political drives and the willingness and experience of local stakeholders were key aspects in the choice of this combination.

The Foz do Rego Basin and the adjacent coastal area is located in the Almada Municipality, a 70 km^2 area, with 16 km along the Tagus Estuary and 14 km of Atlantic beachfront. This area has already approved Master and Strategic Plans that include NBS aiming at the increase of territorial

Figur 1 Location of LSDs

resilience and the reduction of risks associated with floods, soil and water courses erosion, and landslides as well as dunes over-washed, coastline regression and Mediterranean ecosystems endangered, keeping the river's ecosystem and coastal sand dunes as structuring elements. Among the solutions already in place or to be implemented at Foz do Rego site are included: small on-line detention basins , nature based engineering stabilization measures (i.e., bio gabions, bio wood living retaining walls, living stem mats), and multi function micro-gardens. By assessing benefits, co-benefits and barriers of replicable NBS, this LSD will contribute to the development of new approaches and businesses related with NBS to enhance the hydrographic network, promote infiltration, aquifer recharge and biodiversity, value public space, and recover coastal sand dune system by dynamic natural structures.

The Lezíria GVFX is a 134 km^2 agricultural area below the average sea level, located on the left bank of the Tagus River, which is surrounded by a 62 km earth dyke built in the 1950s by a farmers association to protect from tides and floods. ABLGVFX is the association that manages this large hydro-agricultural infrastructure, where more than 400 companies (mostly SMEs) operate. Lezíria is a wetland area subject to a number of environmental, ecological and agricultural protection Plans. The area's prosperity is highly dependent on climate risks, including river floods, dyke breaks due to water overflows and salinization of soils and water for irrigation due to droughts and sea level rise. Among the NBS solutions to be studied are vegetated dykes and source control drainage techniques. This LSD aims at assessing the benefits, but also spreading and improving them by sharing with others a successful, replicable set of NBS, procedures and empirical knowledge-based practices. It includes the use of agriculture as NBS and monitoring and control of irrigation water to cope with increases in estuary salinity. This LSD will benefit from and add value to the results of the ongoing H2020 BINGO project, in which downscaling climate prediction and impacts on the water cycle are being studied and the CoP is already well established.

Messolongion Lagoon, Greece, is situated in the western part of Greece. There is no freshwater flow into the lagoon except agricultural runoff. The two rivers that originally formed the lagoon have shifted their courses. Human activities are affecting the hydrological state of the lagoon through infrastructure, agrochemical and other pollutant runoff, increase of salinity, and uncontrolled and illegal solid waste dumps. The state of the lagoon is expected to continue to degrade without significant efforts to reverse the trend. NBS solutions that will be tested in the project include:

- Develop shore rehabilitation actions, including pedestrian and cycling pathways, and re-establishing natural vegetation corridors to also serve as flood control dissipation and routing areas.
- Install NBS waste water treatment options (i.e. reed beds) for the minimization of pollution in selected areas of effluent flows (i.e. culverts of the bypassing major Ionian AutoRoute).
- Develop environment and ecology related activities for public participation.
- Redirect the excess flood water of Achelous river into the lagoon and mimic the altered natural processes.
- Rehabilitate the dunes separating the lagoon from the sea. Frequent sea-level changes together with sea water depths of only 60m in the entrance of the mouth of the lagoon means that the outer gulf regularly turns into a lake. NBS of appropriate materials and plant species introduction to increase the resilience to erosion, accompanied by flood mitigation measures on the opposite end, will be tested.

Dallenwil, Buochs, St. Antönien, Fideris and Brienz, Switzerland. In Switzerland, erosion and landslides have caused substantial damage to infrastructure and property, as well as considerable loss of lives in the recent past. In 2005, a devastating event caused more than 5,000 shallow landslides. The frequency of such extreme events are expected to increase. Despite ongoing research efforts, protection against, as well as prevention and prediction of superficial soil failure, remain difficult.

Vegetation is recognized to play an important role in erosion control and protection against shallow landslides. However, to what extent plants reduce geomorphic hazards is still questioned. During the last decades, field and laboratory investigations have been conducted to quantify the effects of vegetation on slope stability. Influence of forest structure and land-use management on susceptibility of shallow landslides has also been analyzed.

