Climate risks and vulnerabilities for each target area

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Deliverable Number 3.2.2

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Deliverable Title	Climate risks and vulnerabilities for any target area
Partner in Charge	PP1 - IRENA – Istrian Regional Energy Agency
Partners involved	All
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Distribution	Public

Summary

Introduction

The deliverable D.3.2.2. is linked to the Context analysis every project partner is obliged to complete for their target area and is considered as the knowledge-base of data for learning and disseminating values of each territorial context. Two phases of the activity are designed to investigate all existing policies, plans (SEAPs) and measures already put in place in each territorial context (district level) with a special focus on energy and climate issues in the first phase, and should, if possible, include an analysis of funding tools, listing the potential sources or initiatives that would be useful during the implementation phase (WP4), while the second phase is dedicated to the compulsory analysis to respond to CoM requirements about SECAP plans and should set-up an assessment of risks and vulnerabilities that would potentially affect each territory where partners are intended to develop and implement joint adaptation measures.

This report is a part of the second sub-action of deliverable D.3.2.2. and is aimed at collecting and possibly mapping all climate risks and vulnerabilities for the partners' designated target areas. The goal of the report is to summarize the collection of the assessments produced in each territory.

In Annex I Part A and Part B, the contributions in the local language for each target have been reported.

2. Risk and vulnerability assessment summary

2.1 [PP1] IRENA – ISTRIAN REGIONAL ENERGY AGENCY

Summary

The Risk and Vulnerability Assessment analysis was coordinated by PP1 – IRENA – Istrian Regional Energy Agency with SENSUM ltd. as the technical supervisor and contractor. The process of the assessment started in June 2019 and was completed in October 2019.

Groups of stakeholders and key actors involved include the Agency for Payments in Agriculture, Fisheries and Rural Development (*Agencija za plaćanja u poljoprivredi, ribarstvu i ruralnom razvoju*), Bureau of Statistics (*Državni zavod za statistiku*), City of Buje – Buie, City of Novigrad – Cittanova, Croatian Chamber of Commerce (*Hrvatska Gospodarska Komora*), Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture (*Uprava za stručnu podršku razvoju poljoprivrede i ribarstva Ministarstva poljoprivrede*), Fund for Development of Agriculture and Agritourism of Istria (*Fond za razvoj poljoprivrede i agroturizma Istre*), In Konzalting ltd., Institute for Physical Planning of Istria County (*Zavod za prostorno uređenje Istarske županije*), Institute of Public Health of the County of Istria (*Zavod za javno zdravstvo Istarske županije*), Istrian County Water supply (*Istarski vodovod ltd.*), Istrian County Tourist Board (*Turistička zajednica Istarske županije*), Jaić Consulting ltd., Ministry of Environment and Energy (*Ministarstvo zaštite okoliša i energetike*), Municipality of Brtonigla – Verteneglio, State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service (*Državni hidrometeorološki zavod, Sektor za meteorološka istraživanja i razvoj, Služba za klimatološka istraživanja i primijenjenu klimatologiju*) and Urbanex ltd.

The impact chains developed include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat strokes in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. No additional difficulties were reported during the assessment development. The results of the assessment process, carried out for the agriculture, health, water supply, tourism, fisheries and coastal sectors, include simulations of the future climate which indicate an increase in air temperature, number of hot days, hot nights and an extension of the duration of warm periods in the target area, while in the precipitation domain, the results depend on the climate model (possible increase or decrease of precipitation, prolongation or shortening of the duration of dry periods). The fisheries and coastal sectors are assumed to have the same level of vulnerability estimated at national level. The level of data availability for these sectors indicates the need for further targeted research and improvements in the availability of information itself.

Although the overall risks were assessed as intermediate, further activities are needed to improve the condition of all risk components, i.e. to reduce sensitivity and exposure and to increase adaptability. One

of the most important stakeholders in this adaptation process are certainly the local and regional self-government units, whose strategic and development plans for climate change adaptation require increasing attention.

M1-Preparing the risk assessment

The context area consisting from the administrative units of Brtonigla - Verteneglio municipality, Novigrad - Cittanova city and Buje - Buie city was identified and confirmed at the beginning months of the project. During the preparation of the assessment, the existing local/territorial plans included SEAP revisions and SECAPs done for several cities in Istrian County in the scope of project EMPOWERING (Horizon 2020)[1], as well as parallel ongoing local and regional energy and climate strategies (for example Energy Efficiency Action Plan for Istrian County for the 2019. - 2021. period, Local development strategy for Central Istria for the 2014 - 2020. period, Istrian County Development Strategy until year 2020 etc.). The M1 module was developed jointly with the local stakeholders who actively participated in the process and provided the necessary data for the assessment as requested by the contractor and coordinator. The main stakeholders included the target area administrative units of Brtonigla - Verteneglio municipality, Novigrad - Cittanova city and Buje - Buie city, but other stakeholders were also contacted in order to provide data for the assessment. Other stakeholders were the Agency for Payments in Agriculture, Fisheries and Rural Development (*Agencija za plaćanja u poljoprivredi, ribarstvu i ruralnom razvoju*), Bureau of Statistics (*Državni zavod za statistiku*), Croatian Chamber of Commerce (*Hrvatska Gospodarska Komora*), Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture (*Uprava za stručnu podršku razvoju poljoprivrede i ribarstva Ministarstva poljoprivrede*), Fund for Development of Agriculture and Agritourism of Istria (*Fond za razvoj poljoprivrede i agroturizma Istre*), In Konzalting ltd., Institute for Physical Planning of Istria County (*Zavod za prostorno uređenje Istarske županije*), Institute of Public Health of the County of Istria (*Zavod za javno zdravstvo Istarske županije*), Istrian County Water supply (*Istarski vodovod ltd.*), Istrian County Tourist Board (*Turistička zajednica Istarske županije*), Jaić Consulting ltd., Ministry of Environment and Energy (*Ministarstvo zaštite okoliša i energetike*), State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service (*Državni hidrometeorološki zavod, Sektor za meteorološka istraživanja i razvoj, Služba za klimatološka istraživanja i primijenjenu klimatologiju*) and Urbanex ltd. The stakeholders involved were very cooperative, so no difficulties regarding stakeholder involvement was noted.

[1] https://www.empowering-project.eu/en/sample-page/

M2-Developing impact chains

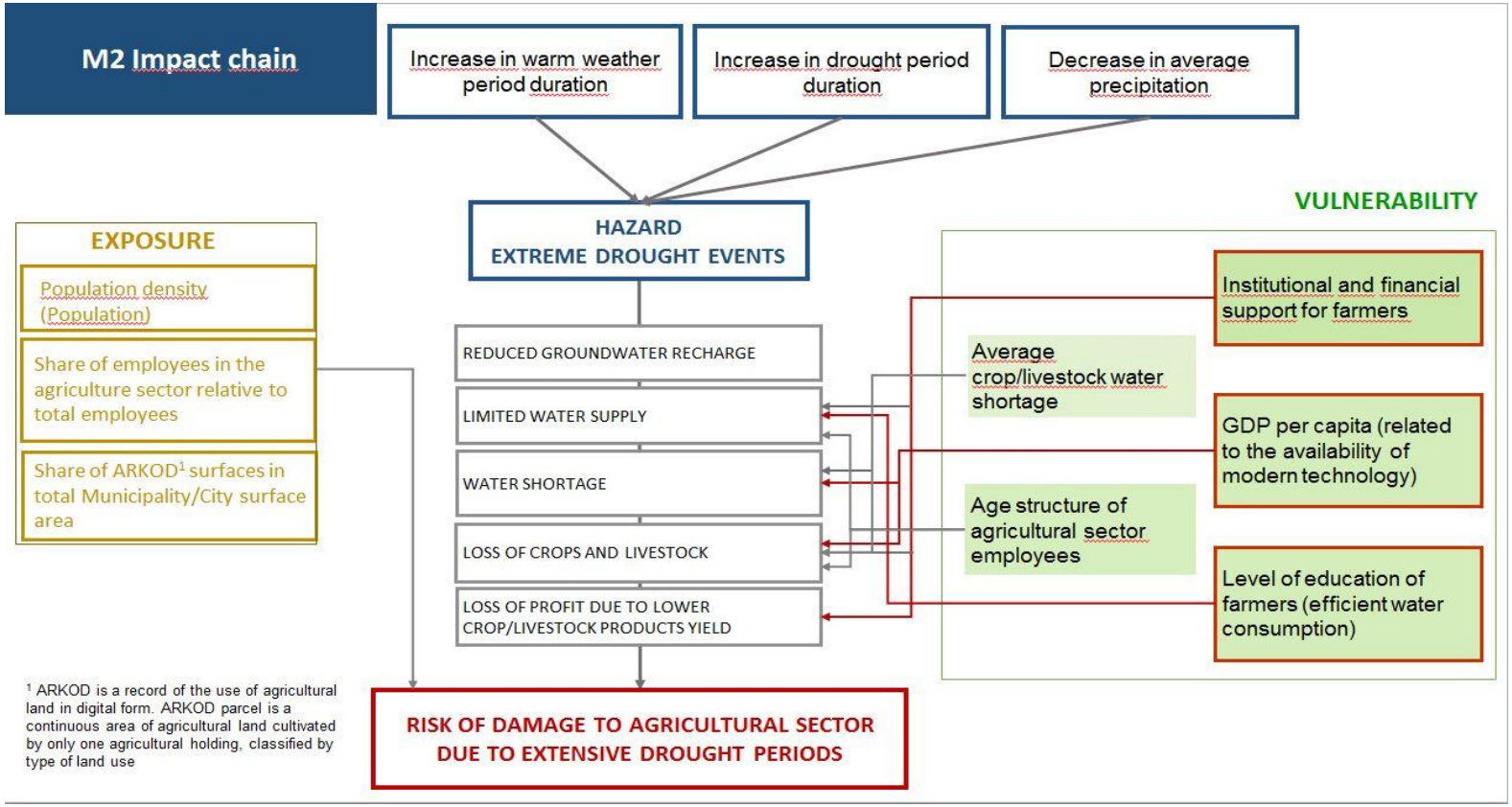
The hazards chosen for the assessment include extreme drought events, heat stroke hazard, increase in average temperatures and extreme precipitation as the events with the highest probability for occurrence and the greatest factors for potential influence related to climate changes.

The identified and developed impact chains include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat strokes in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. All listed impact chains were finalized and included in the assessment. The impact chains were developed by the external consultant SENSUM ltd, while the M2 module was developed in cooperation with the coordinator IRENA.

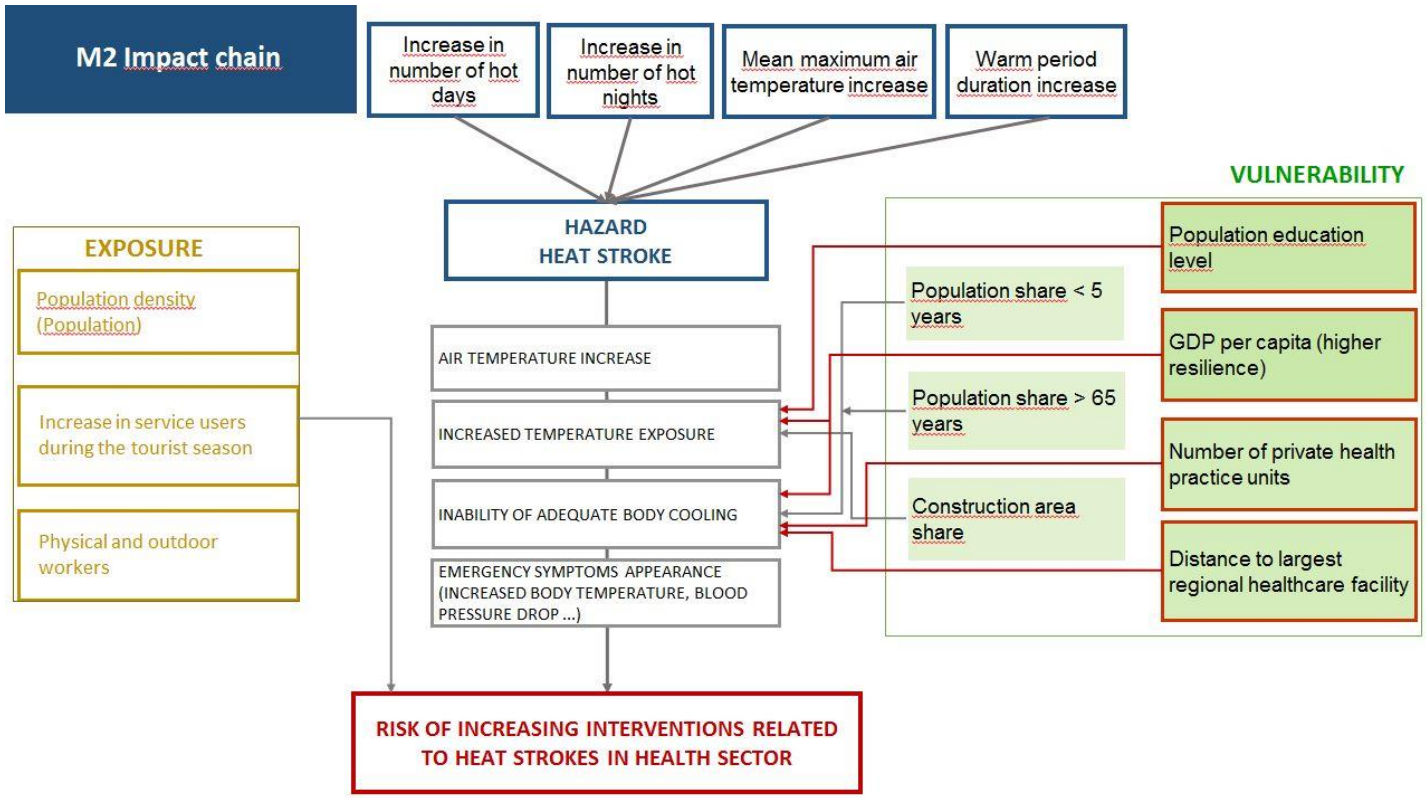
The data used to develop the impact chains included data taken from the Agency for Payments in Agriculture, Fisheries and Rural Development (*Farmers' Register_agricultural economy no.2018_31.12.2018.; ARKOD number and area display by settlements and type of agricultural land use_31_12_2018.*), Fund for Development of Agriculture and Agritourism of Istria (*Fund work report for the 1995 – 2017. period*), Institute of Public Health of the County of Istria (*2017. Report - Data on the health status of the population and the work of health care in the County of Istria in 2017*), Istrian County Water supply (*Water Supply Plan of the County of Istria (with planning period until 2020)*), *Istrian County Tourism Master Plan for 2015 - 2025 period*, Istrian County Tourist Board (*Tourist arrivals and overnights in Istria by tourist boards*), Croatian Chamber of Commerce (*Estimation of population increase in tourist season, 2018.*), Institute for Physical Planning of Istria County (*Report on the Istrian County territory condition for the 2013 - 2016 period, Report on the Istrian County territory condition for the 2007 - 2012 period), Major accident risk assessment for the Municipality of Brtonigla - Verteneglio, 2018.,* In Konzalting ltd (*Fire and technological explosion risk assessment risk for Brtonigla - Verteneglio Municipality, 2016.),* HDC ltd (*Strategic Tourism Development Plan for the Municipality of Brtonigla – Verteneglio, Natural factors of agricultural production in the Municipality of Brtonigla - Verteneglio, 2001.*), Urbis 72 ltd (*Coastal Purpose Study Brtonigla Municipality - Verteneglio, 2006.*), Jaić Consulting ltd (*Overall Development Program - Local Development Strategy of Brtonigla Municipality - Verteneglio 2014-2020*), Official Gazette of the Municipality of Brtonigla - Verteneglio nos. 08/08 and 08a / 08 - correction, 06/11, 07/11 - consolidated text, 09/12 and 03/13, 06/17 (*Spatial Plan of the Municipality of Brtonigla – Verteneglio*), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (*The Vulnerability Sourcebook, Risk Supplement to the Vulnerability Sourcebook, 2017.),* State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service (*Observed and expected changes in precipitation, air temperature and extrema index for the city of Rovinj, 2016.*), Ministry of Environment and Energy (*Climate Change Adaptation Strategy Draft in Republic of Croatia up to 2040 period with a 2070 projection*), *Rural Development Program of the Republic of Croatia for the period 2014 – 2020*, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture – consulting packages, Central Bureau of Statistics (*2011 Population Census*), *Istrian County Development strategy until 2020*, IGH ltd. (*Istrian County irrigation base*

plan adjustment, 2007.), *Istrian County major accident risk assessment, 2018.*, *Major accident risk assessment – Buje City, 2018., Buje – Buie City development strategic plan 2016 – 2020*, Urbanex ltd. (*Tourism Development Strategy Draft for City of Buje-Buie, 2019.*), *City of Buje-Buie Spatial plan Major accident risk assessment - Novigrad – Cittanova City, 2018., Overall development program for the City of Novigrad - Cittanova 2015-2020.*, TENEO (*Definition of tourist offer Novigrad - Cittanova, 2019.*), Official Gazette of the City of Novigrad - Cittanova no. 01/08, 04/11, 04/12 - Corrections 01/14 and 07/14 (*City of Novigrad - Cittanova Spatial plan*).

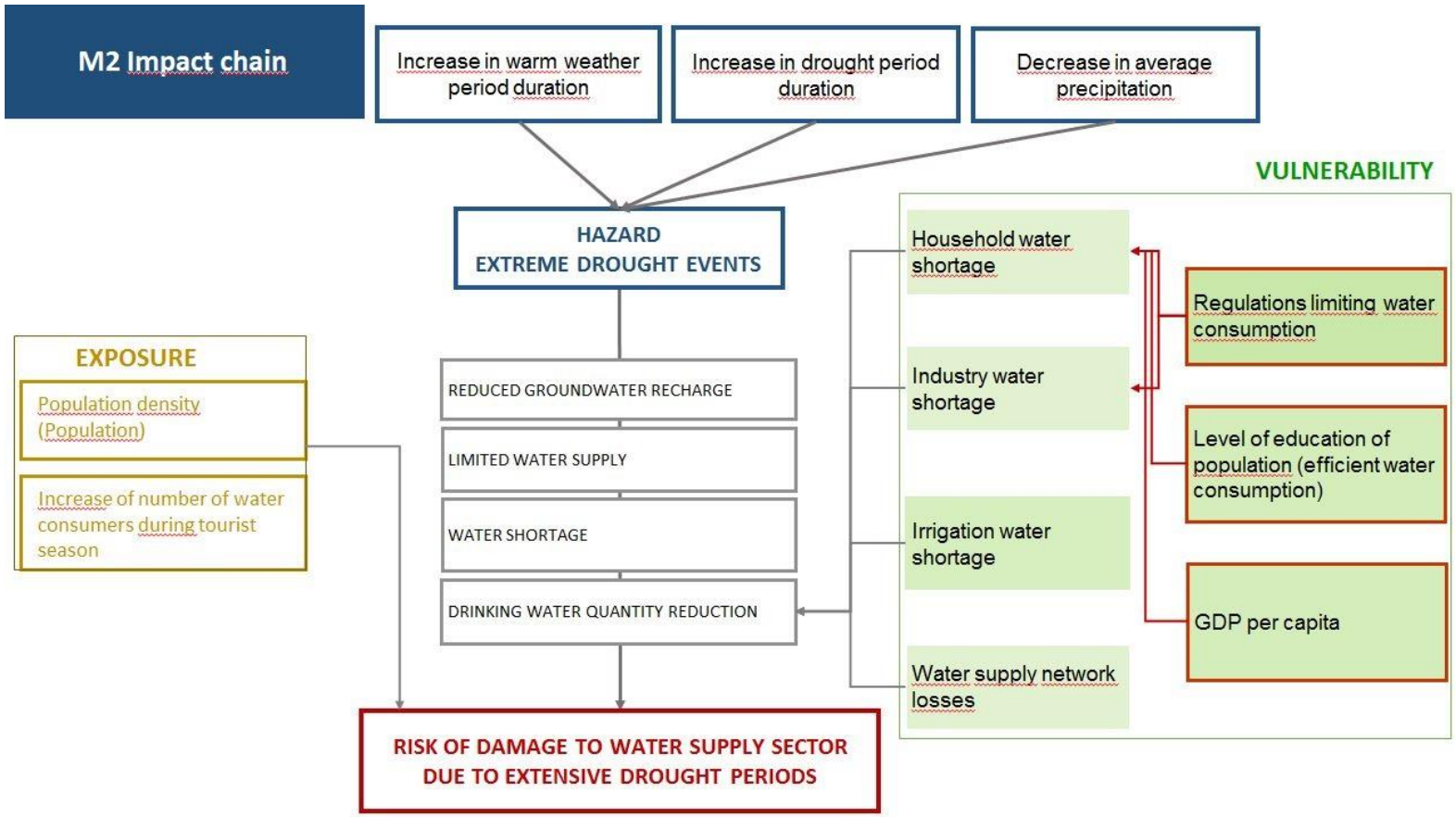
The methodology described in the tutorial, including the Vulnerability Sourcebook and the Risk Supplement files consistent with IPCC AR5 Synthesis Report, was used for the assessment. No difficulties were noted in the impact chain development process.



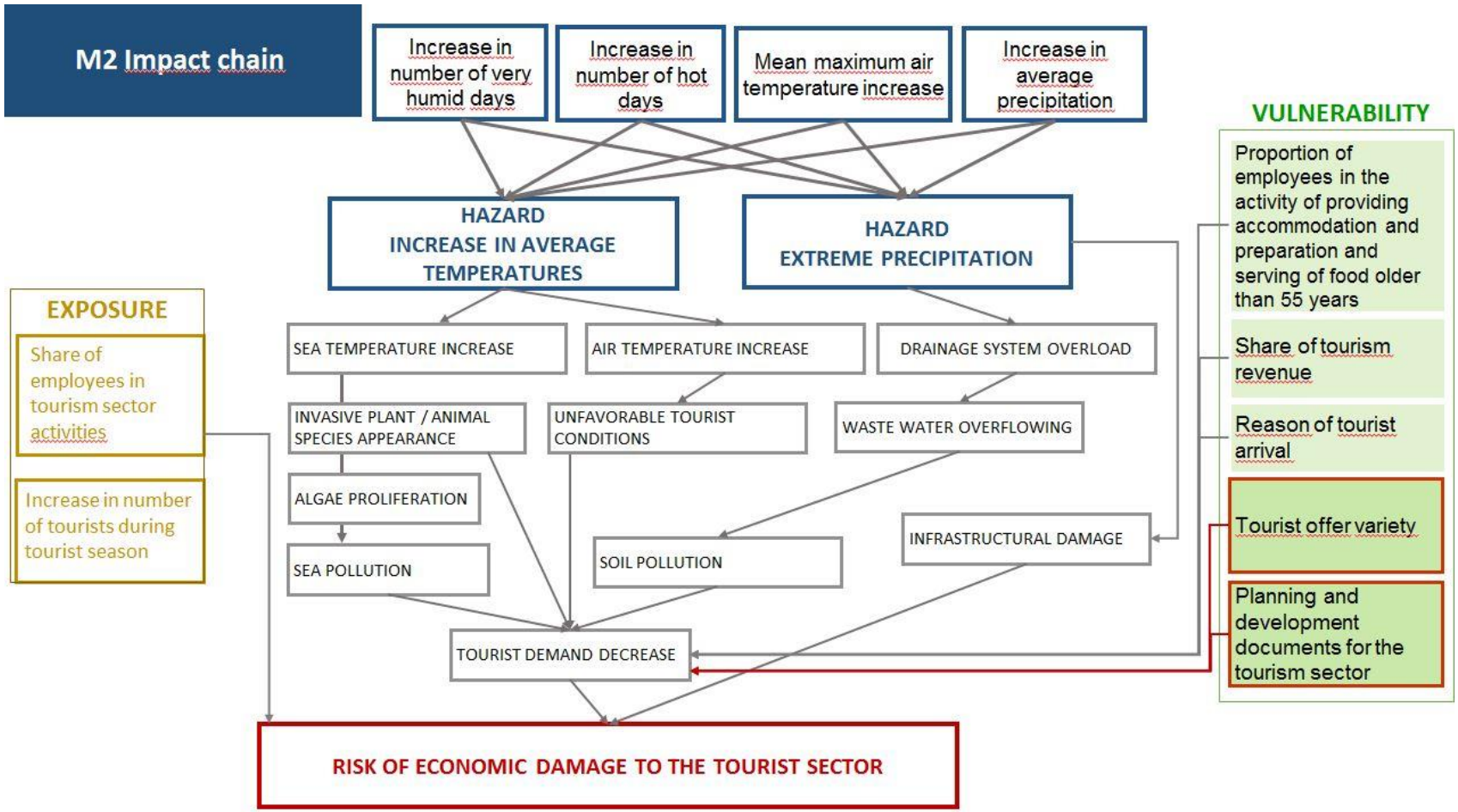
Picture 1: IRENA M2 Impact Chain – Risk of damage to agricultural sector



Picture 2: IRENA M2 Impact Chain – Risk of heat strokes in health sector



Picture 3: IRENA M2 Impact Chain – Risk of drought damage in water supply sector



Picture 4: IRENA M2 Impact Chain – Risk of economic damage in tourist sector

M3-Identifying and selecting indicators, M4-Data acquisition and management

Regarding the climate change factors in the listed impact chains of M3 module, Risk of damage to agricultural sector due to extensive drought periods includes 11 identified factors and 13 selected indicators, Risk of increasing interventions related to heat strokes in health sector includes 14 identified factors and 15 selected indicators, Risk of damage to water supply sector due to extensive drought periods includes 12 identified factors and 12 selected indicators and Risk of economic damage to the tourist sector includes 11 identified factors and 12 selected indicators. There is a minimum of 1 indicator for each factor.

The indicators were developed by the external consultant SENSUM ltd., while the module was developed jointly with coordinator IRENA. Both qualitative (8) and quantitative (28) indicators were used, and the detail level for the indicators includes 16 indicators on national level, 17 indicators on regional level and 3 indicators on local level. Some issues included inaccessibility of data from the State Hydrometeorological Institute. An excel database with all the indicators and relevant metadata was created.

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

The instruments used for weighting and aggregating data included the extrapolation of data through the excel tables provided by the Lead Partner. The normalization of data was done with min-max method for metric and 5 class evaluation schemes for categorical indicator values. The normalization, weighting and aggregation of data was performed by the external consultant and later adjusted for the provided excel tables by the coordinator. The aggregated risk based on the provided data was presented with GIS mapping for each target.

