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Accelerating and upscaling transformational adaptation in Europe: demonstration of water-related innovation packages

Set of adaptation transformation pathways per demonstrator

Deliverable 3.3

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Author(s)	Mampionona RAKOTONIRINA, Elise EYMARD
Contributors	Amaya SOTO, Lucía FRAGA, Silvia PIEDRACOVA, Silvia TORRES, Andrea OGANDO, Carlos RODRÍGUEZ, José GUITIÁN, Xose ANTÓN ALVAREZ SALGADO, Isabel FUENTES SANTOS, Jose ALBERTO DE SANTIAGO MEJIDE, Margaretha BREIL, Yannis CHARALAMPIDIS, Laurence COULDRICK, Katie JOHNSON, Stelios KAROZIS, Rim KHAMIS, Giles RICKARD, Nicola ROGERS, Tobias PILZ, Antonio TRABUCCO, Dimitris TZEMPELIKOS, Sanna VARIS, Marie-Edith VINCENNES, Mariia ZHAUROVA and all workshop participants
Primary Contact and Email	mampionona.rakotonirina@acterraconsult.com; +33 (0)7 52 05 24 61
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Climate change is known as the defining issue of our time, territories, communities, activities, and sectors. It is urgent to both mitigate climate change by reducing the greenhouse gas emissions and to adapt to its impacts. The European Commission - EC (2021), in its new EU Strategy on Adaptation to Climate Change affirmed that "climate change is happening today, so we have to build a more resilient tomorrow." To be sure that we are implementing the right and relevant actions to adapt to climate change with the purpose of increasing resilience to climate change, a sound strategic planning process is needed. Adaptation Pathways are one of the relevant concepts used to plan for adaptation to climate change, it takes into account decision making under uncertainty due to climate change and climate projections. In the framework of the TransformAr project (https://transformar.eu/), a methodology was developed to set up Adaptation Pathways (see "The Adaptive Pathway Transformation Playbook: deliverable D3.10"). From February 2022 to January 2023, the six demonstrators of the TransformAr project (West Country Region (UK), Oristano (Italy), Egaleo (Greece), City of Lappeenranta (Finland), Guadeloupe (France), Galicia (Spain)) organised workshops to apply the methodology to co-construct adaptation pathways at territorial and sectoral levels. A total of 16 workshops were organised online or in person, at the demonstrator level with stakeholders from different domains. This report presents the processes and results of all the workshops organised by each demonstrator. Main results include: the risk chain per territory or per sector, the risk evolution description, and indicators to monitor them, the critical thresholds, the adaptation vision, and the adaptation pathways or identified adaptation actions per impact/risk level. This report also presents the lessons learnt from the application of the Playbook methodology in the six demonstrators. These include lessons learnt from the preparation (technical and logistical preparations), implementation (presentation of elements to pay attention to and some suggestions for the development of each output) and facilitation of the co-construction workshops of adaptation pathways.

LIST OF ACRONYMS

ADEME	French Environment and Energy Management Agency
AR6	IPCC Sixth Assessment Report
AR5	IPCC Fifth Assessment Report
CC	Climate change
CET	Central European Time
CETMAR	Centro Tecnológico del Mar
CMCC	Euro-Mediterranean Center on Climate Change
CMIP 6	Coupled Model Intercomparison Project Phase 6
E3M	Energy Economy Environment Modelling
EEST	Eastern European Summer Time
GCMs	Global Circulation Models
GMT	Greenwich Mean Time
IPCC	Intergovernmental Panel on Climate Change
KCS	Key Community System
MEDSEA	Mediterranean Sea Acidification in a changing climate
NGO	Non-Governmental Organisation
PIK	Potsdam Institute for Climate Impact Research
RCP	Representative Concentration Pathway
SME	Small and medium-sized enterprises
SSP	Shared socio-economic pathway
UK	The United Kingdom
UVigo	University of Vigo
WCR	West Country Region
WRT	Westcountry Rivers Trust
WS	Workshop

INTRODUCTION

TransformAr: *"Accelerating and upscaling transformational adaptation in Europe: Demonstration of water-related innovation packages"* (https://transformar.eu/) is a project funded by the European Commission's H2020 programme for a period of 4 years (2021 - 2025). It aims to develop, test and upscale products and services to initiate and accelerate large-scale transformational adaptation in vulnerable regions and communities across Europe. The project brings together 22 partners (universities, research centres, consultancy firms, NGOs, SMEs, public institutions, local authorities, etc.) from 11 European countries (Belgium, Italy, France, Greece, Germany, Spain, Czech Republic, Finland, Norway, Malta, United Kingdom). TransformAr works in 6 demonstration territories: Guadeloupe (France), Galicia (Spain), West Country Region (UK), Sardinia (Italy), Lappeenranta (Finland) and Athens (Greece) to implement adaptation solutions in Key Community Systems (KCS).

In the framework of Work Package 3 (WP3): "Envisioning transformative pathways for the demonstrators", a methodology has been developed to co-construct climate change adaptation pathways for demonstrator territories and related key sectors: the Playbook (Deliverable D3.10). Each demonstrator applied the methodology to co-develop adaptation pathways with key stakeholders for their territory and KCS. This report shows the results of this process.

The report is structured as follows:

- First, the Playbook methodology with conceptual elements (adaptation pathways, transformative adaptation, IPCC Fifth Assessment Report –AR5- conceptual definition for risk chain components) is briefly introduced.
- Second the schedule and steps to take to organise workshops is presented.
- Then, results of workshops for each demonstrator are showcased, based on the minutes or reports written and shared by the organisers of each workshop. They include the description of risk chain components (hazards, exposure, vulnerability, most prominent risk and economic risks) per territory or per KCS (depending on the approach chosen by organisers), the characterisation of impact / risk levels per territory or per KCS, the characterisation of critical thresholds (which was quite challenging for almost all of the participants of all workshops), adaptation visions and the adaptation pathways or the identification of relevant actions per impact / risk level.
- Finally, a section with the conclusions and lessons learnt is developed.

The TransformAr team is particularly grateful to all Transformar partners (local and technical partners) who organised, prepared, implemented, and reported for the workshops as well as to all workshop participants for their commitment, availability, and their active participation in the discussions which allowed us to prepare this report.

1.0 THE ADAPTIVE PATHWAY TRANSFORMATION PLAYBOOK

The Adaptive Pathways Transformation Playbook, hereafter referred to as the "Playbook", is one of TransformAr's project deliverables (D3.10) in WP3. The Playbook presents a methodology developed to guide the co-construction of climate change adaptation pathways by integrating a transformational vision for regions seeking to implement transformational adaptation.

"Climate change adaptation pathways" is an emerging concept used to support decision-making and planning for adaptation to climate change in a context of uncertainty. As defined by Werners, et al. (2021), "adaptation pathways are broadly understood as sequences of actions, which can be implemented progressively, depending on future dynamics." As shown in Figure 1. Adaptation pathways are processes based on contextual knowledge and stakeholder participation.

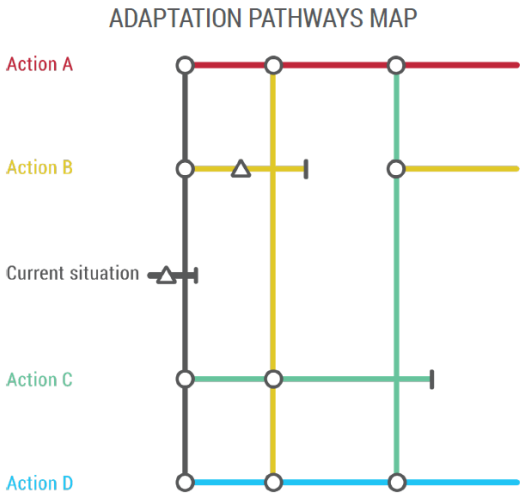

Figure 1. Adaptation pathways map (Source : Zandvoort et al. (2017))

According to Fedele et al. (2019), there are four main types of strategies for coping with climate change impacts: inaction, coping, incremental adaptation and transformational adaptation (as illustrated by examples from the agricultural sector in Figure 2 below). Transformational adaptation is an approach to address the root causes of vulnerabilities to climate change over the long term by transforming systems and moving away from unsustainable practices. This type of adaptation to climate change has 6 characteristics: restructuring, path-shifting, multiscale, innovative, persistent, systemwide (Fedele et al., 2019). Adaptation pathways integrate the concept of transformative adaptation.

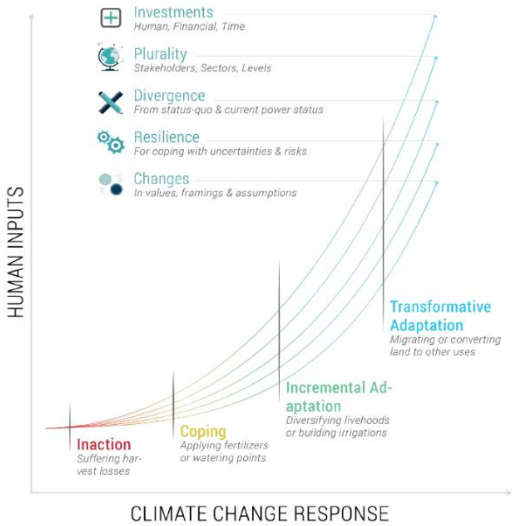

Figure 2. Types of climate change adaptation strategies (Source: Fedele et al., (2019))

In the framework of TransformAr WP3, the Playbook has been designed as a step-by-step guide for the co-construction of climate change adaptation pathways. It is based on three workshop sessions:

The methodology is based on local stakeholder expertise combined with scientific knowledge in a participatory format of multi-stakeholder workshops. It integrates participatory activities and scientific and conceptual inputs with presentations with templates to be filled in by participants. Before the workshops, some procedures must be done to identify and to engage the relevant participants to be part of the workshop discussions.

Some terms used in the framework of the Playbook:

Risk chain components identified by each demonstrators use the definitions from the IPCC AR5 as shown below:

Climate change mitigation: Involves actions that reduce the rate of climate change. Climate change mitigation is achieved by limiting or preventing greenhouse gas emissions and by enhancing activities that remove these gases from the atmosphere, such as carbon sequestration.

Climate change adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities accepting and dealing with CC, through disaster management, proactive planning, or behavioural modification for example.

Hazards (risk factors): physicochemical phenomena related to climate change (CC).

Exposure: presence of animal or plant species, infrastructure, population, heritage likely to be affected.
Vulnerability: sensitivity factor of a given system and its adaptability.

Risk: combination of the probability of an event occurring and its negative consequences. The factors that compose it are hazard and vulnerability.

2.0 WORKSHOP ORGANISATION

2.1 Workshops schedule

The adaptation pathways co-construction workshops for the six TransformAr demonstrators were held in one year, from February 2022 to January 2023. The first version of the Playbook methodology was developed and tested with the first workshops in the West Country Region (UK). The five other demonstrators used this first version and considered lessons learnt from other workshops when organising their own.

A total of 16 workshops were organised by a duo of TransformAr organisations per demonstrator. The schedule of workshops is presented in the Table 1 below.

Table 1. Schedule of adaptation Pathways workshops per demonstrator

DEMONSTRATOR	WORKSHOP (WS) TITLE	DATE	FORMAT
West Country Region (UK)	**WS 1** "Climate Perception, challenges, and existing solutions »	18th of February 2022	Online
	WS 2 "Climate vulnerability, impacts and projections (based on scientific modelling/projections)"	02nd of March 2022	Online
	WS 3 "Vision, solutions and way forward (construction of adaptation pathways)"	16th of March 2022	Online
Oristano (Italy)	**WS 1** "Climate Perception, challenges, and existing solutions"	11th of October2022	In person
	WS 2 "Climate vulnerability, impacts and projections (based on scientific modelling / projections)" "Vision, solutions and way forward (construction of adaptation pathways)"	12th of October 2022	In person
Egaleo (Greece)	TransformAr Municipality of Egaleo Workshop	10th of October 2022	In person
City of Lappeenranta (Finland)	**WS 1** "Climate Perception, challenges, and existing solutions"	02nd of November 2022	In person

DEMONSTRATOR	WORKSHOP (WS) TITLE	DATE	FORMAT
	WS 2 "Climate vulnerability, impacts and projections »	03rd of November 2022	In person
	WS 3 "Vision, solutions and way forward (construction of adaptation pathways)"	03rd of November 2022	In person
	WS 4 "Defining pathways"	24th of January 2023	In person
Guadeloupe (France)	**WS 1**: "Climate perception, impacts on the agricultural sector and solutions"	28th of November 2022	In person
	WS 2: "Agricultural sector adaptation governance and investment potential to increase resilience"	30th of November 2022	In person
	WS 3: "Climate perception, impacts on Tourism sector and solutions"	08th December 2022	In person
	WS 4: "Tourism sector adaptation governance and investment potential to increase resilience"	09th December 2022	In person
Galicia (Spain)	**WS 1** "Climate Perception, challenges, and existing solutions"	23rd of September 2022	Online

DEMONSTRATOR	WORKSHOP (WS) TITLE	DATE	FORMAT
	WS 2 "Climate vulnerability, impacts and projections (based on scientific modelling / projections)" "Vision, solutions, and way forward (construction of adaptation pathways)"	27th of January 2023	In person

2.2 Steps to take for workshop organisation

Workshops were organised by local and technical support partners of TransformAr for each demonstrator. To prepare the workshops, partners coordinated the organisation of the workshops. They had to establish key climate challenges of territories and sectors to be addressed. The identification of the relevant stakeholders to contribute to exchanges was a principal key in the preparation process. The interaction framework between stakeholders had to be understood by workshop organisers. The way actors would be involved had to be adapted with the relationship framework. In some cases, actors could be involved in the same workshops while in certain cases, groups of participants were invited separately. For some cases, bilateral meetings had to be organised with some specific actors in preparation of the workshops. It is important to consider all of relationship dynamics between workshops participants before holding the events. When all these preparatory elements were clear, workshop organisers could move on with the preparation of the logistics.

The steps taken by each organiser are summarised in the Figure 3 below.

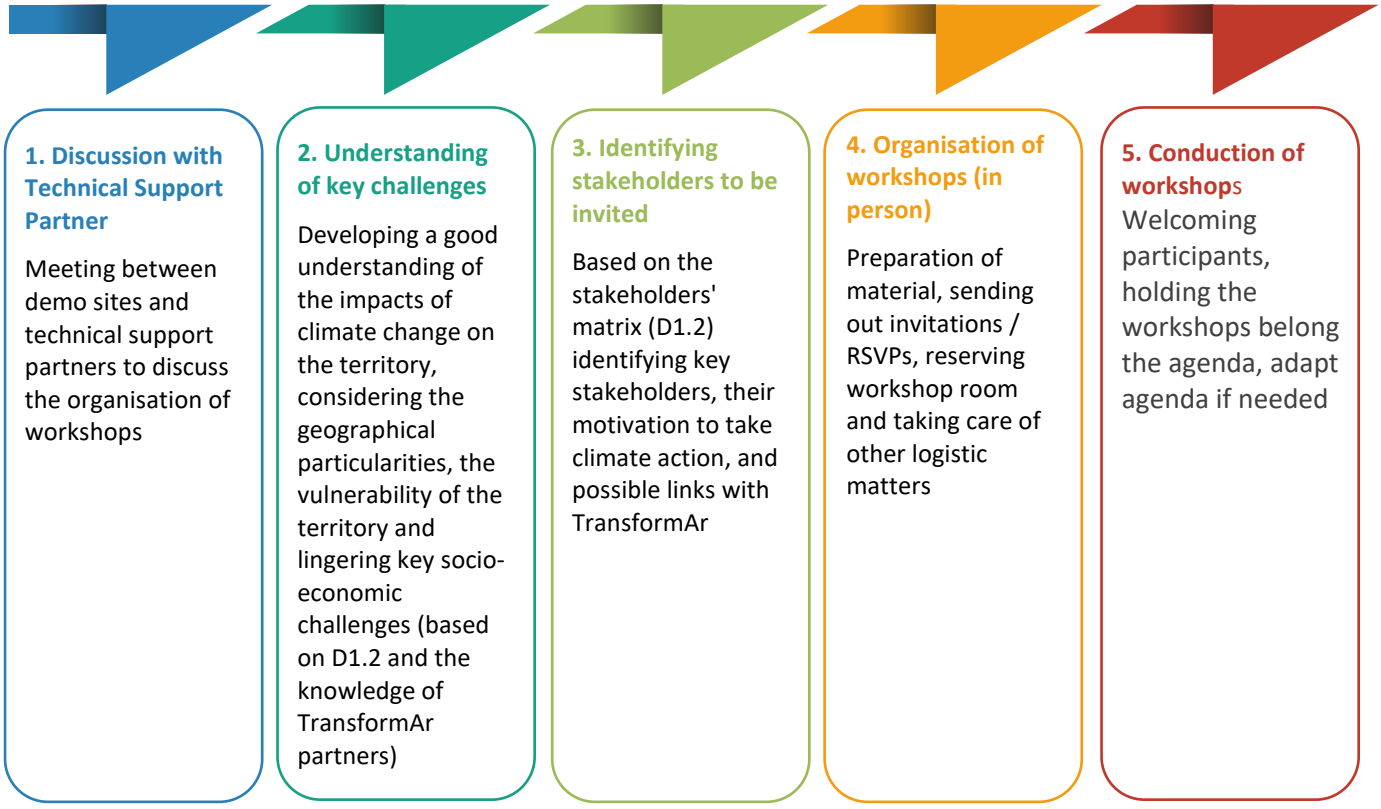

Figure 3. Steps to be taken to prepare workshops

After each workshop, the duo of the technical support organisations and the local partner in the given demonstrator shared a workshop report. Results were then validated by participants and materials used during the workshops were shared.

Each TransformAr demonstrator organised its workshops based on the Playbook methodology. Depending on the context, each partner adapted the methodology and how results would be presented. In the next sections, the methodology adopted, the results including risk chains, impact levels and adaptation pathways are presented per demonstrator.

3.0 WEST COUNTRY REGION, THE UNITED KINGDOM (UK)

3.1 General information on the workshops

The West Country Region (WCR) was the first demonstrator to hold workshops to set up adaptation pathways within WP3 of the TransformAr project. Three workshops were organised online, involving all stakeholders from all Key Community Systems (KCS) identified for the demonstrator: Agriculture, Water management and Biodiversity.

Workshops type	Three full online workshops organised in half-days involving all stakeholders from all KCS in the same workshops
Dates of the workshops	**WS 1:** 18th of February 2022, 9:00 am to 12:00 pm (GMT) **WS 2:** 03rd of March 2022, 9:00 am to 12:00 pm (GMT) **WS 3:** 16th of March 2022, 9:00 am to 12:00 pm (GMT)
Location of the workshop	Online, using Zoom software
TransformAr organisers	ACTERRA, VERHAERT, CMCC and WRT
Key Community System (KCS)	Agriculture, Water management, Biodiversity

The main objective of the process is to set up adaptation pathways for the demonstrator per KCS. To achieve this goal, specific objectives were identified for the three workshops as shown in the Table 2 below.

Table 2. Title and objectives of WP3 workshops in the West Country Region

WORKSHOPS TITLE	OBJECTIVES
Workshop 1: Climate Perception, challenges, and existing solutions (based on local experiences)	Determine the climate perspective of local actors, challenges they face, and existing solutions to overcome these challenges
Workshop 2: Climate vulnerability, impacts and projections (based on scientific modelling / projections).	Add a "scientific layer" to the first workshop (communicating maps, projections, critical thresholds & climate relevant scientific data) which would allow to build the conversation and propose adequate solutions based on solid evidence

WORKSHOPS TITLE	OBJECTIVES
Workshop 3: Vision, Solutions and Way forward (Construction of Adaptation pathways).	Vision, solutions, and way forward (construction of adaptation pathways)

3.2 Workshop organisation

The first workshop in the West Country Region was dedicated to understanding local perceptions of climate change, to identifying challenges faced by stakeholders and existing solutions by using participants' knowledge. The aim of this workshop was to establish Risk chains by KCS. It was organised virtually and due to due to a storm coinciding with the workshop, many people invited were not able to attend as the internet connection in the region was impacted by the weather conditions. 7 participants attended Workshop 1 from different types of organisations: governmental bodies, NGOs, the private sector, etc. To reach the objective of constructing risk chains, the half day was organised as follows: the first part of the workshop aimed to collect elements concerning the risk perception, and risk factors for risk chain components. At this stage, some conceptual inputs were given to participants as well. The second part was organised to develop the risk chain per sector themselves by participants who were divided in a working group. Results were presented and discussed together at the end of the Workshop.

The second Workshop in the West Country Region was held a couple days after the first one (2 weeks between the two workshops). During this session, scientific elements such as climate projections, biophysical impacts of climate change and socio-economic impacts of climate change in the selected KCS were presented by TransformAr scientists' partners. Based on the climate risk and climate impacts local perceptions identified during the first workshop and the scientific inputs, participants identified the prominent risks faced by each sector. 7 persons attended Workshop 2 from different types of organisations: governmental bodies, NGOs, the private sector, etc. 5 out of the 7 participants were present in the first workshop. To reach the fixed objective of the second workshop which was the identification of risk levels and thresholds, the half day was organised as followed: a wrap up of the first workshop was needed at the beginning to refresh participants' minds of. To present the background useful for the next steps of the work to new attendees, scientists from TransformAr presented their research results around climate projections, biophysical impacts of climate change and socio-economic impacts of climate change. Based on this information, participants identified: prominent risks, risk levels and critical thresholds at the end of the workshop.

The last workshop organised in the West Country Region had the ultimate objective to develop step by step the adaptation pathways for each identified KCS. 7 participants attended the Workshop 3. Some persons were already present in the two previous workshops and there were also new persons attending for the first time. To reach the adaptation pathways development objective, a wrap-up of the two last workshop sessions was presented. Then, a conceptual framework was presented to participants to allow them to understand the theoretical aspect of adaptation pathways and transformative adaptation. Interactive sessions were organised to collect all the needed elements to build adaptation pathways for each KCS.

3.3 Results of the workshops

During the first workshop, participants agreed that the West Country Region is already dealing with the impacts of climate change with moderate or heavy impacts. According to them, the current and projected climate conditions are related to heavy rainfall events, floods, extended periods of dry weather, droughts, less difference between seasons, increased droughts, increased storms, rivers warming, ocean warming and acidification, and increased uncertainty around the gulf stream. At the regional scale of the West

Country Region, participants identified existing impacts, potential impacts and risks related to those changes like risk to health for older populations, danger to life from storms, wildfire on the moors, erosion, changing seasonal patterns and impacts to crops. All participants agreed that the climate situation would worsen in the coming 10 years so taking action to manage and to reduce risks and impacts are urgent.

The PIK Institute used data from Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) (https://www.isimip.org/) Phase 3b based on 5 Global Circulation Models (GCMs) of the CMIP 6 family which were used for the latest IPCC report (AR6) for climate projections. The results from 3 emission scenarios (as used in latest IPCC report, AR6) were presented to the participants:

- SSP 1 RCP 2.6 (optimistic)
- SSP 3 RCP 7.0 (business as usual)
- SSP 5 RCP 8.5 (pessimistic)

Climate projections shows that:

- Heavy increase in temperature is foreseen although temperature variability depends on emission scenario. The temperature increase is worse during summer months.
- For rainfall projections, variation seems not too big, but real change is per season (wetter winters, drier summers).
- There is a large uncertainty concerning runoff (surface water availability) – little annual change is projected.
- River flow will see strong decrease all over UK but especially in the West Country Region (WCR) (more in summer and winter).
- Heat stress will also be of major concern (droughts more pronounced in south so WCR will be impacted).
- Wettest day ever was registered in 2020. This situation is to become more likely in the future.
- Sea level rises in WCR will have major impact over next 50 years. WCR is very vulnerable region for this.
- Overall, for WCR: hotter and drier summers, wetter winters will lead to heat stress, droughts and floods will be more prominent.

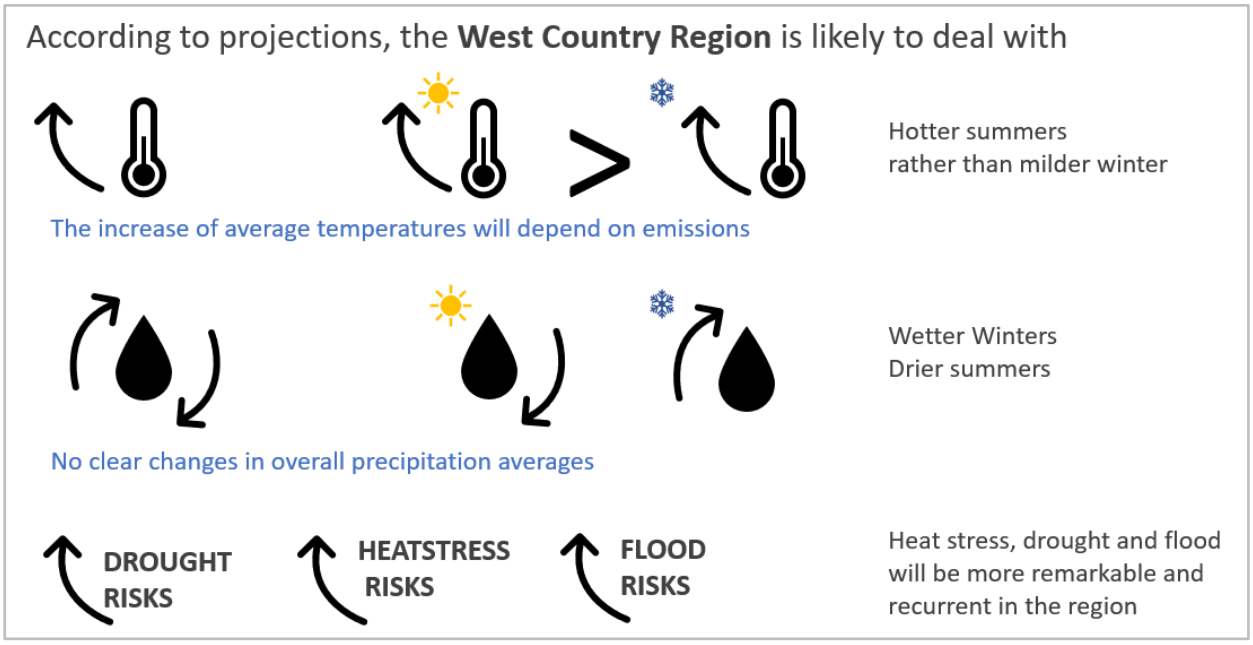

Figure 4. Summary of climate projections for the West Country (Source: PIK presentation during the WS 2)

The main Intermediate impacts of climate change in WCR presented by CMCC show that:

- 2018 drought in UK had big impact on agricultural production.
- Climate change can bring risks and opportunities as advance crop growth, longer growing season, an earlier planting, cash crops for warmer climates The recurrence of summer droughts may limit growth and grain filling.
- There might be a need to change types of crops due to the changing condition of the climate (e.g., maize is more tolerant to droughts than grass)
- For agriculture, heat stress in dairy cattle is projected to increase significantly by nearly 1000% in Southwest England.
- For the soil, future climate condition with 10% increase in winter rainfall may have impact like an augmentation of 150% of soil erosion in wet years. Elevated CO2 and warming will increase nitrogen deposition, abundance of bacteria, fungi in soil.
- Climate change has an impact in the ecosystems. With climate warming (drought, seasonal variations, lower frost risks), species and ecosystems are moving at higher latitude and altitude. There will be an association between species and major changes in species distributions and interactions are expected. Climate change may have alterations in plant as well.

The presentation of E3M concerning socio-economic impacts of climate change shows that the high vulnerability of the region in economic terms, volatile growth rate of agriculture, economic impact will have ramifications beyond the scope of agri-industry and WCR is more at risk than other regions in UK. Based on these elements, participants from the three workshops co-developed a risk chain. They defined the risk levels by sector, and they identified solutions to tackle each risk level. Risk chains, risk levels and adaptation pathways are presented below by sector (agriculture, water management and biodiversity).

3.3.1 Agriculture

3.3.1.1 Risk chain

The risk chain for agriculture sector was developed with 2 participants of the first workshop: local councillor & farmer and a personnel from Natural England – Catchment Sensitive Farming. They identified elements for each component (hazards, exposure, vulnerability, intermediate impact, risks, and socio-economic impacts) of the risk chain.

- **Hazards**: the agricultural sector in WCR is facing increased winter rainfall, heatwaves, and droughts.
- **Intermediate impact (climate impacts):** outwintering of livestock, lack of natural shading for livestock, narrower windows for safety applying fertiliser and other inputs, farm infrastructure and guttering not coping with extreme rainfall, invasive species, maize, and difficulty in harvesting without environmental impact, decreasing slurry storage capacity.
- **Exposure**: elements of exposure identified by participants for the agriculture sector are high proportion of large dairy farms, the number of livestock, the high risk of arable land and the topography.
- **Vulnerability:**
    - **Sensitivity**: risk to water quality, soil risk of runoff, animal types and species.
    - **Lack of adaptation capacities**: uncertainty around future farm support, high reliance on subsidies and uncertainty around future farm support, farmer demographics (age, support, IT ability, broadband) and increasing of inputs costs.

- **Identified risk to be addressed:** decrease in agricultural output / cropping, decrease in productivity of rainfed crops, decrease in productivity of livestock and crops, crops failure and decrease of quality.
- **Socio-economic impacts:** increased food costs for demand side, environmental assurance of milk produce, income loss for farmers and workers in the field and poor public perception of farming for supply side.

The summary of the risk chain for agriculture sector in the West Country Region from the discussion between the participants to the working group is portrayed in the Figure 5 below.

