UNCHAIN – Unpacking climate impact CHAINs.
A new generation of action- and user-oriented climate change risk assessments

List of participants			
Part. no.	**Participant organization name**	**Short name**	**Country**
1 (CO)	Western Norway Research Institute	WNRI	Norway
2	Wageningen University & Research	WUR	Netherlands
3	Gesellschaft für Wirtschaftliche Strukturforschung	GWS	Germany
4	Instituto Español de Oceanografía	IEO	Spain
5	Paris-Lodron University Salzburg	PLUS	Austria
6	Nordland Research Institute	NRI	Norway
7	Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V.	FhG	Germany
8	Stockholm Environment Institute	SEI	Sweden
9	Rambøll (initially TEC Conseil)	Ramboll	France
10	Institut National des Sciences Appliquées de Strasbourg	INSA	France

Research innovations

Planning CC adaptation requires a rigorous and shared scientific knowledge base which must be translated into local practical and actionable knowledge on climate risks and adaptation options. Therefore, a constructive dialogue between researchers and stakeholders is at the core of this project. Exchange of information through knowledge sharing, joint reflection and learning, e.g. co-exploration and co-production exercises, promotes joint understanding and awareness, which ultimately shapes knowledge development, influences decisions and shapes behavior (Gramberger et al., 2014).

The project "Unpacking climate impact chains - a new generation of climate change risk assessments" (UNCHAIN) will take as reference point the concept **'impact chain' (IC)**, first published by Schneiderbauer et al. (2013), and then 'catalyzed' by the German cooperation (GIZ), in the Vulnerability Sourcebook (Fritzsche et al. 2014). This concept focuses on identifying and describing important links between the different components of climate risks. Then indicators are selected for each of these components, and the data collected are normalized before being aggregated with different weights. The IC approach has been well-received by different organizations partly due to its ability to bring context-specific information into the risk assessment. This project will further develop the approach to support climate change (CC) adaptation capacity-building, by introducing **five methodological innovations**.

The **first** innovation of UNCHAIN is to develop and test an approach to assess CC risks that covers both the short-term need for 'adjusting' within the current societal framework and the possible need for long-term and large-scale efforts of **'societal transformation'**, in which the latter relates to "(t)he altering of fundamental attributes of a system (including value systems; regulatory, legislative, or bureaucratic regimes; financial institutions; and technological or biological systems)" (IPCC, 2012:4).

The **second** innovation of UNCHAIN is to refine a structured method of **co-production of knowledge** and integrate this into impact modelling to better account for different views on desirable and equitable climate resilient futures. This will also allow development of user-oriented, decision-driven Climate Services that support the goal of actionable knowledge (Gerger Swartling, et al, in press). In this project we recognize the definition of climate services as put forward by the Global Framework for Climate Services (GFCS) as "providing climate information in a way that assists decision-making by individuals and organizations" (WMO 2014: 2).

By now, it is well established that knowledge to inform CC adaptation needs to go beyond projections from deterministic or probabilistic climate models (e.g. CMIP5, CORDEX), and must include also scenarios for social, economic and political development (Moss et al, 2010). However, it has proven challenging to implement such approaches in the real world. Thus, the **third** innovation of UNCHAIN is to develop and test an applicable framework for analyzing how **societal change** can affect local climate change vulnerabilities, how to conduct an integrated assessment of the combined effect of potential climate and societal changes, and how to better understand the socio-economic consequences involved in local climate change adaptation.

Schneider and Kuntz-Duriseti (2002) suggest that climate policy-making can address climate-related uncertainties by attempting to reduce uncertainty, through supporting more data collection, research, modelling, simulation etc. However, the daunting uncertainty surrounding climate change, the speed at which the climate is changing, and the need to make decisions well before uncertainty is better addressed, lead to the claim to manage uncertainty rather than master it, by means of integrating uncertainty into policymaking. Thus, the **fourth** innovation of UNCHAIN is to develop and test a standardized analytical framework for addressing **uncertainties** involved in local decision-making on climate change adaptation.

The **fifth** innovation of UNCHAIN explores the possibility of expanding the logic of impact change along two dimensions: 'time & space', and 'scope'. The **first** dimension is about including the **indirect** impacts of climate change. A limited number of studies, mostly addressing the national level, have pointed out that, in high-consuming countries with an open economy, the transnational – i.e. indirect - effects of climate change can be more challenging than the local – or direct - ones (Benzie et al, 2016; Hedlund et al, 2017). The ambition in the UNCHAIN project is to assess how impacts of climate change can transcend country borders mediated by means of societal change to produce or exacerbate local vulnerabilities. Exposure to transnational climate impacts in future will depend to a high degree on the shape and nature of future socio-economic development, meaning there is also a need to consider future variables such as trade openness, financial investment, supply chains, migration and globalization when assessing future climate vulnerability in Europe (Benzie et al, 2017). The **second** dimension concerns **linking mitigation and adaptation**. As both mitigation and adaptation efforts are expected to gradually become more substantial, it is reasonable to expect that interaction between the two streams of action will increasingly occur. This may manifest itself as mal-adaptation (adaptation increasing greenhouse gas emissions) and mal-mitigation (mitigation increasing exposure to negative effects of climate change), which again makes it critical to integrate mitigation and adaptation policy-making to a much higher extent than as is currently the case (Santarius et al, 2016).

Knowledge background

Adapting to climate change is one of the great challenges of our time, and it requires a rigorous, but also shared knowledge base on climate risks and vulnerability. Both in the context of voluntary or mandatory local climate action plans as recommended by the EU adaptation strategy, or implementation of National Adaptation Plans in developing countries as requested by UNFCCC, policy makers have increasingly pressing needs. They require accurate, science based, high resolution assessments, as well as an economic vision of impacts in order to prioritize resources for adaptation. This presents the scientific community with the challenge to answer to these societal needs, whilst simultaneously seeking acceptance of there being uncertainties inherent to climate projections and impact modelling.