Indicator	Measurement unit	Indicator value - Brtonigla	Indicator value - Novigrad	Indicator value - Buje
% of agricultural land in the total area of the selected area	Km2	0,60	0,70	0,40
% of employees in accommodation, food preparation and service activities	Number of persons employed	0,57	0,82	0,53
% of funds from the Agricultural and Agritourism Development Fund of Istria	HRK (Croatian Kuna)	0,30	0,30	0,30
% of losses in the water supply network	m3	0,40	0,40	0,40
% of the construction area in the total area of the selected area	Km2	0,50	0,65	0,35
% of tourism revenue in total revenue	HRK (Croatian Kuna)	0,02	0,47	0,17
% of workers in the agriculture, forestry and fisheries sectors	Number of persons employed	0,55	0,40	0,30
% of workers in the construction sector	Number of persons employed	0,60	0,53	0,40
Age distribution of employees (> 55 years = higher sensitivity)	Number of employees	0,59	0,51	0,20
Amount of investment in diversification of tourist offer	HRK (Croatian Kuna)	0,50	0,40	0,30
Average irrigation water consumption in m3/year and share in total water consumption for the selected area	m3/year	0,54	0,48	0,56
Average water consumption in m3/year for the household sector and share of total water consumption for the selected area	m3/year	0,45	0,30	0,50
Average water consumption in m3/year for the industry sector and share of total water consumption for the selected area	m3/year	0,43	0,36	0,40
GDP/Capita	HRK (Croatian Kuna); EUR (Euro)	0,10	0,10	0,10
m3/ha/year	m3/ha/year	0,72	0,24	0,55
Number of days in periods of at least 6 consecutive days with a maximum air temperature> 90th percentile of the maximum air temperature for a calendar day in the reference period	° C	0,60	0,60	0,60
Number of days with a maximum daily air temperature of ≥ 30 ° C	° C	0,43	0,43	0,43
Number of days with a minimum air temperature > 20 ° C	° C	0,39	0,39	0,39
Number of days with daily rainfall ≥ 20 mm	mm	0,50	0,50	0,50
Number of days with daily rainfall ≥ 20 mm and consecutive days with daily rainfall Rd <1 mm	mm	0,59	0,59	0,59
Number of days with maximum daily air temperature ≥ 30 ° C + number of days with minimum air temperature > 20 ° C	° C	0,52	0,52	0,52
Number of minutes from the selected area to Pula General Hospital	Minutes	0,70	0,73	0,70
Number of nights per capita	Number of overnight stays	0,80	0,70	0,55
Population + number of tourists per unit of private health practice	Population number/number of private health practice units	0,90	0,90	0,40
Population below 5 years of age in the total population in the selected area	Number of people	0,35	0,50	0,45
Population over 65 years of age in the total population in the selected area	Number of people	0,45	0,50	0,40
Population per km^2 in the selected area	Number of people/km2	0,30	1,00	0,35
Sequence of days with daily precipitation of Rd <1 mm	mm	0,52	0,52	0,52
Share of employees in the sector of agriculture, forestry and fisheries over 60 years of age in the total number of employees	Number of employees	0,65	0,55	0,59

Table 1: IRENA normalization of metric indicator values

Indicator	Measurement unit	Indicator value - Brtonigla	Indicator value - Novigrad	Indicator value - Buje
% of family farm holders with a minimum of secondary education	Ranking in classes	0,54	0,70	0,62
Activities of the Administration for Expert Support to the Development of Agriculture and Fisheries of the Ministry of Agriculture and the Agency for Rural Development of Istria	None (descriptive classes)	0,30	0,30	0,30
Applicable regulations at national (Water Act, Official Gazette, No. 66/19) and regional level (Statute of the County of Istria, Official Gazette of the County of Istria, No. 10/09)	None (descriptive classes)	0,30	0,30	0,30
Distribution of population share by education level (graph)	Ranking in classes	0,50	0,40	0,40
Measures of the Rural Development Program of the Republic of Croatia for the period 2014 - 2020	None (descriptive classes)	0,30	0,30	0,30
Number of activities and programs not based on the product of the sun and the sea	None (descriptive classes)	0,50	0,40	0,30
Number of reasons related to sun and sea	None (descriptive classes)	0,80	0,80	0,40
Number of strategic planning documents for tourism development that take climate change into account	None (descriptive classes)	0,30	0,30	0,30

Table 2: IRENA normalization of categorical indicator values

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1	Normalised Indicator value for Target Area 2	Normalised Indicator value for Target Area 3
Hazard	Increase in warm weather period duration	Number of days in periods of at least 6 consecutive days with a maximum air temperature> 90th percentile of the maximum air temperature for a calendar day in the reference period	°C	0,60	0,60	0,60
	Increase in drought period duration	Sequence of days with daily precipitation of Rd <1 mm	mm	0,52	0,52	0,52
	Decrease in average precipitation	Number of days with daily rainfall ≥ 20 mm and consecutive days with daily rainfall Rd <1 mm	mm	0,59	0,59	0,59
	Increase in number of hot days	Number of days with a maximum daily air temperature of ≥ 30 ° C	°C	0,43	0,43	0,43
	Increase in number of hot nights	Number of days with a minimum air temperature > 20 ° C	°C	0,39	0,39	0,39
	Mean maximum air temperature increase	Number of days with maximum daily air temperature ≥ 30 ° C + number of days with minimum air temperature > 20 ° C	°C	0,52	0,52	0,52
	Increase in number of very humid days	Number of days with daily rainfall ≥ 20 mm	mm	0,50	0,50	0,50
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalized Indicator value for Target Area 2**	**Normalized Indicator value for Target Area 3**
Exposure	Population density (Population)	Population per km2 in the selected area	Number of people/km^2	0,30	1,00	0,35
	Share of employees in the agriculture sector relative to total employees	% of workers in the agriculture, forestry and fisheries sectors	Number of persons employed	0,70	0,31	0,30
	Share of ARKOD surfaces in total Municipality/City surface area	% of agricultural land in the total area of the selected area	km^2	0,75	0,35	0,40
	Increase in service users during the tourist season	Number of nights per capita	Number of overnight stays	0,80	0,70	0,55
	Physical and outdoor workers	% of workers in the construction sector	Number of persons employed	0,62	0,89	0,48
	Physical and outdoor workers	% of workers in the agricultural, fisheries and forestry sectors	Number of persons employed	0,48	0,79	0,41
	Increase of number of water consumers during tourist season	Number of nights per capita	Number of overnight stays	0,80	0,70	0,55
	Share of employees in tourism sector activities	% of employees in accommodation, food preparation and service activities	Number of persons employed	0,57	0,82	0,53
	Increase in number of tourists during tourist season	Number of nights per capita	Number of overnight stays	0,80	0,70	0,55
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalized Indicator value for Target Area 2**	**Normalized Indicator value for Target Area 3**
Vulnerability	Institutional and financial support for farmers	Measures of the Rural Development Program for Republic of Croatia for the 2014 - 2020 period	None (descriptive classes)	0,30	0,30	0,30
	Institutional and financial support for farmers	% of funds from the Fund for Development of Agriculture and Agritourism of Istria	HRK (Croatian Kuna)	0,74	0,47	0,56
	Institutional and financial support for farmers	Activities of the Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture and the Agency for Rural Development of Istria	None (descriptive classes)	0,42	0,28	0,49
	GDP per capita (related to the availability of modern technology)	GDP/Capita	HRK (Croatian Kuna); EUR (Euro)	0,10	0,10	0,10
	Level of education of farmers (efficient water consumption)	% of family farm holders with a minimum of secondary education	Ranking in classes	0,54	0,70	0,62
	Average crop/livestock water requirements	m^3/ha/year	m^3/ha/year	0,72	0,24	0,55
	Age structure of agricultural sector employees	Share of employees in the sector of agriculture, forestry and fisheries over 60 years of age in the total number of employees	Number of employees	0,65	0,55	0,59
	Population education level	Distribution of population share by education level (graph)	Ranking in classes	0,50	0,40	0,40
	Number of private health practice units	Population + number of tourists per unit of private health practice	Population number/Number of private health practice units	0,90	0,90	0,40
	Distance to largest regional healthcare facility	Number of minutes from the selected area to Pula General Hospital	Minutes	0,70	0,73	0,70
	Population share < 5 years	Population below 5 years of age in the total population in the selected area	Number of people	0,35	0,50	0,45
	Population share > 65 years	Population over 65 years of age in the total population in the selected area	Number of people	0,45	0,50	0,40
	Construction area share	% of the construction area in the total area of the selected area	km^2	0,50	0,65	0,35
	Regulations limiting water consumption	Applicable regulations at national (Water Act, Official Gazette, No. 66/19) and regional level (Statute of the County of Istria, Official Gazette of the County of Istria,	None (descriptive classes)	0,30	0,30	0,30
	Household water requirements	Average water consumption in m3/year for the household sector and share of total water consumption for the selected area	m^3/year	0,45	0,30	0,50
	Industry water requirements	Average water consumption in m3/year for the industry sector and share of total water consumption for the selected area	m^3/year	0,43	0,36	0,40
	Irrigation water requirements	Average irrigation water consumption in m3/year and share in total water consumption for the selected area	m^3/year	0,54	0,48	0,56
	Water supply network losses	% of losses in the water supply network	m^3	0,40	0,40	0,40
	Proportion of employees in the activity of providing accommodation and preparation and serving of food older	Age distribution of employees (> 55 years = higher sensitivity)	Number of employees	0,59	0,51	0,20
	Share of tourism revenue	% of tourism revenue in total revenue	HRK (Croatian Kuna)	0,02	0,47	0,17
	Reason of tourist arrival	Number of reasons related to sun and sea	None (descriptive classes)	0,80	0,80	0,40
	Tourist offer variety	Amount of investment in diversification of tourist offer	HRK (Croatian Kuna)	0,50	0,40	0,30
	Tourist offer variety	Number of activities and programs not based on the product of the sun and the sea	None (descriptive classes)	0,40	0,35	0,30
	Planning and development documents for the tourism sector	Number of strategic planning documents for tourism development that take climate change into account	None (descriptive classes)	0,30	0,30	0,30

Area target 1: Brtonigla Municipality; Area target 2: Novigrad City; Area target 3: Buje City

Table 3: IRENA list of all indicators and indicator value

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Brtonigla Municipality			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,57	1	
Exposure			
	0,58	1	0,55
Vulnerability			
	0,50	1	

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Novigrad City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,57	1	
Exposure			
	0,55	1	0,50
Vulnerability			
	0,38	1	

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Buje City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,57	1	
Exposure			
	0,35	1	0,46
Vulnerability			
	0,46	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Brtonigla Municipality			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,48	1	
Exposure			
	0,55	1	0,51
Vulnerability			
	0,50	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Novigrad City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,48	1	
Exposure			
	0,85	1	0,62
Vulnerability			
	0,54	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Buje City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,48	1	
Exposure			
	0,45	1	0,44
Vulnerability			
	0,40	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Brtonigla Municipality			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,57	1	
Exposure			
	0,55	1	0,50
Vulnerability			
	0,38	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Novigrad City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,57	1	
Exposure			
	0,85	1	0,58
Vulnerability			
	0,32	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Buje City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,57	1	
Exposure			
	0,45	1	0,46
Vulnerability			
	0,36	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Brtonigla Municipality			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,51	1	
Exposure			
	0,68	1	0,54
Vulnerability			
	0,43	1	

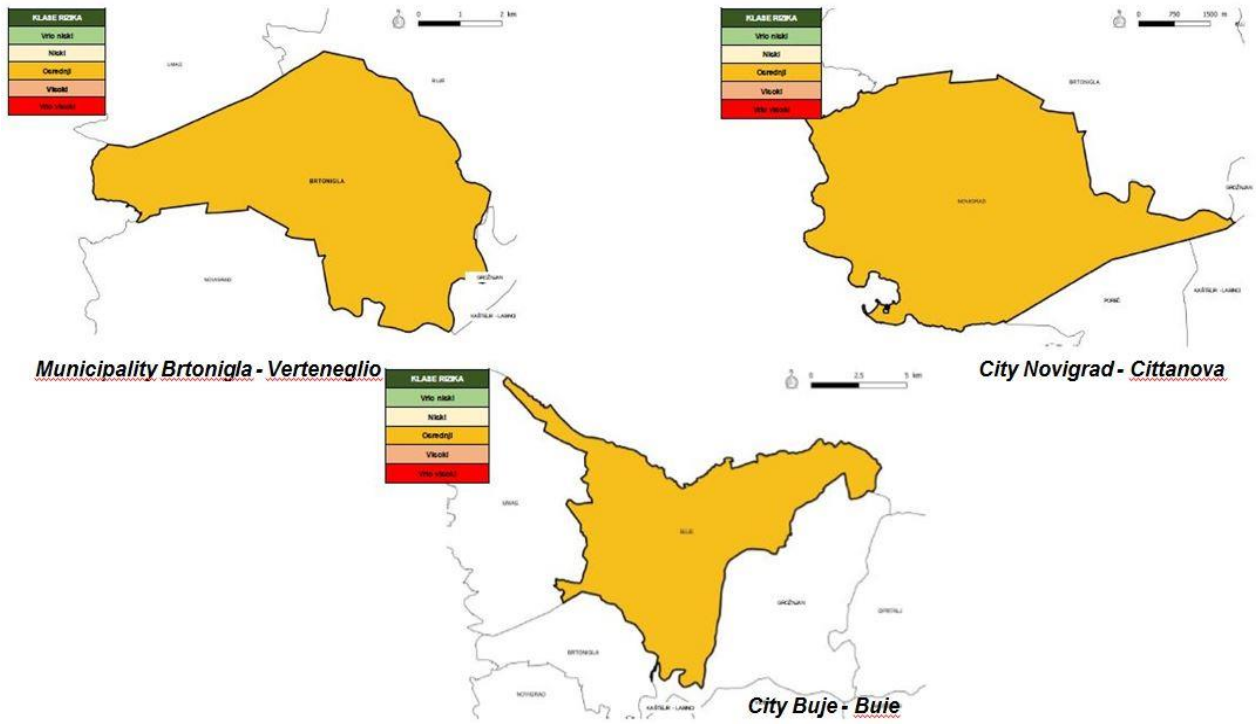
Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Novigrad City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,51	1	
Exposure			
	0,76	1	0,58
Vulnerability			
	0,47	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Buje City			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,51	1	
Exposure			
	0,54	1	0,44
Vulnerability			
	0,28	1	

Table 4: IRENA final risk values by impact chain and target area

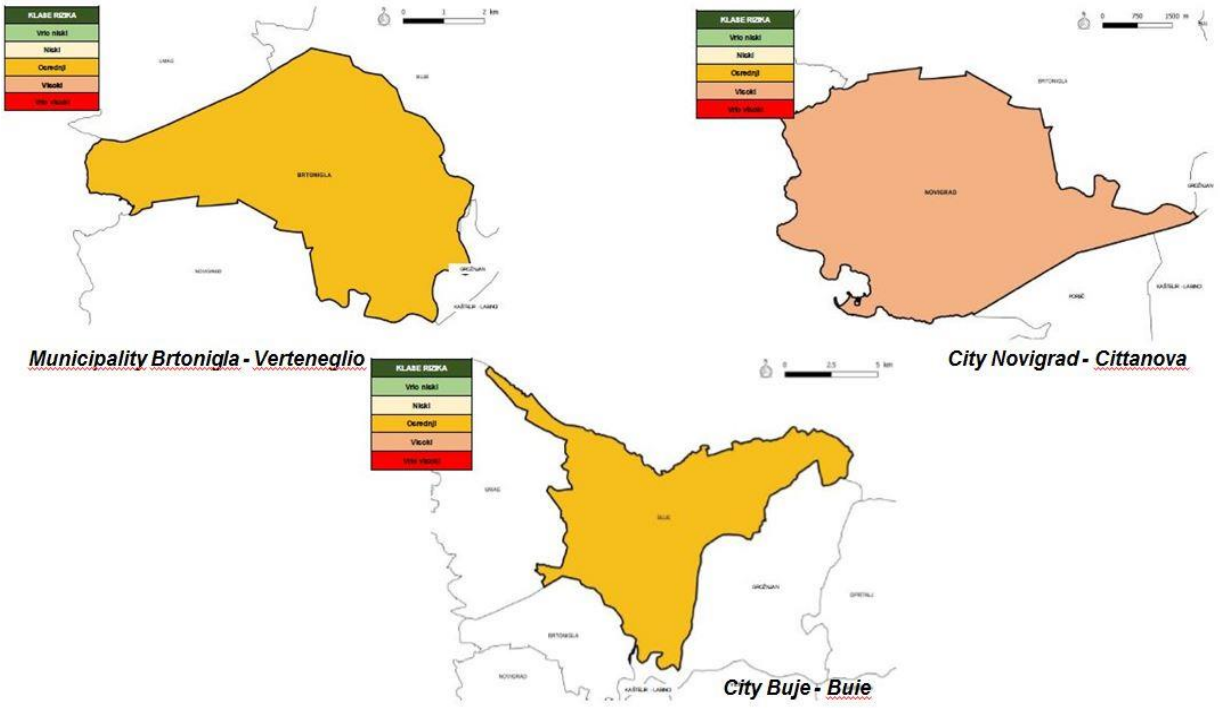
M8-Presenting the outcomes of your risk assessment

The data from the risk assessment was presented through excel methodology modules, GIS maps and finally through the deliverable summary report. The results of the Risk and vulnerability assessment were also presented to stakeholders by the coordinator and external expert during the meeting held in the Chamber of Commerce in Pula on 27.11.2019. The finalized documents are available on the official web pages of the target area administrative authorities and are freely accessible at all times[2].



Picture 5: IRENA estimated risk of drought for agriculture and water supply sectors and economic damage for tourism sector for target area

[2] http://www.novigrad.hr/hr/administracija/dokumenti/category/strateshki_dokumenti; https://brtonigla-verteneglio.hr/hr/strateski-dokumenti/item/4225-procjena-ranjivosti-i-rizika-od-klimatskih-promjena; https://www.buje.hr/hr/novosti/procjena-ranjivosti-i-rizika-od-klimatskih-promjena



Picture 6: IRENA estimated risk of heat stroke for health sector for target area

Potential influence	Possibility of appearance[1]	Degree of influence[2]	Degree of vulnerability[3]
Climate characteristics change: Sea temperature increase			
Migration to the northern Adriatic or deeper sea of cold-loving species (shrimp, hake)	5	4	high
Poorer growth of cold-loving fish and shellfish (sea bass, oyster)	5	3	medium
Increase in abundance of alien species and impact on native species	5	4	high
Occurrence and spreading of exotic fish diseases	4	3	medium
Climate characteristics change: Change in water circulation due to thermohaline causes			
Reduced primary production with consequences in pelagic fish abundance	4	4	high
Climate characteristics change: Sea temperature increase			
Loss of habitat and hatchery of species from freshwater and brackish water	5	2	medium
Climate characteristics change: Sea temperature increase			
Poorer growth and higher mortality of shellfish	4	4	high
Impaired phyto and zooplankton growth	4	2	high

Table 5: IRENA estimated risk of fisheries sector from climate change for target area

2.2 [PP2] Municipality of San Benedetto del Tronto

Summary

The process was coordinated by the project manager for the municipality of San Benedetto del Tronto, dr. Sergio Trevisani. The impact chains developed concern 4 risks of damage to people and urban structures due to the consequences of extreme weather events, namely: risk of river flooding, urban flooding, coastal flooding and landslide.

A private company based in Rome - Cras ltd - was in charge of the technical elaboration as external assistance of the Municipality. The process was started in October 2019 and was concluded in March 2020. Representatives of the municipal technical office was involved as stakeholders, mainly as far as the collection of information and the identification of the most relevant impacts to be considered and analysed in terms of impact chain.

Some difficulties were encountered to identify the proper unit of analysis, the census sections scale was selected as able to provide significant results at a sub-municipal scale even if the dimensional inhomogeneity can have consequences in terms of output's readability. A synthetic elaboration per municipality was also produced. Moreover, evidence suggests important adjustments when applying the proposed methodology at a such scale: 1) Hazard indicators should be related with impacts instead of climate stimuli when analysis is performed at a sub-regional scale, when climate characteristics are homogeneous (precipitation) while risks are localized (floodable areas, coastal zones,…). 2) The risk formula should adopt multiplication of factors instead of addiction, in order to ensure the internal coherence: at sub-municipal scale, a risk can be localized (i.e coastal risk) while vulnerability factors (i.e. old age, low income) are normally widespread so the risk should be null when exposure is null, even if vulnerability is positive.

M1-Preparing the risk assessment

The context area identified in the proposal was confirmed and includes 4 neighboring Municipalities: San Benedetto del Tronto; Grottammare, Cupra Marittima and Monteprandone. This module was developed starting from the analysis of climate adaptation policies, plans, measures and funding sources performed to fill in the deliverable A3.2.1. The most interesting local plan in terms of source of information were LL 1. Local development participatory strategy for the SOUTHERN MARCHE Fishery Local Action Group, LL3. Civil Defence Municipal Plans and LL6. Water services management plan "ATO 5", while the most interesting territorial plans in terms of source of information were NL1. National Climate Change Adaptation Strategy and Plan, NL 3. Central Apennines' Hydrographic District Management Plan, NL 4. Central Apennines' Hydrographic District Flood Management Plan, RL 3. Regional Water Safeguard Plan and RL 4. Integrated Coastal Zones Management Plan.

Up to the moment of writing this report, stakeholders' consultation was limited to the representatives of the technical office in the four municipalities included in the target area. They were asked to fill in a questionnaire to identify which climate change risks are perceived as the most relevant in each context in order to decide which ones deserve to be further developed as impact chains. Impacts were considered as the most easy-to-understand starting point to collect stakeholders' perception about climate risks, for this reason the questionnaire was structured as a list of impacts prepared starting from the list of potential impacts per sector contained in the National Plan Climate Change adaptation. Municipal staff was asked to rank such climate change related impacts according to a 1-5 scoring system and to provide a justification referring to past events, specific information sources, local news and including spatial details whenever possible.

There were no difficulties in involving key actors in this process, apart from some delays in collecting the questionnaires back and to obtain detailed justifications.

M2-Developing impact chains

The considered hazards during the assessment phase for module M2 include:

- Concentration of precipitation in few intense events

- Decrease in Average Precipitation

- Increase in Average Temperatures

These resulted as the most relevant climate change phenomena according to the perception of the stakeholders involved.

Four impact chain were developed, related to the following risks:

a. Risk of damage to urban structures and people from consequences of extreme weather events
b. Risk of economic damage for the tourist sector
c. Risk of economic damage for the farming sector
d. Risk of losing residual coastal/wetland habitats due to erosion and alteration of ecosystems.

Nevertheless, at a second stage, it was decided to focus on the first risk considered the broadest and able to converge the interests of the four municipalities. As the original impact chain was too complex to be developed in analytical terms, it was split it into 4 different impact chains describing the impacts consequent to the same climate hazard namely "the concentration of precipitation in few very intense events accompanied by high winds":

a. Risk of river flooding,

b. Risk of urban flooding,

c. Risk of coastal flooding,

d. Risk of landslide.

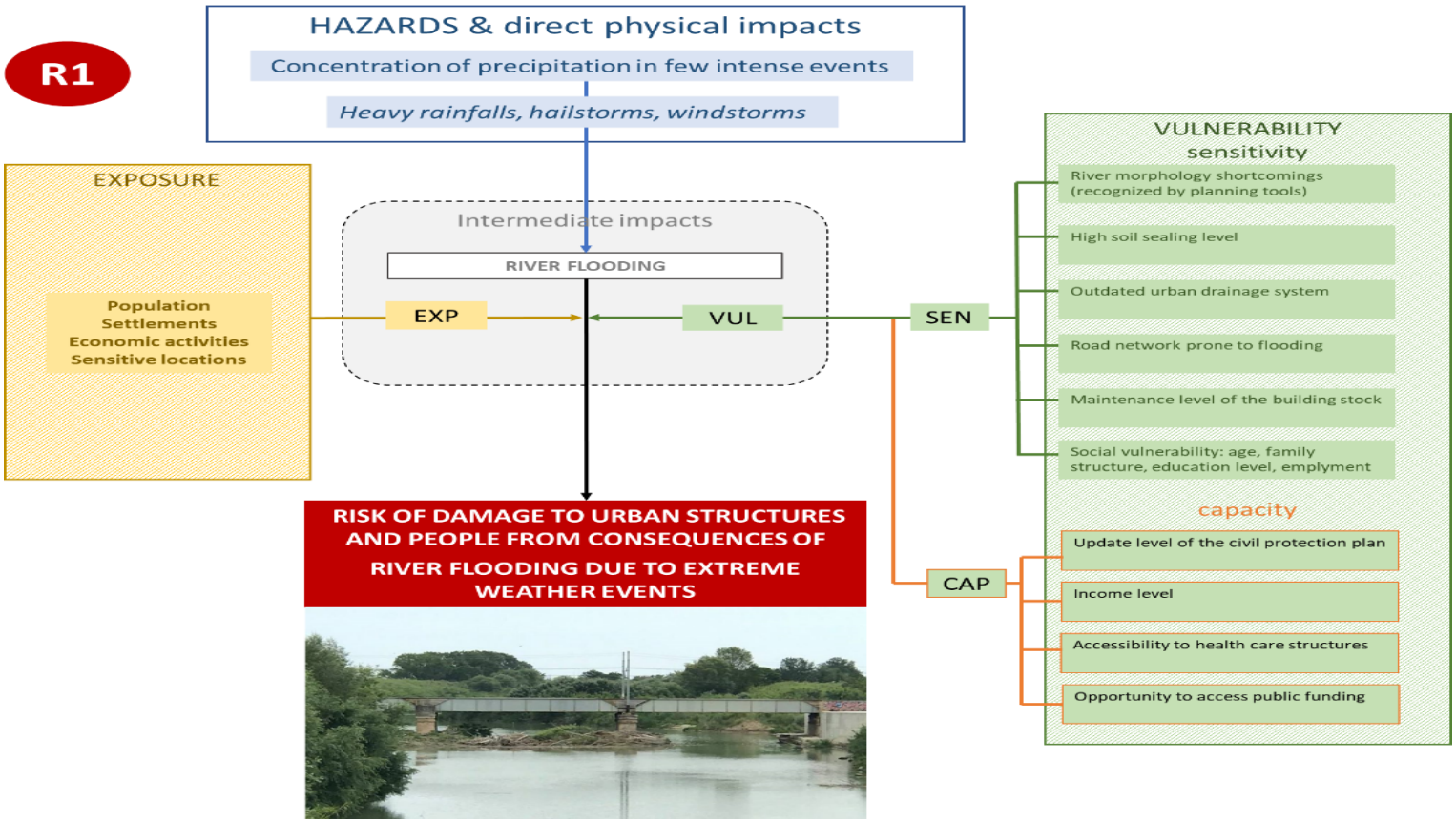
The choice of such a focus to implement the assessment through the impact chains does not imply that other risks, linked to different hazards – for instance the increasing temperatures - will be neglected in the subsequent phases of the planning process.

The impact chains were developed by external consultants, supported by the staff of the Municipality of San Benedetto del Tronto.