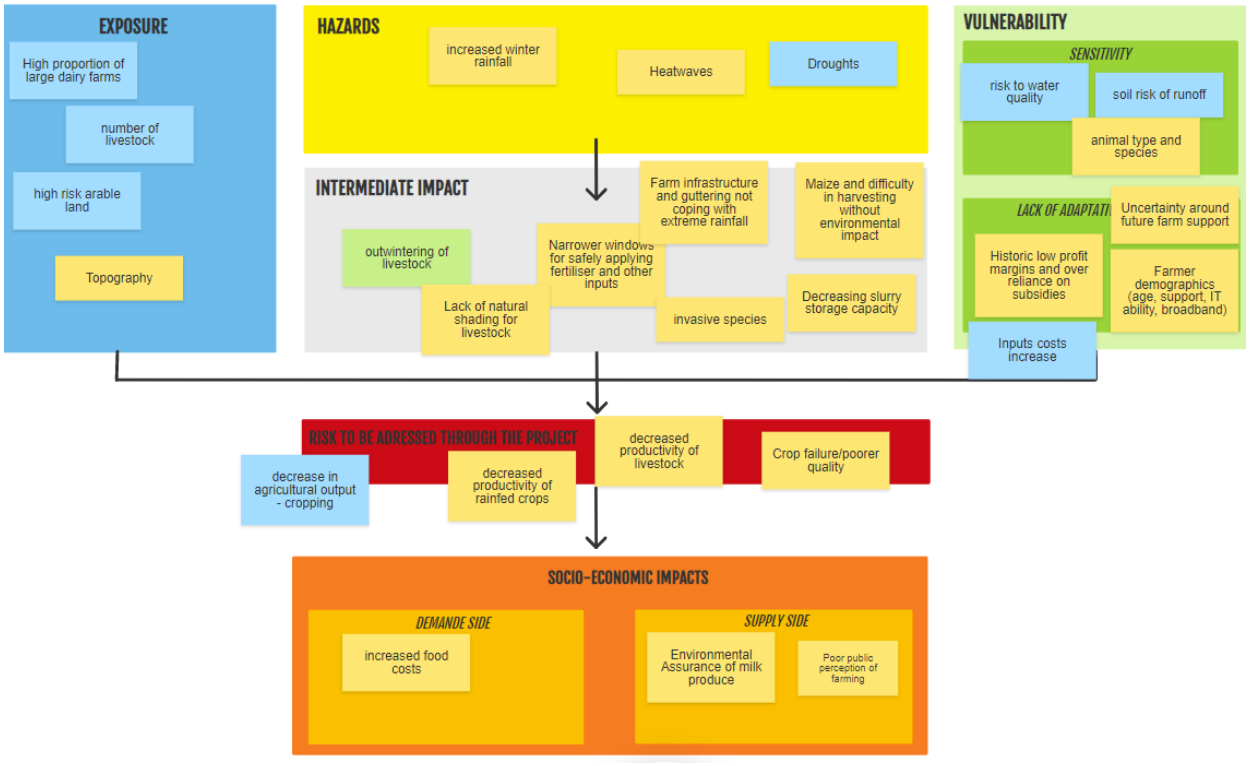

Figure 5. Risk chain for agriculture sector in the West Country Region

The agriculture group had discussions around high phosphate concentrations, the moratorium on development, and Southwest Water dumping in the river. In the discussion, participants stated that agriculture still has a high social reputation but could become critical with increasing pressure.

3.3.1.2 Impact / Risk evolution, indicators, critical threshold

Risk levels were defined during the second Workshop in the West Country Region. The work was done collectively and participants identified the main concern of the sector in the first stage of the discussions.

They agreed that the **most prominent risk to be addressed by the agricultural sector are soil degradation and loss (erosion) due to climate change** which are core components of the agricultural sector. According to participants, the sector and its performance is linked to soil quality and is the bridge to sustainability, productivity, etc. Nonetheless, it is important to note that soil quality degradation is also a result of human activities, regardless of climate change. There are multiple facets to the problem and multiple ways to tackle the issue.

Participants characterised the **four levels of impacts** after the identification of the most prominent risk and characterised them as listed below:

- **Low impact**: soil erosion leading to low level diffuse pollution, lower grass growth and low-level compaction.
- **Medium impact**: soil erosion leading to soil quality deterioration, productivity decline, landslip, and contamination.
- **High impact**: soil erosion leading to field scale soil compaction, loss of soil organic matters, loss of productivity / productivity limited to summer periods, inability to grow annual crops and diffused pollution.
- **Very high impact**: soil erosion leading to wholesale soil loss, land no longer fertile/viable for agriculture practices and serious direct and indirect economic consequences.

Participants identified two **relevant indicators** to assess the risk: **water logging and plant health**.

The summary of the risk impact levels characterised by participants for agriculture sector is shown in the Figure 6 below.

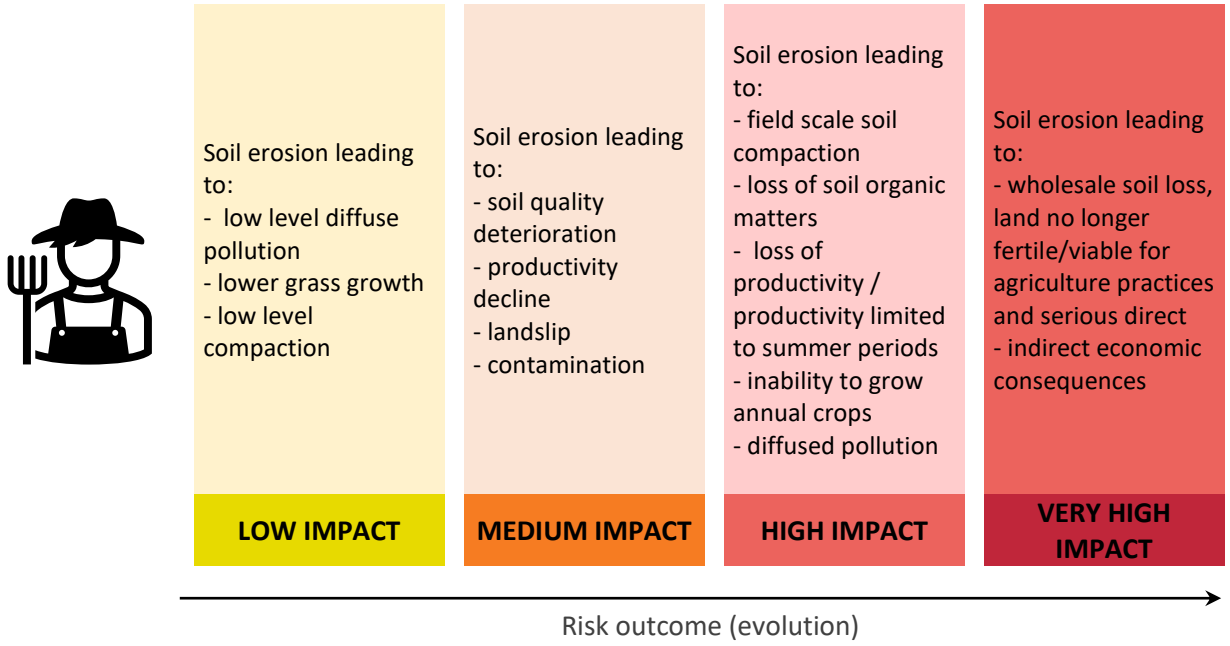

Figure 6. Climate risk levels for agriculture sector in the West Country Region

3.3.1.1 Adaptation desired outcome per impact level

To be able to define actions that could be relevant per impact level, during the third workshop, participants identified the desired outcomes for adaptation for each impact level as shown in the Table 3 below.

Table 3. Climate desired outcomes per impact / risk level for the agricultural sector in WCR

	LOW IMPACT	MEDIUM IMPACT	HIGH IMPACT	VERY HIGH IMPACT
ADAPTATION DESIRED OUTCOME PER IMPACT / RISK LEVEL	- Soils stay within fields - Improve water quality - Better soil structure - Soils with higher soil organic matter	- Maintain yields with reduced inputs and reduced tillage - Develop a system to enable cross slope cultivations as standard practise - Carbon sequestrated in soils - Farmers are obliged/encouraged to record soil health measures on a regular basis	- Increased organic matter to sequester carbon - Reduced need for artificial fertiliser - Increased productivity of soils - Land able to infiltrate rainfall	- Increase soil organic matter by 5% by 2030 - Crops suitable to local climate - Develop a system to enable cross lope cultivations as standard practice

3.3.1.2 Adaptation Pathways

Adaptation pathways were developed during the third workshop for the West Country Region. Participants identified actions that could lead to the adaptation desired outcomes per impact / risk level. Then, they assessed each proposed solution if it is relevant or not according to some criteria (cost, impact of the solution to the environment, danger, etc.). Table 4 below summarises the results of all the work done for the agricultural sector in the West Country Region. It presents: the prominent risk identified, the characterisation of each impact level, the definition of climate desired outcomes per impact / risk level and relevant solutions to be taken per impact level (which can lead to a definition of pathways).

Table 4. Summary of the results of workshops: the most prominent risk, impact/risk levels, climate desired outcomes per impact/risk level, and solutions to adapt to climate change by impact level for agriculture sector in the West Country Region

Addressed Climate-related risk: Soil degradation and loss (erosion) due to climate change			
Soil erosion leading to low level diffuse pollution, lower grass growth and low-level compaction lower growth	**Soil erosion leading to soil quality deterioration, productivity decline, landslip, and contamination**	**Soil erosion leading to field scale soil compaction, loss of soil organic matters, loss of productivity/productivity limited to summer capacity, inability to grow annual crops and diffused pollution**	**High value soil erosion leading to wholesale soil loss, land no longer fertile/viable for agricultural practices**
Low Impact	**Medium Impact**	**High Impact**	**Very High Impact**
Climate desired outcomes per Impact / risk level			
• Soils stay within fields • Improve water quality • Better soil structure • Soils with higher soil organic matter	• Maintain yields with reduced inputs and reduced tillage • Develop a system to enable cross slope cultivations as standard practise • Carbon sequestrated in soils • Farmers are obliged/encouraged to record soil health measures on a regular basis	• Increased organic matter to sequester carbon • Reduced need for artificial fertiliser • Increased productivity of soils • Land able to infiltrate rainfall	• Increase soil organic matter by 5% by 2030 • Crops suitable to local climate • Develop a system to enable cross slope cultivations as standard practice
Relevant solutions to be taken per impact level (that will conduct to the adaptation pathways)			
Low impact farming in water sensitive areas	Develop maps determining vulnerability of agricultural lands to floods, droughts, and other extreme events (does not work at granular local scale)	Develop more sophisticated remote sensing techniques to estimate soil moisture, vegetation, drought stress, etc.	
Change sowing date to adapt to changing weather conditions	Improve crop rotation (to improve nutrients' balance, soil, health and increase biodiversity		
Support women working in the agriculture field and address gender gaps			
Organise roundtable exchanges with farmers and experts in the field			
Pay farmers for conserving the landscape and ecosystems (incentives) → to preserve high value places			
	Insect farming		
Increase awareness on adequate farming practices (supply-side) / probably not very ambitious			
	Promote home gardening and community supported agriculture		
	Top level research development		
	Plant novel crops		
		Plant genetically engineered / modified crops able to withstand extreme weather conditions → controversial	
		Utilise organic farming principles → Climate friendly / regenerative farming, sustainable techniques	
Create habitat zone buffering agriculture from the river			
Indicator: Water logging / Plant health			

3.3.2 Water management

3.3.2.1 Risk chain

The risk chain for the water management sector was developed by 2 participants of the first workshop: a fishery owner and a member of staff from the Cornwall authorities. They identified elements for each component (hazards, exposure, vulnerability, intermediate impact, risks, and socio-economic impacts) of the risk chain for water management sector in the West Country Region.

- **Hazards**: low rainfall periods, increased rainfall, storm surges, changing weather patterns, intense rainfall and rising sea levels.
- **Intermediate impact (climate impacts):** habitat condition deteriorating, domestic and farm pollution, flooding, groundwater becoming salinized, drought, biodiversity impact (habitat for species).
- **Exposure**: agriculture, people, environment / biodiversity, soil management compaction and contamination, heritage assets, water systems are not well connected to the rest of the UK.
- **Vulnerability:**
  - **Sensitivity**: soil health, increase of water demand caused by increasing population, water demand from tourism.
  - **Lack of adaptation capacities**: coastal squeeze, knowledge and skills in soil management and conservation, vulnerability to water restrictions for elderly, elderlies and pensioners living in the area.
- **Identified risk to be addressed:** water quality failures, weak water flows, water shortage.
- **Socio-economic impacts:**
  - **for demand side:** impact on selfish businesses, increased cost of water supply.
  - **for supply side:** reduction of tourism value in the river system.
  - **between demand and supply sides**: crop failure, lack of water for livestock, tourist sector (increase in population water use and wastewater).

The summary of the risk chain for the water management sector in the West Country Region emerging from the discussion between the participants in the group is portrayed in Figure 7 below.

The water group voiced their concern about pollution in the river basin caused by run off due to heavy rainfall events. They presented socio-economic factors increasing the exposure of the territory to climate change to heavy rainfall such as increased in soil impermeabilisation (due to urbanisation), and lack of capacities for soil management. The group highlighted the risk of pollution due to sewage overflows and unsustainable agricultural practices. The pollution has direct impact on water quality with ramifications on shellfish cultivation and the aesthetics of the river area for tourism.

The water group discussed the exposure of rainfed agriculture to droughts and water scarcity. The group expressed its concern of the increased water pressure due to tourism (i.e., tourists are high water consumers). In terms of vulnerability, the group highlighted the lack of adaptive capacity (no inter-basin exchange, no water saving culture) and the sensitivity of elderly to drinking water rationing.

The water group also raised their concern on sea level rise as small coastal communities and infrastructure are situated along the coast and presented the effect of coastal squeeze due to topography: no place for habitats and infrastructure to move inland. The heritage and consolidated settlements are situated around small harbours along the coast (scarce adaptive capacity, will need to relocate on the long run but “nobody does wants to consider this option and people (also participants in the workshop) rely on coping strategies instead”. In terms of vulnerability, the demographic structure reducing adaptive capacity and increasing sensitivity with young and active population moving out and pensioners who want to spend their retirement at the seaside moving in.

The water group elaborated on scarce exposure of ground water to salinisation (drinking water is not extracted close to the coast), but on the nearby Scilly Islands, which are flat, and water scarcity and flooding drive salinisation of natural and artificial (water harvesting) resources. The water group clarified that the people on the Scilly islands have developed a water saving culture people in Cornwall could learn from, see also scarce options for water sharing across the UK due to physical distance and lack of connectivity mentioned above. The group also underlined the sensitivity to water scarcity due to high water consumption in the tourism sector (both on Scilly islands and in Cornwall).

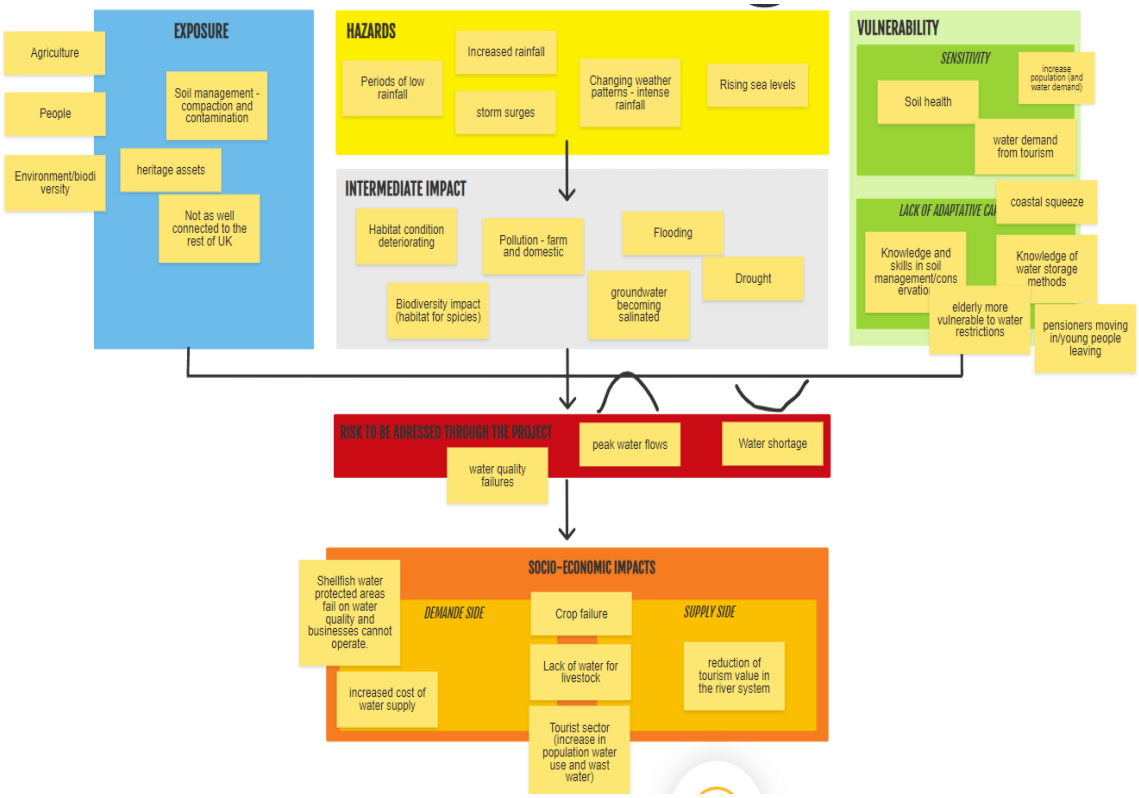

Figure 7. Risk chain for Water management sector in West Country Region

3.3.2.2 Impact / Risk evolution, indicators, critical thresholds

Risk levels were defined during the second workshop in the West Country Region. Participants identified at the first stage the main concern of the sector. They agreed that the **most prominent risk to be addressed by water management sector is the degradation of water quality and decrease in availability due to climate change.**

- **Low impact**: decreased water quality and quantity leading to increased demand for dredging, increased demand on ground water, increased development overwhelming local infrastructure, not meeting some Water Framework Directive targets.
- **Medium impact**: decreased water quality and quantity leading to deficiency of agriculture outputs (increasing demand on imported food) and harmful impacts on human health.
- **High impact**: decreased water quality and quantity leading to significant loss of agriculture output (food shortage), risk to health (e.g., bathing water posing risk to health), loss of species and increased costs of remediation.
- **Very high impact**: decreased water quality and quantity leading to loss of water usability (e.g., for recreation use), breakdown in supply of ground water, loss of soil health and productivity (direct loss of crops) and dead rivers.

A couple of indicators were proposed by participants to assess the water quality degradation: safety for recreation use, river flows, quality standards, mortality rates of fish and biodiversity, eutrophication events in the summer. The **relevant indicator** chosen was **meeting quality standards.**

Detailed Risk impact levels developed by participants for the water management sector in the West Country Region is shown in the Figure 8 below.

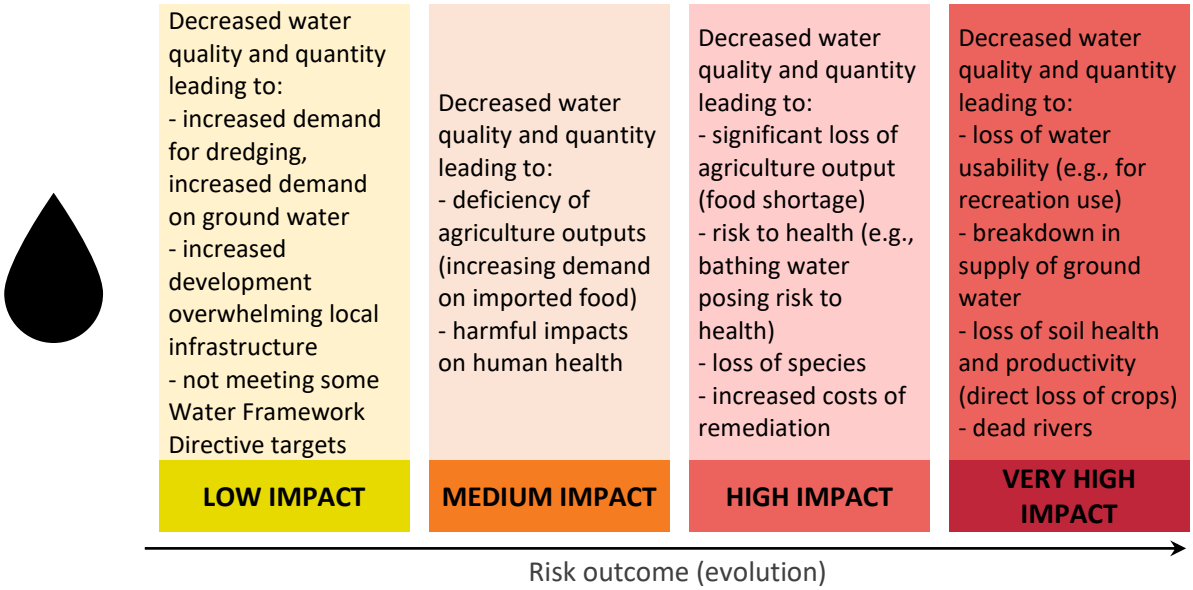

Figure 8. Climate impact / risk levels for water management sector in the West Country Region

The critical thresholds were defined as follow:

Moving from low to medium impact/risk:

- Phosphate levels > 40 ug/L (SAC threshold NE Camel)
- Water quantity daily mean flow (m^3/s) river Camel at Dunmere below 0.7 m^3/s for extended periods

Moving from medium to high impact/risk:

- Phosphate levels > 50 ug/L WFD threshold
- Water quantity daily mean flow (m^3/s) river Camel at Dunmere below 0.5 m^3/s for extended periods

Moving from high to very high impact/risk:

- Phosphate levels > 70 ug/L elevated
- Water quantity daily mean flow (m^3/s) river Camel at Dunmere below 0.4 m^3/s for extended periods

3.3.2.1 Adaptation desired outcome per impact level

To be able to define actions that could be relevant per impact level, during the third workshop, participants identified the adaptation desired outcomes for each impact level as shown in the Table 5 below.

Table 5. Climate desired outcomes per impact / risk level for the water management sector in WCR

	LOW IMPACT	MEDIUM IMPACT	HIGH IMPACT	VERY HIGH IMPACT
ADAPTATION DESIRED OUTCOME PER IMPACT / RISK LEVEL	- Measurable organic matter - Water quality meeting SAC regulations	- Reduced number of properties at flood risk - Meeting WFD - Sufficient water quantity in summer - Retain nutrients in the fields	- Widespread natural flood mitigation / defence - Rivers with lower sediment loadings	Low water turbidity in streams and main rivers

3.3.2.2 Adaptation Pathways

Adaptation pathways were developed during the third workshop in the West Country Region. Participants identified actions that can lead to the desired adaptation outcomes for each impact / risk level. Then, they assessed each proposed solution if it is relevant or not according to some criteria (cost, impact of the solution to the environment, danger, etc.). Table 6 below summarises the results of all the work done for the water management sector in the West Country Region. It presents: the prominent risk identified for the sector, the characterisation of each impact / risk level, critical thresholds, the definition of climate desired outcomes per impact level and relevant solutions to be taken per impact level (which can conduct to a definition of pathways).

Table 6. Summary of the results of workshops: the most prominent risk, impact/risk levels, climate desired outcomes per impact/risk level, critical thresholds, and solutions to adapt to climate change by impact level for water management sector in the West Country Region

Addressed Climate-related risk: Degradation of water quality and decrease in availability due to climate change			
Decreased water quality and quantity leading to increased demand for dredging and increasing demand on ground water	**Decreased water quality and quantity leading to deficiency of agricultural outputs (resulting in increasing demand on imported food from overseas) and harmful impacts on human health**	**Decreased water quality leading to significant loss of agricultural output (food shortage), risk to health (e.g., bathing water posing risk to health), loss of species and increased costs of remediation**	**Decreased water quality and quantity leading to the loss of water usability (e.g., for recreational use), the breakdown in supply of ground water, loss of soil health and productivity (direct loss of crops and agricultural outputs) and dead rivers**
	- Phosphate levels > 40 ug/L (SAC threshold NE Camel) - Water quantity daily mean flow (m3/s) river Camel at Dunmere below 0.7 m3/s for extended periods	- Phosphate levels > 50 ug/L WFD threshold - Water quantity daily mean flow (m3/s) river Camel at Dunmere below 0.5 m3/s for extended periods	- Phosphate levels > 70 ug/L elevated - Water quantity daily mean flow (m3/s) river Camel at Dunmere below 0.4 m3/s for extended periods
Low Impact	**Medium Impact**	**High Impact**	**Very High Impact**
Climate desired outcomes per Impact / risk level			
• Measurable organic matter • Water quality meeting SAC regulations	• Reduced number of properties at flood risk • Meeting WFD • Sufficient water quantity in summer • Retain nutrients in the fields	• Widespread natural flood mitigation / defence • Rivers with lower sediment loadings	Low water turbidity in streams and main rivers
Relevant solutions to be taken per impact level (that will conduct to the adaptation pathways)			
Improve catchment management to improve water quality			Relocating vulnerable / exposed population
Improving skills in land management			
Public ownership of water companies			
Developing sustainable drainage systems			
	Soft defences (e.g., Wetland rehabilitation or managed retreat) (risks affecting local livelihoods)		
		Installing water storage systems	
Improving water regulations			
Natural flood management (e.g., Wetland creation to buffer peak flows, improve water quality and increase water storage capacity)			
Education awareness raising			
Decentralisation			
Indicator: meeting quality standards			

3.3.3 Biodiversity

3.3.3.1 Risk chain

The risk chain for the sector of Biodiversity was developed by 2 participants of the first workshop from Cornwall government. They identified elements for each component (hazards, exposure, vulnerability, intermediate impact, risks, and socio-economic impacts) of the risk chain for the sector as shown below:

- **Hazards**: heavy rainfall events, drought, changing seasonal weather
- **Intermediate impact (climate impacts):** localised flood, increased run-off, eutrophication, invasive species
- **Exposure**: local fisheries, wetland species, climate sensitive habitats and species.
- **Vulnerability:**
    - **Sensitivity**: lack of natural floodplain extent, development, wetland extent, policies could be improved
    - **Lack of adaptation capacities**: adaptive capacities not defined, payments for ecosystem services, lack of data.
- **Identified risk to be addressed:** peak water flows, loss and reduction of number of species, public and stakeholder perceptions of biodiversity, increase in phosphate level, loss of biodiversity.
- **Socio-economic impacts:**
    - **for demand side:** impact on Tourism sector, loss of resilience
    - **for supply side:** crop failure, impact on productivity of the land (through loss of biodiversity), planning consent.
    - **between demand and supply sides**: high value habits and green spaces.

The summary of the risk chain for biodiversity sector in the West Country Region emerging from the discussion between the participants to the group work is portrayed in the Figure 9 below.

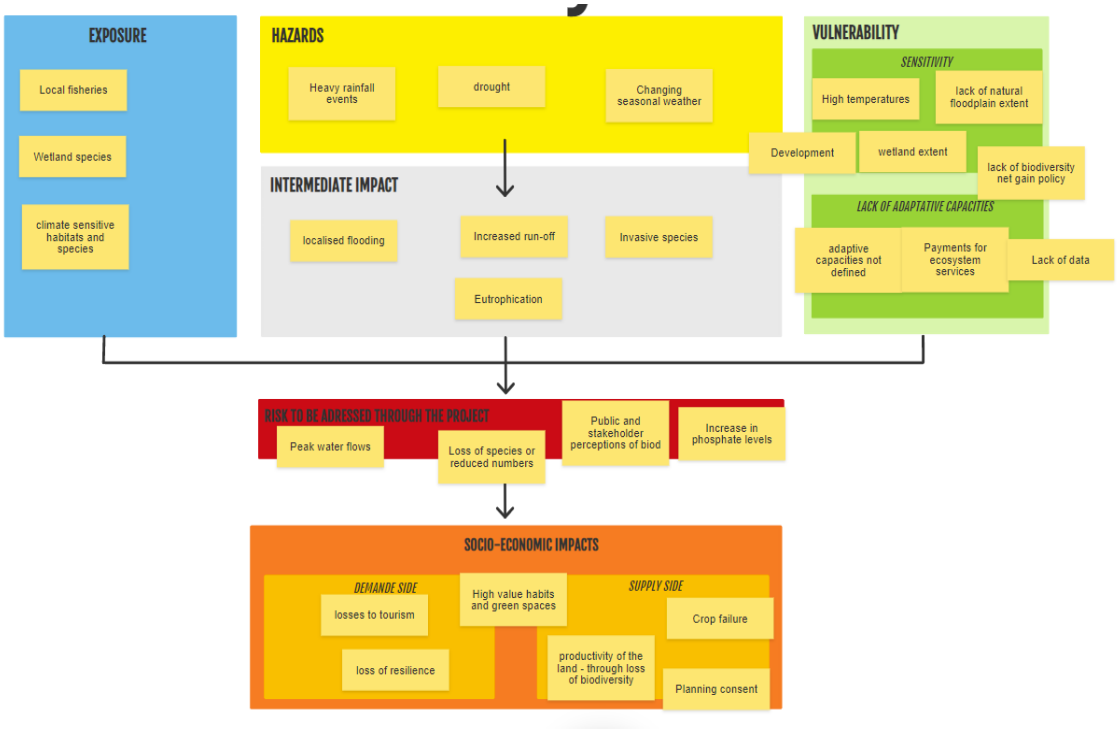

Figure 9. Risk chain for Biodiversity sector in the West Country Region

3.3.3.1 Impact / Risk evolution, indicators, critical thresholds

Risk levels were defined during the second workshop in the West Country Region. Participants identified at the first stage the main concern of the sector. They agreed that the **most prominent risk to be addressed by the sector of biodiversity is ecosystem function collapse due to climate change** which leads to biodiversity loss or extinction of species which can damage the population of other plants and animals, and which leads to the decline of marine ecosystems.

- **Low impact**: ecosystem function deterioration leading to impacts on habitats, reduced number of some species, perturbation to the functioning system.
- **Medium impact**: ecosystem function deterioration leading to lower genetic diversity of species and change in species dominance (e.g., due to migration, etc.).
- **High impact**: ecosystem function deterioration leading to increased stress of invasive species, loss of recreation, impact on value of fisheries.
- **Very high impact**: ecosystem function deterioration leading to loss of habitats and species mortality.

A couple of indicators were proposed by participants to assess the water quality degradation: habitats and protected sites are in poor health, stress on agriculture productivity could lead to less habitat protection on farms, habitat loss and fragmentation, mortality rate of species, eutrophication and biodiversity loss, percentage of habitat loss, degree of level of perturbation of a system. The **relevant indicators** chosen were **species extinction rate and wetland surface change.**

The critical thresholds were defined as follow:

- **Moving from low to medium impact/risk:** Current wetland surface (potential to be mapped on the Camel)
- **Moving from medium to high impact/risk:** 20% loss of wetland surface from current baseline
- **Moving from high to very high impact/risk:** > 40% loss of wetland from current baseline

Risk impact levels for the sector of Biodiversity in the West Country Region is summarised in the Figure 10 below.