Even as climate projections become more sophisticated, they are generally not translated into adaptation decisions and action (Klein & Juhola, 2014; Larsen et al., 2012). This pertain to the larger challenge of connecting science with policy, which the United Nations Environmental Program (UNEP) has listed the as the fourth largest unresolved problem in environmental management (UNEP 2012). This inertia has inspired an increasing amount of scholarship on how scientific knowledge production should be conducted in order to better inform policies for climate change action (Dannevig and Aall 2015; Graham and Mitchell 2016; Hoppe and Wesselink 2014, Lövbrand and Stripple, 2011). A key lesson from this research is that the way climate change knowledge is produced, communicated, and translated need to be tailored to the users, boundary work that is (Vaughan and Dessai, 2014). And while substantial efforts have recently been devoted to producing usable information about climate change for adaptation and other coupled human-environmental problems, climate services have tended to have a supply-based perspective (Lourenço et al., 2015). Future models and arenas for science-user interface must consider that currently most climate information providers typically do not fully understand the contexts in which the decisions they hope to inform are being made (Klein & Juhola, 2014; McNie, 2007). This requires a focus on interaction, co-ownership and an understanding of what makes power relevant in researcher-politics-community relationships (decision making context, institutional context), and how to overcome them, thus seeking to enable actors involved to take proactive choices.

The policy discourse is still to a large extent about analyzing the isolated effect of climate change and developing adaptation strategies on that ground (Aall, Juhola and Hovelsrud, 2015), and there is thus a need to combine physical (e.g. CMIP5, CORDEX) with socio-economic models. Also, there is uncertainty in other ways than just trying to reduce it; i.e. to understand also the nature and location, not merely the level, of uncertainties; thus leading to a shift in modus operandi from that of "predict-then-act" to "reflect then act" (Schneider, and Kuntz-Duriseti, 2002) and to how to act under uncertainty rather than trying to master it.

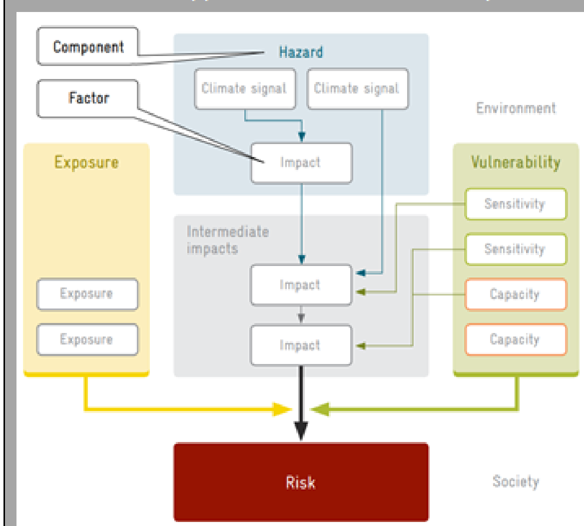
There is a need to overcome the difficulties of combining results from various sources and methodologies, combining qualitative and quantitative analysis - each with a different quality and degree of robustness – and target such information to decision-making processes (Funtowicz and Ravetz, 1990). Climate risks assessments combine quantitative modelling with data from qualitative analysis through literature reviews, interviews, expert judgments and fieldwork. This combination of multiple methodological efforts thus represents a new integrated quantitative assessment model.

UNCHAIN also tackles some challenges associated with assessing climate impacts across space, for example across local administrative or national boundaries or even via international teleconnections (i.e. "transnational" or "indirect" impacts) (Moser & Hart, 2015). This magnifies the challenges described above, most notably those of accounting for socio-economic variability and uncertainty and is expected to be a challenge for European countries (Benzie et al, 2017). Research has suggested that this dimension of climate risk is poorly understood and often missing, even in cutting edge impacts, vulnerability and adaptation research (Liverman, 2016).

Objectives and research questions

The **overall** objective of UNCHAIN is to improve climate change (CC) risk assessment frameworks aimed at informed decision-making and CC adaptation action. The research approach is based on the recent concepts of Impact chain (IC) and co-production of knowledge. To support CC adaptation capacity building, UNCHAIN will engage a broad array of stakeholders, i.e. local authorities, private sector actors (businesses and residents), sub-national and national authorities, NGOs and trans-national organizations with stakes in CC adaptation.

Structure and key elements of an impact chain (from Risk Supplement, Zebisch et al 2017)



UNCHAIN's **scientific** objectives are to (1) contribute to accurate, science-based, high resolution and context specific CC risk assessments (2) improve methods to assess impacts of CC on the economy and society (3) apply the concept of co-production of knowledge in all stages of knowledge development, and (4) investigate how future scenarios can be made more comprehensive by combining societal exposure and vulnerability projections with climate projections and impact models, yielding a novel combination of a quantitative and qualitative risk assessment approach.

To achieve these objectives, UNCHAIN will further develop the Impact Chain concept (Schneiderbauer et al, 2013), provide measurable input and support to stakeholder decision-making and capacity-building processes and apply co-development (stakeholders, experts and researchers) as well as validation methods and tools. The concepts will be applied in case studies where multi-method approaches are employed on different levels. They will aid local stakeholders in their CC adaptation processes. The stakeholder-oriented process for planning and monitoring of project impacts will define clear success criteria. Key outputs will be policy briefs and other resources for risk communication.