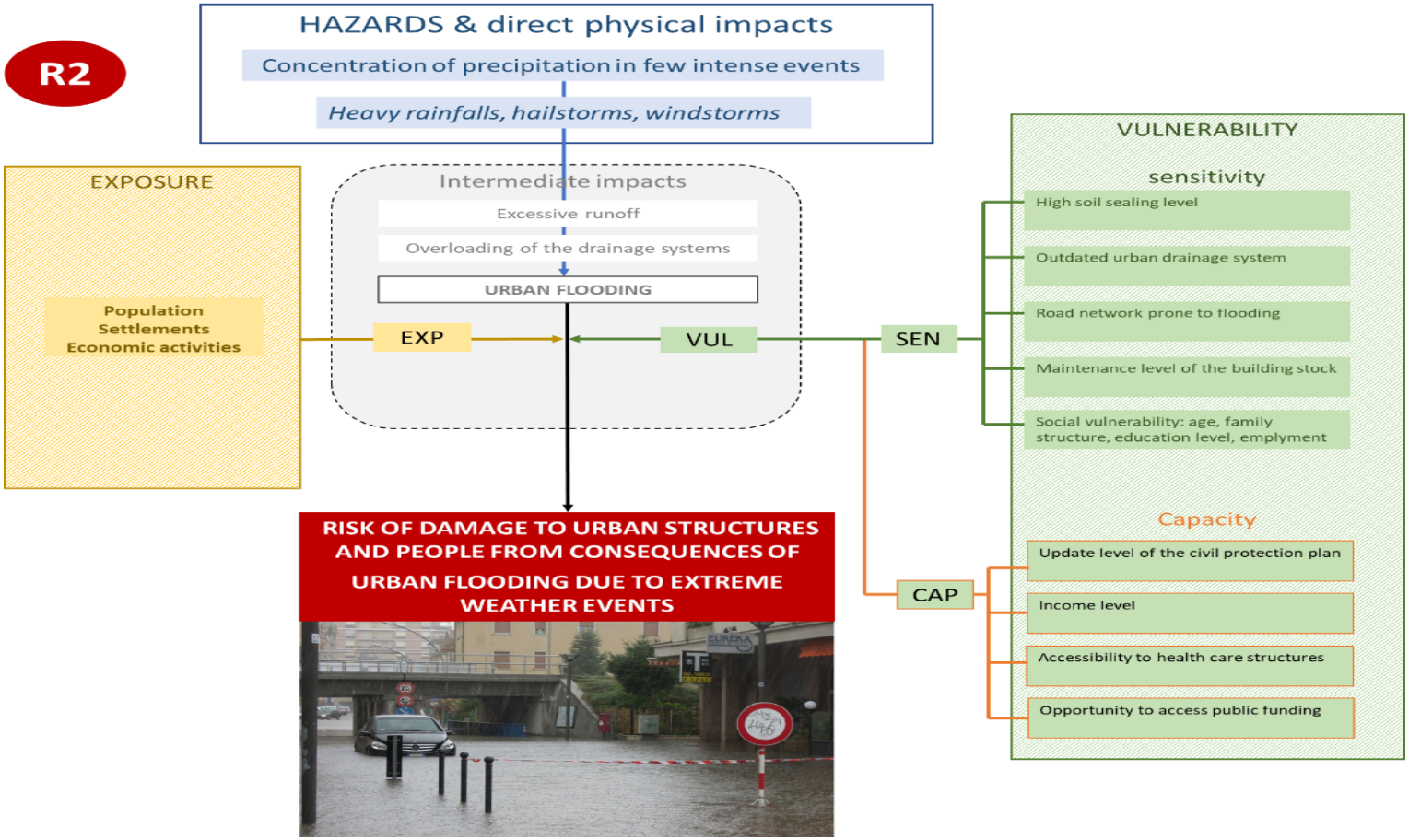
The impact chains were developed based on the results of the stakeholders' consultation for what concerns the selection of most relevant impacts; on existing planning tools for what concerns the description of phenomena and the cause-effect relationships; on past researches for what concern the climate baseline and projections.

The M2 module was only partially developed jointly with local key actors/stakeholders: impact chains were developed also basing on the information gathered through the questionnaires mentioned at the previous module.

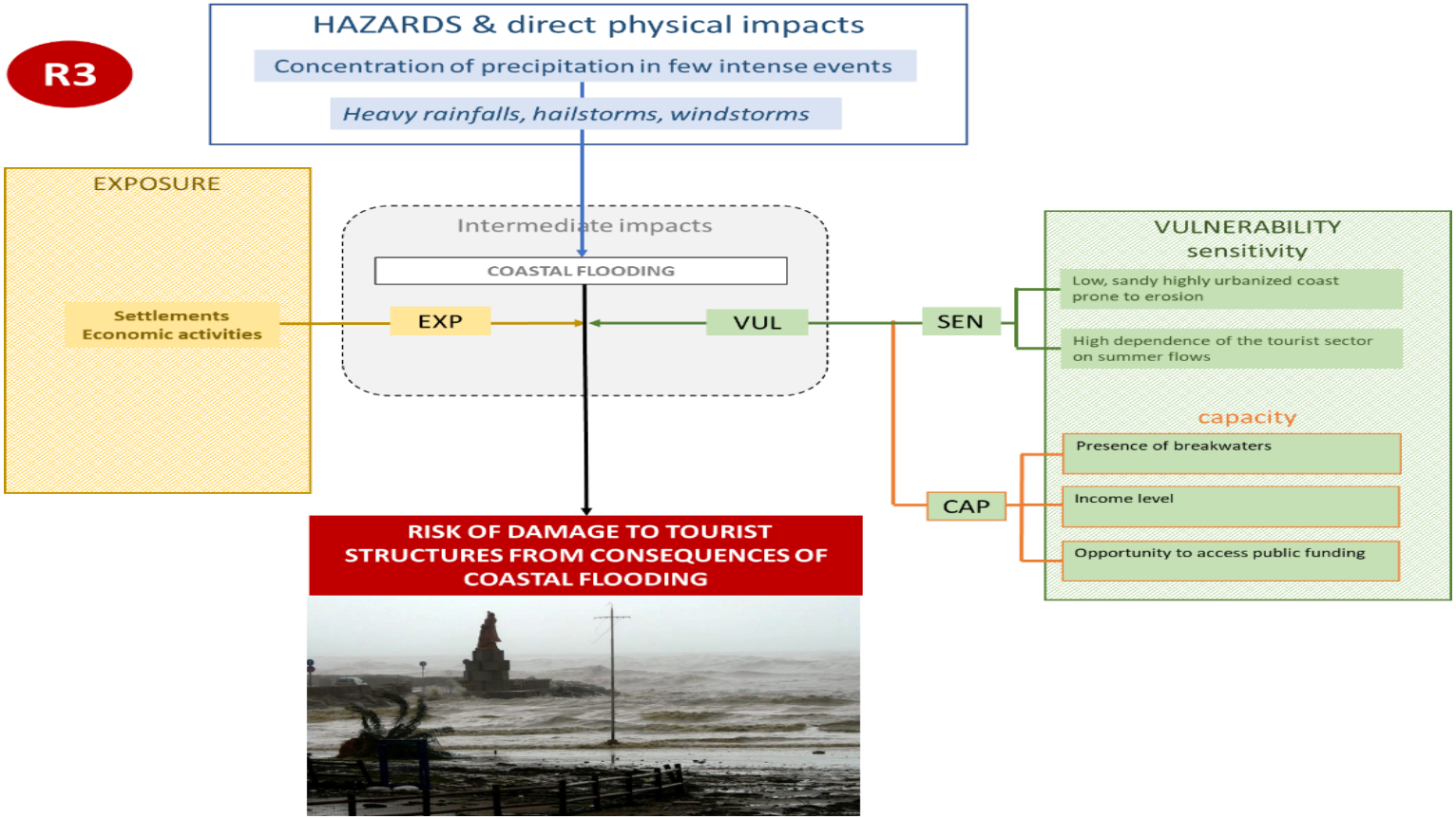
Some difficulties during the impact chains development were encountered in distinguishing risks and impacts and identifying the related factors. So first of all, a full list of exposure and vulnerability factors was prepared and then the single impact chains were prepared grouping the relevant factors from the list. The methodology suggested in the project tutorial was used for this module.



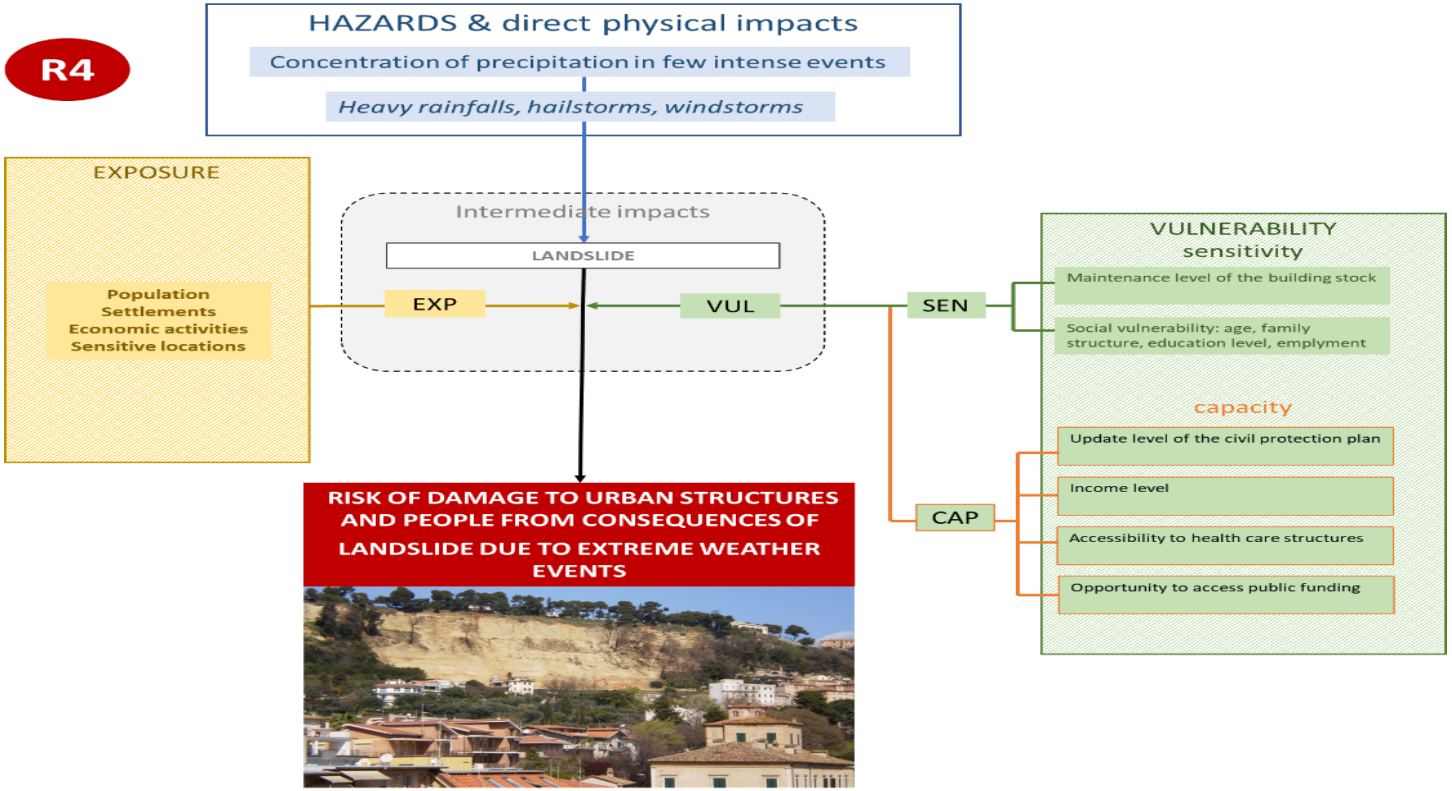
Picture 7: S.B.D. Tronto M2 Impact Chain – Risk of damage to urban structures and people due to river flooding



Picture 8: S.B.D.Tronto M2 Impact Chain – Risk of damage to urban structures and people due to urban flooding



Picture 9: S.B.D.Tronto M2 Impact Chain – Risk of damage to tourist structures due to coastal flooding



Picture 10: S.B.D.Tronto M2 Impact Chain – Risk of damage to urban structures and people due to landslide

M3-Identifying and selecting indicators, M4-Data acquisition and management

The following table shows the indicators identified and used:

Impact chain	EXPOSURE		SENSITIVITY		CAPACITY	
	FACTORS	INDICATORS*	FACTORS	INDICATORS*	FACTORS	INDICATORS*
R1 RIVER FLOODING	5	5	6	11	4	6
R2 URBAN FLOODING	3	3	5	10	4	6
R3 COASTAL FLOODING	3	3	2	2	3	4
R4 LANDSLIDE	5	5	2	4	4	6

** including sub-indicators*

Table 6: S.B.D.Tronto Indicators table

The exposure indicators, namely the ones related to the people, building and enterprises in flood and landslide prone areas are common and publicly available at municipal level by the National risk map developed by ISTAT and ISPRA[3]. Also, some of the vulnerability indicators were developed by others, in particular: the indicator related to soil sealing (imperviousness index) was developed by EEA.

Many of vulnerability indicators were developed on purpose. For instance, the indicator concerning the social vulnerability was developed to reproduce a complex indicator used by the Italian institute of statistics and available only at municipal scale[4]. The indictors concerning the number/kind of obstacles to river flow, railway underpasses, sensitive locations, beach facilities were developed autonomously. Also, the proxy indicators about the accessibility to public funding were developed on purpose basing on qualitative information.

The indicators were developed by external consultants, supported by the staff of the Municipality of San Benedetto del Tronto.

The module was partially developed with local key actors/stakeholders. Since significant data source are publicly available, the direct involvement of stakeholders was not necessary, some indicators and

[3] ISTAT: https://www.istat.it/it/mappa-rischi; ISPRA: http://www.isprambiente.gov.it/it/pubblicazioni/rapporti/dissesto-idrogeologico-in-italia-pericolosita-e-indicatori-di-rischio-edizione-2018

[4] Social and material vulnerability Index, developed by Istat (https://www.istat.it/it/mappa-rischi/documentazione)

in particular the more complex ones combining qualitative and quantitative information were discussed with and approved by the staff of the Municipality of San Benedetto del Tronto.

Both qualitative and quantitative indicators were used during the process, in some cases the indicators are composite and combine both qualitative and quantitative information.

During the indicator selection process, difficulties were encountered in obtaining homogeneous climate data at the municipal scale to be used as hazard indicator. Provided that the four municipalities in the target area are neighboring and all belong to the same class of the Koppen Climate Classification (Ligurian-Tyrrhenian, Middle Adriatic and Ionian coastal regions/temperate-Warm), regional data from the analysis contained in the National Adaptation Plan were used to express bot the climate baseline and projections, it means the same values applies to the 4 municipalities.

Impact chain	**Number of used indicators per level**			
	Regional	**District**	**Municipal/local**	**Sub-Municipal**
R1 RIVER FLOODING	---	2H	1E, 6C	4E, 11S
R2 URBAN FLOODING	---	2H	4C, 6C	3E, 10S
R3 COASTAL FLOODING	---	2H	4C, 1S, 3C	3E, 1S, 1C
R4 LANDSLIDE	---	2H	1E, 6C	4E, 7S

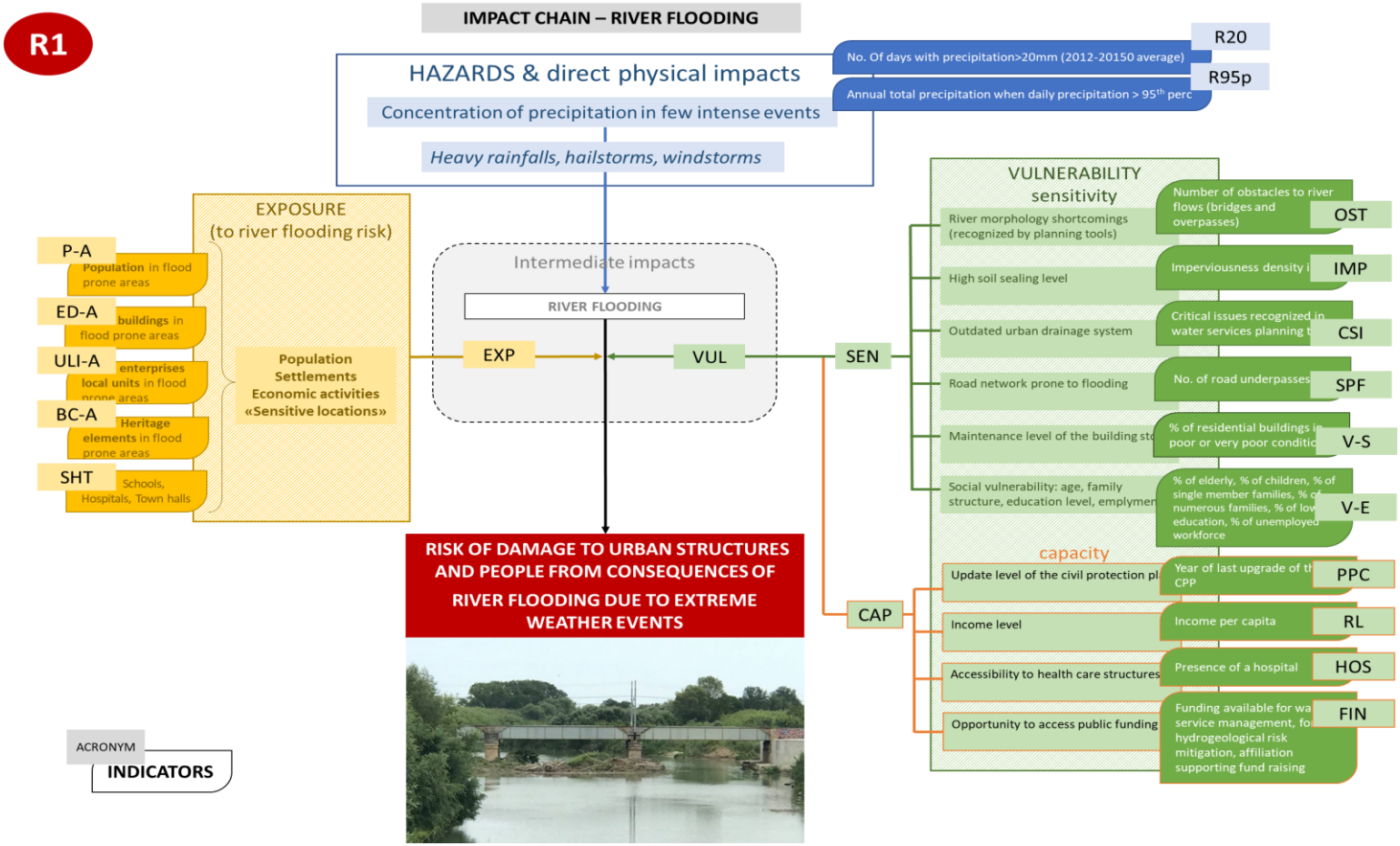
Letter indicates the risk component the indicators refer to : H= hazard, E= exposure, S= sensitivity, C= capacity

Table 7: S.B.D.Tronto number of used indicators table

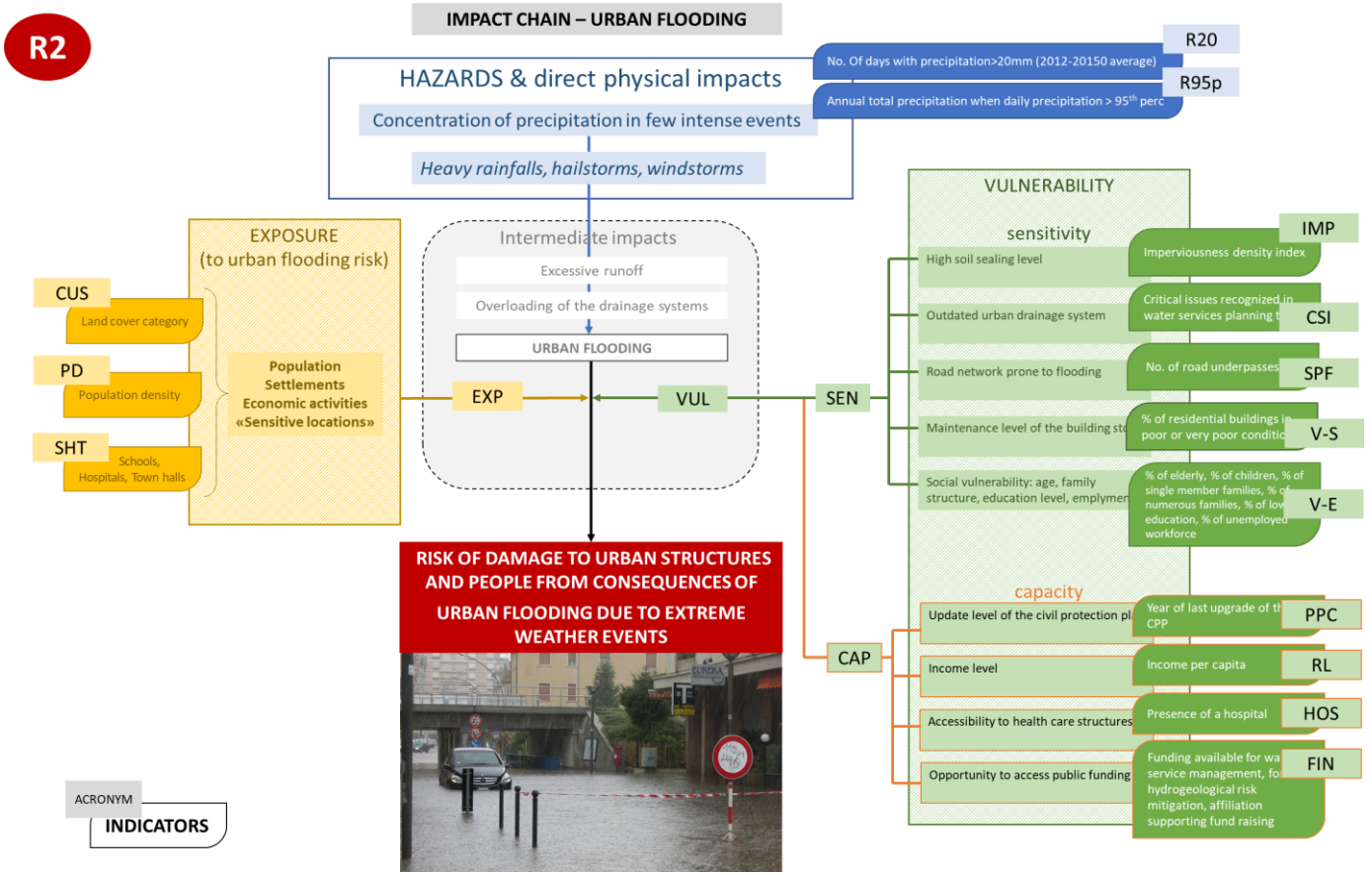
Many of the vulnerability indicators had to be produced on purpose, since data at the required scale was not already available. All the composite indicators required an internal weighting that is necessarily questionable. All the indicators were gathered into a geographic database.

Some metadata are available for each indicator, even if they do not comply with the international metadata standards (INSPIRE). Actually, in most case, also the source data lack a full metadata sheet.

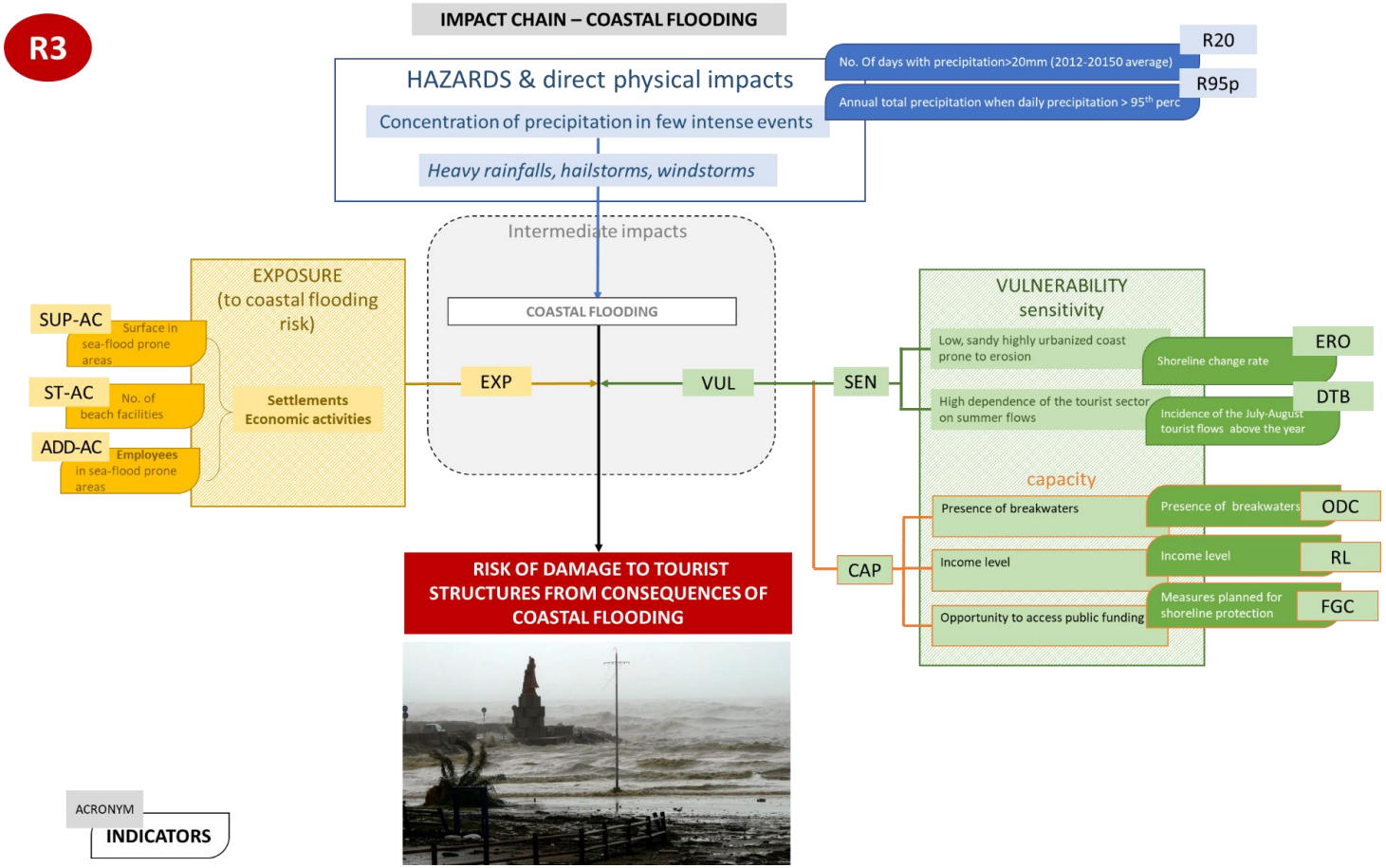
The following pictures summarize the indicators selected for each risk factor.