INSuRe plans to combine a "3-step filter" with a statistical approach based on distribution functions under consideration of soil mechanical investigations on root-permeated soil. The method will be tested and improved at the different study sites and later in other regions of Switzerland. It will provide an important basis for producing interactive maps on land-cover and risk of landslides, and a basis for producing an interactive shallow landslide susceptibility map for Switzerland, with potential applicability to other mountainous regions.

East Friesland, Germany. The island Spiekeroog is situated within a sensitive natural area, the Lower Saxon Wadden Sea National Park, in East Friesland. The area is a biosphere reserve and since 2009 on the UNESCO World Heritage List. The drinking water supply used by residents and tourists relies on a freshwater lense below the island, a highly sensitive freshwater ecosystem. Storm surges as well as sea-level rise degrade the fresh water reservoir of the island, thus threatening water supply continuity. A thorough management of this sensitive fresh water source is required, since alternative drinking water supplies in future situations with insufficient fresh water capacity from the lense would be of very high costs. Furthermore, alternative water supply from continental land, e.g. by use of a main pipeline, would cause ecological damage to the sensitive natural area.

Additionally, extreme precipitation events have already lead to hydraulic overload of the sewer system and the wastewater treatment plant of the island. This has caused sewer overflow events into the North Sea, causing ecological damage to the coastal/Wadden ecosystem. This is expected to worsen with growing climate change. Risk reduction measures, incorporating a systemic nature-based approach using green and blue infrastructure will be developed within INSuRe. The conceptual work will build on existing preliminary concepts, funded under the European Regional Development Fund such as the Cradle-to-Cradle Islands project (C2CI). The solutions will be developed, demonstrated and deployed on a pilot scale-level, following a multi-stakeholder approach. Investigation will include the extent to which a transfer of the case's NBS to infiltrate rainwater, combat saltwater intrusion and secure drinking water supply can be transferred to other regions facing comparable challenges, e.g. the wider area in East Friesland that faces similar risks from hydro-met events.

Limburg, the Netherlands. The LSD addresses Regional Climate Adaptive and Anticipative Water Management. Climate change may give more prolonged dry periods alternated with more intensive rainfall events. These hydro-met extremes amplify soil moisture dynamics and thus impair crop yields. In the Netherlands alone, agricultural production of crops represents an annual market exceeding 2 Billion euros. To safeguard this economic value, water management authorities continuously aim to balance between water supply and drainage. Conventional engineered-based water solutions, however, provide insufficient flexibility to manage extreme hydro-met events, both at field and regional scale. Controlled drainage allows active management of water resources by increasing soil storage capacity. Within the LSD area (2,200 km^2), Waterschap Limburg aims at a complete transition from conventional drainage towards controlled drainage by the end of 2018. Currently, they have developed an operational model for anticipative water management to manage extreme hydro-met events on regional scale. INSuRe will link model predictions to actual actions using Climate Adaptive Drainage (CAD). INSuRe will combine parallel field measurements and continuous model simulations using hydro-met forecasts. CAD-systems will optimize water management with respect to crop production and flood management on regional scale. The LSD will comprise a CoP to strengthen the cooperation and communication between farmers and the water management authority, as the basis for balanced and participatory water management at the regional scale.

The CAD-system, which links hydro-met forecasts to water management actions, can be incorporated in all existing and new controlled drainage systems. For the Netherlands alone, there is a potential to apply CAD in over 375,000ha of agricultural land and thus for several thousands of systems. CAD can be applied in drained agricultural regions throughout Europe and worldwide. Therefore, INSuRe will investigate the potential and business opportunities for replication of CAD, combined with continuous model simulations using hydro-met forecasts building on earlier market scans in e.g. Poland, Romania, and the flatlands of the Danube basin.