Impact chains (ICs) is an analytical tool that helps to better understand, systemise and prioritise the factors that drive climate impact related risks in a specific system of concern and serve as a backbone for an operational climate risk assessment. The concept was developed by EURAC Research for studies on climate vulnerability in the Alps (Schneiderbauer et al, 2013) and further developed for the national climate vulnerability assessment for Germany (Buth et al, 2017) and the GIZ Vulnerability Sourcebook on climate vulnerability assessment in the context of international cooperation (Fritzsche et al, 2014). Recently, the concept has been adapted to the new IPCC AR5 concept of climate risk (Zebisch et al, 2017) and recommended for climate risk assessments in the context of Ecosystem Based Adaptation (Hagenlocher et al, 2018). ICs have since then been more and more widely used as a climate risk assessment method. The method is perceived as a very useful tool for analysis as well as for communication of complex cause-effect relationships in climate change impacts and risks.

Impact chains are foremost a conceptual model for a specific climate risk, composed of risk components according to the IPCC AR5 concept (hazard, exposure, vulnerability) and underlying factors for each of these components. The structure of the impact chain represents the main cause effect chains: a climate signal (e.g. a heavy rain event) may lead to a sequence of intermediate impacts (e.g. erosion upstream that contributes to flooding downstream), which in interaction with the vulnerability of exposed elements of the social-ecological system finally lead to a risk (or multiple risks). For an operational risk assessment, impact chains serve as a basis for the selection of appropriate indicators as well as a backbone for the aggregation of indicators to composite risk indicators. Operational assessments based on impact chains can combine data and model driven approaches with expert-based approaches. Participatory methods (to be conducted in f. ex workshops) are implemented at all steps, to validate the results and ensure ownership and sustainability. ICs increase the usability of climate projections, climate impact models as well as the integration of social, economic and institutional drivers, articulating their results and formatting them in a more understandable format. ICs have the capacity to be inclusive, open and cross sectoral and cross scale and allow to identify and aggregate, downscale risks, and compare sectors.

The cases

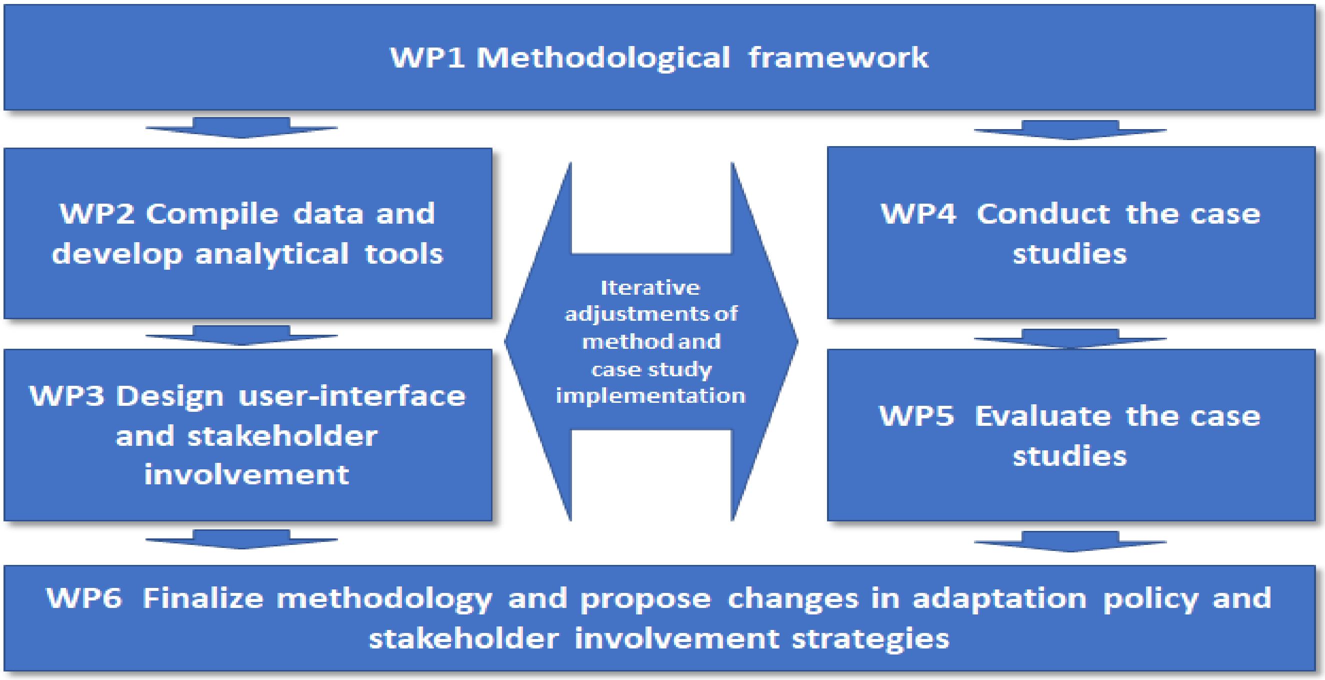
At the core of UNCHAIN are several **cases** conducted in each of the involved countries, as well as in third countries (i.e. concerned by cooperation projects). The objectives of the case studies are: (1) To develop in dialogue with local stakeholders and subsequently test changes and alterations of the current impact chain model for risk assessments; (2) to evaluate the effect of this model with respect to creating a more resilient and climate robust society; and (3), ensure that the project encounters as many of the multiple ways in which climate change, climate change policies and its impacts influence individual and collective adaptation measures as possible, including the effects of climate impacts across space (transnational climate impact exposure). The case studies are 'local' in the sense that they involve stakeholders involved in 'real' decision-making processes on how to adapt society to climate change. The case studies differ in scope. They are multi-method in the sense that they combine quantitative modelling and qualitative methods such as document analysis, interviews and workshop techniques (e.g Gerger Swartling in press). They also involve all partners: experts on economics simulate the "hard" economic indicators and conduct analyses for case studies in some countries, climate modelling analyses risks across several cases and the results are used as illustration material for the bottom-up approaches (i.e. for initial discussions with stakeholders). The cases will be established to cover different aspects of the new approach and so that for each selected topic we will have cases in at least 2 countries. The partners will have the main responsibility for the cases in their respective country but will also be involved in cases in other countries depending on their knowledge profile. For each of the four objectives described above, we will establish a case cluster consisting of 2-4 individual cases located in 2-4 countries, thus allowing for cross-country comparison, as well as the consideration of interactions between case studies or across space more generally. Thus, each individual case will contribute to results within more than one cluster.
The UNCHAIN case studies are presented in the table below.