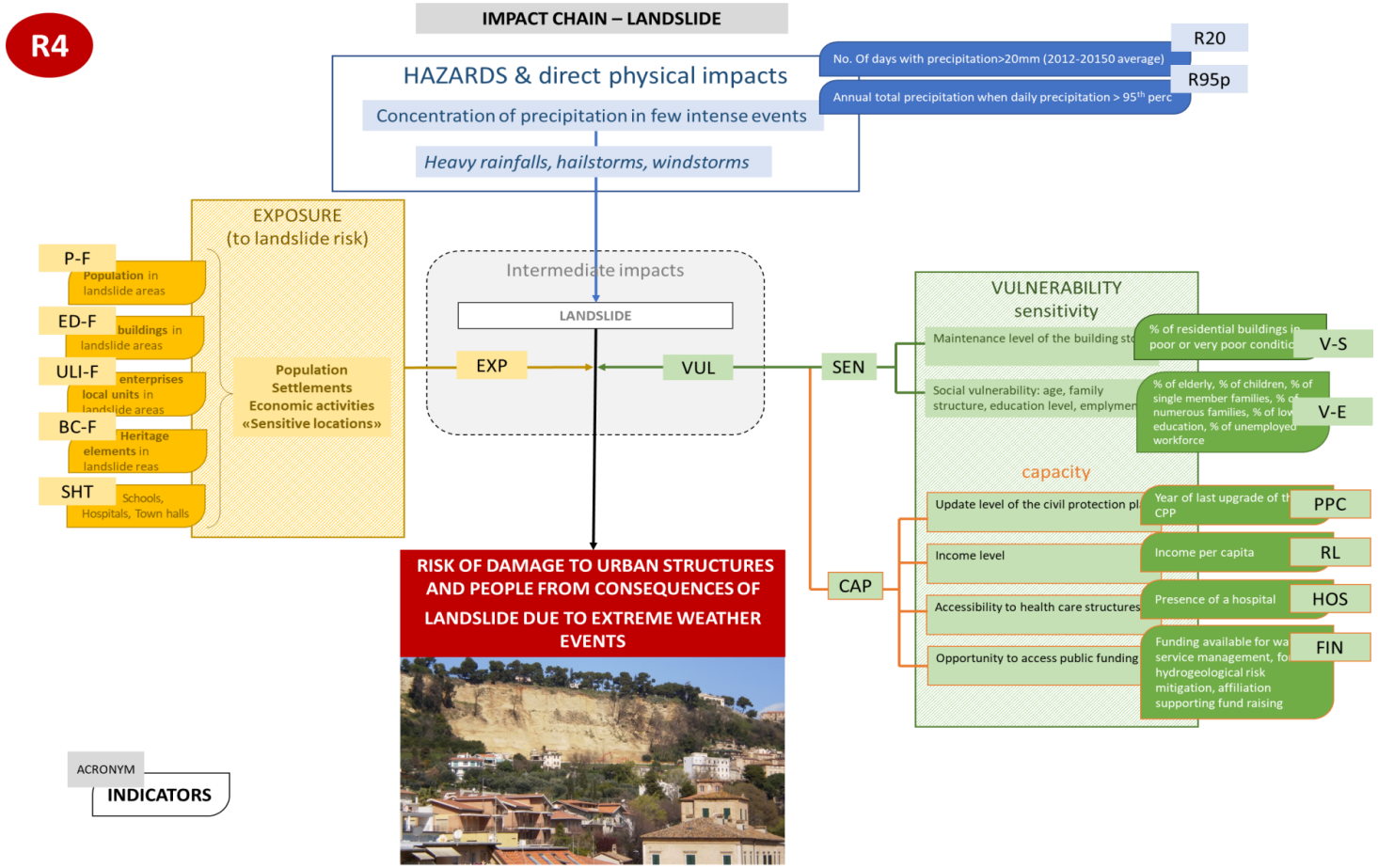
Picture 11: S.B.D.Tronto – Risk of damage to urban structures and people due to river flooding with indicators



Picture 12: S.B.D.Tronto– Risk of damage to urban structures and people due to urban flooding with indicators



Picture 13: S.B.D.Tronto– Risk of damage to tourist structures due to coastal flooding with indicators



Picture 14: S.B.D.Tronto– Risk of damage to urban structures and people due to landslide with indicators

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

Methods and instruments were used to normalize, weigh and aggregate data include Census section data: arithmetic normalization on a 0-1 scale, adopting as 0 and 1 the lowest and highest values of the data series represented by the 634 census sections; Municipal data: arithmetic normalization on a 0-1 scale, adopting as 0 and 1 the lowest and highest values of the data series represented by the 4 municipality, in certain cases (i.e. the income) the regional maximum and minimum values was assumed as 1-0 in the normalization.

The operations on indicators were developed by external consultants, weighting was discussed and approved by the staff of the Municipality of San Benedetto del Tronto. All the elaboration on geographic data was performed using the open-source GIS software Q-GIS "A Coruña" 3.10 version [5]

Issue related to multiform-interrelated concept of risk:

The climate stimulus considered as hazard in the impact chain produces different impacts and the resulting risk is quite comprehensive. In a preliminary stage it was defined as "Risk of damage to people and urban structure due to consequences of extreme weather events".

Since the various exposure and vulnerability factors play a different role in regard to each phenomenon/impact of the overall risk (up to be completely irrelevant), the SBT team agreed to work on 4 different aspects of the risk developing 4 impact chains - river, urban and coastal flooding and landslide, all consequences of the same hazard, namely "the concentration of precipitation in few very intense events accompanied by high winds". There is still the possibility to combine the 4 risks into an overall one.

Issues related to the weighting process

Provided that when considering many indicators, their weighting is very important as well as questionable. In the case of the present target area, the selection of all the weights was performed using the technique of "paired comparison" with the support of a panel of 3 experts.

The weights assigned to the indicators differ from a sub-risk from the other, since as mentioned before each factor plays differ roles within the various phenomena/potential impacts.

Issues related to the aggregation formula

As already mentioned, the fact that the risk aggregation formula uses the addiction instead of the multiplication may produce inaccurate results. In the case of present target area, during the aggregation of components to risk, a sort of "internal coherence check" was introduced to annul the risk when the

[5] https://www.qgis.org/it/site/

exposure to a certain phenomenon was null and the vulnerability was positive, considering the scope of indicators used for sensitivity.

Issues related to the representation per census sections

The choice of the census section as unit of analysis can cause some readability problems due to their different size: highly populated sections are very small, low populated ones can be significantly larger6, the indicators are attributed to the entire section even if the part interested by the phenomenon is the minority (i.e. a large census section interested for a small part by river exposure). In the case of the present target area, in addition to the internal coherence check mentioned before, the problem was solved on the maps using a "cover layer" in order to visualize only the areas exposed to each impacts (it allows to see only floodable areas in the case of river flooding risk; the urban areas in the case of urban flooding risk, the coastal areas in the case of coastal flooding risk), a picture is provided to display such perimeters, all derived by planning tools of "official" data source.

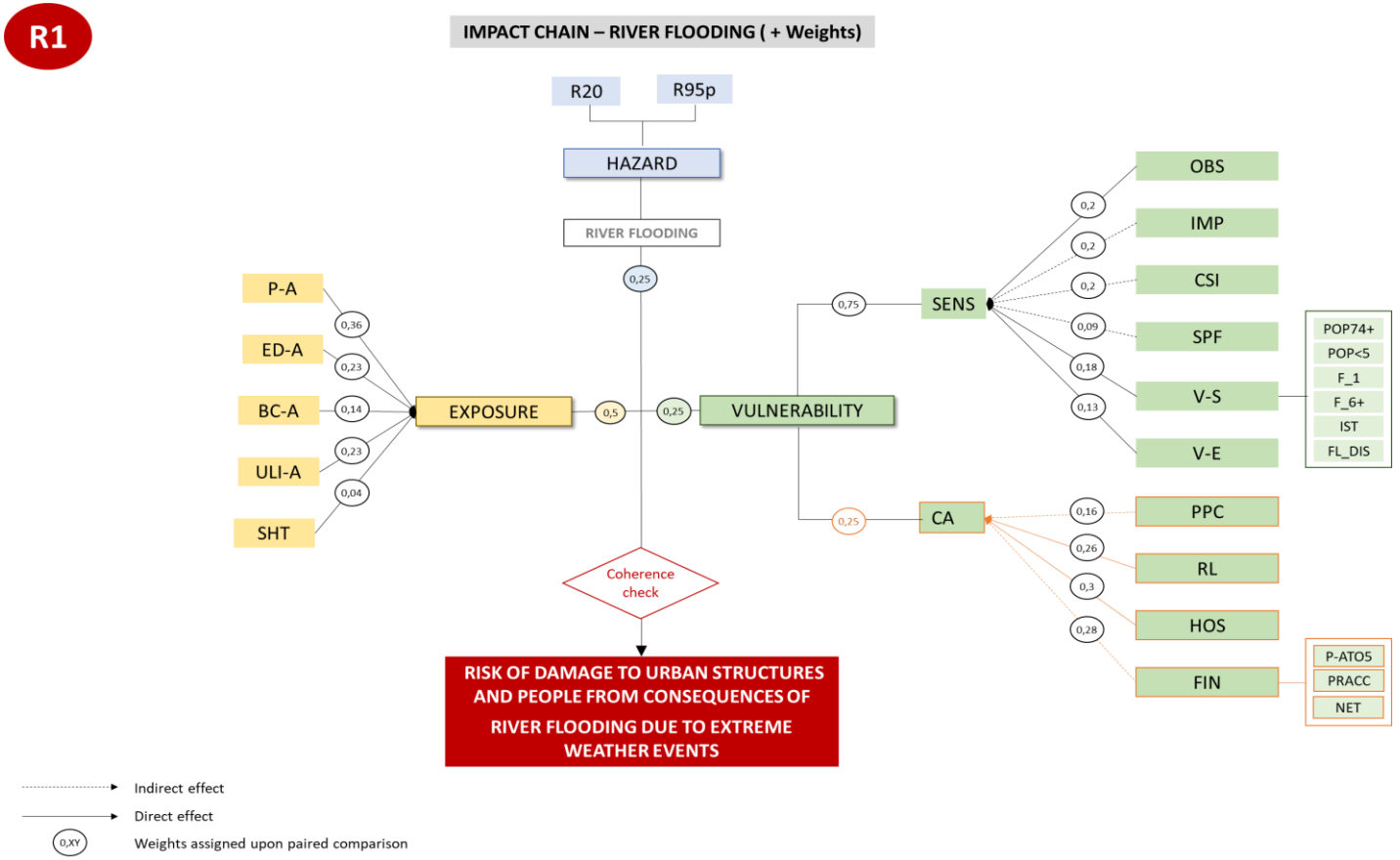
Issues related to classification of values on the maps

The method of classification of risk values plays an essential role, and maps resulting from applying a classification per equal count, per equal interval or per natural breaks can be very different in communicative terms, so this choice has a "political" significance.

For this reason, 2 different versions of the risk maps were produced: one adopts a classification by equal intervals on a 0-1 scale (absolute scale), the other adopts a classification by equal intervals on a min-max scale (relative scale) with indication of the max value of the data series. In both cases null values are grouped as "Not Exposed".

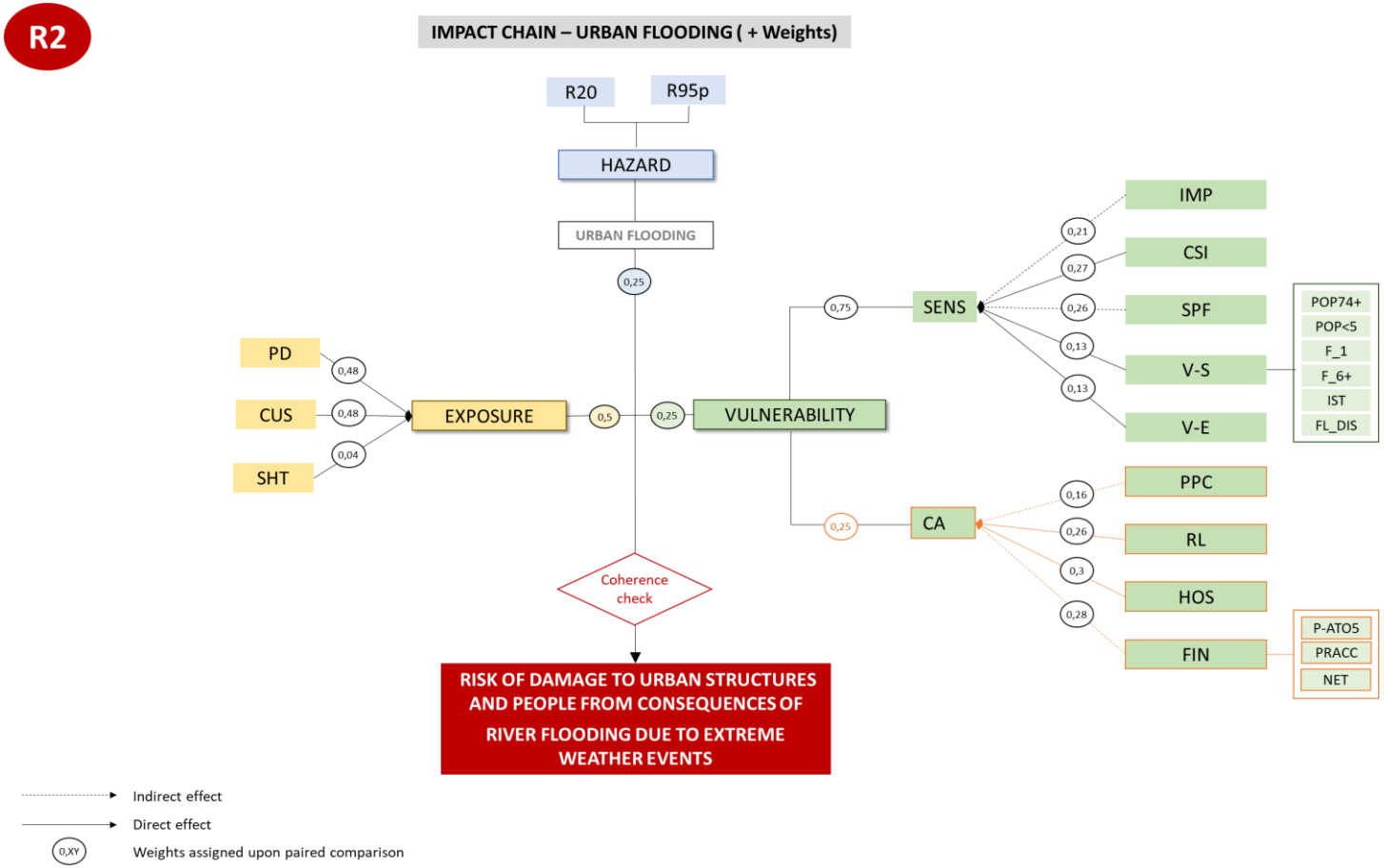
The following pictures summarize the weight assigned to the indicators in the calculation of each component of the 4 risks.

[6] Indeed it was noticed also that the average surface of the census sections differs also from a municipality from the other, for instance Cupra's sections are generally very bigger than San Benedetto's.



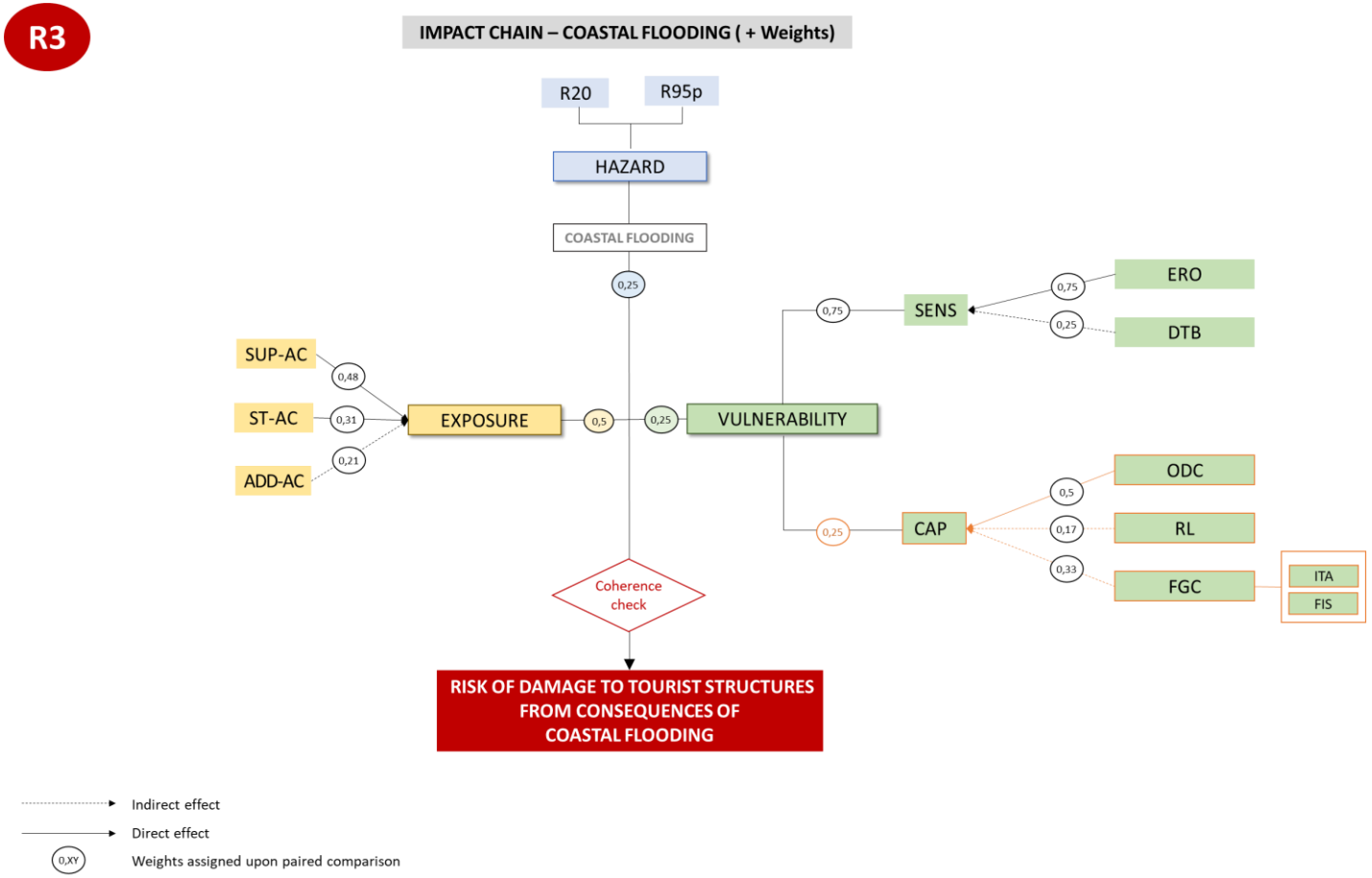
Picture 15: S.B.D.Tronto impact chain R1 (weighted)

R2



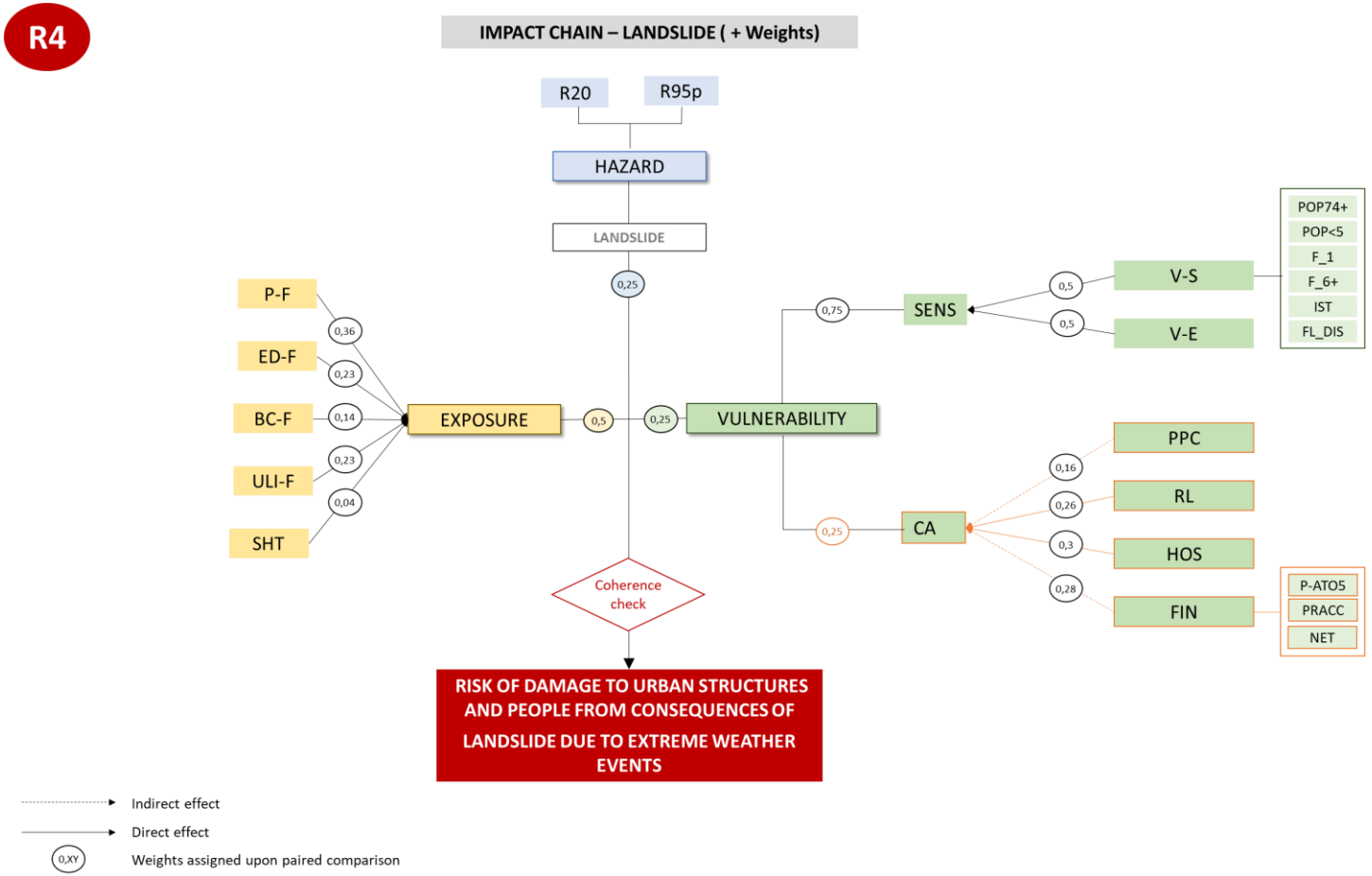
Picture 16: S.B.D.Tronto impact chain R2 (weighted)

R3



Picture 17: S.B.D.Tronto impact chain R3 (weighted)

R4



Picture 18: S.B.D.Tronto impact chain R4 (weighted)

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1	Normalised Indicator value for Target Area 2	Normalised Indicator value for Target Area 3	Normalised Indicator value for Target Area 4
Hazard	Concentration of precipitation in few, very intense events	R20 - No. of days/year with precipitation>20mm (Expected anomaly 2021-2050 respect to 1981-2010 average according to COSMO CLM RCP 4.5 scenario)	no. of days	1,00	1,00	1,00	1,00
		R95p - Annual total precipitation when daily precipitation>95th perc (Expected anomaly 2021-2050 respect to 1981-2010 average according to COSMO CLM RCP 4.5 scenario)	mm	1,00	1,00	1,00	1,00
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalised Indicator value for Target Area 1**	**Normalised Indicator value for Target Area 2**	**Normalised Indicator value for Target Area 3**	**Normalised Indicator value for Target Area 4**
Exposure	Settlements in river flood-prone areas (return period 200 ys)	People in flood-prone areas /Kmq	In./kmq	0,06	0,02	0,05	0,11
	Settlements in river flood-prone areas (return period 200 ys)	Buildings in flood-prone areas/Kmq	num. of buildings/kmq	0,07	0,02	0,04	0,15
	Settlements in river flood-prone areas (return period 200 ys)	Enterprises in flood-prone areas/Kmq	num. of enterprises/kmq	0,01	0,01	0,02	0,07
	Settlements in river flood-prone areas (return period 200 ys)	No. of heritage elements in flood-prone areas per Municipality	no. of heritage elements	0,63	1,00	0,00	0,58
	Settlements in river flood-prone areas (return period 200 ys)	Presence of sensitive locations such as hospital, schools, town hall	Y/N	0,08	0,28	0,20	1,00
	Settlement prone to urban flooding	Land cover classification	adimensional (LCL codes)	0,43	0,45	0,54	0,64
	Settlement prone to urban flooding	Population density (In./kmq)	In./kmq	0,17	0,48	0,26	1,00
	Settlement prone to coastal flooding (return period >100 ys)	% of surface interested by coastal flooding (return period 100 ys)	%	0,14	0,20	0,00	1,00
	Settlement prone to coastal flooding (return period >100 ys)	No. of beach facilities	No.	0,40	0,37	0,00	1,00
	Settlement prone to coastal flooding (return period >100 ys)	Employees in sea-flood prone areas/Kmq	No. of employees/kmq	0,01	0,02	0,00	0,01
	Settlements in landslide-prone areas (return period 200 ys)	People in landslide-prone areas/kmq	In./kmq	0,01	0,03	0,03	0,00
	Settlements in landslide-prone areas (return period 200 ys)	Buildings in landslide-prone areas/kmq	no.of buildings/kmq	0,01	0,05	0,04	0,00
	Settlements in landslide-prone areas (return period 200 ys)	Enterprises in landslide-prone areas/Kmq	num. of enterprises/kmq	0,02	0,04	0,04	0,00
	Settlements in landslide-prone areas (return period 200 ys)	No. of heritage elements in landslide-prone areas per Municipality	no. of heritage elements	0,00	1,00	0,00	0,09
	Settlements in landslide-prone areas (return period 200 ys)	Presence of sensitive locations such as hospital, schools, town hall	no.	0,08	0,28	0,20	1,00
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalised Indicator value for Target Area 1**	**Normalised Indicator value for Target Area 2**	**Normalised Indicator value for Target Area 3**	**Normalised Indicator value for Target Area 4**
Vulnerability	River morphology shortcomings	No. of obstacles to river flows (bridges and overpasses on main and secundary water courses)	no.	0,08	0,00	0,15	1,00
	High soil sealing level	Imperviousness Index	%	0,18	0,41	0,36	1,00
	Outdate urban drainage system	Critical issues recognized by Water Service planning tool	No of occurrence on the list of critical issues	1,00	0,67	0,00	0,33
	Road network prone to flooding	No. of railway underpasses	No. of underpasses	0,44	1,00	0,00	1,00
	Social vulnerability	% of people over 74 years old	%	0,13	0,10	0,08	0,13
	Social vulnerability	% of people below 5 years old	%	0,17	0,19	0,22	0,15
	Social vulnerability	% of single member families	%	0,12	0,11	0,08	0,12
	Social vulnerability	% of numerous families (>5 members)	%	0,04	0,04	0,04	0,03
	Social vulnerability	% of people with lower education	%	0,48	0,46	0,54	0,43
	Social vulnerability	% of unemployed workforce	%	0,11	0,13	0,15	0,16
	Maintenance level of the building stock	% of residential buildings in poor and very poor conditions	%	0,13	0,10	0,24	0,10
	Update level of the Civil protection plan	Year of the last upgrade of the CPP	year	1,00	1,00	0,50	0,00
	Income level	Average per-capita income (€/Y)	€/Year	0,58	0,54	0,78	0,48
	Accessibility to health care structure	Presence of Hospital	Y/N	0,00	0,00	0,00	1,00
	Accessibility to public funding	Per capita investment indicated by Water Services planning tool (K€)	K€	0,01	0,00	0,29	0,60
	Accessibility to public funding	No. of measures identified by Flood Risk Plan	No. of Measures	0,42	0,17	0,50	0,00
	Accessibility to public funding	Affiliations to networks supporting fund raising	No. of networks	0,00	0,00	0,00	0,00
	Low sandy coast prone to erosion	Shoreline change rate	adimensional (coast balance categories)	0,51	0,44	0,00	0,44
	Relevance of seaside tourism	Incidence of summer tourist flows over the year	%	0,92	0,76	0,69	0,86
	Presence of breakwaters	% of protected shoreline segments	%	0,00	0,14	0,00	0,34
	Accessibility to funding for coastal protection	% of retreating shoreline segments interested by structural measures	%	0,00	0,50	0,00	0,23
	Accessibility to funding for coastal protection	Planned investments (M€)	M€	0,78	0,00	0,00	0,75