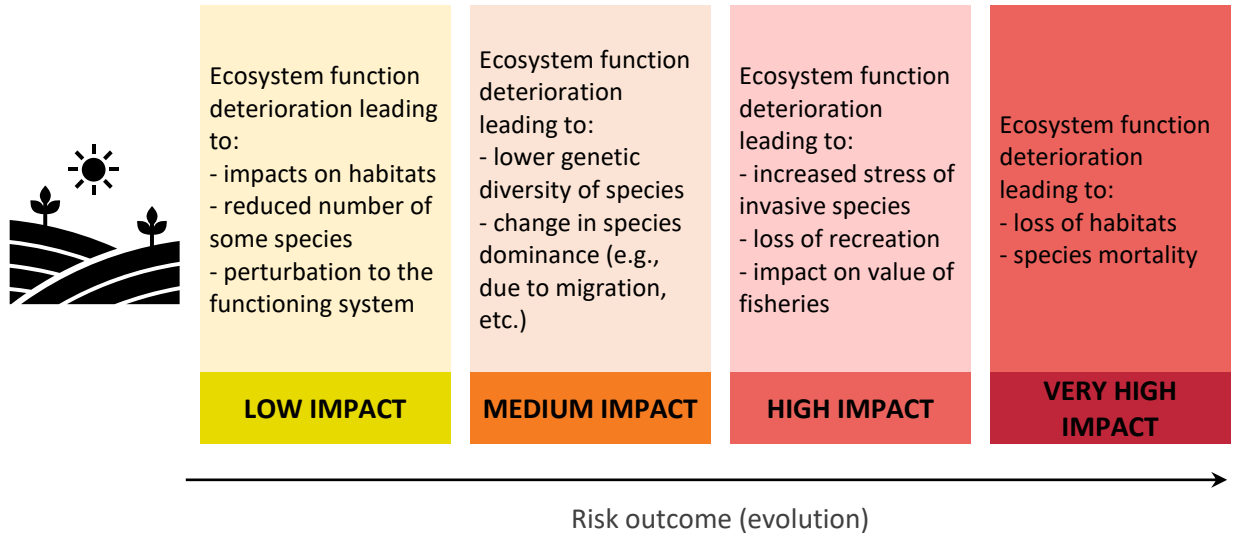

Figure 10. Climate impact / risk levels for the sector of Biodiversity in the West Country Region

3.3.3.1 Adaptation desired outcome per impact level

To be able to define actions that could be relevant per impact/risk level, during the third workshop, participants identified the adaptation desired outcomes for each impact level as shown in the Table 7 below.

Table 7. Climate desired outcomes per impact / risk level for the Biodiversity sector in WCR

	LOW IMPACT	MEDIUM IMPACT	HIGH IMPACT	VERY HIGH IMPACT
ADAPTATION DESIRED OUTCOME PER IMPACT / RISK LEVEL	- Halt decline - Space for nature in the urban environment	- Diverse & robust populations of salmon and other fish species - Maintain and increase areas of high biodiversity - Landscape nature recovery	- Maintain and increase areas of high biodiversity - Landscape nature recovery - Healthy riparian habits with diverse species mix	Healthy riparian habits with diverse species mix

3.3.3.2 Adaptation Pathways

Adaptation pathways were developed during the third workshop in the West Country Region. Participants identified actions that can lead to the desired adaptation outcomes for each impact / risk level. Then, they assessed each proposed solutions if it is relevant or not according to some criteria (cost, impact of the solution to the environment, dangerousness, etc.). Table 8 below summarises the results of all the work done for the Biodiversity sector in the West Country Region. It presents: the prominent risk identified for the sector, the characterisation of each impact / risk level, critical thresholds, the definition

of climate desired outcomes per impact level and relevant solutions to be taken per impact level (which can conduct to a definition of pathways).

Table 8. Summary of the results of workshops: the most prominent risk, impact/risk levels, climate desired outcomes per impact/risk level, critical thresholds, and solutions to adapt to climate change by impact level for Biodiversity sector in the West Country Region

Addressed Climate-related risk: Ecosystem function collapse due to climate change			
Ecosystem function deterioration leading to impacts on habitats (i.e.., not meeting favourable status assessments such as special sites of scientific interest), are reduced numbers of some species and perturbation to the functioning systems	**Ecosystem function deterioration leading to lower genetic diversity of species and change in species dominance (due to migration)**	**Ecosystem function deterioration increasing the stress of invasive species, leading to loss of recreation, and impacting value of fisheries**	**Ecosystem function deterioration leading to loss of habitats and species mortality**
Current wetland surface (potential to be mapped on the Camel)	20% loss of wetland surface from current baseline	> 40% loss of wetland from current baseline	
Low Impact	**Medium Impact**	**High Impact**	**Very High Impact**
Climate desired outcomes per Impact / risk level			
• Halt decline • Space for nature in the urban environment	• Diverse & robust populations of salmon and other fish species • Maintain and increase areas of high biodiversity • Landscape nature recovery	• Maintain and increase areas of high biodiversity • Landscape nature recovery • Healthy riparian habits with diverse species mix	Healthy riparian habits with diverse species mix
Relevant solutions to be taken per impact level (that will conduct to the adaptation pathways)			
Restore wetland and water retention features (e.g., Wider buffers/riparian zones)	Build new reservoirs and water ponds	Re-conversion of communal forests into climate-tolerate mixed forests / re-conversion of arable land into waterlogged grasslands	
Development of payment and support systems (this has an expiry date, to which date would support systems last ?)			
Raising education and awareness			
Support for regenerative / organic farming			
	Connecting, expanding, and restoring ecological spaces in catchments, on land (green framework) and in the aquatic environment (blue framework)		
	Increasing biodiversity embraced by non-agriculture sectors		
		Introduction or reintroduction of a type of species (This comes at a later stage after improving the habitat)	
Decentralisation			
Indicator: species extinction rate and wetland surface change			

4.0 ORISTANO, ITALY

4.1 General information on the workshops

Oristano was the second demonstrator which conducted workshops to set up adaptation pathways. Two half-days sessions were organised, involving all stakeholders from all Key Community Systems (KCS) identified for the demonstrator: Agriculture and Fisheries. The planned dates of the workshop, foreseen in September 2022, were changed due to a fishing festival organised by the local stakehoders. The new dates were chosen based on the availability of members of the fishing consortium and other important stakeholders. Workshops were held in person.

Workshops type	2 half-days in-person workshops, involving all stakeholders of all KCS
Date of the workshops	**WS1:** 11th of October 2022, 15:00 pm to 18:30 pm **WS2:** 12th of October 2022, 15:00 pm to 18:30 pm
Location of the workshops	Museo del Mare di Marceddì, Sardinia, Italy
TransformAr organisers	CMCC and MEDSEA
Key Community Systems (KCS)	Agriculture and Fisheries

The main objective of the process is to co-construct adaptation pathways, made up of a sequence of decision-points and measures allowing for decision-making under uncertainty in Oristano based on local and scientific expertise. For the Oristano demonstrator, adaptation pathways were developed at territorial level and not per KCS. To achieve the goal, specific objectives were identified for the two workshop sessions as shown in the Table 9 below.

Table 9. Title and objectives of WP3 workshops in Oristano

WORKSHOPS TITLE	OBJECTIVES
Workshop 1: Climate Perception, challenges, and existing solutions	Determine the climate perspective of local actors, challenges they face, and existing solutions to overcome these challenges
Workshop 2: Climate vulnerability, impacts and projections; Vision, Solutions and Way forward	Add a "scientific layer" to the first workshop which would allow to build the conversation and propose adequate solutions based on solid evidence

4.2 Workshop organisation

Only a portion of invited people attended the workshop, due to the overlap with several other activities (especially for public authorities). Stakeholders were involved through the consortium that groups the various fishing cooperatives operating in the lagoon, in a manner similar to that used in agriculture. However, despite the support of the coordinator of the consortium and other local stakeholders, the fishermen did not participate in the initiative, although they had guaranteed their presence. The climate favourable to fishing, the limited direct (personal) knowledge of the organisers and the lack of perception of the direct benefits of the project probably diminished interest in the event. Ten invited persons apologised for not coming and beside TransformAr partners, seven people participated in the workshops, representing 2 sectors: Agriculture and Fisheries. Participants in the workshops included representatives of local authorities (the mayor and assessors from municipalities around the lagoon) and the regional level, and SME working in the agriculture sector, an expert for the fisheries sector, a representative from an association of farmers and a farm owner.

The first workshop aimed to co-construct risk chains based on local perceptions. To reach the goal, the half-day workshop was organised as followed: presentation of the difference between adaptation and mitigation, a conceptual presentation of the risk chain with its components, then a presentation of existing solutions to deal with climate change adaptation.

The second day workshop in Oristano had the objective to co-develop adaptation pathways with stakeholders. For this purpose, scientific inputs on climate projections, biophysical impacts of climate change and socio-economic impacts of climate change in Oristano were presented to participants by scientists from TransformAr as an introduction to the working session to define thresholds, objectives, and prioritisation of solutions.

4.3 Results of the workshops

The PIK Institute used data from Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) (https://www.isimip.org/) Phase 3b based on 5 Global Circulation Models (GCMs) of the CMIP 6 family which were used for the latest IPCC report (AR6) for climate projections. The results from 3 emission scenarios (as used in latest IPCC report, AR6) were presented to the participants:

- SSP 1 RCP 2.6 (optimistic)
- SSP 3 RCP 7.0 (business as usual)
- SSP 5 RCP 8.5 (pessimistic)

For Oristano, climate projections show that:

- Average temperatures will increase in the future and the level of warming depends on the emission scenarios.
- The temperature increase will be higher in summer (+ 1.5 °C in Aug) than in winter (+ 0.7 °C in Feb).
- Small decrease in rainfall is expected.
- There is no clear intra-annual pattern for precipitation. Large uncertainties in projections (with differences in foreseen patterns originating primarily from different climate models rather than from different emission scenarios).
- Related to heat stress, projections show that in the future, there will be an increase in the:
    - number of **summer days** (Tmax > 25 °C): **+ 15 %** (9 – 28 %)
    - number of **tropical nights** (Tmin > 20 °C): **+ 60 %** (37 – 100 %)

- number of **warm spells** (at least 6 consecutive days with very high temperatures): **+ 284 %** (146 – 570 %)
- number of months under **meteorological drought**: **+ 33 %** (-20 – 71 %)
- number of months under **hydrological drought**: **+ 28 %** (-43 – 289 %)

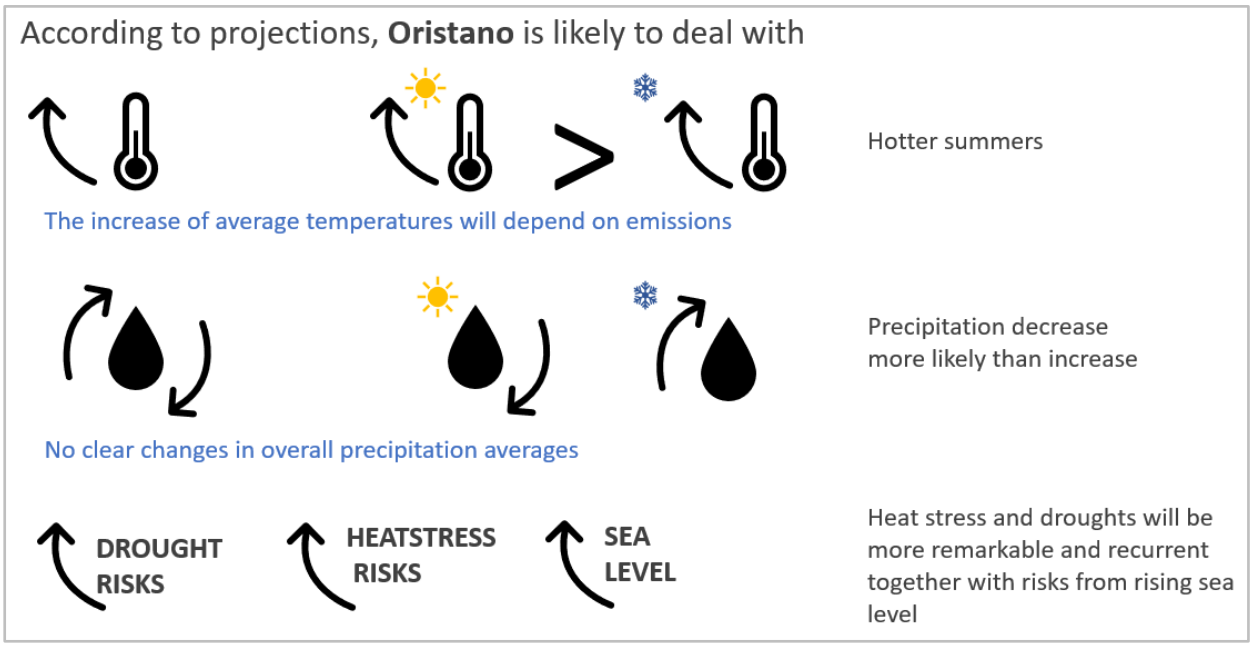

Figure 11. Summary of climate projections for Oristano (Source: PIK presentation during the WS 2)

Climate change has and will have biophysical and socio-economic impacts in Oristano. Based on the presentation of E3M, the socioeconomic impacts of climate change in Sardinia have been assessed in the context of the SOCLIMPACT project. Climate change impacts were assessed under two alternative climatic scenarios (RCP2.6 and RCP8.5). The study focused on blue economy sectors: Tourism, Energy and Maritime transport. For Sardinia, the cumulative GDP losses (over the period up to 2100) impacts were found to be equal to 1.1% in the RCP2.6 and 3.4% in the RCP8.5. In the framework of TransformAr project, E3M will assess the socioeconomic impacts of climate change for the Oristano region and will capture both the direct and indirect effects on the local economy stemming from changes in specific sectors (e.g., agriculture, tourism) and infrastructure developments.

4.3.1 Risk chain

Participants to the first day workshop developed the risk chain for the territory of Oristano.

Figure 12. Discussion during the establishment of the risk chain

They identified elements to characterise each component of the Risk chain (hazards, exposure, vulnerability, and risk) as described below:

- **Hazards:** the main climate hazards identified by stakeholders are change of precipitation patterns, increase in mean temperature, extreme temperature, sea level rise, increasing of sea surface temperature. The mayor noted that during the previous lunar cycle the waves increased a lot, flooding some street and houses.
- **Exposure:** the lagoon ecosystem is exposed to an increasing variation in salinity, and an increase in sedimentation and pollution due to higher amounts of freshwater entering the lagoon via the river following heavy precipitation events and an intervention is envisaged to improve circulation between mouth and sea area. Agriculture is developed on reclaimed surfaces at an elevation close to sea level making it more exposed to saltwater infiltration due to sea level rise. Saltwater infiltration into aquifers is a common issue along all Sardinia coasts, a risk which is enhanced due to water extraction from aquifers during recurring drought periods; moreover, water from aquifer is largely used to feed cattle in the area. The small coastal settlement (mainly seasonal) is already affected by coastal inundation from storm surges; sea level rise increases exposure.
- **Vulnerability:** the vulnerability component was characterised by sector:
    - **Agriculture**

Agriculture is the main economic activity in the area around the lagoon while tourism has a minor role. Recreational fishing is not allowed in productive lagoons where fishing cooperatives operate, who have the concession of the area by the region of Sardinia. Some birdwatching and photography recreational activities are carried out in the area by single person or small local association. Currently, no ecotourism activities are developed in the area.

Agriculture is dependent on surface water fed irrigation; changing precipitation patterns affect the availability of surface water used for irrigation (surface water for irrigation is managed at a regional level using interconnected reservoirs).

The crops grown are sensitive to changes in temperature and salinity.

The species of cattle typically used in dairy farming is not well suited for hotter weather conditions, producing less milk.

- **Marine and fisheries**

Fishing inside the lagoon is a traditional activity managed by several cooperatives merged in a larger consortium. Mullet, seabass, and seabream are the most important species, but the area is especially known for a native clam, severely affected by overfishing and changes in salinity due to extreme rainfalls and extremely high temperatures. Fishing production is mainly addressed to local market, especially restaurants.

Invasive species are entering and survive in the lagoon and coastal areas due to warmer water temperatures, which are allowing for a shift in the composition of the ecosystem and species available for fisheries. Some species used as bait are no longer available (intermediate impact).

In San Giovanni Pond, water quality is affected by pollutants and solids from the river flowing through the mining area upstream during heavy precipitation events.

- **Heat and wellbeing**

The residents are vulnerable to extreme heat but have traditional resources which help them to cope (i.e., limited outdoor activity during the hottest hours of the day, use of shading inside buildings, etc.).

The small coastal settlement includes historical buildings with cultural significance for the wider regional population; loss of the lagoon area would affect regional cultural identity.

- **External drivers of vulnerability**

Lack of management of the lagoon, also including the infrastructure (bridge) used as the only connection to cross both sides of the lagoon, poor management of riparian areas and canals reduce water exchange between the lagoon and the open sea

The risk chain for Oristano is presented in Figure 13 below.

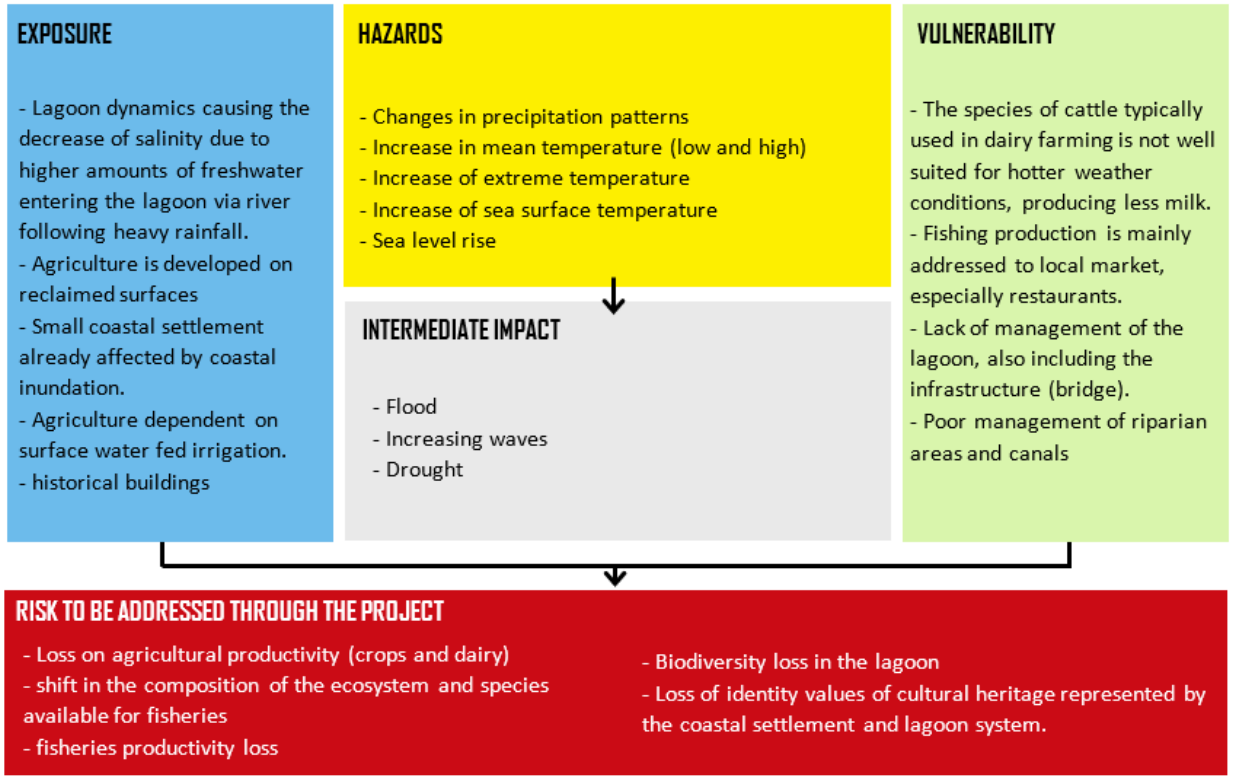

Figure 13. Risk chain for Oristano (all sectors included)

4.3.2 Impact / Risk evolution, indicators, critical thresholds

During the workshops for the Oristano demonstrator, there were difficulties with the identification of critical threshold indicators. These are extremely dependent on individual farmers' conditions although critical thresholds are being reached and transformation is starting at individual/farm level, while fishermen did not yet reach a state where practical experience with critical thresholds was made, adaptation solutions were considered in terms of generic rating of impacts (low, medium, high, and very high risks).

4.3.3 Adaptation vision

Participants from the workshops identified the vision of **maintaining the characteristics of the area as a flourishing agricultural area, and the conservation of the lagoon as a crucial part of the cultural identity**. The agricultural sector is already preparing for different climate conditions, the fisheries sector relies on measures to ensure the stability of the lagoon under changing climatic conditions and is gradually adapting to shifts in species and targeting invasive species as new products for the market.

4.3.4 Adaptation pathways

Solutions to address the four risk levels were identified by participants of the second workshop in Oristano. They are presented in the Table 10 below. Solutions are specified by risk/impact levels and by type (incentives/ governance / management, communications & roundtable, research & innovation, technical / engineered solutions, green / nature-based solutions) and by sector as well (biodiversity, marine and water, agriculture, other). All sectors are included. It should be noted that, with regards to biodiversity and conservation of coastal wetlands, all municipalities, the province and the Regional authorities alongside with the Reclamation Consortium engaged in a "Coastal Wetlands Contract" since 2021, aiming at improving protection of the peculiar coastal wetlands.

Table 10. Solutions for adaptation to climate change by impact level in Oristano (all sectors included)

Adaptation vision: maintaining the characteristics of the area as a flourishing agricultural area, and the conservation of the lagoon as a crucial part of the cultural identity				
	Durability/viability of solutions			
Types of adaptation solutions	Low Impact	Medium Impact	High Impact	Very High Impact
	Solutions by impact level			
Incentives / Governance / Management	Adopt rules for biodiversity conservation			
	Creation of marine and terrestrial protected areas (with a single governing entity)			
		Encourage diversification of economic activities (multifunctional enterprises in fisheries)		
		Shifting periods of agriculture production		
		Diversification of the cultivation and selection of plants and breeding of livestock/fisheries		
	Flood risk map for agriculture			
Communications & roundtable exchanges	Sensitisation on climate change impacts on sectors			
	Promote sustainable fishing techniques			
	Increase knowledge on climate resilience of plants to drought and flooding			
Research & Innovation	Monitoring water quality and biodiversity			
	Improve knowledge on vulnerability of agriculture soils to extreme events			
	Mapping of groundwater for vulnerability to saltwater intrusion			
	New agriculture methods and techniques for new climate conditions			
Technical / Engineered solutions	Project for the requalification of the ecological connections and the reduction of habitat fragmentation in the San Giovanni-Marceddì wetland compendium and the Corru S'Ittiri pond to restore the ecological connections within the water bodies			
	Installation of a system of smart barriers to protect the lagoon from freshwater from the river			
		Precision agriculture for irrigation and crop management (drone)		
		Technological innovation for water freshwater treatment (Geolana/Geowool to absorb and biodegrade oil spill in boats)		
Green / Nature-based solutions		Development and enhancement of soft defence areas (wetlands)		
		Development of landscape for water retention		
		Phyto depuration to reduce water pollution		
Indicator:				

Green: Biodiversity; Blue: Marine and water; Brown: Agriculture (groundwater); Grey: other

5.0 EGALEO, GREECE

5.1 General information on the workshops

Egaleo was the third demonstrator that conducted workshops to set up adaptation pathways. A one-day in person workshop was organised with involvement of all stakeholders from all Key Community Systems (KCS) identified for the demonstrator: Urban planning and Social services. A one-day format was chosen to avoid the multiple invitations of participants.

Workshop type	One-day in-person workshop, involving all stakeholders from all KCS
Date of the workshop	10th of October 2022, 9:30 am to 17:00 pm (EEST)
Location of the workshop	Innovation Hub, Thivon 268, Egaleo, 12241, Greece
TransformAr organisers	Municipality of Egaleo & NCSR "Demokritos"
Key Community System (KCS)	Urban planning and Social services

5.2 Workshop organisation

Participants to the workshop are from diverse organisation types: municipality, governmental bodies and agencies, school personnel, researchers, association, etc. They brought their specific knowledge from a range of sectors (social services, infrastructure, urban planning, education, climate change, health, climate risk, water management). For the demonstrator of Egaleo, solutions were defined per prominent risk.

5.3 Results of the workshops

5.3.1 Risk chain

Participants to the workshop developed the risk chain for the City of Egaleo. They identified elements to characterise each component of the Risk chain (hazards, exposure, vulnerability, and risk).

Figure 14. Group exercise to develop risk chain in Egaleo.

The characterisation of each risk chain component is presented below.

- **Hazards:** The participants identified 7 climatic hazards, which according to their opinion and personal experience are the most prominent in the area of Egaleo and Western Athens region in general. Theses hazards are:
  - Extreme rainfall / Storms
  - Earthquakes
  - High Winds
  - Heatwaves
  - Fires
  - Floods
  - Drought

Based on the number of responses, it is evident that the most prominent hazard (39%) are heatwaves, with floods to be the second most prominent hazard (22%), as shown in Figure 15 (left).

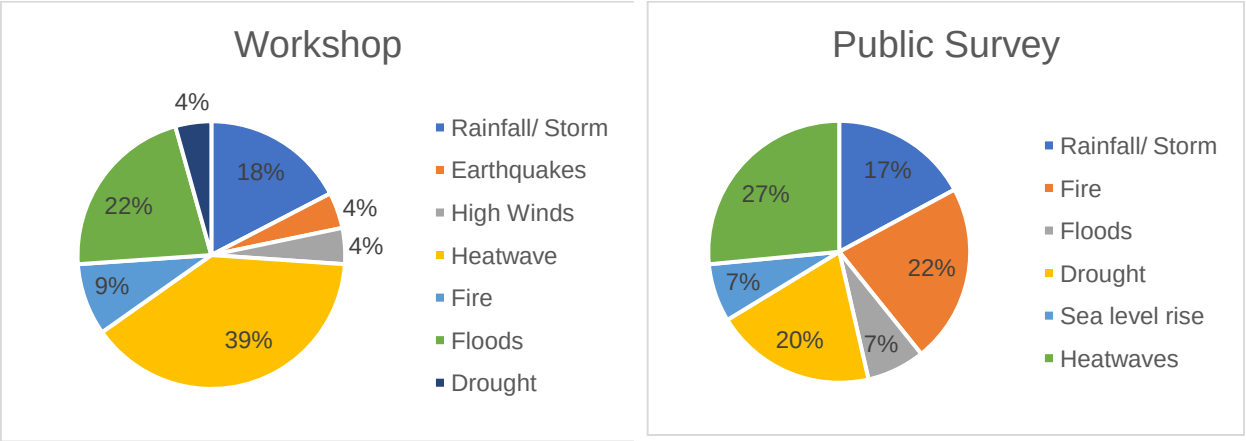

Figure 15. Climatic Hazards int the Egaleo Area. Comparison between Workshop results (left) and public survey (right)

The workshop results were also compared with the public survey conducted as part of the people engagement campaign during the European Mobility week, with **Heatwaves** also to be the most prominent hazards for the area.

- **Exposure:** Given the responses of the participants, and their backgrounds, their main focus what solely on population composition. As shown in Figure 16 (left), the participants believe that the population of children and elderly increase the exposure of Egaleo. These responses are in combination of additional parameters. Such parameters are the condition and the age of existing infrastructure and the increase of extreme events.

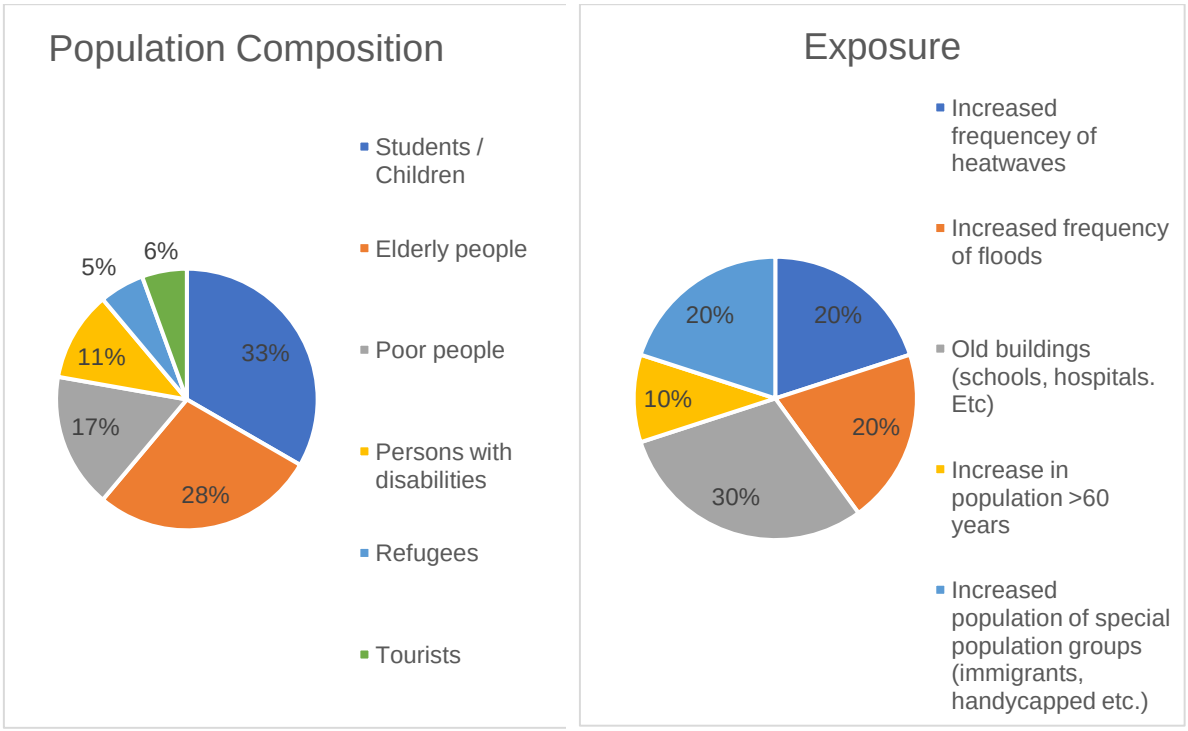

Figure 16. Exposure in the Egaleo Area

- **Vulnerability:** the vulnerability of the city of Egaleo is based on the combination of the population and the effect of extreme events and their effects on it and the existing infrastructure. The majority of the schools, social services, and elderly homes in the area are lacking modern thermal isolation and there is absence of air-conditioning. The teachers and psychologists, who took part in the workshop, indicated that students are unable to concentrate in classroom when **extreme temperatures** are reached (summer or winter), causing them to underperform. In addition to that, especially in the winter, due to either **extreme weather events** or poor school isolation, the students' health is negatively affected. The social services representatives, also emphasized on the effect of **extreme weather events** on elderly but also to the increasing number of refugees and homeless. The disastrous effect of flooding on public and private infrastructure, after severe storms, was also emphasized upon. Similar input was received by the social services representatives and MOE representatives, regarding the social services and elderly homes. It is evident that the **heatwaves** Egaleo is experiencing during the summer months, has a negative effect on "high-risk population". These people are lacking air-conditioning, which would give them some comfort, but more importantly their **health condition degrades** during this period. Heatwaves are not the only risk this part of the population is affected by. During the winter months, the occasional flooding in certain areas forces especially the elderly people or people with moving disability to stay indoors.

This isolation not only affects their everyday needs, but as noted by the psychologist, in the group, is the cause of certain psychological trauma or depression.

- **Main climate risk:** The most prominent risks identified by participants are floods, heatwaves, drought, and water scarcity.

Based on those information and elements of discussion during the workshop, the risk chain of the City of Egaleo is summarised in the Figure 17 below.