Case title	Case description
1. Impacts of climate change on a sand & tourism destination *(Spain)*	The potential risks of climate change on tourism comfort and destination attractiveness will be assessed through the impact chains. The Balearic Islands will be used as a case study due to its socioeconomical dependence on sand & sun tourism. The major methodological challenge in this case study comes from the uncertainties existing in the required indicators, that should be converted into a probabilistic risk assessment.
2. Economic effects of adapting critical infrastructure *(Germany)*	Despite public awareness of infrastructure vulnerability to extreme weather events, few economic assessments of future infrastructure developments under different climate scenarios have been developed. This case study fills this gap through assessing the risk for industries, services, logistics companies and eventually households represented by potential infrastructure damages and resulting service shortfalls.
3. Improving climate change impact assessments of international supply chains *(transboundary)*	We assess the impacts of foreign climate change effects via multi-national supply chains on the German economy by dynamic simulation studies with the simulation models GINFORS and PANTA RHEI. The case study will consider damages to production facilities and transport infrastructures in the respective regions of export and import trading partners and trace the resulting socio-economic effects in Germany.
4. Drought in Alpine regions *(Austria)*	Austria was affected in 2018 by record-breaking high and long temperature series as well as severe drought conditions, having led to strong impacts on the agricultural sector. Future climate projections indicate increased temperature values as well as variability for precipitation, with a trend to drier summers in some regions. The Austrian case study aims to integrate two components of the project: the revision and adaptation of the impact chain methodology as well as decision-making processes and adaptation policies and reflect on existing adaptation policy frameworks on how such drought events are managed on local (farm level) to national scale.

5. Adaptation to climate change risks and impacts in the forestry sector *(Sweden)*	With the aim to further understanding of how a co-produced and improved risk assessment methodology may support adaptation decision-making and action, this case study will focus on how key stakeholders in the Swedish forestry sector perceive and manage risks and impacts associated with a warmer and drier climate. It also includes economic and other societal and socio-economic impacts of climate change. Challenges related to how stakeholders balance between different objectives and interests such as mitigation and adaptation will also be in focus as well as their needs for different types of knowledge and information that could guide the work with adaptation forward and help identify sustainable adaptation options.
6. Securing sustainable food production in semi-artic conditions under the auspices of climatic changes *(Norway)*	Both on land and at sea, communities in the County of Nordland, Norway are embedded, both economically, structurally and culturally, to food production in industries such as fishing, agriculture and aquaculture. Multiple stressors threaten the future viability of these industries though, of which climate change are but one, if at all recognized. This case will seek to understand how the culturally embedded notion of resilience and adaptive capacity enables (or un-ables) industry actors when facing the cumulative impacts of global climatic changes and the policies expected to arise when seeking to adapt to them.
7. Tourism mobility and climate change *(Norway)*	We will investigate how climate change taking place locally may affect tourism mobility in one of the major tourism destinations of Norway (Aurland). In addition, we will investigate the transboundary effects of climate change in competing markets (e.g. the Alps) and in the home country of visiting tourists (e.g. increase in extreme heat in South Europe).
8. Climate change impacts on financial investment portfolios *(Netherlands)*	PGM is one of the largest pension funds in the Netherlands and has stated an interest in the biophysical climate change impacts on their investment portfolio. One of the challenges is that risks need to be defined at different scales because not all their investments are local, and they also invest in large multinationals. In addition, a major challenge is how to integrate climate and financial risks including future socio-economic change.
9. Risks and impacts of climate change on railway infrastructure *(Netherlands)*	Prorail is the Dutch company responsible for the railway tracks in the Netherlands and has stated their concern about excessive heat and changes in future storms. The challenge here is the different timescales at which the risks need to be assessed. Storms are short term extremes especially affecting decision on tree cutting while heat stress and future snow and ice affect long term investments.
10. Sensibilities and vulnerabilities of small and medium enterprises in the Upper Rhine Region *(Germany)*	This case study aims to identify the sensibilities and vulnerabilities to climatic changes of small and medium enterprises at the Upper Rhine and how this might affect productivity. We will seek feedback from businesses such as forestry, winter tourism industry, logistic and textile branches on potential adaptation paths. The Rhine as well as the small rivers, which provide water to the valleys, are important infrastructures. Current adaptive initiatives include negotiations between different stakeholders to adopt a chart (parc naturel regional des Vosges du Nord) in the region. The transnational aspect is provided through comparison between French, German and Swiss parts of the Rhine waterway.
11. Multi-sectoral and multi scale approach of the climate vulnerability assessment *(Bangladesh)*	Based on the Nationwide Climate Vulnerability Assessment (CVA) conducted by TEC for Bangladesh (2016-2018), we will investigate how to improve the methodology and the operationalization of the impact chain concept for strengthening CVA (uncertainties, robustness, GIS mapping etc.). This case study will also serve as a basis for exploring how to ensure capacity building, ownership and sustainability of the IC approach with end-users (policy makers, stakeholders etc.).