Area target 1: Cupra Marittima; Area target 2: Grottammare; Area target 3: Monteprandone; Area target 4: San Benedetto del Tronto

Table 8: San Benedetto del Tronto list of all indicators and indicator values

Impact chain 1 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF RIVER FLOODING DUE TO EXTREME WEATHER EVENTS - Cupra M.			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,19	0,50	0,42
Vulnerability			
	0,34	0,25	

Impact chain 1 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF RIVER FLOODING DUE TO EXTREME WEATHER EVENTS - Grottammare			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,26	0,50	0,46
Vulnerability			
	0,33	0,25	

Impact chain 1 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF RIVER FLOODING DUE TO EXTREME WEATHER EVENTS - Monteprandone			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,04	0,50	0,32
Vulnerability			
	0,21	0,25	

Impact chain 1 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF RIVER FLOODING DUE TO EXTREME WEATHER EVENTS - San Benedetto			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,26	0,50	0,50
Vulnerability			
	0,49	0,25	

Impact chain 2 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF URBAN FLOODING DUE TO EXTREME WEATHER EVENTS - Cupra M.			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,29	0,50	0,50
Vulnerability			
	0,43	0,25	

Impact chain 2 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF URBAN FLOODING DUE TO EXTREME WEATHER EVENTS - Grottammare			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,46	0,50	0,60
Vulnerability			
	0,50	0,25	

Impact chain 2 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF URBAN FLOODING DUE TO EXTREME WEATHER EVENTS - Monteprandone			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,39	0,50	0,49
Vulnerability			
	0,18	0,25	

Impact chain 2 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF URBAN FLOODING DUE TO EXTREME WEATHER EVENTS - San Benedetto			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,83	0,50	0,79
Vulnerability			
	0,49	0,25	

Impact chain 3 - RISK OF DAMAGE TO TOURIST STRUCTURES FROM CONSEQUENCES OF COASTAL FLOODING - Cupra M.			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,26	0,50	0,50
Vulnerability			
	0,52	0,25	

Impact chain 3 - RISK OF DAMAGE TO TOURIST STRUCTURES FROM CONSEQUENCES OF COASTAL FLOODING - Grottammare			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,27	0,50	0,50
Vulnerability			
	0,45	0,25	

Impact chain 3 - RISK OF DAMAGE TO TOURIST STRUCTURES FROM CONSEQUENCES OF COASTAL FLOODING - Monteprandone			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,00	0,50	0,00 (0,29*)
Vulnerability			
	0,16	0,25	

Impact chain 3 - RISK OF DAMAGE TO TOURIST STRUCTURES FROM CONSEQUENCES OF COASTAL FLOODING - San Benedetto			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,96	0,50	0,85
Vulnerability			
	0,51	0,25	

Impact chain 4 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF LANDSLIDE DUE TO EXTREME WEATHER EVENTS - Cupra M.			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,01	0,50	0,34
Vulnerability			
	0,18	0,25	

Impact chain 4 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF LANDSLIDE DUE TO EXTREME WEATHER EVENTS - Grottammare			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,27	0,50	0,51
Vulnerability			
	0,16	0,25	

Impact chain 4 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF LANDSLIDE DUE TO EXTREME WEATHER EVENTS - Monteprandone			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,03	0,50	0,36
Vulnerability			
	0,23	0,25	

Impact chain 4 - RISK OF DAMAGE TO URBAN STRUCTURES AND PEOPLE FROM CONSEQUENCES OF LANDSLIDE DUE TO EXTREME WEATHER EVENTS - San Benedetto			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	1,00	0,25	
Exposure			
	0,06	0,50	0,37
Vulnerability			
	0,13	0,25	

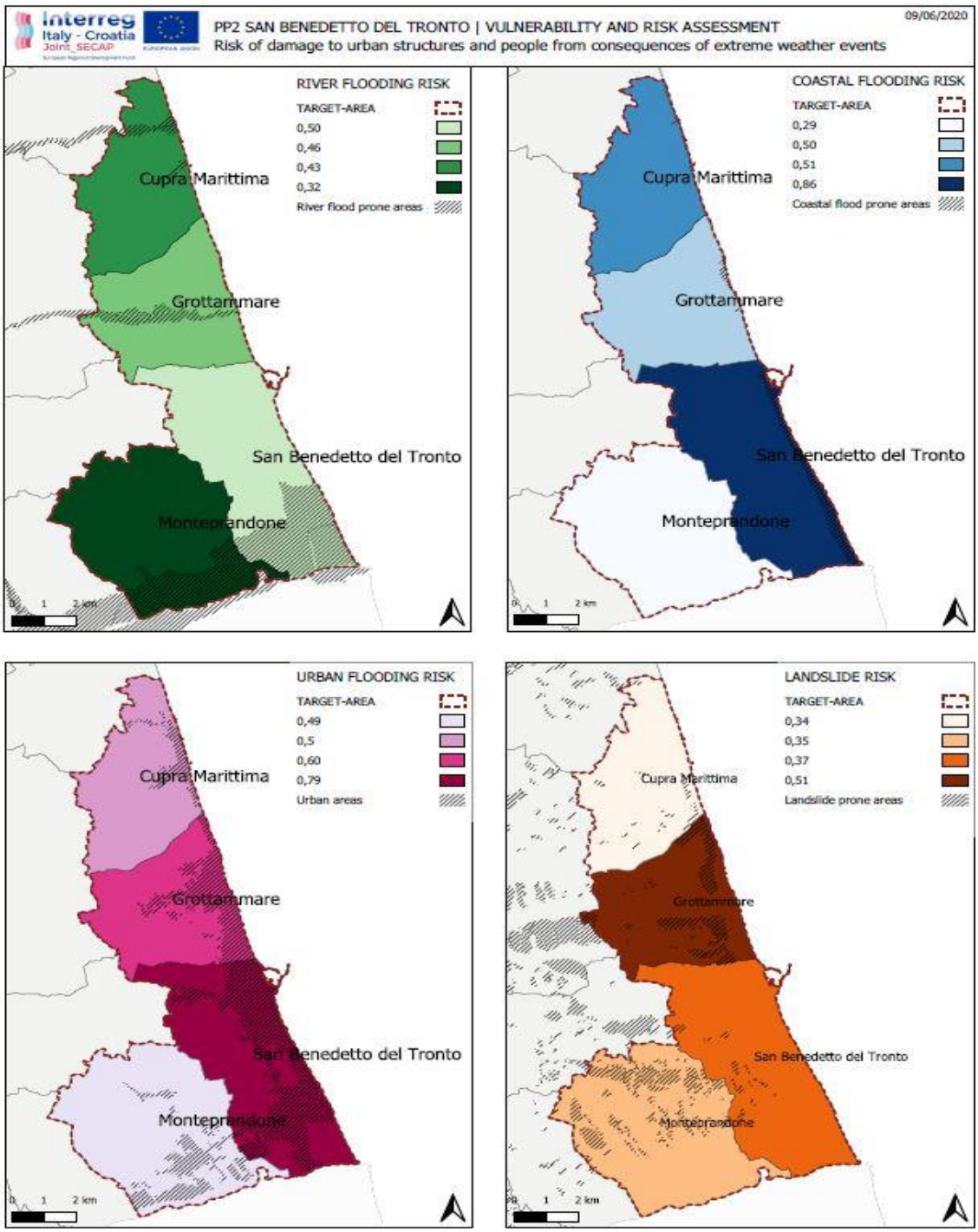
* The M6+M7 module risk formula uses the formula to calculate the sum of risk components (risk 0,29), however the resulting risk should be 0 in the case the exposure value is 0.

Table 9: San Benedetto del Tronto final risk values by impact chain and target area

M8-Presenting the outcomes of your risk assessment

The data regarding the outcomes of the risk assessment was presented in the form of maps. Results of the analysis have not been presented to the public during the making of this report.

The presentation of the data should probably be performed by a mixed group with coordinating authority, consultants and stakeholders and the administrative level on which the data will be presented will be done accordingly with the response of the local public.



Picture 19: S.B.D.Tronto Overall risk map

2.3 [PP3] ABRUZZO REGION

Summary

The risk and vulnerability assessment was coordinated by Abruzzo Region supported by the external consultants from AGENA (the Agency for energy and environment of the Province of Teramo) for the development of impact chains, selection of indicators and for their technical/graphical elaboration.

The risk and vulnerability assessments developed following the methodological guidelines defined by the lead partner Unicam, based on the methodological framework defined by the International Panel on Climate Change (IPCC) in the Fifth Assessment Report and on the Vulnerability Sourcebook by Giz.

A list of about 50 stakeholders were involved. They represent:

• Local administrators

• Regional departments working on natural resources, rural or urban development, biodiversity, disaster risk reduction, etc and regional agency for environment protection;

• Regional meteorological offices;

• Local Action Groups;

• Civil protection (as source of information/key actor in case of emergency);

• Health facilities managers (as source of information/key actors in case of emergency)

• Trade associations agriculture, tourism, fishery (as actors for certain measures)

• citizens' associations

• environmental education centers.

The assessment process lasted from September to March, much more than expected by the proposal, because of the difficulty to collect and analyze data (i.e. climate data), to identify and involve the stakeholders and to select the indicators, enough representative for the target areas.

Four impact chains for each target areas were built.

	IMPACT CHAIN
TARGET AREA 1	**1** Risk of damage for extreme precipitations to buildings, tourism, agriculture & forest and industry sectors
	2 Risk of damage for drought to population, tourism, agricolture & forest and industry sectors
	3 Risk of damage for extreme heat and increase of temperature to population, tourism, agricolture & forest and industry sectors
	4 Risk of damage for extreme heat and drought to population, tourism, agricolture & forest and industry sectors for forest fires

Table 10: Abruzzo region Target area 1 impact chain

	IMPACT CHAIN
TARGET AREA 2	**1** Risk of damage for extreme precipitations to buildings, tourism, agriculture & forest and industry sectors
	2 Risk of damage for extreme weather conditions to population, tourism, environment and biodiversity sectors for coast erosion
	3 Risk of damage for extreme heat to population and to tourism, agriculture & forest and industry sectors
	4 Risk of damage for drought to population and to tourism, agriculture & forest and industry sectors

Table 11: Abruzzo region Target area 2 impact chain

The adopted methodology is a twofold approach: a bottom - up approach and a top - down, in order to complement each other. In particular, top-down assessment has been adopted in the initial phase, taking climate model projections as a starting point to assess physical and ecological impacts, and using multiple projections to assess ranges of uncertainty for future states. At the same time, where data are available specifically for the target area, it has been created a tailor made scenario, because there is a finer geographical scale and focus on physical, ecological or social processes. The bottom up approach has been integrated through participatory processes.

The analysis focused on the most strategic sectors for each target area (as identified from the questionnaires and coherent with the list proposed by the CoM) that are: agriculture and forestry in relation to drought and forest fires, land use planning in relation to hydrogeological risk, tourism, industry and civil protection and emergency in relation to climate change. Based on a scale of values from 0 (very

low) to 1 (very high), for the area target 1, the overall risk analysis shows a high risk of damage to population, tourism, agricolture & forest and industry sectors due to extreme heat and to the increase of high temperatures, followed by a high risk due to extreme precipitations (greater impact risk for the landslide and lower for the flooding), whereas drought risk and fire risks are intermediate.

For the area target 2, the overall risk analysis shows a high risk of damage to population, tourism, agricolture & forest and industry sectors for flooding due to extreme precipitations, intermediate risk for landslide, followed by risk for coastal erosion, drought risk and risk due to the increase in high temperatures, that are as well, intermediate.

In particular, the potential changes induced by climate change on the frequency and intensity of some types of atmospheric events such as, for example, short duration and high intensity rainfall, persistent rainfall, which are the driver of instability phenomena, could represent a substantial increase in current risk conditions.

Below is a summary table of the results obtained.

RISK OF DAMAGE FOR AREA TARGET 1	Risk value	Risk level
1/A Risk of damage for extreme precipitations to buildings, tourism, agriculture & forest and industry sectors (flood risk)	0,55	Intermediate level
1/B Risk of damage for extreme precipitations to buildings, tourism, agriculture & forest and industry sectors (landslide risk)	0,69	High level
2 Risk of damage for drought to population, tourism, agricolture & forest and industry sectors	0,55	Intermediate level
0**3** Risk of damage for extreme heat and increase of temperature to population, tourism, agricolture & forest and industry sectors	0,71	High level
4 Risk of damage for extreme heat and drought to population, tourism, agricolture & forest and industry sectors for forest fires	0,45	Intermediate level

Table 12: Abruzzo region Target area 1 risk of damage

RISK OF DAMAGE FOR AREA TARGET 2	Risk value	Risk level
1/A Risk of damage for extreme precipitations to buildings, tourism, agriculture & forest and industry sectors (flood risk)	0,71	High level
1/B Risk of damage for extreme precipitations to buildings, tourism, agriculture & forest and industry sectors (landslide risk)	0,52	Intermediate level
2 Risk of damage for extreme weather conditions to population, tourism, environment and biodiversity sectors for coast erosion	0,48	Intermediate level
3 Risk of damage for extreme heat to population and to tourism, agriculture & forest and industry sectors	0,44	Intermediate level
4 Risk of damage for drought to population and to tourism, agriculture & forest and industry sectors	0,44	Intermediate level

Table 13: Abruzzo region Target area 2 risk of damage

M1-Preparing the risk assessment

For PP3 - Abruzzo region - there are two areas where the assessment is taking place:

1. **Area target 1** – it includes 4 Municipalities: Penne, Elice, Castilenti and Castiglione Messer Raimondo. All the municipalities have common characteristics and they can be considered as an homogeneous area. They are partly located in the Province of Teramo (Castilenti and Castiglion Messer Raimondo) and partly in the province of Pescara (Penne and Elice). The target area 1 covers an area of 160 km^2, that represents 1,49% of the regional territory. The total population is 19.424 (referring to the 1st January 2019), that represents around 1,48% of the regional population. The population density is around 108 inhabitants /km2 against a regional value of around 122 inhabitants /km2.
2. **Area target 2** – it includes 5 Municipalities: Giulianova, Roseto degli Abruzzi, Pineto, Silvi and Mosciano S.Angelo. All the municipalities have common characteristics and they can be considered as an homogeneous area. They are located in the Province of Teramo on the east and 4 out of 5 are on the Adriatic sea. The target area covers an area of 188,46 km^2, that represents 9,64% of provincial territory and the 1,75% of the regional one.
   The total population is 89.530 (referring to the 1st January 2019), that represents around 29,1% of the provincial population and 6,83% of the regional population. The population density is around 475 inhabitants /km^2 against a regional value of around 122 inhabitants /km^2.

For each target area the territorial (e.g. localization of the area, climate macro-region, river basins, natural areas and resources, etc.) and social framework (e.g. population and its structure, density, main economic activities, etc.) were described with the aim to provide a preliminary basis for the vulnerability and risk analysis.

For both areas, the context areas have been extended as compared to the proposal. In particular, for area target 1, the municipalities of Elice, Castilenti and Penne were added; for area target 2, the municipality of Giulianova was added. The main purpose was to allow small neighbouring municipalities benefit from preparing a joint Sustainable Energy and Climate Action Plan. This means that the group engages in building a common vision, preparing an emission inventory, assessing climate change impacts and defining a set of actions to be implemented both individually and jointly in the concerned territory. The joint SECAP aims at fostering institutional cooperation and joint approaches among local authorities operating in the same territorial area.

A joint approach to energy and climate change mitigation and adaptation planning allows for achieving more effective results than an isolated one, as in some circumstances, opportunities for high-impact actions can be more easily identified within the administrative boundaries of an aggregation of neighboring local authorities. Furthermore, municipalities involved in joint implementation of measures can also benefit from economies of scale, such as in public procurement. In addition, some municipalities face the problem of lack of human and financial

resources to achieve the Covenant commitments. Thus, it becomes easier for them to bundle efforts on action plan preparation, implementation and monitoring.

All the municipalities had developed individual Sustainable energy action plans. The baseline refers to 2005 year. The adopted methodology is the same for all the municipalities of the province of Teramo, but only the mitigation aspect has been addressed.

Concerning the territorial plans, all regional plans were taken into consideration, but mostly in the assessment were considered:

- The regional climate profile;
- Regional Plan for the coastal defence
- Regional plan for the forecasting, prevention and active fight against forest fires
- Hydrogeological plan (PAI)
- Flood defence plan (PSDA)
- Management Plan of flood risk (PGRA)

At municipal level, the emergency municipal plans were considered. Both anthropic and natural risks are dealt with in the emergency planning. The emergency plan is considered one of the instruments that can best contribute to the increase of urban resilience, especially in relation to the main phases of emergency planning, namely forecasting, prevention, relief and overcoming of the disastrous event.

Local actors and stakeholders had been involved in the selection of risks and development of impact chains. A list of about 50 stakeholders was drawn up on the basis of their competence or interest in the sectors selected.

The stakeholders include:

- Local administrators
- Regional departments working on natural resources, rural or urban development, biodiversity, disaster risk reduction, etc and regional agency for environment protection;
- Regional meteorological offices
- Local Action Groups: i.e. Flag Costa blu
- Civil protection (as source of information/key actor in case of emergency)
- Health facilities managers (as source of information/key actors in case of emergency)
- Trade associations agriculture, tourism, fishery (as actors for certain measures)
- citizens' associations
- environmental education centers.

A Risk and Vulnerability Assessment determines the nature and extent of a risk by analyzing potential hazards and assessing the vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

The easier and faster way to assess the risk was to provide a questionnaire to the identified stakeholders. In fact, impacts were considered as the easier-to-understand starting point to collect stakeholders' perception about climate risks.

For the stakeholder consultation, it was adopted the questionnaire developed by CRAS, the technical consultant of the municipalities of San Benedetto. The questionnaire was sent by mail and had to be filled specifically for each target area.

The questionnaire provides 3 columns: 1) the potential climate impact per sector, 2) the relevance of each impact and 3) short explanation of the impact, referred (if possible) to a specific past event. The potential climate impacts per sector were listed starting from list of potential impacts per sector contained in the Italian National Adaptation Plan to Climate Change (NAPCC).

The relevance of the impact is based on 1-5 scoring system (where 1 means negligible and 5 means very significant).

The climate related risks are linked to hazardous events, such as extreme heat, extreme cold, extreme precipitation.

For the assessment of the target areas, only the climate signals more relevant from the questionnaire have been analyzed deeply and used for developing impact chain.

Concerning local administrators of the municipalities of the target areas, since the beginning of the project, there has been the involvement of both political and technical representatives of each municipality in order to build a team, supported by the Region and external consultants. The decision makers have a very important role to provide:

- good- quality information on what impacts are occurring now, their location and the groups or systems most affected;
- reliable estimates of the impacts to be expected under projected climate change;
- estimation of different risks and opportunities associated with climate change.

Additional information from local administrator of the municipalities of the target areas were collected during the meeting in Pescara on the 3rd October.

External consultants were in charge for the developing of impact chains, for the identification and selection of indicators, data acquisition and management, normalization of indicator data and for the aggregation of indicators to define the composite risk indicator.

The difficulties have been extremely reduced, thanks above all to the close collaboration among the various regional sectors. Some difficulties referred to the delay with respect to the deadline in the receipt

of some questionnaires and, consequently, the processing of data to identify the significant impacts for the target areas.

M2-Developing impact chains

The climate hazards were identified as critical states in order to facilitate the risk assessment. The preliminary list of climate hazards was taken from the Covenant of Mayors template.
Climatic hazards are linked to the occurrence of extreme weather events, which in turn are related to a number of physical variables such as temperature, precipitation, or wind. Extreme weather events can lead to well-known natural hazards such as river and coastal floods, droughts, forest fires, heat and cold waves, windstorms; these climatic hazards have a direct impact on people's well-being and on a number of economic sectors such as agriculture, energy, transport, health, tourism, etc. Other effects of climate change can lead to hazards that are not directly linked to extreme weather but more to longer-term processes such as sea level rise, which will directly affect coastal cities.

The climate hazards chosen for the assessment are reported in the following table:

Indicator	**Acronym**	**Description**	**Unit of measure**
Intense precipitation days	R20	Annual average of the number of days with daily precipitation greater than 20 mm	Days/year
Precipitation	PA	mm of annual rain	mm/year
Rise in water level	R	Water level rise caused by breaking waves	m
Consecutive dry days	CDD	Annual average of the maximum number of consecutive days with rain less than 1 mm / day	Days/year
Summer days	SU95P	Annual average of the number of days with maximum temperature higher than 29,2°C	Days/year

Table 14: Abruzzo region climate hazard indicators

The selected indicators are a small part of the indicators used for the Italian National Adaptation Plan, for the study of recent changes in the frequency and intensity of the extremes of temperature and precipitation in Italy.

Assessment of the impacts of climate change requires updated estimates of trends of both average values and extremes of temperature and precipitation.

All the data were provided by the Functional center and hydrographic office of Abruzzo Region (Centro Funzionale e Ufficio Idrografico Regione Abruzzo).

For the assessment of the target area, only the climate signals more relevant from the questionnaire have been analyzed deeply and used for developing impact chain.

The identification of the impact chains involved two phases: a preliminary phase in which the impacts for the two target areas were identified and a phase of improvement in which the impact chains were "adapted" in order to be populated by indicators for any factor of hazard, exposure and vulnerability. For each target area, four impact chains were identified and developed and all have been finalized and included in the assessment.

The impact chains were developed by external consultants of Abruzzo Region in close collaboration with the Abruzzo Region.

In order to develop the impact chains, the main used sources refer to:

- the methodology “Vulnerability and risk assessment” proposed by the lead partner;
- the questionnaires from the stakeholders for the identification of the relevant sectors;
- the additional information collected during the meeting in Pescara on 3rd October 2019;
- the National Plan for Adaptation to climate change, for the identification of intermediate impacts and vulnerabilities of the individual socio-economic and environmental sectors;
- the Vulnerability Sourcebook Concept and guidelines for standardized vulnerability assessments and Risk-Supplement-to-the-Vulnerability-Sourcebook, by GIZ;
- Risk and vulnerability assessment – part 2 of Guidebook “How to develop a Sustainable Energy and Climate Action Plan” by JRC

The identification of the potential impacts which will likely to occur in the target areas as a consequence of the selected climate-related hazards was firstly performed starting with a desktop review of potential impacts based on the available local studies, researches, scientific sources and planning documents dealing with climate change and its impacts. Then the list of potential impacts was included into the

questionnaire to be shared and filled by the key local stakeholders of each target area.

Local actors and stakeholders had been involved in the selection of relevant sector for the development of impact chains through the compilation of the questionnaires. The list of stakeholders is the same of the previous list.

The chains were developed in two stages. The first phase, based on the results of the questionnaires, led to a “more” qualitative impact chains, composed of risk components (hazard, vulnerability, exposure).

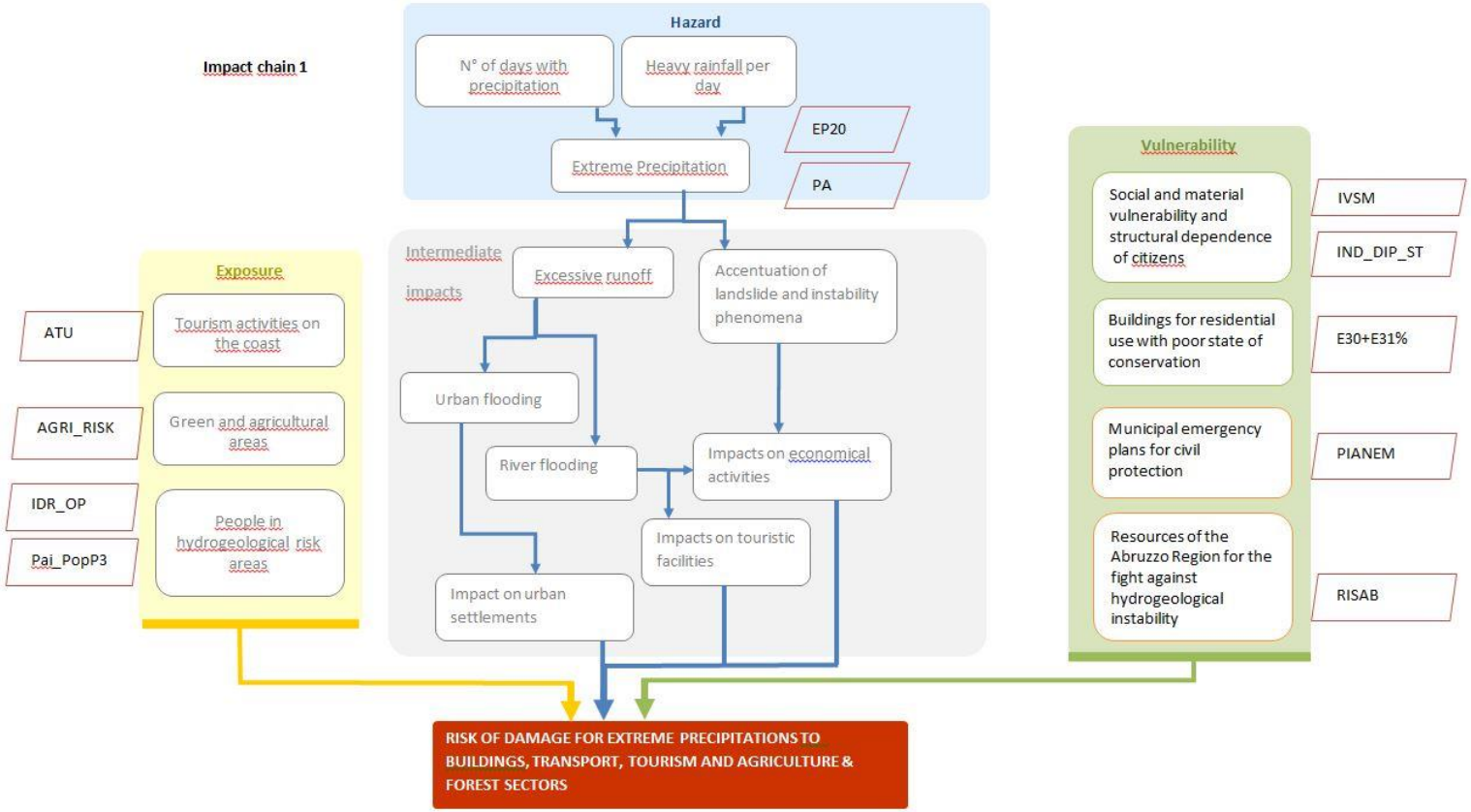
In the second phase, the impact chains, even maintaining consistency with the questionnaires, had become “more” quantitative, in fact the different factors were identified, in order to quantify, assess and measure the relevant factors.