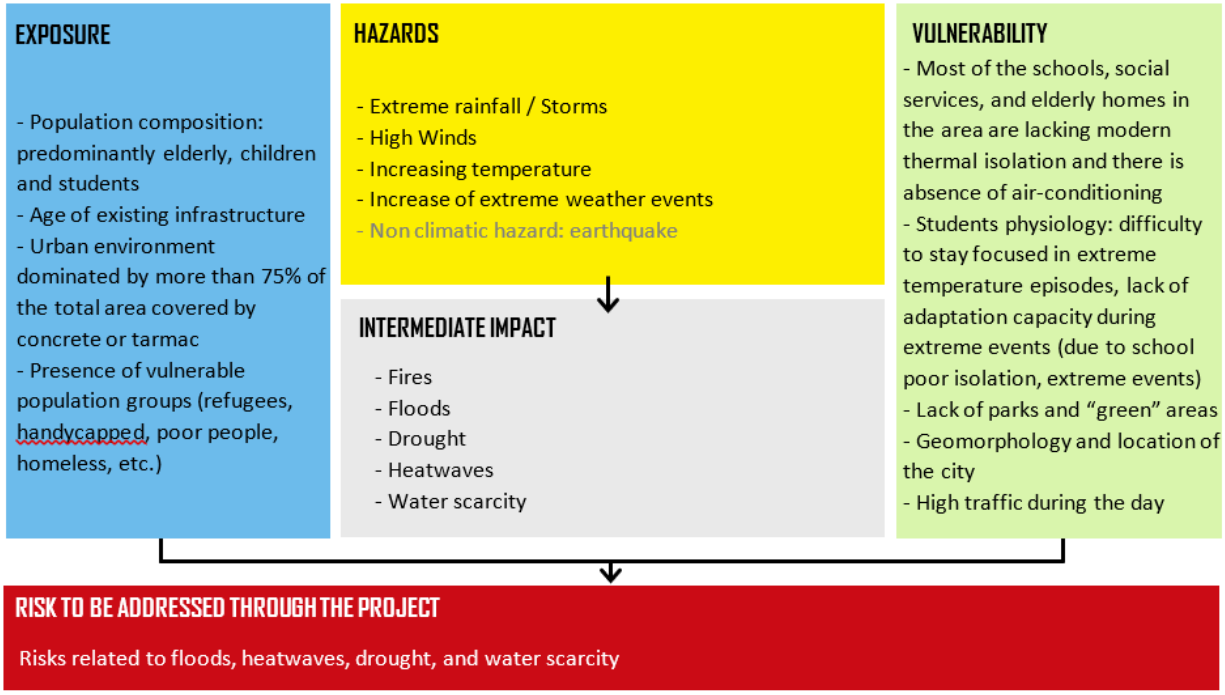

Figure 17. Risk chain for the City of Egaleo

5.3.2 Impact / Risk evolution, indicators, critical thresholds

Based on the information shared on the current and predicted climatic data for the area, participants to the workshop characterized the different risk levels as presented in the Figure 18 below.

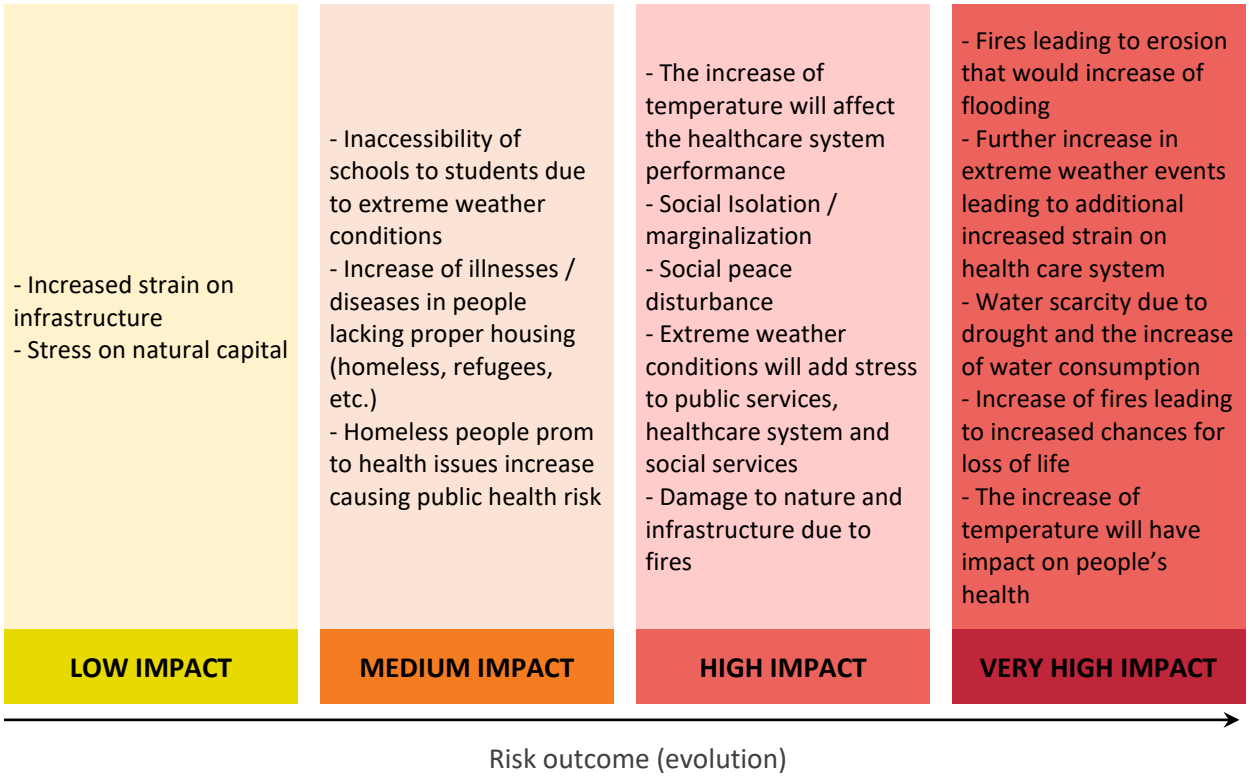

Figure 18. Climate risk / impact levels for Egaleo

5.3.3 Adaptation vision and solutions per risk

For the Egaleo demonstrator, the principle result of the workshop is a list of identified solutions per prominent risk. The main risks identified, by the participants, for the city of Egaleo are **floods, heatwaves, and drought and water scarcity**.

The vision for the City of Egaleo, based on the input from the participants, is to **have a city that is safe for its citizens against the direct and indirect effects of climate change.**

- **Managing flood risk**

The primary objective, to ensure citizens' safety, is to tackle the flood problem as its source. The **main reasons** behind this risk are:

- Urban environment dominated by more than 75% of the total area covered by concrete or tarmac,
- Geomorphology and location of the city,
- Extreme weather events – Extreme rainfalls.

The city of Egaleo is located along the flood plain of Cephissus river and at the foot of mount Egaleo. It is also neighbouring the city of Haidari which drains the mountain ridge at the north-west of the Athens region. Thus, the location of city of Egaleo receives the run-off water from an area larger than the city itself. Adding to this, the area is covered in its larger area from concrete or tarmac. Consequently, the vertical infiltration of the rainwater is limited to non-existent. The existing infrastructure is unable to collect and distribute the amount of runoff water when extreme weather events take place.

In the case of floods, the **proposed solutions** by the participants are:

- Nature-based solutions to rainwater catchment and distribution (either to the aquifer or to the Cephissus river),
- Increase of "green" coverage throughout the extend to the municipality,
- "Communicate climate change and its effects" with the local population, with emphasis on students,
- Early warning system for extreme events,
- Collaboration with neighbouring municipalities to apply all the above solutions since the risk of flooding is a global effect. This can be done via the regional administration of West Attica.

- **Managing heatwave risk**

The second risk that the area is prominent are heatwaves during summer. This risk is of higher importance that flooding since it occurs at a higher frequency. The **main reasons** for this risk are:

- Urban environment dominated by more than 75% of the total area covered by concrete or tarmac,
- High duration of warm days,
- High traffic during the day,
- Lack of parks and "green" areas.

As an urban environment that most of its area is covered mainly build buildings and roads, with the "green areas". This lack of parks and "green areas" positively affects the increased temperatures during the summer period. Moreover, the city of Egaleo suffers from high traffic throughout the year. This phenomenon adds to the problem due to 3 main factors: increased CO_2 emissions and additional heat emitted from the traffic, and the heat emitted from air-conditioning units in the area. The effect of heatwaves was extensively discussed by the attendees, especially with social sciences background. They focused on the negative effects on the mental state of the citizens and their health in general.

In the case of heatwaves, the **proposed solutions** by the participants are:

- Increase of "green" coverage throughout the extend to the municipality,
- Use of advanced materials and techniques to absorb or reduce the reflection of solar radiation,
- "Communicate climate change and its effects" with the local population, with emphasis on students,
- NBS solutions, porous pavements or similar, that will create a cooling effect due to water evaporation,
- Improve thermal isolation of buildings to decrease the need or increase efficiency of air-conditioning (indirect decrease of heat generation)

- **Managing drought and water scarcity**

The third risk in the city that has a global effect is drought and water scarcity. This risk is not evident for the citizens at the city of Egaleo or any other city in the Attica region. The **main reasons** for this risk are:

- Urban environment dominated by more than 75% of the total area covered by concrete or tarmac,
- Decrease in rainfall,
- Decrease of snow and snow caps at the mountains at N. Attica.

The effect of drought and water scarcity, as stated above, is not a local risk but a global. This risk is not communicated to the citizens, since they do not suffer its effect, yet. Municipality of Egaleo is supplied with water from EYDAP, the water administration company of Athens region. The water sources are a number of lakes at the N. Attica: Lake Marathon, Lake Yliki, Mornos, and a number of wells at the north of the region.

In the case of drought, the **proposed solutions** by the participants are:

- Nature-based solutions to rainwater catchment and storage into the aquifer,
- Rainwater harvesting and treatment,
- “Communicate water scarcity” with the local population, with emphasis on students,
- “Communicate water economy” with the local population, with emphasis on students,
- Policy on water usage limitation during summer months.

6.0 CITY OF LAPPEENRANTA, FINLAND

6.1 General information on the workshops

The City of Lappeenranta was the fourth demonstrator which conducted workshops to setting up adaptation pathways. Three half-days workshops were organised in November 2022 which involved all stakeholders for all Key Community Systems (KCS) identified for the demonstrator: Water management and Urban planning. Due to lack of time, a half day workshop was organised in January 2023 with stakeholders from all KCS to finalise the construction of the adaptation pathways. Workshops were organised in person.

Workshop type	Four workshop sessions organised in two days, involving all stakeholders from all KCS
Date of the workshops	**WS 1:** 02nd of November 2022, 10:00 am to 15:00 pm (GMT+3) **WS 2:** 03rd of November 2022, 08:30 am to 12:00 pm (GMT+3) **WS 3:** 03rd of November 2022, 13:00 am to 15:30 pm (GMT+3) **WS 4:** 24th of January 2023, 09:00 am to 11:15 am (GMT+3)
Location of the workshops	Lappeenranta City Hall + Teams
TransformAr organisers	City of Lappeenranta, LUT University
Key Community Systems (KCS)	Water management and Urban planning

The main objective of the process is to co-construct adaptation pathways, made up of a sequence of decision-points and measures allowing for decision making despite uncertainty in Lappeenranta based on local and scientific expertise. For the City of Lappeenranta demo, adaptation pathways were developed per KCS. To achieve the goal, specific objectives were identified for the four workshop sessions as shown in the Table 11 below.

Table 11. Title and objectives of WP3 workshops for the City of Lappeenranta

WORKSHOPS TITLES	OBJECTIVES
Workshop 1: Climate Perception, challenges, and existing solutions (based on local experiences)	Determine the climate perspective of local actors, challenges they face, and existing solutions to overcome these challenges
Workshop 2: Climate vulnerability, impacts and projections (based on scientific modelling / projections).	Scientific inputs concerning climate vulnerability, impacts and projections

WORKSHOPS TITLES	OBJECTIVES
Workshop 3: Vision, Solutions and Way forward (Construction of Adaptation pathways).	Vision, solutions, and way forward (construction of adaptation pathways)
Workshop 4: Construction of pathways	Defining adaptation pathways based on the result of WS3

6.2 Workshop organisation

The first workshop aimed to determine the climate perspective of local actors, the challenges they face, and to identify existing solutions to overcome these challenges involved 10 participants from University and the City of Lappeenranta. This first half-day was organised as follows: conceptual backgrounds were shared concerning the risk chain components. Participants were divided into 2 working groups to develop the risk chain per sector.

Figure 19. Group exercise to establish risk chains

There were 14 attendees in the second workshop aiming to share scientific inputs concerning climate vulnerability, impacts and projections from TransformAr scientists. Most people invited attended. There were also online participants who joined for the scientific presentations (from Gjøvik municipality and Centre for Economic Development, Transport and the Environment "ELY"). Group exercises were in Finnish only, and online participants did not participate in the exercises. The second workshop was organised as follows: a wrap-up of the first workshop was done. Then, scientists from TransformAr (PIK, CMCC and E3M) presented climate projections, biophysical impacts of climate change and socio-economic impacts of climate change. After each presentation the stakeholders were allowed to ask questions either in English or in Finnish, translated by facilitators. There weren't many questions but

during the group exercises there was more discussion about the presentations and scenarios presented. Participants were divided into working groups to work on the definition of critical thresholds.

Figure 20. Group exercise on the definition of critical threshold definition with stakeholders in the City of Lappeenranta

The third workshop was held with the same participants as the second one (only one participant left) as it was organised the same day. The session was organised as follows: the objective of the third workshop was presented, then, conceptual framework concerning adaptation pathways and transformative adaptation were shared to participants to allow them to understand the theoretical part before doing the exercise. Stakeholders worked together to define a transformative vision, to develop pathways per KCS. The time was lacking to go to the end of the exercise of developing the adaptation pathways. Participants stopped at the stage of defining solutions per impact / risk level. A fourth workshop session was designed to finish the work on construction of adaptation pathways per KCS for the City of Lappeenranta demo.

11 persons attended the last workshop organised. Introduction to the results of workshops and the objectives for the session were briefly presented at the beginning of this session. The aim was to determine the adaptation pathways.

6.3 Results of the workshops

Most of the participants from the first workshop agreed that the City of Lappeenranta is already dealing with the impacts of climate change, with moderate impact (63% of participants give this answer).

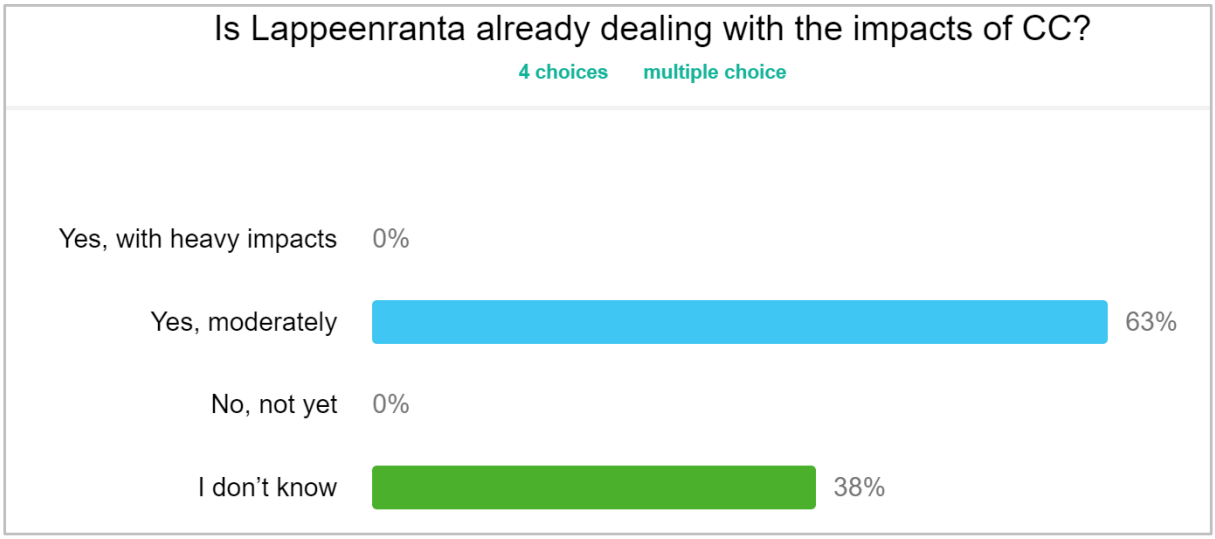

Figure 21. Result of the survey carried out with the participants of WSI concerning the perception of the impact of climate change in the City of Lappeenranta

The most affected sector by climate change in Lappeenranta is environment (biodiversity) according to the participants of the first workshop.

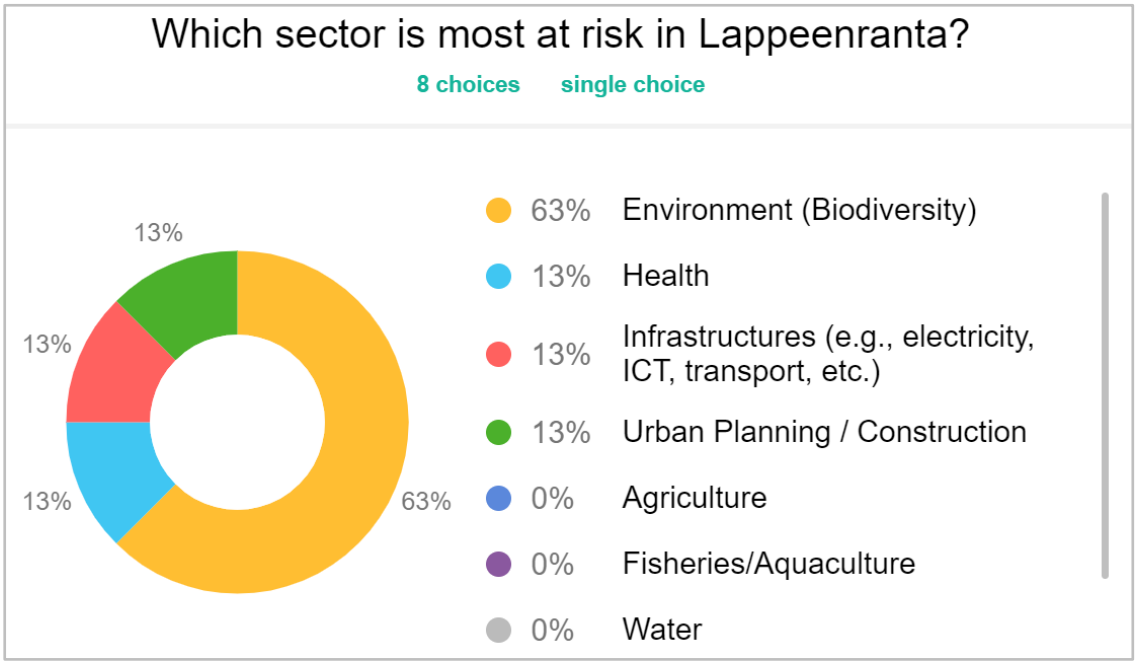

Figure 22. Result of the survey carried out with the participants of the WSI concerning the identification of the most affected sectors in Lappeenranta.

Most of the participants of the first workshop were aware that there is an emergency to act to manage climate risk. Otherwise, the situation will be worsened in the upcoming 10 years. But some of them perceived that the situation would remain the same or it will be improved, because measures have already been taken.

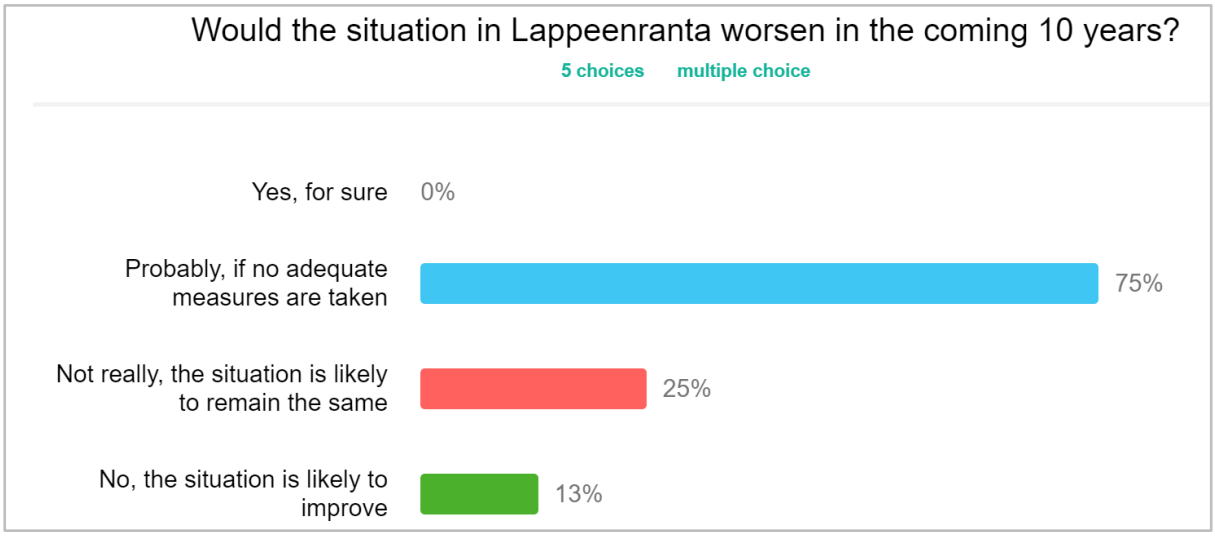

Figure 23. Result of the survey carried out with the participants of the WSI concerning the perception on the evolution of the impact of climate change in Lappeenranta in the upcoming years.

The PIK Institute used data from Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) (https://www.isimip.org/) Phase 3b based on 5 Global Circulation Models (GCMs) of the CMIP 6 family which were used for the latest IPCC report (AR6) for climate projections. The results from 3 emission scenarios (as used in latest IPCC report, AR6) were presented to the participants:

- SSP 1 RCP 2.6 (optimistic)
- SSP 3 RCP 7.0 (business as usual)
- SSP 5 RCP 8.5 (pessimistic)

For the City of Lappeenranta, climate projections show that:

- Strong temperature increase over 21st century relative to current conditions.
- The heating depends much on the emission scenario.
- For the next 30 years there will be an increase of + 1.5 °C of the mean temperature
- Temperature increases stronger in winter (+ 2.2 °C in Jan) than in summer (+ 1.2 °C in Jun), but uncertainty is also very high in winter.
- Increase in rainfall is expected in the future.
- Rainfall increase is stronger in winter and spring (+ 11 % in Jan and May).
- There is a large uncertainty in projections (caused primarily by climate models rather than emission scenarios).
- Related to heat stress, projections show that in the future, there will be an increase on the:
    - number of **summer days** (Tmax > 25 °C): **+ 64 %** (29 – 145 %)
    - number of **frost days** (Tmin < 0 °C): **- 14 %** (- 37 – - 10 %)
    - number of **icing days** (Tmax < 0 °C): **- 17 %** (- 41 – - 8 %)
    - number of **warm spells** (at least 6 consecutive days with very high temperatures): **+ 224%** (130 – 529 %)
    - number of **cold spells** (at least 6 consecutive days with very low temperatures): **- 75 %** (- 100 – 0 %)
- There will be a slightly increasing rainfall intensities. (Large variation in climate models especially for rare events).

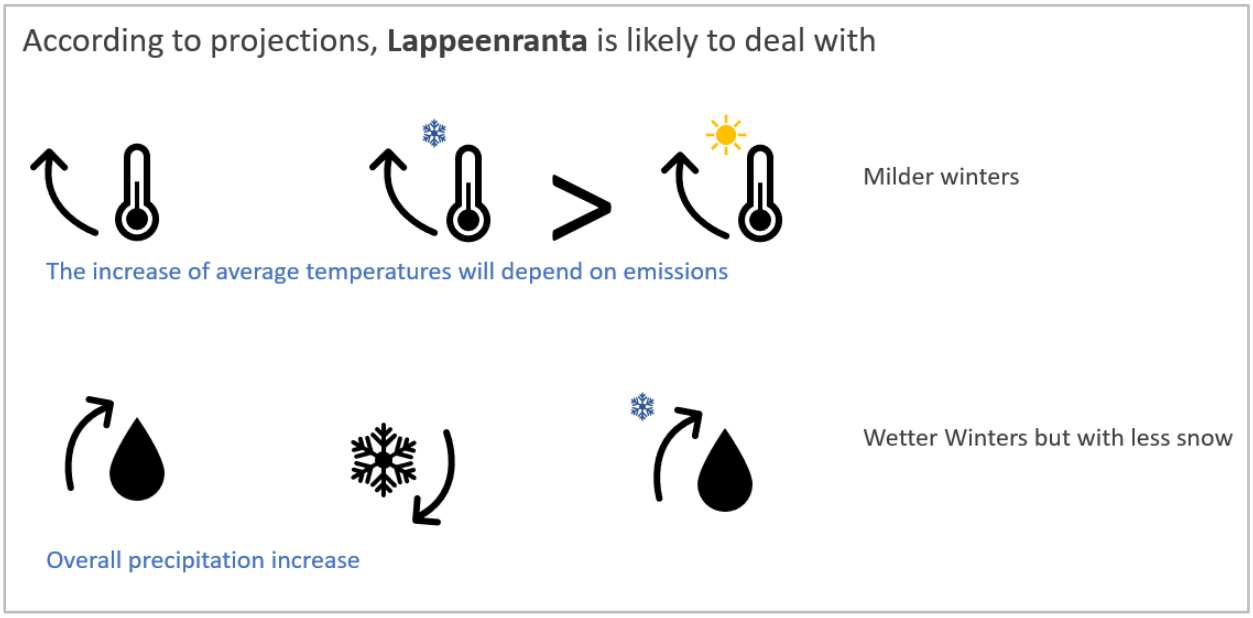

Figure 24. Summary of climate projections for the City of Lappeenranta (Source: PIK presentation during the WS 2)

From the presentation of E3M concerning socio-economic impacts of climate change in Lappeenranta, the overall impact on the Finnish economy is not straightforward. There are both possibilities (advantages) for certain sectors and risks (damages). The net effect will be determined by sectorial interlinkages, the relative size of the industries that are expected to be negatively/positively affected as well as from global effects (through trade channels). Floodings and other extreme weather events imply direct damages on infrastructure, residential buildings, and production facilities. In 2012, the cost of flooding at the national level was 10 million € while in 2013 5 million €. Future costs estimated (for Finland) vary between studies:

- Estimates of annual (direct) cost of flooding range between that the annual costs of floodings in Finland may reach 644 million € and 2491 million € in 2050's (depending on adaptation measures) – (Rojas et al. 2013)
- Other estimations place the cost of flooding up to 8.8 million euros annually for specific regions (Helsinki and Espoo)

Changes in climate may lead to increased agricultural and forestry output and construction activities are expected to face increased demand stemming from reconstruction.

In the framework of the TransformAr project, E3M aims to assess the socioeconomic impacts of climate change for Lappeenranta; to capture both the direct and indirect effects on the local economy stemming from changes in specific sectors (e.g., agriculture, manufacturing) and infrastructure developments using tools like Input-Output analysis, Computable general equilibrium model (GEM-E3).

6.3.1 Water management

6.3.1.1 Risk chain

The risk chain for Water management sector was developed with 5 participants of the first workshop. They identified elements for each component (hazards, exposure, vulnerability, intermediate impact, risks, and socio-economic impacts) of the risk chain.

- **Climate hazards**: Heavy rainfall, storms during wintertime, extreme weather conditions, dry hot season.
- **Intermediate impact (climate impacts):** floods
- **Exposure**: An increase in the proportion of impervious surfaces in urban areas.
- **Vulnerability:** Lacking stormwater network capacity, the absence of a real-time monitoring system.
- **Main climate risk considering exposure and vulnerability:** flooding and the spread of harmful substances into water bodies.

The summary of the risk chain for the water management sector at Lappeenranta from the discussion between the participants to the working group is portrayed in the Figure 25 below.

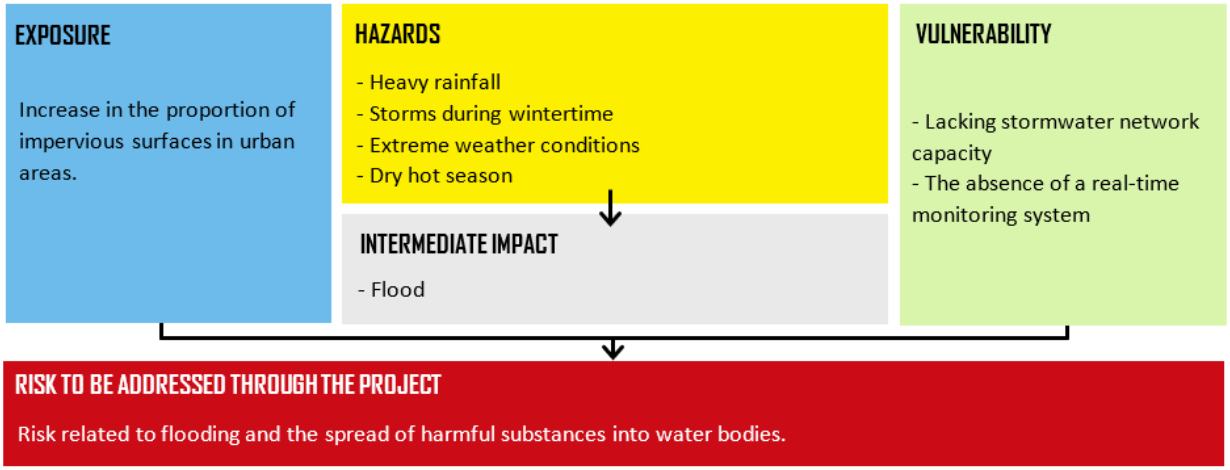

Figure 25. Risk chain for the sector of Water management for the City of Lappeenranta

6.3.1.2 Risk evolution, indicators, critical thresholds

For the Water management sector in Lappeenranta, the **most prominent risk identified was related to flooding and the spread of harmful substances into water bodies**.

Participants characterised the **four levels of impacts** after the identification of the most prominent risk as listed below:

- **Low impact**: flooding on the streets causes difficulties in traffic and for pedestrians
- **Medium impact**: pollutants and harmful substances are washed from built-up areas into water bodies
- **High impact**: stormwater intrusion into buildings, nutrient load to water bodies.
- **Very high impact**: mixing of sewage and stormwater. Sewage overflows into waterbodies.

Participants identified the following **indicators** to assess the risk: **water quality classification,** since it would be possible to measure and note if the water quality classification would be deteriorating.

The summary of the risk / impact levels characterised by participants for water management sector is shown in the Figure 26 below.