Gauldal, Orkladal, Romsdal and Gudbrandsdal, Norway. Floods and landslides in mountainous regions and in steep slopes is a growing international problem and in this mountainous region of central Norway have caused significant damage to infrastructure and residential areas in recent years, and also affected transportation reliability on main roads and national railways – causing danger for travelers as well as local citizens. The region has flood-exposed rivers passing through villages and rural settlements, and in close vicinity of main roads and railways. Intense rainfalls on steep slopes ranging from the valley bottom to mountains create extreme floods, with water forces and debris flowing from erosion of thin mountain soils and river embankments escalating into large volumes damaging and destroying everything in their way, flooding infrastructure, threatening settlements and leaving thick layers of debris on agricultural land.

In the next 10-20 years heavy investments is expected in road infrastructure. HMR comprise the major risk to these investments, and there are several conflicts of interest between stakeholders. Planning is ongoing with the aim of starting construction within five years. Information on planning assumptions as well as conflict resolution will be available for INSuRe.

NBS in this LSD include the use of existing hydropower reservoirs for flood control, sensor technology for surveillance, safe tracks for road and railways, landscape measures such as revegetation, physical barriers and soil strengthening nets to prevent erosion and landslides and improved design of watercourses, landscape and structures to withstand forces from water and debris flows. These NBS measures will be tested and evaluated in the site.

A prominent product from INSuRe related to this site will be a hydrological model incorporating downscaled climate scenarios for long-term planning as well as short-term forecasting to minimize the risk of damage due to extreme rainfall/runoff events and that incorporates the benefits of the NBS. Through use of this tool, the possible extreme rainfall-runoff events can be transformed into known potential consequences to existing and planned installations, and thus enable the authorities to take action and realize contingency plans. The project development will be concentrated in a smaller area within the region, and then upscaled to the entire region. In cooperation with Powel, the solutions will be made available to other regions and internationally.

How Activity Lines (AL) will be implemented

Activity Line 0 – Coordination, management and procedures (Leader NTNU)

A comprehensive INSuRe coordination and management will be accomplished through careful planning and internal communication procedures (including an intranet) with the aim to achieve the project objectives. The tasks will cover administrative, financial and technical co-ordination of the project including provision of financial and progress reports to the EC, and IPR management of the consortium. It will monitor the progress of activities and organisation of meetings of the Management Board (AL leaders), the Scientific Board, the representatives of LSDs end user institutions, the Demonstrators Interest Group (DIG) and the Project Advisory Committee - PAC (top level experts).

Activity Line 1 – Demonstration cases (O1, leader NTUA)

The LSD cases constitute the main activity in INSuRe. To ensure a consistent organization method, and to achieve maximum synergies through INSuRe, they will be organized as one activity line with an AL leader and a leader for each case.

Activity Line 2 – Identification of NBS opportunities for risk reduction (O2, leader IWW)

AL2 develops a framework for the comparison of alternative risk reduction solutions for HMR of INSuRe's case studies. This will enable the evaluation of the effectiveness of the risk reduction potential by NBS in terms of their economic benefit. Additionally it

will include the evaluation of co-benefits such as enhanced ecosystem states including biodiversity gains and non-monetary effects on human well-being. In order to envelop all of the effects of NBS, these effects will be grouped into sustainability assessment dimensions. A set of ecosystems services will be mapped, allowing an integrated assessment of the NBS. This task will benefit from previously developed evaluation frameworks in FP7, in which members of the INSuRe consortium have been involved. Examples include the water cycle safety planning from PREPARED, the sustainability assessment framework from TRUST and the framework for ecosystem service evaluation from DESSIN.

This activity line will also provide monitoring and ICT tools for systemic and assessment of NBS in the LSDs. The tools will support the systemic modelling and enable the simulation of the system by (a) providing system wide key performance indicators, (b) analyzing the value chain and provide economic indicators, (c) calculating impacts and economic outputs for all involved actors. The assessment and comparison of different NBS will be accomplished by developing predictive scenarios and comparing to the baseline assessment.

Activity Line 3 – Communities of Practice for responsible innovation (O3, leader LNEC)

AL3 identifies and assesses the political, economic, social, technical, legal and institutional factors, which can influence the implementation of NBS, through using the PESTLE analysis framework. The most significant barriers inhibiting system transition will be recognized and the instruments and arrangements that are needed to boost their wider implementation will be prioritized. Participatory decision-making processes will be followed for barriers identification and confrontation, engaging the local stakeholders and incorporating their views and requirements, as well as starting the road mapping for NBS implementation.