Work packages and tasks

The planning, implementation and analysis of case studies and the results emanating from them will be organized in six **work packages** (WPs). WP 4, 5 and 6 cover the case-studies, whereas WP 1, 2 and 3 are set up to support the cases, thus do not involve case (stakeholder) partners (cf. Figure). WP2 includes sustainable data management, WP3 will also address the collaboration, integration, and co-design goals of the call.



WP1	**Methodological framework, scientific coordination and communication**							**Lead: WNRI Start M1, End M36**		
Partners	**WNRI**	WUR	GWS	IEO	PLUS	NRI	FhG	SEI	TEC	INSA
PM	**13**	3	3.25	7.0	3,5	1	3,39	3	12	1

Objectives

To identify the specific challenges and knowledge gaps to be filled with respect to further developing the impact chain model, which will serve as input to WP2 (tasks 2, 3, 5, 6 and 7) and WP3 (tasks 4 and 8).

Description of work and role of participants

Task 1.1 Co-ordinate WP1: WNRI (5 pm); TEC (8 pm). Time: M1-M36
Have contacts with all the involved partners, develop a common case-protocol structure for all the inputs in the tasks below to follow, develop project steering and reporting routines.
Task 1.2 Co-ordinate and support communication actions: WNRI (5 pm); TEC **(**5 pm); WUR (1 pm); SEI (1 pm); IEO (1 pm); PLUS (0,5pm); FhG (1,39 pm); NRI (1 pm). Time: M1-M36. Initiate, coordinate and support production of popular science and user-oriented disseminations from the WPs
Task 1.3 Knowledge review on the impact chain model: PLUS (2 pm), EURAC (0,5 pm), GWS (0.25 pm), FhG (1 pm). Time: M1-M6 Identifying knowledge gaps and areas for further development.
Task 1.4 Knowledge review on available services for downscaling climate scenarios: IEO (6 pm); WNRI (0,25 pm). Time: M1-M6. Suggesting best ways for using downscaling services in the involved partner countries.
Task 1.5 Knowledge review on socio-economic scenarios illustrating societal exposure to climate change: GWS (2,5 pm); WNRI (0,25 pm), FhG (1 pm), PLUS (0,5 pm), WUR (2 pm), INSA (0,5 pm). Time: M1-M6. Develop a framework on how to develop and integrate socio-economic scenarios into the impact chain model
Task 1.6 Knowledge review on user-interface and stakeholder involvement: SEI (1 pm), PLUS (0,5 pm), WNRI (0,5 pm). Time: M1-M6: Develop a framework for user-interfaces and stakeholder involvement in relation to the impact chain model.

Task 1.7 Knowledge review on methods for assessing the local and transboundary consequences of climate change: WNRI (2 pm); SEI (1 pm); GWS (0.5 pm), INSA (0,5 pm). Time: M1-M6: Develop a framework for consequence assessment methods in relation to the impact chain model.

Description of deliverables

D1.1 (WNRI, TEC, all) A description of the methodological and scientific framework for further developing the impact chain model. A compilation of the work done in tasks 1.3-1.7 functioning as a baseline for WP2 (tasks 2, 3, 5, 6 and 7) and WP3 (tasks 4 and 8). Internal Report. Delivery date: M6.

WP2	**Data and quantitative modeling tools**								**Lead: GWS Start M4, End M18**
Partners	WNRI	WUR	**GWS**	IEO	PLUS	NRI	FhG	SEI	TEC	INSA
PM	1	2	**11**	13	2,2	1	9,75	0	6	0

Objectives

- Ensure effective implementation of modeling chains
- Identify data needs of planned impact chain applications
- Develop data compilation routines for the standardized consolidation of relevant expertise within the consortium
- Generate methodological advances in climate change impact assessments and in impact chain modeling

Description of work and role of participants

WP2 handles data needs as well as availabilities and ensures the data flow for the different activities within the project. The task to use data and to apply related tools in the cases remains with the respective work packages. Subsequently, WP2 addresses two different target areas: 1) data needs and gaps across case studies, and 2) data needs and gaps from a researcher perspective. This research work focusses on progress towards an advanced integration of socioeconomic data in climate change scenario studies as well as developing more robust quantifications of impact chains and implied uncertainties.

Task 2.1 Co-ordinate WP2 GWS (0.7 pm); FhG (0.75 pm). Time: M04-M18

Task 2.2 Identification of project relevant data flows for the case studies: GWS (4 pm); WNRI (0,5 pm), IEO (3,5 pm), FhG (1 pm), WUR (1pm), PLUS (0,7 pm). Time: M04-M12. This task facilitates the systematic identification of data needs and data availabilities within the consortium across cases. It will develop and test a template to collect information on data needs from the case studies conducted during the project. After testing, the refined template will be applied for a systematic collection of data needs and data availabilities for the planned case studies.

Task 2.3 Advancing climate change impact assessments- Methodological research on an improved integration of socio-economic aspects and framings across scale and sectors: GWS (5.5 pm); WNRI (0,5 pm), WUR (0,5 pm), IEO (2,5 pm), FhG (2 pm), TEC (3 pm), PLUS (0,5 pm), NRI (0,5 pm). Time: M04-M18. Socio-economic projections like the SSPs only provide aggregated indicator projections (like GDP) on national levels. This task explores the feasibility to provide further detailed economic input data from applications of the global multi region simulation model GINFORS (see Meyer at al. 2018). For two selected WP4 case studies, economic input data available from a medium term GINFORS-baseline projection will be compared with individual input needs. Then, possible approaches for a target-oriented further breakdown of these socio-economic input data will be methodologically discussed and documented. As so-called, GINFORS is an environmental-economic model that features a detailed economic mapping of primary, secondary and tertiary sectors of the global economy broken down to 39 world regions. For each modelled world region, the model fully integrates all cross sectoral economic interdependencies on the production side as well as the complex interplay between public sector, private households and foreign demand; integrated environmental modules report on territorial CO_2 emissions and natural resource extractions.