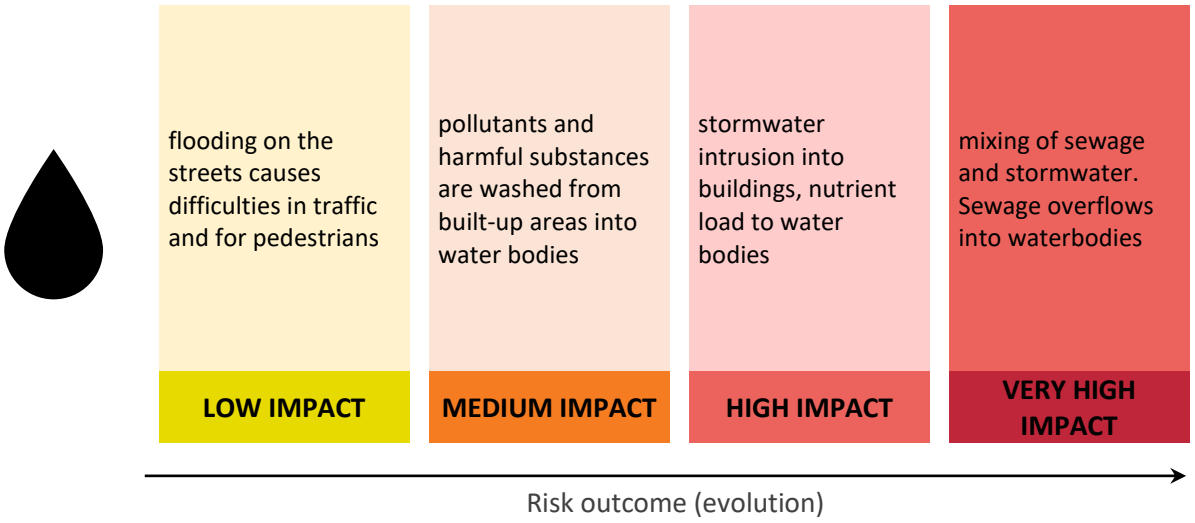

Figure 26. Climate impact / risk levels for water management sector for the City of Lappeenranta

6.3.1.3 Adaptation vision

Participants from the third workshop identified the following vision for Water management sector in Lappeenranta:

- cleaner waters, water balance management.
- The risk of oxygen loss and eutrophication decreases.
- The risk of wastewater and stormwater mixing is eliminated, harmful substances do not migrate into the groundwater. If no actions were taken, nutrients are carried into waterbodies with stormwater and stormwater and wastewater mix.

6.3.1.4 Adaptation pathways

Although it was difficult to come up with the measurable indicators, the pathways were relatively simple to form in context of highest impact to climate adaptation. The stakeholders brought up effect of time on the pathways: different pathways and actions might have different time scales. While some actions can be taken immediately and the outcome can be seen in short term, there are pathways which require more time to be effective.

Three pathways were developed for the sector of Water management: Pathway A, Pathway B and Pathway C.

Pathway A is based on spreading knowledge about the city of Lappeenranta's stormwater program and introducing storm water fee (not currently in use in Lappeenranta). Regarding this pathway, both existing and new solutions should be implemented wider. Also support from decision makers (political alignments) is needed.

Pathway B is more about monitoring the quantity and quality of storm waters, and based on the monitoring results, water should be treated decentralized to reduce the need to increase pipe sizes in storm water sewer system, and to ensure the water is treated and purified before being led to the drainage system. Existing solutions should be implemented in this pathway also. Indicator: water quality classification. Pathway B reaches the very high impact, but not as high as Pathway A.

Pathway C includes introducing storm water fee to finance the new treatment measures, of which decentralized solutions are seen as the most important.

The three pathways developed by participants for the sector of Water management in the City of Lappeenranta are presented in the Figure 27 below.

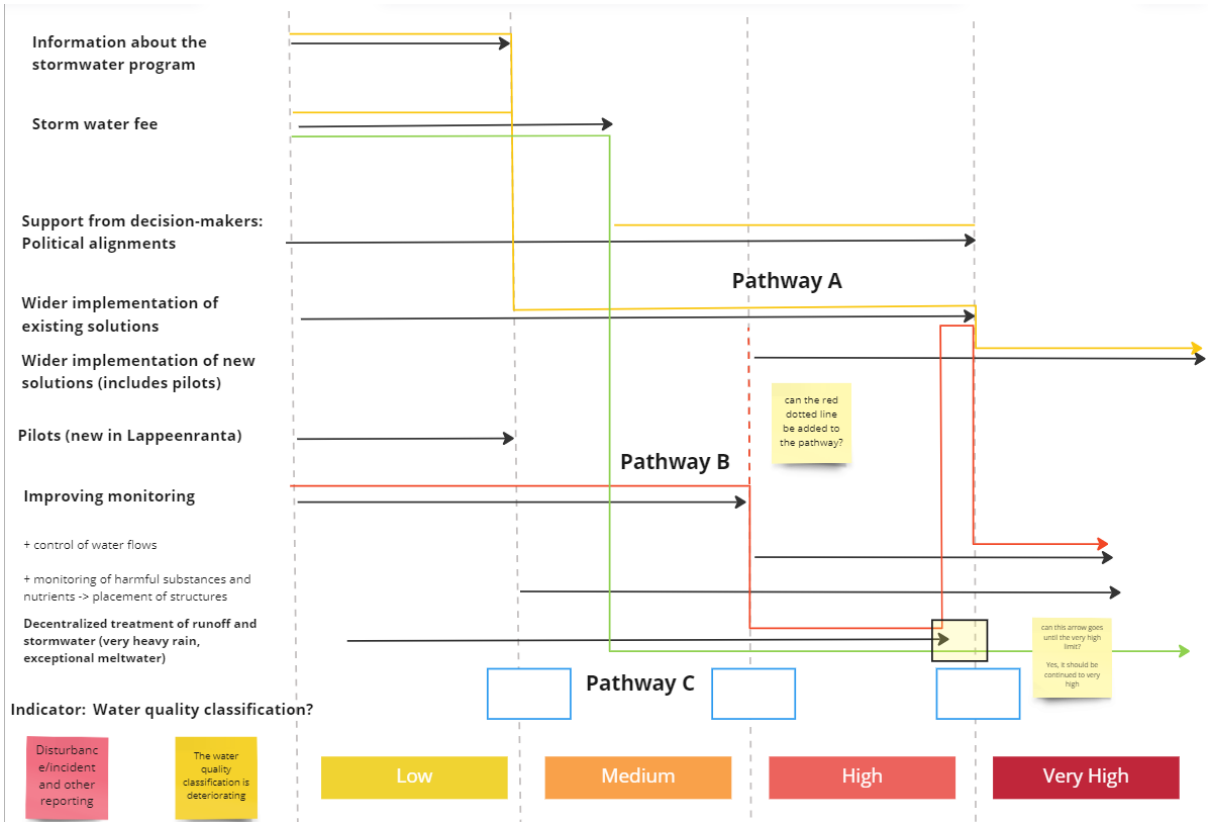

Figure 27. Adaptation pathways for the sector of water management for the City of Lappeenranta

6.3.1 Urban planning

6.3.1.1 Risk chain

The risk chain for the Urban planning sector was developed with 5 participants of the first workshop. They identified elements for each component (hazards, exposure, vulnerability, intermediate impact, risks, and socio-economic impacts) of the risk chain.

- **Climate hazards and intermediate impact**: storms and windiness, flooding, and heavy rainfall, cold, heat and drought, hail
- **Exposure**: dense built environment, densification at the expense of green areas. E.g., if the street area is widened, it usually means widening the lanes, i.e., more space for cars and traffic. However, more space would be needed in green areas, for example, to place storm water structures. It is about policy and decision making.
- **Vulnerability:** reduction of land areas used for construction, leading to pressure for dense built environment.
- **Main climate risk considering exposure and vulnerability:** Reduction of the diversity of urban nature, flooding resulting in moisture damage to buildings. Water pollution.

The summary of the risk chain for Urban planning sector at Lappeenranta from the discussion between the participants to the working group is portrayed in the Figure 28 below.

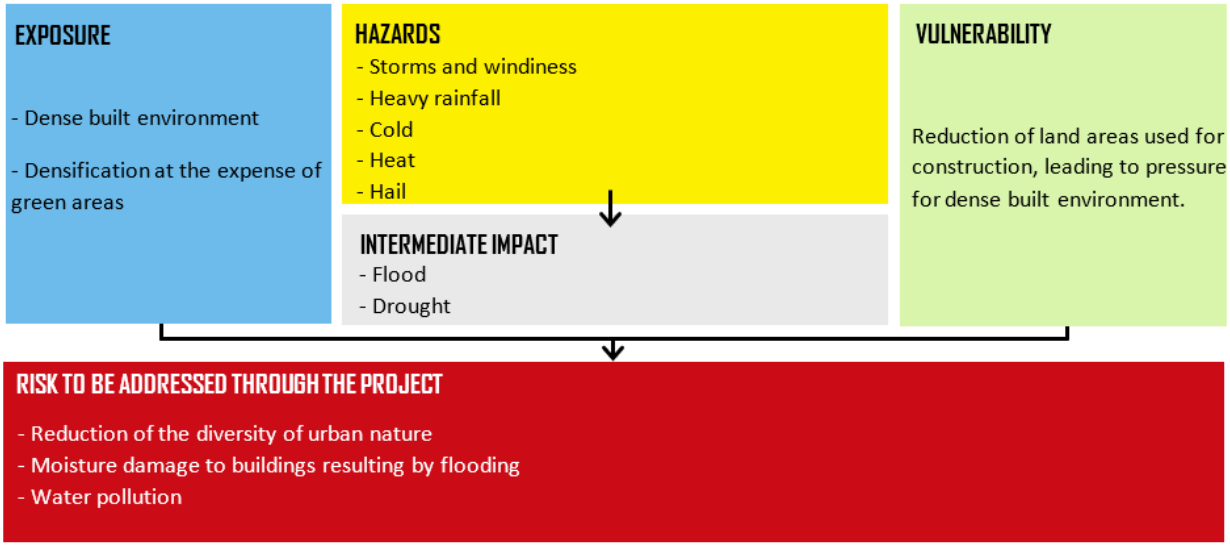

Figure 28. Risk chain for the sector of Urban planning for the City of Lappeenranta

6.3.1.2 Impact / risk evolution, indicators, critical thresholds

For the Urban planning sector in Lappeenranta, the **most prominent risks identified were related to the reduction of the diversity of urban nature, to moisture damage to buildings resulting by flooding and to water pollution.**

Participants characterised the **four levels of impacts** after the identification of the most prominent risk as listed below:

- **Low impact**: the streets are slippery, the need for sanding increases. The conditions for moving outside are bad.
- **Medium impact**: the structures require premature renovation. In hot conditions, the need and consumption of water increases.
- **High impact**: atrophy of urban nature. withdrawal of ecosystem services.
- **Very high impact**: not defined.

Workshop facilitators proposed at the fourth workshop the **indicator of green factor** as an indicator to assess the risks. Green factor was brought up by the stakeholders and discussed during the first workshop. Green factor is used to control the green structure in connection with urban planning, usually at the block level. The idea was based on the adaptation vision that in urban areas a balance should be found between compact construction and natural areas. The green factor has been discussed in urban planning in Lappeenranta, but it has not yet been used in connection with planning.

The summary of the risk / impact levels characterised by participants for Urban planning sector at Lappeenranta is shown by the Figure 29 below.

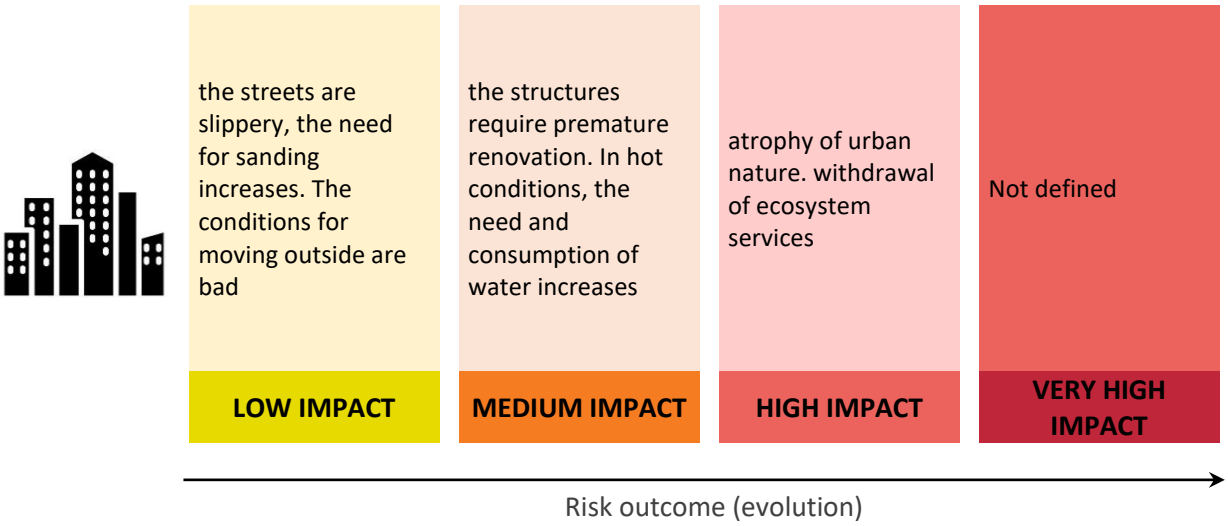

Figure 29. Climate impact / risk levels for Urban planning sector for the City of Lappeenranta

6.3.1.3 Adaptation vision

Participants from the third workshop identified the following vision for Urban planning sector in Lappeenranta:

- urban structure in balance
- stormwater management
- green environment

6.3.1.4 Adaptation pathways

Although it was difficult to come up with the measurable indicators, the pathways were relatively simple to form in context of highest impact to climate adaptation. The stakeholders brought up effect of time on the pathways: different pathways and actions might have different time scales. While some actions can be taken immediately and the outcome can be seen in short term, there are pathways which require more time to be effective.

Three pathways were developed for the sector of Urban planning: Pathway A, Pathway B and Pathway C.

Pathway A is thought to be a "shorter term" pathway. It requires attitude change, which includes environmental education and information in general, plus political alignment (resources/funding, legislation). Technical solutions, e.g., new construction methods, as well as nature-based solutions should also be implemented. In this context, the stakeholders highlighted the importance of environmental education. It is something that should be invested in both in schools and in working life to distribute knowledge about climate change adaptation.

Pathway B is a "longer term" pathway: Attitude change/information in general and a major change in the design procedures.

Pathway C is also a "longer term" pathway, including actions in land use planning, by which is meant to reserve areas for water treatment (both current and adding new areas), and implementing nature-based solutions, both existing, but not yet used in Lappeenranta, and new innovative solutions.

The three pathways developed by participants for the sector of Urban planning in the City of Lappeenranta are presented in the Figure 30 below.

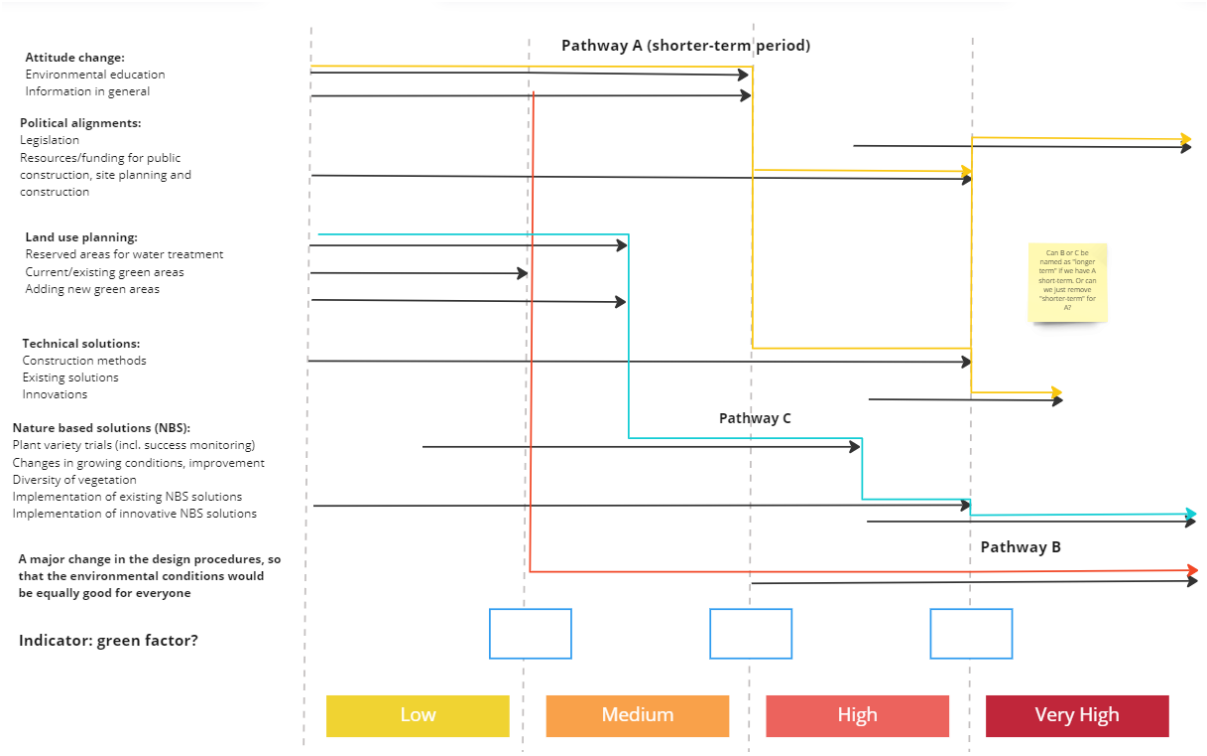

Figure 30. Adaptation pathways for the sector of Urban planning for the City of Lappeenranta

7.0 GUADELOUPE, FRANCE

7.1 General information on the workshops

For Guadeloupe, the workshops were organised by key sector and by stakeholder group. For the agriculture sector, two workshops were held: a half-day workshop with farmers and another half-day workshop with institutional actors. This choice is motivated to the complex existing relationship between practitioners and institutional in Guadeloupe. In addition to the objective of testing the Playbook methodology for co-developing climate change adaptation pathways, another objective was identified for these sessions: to contribute to the development of a regional climate change adaptation strategy for Guadeloupe. The same pattern was adopted for the tourism sector. In total, four workshops were held between the end of November and the beginning of December 2022.

Workshop type	Four workshop sessions organised in four half-days, involving different stakeholders' groups for each session. Participants personally attended the workshops.
Date of the workshops	**WS 1:** 28th November 2022, 12:00 PM – 05:00 PM (AST) **WS 2:** 30th November 2022, 08:00 AM – 12:00 PM (AST) **WS 3:** 08th December 2022, 12:00 PM – 05:00 PM (AST) **WS 4:** 09th December 2022, 08:00 AM – 12:00 PM (AST)
Location of the workshops	Jardin de Valombreuse, Petit-Bourg, Guadeloupe
TransformAr organisers	ADEME Guadeloupe, ACTERRA
Key Community Systems (KCS)	Agriculture and Tourism

The **overall objective** of the **four workshops** was to: "co-construct climate change adaptation pathways made up of a sequence of decision points and measures enabling decision-making despite uncertainty in Guadeloupe on the basis of local and scientific expertise". To achieve this goal, specific objectives were identified for the three workshops as shown in the Table 12 below.

Table 12. Title, objectives, and participants of WP3 workshops in Guadeloupe

WORKSHOPS	OBJECTIVES	PARTICIPANTS
Workshop 1: Climate perception, impacts on the agricultural sector and solutions	• Building a risk chain for the agricultural sector in Guadeloupe based on the participants' responses. • Characterise the risk evolution, identifying indicators and critical thresholds. • Identifying existing and missing solutions to adapt the Guadeloupean agricultural sector to climate change. • Co-constructing a preferential adaptation pathways to climate change for the Guadeloupean agricultural sector	Farmers
Workshop 2: Agricultural sector adaptation governance and investment potential to increase resilience	• Share the results of the Workshop I with farmers (hazards, climate change adaptation actions by level of impact). • Contribute to the definition of a climate change adaptation strategy for the Guadeloupean agricultural sector. • Identify investment potential for the establishment of a local climate change adaptation fund (in the form of a survey distributed to participants)	Institutional actors of the agricultural sector
Workshop 3: Climate perception, impacts on Tourism sector and solutions	• Building a risk chain for the tourism sector in Guadeloupe based on the participants' responses. • Characterise the risk evolution, identifying indicators and critical thresholds. • Identifying existing and missing solutions to adapt the Guadeloupean tourism sector to climate change. • Co-constructing a preferential adaptation pathways to climate change for the Guadeloupean tourism sector	Tourist operators
Workshop 4: Tourism sector adaptation governance and investment potential to increase resilience	• Share the results of the Workshop 3 with tour operators (hazards, climate change adaptation actions by level of impact). • Contribute to the definition of a climate change adaptation strategy for the Guadeloupean tourism sector. • Identify investment potential for the establishment of a local climate change adaptation fund (in the form of a survey distributed to participants).	Institutional actors of the tourism sector

7.2 Workshop organisation

A call for expressions of interest was launched by ADEME Guadeloupe to farmers to participate in Workshop 1. The number of participants was limited to a maximum of 15 people in order to ensure the smooth running of the exchanges and discussions. The selection of participants was carried out by ADEME Guadeloupe to ensure that the sector and the types of crops were well represented. Finally, ten farmers: sugar cane producers, vanilla producer, market gardener, stockbreeder, and beekeeper participated in the Workshop. The first workshop began with a conceptual introduction in the difference between adaptation and mitigation. Then, scientific inputs concerning climate projections, biophysical and socio-economic impacts of climate change on the agricultural sector in Guadeloupe were presented by scientists from TransformAr. After, participants worked on the development of the risk chain and adaptation pathways for the sector.

ADEME Guadeloupe identified the relevant stakeholders for Workshop 2 dedicated to institutional from the agricultural sector and invited them. 11 persons participated in the second Workshop from Universities, Research centres, the regional directorate of environment, planning and housing, consulting firm, Departmental council, Chamber of Agriculture, and local authorities. The second workshop began with a conceptual introduction on the difference between adaptation and mitigation. Then, scientific inputs concerning climate projections, biophysical and socio-economic impacts of climate change on the agricultural sector in Guadeloupe were presented by scientists from TransformAr. The results from the first Workshop were presented to the attendees of the second workshop. They commented and provided feedback before working on the identification of challenges and solutions to address them. This was planned to contribute to the definition of a regional adaptation to climate change strategy for Guadeloupe.

The same scheme was adopted for the Workshop 3 and Workshop 4 for the Tourism sector. 6 persons (cottage owners, Chamber of Industry, Zoo personnel) participated in Workshop 3. 5 persons participated in the Workshop 4 (Chamber of Industry and Trading, National parc of Guadeloupe, Jardin de Valombreuse, local authority).

7.3 Results of the workshops

The PIK Institute used data from Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) (https://www.isimip.org/) Phase 3b based on 5 Global Circulation Models (GCMs) of the CMIP 6 family which were used for the latest IPCC report (AR6) for climate projections. The results from 3 emission scenarios (as used in latest IPCC report, AR6) were presented to the participants:

- SSP 1 RCP 2.6 (optimistic)
- SSP 3 RCP 7.0 (business as usual)
- SSP 5 RCP 8.5 (pessimistic)

For Guadeloupe, climate projections show that:

- There is a strong temperature increase over 21st century relative to current conditions. Increase depends much on the emission scenario.
- For the next 30 years: increase temperature + 0.6 °C (ensemble mean). Temperature increases more or less equally distributed over the year.
- Small decrease in rainfall is expected. Decrease depends much on the emission scenario.
- There would be a shift in seasonality: wetter in November, drier around the onset of rainy season. But there are large uncertainties in projections (caused primarily by climate models rather than emission scenarios).

- Sea level projections for Pointe-à-Pitre gauge relative to 1995-2014 (IPCC AR6): **+ 16 cm** (8 – 27 cm) until 2050 relative to recent conditions

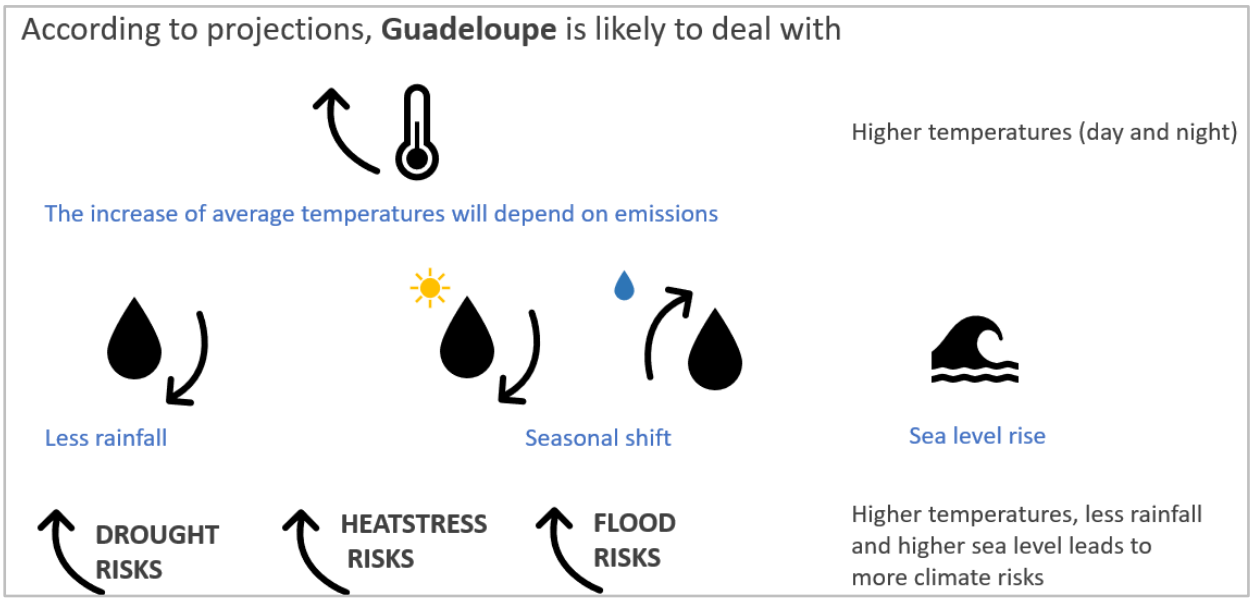

Figure 31. Summary of climate projections for Guadeloupe (Source: PIK presentation)

The presentation of CMCC concerning the biophysical impacts of climate change shows that:

- Islands depend on rain-fed agriculture and water resources, which are affected in various ways by climate change, including floods and droughts, contamination of freshwater and soil through salt-water intrusion.
- Severe rainfall and extreme events such as cyclones during planting seasons can damage seedlings, reduce growth, and provide conditions that promote plant pests and diseases.
- More pronounced dry seasons, warmer temperatures and greater evaporation could cause plant stress reducing productivity and harvests.
- Biodiversity loss from traditional agroecosystems has been identified as one of the most serious threats to food and livelihood security (e.g., insects for pollination services).
- The impacts of drought may hinder insects and animals from pollinating crops, trees (and agroforestry crops) and other vegetative food sources.
- Higher temperatures could increase the presence and incidence of pests, diseases and invasive species growing vulnerability of the agricultural systems.
- Changes in weather patterns can also disrupt food transportation and distribution systems on islands where indigenous communities are often located in remote areas.
- moderate climate change can actually increase the number of days suitable for tourism in a given year.
- Guadeloupe has a wetter climate than Cuba. If climate change brings about a drier climate, this can increase suitability even further.
- However, major worries come not from “normal” climate, but from the increased chances of extreme events, and from indirect effect on health from vector-borne diseases and worse water quality and biodiversity.
- Adaptation is crucial, and correct information is key to adaptation.

The presentation of E3M concerning the socio-economic impacts of climate change shows that the following risks were considered with respect to tourism: reduction of beaches (due to sea level rise), increased risk of forest fires (due to temperature increase), thermal comfort, degradation of marine environment and diseases.

7.3.1 Agriculture

7.3.1.1 Risk chain

The risk chain for the Guadeloupean agricultural sector was developed by identifying the elements of hazard, exposure, vulnerability, and current risks. The entire exercise of identifying all the components of the risk chain could not be done due to time constraints. Assuming that farmers already have a very good knowledge of their sector and territory, the shortening of the risk chain work does not have a serious impact on the construction of the climate change adaptation pathways. The risk chain exercise was completed by a listing of the existing solutions for adapting to climate change practised by the farmers in the area. We distinguish two main categories of solutions that were identified: the first one gathers the solutions oriented towards irrigation management and the second one concerns the solutions related to cultivation techniques and practices. The hazards faced by the agricultural sector emerged from the discussions during the co-development of climate change adaptation pathways exercise. For participants, it seemed logical to identify the climate hazards facing their activities before working on defining solutions and adaptation pathways. We have grouped the hazards identified by the participants into four categories: hazards related to meteorological parameters, hazards related to hydro-meteorological and hydro-climatic phenomena, hazards related to phenomena induced by meteorological or climatic events and non-climatic hazards. A first list of hazards was established by farmers during Workshop 1, which was completed by the participants of Workshop 2.

Hazards related to meteorological / climatic parameters:

- Temperature difference between day and night (impacts on plant phenology)
- Temperature differential (leads to more evaporation)
- Humidity: quantity of water vapour in the air which increases and dries out the soil (proposition from Workshop 2: to be checked with the farmers, linked to the temperature differential)
- Wind: drying of the soil (leads to more evaporation)
- Sun: drying of the soil (leads to more evaporation)

Hazards related to hydro-meteorological / hydro-climatic phenomena:

- Drought
- Flooding
- Heavy rainfall events (different from floods) causing erosion
- Heat wave (from 34°C): problematic for photosynthesis
- Rising water
- Cyclones

Hazards related to phenomena induced by meteorological / climatic events:

- Erosion
- Multiplication of pests

Non-climatic hazards:

- Rising input and energy prices
- Pests: the link between the increase in pests and climate change is not yet clearly established at scientific level

The collective reflection was not conducted in depth to characterise the exposure, vulnerability, and current risks of the agricultural sector.

The most important risk identified by participants of the Workshop 1 for the agricultural sector in Guadeloupe is linked to the **availability, accessibility, and management of water resources for agricultural activities.**

The summary of the risk chain for Agriculture sector in Guadeloupe from the discussion between the participants is portrayed in the Figure 32 below.