The hazard component includes factors related to the climate signal and direct physical impact. The exposure component is comprised by one or more exposure factors. The vulnerability component consists of sensitivity and capacity factors. In contrast to these three components, intermediate impacts are not a risk component by themselves but merely an auxiliary tool to fully grasp the cause-effect chain leading to the risk. By definition, they are a function of both hazard and vulnerability factors, which means that all impacts identified which do not only depend on the climate signal but also on one or several vulnerability factors need to be placed here.

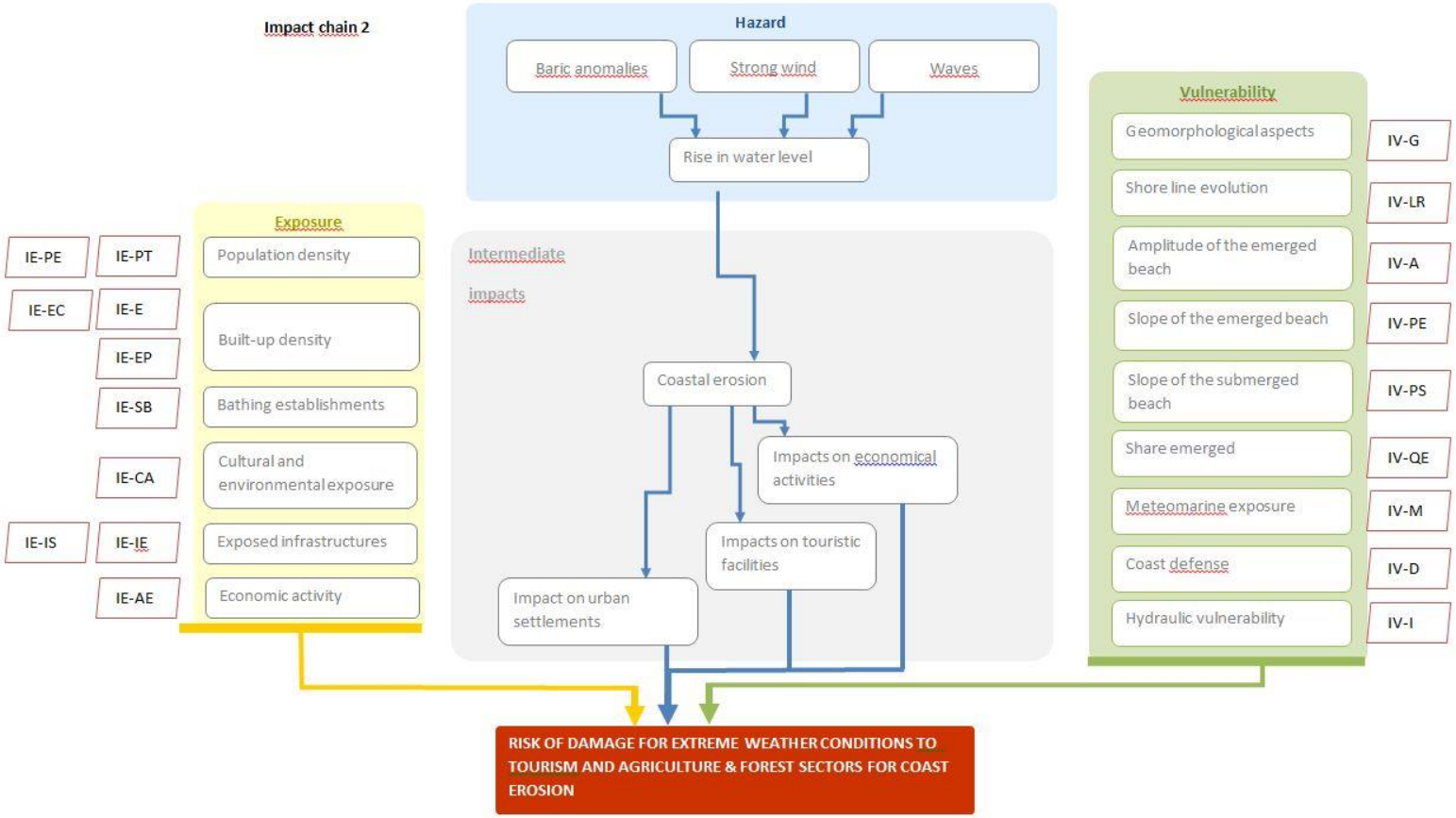
Some difficulties were linked to represent graphically and a clear way the complexity of environmental phenomena, because the impact chains represent a too simplified reality which does not correspond to the evolution of natural phenomena.

But, the major difficulty was linked to the need to find parameters able to assess in a reliable and credible way the risk components and able to be measured with temporal and spatial resolution.

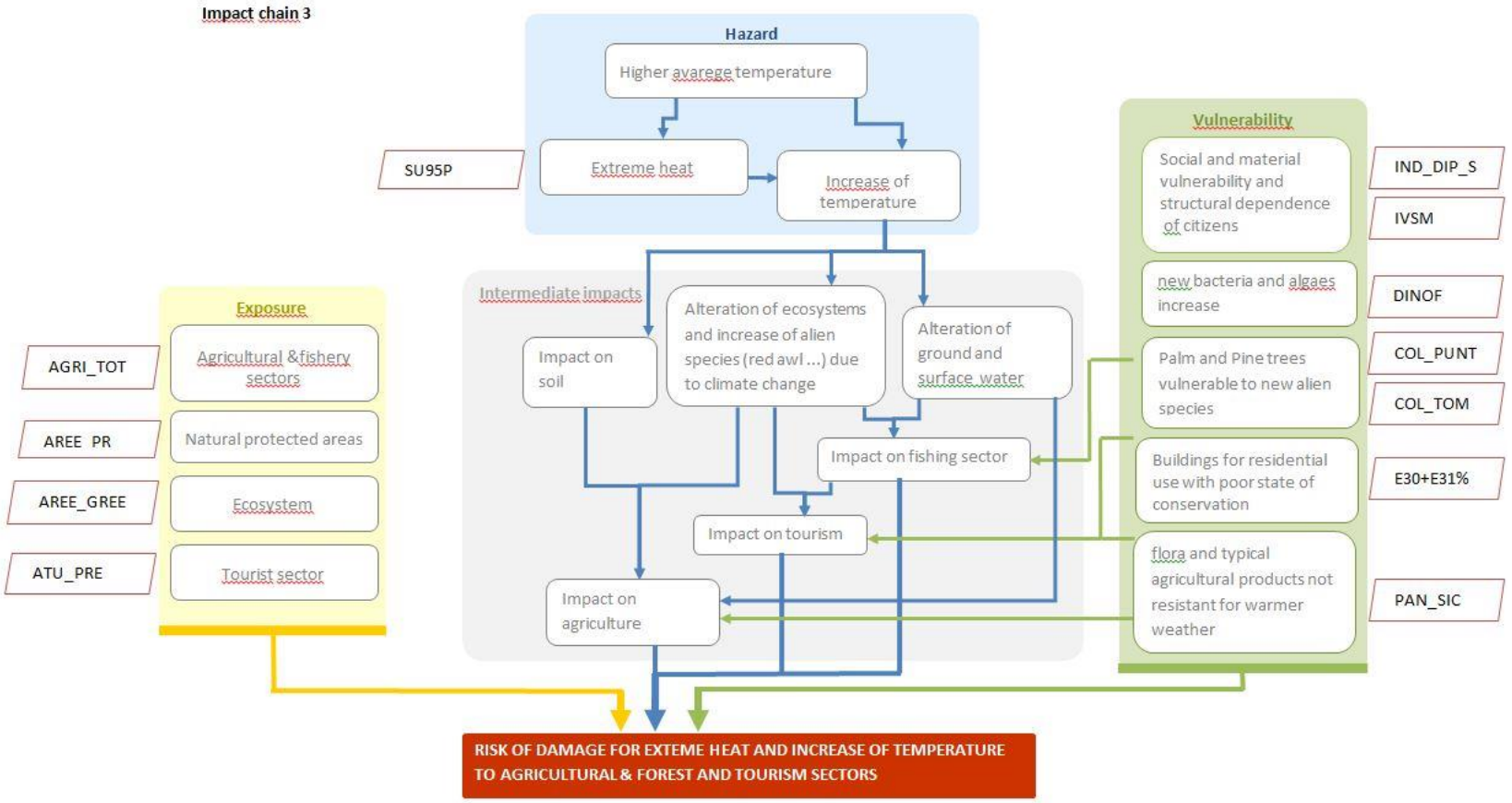
The method suggested by the tutorial was used. The impact chain were built on the basis of stakeholder involvement and on the basis of existing documents at national, regional and local level, in order to better understand, systemize and prioritize the factors that drive risk in the two target areas, as well as their cause and effect relationship.



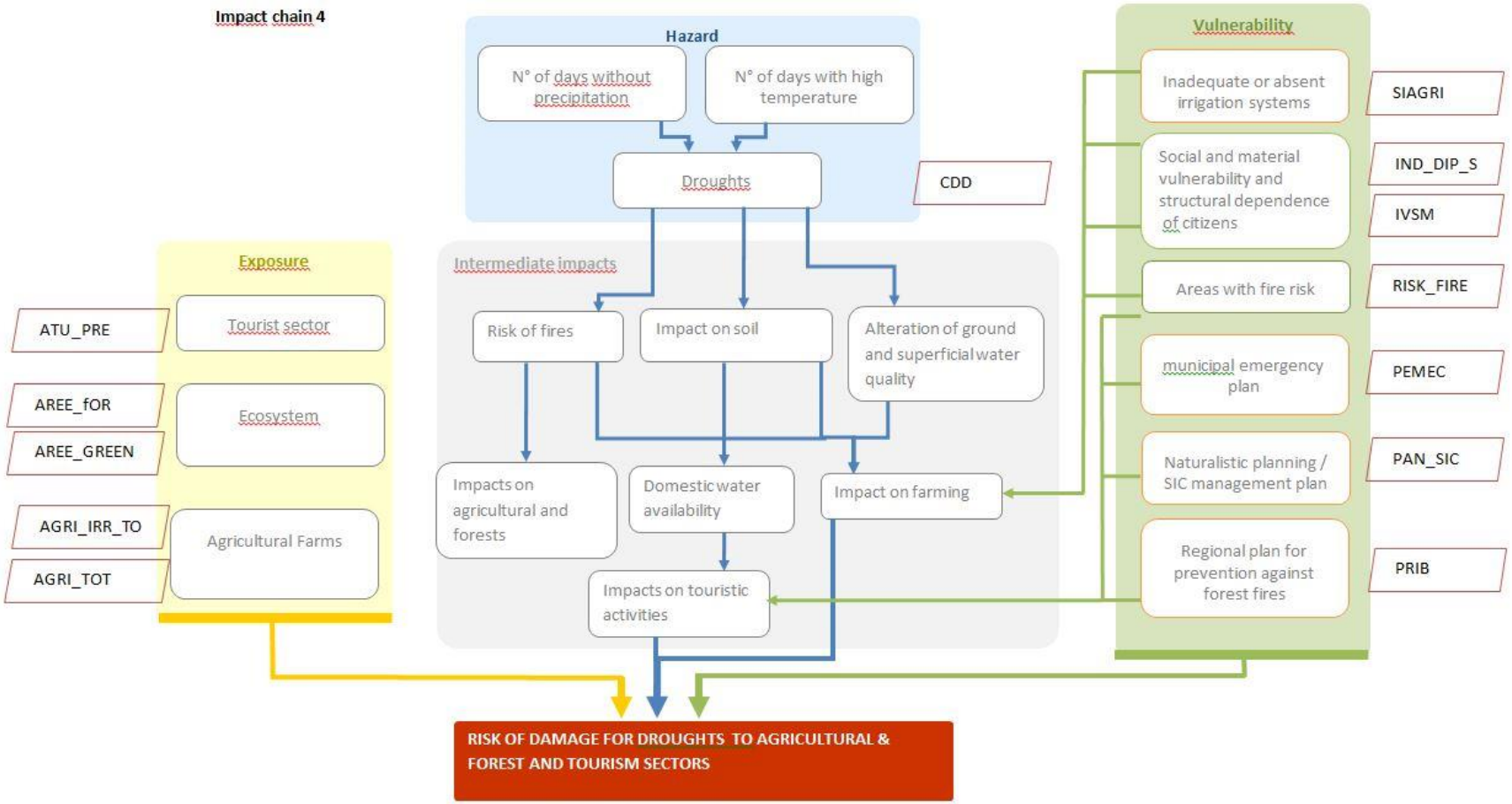
Picture 20: Abruzzo Region impact chain 1 (target area 1)



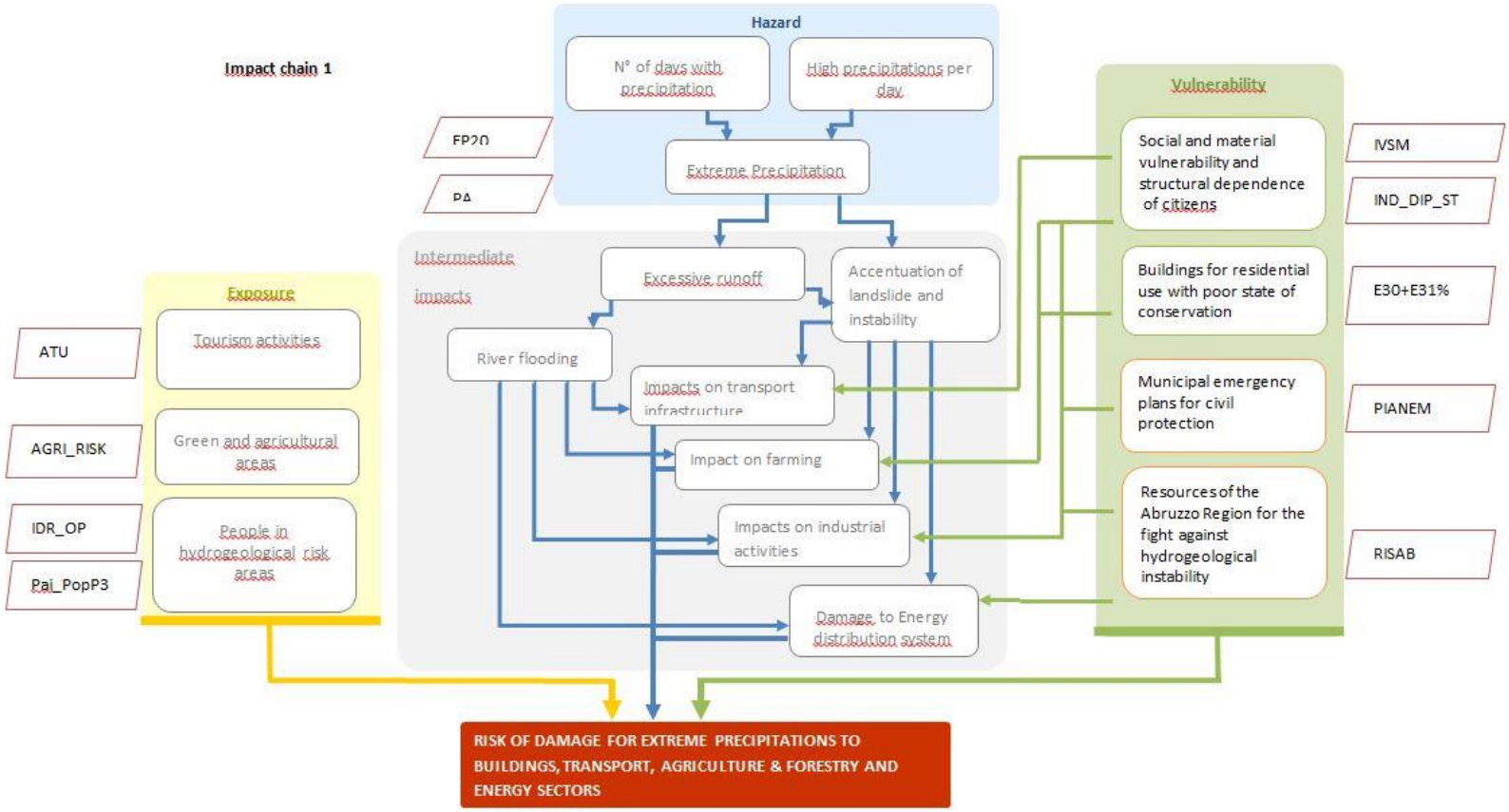
Picture 21: Abruzzo Region impact chain 2 (target area 1)



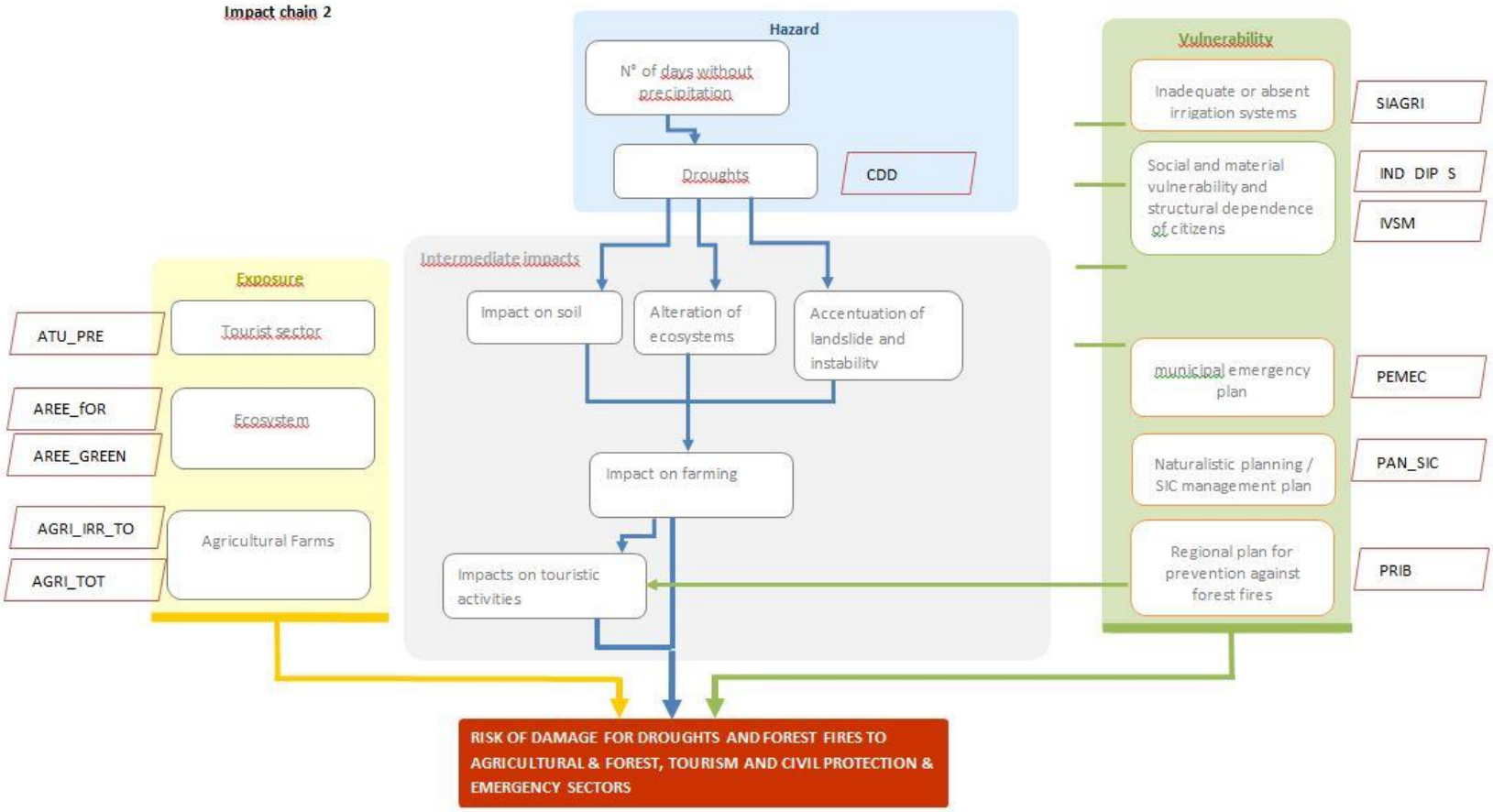
Picture 22: Abruzzo Region impact chain 3 (target area 1)



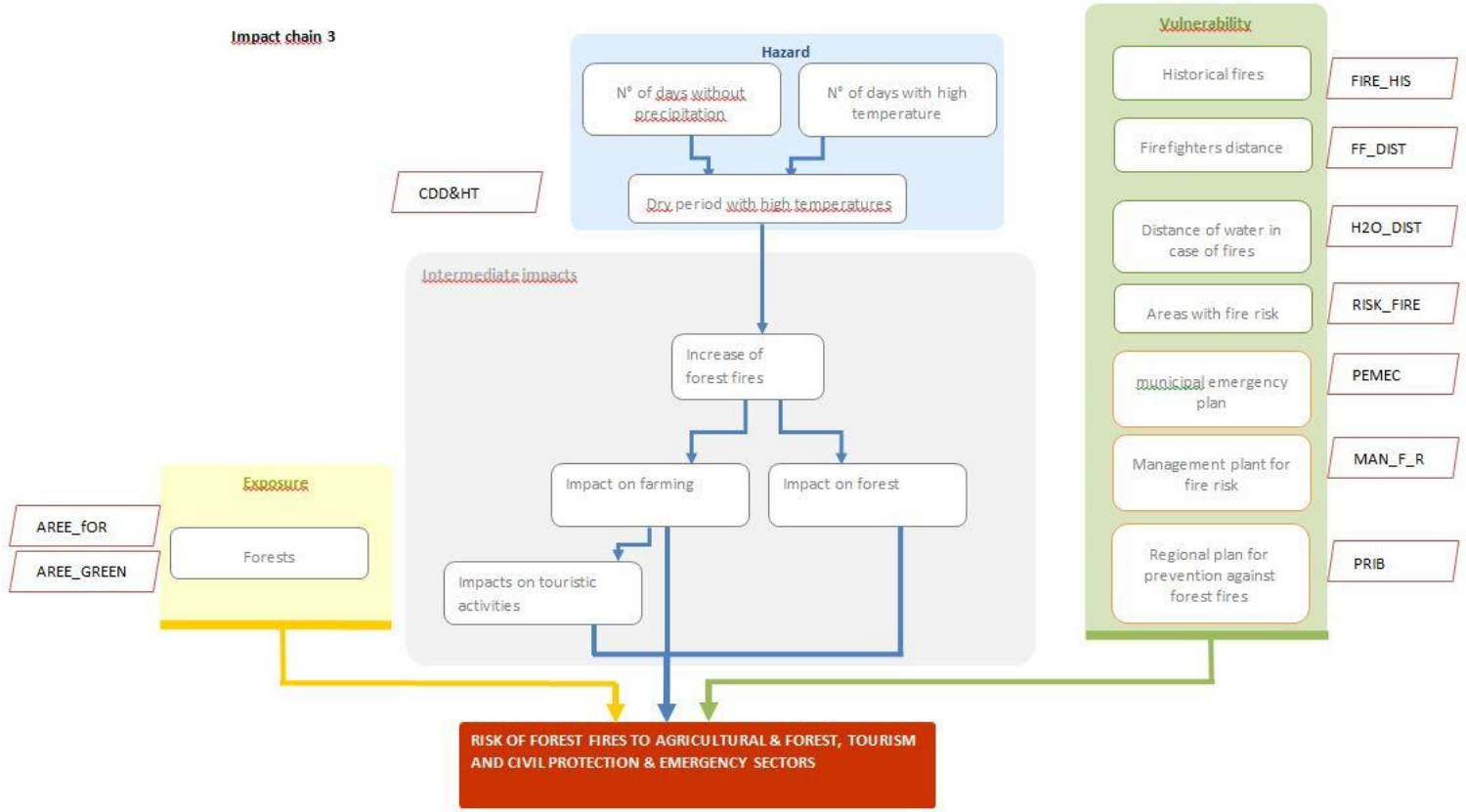
Picture 23: Abruzzo Region impact chain 4 (target area 1)



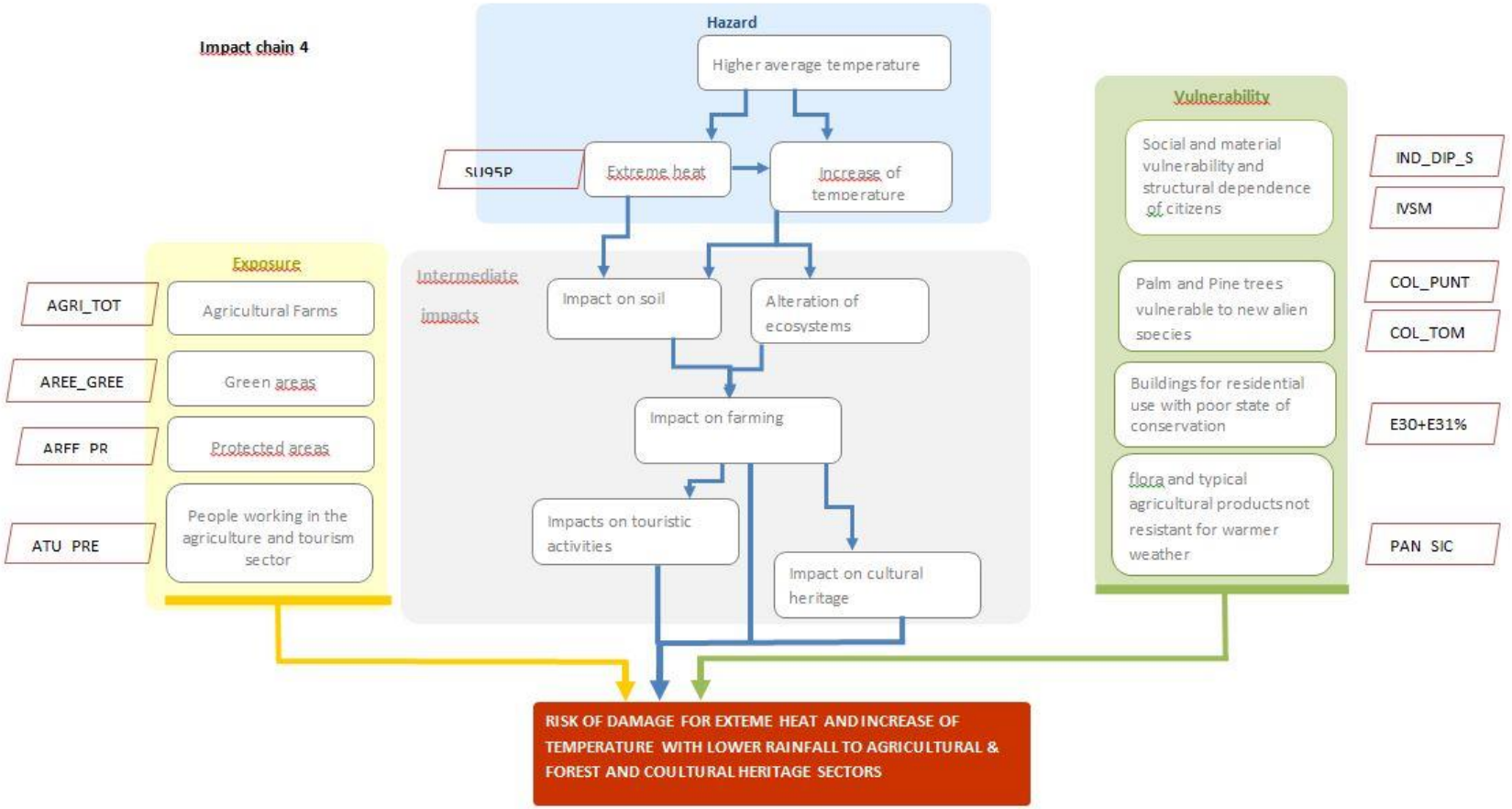
Picture 24: Abruzzo Region impact chain 1 (target area 2)



Picture 25: Abruzzo Region impact chain 2 (target area 2)



Picture 26: Abruzzo Region impact chain 3 (target area 2)



Picture 27: Abruzzo Region impact chain 4 (target area 2)

M3-Identifying and selecting indicators, M4-Data acquisition and management

Regarding climate change factors (single factors within Exposure and Vulnerability), 19 Indicators were selected. The list is in the following table.