Task 2.4 Advancing impact chain modeling: Methodological refinements of State-of-the-Art indicator

implementations. FhG (6pm); GWS (0,8 pm), WUR (0,5 pm), IEO (4,5 pm), TEC (3 pm), PLUS (0,5 pm), NRI (0,5 pm). Time: M09-M18. Based on the findings from Task 2.2 and WP1 (notably Tasks 1.2 to 1.4), this task will develop a general-purpose reference set of indicators and assess their reliability and validity under different measurement and calculation approaches´. Based on an initial systematic review of state-of-the-art indicator sets, a refined indicator set will be developed, whose empirical applicability will be tested during the case studies of WP4. The results of this task will be reported in D2.3.

Task 2.5. Considering uncertainties in the impact chains. IEO (2,5 pm), PLUS (0,5 pm). Time: M09-M18. The estimates of the different indicators used in applied impact chain analyses suffer from inherent uncertainty due to inaccuracies in the modelling or unknown factors. This task explores different methodologies to propagate these uncertainties till the final risk assessment, so the quantification of impacts will be probabilistic, which can enormously help the stakeholders when considering the robustness of the estimates.

Description of deliverables

D2.1 Data needs and data availabilities (GWS); *Internal note* outlining suggested data flows to fill identified gaps with respective expertise within the consortium. Delivery date: M12

D2.2 Methodological possibilities for an improved integration of socio-economic aspects and framing in impact chain modeling studies. *Journal article*. Delivery date: M18

D2.3 Methodological refinements of indicator implementations in impact chain modeling studies. *Journal article*, Delivery date: M18

D2.4 Methodological approaches towards probabilistic impact chain analyses (FhG, GWS, other WP2**).** *Report.* Delivery date: M18

WP3	**Science - stakeholder interface and co-production processes**									**Lead: SEI Start M3, End M24**
Partners	WNRI	WUR	GWS	IEO	PLUS	NRI	FhG	**SEI**	TEC	INSA
PM	3,5	1	0,25	0	1	2,5	0	**4,75**	2	0,5

Objectives

- To develop conceptual framework and methodology for co-production of knowledge to be integrated into impact modelling
- To guide the stakeholder involvement in case studies

Description of work and role of participants

To allow for effective co-production of knowledge between stakeholders and researchers that supports adaptation processes (e.g. contributes to informed decision-making and CC adaptation action) – careful design is required to ensure relevant perspectives are acknowledged, and there are common understandings and joint ownership of the process. WP3 will offer the conceptual foundation for and facilitate stakeholder involvement throughout the research process and the case studies. It will also enable the establishment of a platform for exchange of knowledge, mutual learning and communication between researchers and stakeholders and between researchers from multiple disciplines. WP3 connects improved climate change risk assessment techniques (WP2) with a methodological framework for participatory, co-produced climate services (Daniels et al, forthcoming) which will be applied across case studies. All tasks will be jointly developed with NRI (WP4) and coordinated with GWS (WP2). The results will also feed into WP6 (Task 6.4 and Task 6.5).

Task 3.1 Co-ordinate WP3: SEI (1 pm); NRI (0,5 pm) Time: M03-M24

Task 3.2 Design (participatory) methodology for co-production of knowledge: SEI (1 pm); WUR (0,5 pm), NRI (0,5 pm), GWS (0.25 pm); WNRI (1 pm), PLUS (0,5 pm), TEC (1 pm). Time: M3-M8. This task aims at designing a participatory methodology for application in the case studies (WP4) and that will be further refined and developed throughout the project. It will start from a process-led, decision-driven, science-informed and user-oriented framework (Daniels et al, forthcoming) and integrate input on the challenges and knowledge gaps identified in WP 1 (Task 1.5 and Task 1.9) and in coordination with WP2 and WP4. Key elements of the methodology will include: a) Identification of the adaptation challenge(s) and key stakeholders as well as understanding of the institutional and decision contexts; b) Co-exploration of data and information needs, sources, formats and modes of dissemination and appraisal of adaptation options; c) Evaluation and feedback. The methodology will be summarized in a guidance document for case study coordinators (D3.1.).

Task 3.3 Support application of methodology in case studies: NRI (0,5 pm); WUR (0,25 pm), SEI (0,25 pm); WNRI (0,5 pm), PLUS (0,25 pm). Time: M08-M21. This task involves regular internal meetings to support and give advice to researchers involved in the case studies on how to operationalize and apply the methodology in case studies. This task will also ensure that the different elements of the methodology are refined and adapted to case specific contexts.

Task 3.4 Monitor and evaluate the co-production of knowledge: SEI (1 pm); WUR (0,25 pm), NRI (0,5 pm), WNRI (0,5 pm), PLUS (0,25 pm). Time: M08-M24. Monitor and evaluate the knowledge co-production processes in case studies based on criteria set out in Task 3.2 and WP6 Task 6.1. This task also includes feedback and lessons learned from applying the participatory methodology in case studies with focus on both the process and adaptation outcomes. Furthermore, insights will be made on how to develop user-focused Climate Services products that support the goal of actionable knowledge for climate action.

Task 3.5 Synthesize findings on application of methodology: SEI (1,5 pm); NRI (0,5 pm), WNRI (1,5 pm), TEC (1 pm), INSA (0,5 pm). Time: M18-M24. This task aims at synthesis findings on application of the methodology for co-production of knowledge based on Task 3.4. Results will feed into WP6 Task 6.4 for wider assessment and consolidation in relation to the projects overarching objectives.