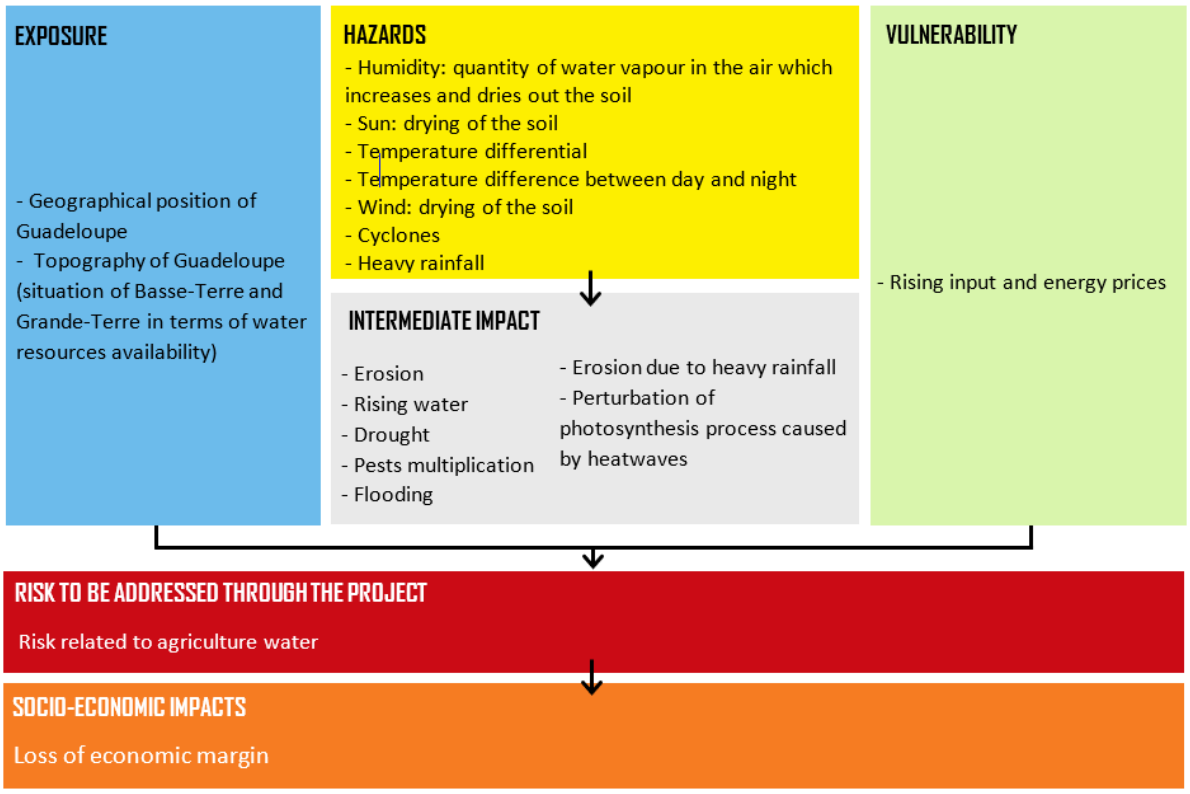

Figure 32. Risk chain for the sector of Agriculture in Guadeloupe

The risk chain exercise was completed by a listing of the existing solutions for adapting to climate change practised by the farmers in the area. Two main categories of solutions were identified: the first one gathers the solutions oriented towards irrigation management and the second one concerns the solutions related to cultivation techniques and practices.

Irrigation solutions:
Water reservoir, artificial water catchment

- Use of irrigation management tool
- Prioritization of crops for drip irrigation (problems with drip irrigation: network, availability of water resources)
- Use of battery-operated solenoid valves for irrigation
- Use of water-efficient cropping systems

Technical solutions / cultural practices:

- Mulching to keep the soil moist (for sugar cane cultivation)
- Keeping the soil covered: beneficial for keeping moisture in the soil, beneficial for biodiversity in the soil
- Establishment of plant corridors
- Establishment of hedges

- Use of compost (self-made)
- Use of resistant species
- Use of service crops
- Favouring some species over others because of their resilience
- Permaculture
- Agroforestry
- Reforestation
- Establishment of buffer zones (to maintain the ecosystem)
- Taking a holistic approach

7.3.1.2 Impact / risk evolution, indicators, critical thresholds

The process of building climate change adaptation pathways begins with the identification of an indicator for monitoring the impacts of climate change on a territory or a sector. The exchanges between the participants in Workshop 1 led to the choice of the following indicator for monitoring the impacts of climate change on the agricultural sector: **"loss of economic margin over an average of 3 years"**. Participants chose "economic margin" instead of "turnover". This seemed to them to be a more relevant way of tracking economic gains. The choice to monitor the loss of economic margin over an average of 3 years was justified by: the existence of perennial crops in Guadeloupe (e.g., vanilla cultivation), the choice not to overreact after a single season but to take a step back by adopting a posture of adaptive and progressive management of impacts. For the farmers, the choice of an economic impact indicator seemed to be the most relevant. In the words of one of the participants: "any impact of climate change on the agricultural sector has to be quantified economically, in the end...".

Figure 33. Group exercise to characterise risk levels for agricultural sector with farmers in Guadeloupe

The next step after the choice of the indicator was to characterise four levels of climate change impacts on the sector. Discussions fuelled by arguments based on past experiences and knowledge of the sector in the territory enabled the participants in Workshop 1 to describe the four levels of impact of climate change on their sector. They were formulated as follows:

- An agricultural activity in Guadeloupe with a **low impact** of climate change is one that has a **loss of economic margin of 5% over an average of 3 years**.
- A Guadeloupean agricultural activity **moderately impacted** by climate change is an activity with an **economic margin loss of between 5% and 10% over an average of 3 years**.
- A Guadeloupean agricultural activity **strongly impacted** by climate change is an activity recording a **loss of economic margin between 10% and 30% over an average of 3 years**.
- An agricultural activity in Guadeloupe that is **very strongly impacted** by climate change is an activity with an **economic margin loss of more than 30% over an average of 3 years**.

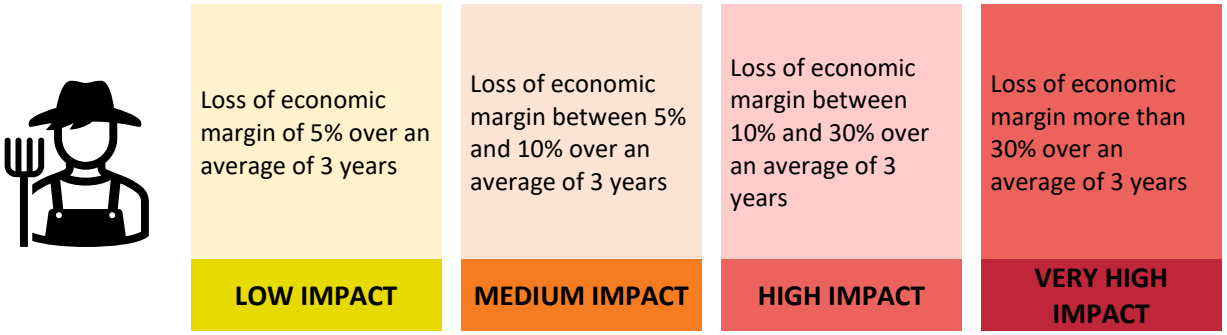

Figure 34. Climate impact / risk levels for Agriculture sector in Guadeloupe

At the same time, critical thresholds for moving from one level of impact to another have been identified in the characterisation of risk levels. The thresholds are:

- A loss of economic margin of 5% to move from low to medium impact level.
- A 10% loss of economic margin to move from medium to high impact level.
- A 30% loss of economic margin from high to very high impact.

7.3.1.3 Adaptation vision

After the results of the steps just described and before reaching the objective of building climate change adaptation pathways, the Playbook methodology takes us through the definition of a climate change adaptation outcome for each impact level. The outcomes are formulated as overall objectives to be achieved for each impact level.

The discussions led to the following results:

- Adaptation outcome for the **low impact level** (level 1): **"Diagnostic to reduce future risks (development of a risk management strategy)".** As the level of impact is low, the participants agreed at this stage not to undertake major actions but to take stock, to carry out a diagnosis work to understand the current and future impacts and to establish a strategy to reduce future risks.
- Adaptation outcome for the **medium level** of impact (level 2): "**Adjustment of the risk management strategy defined in the Low impact level, based on its evaluation".**
- Adaptation outcome for **high impact level** (level 3): **"Activity diversification".** At this stage, actions would be oriented towards integrating activities that are not directly linked to production. A reflection work to identify existing skills is necessary before this impact level and the activities identified for this stage are prepared in advance.
- Adaptation outcome for the **very high impact level** (level 4): **"Change of business model".** An extreme transformative vision was adopted by the participants in Workshop 1 in identifying this

climate change adaptation goal. Discussions revealed that transformational adaptation remains a challenge as it involves disruption. Farmers who have only been practising and investing in their usual activities would find it difficult to completely change direction and activities.

The climate desired outcomes per impact / risk level for Agriculture sector in Guadeloupe is presented in the Table 13 below.

Table 13. Climate desired outcomes per impact / risk level for the Agriculture sector in Guadeloupe

	LOW IMPACT	MEDIUM IMPACT	HIGH IMPACT	VERY HIGH IMPACT
ADAPTATION DESIRED OUTCOME PER IMPACT / RISK LEVEL	Diagnostic to reduce future risks (development of a risk management strategy)	Adjustment of the risk management strategy defined in the Low impact level, based on its evaluation	Activity diversification	Change of business model

7.3.1.4 Adaptation pathways

During the workshop with the farmers (Workshop 1), some elements of discussion and reflection are reported below. That information is not directly taking part of the expected results of the workshops, but can help to understand the context of the sector:

- The adaptation strategies to be adopted will depend on several factors such as: the size of the farm or the current level of resilience of the activity (e.g., a monoculture farm is less resilient than a farm with several crops. The adaptation actions will be different for the two cases), the means available to the actors (will a small farmer have the technical, human, or financial means to implement all these adaptation actions? This requires the establishment of a financing and support system)
- The transformative vision for the very strong level depends on the context.
- A concrete example was given by farmers regarding the topic of bringing coherence to regulations in different sectors which was reported in the solution on policy changes / incentives / governance / management. Revision of some regulations would be needed so that agriculture and ecology can be compatible. For example: with water stress, many solutions are to set up water retention systems, a water body of more than 1,000 m^2 must be declared and certain rules must be followed. These rules can be restrictive for the farmer's activities. Similarly, if biodiversity is noted on a water reservoir (e.g., on an artificial pond) created by the farmer, it is somehow "demonised" to use this water reservoir for watering or for irrigation.

The work carried out in Workshop 1 with farmers led to the result in Table 14 below. It presents the adaptation actions by level of impact which do not yet constitute finalised pathways. Prioritisation and analysis of compatibility between the actions will lead to the identification of these pathways.

Table 14. Summary of the results of workshops: the most prominent risk, impact/risk levels, climate desired outcomes per impact/risk level, critical thresholds, and solutions to adapt to climate change by impact level for Agriculture sector in Guadeloupe.

Classification of CCA solutions Sustainability/Viability of CCA solutions	Most important risk for the agricultural sector in Guadeloupe: linked to the availability, accessibility, and management of water for agriculture			
Awareness campaign / Round table - using existing farmer networks to work on climate change adaptation	**Loss of economic margin of 5% over an average of 3 years** Loss of 5 % **Low Impact**	**Loss of economic margin between 5% and 10% over an average of 3 years** Loss of 10 % **Medium Impact**	**Loss of economic margin between 10% and 30% over an average of 3 years** Loss of 30 % **High Impact**	**Loss of economic margin >30% over an average of 3 years** **Very High Impact**
Policy changes / Incentives / Governance Making sectoral policies compatible to each other (e.g., policy related to water, agriculture, biodiversity)	**Climate desired outcomes per Impact level**			
	Diagnostic to reduce future risks (development of a risk management strategy)	Adjustment of the risk management strategy defined in the Low Impact level, based on its evaluation	Activity diversification	Change of business model
Research and innovation	**Relevant solutions to be taken per impact level (that will conduct to the adaptation pathways)**			
	Risk and impact assessment	Crop replacement		
	Identify actions to be taken in the future	Area-wide chaining plan for agricultural parcels	Diversification of activities: development of agrotourism, catering, cooking classes, …	Relocation
Engineering / technological solutions - Storage tank - Desalination station (useful for electricity, water resources, agriculture) - Crop replanting	Climate resilient agroecological land management	Drainage works at a regional scale financing		Changing the choice of crops
	Identification of actions to be taken for the next agricultural season	Matching water resources to needs		
		Finding water storage solutions (e.g.: moderate size reservoir between 5 000 and 50 000 m^3		
Nature-based solutions / green solutions		Irrigate at night		
		Agricultural water management strategy (irrigation schedule) Water distribution: treatment plants should be made to work during the day, as it is neither logical nor ecological for farmers to have water during the day and not at night. Ensure that agricultural water is returned to farmers		
Other - Installation of the farmer on his farm (not directly linked to climate change) - Diversification of activities linked to the farms according to the specific skills available (value chain approach, agrotourism, cooking, etc.) - Technical, human, and financial support for farmers to adapt - Free up land for young farmers (sensitive to current issues)		Rainwater harvesting (risky because of water resource availability)		
		Drainage		
		Ground water catchment (dangerous!)		
	Agroecological farm			
	Indicator: Loss of economic margin over an average of 3 years			

7.3.2 Tourism

7.3.2.1 Risk chain

The risk chain for the Guadeloupean tourism sector is developed by identifying the elements of hazards, exposure, vulnerability, and current risks. The risk chain exercise was completed by a non-exhaustive listing of existing climate change adaptation solutions practised by the territory's tourism operators. Workshop 3 participants identified hazards related to climatic parameters, hydro-meteorological / hydro-climatic phenomena, phenomena induced by meteorological or climatic events and a particular non-climatic hazard which is concreting. The workshop participants particularly highlighted a major issue related to the latter hazard.

Hazards related to meteorological / climatic parameters:

- Increasing temperature
- Heavy precipitation
- Rising sea levels

Hazards related to hydro-meteorological / hydro-climatic phenomena:

- Cyclone, more frequent storms
- Flooding
- Rising water

Hazards related to phenomena induced by meteorological / climatic events:

- Landslide, rockfall, earth movement (closure of tourist sites)
- Coastline retreat, beach erosion
- Sargassum: the increase in sea temperature favours its multiplication
- Volcano smoke
- Destruction of corals
- Destruction / modification of flora and fauna
- Water pollution

Non-climatic hazard: concreting the soil

The summary of the risk chain for Tourism sector in Guadeloupe from the discussion between the participants is portrayed in the Figure 35 below.

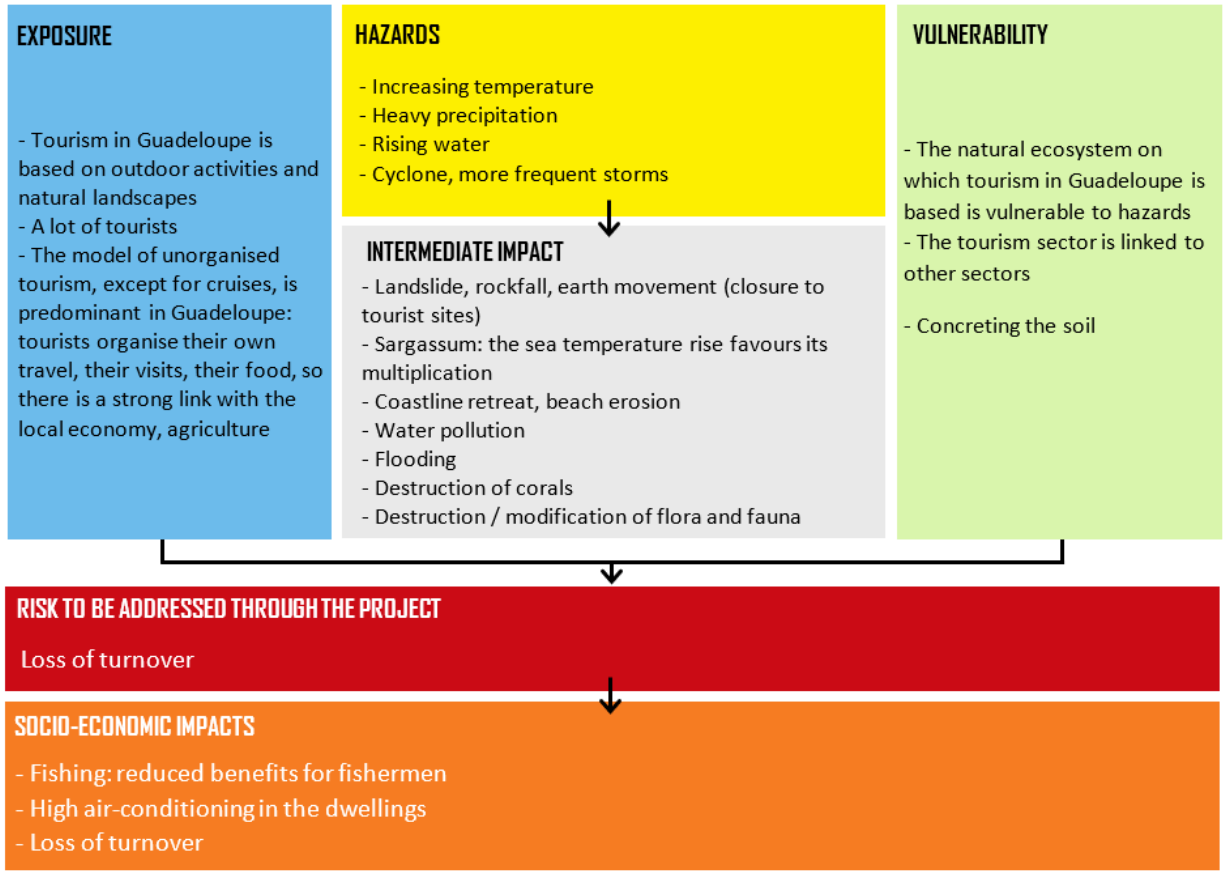

Figure 35. Risk chain for the sector of Tourism in Guadeloupe

The outcome of the hazard work was informed by presentations made by TransformAr scientists as well as by in situ observations made by the operators themselves.

The current risks identified by the participants can be grouped into 3 categories:

- **Risk of impacts on the natural landscape, biodiversity, and natural resources:**
  - Reduction of mangroves and biodiversity (due to rising water levels and rising temperatures). Activities such as water sports bases, canoeing, water excursions are impacted
  - Water pollution from wastewater due to flooding
  - Degradation of the tourist image of Guadeloupe
  - Degradation of the quality of running water leading to a bad image of water in Guadeloupe and excessive purchase of bottled water (lots of plastic)
- **Health risks:**
  - Water pollution leading to health problems (e.g., ear infections in Malendure)
  - Climate-sensitive diseases (e.g.: multiplication of disease-carrying mosquitoes)
- **Economic and environmental risks:**
  - Fishing: reduced benefits for fishermen (fewer tourists = fewer restaurants)
  - High air-conditioning in the dwellings

According to the participants to Workshop 3, the tourism sector in Guadeloupe is particularly exposed to climate change because of the number of tourists who come to visit the archipelago, the nature of tourism which is mainly based on natural heritage, and the predominant model of tourism in the

archipelago which is unorganised and therefore relies on local economic activities (agriculture, fishing, etc.). The vulnerability of the Guadeloupean tourism sector to climate change is due to the fact that the sector depends on several factors and is linked to other sectors (agriculture, catering, transport, natural ecosystems, etc.). In this context, measures and actions are already being implemented by the actors of the tourism sector.

Air conditioning solution:

- Key switches for air conditioning
- Use of solar water heaters
- Use of air movers, fans instead of air conditioners

Water resources management:

- Reduction of water use, use of wastewater (e.g., for washing machine)
- Use of tarpaulins to cover swimming pools to reduce water loss through evaporation by 20%.

Nature-based solutions:

- Intelligent revegetation
- Reducing soil erosion by plants (bois patate, vetiver)
- Eco-mesh
- Restoration of mangroves
- Coral planting

Information, Education, Communication: Communication for the proper use of resources
Others: sargassum collection (mechanical problems with the sands), restricting access to sites or closing sites.

7.3.2.2 Risk evolution, indicators, critical thresholds

The process of building climate change adaptation pathways begins with the identification of an indicator for monitoring the impacts of climate change on a territory or a sector. The exchanges between the participants in Workshop 1 led to the choice of the following indicator for monitoring the impacts of climate change on the tourism sector: "**Loss of annual turnover**". This seemed to them to be more relevant for monitoring economic gains and losses. The choice was made to monitor the indicator over one year. The step following the choice of the indicator is the characterisation of four levels of climate change impacts on the sector. The discussions, fuelled by arguments given based on past experiences and knowledge of the sector in the territory, enabled the participants in Workshop 3 to describe the four levels of impact of climate change on their sector (Figure 36):

- An activity in the Guadeloupean tourism sector that is **weakly impacted by climate change** is an activity with a **5% loss of turnover due to climatic events over a year**.
- An activity in the Guadeloupean tourism sector **moderately impacted by climate change** is an activity recording a **10% loss of turnover due to climatic events over one year.**
- An activity in the Guadeloupean tourism sector **strongly impacted by climate change** is an activity recording a **loss of turnover between 10% and 50% due to climatic events over a year.**
- An activity of the Guadeloupean tourism sector **very strongly impacted by climate change** is an activity recording a loss of turnover of **more than 50% due to climatic events over one year.**

At the same time, critical thresholds for moving from one impact level to another were identified in the characterisation of the risk levels:

- 5% loss of turnover to move from low to medium impact level.
- 10% loss of turnover to move from medium to high impact level.
- 50% loss of turnover to move from high impact to very high impact.

5% moss of annual turnover due to climatic events	5% to 10% moss of annual turnover due to climatic events	10% to 50% moss of annual turnover due to climatic events	Loss of annual turnover more than 50% due to climatic events
LOW IMPACT	**MEDIUM IMPACT**	**HIGH IMPACT**	**VERY HIGH IMPACT**

Figure 36. Climate impact / risk levels for Tourism sector in Guadeloupe

The discussion between the participants in Workshop 3 did not allow us to identify a single risk faced by the tourism sector in Guadeloupe. Indeed, the sector is quite complex, in the sense that it is strongly linked to other areas or sectors: biodiversity, transport, agriculture, etc.

7.3.2.3 Adaptation vision

After the results of the steps just described and before reaching the objective of building adaptation pathways, the Playbook methodology takes us through the definition of a climate change adaptation outcome for each impact level. The outcomes are formulated as overall objectives to be achieved for each impact level. The discussions led to the following results:

- **Adaptation outcome for the low impact level** of impact (level 1): "**Controlling expenditure (investing to avoid further expenditure in the future)**". As the level of impact is low, participants agreed at this stage to only put in place "small measures" that would be beneficial in the future.
- **Adaptation outcome for the medium level** of impact (level 2): **"Propose complementary activities"**. At this level, participants identified partnership actions and the implementation of more enterprising actions than "small measures" as in level 1.
- **Adaptation outcome for the high impact level** (level 3): "**Change in the behaviour of professionals in the sector and tourists**". At this stage, the actions to be implemented are of the order of "thinking outside the box" to see the different possibilities for developing the sector's activities.
- **Adaptation outcome for the very high impact** level (level 4): "**Rethinking the tourism sector completely (reinventing, professional retraining)**". A transformative vision was adopted by the participants in Workshop 3 towards a new vision of the sector: building on other forms of tourism, putting in place new policies and strategies to develop the sector, building on other assets such as cultural tourism, etc.

Table 15. Climate desired outcomes per impact / risk level for the Tourism sector in Guadeloupe

	LOW IMPACT	MEDIUM IMPACT	HIGH IMPACT	VERY HIGH IMPACT
ADAPTATION DESIRED OUTCOME PER IMPACT / RISK LEVEL	Controlling expenditure (investing to avoid further expenditure in the future)	Propose complementary activities	Change in the behaviour of professionals in the sector and tourists	Rethinking the tourism sector completely (reinventing, professional retraining)

7.3.2.4 Adaptation pathways

The work carried out in Workshop 3 with tourism operators led to the identification of relevant actions to address every impact level identified.

Figure 37. Group exercise with tourist operators in Guadeloupe

The result is presented in Table 16 below. The final result presents the adaptation actions by level of impact which do not yet constitute finalised adaptation pathways. Prioritisation and analysis of compatibility between actions will lead to the identification of these pathways.

Table 16. Summary of the results of workshops: the most prominent risk, impact/risk levels, climate desired outcomes per impact/risk level, critical thresholds, and solutions to adapt to climate change by impact level for Tourism sector in Guadeloupe.

Most important risk for the tourism sector in Guadeloupe: multiple			
5% moss of annual turnover due to climatic events Loss of 5 %	5% to 10% moss of annual turnover due to climatic events Loss of 10 %	10% to 50% moss of annual turnover due to climatic events Loss of 50 %	Loss of annual turnover > 50% due to climatic events
Low impact	**Medium Impact**	**High Impact**	**Very High Impact**
Climate desired outcomes per Impact level			
Controlling expenditure (investing to avoid further expenditure in the future)	Proposing complementary activities	Changing behaviour of professionals of the sector and tourists	Total rethinking of the tourism sector (reinventing itself, professional retraining)
Relevant solutions to be taken per impact level (that will conduct to the adaptation pathways)			
Labelling process			
Charging for services that were not charged before	Develop partnerships with places to visit, restaurants, spas, diving centres, etc.	Price increasing	Modularity of accommodation: rent to students, sell to become permanent accommodation
Putting in place "small measures": - reduction of water pressure - install a water sensor - install electrical sub-meters - install LEDs	Redevelopment of spaces: natural space, return to authenticity	Diversification of distribution channels (e.g., Booking.com)	Do not only sell the landscape but also cultural tourism: create cooking or craft courses, diversify the tourist offer
Changing the tourist imaginary for tourism in Guadeloupe, especially in the media, cinema...	Targeting/sorting of tourists (economic means, respect for the place): fewer tourists who will be able to ensure the inflow of money)	Communication campaign	New strategy and policy
Provide visitors/tourists with instructions on how to use air conditioning and other equipment		Forming partnerships: federation, network of actors	Limiting the flow of tourists
		Limiting the number of visitors to major tourist sites	Compensating for the disappearance of natural areas through artificialisation (problematic)
	Wooden cladding for walls		
	Offer both air conditioning and fan		
	Windscreen system (traditional architecture in Guadeloupe) instead of blinds		
	Using of creole traditional building cultures techniques		
Avoiding soil sealing: a very important element			
Finding solutions for water harvesting (in connection with soil concretisation)			
Preserving biodiversity: sensitization on the role of biodiversity			
Recreating a new tourism offers (cuisine, crafts, local cinema, etc.): preparation from the 1st impact level			
Communication action			
Indicator: Loss of annual turnover			

8.0 GALICIA, SPAIN

8.1 General information on the workshops

Galicia was the sixth demonstrator which conducted workshops to set up adaptation pathways. The specificity of this demonstrator is that they conducted bilateral visits before holding the workshops themselves. At the end of 2022, the Galicia TransformAr team held bilateral meetings with key actors to discuss the adaptation of the Galician clam and mussel sector to CC. Two workshops were organised after that for the co-construction of adaptation pathways.

Workshop type	Bilateral meetings with key actors before two workshop sessions, involving stakeholders from the KCS. The first workshop was organised online and the second one was an in-person workshop
Date of the workshops	**End of 2022**: bilateral meetings with key actors to discuss the adaptation of the Galician clam and mussel sector to climate change **WS 1:** 23rd of September 2022, 10:00 am to 12:00 pm (CET), online **WS 2:** 25th of January 2023, 09:30 am to 14:00 pm (CET), in person
Location of the workshops	**WS 1:** online **WS 2:** at the Vilagarcía de Arousa auditorium
TransformAr organisers	CETMAR and UVigo
Key Community Systems (KCS)	Mussel and clam culture sector

The main objective of the process is to co-create a transformative vision and adaptation pathways to climate change for the economy, the society, and the environment. More specifically, it is expected to evaluate the present situation and propose actions and viable solutions to avoid damage that will result in one or more alternatives in the short and long term for the clam and mussel sector in Galicia. The two workshops organised for Galicia demo were named:

- **Workshop 1**: Climate risks for mussel and clam culture in Galicia. Perceptions and projections for a better adaptation.
- **Workshop 2**: Proposals to face the risks of climate change in the clam and mussel sector in Galicia.

8.2 Workshops organisation

A total of 25 organisations from the sector, administration, research, society, and the environment have collaborated in the exercise to try to answer the questions raised by the TransformAr project. Most of the invitees participated in the workshops and visits except for some who apologised for incompatibility of work schedules and expressed their interest in the results.

Bilateral and informal meetings aimed to collect information concerning risk chain components as well as the first workshop. The second workshop had the objective to setting up adaptation pathways.

8.3 Results of the workshops

8.3.1 Risk chain

Questions concerning risk chain components were raised both in the bilateral visits (during the months of September, October, and December 2022), and in the workshops (September 2022 and January 2023). The idea was to know if weather alterations, such as those attributed to CC, are being noticed in the Galician clam and mussel sector. Although in some cases the response was negative or hesitant, most of the stakeholders answered "yes, with great impact" or "yes, moderately". There were comments such as "there is a huge climate change" "last week we had the strongest Northern wind in recent years" "ignoring climate change is a mistake".

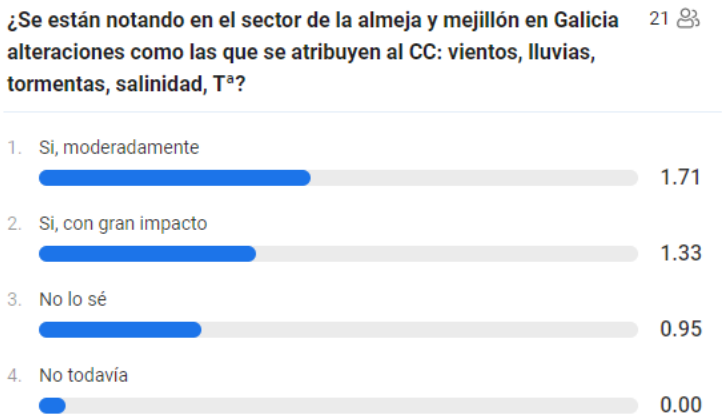

Figure 38. Replies from 21 participants 01/25/2023.

Most of participants to bilateral meetings and workshops agreed that climate change is affecting the sector and identified the risk chain components as described below.

- **Climate hazards:**

The climatic hazards affecting the sector vary depending on the production of clams or mussels. Despite the comments from those who hardly noticed CC alterations, the different organizations and participants in the visits and workshops perceive:

- Systematic increase in the surface temperature of seawater
- Changes in salinity/ rainfall and runoff regime
- Heat waves/fires
- Alteration in the winds/upwelling
- Increase in extreme events in winter: waves / storms

It is observed that the rise in sea level and acidification are less mentioned factors.

The presentation by X. Antón A. Salgado[1] (CSIC Marine Research Institute) defines the main characteristics of the territory and the sector in terms of their exposure and vulnerability to CC. This information, together with the one gathered in the bilateral visits and the workshops, served to characterise the exposure and vulnerability of the sector and the territory.