Informed by this inventory of barriers, a set of Communities of Practice (CoP) will be established. The most relevant stakeholders around each case will be identified through a survey on political, economic, social, technical, legal and environmental factors. These CoPs will provide direct feedback to the technological development by discussing it in its wider context, addressing both barriers and opportunities. The approach to the communities will build on the experiences in BINGO. Methods for societal engagement developed in the context of the RRI Tools project will be employed. INSuRe will feed the communities with a deeper understanding of particular barriers and opportunities based on interviews with focus groups and specific stakeholder groups.

A digital platform will support the communication within each CoP and cross-national learning between the different CoPs and resources will be dedicated for training the researchers on use of CoP and co-creation.

Activity Line 4 – Exploitation, replication, upscaling and market uptake of NBS (O4, leader SINTEF)

AL4 ensures that the results are both made easily available and exploited by interested users at different levels and in various regions of the world. It will be provided in close relation with AL6 in order to boost the implementation, replication and market uptake of NBS for the mitigation of HMR and the creation of new/extended business opportunities. This will be achieved by creating and marketing the products and providing services for NBS solutions. In close linkage to AL1, AL2 and AL3, best practices, protocols and specifications regarding the planning, design, operation and maintenance of NBS will be developed. Studies of innovative investment strategies and funding mechanisms focusing on public-private partnerships and aiming at multi-stakeholder involvement and collaboration including methods for the identification and attraction of key potential investors, including banks and insurance companies will also be carried out. This will allow the exploitation of insurance value of ecosystems compared to other investments. Models, strategies and mechanisms developed and adopted by other entities worldwide will be analysed and replicated.

A comprehensive NBS market analysis based on PESTLE (AL3) will determine the best strategies of NBS market uptake. An Exploitation Plan including measures, roles and responsibilities for the partners to maximize uptake of the NBSs will be developed based on the Business Model Generation – Canvas.

INSuRe will collect and provide information about relevant sources of funding and investment for the implementation of NBS after the project lifetime. The funding schemes sought include the European Structural and Investment Funds, and European Regional Development Fund among others. At the end of the project, comprehensive knowledge will be available and widely spread to facilitate the investment in further business opportunities by technology providers and land management planners. In addition, a range of business models will be developed to enable the INSuRe solutions (including the evidence base platform) to be brought into the market.

Activity Line 5 – Consolidate, public, evidence base (O 5&6, leader KWR)

AL5 will develop an online evidence base, which consolidates materials produced in previous ALs. This includes best practices, standards and protocols (AL4); showcases of the LSD sites (AL1); results of the performance assessments, life cycle costs and the multiple benefits of NBS implementation in the cases (AL4); and results, lessons and insights (AL3). The evidence base will support effective communication, public engagement and exchange of best practices and lessons learned by stakeholders and thus drive dynamic content co-creation and collaborative knowledge sharing by its users. The evidence base will benefit from work on knowledge base development and deployment by INSuRe partners within the FP7 project SUBSOL and will feature methodological and technological links to the EIP Marketplace. Lessons learned from adaptation strategies within BINGO will also be valuable. Experiences from applying environmental economic assessment methods within the DESSIN will accelerate the evaluation of environmental benefits expectable from NBS at the LSDs

AL5 will ensure linkages to the growing body of evidence developed in other relevant projects such as the FP7 project ThinkNature. The INSuRe evidence base will be hosted under the Watershare platform, whose framework and business model will help ensure long-term sustainability and global outreach of the platform.

Activity Line 6 – Dissemination & Communication (leader SPI)

AL6 will be centered on the development and implementation of the Dissemination and Communication Action Plan – which will ensure that the project creates a strong awareness among the target groups in the EU and beyond. The tools will be a mix of outward-looking tools (such as website, leaflets, brochures, online newsletters, posters, roll-ups, etc). Further tools include the development of podcasts and videos produced at each of the case studies and communicated with the external stakeholders – bringing together the direct social interactions in the case studies (AL3) and the interactions with the wider EU and global community. Interactive tools will be developed in AL6 - social networks will be set up to reach and interact with the different stakeholder groups to encourage them to take part in planned interactions (webinars to conferences).