Description of deliverables

D3.1 Participatory methodology design (SEI): *Internal guidance document* with summary of key steps and critical issues of the methodology that will guide the application in case studies. Delivery date: M8

D3.2 Lessons learned from the co-production of knowledge (SEI, WNRI, all**)**: *One journal article* that will present the methodological framework and the lessons learned from the development and application in case studies. Delivery date: M24

WP4	**Conduct the case studies**								**Lead: NRI** **Start M1, End M24**
Partners	WNRI	WUR	GWS	IEO	PLUS	**NRI**	FhG	SEI	TEC	INSA
PM	8	12	10,5	2	3	**4**	3	6,5	4	2,5

Objectives

- To ensure comparability between individual cases and case clusters and support partners in the case-work
- To execute the case studies

Description of work and role of participants

This WP will organize and conduct the case studies pertaining to the intentions outlined in WPs 1-3 and the needs of WPs 5-6. Number of tasks in limited to focus on implementation, seeking to support WP 3 (in particular) pertaining to methodological development.

Task 4.1 Co-ordination of WP4: NRI (2 pm); SEI (0,5pm). Time: M01-M24**.** This task includes coordination and communication between all PIs in all case studies, related WP ers and overall project coordinators/management.

Task 4.2 Comparative design/ clustering: NRI (0,5 pm), SEI (0,5 pm). Time: M3-M18**.** This task aims at utilizing and operationalizing the methodology designed as task 3.2 WP 3, ensuring relevant input on the challenges and knowledge gaps identified in WP 1 (Task 1.5 and Task 1.9). An important focus will be on ensuring comparability between individual and clusters of case studies

Task 4.3 Co-production as methodology in case studies: NRI (0,5 pm), SEI (1,5 pm). Time: M06-M12. This task includes following up of the intention of co-production as a methodological ambition in all cases, in conjunction with WP 3 (task 3.4).
Task 4.4 Carrying out the case studies: **NRI** (1 pm), WNRI (8 pm), TEC (4pm), WUR (12 pm), GWS (10,5 pm), IEO (2 pm), PLUS (3 pm), FhG (3 pm), SEI (4 pm), INSA (2,5 pm). Time: M3-M18. The major task of this WP is to carry out the case-study in cooperation with the involved local stakeholders, including one to two workshop per case (n=11)

Description of deliverables

D4.1 Introduction to the UNCHAIN case studies (NRI). Brief/internal note issued to the involved local stakeholders in case, produced in the native language of each country. Delivery date: M06
D4.2 Overview of the cases (NRI, all WP4 participants). A compiled and standardized presentation of each case (case content, stakeholders and climate change/ adaptation/ impact variables) presented on the web-pages of the partner institutions. Delivery date: M1-M18 (continuously updated).
D4.3 Lessons learned, case study implementation (one per case) (NRI, all WP4 participants). A short summary of the process and outcome of each case, in the native language and with an English summary. This deliverable will feed into the reports/ peer review articles described in WPs 5-6. Delivery date: M18.

WP5	**Evaluate case studies**								**Lead: WUR** **Start M1, End M34**
Partners	WNRI	**WUR**	GWS	IEO	PLUS	NRI	FhG	SEI	TEC	INSA
PM	1	**18**	0,5	2	2	1	0	2	2	1

Objectives

- To develop a methodology for the evaluate how the case studies contribute in testing the five main innovation of UNCHAIN
- To evaluate how the five innovations have been included in the case studies and to what extent they have contributed to improved risk assessment and climate change adaptation.

Description of work and role of participants

This work package will evaluate the case studies. The focus will be on evaluating how the five innovations of UNCHAIN have been applied in the different case studies and how the innovations have contributed to improved climate risk assessment, stakeholder involvement and climate change adaptation outcomes.
Task 5.1 Development of case study evaluation framework: WUR (3pm), PLUS (1 pm); SEI (1 pm). Time: M1-M12. This task will develop a framework for the evaluation of the case study. The framework will describe how the case studies will be compared, develop evaluation criteria and evaluate he cases in relation to the five expected innovations of the project. In addition, the framework will describe which information and data will be requested from the data case studies which are needed for the evaluation.
Task 5.2 Collection of data and information on how the case studies have implemented the five main innovation of the UNCHAIN project: WUR (6 pm); WNRI (1 pm); PLUS (1 pm); GWS (0,5 pm); TEC (1 pm), SEI (1 pm), IEO (1 pm); NRI (1pm), INSA (0,5 pm), Time: M12-M30. This task will collect the information and data from the case studies which are needed for the evaluation of task 5.3. Based on the framework developed in task 5.1, a protocol will be developed outlining what the different case studies need to deliver for the evaluation of the cases.
Task 5.3 Evaluation of how the implementation of the five UNCHAIN innovations in the case studies have contributed in improved risk assessment and adaptation outcomes. WUR (9 pm), TEC (1 pm), IEO (1 pm), INSA (0,5 pm). Time: M18-M34. This task will use the data collected in task 5.2 in combination with framework in task 5.1 to evaluate the case studies. The task will systematically assess how the five UNCHAIN innovation have been applied in the different cases. Furthermore, we will assess how each of these innovations have contributed to improved risk assessment and better-informed decision-making and CC adaptation action in the

different case studies. Based on this analysis, a set of lessons learned will be defined for the improvements of future climate change impact and risk assessments.

Description of deliverables

D5.1 Framework for evaluation of the case studies (WUR): A *report* describing the evaluation framework and identifying the data and information needed from evaluating the cases studied. Delivery date: M12
D5.2 Evaluation of how the implementation of the five UNCHAIN innovations in the case studies have contributed improved risk assessment and adaptation (WUR, all**):** A *fact sheet* for each case in the native language of each country and with an English summary: Delivery date: M30
D5.3 Cross-country and cross-case comparisons of how the implementation of the five UNCHAIN innovations have contributed improved risk assessment and adaptation: Five *journal articles*. Delivery date: M34.