[1] "Climate change risk factors and challenges for the clam and mussel sectors in Galicia", XA Salgado (CSIC), Trabucco A. (CMCC), Piedracoba S. (CETMAR), Pilz T. (PIK) available at the following link: https://drive.google.com/file/d/1Y87NHGN8uWrmmif4d2M4S0qIKAge_Bse/view?usp=share_link

- **Exposure:**

  - Galicia is especially sensitive to CC: located in the region between the subtropical and subpolar gyres of the North Atlantic.
  - It has an important seasonal upwelling (April-October) that depends on the intensity and direction of coastal winds.
  - The topography of the coast is steep but has flat areas of sand.
  - The geomorphology provides protection against storms.
  - Exceptional place for the extraction of bivalves on beaches and the cultivation of mussels in rafts.
  - Great socioeconomic and cultural importance with national and international influence.
  - Economic driving force on which many other sectors depend.
  - Concentration of infrastructures (rafts, treatment plants, warehouses...) and population on the coast, even reclaiming land from the sea.

- **Vulnerability:**

  - Main source of income for many families and small/medium businesses.
  - Group especially sensitive to environmental conditions with no chance to protect from adverse weather and persistent humidity. Great physical effort.
  - Activity carried out by a high percentage of women, but little presence in management positions.
  - The aging of the population makes it more vulnerable to extreme events and ecosystem alteration.
  - Proliferation of easily flammable plantations on the coast.
  - Lack of concrete plans to adapt to CC in the clam and mussel sector (production and culture of bivalves).
  - Spaces of growing tourist attraction (pollution) and development of other uses (energy).

It should be mentioned the Xunta de Galicia Coastal Observatory (https://marnaraia.org/), which is understood as a strength in the context of climate change. For more than a decade, it has offered ocean-meteorological information on the Galician coast, being very useful for research, decision-making by administrations, and the development of ecosystem services related to the blue economy and coastal protection, including climate change indicators.

- **Main climatic risks:**

To answer the question of "**what is the main climatic risk considering exposure / vulnerability?"** it was conducted a selection of hazards (risk factors) and risks for the culture of bivalves in Galicia. The selection was made considering the above-mentioned context (exposure and vulnerability factors), studies developed by the Marine Research Institute – CSIC, along with the information from several projects (MarRisk, ClimeFish, AquaVitae …). It was then completed and explained with comments from the first workshop and the bilateral visits. In the second workshop, it was presented the list of hazards and risks to assess, complete and/or modify the information and prioritize the most relevant risks. It was reviewed in groups of 9-10 people (including rapporteur and moderator).

The exercise leaded to identify the risks generated by climate change that are considered to impact the most:

- Erosion or modification of sedimentary banks / Floods

- Habitat alteration: growth, survival, seasonality and reproductive cycle, red tides, massive mortality, food availability (it could increase and become an opportunity)
- Invasive species or modification of existing populations (alteration in the species of clams and predators)
- Location and availability of mussel spat and other bivalve recruitment
- Culture operations (mussel detachment) and damage to productive and coastal structures
- Rise of Algae (wrack) / Seaweed washed ashore

The risk chain for the sector of clam and mussel culture in Galicia is summarised in the Figure 39 below.

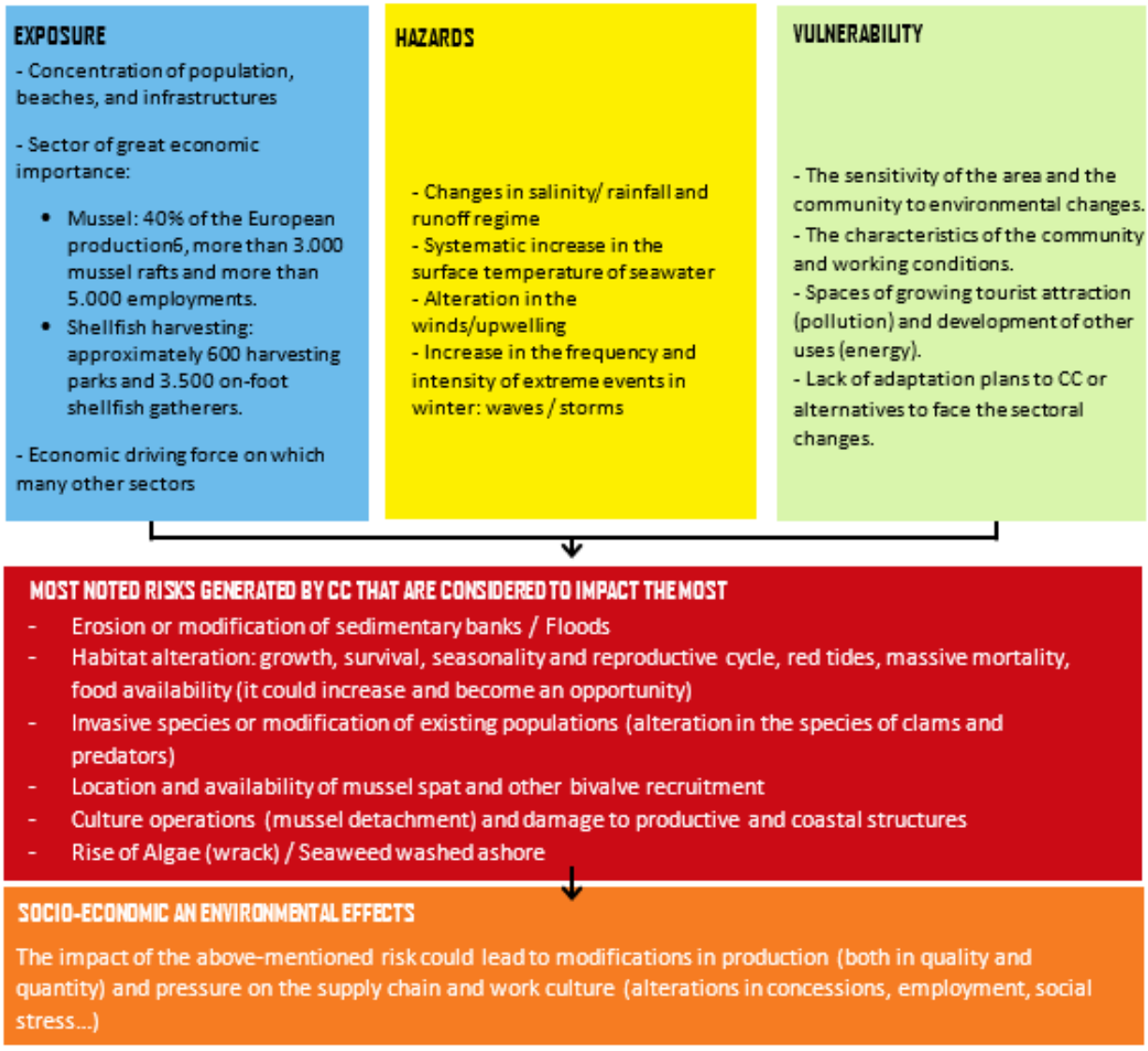

Figure 39. Risk chain for the sector of clam and mussel in Galicia

8.3.2 Risk evolution, indicators, critical thresholds

Nowadays some risks are routinely monitored, others are not yet, and others are but they are not widely known. During the visits and the workshops, it is expressed the lack of knowledge in all the communities (scientific, productive, governance, etc.) about the indicators applied currently for monitoring.

INTECMAR usually represents the main known source of data, although both the sector and the scientific community point out that the systematic collection of information points are usually very distant from the areas of interest and the models focus more on the platform area than in the *Rías*.
In general, it seems that just a few data have been collected systematically for years for the growing areas. However, it is noticed the interest and purpose to achieve long series and obtain practical and useful analyses. For some groups of producers, the access to scientific information is intricate and complex; sometimes there is a high mortality rate in the banks, and they do not know why.
Regarding the publication of data, it is suggested that the data obtained by public institutions should be public and accessible in accordance with European regulations. Right now, the producers consider very difficult to know what data are generated, who generate them and who is the target to receive them. The data are much dispersed. In addition, sometimes these data are generated by companies, and this adds complexity to the transfer.
It is brought to the attention of the participants that there is a legal or governance framework to properly manage the data and their publication by public entities, and that there is a current effort of the complementary plan for marine sciences[2] to achieve greater transparency and accessibility, but its complexity is highlighted. However, most attendees highlight the complexity of accessing information.
Therefore, there is a claim for a greater publication of data as far as possible, emphasizing disaggregated production data, although it is also recognized that the administration is already taking the first steps.
The solutions section tackles in detail the need for more local and accessible data; that is why, at this point, it was intended to discuss the existing and necessary data to obtain a first list of **indicators** that allows following the evolution of the relevant risks and better understanding the critical thresholds.

SURVIVAL/GROWTH CHANGES

Some production data is recorded together with the exploitation plans, but it is difficult to find it disaggregated with the required detail in the species, space, and time. There is also dispersed information and specific publications[3] that are accessible but are sometimes unknown, not shared and/or have a limited duration in time.

Galician fishing statistics: https://www.pescadegalicia.gal/cotizaciones/ventas.aspx ; https://www.pescadegalicia.gal/estadisticas/

The indicators mentioned are:

- Extraction / sale data in the auctions to estimate production data (without harming the data protection law).
- Spatial maps of bivalve culture (what, where and how much is grown and collected). The variations of the maps over time and their projections would serve to establish critical thresholds.
- Temporal graphs of growth and survival (more complete record of information and its sharing)**. Here the detachment of the mussel would also be recorded.** In order to carry out local prediction models and discriminate the effect of climate change variables, information on the growing areas is needed:

Oceanographic physical-chemistry
• Swell

[2] Complementary Plan in Marine Sciences between the Ministry of Science and Innovation and the Autonomous Communities of Galicia, Andalusia, Cantabria, the Region of Murcia and the Valencian Community (Investment 1 of Component 17 of the Mechanism for Recovery and Resilience of the funds Next Generation EU, which is part of the State's Transformation and Resilience Recovery Plan).

[3] Mexilón de Galicia, companies, brotherhoods, Rías Gallegas Forum, Studies in Cambados by the University of Vigo (Elsa Vazquez Labie Román et al., 2022)

- Currents
- Air temperature
- Sea water temperature
- Temperature in the extraction zones
- Salinity
- Turbidity
- Dissolved organic matter
- Dissolved oxygen
- Phytoplankton
- PH
- Wind direction and speed
- RH
- Atmospheric pressure (very important for shellfish gathering)

River

- Gauging stations closest to the mouths
- Periodicity of the data of greater capacity (some are weekly)
- History of the opening of dams

ALTERATION OF LOCATION AND AVAILABILITY OF MUSSEL SPAT AND OTHER BIVALVE RECRUITS

- **Mapping of mussel spat supply zones:** coverage measure (where is the resource)

- Abundance and distribution of larvae in the environment: current dynamics to know how the seed will move at a micro level. For the count of mussel larvae there is a probe that is dragged along with the ship, but the agents in the sector ignore the frequency and results. It seems that this data could be available in INTECMAR and there are other publications on the subject [4]. It is highlighted that, at least from February to May (spawning), the counting frequency should be weekly.

- Perhaps another would be **the variation of the seed uptake in collecting ropes**

FOOD AVAILABILITY

- **Regular chlorophyll concentration measurements**, which are done by INTECMAR but unknown by the sector.

INVASIVE SPECIES OR MODIFICATION OF EXISTING POPULATIONS AND PREDATORS

- **Mapping of the abundance and distribution of species that displace the resource** (invasive or autochthonous). Publish the sampling and works results in a manner that is accessible to society.

- **Peak in the predator's larvae cycle and spawning grounds** (winkle, starfish)

- Extraction permit application: it is difficult to obtain permission for invasive species, but the "application" itself could count as an indicator.

- **Inshore fishing captures**, to identify an increase in the population of predators.

[4] Brea-Bermejo's thesis (2009), Cartography of seeds on the coast based on ours carried out in 2000-2001 and 2005. CETMAR study of 2011.

ACCUMULATION OF SEAWEED WASHED ASHORE / ALGAE WRACK

- Dedication: Number of cleaning days (there is a routine record in the fishermen guilds and some studies of research centers).

- Quantity (time series): Number of containers (not all fishermen guilds have), Number of tractors... Only some fishermen guilds record the volume.

- Geographical and temporal concentration maps.

The toxic algae of the RED TIDES are monitored by INTECMAR. INTECMAR also has epidemiological reports (the last one of 2020)

EROSION / FLOOD

Most of the participants are aware of the existence of "tide gauges" owning to Puertos del Estado, Meteogalicia, a network of fixed platforms (4 buoys and 2 stations), HF Radar and INTECMAR. They are also aware of the INTECMAR's intention to obtain data closer to the coast and to the bivalve exploitation areas. It would be necessary to analyze the georeferenced information of the Territorial Planning plan and a MTPD (Maritime-Terrestrial Public Domain) line, aerial photos, orthophotos and Google Earth photos.

- Changes in beach profile

- Precise mapping of shellfish banks: changes in the morphology of sedimentary banks could be related to variations in productivity

CHANGES IN SUBSTRATE/SEDIMENT

The fishermen guilds obtain specific granulometry data to characterize the extraction area, but time series are needed. Perhaps it is more necessary for other species such as wedge clam in northern Galicia (producers knows previous CIMA studies for these spp[5]).

- Geological index of the substratum: monitoring at certain points of special interest of the change of substratum, continued over time.

- Mobility of the substrate

Data are very necessary to monitor the evolution of risk and obtain indicators that provide useful information to the sector. Although critical thresholds due to climate change are certainly unknown, any impact on production must be associated with adaptation measures.
Thus, in order to reflect on the alternatives and be able to define adaptation strategies, four levels of impact of climate change were proposed as follows:

- **A low impact of CC**: a production loss of 10% which may be a common situation due to other reasons.
- **A medium impact:** a production loss of 30% which is a difficult situation to endure.
- **A high impact:** a production loss of 60% which is hardly recoverable.

[5] Since 2013 CIMA worked in a study with the aim to analyse different environmental and population parameters for the wedge clam to promote its recovery. It is foreseen to maintain that research path until at least 2024.
http://www.ipacuicultura.com/noticias/ultima_hora/78753/el_trabajo_realizado_desde_2013_por_el_c

- **A very high impact:** a production loss of 100%, which means the closure of the activity.

Climate impact / risk levels for clam and mussel culture sector in Galicia as described by workshop participants are summarised by the Figure 40 below.

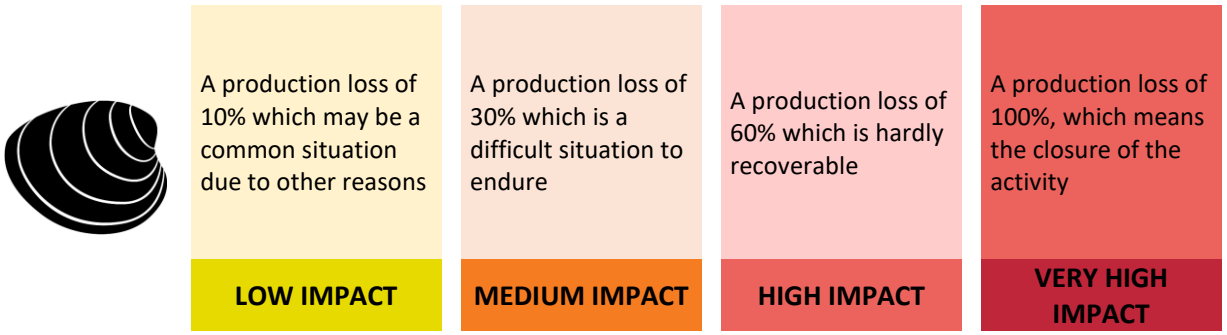

Figure 40. Climate impact / risk levels for clam and mussel sector in Galicia

8.3.3 Adaptation vision

In order to situate the participants in a more utopian vision, they were asked: **What would you like the sector in Galicia to look like in 50 years' time (for future generations)?**
Among the 20 answers, the most repeated was "**Sustainable" and then "Profitable" and "Resilient" and "Self-sufficient"**. It is also expected to be:

- Transparent
- Sensitised
- Productive
- Diversified
- Customisable
- Most influential
- Equally
- Inclusive
- Better
- Empowered

In this sense, the work began with stakeholders aiming to collaborate and seek solutions **to increase the resilience of the sector and alleviate the effects of climate change.** Thus, in workshop 2, a catalogue of solutions regarding governance, awareness, technical, nature-based and research and innovation was presented. Participants were asked which solutions they should implement, and they were invited to select the most relevant and add other necessary ones.
It was reminded to consider the various strategies to manage a risk (information transferred from the AquaVitae project):

- Eliminate the source of the risk
- Reduce likelihood through improved routines
- Mitigate consequences through technical protection or contingency plans
- Share risk taking with other parties
- Maintaining risks through informed decision

8.3.4 Adaptation pathways

For the case of the demonstrator of Galicia, solutions from the catalogue developed in the framework of TransformAr were considered and also new proposals and solutions were also added. Participants

identified solutions per solution type, impact level (low, medium, high and very high impact levels) for the clam and mussels culture sector and organised them in the short, medium, or long term. It was commented that several of these solutions are already being implemented.

Figure 41. Group exercise for solution identification for each level impact

Table 17 presents a collection of the comments and reflections of three working groups. This is the first approach of the participants to this type of debate, which was also limited in time. As such, this result shows the direction of the proposals and priorities that the participants considered for eventual routes to the risks detected. It is a good baseline reference for future actions, which contemplate a more rigorous, systematic, and long-term consultation process.

Perhaps the most complicated part of the debate is to organise the proposed solutions and to devise adaptation strategies according to the different scenarios. The sector understands that a 10% production loss is something relatively common and in circumstances disregarding climate change, but the exercise is carried out trying to imagine the different scenarios where the effects can be attributed to climate change. Thus, overall, the different groups agree to act as soon as possible for each solution, start applying them imminently and not wait for medium, high, or very high impact scenarios.

Table 17. Solutions for adaptation to climate change for the sector of clam and mussels by impact level in Galicia

Type of solution	Applicability
	Production loss of 10% / loss of 10% / Low Impact
	Production loss 30% / loss of 30% / Medium Impact
	Production loss of 60% / loss of 60% / High Impact
	100% production loss / Very High Impact
	Relevant solutions to be taken per impact level (that will conduct to the adaptation pathways)
Governance / Policies / Management	Periodic reviews and modifications in the protocols and closures to adapt to the CC
	Programs to support workers to improve their climate resilience
	Incentives for the diversification of production/economic activity
	National and regional strategies to prevent habitat destruction
	Substitution of crops by other spp / Change of business model
Communication / Awareness	Awareness and knowledge campaigns: workshops, meetings, round tables (close and understandable language)
	Mechanisms to promote communication and exchange of information on the effects of CC in the sector
	Promotion of Ocean Literacy
	Accessible information and analysis that is clear and user friendly
Technical and engineering solutions	Digitizing production monitoring to react more quickly and easily to the effects of CC
	Technical assistance for better and more efficient cultivation, and use of cutting-edge technologies to adapt to CC
	Create reliable prediction models of future scenarios to anticipate necessary actions.
Nature-based solutions	Greater control of spills, Reduce pollution of seas and rias
	Adopt the Living Shorelines Approach (LSA)
	"Green defences"
Research and Innovation	Investing in the improvement of knowledge about the way hazards /stressors deteriorate production
	Control of predators
	New spp, production and harvesting techniques for new climatic conditions

Red: short term // Orange: medium term // Green: long term

LESSONS LEARNT AND CONCLUSIONS

From February 2022 to January 2023, the six demonstrators of the TransformAr project were engaged in the process of setting up adaptation pathways. The organisation of all workshops was based on the Playbook methodology (Deliverable D3.10 developed in the framework of WP3 of the TransformAr project). As a reminder, the Playbook presents a step-by-step guide to co-construct adaptation pathways with stakeholders based on three main participatory workshop sessions. The process involves scientific and local knowledge. In November 2022, when almost all workshops were finished, a debriefing meeting was organised to collect feedback from applying the methodology by TransformAr partners who organised workshops.

The Playbook is to be taken as a general flexible guideline to co-construct adaptation pathways…

Having the step-by-step methodology was very helpful for workshop organisers to guide the workshops preparation, but all organisers highlighted that the Playbook was used as a basis, and that the application was adapted to each demonstrator context. It is important to understand that we can learn from past workshops, but each workshop is different for many reasons (context, stakeholders, sectors…). The Playbook is to be used as a general guide that workshop organisers could adapt. In the framework of the TransformAr project for example, each duo of partners per demonstrator organised workshops in different formats. The Playbook proposes 3 sessions to organise, but when TransformAr partners prepared their workshops, these sessions were organised differently due to various constraints. The 6 demonstrators organised the 3 sessions the following ways: 3 sessions in 3 separate half days, 3 sessions in 1 day, 3 sessions in a half day, 3 sessions condensed in 2 workshops or 4 sessions with different stakeholders' groups…. Involving stakeholders for 3-day workshops is quite difficult but organising all sessions in 1 day raises constraints as well. A balance should therefore be found between those two possibilities. When organising the workshops to set up the adaptation pathways, it is not mandatory to organise and to follow the proposed 3 sessions in the Playbook in 3 days. Rather than thinking about the number of sessions, workshop organisers have to be led by the question: "how can they reach the outcomes of each session (the **establishment of impact chains**, the **definition of risk level**, the **characterisation of critical thresholds,** the **definition of climate adaptation outcomes** and the **establishment of the adaptation pathways**) involving the relevant stakeholders?".

What is the best format to co-construct adaptation pathways: online, in-person or hybrid workshops?

The 3 sessions mentioned in the Playbook methodology could be implemented online, in-person or in a hybrid way. The majority of the workshops for the TransformAr project demonstrators were organised in-person, while some were held online and others in a hybrid way. Each format has its strengths and weaknesses.

For **online workshops**, logistics related to in-person workshops (time needed to travel for participants, room reservation, materials for participatory activities…) were avoided. Nonetheless, they had to be organised on a shorter time scale as one session should not exceed 2,5 hours to limit participant fatigue. For this, it is important to shorten some aspects of the Playbook methodology. At the same time, for these kinds of workshops, organisers are encouraged to use online survey tools (like Klaxoon which was used by some TransformAr demonstrators) to interact with participants to allow them to be remotely involved and to gain confidence in the subject matter.

On the other hand, **in-person workshops** allowed organisers to be more interactive (using papers, sticky-notes…) in the implementation of the sessions. In-person workshops also allowed for the development of professional networks between participants and organisers. This type of in-person workshops is based on the availability of stakeholders which can complicate the workshop organisation. For some contexts, territories, and sectors, it can be difficult to identify the right date to conduct workshops due to this availability constraint. Organisers should be informed on events and calendars of each organisation to be able to identify the right date to conduct workshops.

For a **hybrid participation approach** (some participants are online, and some are present in-person), it is quite difficult to organise the interaction (issues related to microphones, issues related to internet connection, difficulties in organising participatory activities with participants online and present in-person at the same time, …). As the Playbook methodology is based on a participatory approach, it is recommended to conduct workshops fully online or fully in-person if possible and avoid the hybrid way of work.

Who and how should the stakeholders be involved in the workshops?

The Playbook methodology to co-construct adaptation pathways is based on scientific and local expertise. It is crucial to identify the relevant actors to be involved in the process. The methodology of identifying the relevant stakeholders is well described in the Playbook and is related to the actors mapping of WP1 of TransformAr. For the TransformAr project, the choice was made by workshop organisers to involve all stakeholders from all KCS in the same workshop sessions or to involve stakeholders per KCS. Having all stakeholders in the same session can help to have a holistic view and a general understanding of the context of the territory but it is less relevant when discussion is focused on one sector. It is interesting to conduct the first session related to the perception of climate change with all stakeholders from all sectors and it is more interesting to have actors related to one sector when participants are discussing definition of impact levels, critical thresholds, adaptation outcomes for specific sector. It is also relevant to work separately with sectorial actors in the step of co-constructing the adaptation pathways for specific sectors. It is essential to establish the correct organisation in which to identify and to involve all categories of stakeholders to reach representativity of the sectors or the territory.
The Galician demonstrator proved that informal meetings and bilateral meetings with key stakeholders before workshops could be very useful in some circumstances to understand the sector, to be more confident in participants and to encourage involvement in the discussions. It is also important to think about the nature of the relationships between organisations and participants so organisers can adapt the involvement of each type of actors and moderate the sessions. For the Guadeloupe demonstrator for example, sessions had to be organised separately for practitioners and for institutional actors because of the conflictual relationship context between the two groups.

Choosing the period and the location is important while organising workshops for co-construction of adaptation pathways

The organisation of all workshops with TransformAr demonstrators show that the choice of the time and season to conduct workshops is important. Organisers should take into consideration the different organisational and seasonal constraints to be sure that key actors could attend the workshops. The choice of the place of the workshops is important as well. Feedback received from all TransformAr demonstrators highlighted the importance to include breaks between sessions to have time to work on the past sessions, to draw conclusions to present to participants in the next sessions. This time is also needed by participants to allow them to better understand the approach and methodology. It is also relevant to evaluate past sessions and identify necessary deviation for future workshops' organisation and approach (identification of missing actors, adaptation of participatory approach, agenda rearrangement…).

The methodology based on a participatory approach encourage the exchange of opinions among participants of workshops and meetings and involves local knowledge and experiences of stakeholders.

Preparing workshops to co-construct adaptation pathways presents language and common understanding challenges

It is important to underline that the use of the native language is very important when interacting with local actors during workshops. It allows for the fluidity of exchange, even though this raises challenges for organisers. For all TransformAr demonstrators, all workshops organised were held in the local language of each territory. As the Playbook was developed in English, some definitions of concepts were difficult to translate into some languages. Moreover, difficulties were reported by workshop organisers to explain concepts and differences between them (e.g., risk, hazard, impact) to participants who are not familiar to climate change field. For example, for Egaleo demonstrator, the majority of attendees were from different domains: social services, education, health. They needed time to understand the concepts and the approach taken. For this reason, workshop organisers and facilitators should be aware of the background of each participant and should adapt the workshop accordingly.

Lessons learnt related to workshop content, outcomes, and facilitation

This report presents results of organised workshops with all TransformAr project demonstrators to set up adaptation pathways by applying the Playbook methodology. The main results presented are risk chains, impact/risk evolution, indicators to assess impact/risk evolution, critical thresholds, adaptation vision and adaptation pathways. Lessons learnt for each outcome are presented below.

Lessons learnt related to risk chain development

All demonstrators were able to develop the risk chains. They were more or less articulated depending on the time allocated to the exercise. Some demonstrators were able to develop a detailed risk chain (with details for all components), while others presented a fairly simple risk chain containing the essential elements. The main challenge identified by TransformAr workshop organisers to accomplish this task is the capacity and the time needed by participants to understand the definition and the difference between risk chain components (exposure, hazards, vulnerability, intermediate impacts, risk, socio-economic impacts). This is why it is important to prepare before the workshop the definition of each concept in simple words and with concrete examples because confusion may occur while characterising some components of the risk chain. The risk chains developed by some TransformAr demonstrators have been at sectoral scale, while others have been developed at territorial scale. Choosing to develop risk chain at territorial level is interesting for having a holistic view of the impact of climate change. Nonetheless, having risk chains at sectorial level is also interesting to have more precision on impacts of climate change on the addressed sectors. Workshop organisers can choose one approach or can choose to develop both. It is important to identify the relevant stakeholders to involve for each approach chosen. The main purpose of the exercise is to enable participants to have a global understanding of the main causes and consequences of climate change in their territory or sector. This exercise is quite easy to understand and to implement if preparation work is done correctly. During the workshops with TransformAr demonstrators, it was observed that participants may not be able to distinguish climate-related hazards from other type of hazards (environmental hazards, geophysical hazards, man-made hazards…). In this context, what can be done is to reframe the discussions, keeping the non-climatic hazards identified in one category because they may help in other steps of the work, to understand the global context. Similarly, it may be difficult for participants to distinguish intermediate impacts from risks to be addressed. The solution of giving examples is still valid in this context in order to facilitate everyone's understanding.

Lessons learnt related to impact/risk evolution, indicators, and critical thresholds definition

The exercises of defining impact/risk evolution were quite difficult to implement by all TransformAr demonstrators as well as the identification and the quantification of indicators and critical thresholds. To address this issue, workshop organisers could prepare example for each elements (impact/risk evolution, identification and quantification of indicators and critical thresholds) to inspire participants as it was done by Guadeloupe demonstrator. Not all demonstrators achieved the objective of characterising critical thresholds. The concept was well explained and well understood by workshop organisers and participants but the quantification work of them (if quantitative parameters were chosen) was particularly challenging for some demonstrators such as in Oristano. It is important to note that critical thresholds could take different formats: quantitative measures of a social, an economic or a biophysical parameter, qualitative description of a specific social situation, frequency, or intensity of a specific climate event, …. For those demonstrators that achieved the objective of defining critical thresholds, some identified quantitative parameters while others have chosen to qualify a social situation. One approach is not more relevant than the other. The most important thing is that the actors come to understand the logic and identify for themselves what indicator is relevant to assess and what are the critical thresholds according to them. Participants may also choose to assess one or more indicators and characterise one or more critical thresholds as they consider it relevant. Workshop organisers are encouraged to prepare examples of each type of "indicator" and "critical threshold" to present to participants to allow them to understand the scope of the work. The best way to accomplish this task is to identify simple and logical indicators.

Lessons learnt from adaptation pathways development

Almost all TransformAr demonstrators were able to achieve the objective of having an "adaptation pathways" at the end of the workshop sessions. The City of Lappeenranta, for instance, is the only demonstrator which reached the ultimate objective of defining pathways as it is characterised in the Playbook. The other demonstrators are at the stage of solutions identified per impact / risk level. It is interesting to observe that some demonstrators presented the identified solutions per impact / risk level by type of solutions or by time horizon (case of Oristano and Galicia). The feedback received from workshop organisers was that the discussion on elaborating pathways needs time because it is preceded by identification of criteria and assessment of each proposed solutions regarding those criteria. For example, the City of Lappeenranta which achieved the ultimate objective, took the decision to organise an additional workshop to develop the adaptation pathways. Before that, workshop organisers from the City of Lappeenranta had to work internally in the definition of the pathways based on the result and an assessment work with some criteria. Other challenges were identified by TransformAr demonstrators to develop adaptation pathways while applying the Playbook methodology. One is related to the understanding of the concept of "adaptation pathways" and the concept of "transformative adaptation". Workshop organisers need to visualise the expected outcomes and should be the first to understand the concepts as this is an innovative approach to managing climate risks. Workshop facilitators are encouraged to prepare some questions to guide the discussion between participants for this task too. The identification of relevant solutions per impact level can take time. To be more efficient, some demonstrators prepared this step by presenting the catalogue of solutions prepared in the framework of the deliverable D3.2 of the TransformAr project to inspire participants. It is important to guide the participants in the process of "thinking outside the box" while identifying the relevant solutions to address each impact level. This could be done by presenting some examples of innovative solutions or by addressing some questions.

Way forward

The adaptation pathways developed by TransformAr demonstrators provide a sound basis for the adaptation to climate change within other sectors or territories and for next steps of the WP3 of TransformAr project which are the tasks T3.3 “Analysis of avoided damages and other direct benefits of pathways at demonstrator scale” and T3.4 “Ex ante impact assessment and selection of adaptive pathways”. The solutions that are identified in each workshop are from different domains, adapted to different contexts, are inspiring. The results are not just important for the TransformAr project but also to be replicated in other regions in Europe. For example, for the potential replication of the application of the Playbook methodology in the EU Adaptation Mission to accompany by 2030 at least 150 European regions and communities towards climate resilience. Other initiatives include the Regilience project planning to use the Playbook methodology for 10 more regions in 2023 too. The lessons learnt from the experience of the TransformAr project will be useful for these replication efforts.