A further key aspect of AL6 is to control the communication and joint actions with other relevant initiatives and programmes to ensure the European and global outreach of the project results. This will include participation in multiplier events – be these academic, industrial or other natures. Further, the project results will be published in open-access platforms – including publishing project data in open access platforms.

The LSDs of INSuRe are represented by 11 end users and 9 companies. Five of the scientific & innovation core partners of INSuRe - IWW, KWR, LNEC, NTNU and SINTEF - are the founders of ARC, Aqua Research Collaboration. This partnership which was established in 2010 aims at enhancing the effectiveness and efficiency of European, national and own research resources, leading water cycle integration based innovation. The partners have a solid track record of cooperation for many years, that has proven successful in several European and international projects. The partners are aware of the power of jointly addressing challenges of global nature, while using the variety and value of their local and regional experience. The INSuRe consortium also gathers other relevant R&I institutions, including, National Technical University of Athens and Swiss Federal Institute for Forest, Snow and Landscape Research - WSL as well as private companies and public stakeholders at different decision levels, namely policy bodies, utilities services and sector interest organizations.

The different roles and levels within the society of each partner, given in the "List of Participants", shows that the consortium balances the different layers of decision making which will contribute to a high social impact of the results of the project and ensures market uptake of INSuRe's NBS. The societal and international impact will also help to be assured by the assistance of the PAC. The consortium has already ensured the participation of a set of internationally renowned experts in different fields related to the impact of hydro-climatic events, and plans to expand the PAC in the next stage.

National and international research and innovation activities linked to the project
The project builds on previously EU funded research involving risk mitigation, in particular related to extreme hydro-climatic and geotechnical/geological events. For the climate forecast, systems using the recent IPCC report data archives (2013) will be applied, as well as national data from the river basin management, storms, landslides and avalanches. Finally, the EC's White Paper on Adaptation (2009) and results on mitigation and adaptation strategies from other relevant projects in which ARC partners participated (e.g. ClimWatAdapt; GABARDINE, REFRESH, PREPARED, MARSOL, DESSIN, InfraRisk, BINGO, RESCCUE, SUBSOL, AquaNES) will serve as bottom line for the direct and indirect sectorial impact analysis of climate change, as well as modelling adaptation water scenarios. With regards to landslides, the project will build on results from "International Center for Geohazards, ICG (2003-2012)" which was a large centre for excellent research and the follow-up EU FP7 project SAFELAND and later the Norwegian NIFS program (www.naturfare.no) as well as on the former EU FP7 project REVENUES (2013-2016). Further, the project will comprehensively benefit from recent and ongoing national projects, such as the German KURAS, the 30 MEuro Norwegian "Klima 2050", which considers impact of climate change on built infrastructure, and the 80 Million euro Dutch "Knowledge for Climate" programme, which explored the consequences of climate change for the Netherlands and how they should be managed.

1.4   Ambition

Until now, responsible institutions for planning and security of land use have not been able to fully understand, apply and exploit NBS and its potential for the society. There is also no framework established for efficient use of NBS for reducing HMR. Developing and applying knowledge and grass-roots understanding of NBS as an alternative to traditional engineering for risk reduction measures while contributing to a circular economy environment is required. With new tools for monitoring and prediction of hazards threatening people's lives, properties alongside watercourses, transportation reliability, pollution of waters, and agriculture for food security, the INSuRe team aims to reduce this gap by the following progress beyond the State of Art:

Establish a comprehensive evidence base for the effectiveness of NBS: Through the assessment of environment, social and economic value of NBS in the six LSDs, thus contributing to an EU-wide evidence base. INSuRe will create transferable knowledge on NBS effectiveness, acceptability and economic feasibility.