WP6	**Synthesize methodology and identify best practices for adaptation decision making as well as stakeholder involvement strategies**							**Lead: PLUS Start M12, End M36**	
Partners	WNRI	WUR	GWS	IEO	**PLUS**	NRI	FhG	SEI	TEC	INSA
PM	4,2	2	1	2	**6**	1	1,75	5	4	1

Objectives

- To synthesize research findings gained in the case studies including the implementation of methodology for co-production of knowledge
- To finalize and develop a consolidated methodology for the improved used of impact chains and related methods
- To propose policy recommendations for adaptation actions with focus on lessons learned for bridging science and adaptation decision-making

Description of work and role of participants

WP6 aims to synthesize and consolidate findings and methods gained in the UNCHAIN project. It brings together the insights gained in the case studies to develop a consolidated methodology (with a focus on impact chains and science-user interface); and proposes opportunities for changes in adaptation decision making in Europe and beyond. Furthermore, it reflects on the process of stakeholder involvement and knowledge co-production to bridge the gap between climate science, policy and practice, and how related strategies can be improved.
Task 6.1. Develop criteria for validation of case study results for (i) the development and consolidation of methods and (ii) strategies for adaptation policies with stakeholder involvement: PLUS (1 pm), SEI (0,5 pm), IEO (1 pm), FhG (1 pm), TEC (1,25 pm), INSA (1 pm). Time: M12-M15. WP6 will synthesize and reflect on experiences gained during the execution of the case studies. Based on the evaluation conducted in WP5, this task will develop as a first step a guidance and validation criteria to be able to synthesize the main results of this project. This will address the two main streams of the project - (i) consolidation and development of an adapted impact chain methodology as well as (ii) improved decision making in the adaptation context. This task sets the ground for consolidating the work in WP6.
Task 6.2. Methodology: Distil insights on methodology (focus on impact chains) based on criteria from task 6.1 in close exchange with case study coordinators and thematic experts (consultation process, workshops etc): PLUS (1 pm), SEI (0,25 pm), GWS (0.4 pm), FhG (0,25 pm), TEC (0,25 pm). Time: M16-M24. Based on the criteria and guidance developed in task 6.1., this task will consolidate and collect insights on the impact chain methodology. Different streams of data collection will be used, such as direct consultation, short standardized surveys to get key insights, online gatherings and the analysis of case study reports. This task aims to provide the basis to develop the consolidated impact chain methodology in task 6.3.
Task 6.3. Methodology: Document and propose consolidated methodology for impact chains and climate risk assessment: PLUS (1 pm), SEI (0,25 pm), GWS (0.3 pm), FhG (0,25 pm), TEC (0,25 pm). Time: M25-

M31. Based on the consolidated insights from the case study, this task will develop a consolidated methodology for the new generation of impact chains. It is aimed to have two levels of results: A scientific documentation of the new methodology and a hands-on guide on how the methodology can be applied in practice. The adapted methodology and its practice guidance will be consolidated as deliverable 6.4. and published later in academic journals as well as relevant practitioner portals.

Task 6.4. Adaptation decision-making and policy: Distil insights from implementing methodology for co-production of knowledge and impact chains across case studies with focus on lessons learned for bridging science with adaptation action: SEI (1,5 pm), PLUS (1 pm), WNRI (2 pm), FhG (0,25 pm), TEC (0,25 pm). Time: M16-M24. Based on the criteria and guidance developed in task 6.1, with input from WP3 and in close exchange with case study coordinators, this task will consolidate and collect insights on the methodology for co-production of knowledge and how the impact chain methodology contributes to improved adaptation decision-making and influences policy outcome. It will also provide insights on the development of user-focused and action-oriented climate services. This task aims to provide the basis to develop recommendations for adaptation decision-making in task 6.5.

Task 6.5. Adaptation decision-making and policy: Document and propose recommendations: SEI (1,5 pm), PLUS (1 pm), WNRI (2 pm), IEO (1 pm), NRI (1 pm), TEC (1,25 pm). Time: M25-M31. Based on the consolidated insights from task 6.4, this task will document and propose recommendations for producers, intermediaries and users of climate information and climate services on how to bridge science with adaptation action and improve adaptation decision-making. It will also propose recommendations for improved adaptation policy.

Task 6.6. Overall synthesis and development of key science and policy relevant recommendations: PLUS (1 pm), SEI (1 pm), WNRI (0,2 pm), GWS (0.3 pm), TEC (0,75 pm). Time: M31-M36**.** Tasks 6.3 (with D6.2) and Task 6.5. (with D.6.3) consolidated and developed new approaches on the impact chain as well as improved decision making in the adaptation context. This task provides a condensed summary of these two streams and aims to synthesize concrete recommendations for science as well as climate change adaptation in practice. This will be done through a concentrated effort of the respective task leaders together with the consortium partners.

Description of deliverables

D6.1. Criteria list for synthesizing insights gained on methodology and for adaptation decision making: (**PLUS)**; Delivery date: M15. A public *report* with a criteria list, which serves as a basis for the synthesis on the impact chain methodology and improved adaptation decision making.

D6.2. Improved and adapted impact chain methodology (Guidebook and reflection on insights and lessons learnt): *Journal article* and *report*; Delivery date: M31. Presentation of the improved and adapted impact chain methodology targeting two audiences; science, as well as practitioners. This is a core outcome of the project to propose an improved impact chain methodology.

D6.3. Recommendations for improved adaptation decision making and policy: (**SEI)**; *Policy brief* (translated to all partner countries languages); Delivery date: M31. Presentation of recommendations for improved adaptation decision-making targeting both producers, intermediaries and users of climate information and climate services as well as adaptation policy- and decision-makers.

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