Component	Factor	Indicator	Acronym
Hazard	Extreme precipitation events	N° of days with precipitations > 20mm	R20
	Mean of annual precipitations	mm of annual rain	PA
	Higher average temperature	N° days with daily maximum> 29,2°C	SU95P
	Consecutive days with daily PRCP < 1mm	N° of consecutive days with daily Precipitations < 1mm	CDD
Component	**Factor**	**Indicator**	**Acronym**
Exposure	People living in flood prone areas (P3)	% of people living in flood prone areas (P3 areas)	IDR_POPP3
	People living in landslides areas (P3+P4)	% of people living in landslides areas (P3 + P4 areas)	PAI_PopP3+P4
	Agricultural areas	Utilized agricultural area per inhabitant, compared to the regional average	AG_PP
	Natural protected areas	% of municipalities with a protected area	PR _A
	Tourism sector	Nights spent in an accomodation per inhabitant, compared to the regional average	TU_PP
	Industrial sector	% of employees in the industrial sector compared to the regional average	IND_E
	Population	All the population living in the joint area	POP
Component	**Factor**	**Indicator**	**Acronym**
Vulnerability	Social and material vulnerability	Social and material vulnerability index	IVSM
	Structural dependence	Ratio between the population of non-active age (0-14 ys and > 65 ys) and the population of active age (15-65 years) compared to the regional data	IND_DIP_STR
	Buildings for residential use with poor state of conservation	% of residential buildings with poor state of conservation compared to the total municipal stock	E30+E31
	Emergency plans	n° of municipal emergency plans and state of update	M_E_P
	Lack of financial resources for hydrogeological instability	% of financial regional resources for flood and landslides in the joint area compared to regional data	R_A_H
	Fire risk area	% of area with risk of fire of forest with medium/ high level	RF
	Water scarcity in agricolture	Standard Precipitation Index	SPI
	New alien species	Municipalities infested by rhynchophorus ferrugineus	IN_RF

Table 15: Abruzzo Region indicators

At least one indicator for each factor has been identified. This solution had come out with the second draft of impact chains.

The indicators were identified in other used reports. In particular, for the population in landslides and flooding areas were considered the indicators provided by ISPRA in the report "Landslides and floods in Italy: hazard and risk indicators" (2018). It provides an updated overview on landslide and flood hazard over the Italian territory and contains risk indicators related to population, families, buildings, industry and services, and cultural heritage. The Report updates the national maps of the landslide hazard of the River Basin Plans - PAI and of the hydraulic hazard according to the Scenarios of Legislative Decree 49/2010 (implementation of the 2007/60/EC Floods Directive), realized by ISPRA through the harmonization and the mosaic of the hazard zones mapped by the River Basin District Authorities. These indicators provide an official reference framework for landslide and flood risk in Italy and an important tool to support national mitigation policies by identifying intervention priorities, allocation of funds, programming mitigation measures and planning civil protection measures.

These particular indicators were adopted because they respond to transparency and repeatability criteria and uses official data available across the national territory, such as the ISPRA national mosaics of landslide and flood hazard zones and the 15th ISTAT Population Census 2011. The estimation of the population exposed to landslide risk has been processed using the 402,678 ISTAT 2011 census sections as mapping unit. The number of exposed people has been calculated with a proportional method, multiplying the percentage of landslide hazard zones inside each census section for the resident population of the section. The data has been then aggregated on a municipal basis. Similarly, the population exposed to flood risk has been estimated.
For the landslides, the risk is identified for population living in the high and very high hazard classes (P3 and P4). For flood, the risk is identified for population living in areas P3, probability scenario with return period of 30-50 years.
Also, the indicators concerning social and material vulnerability (IVSM), structural dependence (DIP_S) and residential buildings with poor state of conservation (E30+E31) were used. They are computed by ISTAT. The IVSM index is an estimate of the overall socio-economic vulnerability of a municipality. It is computed on the basis of seven different socio-economic indicators: the incidence of population with age between 25 and 64 that is illiterate or without qualification; the incidence of families with at least 6 members; the incidence of single parent families (with age of parent up to 64) over the total of families; the incidence of families with possible welfare poverty; the incidence of population living in severely crowded conditions; the incidence of young people (15-29 years) without occupation; the incidence of families with children with potential economic poverty. The index allows comparison among municipalities across space and time. High values of the index indicate high vulnerability, while low values indicate low vulnerability. The decision to adopt this index is to provide a baseline indication of the inability of the social community (identified as the municipality) to tackle the adverse impacts caused by extreme meteo climate events and to be resilient to its risk.

The structural dependence is the ratio between the population of non-active age (0-14 years and 65 years and over) and the population of active age (15-64 years), multiplied by 100. The structural dependency index calculates how many individuals are in non-active age per 100 in active age, indirectly providing a measure of the sustainability of a population structure. The denominator represents the segment of population that should provide for the maintenance of the range indicated in the numerator. This report

expresses the theoretical social and economic burden of the working age population: values above 50 percent indicate a situation of generational imbalance.

The choice to adopt the indicators related to residential buildings with poor state of conservation (E30+E31) was used to show the vulnerability of the buildings.

In fact, the indicator on the state of conservation of residential buildings allows to verify the state of conservation of the buildings, considering that a building with a poor state of conservation is not able to guarantee a certain resilience to periods of summer thermal stress.

For the coastal risk, the indices provided by the "Regional Plan for the coastal defence "were used. The plan has been realized by Abruzzo Region in close collaboration with University of L'Aquila, Department of Civil Engineering, Building and Environmental Architecture.

The plan aims to:
• define the actual state of the coast;
• assess the level of coastal risk in each identified homogeneous area;
• analyze the effects of interventions performed in the past;
• carry out a detailed analysis of the coast at greatest risk.
In particular, for Risk assessment, the used methodology implies the definition and quantification of three components: hazard, exposure and vulnerability. The plan provides useful index and maps for the coastal risk in all the coastal municipalities.

The hazard index includes the rise in water level.

The exposure index considers the following aspects:

- Total population density index;
- Population density index weighted on age;
- Built density index;
- Built density index weighed on the year of construction;
- Built density index weighed on the number of floors;
- Index of presence of beach resorts;
- Cultural and environmental exposure index;
- Index of exposed infrastructures;
- Support infrastructure index;
- Economic Activities Index.

The vulnerability index depends on a variety of physical aspects:

- Geomorphologic index;
- Shore line evolution index;
- Width index of the beach above sea level;
- Slope index of the beach above sea level;
- Slope index of the beach under sea level;
- quota above sea level index;
- Meteomarine exposure index;
- Defense index;
- Hydraulic vulnerability index.

All these indices were considered, but not calculated. The plan is very recent (2019) and, being the same factors identified and the work well done, we took these parameters and we only calculated the global risk for the target area based on the Joint SECAP methodology.

The specific indicator created concerns the number of municipal emergency plans existing and updated in the target areas. This indicator is easy to collect, but at the same time it's very important, because it represents the coping capacity of the municipality to address, manage and overcome adverse conditions in the short and medium term. Both anthropic and natural risks are dealt with in the emergency planning. Emergency planning is configured as a cyclical risk forecasting and emergency preparedness process, supported by the definition of operating procedures aimed at ensuring the organization of the operations of the individuals involved in emergency management.

Another specific indicator is the financial resources from Abruzzo region for hydrological instability over the years. The indicator for now refers only to resources allocated between 2013 and 2017 by order of the head of the civil protection department. It would be interesting to broaden the monitoring of these resources also by integrating them with others from other programs (European, national and regional).

Another specific indicator for the target areas concerns the number of municipalities of the target area affected by alien species (Rhynchophorus ferrugineus), which has the palm as target species. The presence of alien species can be a consequence of the climate changes. For now, the indicator is limited to the

Rhynchophorus ferrugineus, but it is intended to activate at the target area level also a monitoring of the tree species infested by Tomicus and tingidae, which target trees are pine and plane respectively.

The indicators were developed in close collaboration between Abruzzo Region and external consultants. This module was partially developed with local key actors/stakeholders on the basis of information collected during the meeting. Then Abruzzo Region and external consultants selected the indicators internally in advance to create a limited number and not further burden the work of the municipal technicians/ administrators. At a later stage, the choice of indicators will be shared among municipal staff to support them how to collect and monitor over time.

Quantitative indicators were used. The selection of indicators was quite difficult, in fact they were selected considering the following criteria:

- adequate spatial and temporal resolution;
- presence of continuity (absence of missing data in the database);
- accessibility (coming from an easily accessible database);
- updated information;
- reliability.

The first draft list of indicators on the basis of the first impact chains were changed, because above all indicators for sensitivity and adaptive capacity were not always available and easy to access at local level due to resource constraints (time and budget).

The actual list allows to quantify, assess and measure the relevant factors in an easy and homogeneous way among the municipalities involved in each target area.

The following table shows the detail for each indicator.

Component	Factor	Indicator	Acronym	Source	Spatial coverage	Temporal coverage	Level of updating
Hazard	Extreme precipitation events	N° of days with precipitations > 20mm	R20	Abruzzo Region - Hydrographic and Mareographic Office	idrografic stations (Catignano for target area 1 and Giulianova for target area 2	1974 -2017	annual
	Mean of annual precipitations	mm of annual rain	PA	Abruzzo Region - Hydrographic and Mareographic Office	idrografic stations (Catignano for target area 1 and Giulianova for target area 2	1974 -2017	annual
	Higher average temperature	N° days with daily maximum> 29,2ºC	SU95P	Abruzzo Region - Hydrographic and Mareographic Office	idrografic stations (Catignano for target area 1 and Giulianova for target area 2	1987 -2017 Giulianova 1983-2017 Catignano	annual
	Consecutive days with daily PRCP < 1mm	N° of consecutive days with daily Precipitations < 1mm	CDD	Abruzzo Region - Hydrographic and Mareographic Office	idrografic stations (Catignano for target area 1 and Giulianova for target area 2	1987 -2017 Giulianova 1983-2017 Catignano	annual
Component	**Factor**	**Indicator**	**Acronym**	**Source**	**Spatial coverage**	**Temporal coverage**	**Level of updating**
Exposure	People living in flood prone areas (P3)	% of people living in flood prone areas (P3 areas)	IDR_POPP3	ISTAT - ISPRA	municipality	2015 - 2017	every 5 years
	People living in landslides areas (P3+P4)	% of people living in landslides areas (P3 + P4 areas)	PAI_PopP3+P4	ISTAT - ISPRA	municipality	2015 -2017	every 5 years
	Agricultural areas	Utilized agricultural area per inhabitant, compared to the regional average	AG_PP	ISTAT - Agricolture Census	municipality	2010	every 10 years
	Natural protected areas	% of municipalities with a protected area	PR _A	Abruzzo Region	protected natural area	2014	occasional
	Tourism sector	Nights spent in an accomodation per inhabitant, compared to the regional average	TU_PP	Abruzzo Region - Economic development and tourism department	municipality	2009-2018	annual
	Industrial sector	% of employees in the industrial sector compared to the regional average	IND_E	ISTAT	municipality	2011	every 10 years
	Population	All the population living in the joint area	POP	ISTAT	municipality	2019	annual
Component	**Factor**	**Indicator**	**Acronym**	**Source**	**Spatial coverage**	**Temporal coverage**	**Level of updating**
Vulnerability	Social and material vulnerability	Social and material vulnerability index	IVSM	ISTAT	municipality	2010	every 10 years
	Structural dependence	Ratio between the population of non-active age (0-14 ys and > 65 ys) and the population of active age (15-65 years) compared to the regional data	IND_DIP_STR	ISTAT	municipality	2010	every 10 years
	Buildings for residential use with poor state of conservation	% of residential buildings with poor state of conservation compared to the total municipal stock	E30+E31	ISTAT	municipality	2010	every 10 years
	Emergency plans	n° of municipal emergency plans and state of update	M_E_P	Municipality	municipality	2010-2019	occasional
	Lack of financial resources for hydrogeological instability	% of financial regional resources for flood and landslides in the joint area compared to regional data	R_A_H	Abruzzo Region	municipality	2013-2017	annual
	Fire risk area	% of area with risk of fire of forest with medium/ high level	RF	Abruzzo Region	municipality		
	Water scarcity in agricolture	Standard Precipitation Index	SPI	Abruzzo Region - Technical support service to agricultural sector	pluviometric station (Cellino Attanasio) + pluviometric station (Giulianova)	1951-2020 (Cellino) - 1951-2015 (Giulianova, Arsita e Catignano))	occasional
	New alien species	Municipalities infested by rhynchophorus ferrugineus	IN_RF	Abruzzo Region	municipality	2013 - 2014	occasional

Table 16: Abruzzo Region list of indicators

The main sources of data and information were the following: regional and local planning; regional departments, Statistical National Institute (ISTAT); National Environmental Information System of ISPRA; the Environmental Information System of Abruzzo Region and Regional Environmental Protection Agency (ARTA). Moreover, by using the QGIS tools, it was possible to process data to build and analyze indicators. For each target area, it has been realized a database where it is possible the collection, management, sharing and processing of data structured by different information levels (regional, target area level, municipal).

The risk assessment highlighted the need to improve the availability and quality of the historical data series of climate data, as there is a scarce availability or lack of continuity of historical data series of climate data in some areas. In addition, data have often been collected by different entities (e.g. Hydrographic and Regional Agrometereological Center) and with different methodologies, generating both a dispersion of data and a difficulty in obtaining data and in processing them in a homogeneous way. Furthermore, if data at local scale sufficient for quality and quantity are available to allow a more detailed and new analysis for the area under study, it should be noted that this entails the risk of having high processing times and resources. This condition is not functional both for the Joint-SECAP project timelines and for future updated and monitored risk analysis management.

Moreover, the selection of indicators needed for the elaboration of the Global Indexes had shown that a high level of subjectivity could affect the choice of one indicator rather than another. Furthermore, the unavailability of the required data or the limited access to data sources may limit the choice and force to use proxy indicators.

A database was made for the assessment, and moreover, the database also has a geographic base where possible. Metadata was provided for each indicator using existing database at national, regional and municipal level.

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

For the normalization of data, the methods suggested by the project tutorial were used. In order to elaborate a synthetic global index for each risk component (hazard, exposure, vulnerability) all the values obtained for the risk component indicators were “normalized” with the purpose to transform the indicators values measured at different scales and in different units into unit- less values on a common scale in order to be compared. Depending on the scale of measurement, (i.e. metric, nominal, ordinal) different methods of normalization were used. For metric indicator values (i.e. precipitations), they were normalized by applying the Min-Max method. The normalization process transformed the indicator values in metric scales to a standardised value range from 0 to 1.

For the normalization of ordinal and nominal categories, a five-class evaluation scheme was applied, with the most positive conditions represented by the lowest class and the most negative represented by the highest class. Each indicator value was then allocated to one of the five classes, on the basis of the

meaning attributed to the indicator within the context of the assessment. This allocation was supported by the consultants and other reliable sources. The classified values were then transformed into the value range of 0 to 1.

The normalization of data was done by external consultants in collaboration with Abruzzo Region. The data and indicators were elaborated (when possible) with a GIS tool. In particular, QGIS was used. QGIS is an open source software. QGIS works as geographic information system software, allowing users to analyze and edit spatial information, in addition to composing and exporting graphical maps. QGIS supports both raster and vector layers.

Some issues were identified in the definition of minimum and maximum values when dealing with the normalization of metric. When possible, a context-specific knowledge was used in defining appropriately thresholds. However, the results obtained for each target area are not comparable each other, because for the hazard from climate signals, the thresholds were chosen considering the PNACC values in relation to the macroregions. Target area 1 belongs to macroregion 3 and target area 2 belongs to macroregion 2, so the values for the comparison are different.

Moreover, some issues were identified in the weighting procedure because it is quite subjective and weighting can have a major influence on the results and have to be undertaken with care. Also alignment of indicators and their aggregation represented another challenging step, because of the strong influence they have on the final result and the significance of the whole analysis.

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1	Normalised Indicator value for Target Area 2
Hazard	Extreme precipitation events	N° of days with precipitations > 20mm	N°days/year	0,9	0,90
	Mean of annual precipitations	mm of annual rain	mm/year	0,33	0,13
	Higher average temperature	N° days with daily maximum> 29,2°C	N° days/year	0,9	0,3
	Consecutive days with daily PRCP < 1mm	N° of consecutive days with daily Precipitations < 1mm	N°days/year	0,3	0,3
	Hazard of Giulianova for coast erosion	Average of the hazard indexes derived from "AnCoRa" project	Hazard value for coast erosion	none	0,45
	Hazard of Pineto for coast erosion	Average of the hazard indexes derived from "AnCoRa" project	Hazard value for coast erosion	none	0,26
	Hazard of Roseto degli Abruzzi for coast erosion	Average of the hazard indexes derived from "AnCoRa" project	Hazard value for coast erosion	none	0,27
	Hazard of Silvi for coast erosion	Average of the hazard indexes derived from "AnCoRa" project	Hazard value for coast erosion	none	0,47
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalized Indicator value for Target Area 2**
Exposure	People living in flood prone areas (P3)	% of people living in flood prone areas (P3 areas)	N° people in P3 areas/N° total of population (%)	0,1	0,9
	People living in landslides areas (P3+P4)	% of people living in landslides areas (P3 + P4 areas)	N° people in P3 + P4 areas/ N° population in total (%)	0,7	0,1
	Agricultural areas	Utilized agricultural area per inhabitant) compared to the regional average	Hectares/ N°inhabitants	0,7	0,3
	Natural protected areas	% of municipalities with a protected area	N° municipalities in protected areas/N° municipalities in total (%)	0,25	0,6
	Tourism sector	N° of nights spent in an accomodation per inhabitant, compared to the regional average	N° of nights spent in an accomodation/ N° inhabitants	0,1	0,9
	Industrial sector	% of employees in the industrial sector compared to the regional average	N° of employees in the industrial sector/ N° employees in total	0,9	0,5
	Population	Total population living in the joint area	N°	1	1
	Forest Areas	% of forest area in the joint area	Hectares of forest/ hectares of total area (%)	0,3	0
	Exposure of Giulianova	Average of the hazard indexes derived from "AnCoRa" project	Exposure value for coast erosion	none	0,65
	Exposure of Pineto	Average of the hazard indexes derived from "AnCoRa" project	Exposure value for coast erosion	none	0,43
	Exposure of Roseto degli Abruzzi	Average of the hazard indexes derived from "AnCoRa" project	Exposure value for coast erosion	none	0,5
	Exposure of Silvi	Average of the hazard indexes derived from "AnCoRa" project	Exposure value for coast erosion	none	0,55
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalized Indicator value for Target Area 2**
Vulnerability	Social and material vulnerability	Social and material vulnerability index	Social and material vulnerability index	0,7	0,7
	Structural dependence	Ratio between the population of non-active age (0-14 ys and > 65 ys) and the population of active age (15-65 years) compared to the regional data	N° Population of non-active age (0-14 ys and > 65 ys)/ N°population of active age (15-65 years)	0,3	0,3
	Buildings for residential use with poor state of conservation	% of residential buildings with poor state of conservation compared to the total municipal stock	N°residential buildings with poor state of conservation / N° total municipal stock (%)	0,5	0,3
	Number of emergency and update plans	n° of municipal emergency plans and state of update	N° of plans and level of update	0,81	0,4
	Lack of financial resources for hydrogeological instability	% of financial regional resources for flood and landslides in the joint area compared to regional data	Euros/N° inhabitants	0,1	0,3
	Fire risk area	% of forest area with risk of fire medium/ high level	Hectares of forest at fire risk medium and high / hectares of forest (%)	0,5	0,1
	Forest fires prevention plan	Presence and updating of the regional forest fire prevention plan	Number	0,1	not used
	Scarcity of water in agriculture	Standard Precipitation Index	Number of February montly/quarterly with SPI values <-1 (draught seasons) in the periods 1951-2020	0,36	0,36
	New alien species	Municipalities infested by rhynchophorus ferrugineus	N° municipalities infested/ N° municipalities in total	0,25	0,65
	Vulnerability of Giulianova	Average of the hazard indexes derived from "AnCoRa" project	Vulnerability value for coast erosion	none	0,42
	Vulnerability of Pineto	Average of the hazard indexes derived from "AnCoRa" project	Vulnerability value for coast erosion	none	0,64
	Vulnerability of Roseto degli Abruzzi	Average of the hazard indexes derived from "AnCoRa" project	Vulnerability value for coast erosion	none	0,53
	Vulnerability of Silvi	Average of the hazard indexes derived from "AnCoRa" project	Vulnerability value for coast erosion	none	0,6

Area target 1: Municipalities of Castiglione Messer Raimondo, Castilenti, Elice and Penne
Area target 2: Municipalities of Giulianova, Roseto degli Abruzzi, Pineto, Silvi and Mosciano S.Angelo

Table 17: Abruzzo Region list of all indicators and indicator values

Impact chain 1/A_HILL: RISK OF DAMAGE FOR EXTREME PRECIPITATIONS TO BUILDINGS, TOURISM, AGRICULTURE & FOREST AND INDUSTRIAL SECTORS BY FLOOD			
Hill Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,84*	*1*	*0,55*
Exposure	*0,29*	*1*	
Vulnerability	*0,53*	*1*	

Impact chain 1/B_HILL: RISK OF DAMAGE FOR EXTREME PRECIPITATIONS TO BUILDINGS, TOURISM, AGRICULTURE & FOREST AND INDUSTRIAL SECTORS BY LANDSLIDE			
Hill Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,84*	*1*	*0,69*
Exposure	*0,71*	*1*	
Vulnerability	*0,53*	*1*	

Impact chain 2_HILL: RISK OF DAMAGE FOR DROUGHTS TO POPULATION, AGRICULTURAL & FOREST, INDUSTRY AND TOURISM SECTORS			
Hill Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,40*	*1*	*0,55*
Exposure	*0,65*	*1*	
Vulnerability	*0,60*	*1*	

Impact chain 3_HILL: RISK OF DAMAGE FOR EXTEME HEAT AND INCREASE OF TEMPERATURE TO AGRICULTURAL & FOREST, POPULATION, INDUSTRY AND TOURISM SECTORS			
Hill Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,90*	*1*	*0,71*
Exposure	*0,65*	*1*	
Vulnerability	*0,59*	*1*	

Impact chain 4_HILL: RISK OF DAMAGE FOR EXTREME HEAT AND DRAUGHT TO AGRICULTURAL & FOREST, AND TOURISM SECTORS FOR FOREST FIRES			
Hill Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,60*	*1*	*0,45*
Exposure	*0,32*	*1*	
Vulnerability	*0,43*	*1*	

Impact chain 1/A_COAST: RISK OF DAMAGE FOR EXTREME PRECIPITATIONS TO BUILDINGS, TOURISM, AGRICULTURE & FOREST AND INDUSTRIAL SECTORS BY FLOOD			
Coast Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,82*	*1*	*0,71*
Exposure	*0,79*	*1*	
Vulnerability	*0,51*	*1*	

Impact chain 1/B_COAST: RISK OF DAMAGE FOR EXTREME PRECIPITATIONS TO BUILDINGS, TOURISM, AGRICULTURE & FOREST AND INDUSTRIAL SECTORS BY LANDSLIDE			
Coast Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,82*	*1*	*0,52*
Exposure	*0,23*	*1*	
Vulnerability	*0,51*	*1*	

Impact chain 2_COAST: RISK OF DAMAGE FOR EXTREME WEATHER CONDITIONS TO POPULATION, TOURISM, ENVIRONMENT AND BIODIVERSITY SECTORS FOR COAST			
Coast Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,36*	*1*	*0,48*
Exposure	*0,55*	*1*	
Vulnerability	*0,54*	*1*	

Impact chain 3_COAST: RISK OF DAMAGE FOR EXTEME HEAT AND INCREASE OF TEMPERATURE TO AGRICULTURAL & FOREST, POPULATION, INDUSTRY AND TOURISM SECTORS			
Coast Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,30*	*1*	*0,44*
Exposure	*0,48*	*1*	
Vulnerability	*0,53*	*1*	

Impact chain 4_COAST: RISK OF DAMAGE FOR DROUGHTS TO POPULATION, AGRICULTURAL & FOREST, INDUSTRY AND TOURISM SECTORS			
Coast Area Joint -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard	*0,36*	*1*	*0,44*
Exposure	*0,48*	*1*	
Vulnerability	*0,49*	*1*	