Develop a strategic planning framework for implementation of NBS: Building upon a roadmap approach to meet the relevant related UN SDGs, including level of services. INSuRe will adapt to NBS context to facilitate the collaborative strategic planning process among LSDs. This will include stakeholders in the decision process and integrate NBS into rural planning.

Provide the LSD "owners" with a systematic approach in terms of multi-criteria decision framework to assess the viability, benefits and co-benefits as well as the basic valuation of externalities. This will enable LSD responsible partners to learn with others and to adapt the best knowledge, supporting the selection of the adequate set of NBS to fit their geographical and local conditions, and the levels of protection required.

Organize mutual learning of NBS in rural areas– within Europe and beyond. INSuRe will bring together the knowledge and experience of the core group of LSD within the project with a larger group (DIG), involving partners out of Europe. They can learn from and exchange their own specificities in a structured way, thus enriching and helping in anticipating the potential of market outreach and exploitation of INSuRe.

The INSuRe approach will be pioneering and beyond the state of the art as it will improve the general level of knowledge for decision makers in Europe: 1) Outcomes of several previous studies and projects will allow INSuRe to take a pragmatic approach, focused on improving hydrological prognosis and predictions. Thus, INSuRe will be able to provide new tailored solutions building on currently available knowledge and instruments, but going beyond the present state-of-the art. 2) INSuRe will create actionable or end-users driven validated solutions by engaging different partners and stakeholders and by using dynamic and participatory methodologies from the start of the work, building on previous experiences (e.g. the ongoing BINGO project). 3) Social and human science issues will be addressed based on the significant experience of the partners. INSuRe will construct shared awareness and perceptions in order to support more accurate decision making and action development. This includes the application of a holistic approach and the transferability of project results to other geographical locations. The results of INSuRe will thus have applications far beyond the research sites and so benefit larger areas of Europe and beyond.

Innovation Potential

INSuRe will contribute to innovations within technical, governance and business areas. Technical innovation will be achieved by the evaluation and demonstration of a combination rather than isolated NBS. In addition, the exploration of trade-offs (e.g. between grey, blue and green infrastructure) will be identified and the benefits of NBS quantified. The conceptual innovation lies in the combination of a tailored overarching roadmap framework for making NBS part of an integrated strategic territory planning, and a supporting method and tool for assessing NBS and decision-making. Business models at different scales will be exploited using and optimizing the proved added value of NBS solutions, not just as solutions to mitigate hydrologic-meteorological risks but also as a natural based capital to create value for the Society. Together they will strongly promote the further uptake of NBS in rural areas. Creating governance innovation is key for promoting replication and large-scale implementation NBS. INSuRe will use innovative social practices to help drive increased market uptake of NBS and to establish a participatory approach that promotes interactive and mutual-learning experiences between the different LSD players. New institutional forms will thereby be created which are accountable for the direction of innovation and are capable of providing a critical underpinning democratic culture. Providing tailored skills for implementation of NBS will reveal a great potential for economic development and new jobs creation.

2. Impact

2.1 Expected impacts

INSuRe will have significant impact by reducing HMR at each of the chosen locations. Of even wider importance is the European and global impact of the replication and upscaling plans defined in AL6. Degradation of agricultural land threatens 40% of total global arable land area; 20,000 km of European coast face serious erosion; landslides have caused more than 10,000 casualties, floods more than 40.000 and avalanches close to 1,300 since 2000. In Europe alone the three latter causes amount to an economic loss of over 5 M € pr year (1998-2009). Hence, INSuRe will have an impact on issues that are recognized as major threats to human life and through commercial adoptable NBS has the potential to significantly reduce these threats. INSuRe will also highlight the real economic and financial exploitation and impacts at the wider global level, and in turn create new business and job opportunities. How INSuRe meets the requested impact of the call is further elaborated in table 3.