ANNEX: Participants lists and agenda of workshops per demonstrator

WEST COUNTRY REGION, THE UNITED KINGDOM (UK)

Table 18. Participants list of Workshop 1 in West Country Region

NAME	ORGANISATION
Participants	
Becky Hughes	Cornwall government
Dan Lee	Cornwall government
Dominic Fairman	Cornwall government
Jade Neville	Cornwall wildlife trust org
Sam Hamilton	Fishery owner / River camel
Kate Allingham	Nature England org
Patrick Aubrey	NFU: representing
TransformAr partners	
Rim Khamis	ACTERRA
Léo Lenoir	ACTERRA
Margaretha Breil	CMCC
Katie Johnson	CMCC
Chiarra Trozzo	CMCC
Koen Vriesacker	VERHAERT
Filiep Dewitte	VERHAERT
Giles Rickard	WRT
Laurence Couldrick	WRT

Table 19. Agenda of the Workshop 1 in West Country Region

START	END	SUBJECT	PRESENTER	DUR.
9:00 am GMT	9:30	Introduction (TransformAr/Workshops)	VERHAERT / ACTERRA / WRT	0:30
9:30	9:45	Meet and greet (get to know the participants)	VERHAERT	0:15
9:45	10:05	Climate perception (polls) / Discussion	VERHAERT / ACTERRA	0:20
10:05	10:25	Climate Risk Factors (Hazards, Exposure, Vulnerability)	ACTERRA	0:20
10:25	10:35	Coffee Break		0:10
10:35	11:05	Risk Chain exercise (3 Break-out rooms)	ACTERRA/CMCC/WRT	0:30

START	END	SUBJECT	PRESENTER	DUR.
11:05	11:30	Presenting Results (7 mins per group)	Participants	0:25
11:30	12:00 pm GMT	Identifying solutions	Participants	0:30

Table 20. Participants list of Workshop 2 in West Country Region

NAME	ORGANISATION
Participants	
Chris Jones	Beaver Trust
Rick Garrard	Butterwell fisheries owner
Sam Hamilton	Butterwell Fishery manager
Lily Gray	Cornwall AONB
Becky Hughes	Cornwall Council
Jeremy Clitherow	Duchy estate
James Cooper	Environment Agency –Program Manager
Dominic Fairman	Local councilor & farmer
Kate Allingham	Natural England – Catchment Sensitive Farming
Patrick Aubrey-Fletcher	NFU
TransformAr partners	
Rim Khamis	ACTERRA
Stéphane Simonet	ACTERRA
Léo Lenoir	ACTERRA
Antonio Trabucco	CMCC
Margaretha Breil	CMCC
Katie Johnson	CMCC
Yannis Charalampidis	E3M
Tobias Pliz	PIK
Koen Vriesacker	VERHAERT
Filiep Dewitte	VERHAERT
Giles Rickard	WRT
Laurence Couldrick	WRT

Table 21. Agenda of Workshop 2 in the West Country Region

START	END	SUBJECT	PRESENTER	DUR.
9:00 am GMT	9:15	Wait for everyone to connect, Brief attendees on the results of the first workshop	ACTERRA	0:15
9:15	9:40	Presentation of biophysical hazards/impacts of CC (e.g., changes in precipitation patterns, extreme temperatures, etc.)	PIK	0:25
9:40	9:55	Discussion / Questions	Participants	0:15
9:55	10:15	Intermediary impacts of CC - likelihood and frequency of occurrence (e.g., floods, wildfires) / Critical Thresholds	CMCC	0:20
10:15	10:30	Discussion / Questions	Participants	0:15
10:30	10:40	BREAK		0:10
10:40	11:05	Ramifications of climate hazards and impacts on socio-economic systems	E3M	0:25
11:05	11:20	Discussion / Questions	Participants	0:15
11:20	12:00	Definition of Critical Thresholds (KLAXOON)	ACTERRA / Other TransformAr partners	0:40

Table 22. Participants list of Workshop 3 in the West Country Region

NAME	ORGANISATION
Participants	
James Cooper	
Dan Lee	Cornwall gov
Dominic Fairman	Cornwall government
Jade Neville	Cornwall Wildlife Trust
Kate Allingham	Nature England org
Patrick Aubrey-Fletcher	NFU
TransformAr partners	

NAME	ORGANISATION
Rim Khamis	ACTERRA
Léo Lenoir	ACTERRA
Stéphane Simonet	ACTERRA
Margaretha Breil	CMCC
Katie Johnson	CMCC
Jan Cools	University of Antwerp
Feliep Dewitte	VERHAERT
Nicolas Helssen	WRT
Giles Ricard	WRT

Table 23. Agenda of the Workshop 3 in the West Country Region

START	END	SUBJECT	PRESENTER	DUR.
9:00 am GMT	9:15	Wait for everyone to connect, Brief attendees on the results of the first and second workshop + objective of the third workshop	ACTERRA	0:15
9:15	9:30	Presentation on adaptation pathways and Transformative adaptation	ACTERRA	0:15
9:30	9:50	Klaxoon Exercise: Developing a Transformative Vision (Poll/Discussion)	ACTERRA/Participants	0:20
9:50	10:30	Klaxoon Exercise: determining objectives for AGRICULTURE sector, classifying and prioritizing solutions based on risk levels and fixed objectives	ACTERRA/Participants	0:40
10:30	10:40	BREAK		0:10
10:40	11:20	Klaxoon Exercise: determining objectives for WATER sector, classifying and prioritizing solutions based on risk levels and fixed objectives	ACTERRA/Participants	0:40
11:20	12:00	Klaxoon Exercise: determining objectives for BIODIVERSITY sector, classifying and prioritizing solutions based on risk levels and fixed objectives	ACTERRA/Participants	0:40

ORISTANO, ITALY

Table 24. Participants list of Oristano workshops

NAME	ORGANISATION
Participants	
Marco Ardu	Agronomist and local farmer
Sandro Pili	Commune Terralba
Milo Pinna	Commune Terralba
Stefano Carboni	International Marine Center
Sebastiano Curreli	Latte Arborea
Maria Rosaria Madau	Regione Sardegna
Andrea Liverani	Smart Geo Survey
TransformAr partners	
Margaretha Breil	CMCC
Katie Johnson	CMCC
Vania Statzu	MEDSEA
Francesca Etzi	MEDSEA

Table 25. Agenda of the Day 1 Workshop in Oristano

START	END	SUBJECT	PRESENTER	DUR.
15:00	15:10	Introduction to TransformAr and the workshops	CMCC	0:10
15:10	15:40	Meet and greet	All	0:30
15:40	16:00	Climate perceptions	CMCC	0:20
16:00	16:35	Risk chain exercise	All	0:35
16:35	17:05	Ongoing projects in the lagoon area	MEDSEA	0:30
17:05	17:35	Coffee Break		0:30
17:35	18:10	Solutions exercise	All	0:35
18:10	18:30	Presentation of group work results	Participants	0:20

Table 26. Agenda of the Day 2 Workshop in Oristano

START	END	SUBJECT	PRESENTER	DUR.
15:00	15:10	Recap from day 1	CMCC	0:10
15:10	15:30	Biophysical hazards of climate change	PIK	0:20
15:30	15:50	Intermediary impacts of climate change	CMCC	0:20
15:50	16:10	Ramifications of climate hazards and impacts on socio-economic systems	E3M	0:20
16:10	16:25	Adaptation pathways and Transformative adaptation	CMCC	0:15
16:25	16:55	Critical threshold definition exercise	All	0:30

START	END	SUBJECT	PRESENTER	DUR.
16:55	17:25	Coffee Break		0:30
17:25	18:00	Determine objectives and prioritize solutions exercise	All	0:35
18:00	18:20	Presentation of group work results	Participants	0:20
18:20	18:30	Wrap up and next steps	CMCC	0:10

EGALEO, GREECE

Table 27. Participants list of the workshop in Egaleo

NAME	ORGANISATION	CAPACITY
Participants		
Theodora Gkolomazou	1st Primary School Egaleo	Education
Elissaiou Georgios	Development Association of Western Athens (ASDA)	Infrastructure - Urban planning
Giannibas Dionisios	Development Association of Western Athens (ASDA)	Infrastructure - Urban planning
Lialiara Georgia	Ministry of Education and Religious Affairs	Education
Konstantinos Papaspyropoulos	Ministry of Environment and Energy	Infrastructure – Water management expert
Samara Kiparissia	Municipality of Egaleo (MOE)	Social Services
Thalia Grigoriadou	Natural Environment & Climate Change Agency (N.E.C.C.A.) / ARSINOE representative	Climate Change
Orfeas Rousos	Natural Environment & Climate Change Agency (N.E.C.C.A.) / ARSINOE representative	Climate Change
Giota Dimitropoiulou	Professor of Psychology - University of Crete	Health
Stella Papamichail	University of West Attica	Social Services
TransformAr partners		
Dimitris Tzempelikos	Municipality of Egaleo (MOE)	Urban planning
Eirini Karakasidou	Municipality of Egaleo (MOE)	Health
Evridiki Pavlidi	Municipality of Egaleo (MOE)	Education
Thanasis Sfetsos	NCSR Demokritos (NCSRD)	Climate Risk
Stelios Karozis	NCSR Demokritos (NCSRD)	Climate Risk
Ioannis Zarikos	NCSR Demokritos (NCSRD)	Climate Risk

Table 28. Agenda of the Workshop in Egaleo

START	END	SUBJECT	PRESENTER	DUR.
9:30	10:00	Registration	TransformAr	0:30
10:00	10:15	Municipality of Egaleo - Introduction	MOE	0:15
10:15	10:35	TransformAr - Introduction	NCSRD	0:20
10:35	10:55	General Introduction and Scope of the workshop	NCSRD	0:20
10:55	11:05	Group Exercise 1 - Introduction	TransformAr	0:10
11:05	11:35	Group Exercise 1: Climate perception, Challenges & Existing solutions	TransformAr	0:30
11:35	11:45	Synopsis group exercise 1 / Comparison with public questionnaire	TransformAr	0:10
11:45	12:00	Coffee Break		0:15
12:00	12:15	ARSINOE - Project Introduction	ARSINOE	0:15
12:15	12:35	Presentation and Discussion: Intermediate Impacts	NCSRD	0:20
12:35	12:45	Group Exercise 2 - Introduction	TransformAr	0:10
12:45	13:05	Group Exercise 2: Climate vulnerability, Impacts and Projections	TransformAr	0:20
13:05	13:15	Synopsis group exercise 2	TransformAr	0:10
15:15	14:45	Lunch Break		0:30
14:45	15:00	Climate resilience plans in Western Attica	ASDA	0:15
15:00	15:20	Poll: Future Vision	TransformAr	0:20
15:20	15:30	Group Exercise 3 - Introduction	TransformAr	0:10
15:30	15:50	Group Exercise 3: Setting targets for area A, classifying and prioritizing solutions based on risk levels and predetermined targets	TransformAr	0:20
15:50	16:00	Coffee Break		0:10
16:00	16:20	Group Exercise 3: Setting targets for area B, classifying and prioritizing solutions based on risk levels and predetermined targets	TransformAr	0:20
16:20	16:40	Group Exercise 3: Setting targets for area C, classifying and prioritizing solutions based on risk levels and predetermined targets	TransformAr	0:20
16:40	17:00	Synopsis group exercise 3 / Discussion of proposed	TransformAr	0:20

START	END	SUBJECT	PRESENTER	DUR.
		solution		

CITY OF LAPPEENRANTA, FINLAND

Table 29. Participants list of Workshop 1 in Lappeenranta

NAME	ORGANISATION
Participants	
Toni Savela	Caproc Oy
Juho Tuuliainen	City of Lappeenranta
Jukka Penttilä	City of Lappeenranta
Tiia Sillgren	City of Lappeenranta
Laura Ratilainen	City of Lappeenranta
Raija Aura	City of Lappeenranta
Simo Sihvo	Greenreality
Ville Alppisara	Lappeenranta
Satu-Pia Reinikainen	LUT University
Tuomas Sihvonen	LUT University
TransformAr partners	
Sanna Varis	City of Lappeenranta
Mika Luoranen	LUT University
Mariia Zhaurova	LUT University

Table 30. Agenda of the Workshop 1 in the City of Lappeenranta

START	SUBJECT	PRESENTER
10:00	Introduction	Facilitators
10:10	“Meet and greet”	Participants
10:50	Coffee break	
11:00	Climate perception / Discussion	Facilitators
11:45	Climate Risk Factors	Facilitators
12:00	Lunch at City Hall	

START	SUBJECT	PRESENTER
13:00	Risk Chain exercise (2 Break-out rooms: water management & urban planning)	Facilitators
14:00	COFFEE BREAK	
14:15	Presenting Results	Participants
14:45	Closing	Facilitators

Table 31. Participants list of Workshop 2 in the City of Lappeenranta

NAME	ORGANISATION
Participants	
Simo Sihvo	City of Lappeenranta
Ville Alppisara	City of Lappeenranta
Juho Tuuliainen	City of Lappeenranta
Jukka Penttilä	City of Lappeenranta
Tiia Sillgren	City of Lappeenranta
Laura Ratilainen	City of Lappeenranta
Raija Aura	City of Lappeenranta
Sanni Simonen	City of Lappeenranta
Pilvi-Elina Kupias	ELY
Inger-Katharina Gregersen	Gjovik
Pål Goddard	Gjovik
Satu-Pia Reinikainen	LUT University
Tuomas Sihvonen	LUT University
Risto Soukka	LUT University
TransformAr partners	
Sanna Varis	City of Lappeenranta
Mika Luoranen	LUT University
Mariia Zhaurova	LUT University

Table 32. Agenda of the Workshop 2 in the City of Lappeenranta

START	SUBJECT	PRESENTER
8:30	Introduction (Briefing on results Session 1)	Facilitators
8:45	Presentation of biophysical hazards/impacts of CC (e.g., changes in precipitation patterns, extreme temperatures, etc.)	PIK

START	SUBJECT	PRESENTER
9:10	Discussion / Questions	Participants
9:25	COFFEE BREAK	
9:40	Intermediary impacts of CC - likelihood and frequency of occurrence (e.g., floods, wildfires) / Critical Thresholds	PIK
10:00	Discussion / Questions	Participants
10:15	Ramifications of climate hazards and impacts on socio-economic systems	E3M/Yannis Charalampidis
10:50	Discussion / Questions	Participants
11:20	Group exercise: Critical threshold definition	Facilitators
12:00	LUNCH AT CITY HALL	

Table 33. Participants list of Workshop 3 in Lappeenranta

NAME	ORGANISATION
Participants	
Simo Sihvo	City of Lappeenranta
Juho Tuuliainen	City of Lappeenranta
Jukka Penttilä	City of Lappeenranta
Tiia Sillgren	City of Lappeenranta
Laura Ratilainen	City of Lappeenranta
Sanni Simonen	City of Lappeenranta
Raija Aura	City of Lappeenranta
Pilvi-Elina Kupias	ELY
Inger-Katharina Gregersen	Gjovik
Pål Goddard	Gjovik
Satu-Pia Reinikainen	LUT University
Tuomas Sihvonen	LUT University
Risto Soukka	LUT University
TransformAr partners	
Sanna Varis	City of Lappeenranta
Mika Luoranen	LUT University
Mariia Zhaurova	LUT University

Table 34. Agenda of Workshop 3 in the City of Lappeenranta

START	SUBJECT	PRESENTER
13:00	Introduction (Briefing on results Session 1&2) + objective of the third workshop	Facilitators
13:05	Presentation on adaptation pathways and Transformative adaptation	ACTERRA
13:20	Exercise: Developing a Transformative Vision	Facilitators/Participants
13:45	Group exercise water management	Facilitators/Participants
14:25	COFFEE BREAK	
14:35	Group exercise urban planning	Facilitators/Participants
15:05	Wrap up. Ending the workshop	Facilitators/Participants

Table 35. Participants list of Workshop 4 in Lappeenranta

NAME	ORGANISATION
Participants	
Simo Sihvo	City of Lappeenranta
Juho Tuuliainen	City of Lappeenranta
Jukka Penttilä	City of Lappeenranta
Tiia Sillgren	City of Lappeenranta
Laura Ratilainen	City of Lappeenranta
Ville Alppisara	City of Lappeenranta
Jenna Laakso	City of Lappeenranta
Sanni Simonen	City of Lappeenranta
Satu-Pia Reinikainen	LUT University
Tuomas Sihvonen	LUT University
Risto Soukka	LUT University
TransformAr partners	
Sanna Varis	City of Lappeenranta

NAME	ORGANISATION
Mika Luoranen	LUT University
Mariia Zhaurova	LUT University

GUADELOUPE, FRANCE

Table 36. Participants list of Workshop 1 in Guadeloupe

NAME	ORGANISATION	M/F
Farmers		
NARAYANINSAMY Donovan	Banana producer	M
NARAYANINSAMY Marie-Ketty	Banana producer	F
PORTECOP Yves	Beekeeper	M
TONY Robert Olivier	Farmer	M
TEL Loic	Market gardener	M
LATCHMAN Christophe	Market gardener, banana producer and stockbreeder	M
CHASTANET Dominique	Sugar cane producer	M
CHASTANET Océane	Sugar cane producer	F
MATHIEU Cyrille	Sugar cane producer	M
KANCEL Natacha	Vanilla producer	F
TransformAr partners		
RAKOTONIRINA Mampionona	ACTERRA	F
SIMONET Stéphane	ACTERRA (online)	M
VINCENNES Marie-Edith	ADEME	F
TRABUCCO Antonio	CMCC (online)	M
CHARALAMPIDIS Yannis	E3M (online)	M
PILZ Tobias	PIK	M

Table 37. Agenda of the Workshop 1 in Guadeloupe

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
12h30 PM	60 min	Welcome of participants and lunch	All participants
1h30 PM	15 min	The TransformAr project, objectives of the workshop	ADEME, ACTERRA
1h45 PM	10 min	Difference between adaptation and mitigation	ADEME
1h55 PM	40 min	**Scientific inputs**: • Climate projections,	PIK, CMCC, E3M

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
		• Biophysical impacts of climate change on the agricultural sector in Guadeloupe • Socio-economic impacts of climate change on the agricultural sector in Guadeloupe	
2h35 PM	145 min	**Collective working time**: • Establishing the risk chain: focus on existing solutions and hazards • Definition of indicators, risk evolution and critical thresholds • Identification of climate change adaptation solutions by level of impact to construct an adaptation pathway for the Guadeloupean agricultural sector	All participants
5h00 PM	5 min	**Conclusion of the workshop**	ADEME, ACTERRA

Table 38. Participants list of Workshop 2 in Guadeloupe

NAME	ORGANISATION	M/F
Institutional actors of the agricultural sector in Guadeloupe		
VANDERBECKEN Nadege	CANGT (Communauté d'Agglomération du Nord Grande-Terre)	F
JEAN-CHARLES Pascal	Chamber of Agriculture	M
RAMIN Christophe	Chamber of Agriculture	M
BOULASSY Meagan	DEAL (Regional directorate for the Environment, Planning and Housing)	F
INGADASSAMY Eloïse	Departmental Council	F
MACCES Roger	Elected Departmental Council	M
BLAZY Jean Marc	INRAE (National Institute for Agricultural Research)	M
LASTEL Marie-Laure	IT2 (Tropical Technical Institute)	F
PIERRE Cathy	Région Guadeloupe	F
TREFLE Rodrigue	Safer (Société d'aménagement foncier et d'établissement rural)	M
BERNARD Didier	Université des Antilles	M
TransformAr partners		
RAKOTONIRINA Mampionona	ACTERRA	F
VINCENNES Marie-Edith	ADEME	F
TRABUCCO Antonio	CMCC	M
CHARALAMPIDIS Yannis	E3M (online)	M
PILZ Tobias	PIK	M

NAME	ORGANISATION	M/F
Mahmoud RABIE	VERHAERT	M

Table 39. Agenda of the Workshop 2 in Guadeloupe

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
8h00 AM	30 min	Welcome of participants and breakfast	All the participants
8h30 AM	10 min	Tour de table	All the participants
8h40 AM	10 min	**Workshop contextualisation:** TransformAr, objectives of the workshops	ADEME, ACTERRA
8h50 AM	10 min	**Presentation**: difference between adaptation and mitigation	ADEME
9h00 AM	40 min	**Scientific inputs**: climate projection, biophysical impact modelling, economic impact modelling	PIK, CMCC, E3M
9h40 AM	20 min	- Climate hazards for the Guadeloupean agricultural sector (5 min) - Restitution of discussions on a climate change adaptation trajectory with farmers (15 min)	All the participants
10h00 AM	10 min	Coffee break	
10h10 AM	15 min	**Brainstorming:** challenges for the implementation of identified adaptation solutions	All the participants
10h25 AM	5 min	Prioritisation of 3 main challenges	All the participants
10h30 AM	45 min	***World café*:** solutions to address the 3 main challenges	All the participants
11h15 AM	15 min	Restitution of each *« café »*	All the participants
11h30 AM	5 min	Next steps	ADEME, ACTERRA

Table 40. Participants list of Workshop 3 in Guadeloupe

NAME	ORGANISATION	M/F
Tour operator		
Elodie ESTHER	CCI Business Advisor	F
Nicolas DELACOUR	Gite owner	M
Pascal SCOTTY	Gite owner	M
Mme SCOTTY	Gite owner	F

NAME	ORGANISATION	M/F
Tour operator		
Fance-Lise FRENET-LECOMTE (representing Dominique FRENET)	Gite owner	F
Aïssata DOUMBIA (representing Gerald MAÎTRE)	Zoo De Guadeloupe (Director)	F
TransformAr partners		
RAKOTONIRINA Mampionona	ACTERRA	F
SIMONET Stéphane	ACTERRA (online)	M
VINCENNES Marie-Edith	ADEME	F
TRABUCCO Antonio	CMCC (online)	M
CHARALAMPIDIS Yannis	E3M	M
PILZ Tobias	PIK	M
RABIE Mahmoud	VERHAERT	M

Table 41. Agenda of the Workshop 3 in Guadeloupe

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
12h00 PM	60 min	**Welcome of participants and lunch**	All participants
1h00 PM	15 min	**Tour de table, introduction: Transformar, objective of the workshop**	All participants, ADEME
1h15 PM	10 min	**Nudging presentation**	VERHAERT
1h25 PM	10 min	**Survey:** nudging	Tous, ADEME
1h35 PM	10 min	**Difference between adaptation and mitigation**	ADEME
1h45 PM	30 min	**Scientific inputs:** climate projections, biophysical impacts of climate change, economic impacts of climate change	PIK, CMCC, E3M
2h15 PM	**10 min**	**Coffee-break**	
2h25 PM	35 min	**Working group 1**: hazards, exposition, vulnerability to climate change, existing solutions	All participants

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
2h55 PM	45 min	**Working group 2**: risk evolution, indicators, critical thresholds	All participants
3h40 PM	55 min	**Working group 3**: Construction of adaptation pathways for Tourism sector in Guadeloupe	All participants
4h35 PM	5 min	**Survey:** local climate change adaptation fund	All participants
4h40 PM	5 min	**Conclusion of the workshop**	ADEME, ACTERRA

Table 42. Participants list of Workshop 4 in Guadeloupe

NAME	ORGANISATION	M/F
Institutional actors of the tourism sector in Guadeloupe		
VANDERBECKEN Nadege	CANGT (Communauté d'Agglomération du Nord Grande-Terre)	F
Elodie ESTHER	CCI	F
Gwladys MAURINIER	CCI	F
Lauren DESPREZ	Jardin de Valombreuse	F
Arnaud LARADE	Parc National de Guadeloupe	M
TransformAr partners		
RAKOTONIRINA Mampionona	ACTERRA	F
VINCENNES Marie-Edith	ADEME	F
TRABUCCO Antonio	CMCC	M
CHARALAMPIDIS Yannis	E3M	M
PILZ Tobias	PIK	M
RABIE Mahmoud	VERHAERT	M

Table 43. Agenda of the Workshop 4 in Guadeloupe

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
8h00 AM	30 min	Accueil des participants et petit-déjeuner	All participants
8h30 AM	10 min	Tour de table	All the participants

TIME (AST)	DURATION	SUBJECT	RESPONSIBLE
8h40 AM	10 min	**Workshop contextualisation:** TransformAr, objectives of the workshops	ADEME, ACTERRA
8h50 AM	5 min	**Survey: local climate change adaptation funds**	ADEME
8h55 AM	10 min	**Nudging presentation**	VERHAERT
9h05 AM	10 min	**Differences between adaptation and mitigation**	ADEME
9h15 AM	30 min	**Scientific inputs**: climate projection, biophysical impact modelling, economic impact modelling	PIK, CMCC, E3M
9h45 AM	20 min	**Restitution** **-** Risk chain for the tourism sector in Guadeloupe (5 min) - Restitution of the discussions on the climate change adaptation pathways produced by tour operators (15 min)	ACTERRA
10h05 AM	10 min	Coffee break	
10h15 AM	15 min	**Brainstorming:** challenges for the implementation of identified adaptation solutions	All the participants
10h30 AM	10 min	Prioritisation of 3 main challenges	All the participants
10h40 AM	40 min	***World café:*** solutions to address the 3 main challenges	All the participants
11h20 AM	15 min	**Restitution of each « *café* »**	All the participants
11h35 AM	5 min	**Next steps**	ADEME, ACTERRA

GALICIA, SPAIN

T1=Workshop 1 // T2=Workshop 2 // V=Bilateral visit
M=Moderator // R=Rapporteur

Table 44. Participants list of workshops and bilateral meetings in Galicia

NAME	ORGANISATION	T1	T2	V
Stakeholders				
Juan Carlos Maneiro	AGADE - Asociación Galega de Empresarios Depuradores de Moluscos			X
Emilia Fandiño Camiña	AMEGROVE			X
Cristina Dacosta Blanco	Asociación de Rañeiros de Arousa			X
Juan José Rial Millán	Asociación de Rañeiros de Arousa			X
Suso Méndez	Asociación Rianxeira			X
Carlos Gabín Sánchez	CIMA- Consellería do Mar	X	X	X
José Alberto de Santiago	CIMA- Consellería do Mar	X	X	
Julia xxxx	Cofradía A Illa de Arousa			X
Nel xxxx	Cofradía Aguiño			X
José Carlos Mariño Balsa	Cofradía Cambados San Antonio		X	X
Maria Lourdes Conde	Cofradía Carril Santiago Apóstol		X	X
Ana María Rey Lozano	Cofradía de Cabo de Cruz		X	X
Marta Cascallar	Cofradía O Grove San Martiño			X
María xxxx	Cofradía Pobra do Caramiñal			X
Amelia Caamaño Otero	Cofradía Rianxo Virxe do Carme		X	X
Paula Barreiro Buceta	Cofradía Vilanova A Pastoriza		X	X
Rosalino Diaz Calo	Cofradía Vilanova A Pastoriza		X	X
Ana Alcalde Creo	Cofradía Vilaxoan Virxe do Rosario			X
Lourdes Corvo	Cofradía Vilaxoan Virxe do Rosario			X
Ángeles Longa Portabales	Consello Regulador de Mexillón de Galicia	X	X	X
Joaquín Garrido	Consello Regulador do Mexillón de Galicia	X		X
Isabel Fuentes Santos	CSIC Instituto de Investigaciones Marinas	X	X	
Paula Conde Pardo	CSIC Instituto de Investigaciones Marinas		X	
Xose Antón Álvarez Salgado	CSIC Instituto de Investigaciones Marinas	X	X	
Javier Martínez Durán	Federación de Cofradías de Pontevedra	X		
Jose Manuel	Federación de Cofradías de Pontevedra	X		
Pedro Montero Vilar	INTECMAR	X		
Juan Taboada	Meteogalicia			X
Dolores Gómez	Mulleres salgadas			X
Sandra Amezaga	Mulleres Salgadas		X	
Francisco Castro Nueve	OPMEGA		X	
Jesús Castiñeira Martínez	OPMEGA		X	

NAME	ORGANISATION	T1	T2	V
Ana Rivas Castro	Parquistas de Carril OPP89		X	X
Jose Luis Villanueva	Parquistas de Carril OPP89			X
TransformAr partners				
Amaya Soto (M)	CETMAR	X	X	
Clara Almécija Pereda	CETMAR		X	
Lucía Fraga Lago (M)	CETMAR	X	X	
Silvia Piedracoba (M/R)	CETMAR	X	X	
Silvia Torres (R/M)	CETMAR	X	X	
Óscar Bernárdez Pérez	FEUGA	X	X	
Teresa Sexto Anello	FEUGA		X	
Ana Maria Bernabeu (R)	Universidade de Vigo (Geoma)	X	X	
José Guitián (R)	Universidade de Vigo (Geoma)	X	X	
Andrea Ogando Vidal (R)	Universidade de Vigo (Rede)	X	X	
Carlos Rodríguez García	Universidade de Vigo (Rede)	X	X	

Table 45. Agenda of the second workshop in Galicia

START	END	SUBJECT	PRESENTER	DUR.
9:30	9:40	The TransformAr project	CETMAR	10 min
9:40	10:00	Climate change hazards and challenges for the clam and mussel sectors in Galicia	IIM	20 min
10:00	11:00	**Group discussion** - Validation of the prioritization of risks and impacts based on scientific data.	All participants	60 min
11:00	11:30	**Participatory exercise** - Evolution of risks What changes are perceived? Indicators.	All participants	30 min
11:30	11:50	Coffee Break		20 min
11:50	12:50	Group discussion - The future of the sector in Galicia. What do we want?	All participants	60 min
12:50	13:50	Participatory exercise - Adaptation solutions What can we do?	All participants	60 min
13:50	14:00	Closing of the session and upcoming activities of TransformAr in Galicia	CETMAR	10 min
14:00		Lunch		

Climate change impacts are here and now. The impacts on people, prosperity and planet are already pervasive but unevenly distributed, as stated in the new EU Blueprint strategy (European Commission-EC, 2019). To reduce climate-related risks, the EC and the IPCC agree that transformational adaptation is essential. The TranformAr project aims to develop and demonstrate products and services to launch and accelerate large-scale and disruptive adaptive process for transformational adaptation in vulnerable regions and communities across Europe.

The 6 TransformAr lighthouse demonstrators face a common challenge: water-related risks and impacts of climate change. Based on existing successful initiatives, the project will develop, test and demonstrate solutions and pathways, integrated in Innovation Packages, in 6 territories.

Transformational pathways, including an integrated risk assessment approach are co-developed by means of 9 Transformational Adaptive Blocks. A set of 22 tested actionable adaptive solutions are tested and demonstrated, ranging from nature-based solutions, innovative technologies, financing, insurance and governance models, awareness and behavioral change solutions.

TransformAr

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