Table 3 - INSuRe contribution to the call objectives and expected impacts

SC5-08-2017: Expected Impacts in the call	How much the project will contribute
The EU being recognized as a leader in nature-based solutions for HMR reduction and climate change adaptation and thus enhancement of territorial, socio-economic and ecological resilience and coherence	Provision of an evidence base platform based on outcome from the six LSDs. Link the INSuRe results and body of evidence to other relevant (EU-focused) projects to ensure the long term sustainability and global outreach. *AL5*. Dissemination and communication to show beyond state-of-art results of the project, identifying the EU as leader in the NBS sector. *AL6*

The mainstreaming of NBS in land use planning, landscaping and territorial policies due to the provision of appropriate tools and best practices to assist decision makers, designers, competent authorities, planners, practitioners, enterprises, citizens and other stakeholders in reducing HMR and in climate change adaptation	Communities of Practice (CoP) and associated platforms will bring together and incentivize the contributions of different stakeholders within NBS – and can replicated in other regions, *AL4*. Provision of a comprehensive exploitation and upscaling plan that includes (i) Products and services including a general NBS data model, design and management protocols for each NBS existing on case-studies, (ii) Market analysis about the potential uses of NBS for facing HMR, (iii) Strategy and implementation, and (iv) financial plan *AL4*
Development of an integrated EU-wide evidence base and a European reference framework on nature-based solutions and the stimulation of a new culture for 'land use planning' that links the reduction of risks with local and regional sustainable development objectives	Online evidence base which will consolidate all materials produced (best practices, standards and protocols; showcases of the LSD sites; results of the performance assessments, life cycle costs and the multiple benefits of NBS implementation in the cases; results, lessons and insights developed in collaboration with stakeholders). Hosted under the Watershare platform to ensure the long term sustainability and global outreach *AL5*
Enhanced market demand for NBS for HMR reduction and climate change adaptation, due to the availability of protocols and standards for their design, operation, maintenance, performance monitoring and measuring of their broader economic, societal and environmental benefits	A comprehensive market analysis during the first year of the project to collect data and information on market needs, in order to identify the full range of potential customer segments the potential market opportunities for NBS on the market. Business models to enable the INSuRe solutions to be brought into the market. *AL4*
Improved disaster risk management, due to enhanced capacity for providing quantitative assessments of nature-based solutions for disaster risk reduction and climate change adaptation. Reduced human and financial costs due to better and more flexible disaster risk management with nature-based solutions.	Framework for comparison of alternative risk reduction solutions for HMR. Effectiveness of the risk reduction potential by NBS in terms of economic benefit and other co-benefits such as enhanced ecosystem states. The output will build upon previously developed evaluation frameworks and risk management approaches for projects in which members of the INSuRe consortium have been involved *AL 2 and 3*
Enhanced implementation of EU policies for disaster risk prevention and reduction, for climate change adaptation, for Green Infrastructure, and for water management (Water Framework Directive….), as well as of international frameworks, such as the Sendai Framework for Disaster Risk Reduction 2015-2030	The project will pursues the Sendai framework for Disaster Risk Reduction that calls for a fundamental shift in technology, economics, finance and society as a whole; help in implementing the high-level EU policies including the 7th Environmental Action Program to 2020; contribute to the Commissions priorities of "Jobs, Growth and Investment", Energy Union and Climate, Digital Single Market and Stronger Global Actor", though our comprehensive process of innovation and LSDs.
Contribution to the priorities of the EIP Water	INSuRe will contribute directly to 2 of the 5 vertical pillars of the Strategic Implementation Plan (SIP) of EIP on Water: i)Risk management of water related extreme events; and ii) Ecosystem services, and to 3 cross-cutting priorities and enablers: 1) Water governance;2) management models and monitoring, and 3) financing for innovation. INSuRe will contribute as well to the EIP Action Group on NBS (Nature WAT) principle aims to identify and overcome bottlenecks and barriers (e.g. fragmentation of knowledge; lack of demonstration sites and funding for SMEs; financial issues and technical aspects) related to NBS for water resources management in rural, peri-urban and urban areas
Implementing the Sustainable Development Goals, in particular #15 'Protection, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss' and # 13 'Take action to combat climate change impact"	INSuRE approaches and results will contribute directly to implementing SDS #15 and SDS #13, but also to SDG#8, in promoting inclusive and sustainable economic growth, and productive employment, and # 12, on sustainable consumption and production patterns. Impact of climate change is imbedded in the hydromet analysis to be conducted