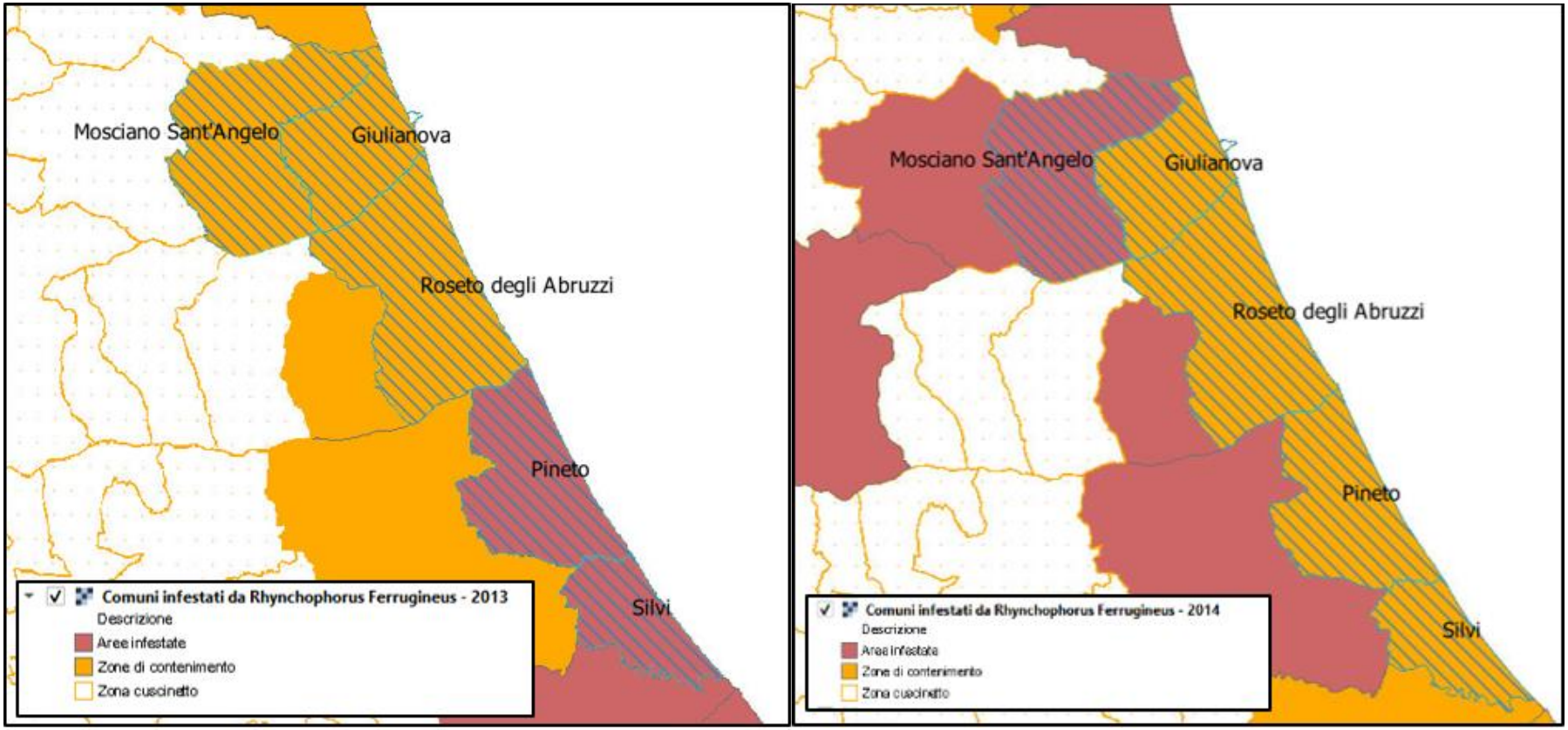
Table 18: Abruzzo Region final risk values by impact chain and target area

M8-Presenting the outcomes of your risk assessment

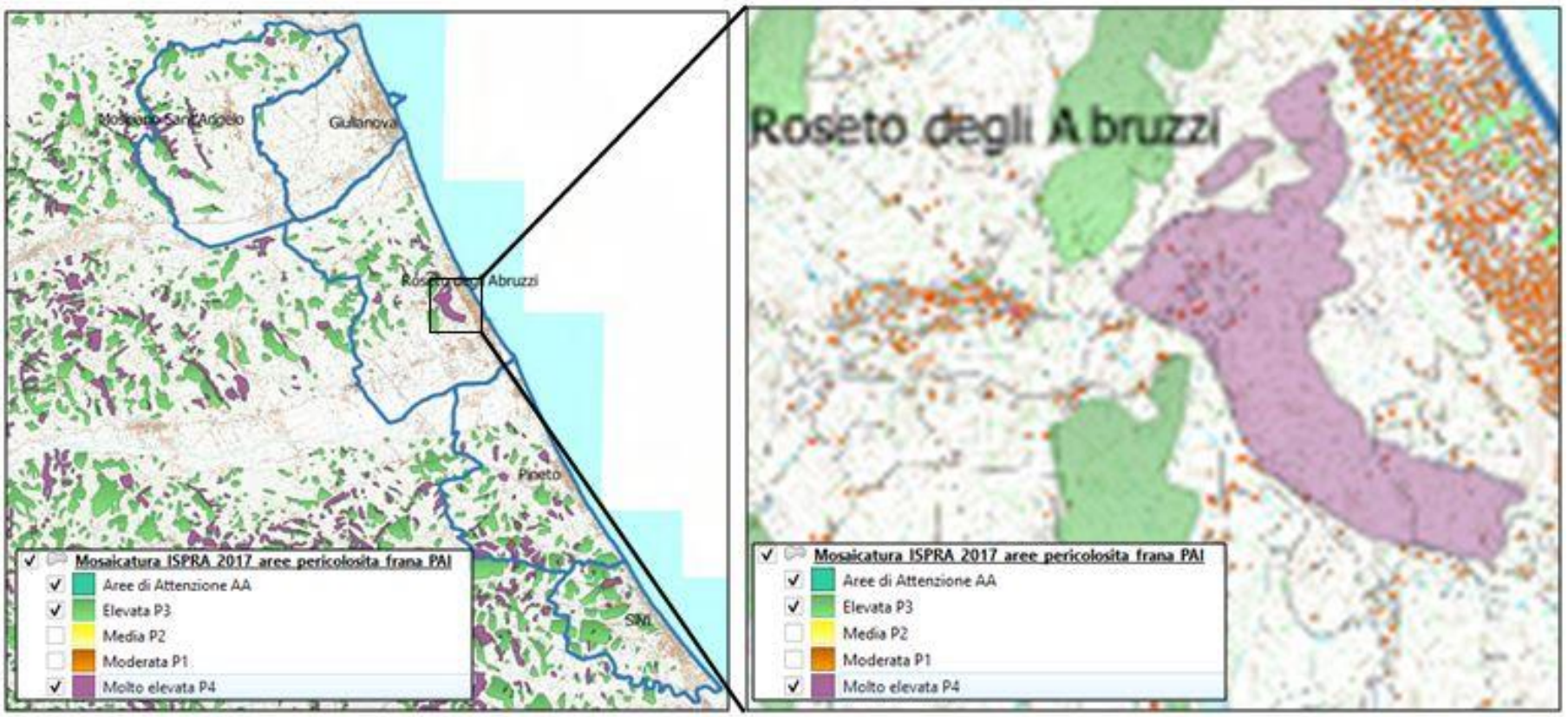
Due to the COV19 virus emergency and due to restrictions imposed by the Italian government, since the beginning of March, it hasn't been possible to organize face-to-face meetings for the presentation of the results. Moreover, the municipalities in target area 1 have been included in the red area, where there are strict restrictions for those who must enter and leave the area. The presentation of the results is not canceled, but simply postponed. The objective is to have 2 public presentations at target area level.

The data was presented in the form of reports, maps, tables, charts etc. The specific report of each target area will be sent to each municipality involved in order to share preliminary the document. The presentations will be done face to face illustrating through maps, tables and charts the climate vulnerability and risk of the target areas. The Risk and Vulnerability Assessment is, along with the Baseline Emission Inventory, the starting point for the development of the Sustainable Energy and Climate Action Plan. The knowledge of climate change vulnerability and related risks could help policy makers to better comprehend the cause/effect relationships behind climate change and their impact on people, economic sectors and socio- ecological systems. This will allow policy makers to better define sustainable policies, strategies of mitigation and adaptation and tangible actions in the Joint SECAP areas, in order to improve the local system resilience to the impacts of climate change.

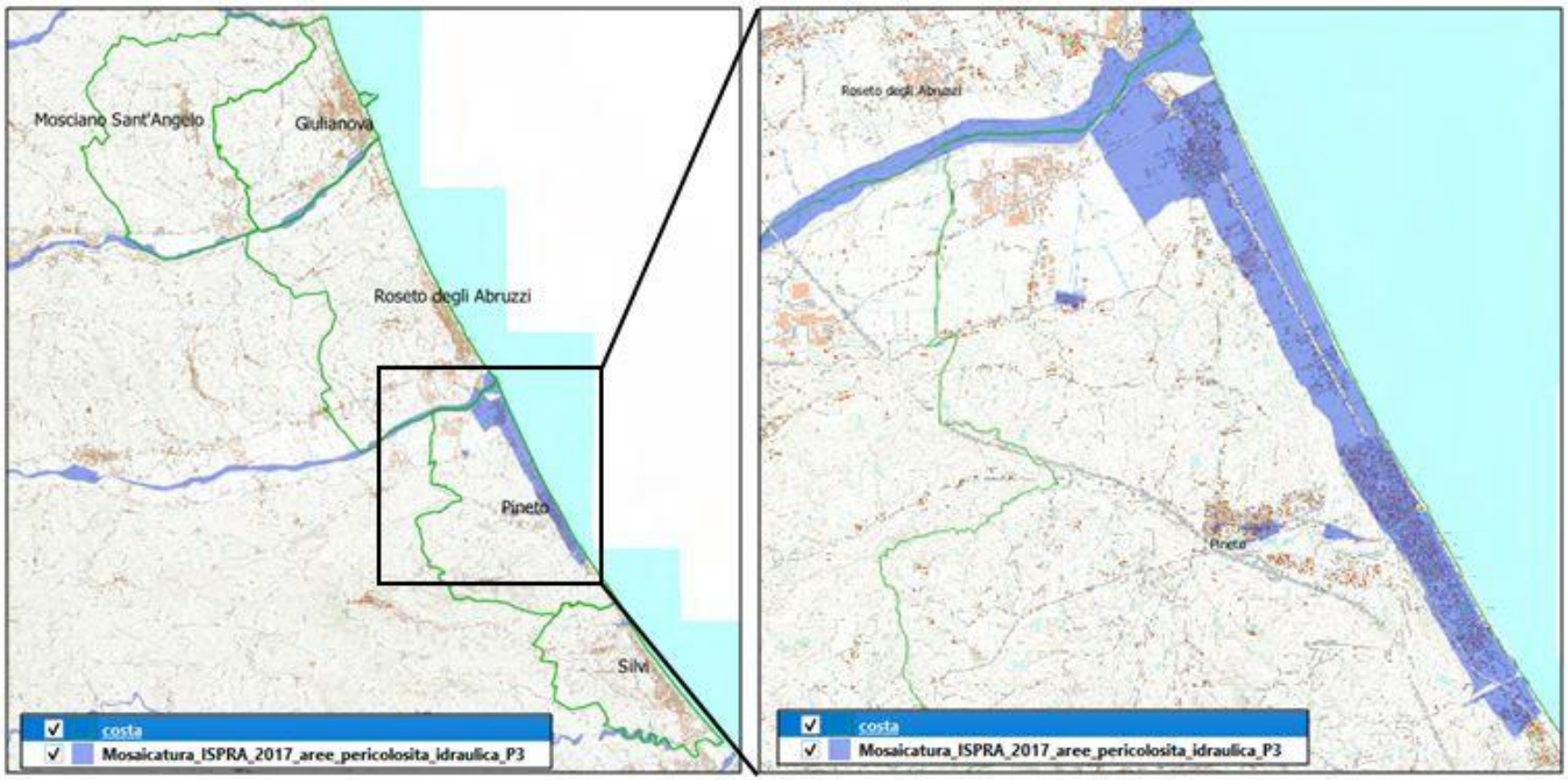
The next maps and tables are some examples that will be included in the presentations.



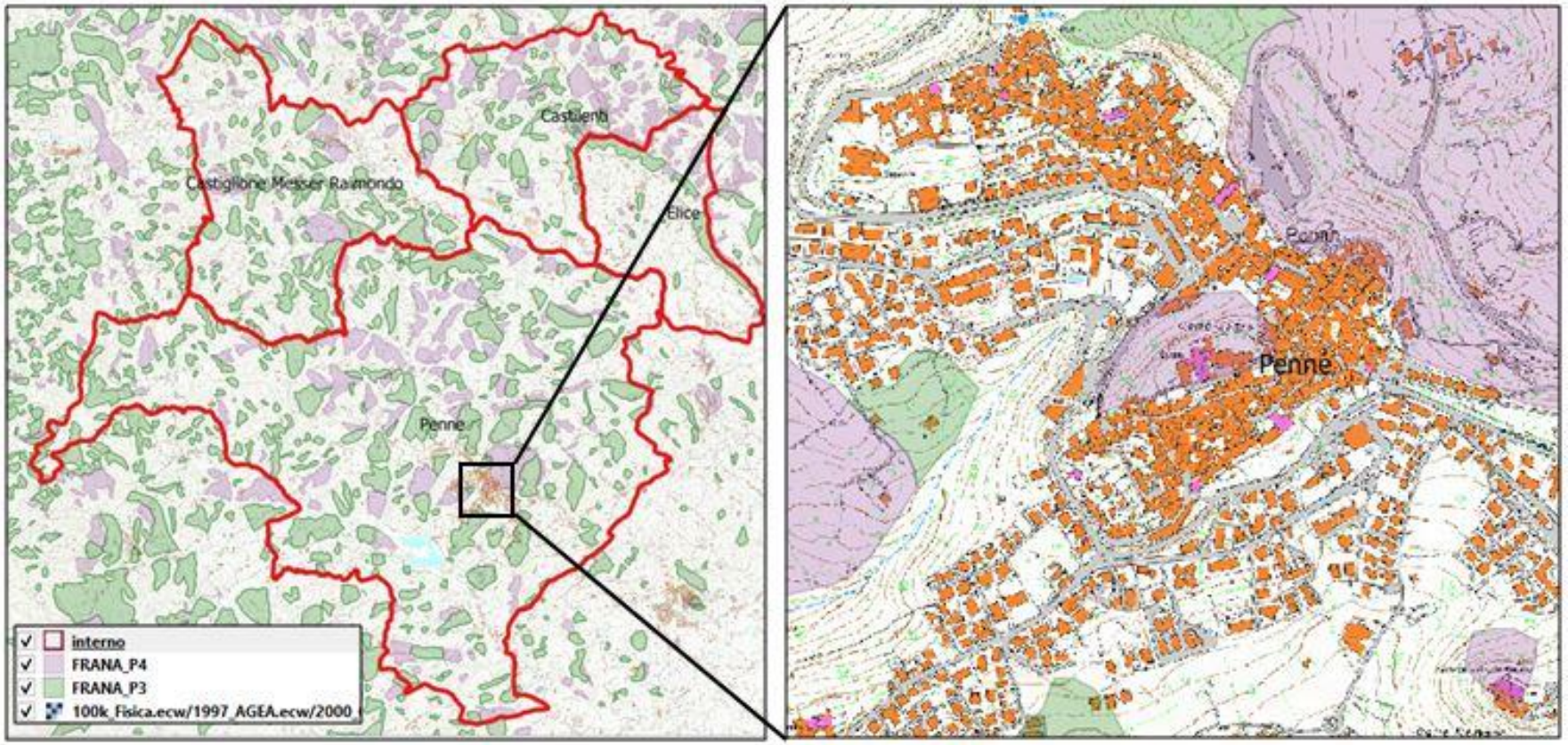
Picture 28: Qgis elaboration - Municipalities of target area 2 infested by rhynchophorus ferrugineus in 2013 and 2014 – Source of GIS maps: Abruzzo Region– Elaboration by AGENA



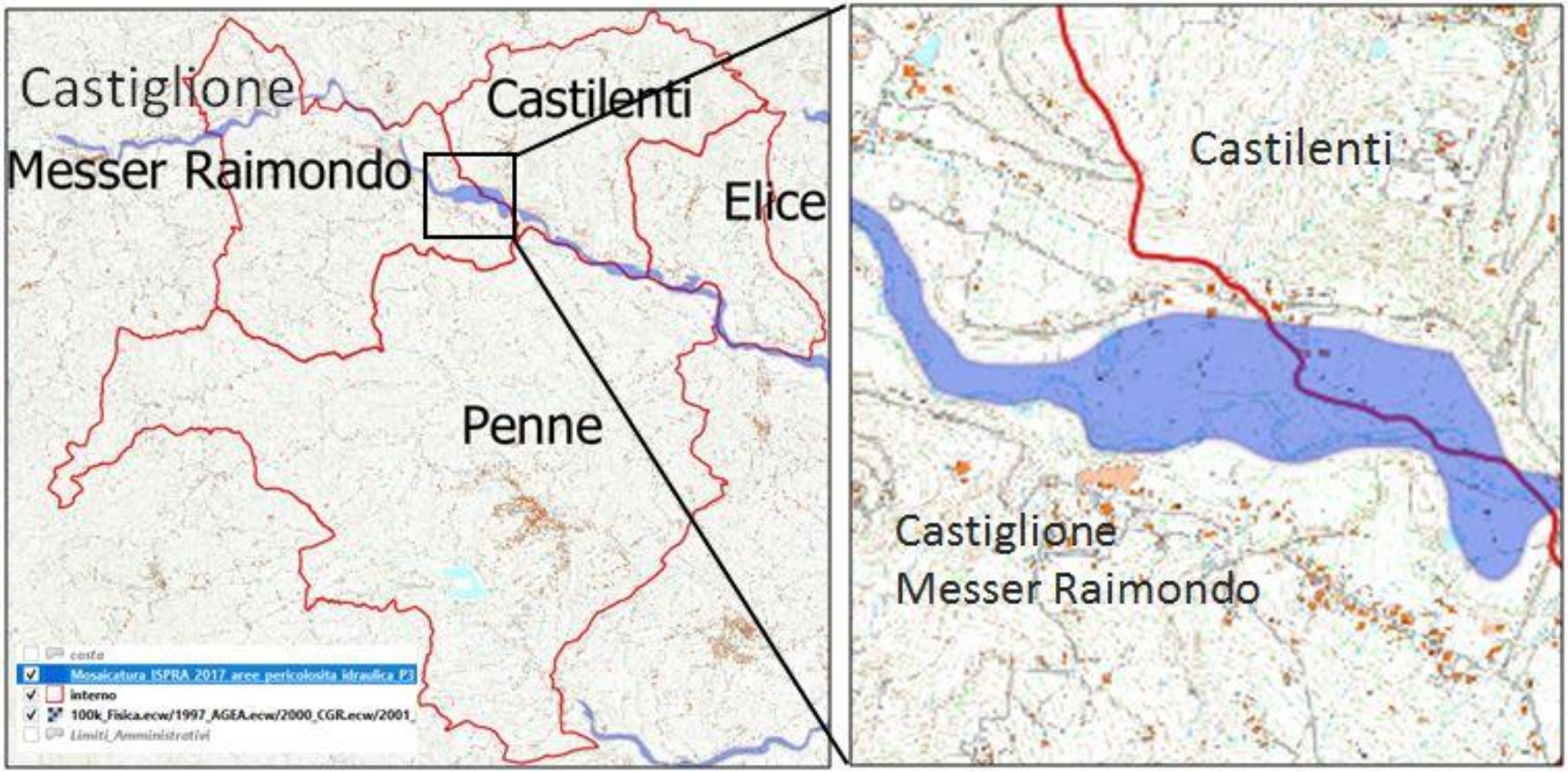
Picture 29: Qgis elaboration – Areas at high (P3) and very high (P4) landslides risk for target area 2 and focus of Roseto degli Abruzzi territory – Source of GIS maps: Abruzzo Region and ISPRA – Elaboration by AGENA



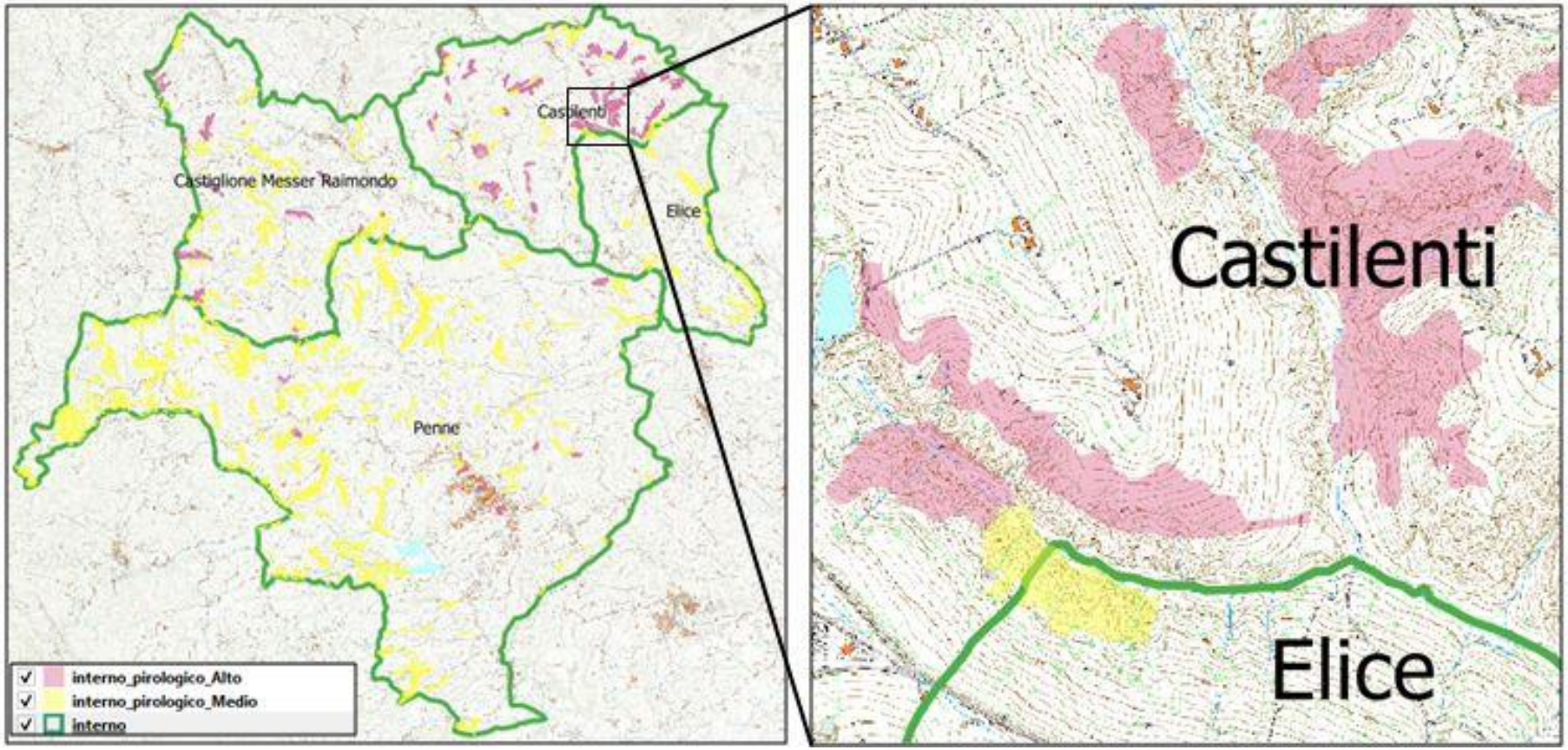
Picture 30: Qgis elaboration – Areas at high (P3) flood risk for target area 2 and focus on Pineto and Roseto degli Abruzzi territories – Source of GIS maps: Abruzzo Region and ISPRA – Elaboration by AGENA



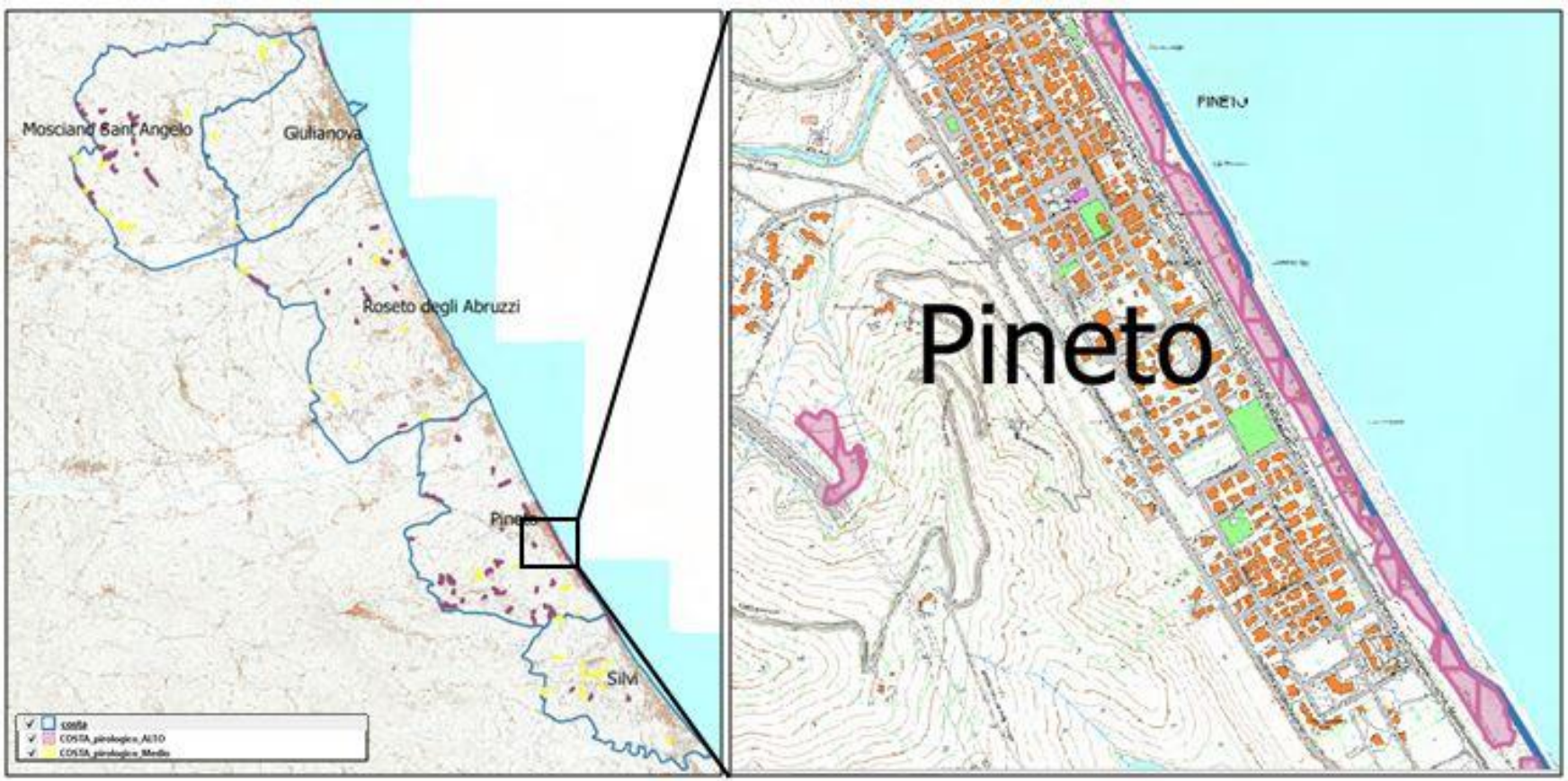
Picture 31: Qgis elaboration – Areas at high (P3) and very high (P4) landslides risk for target area 1 and focus on Penne territory – Source of GIS maps: Abruzzo Region and ISPRA – Elaboration by AGEN



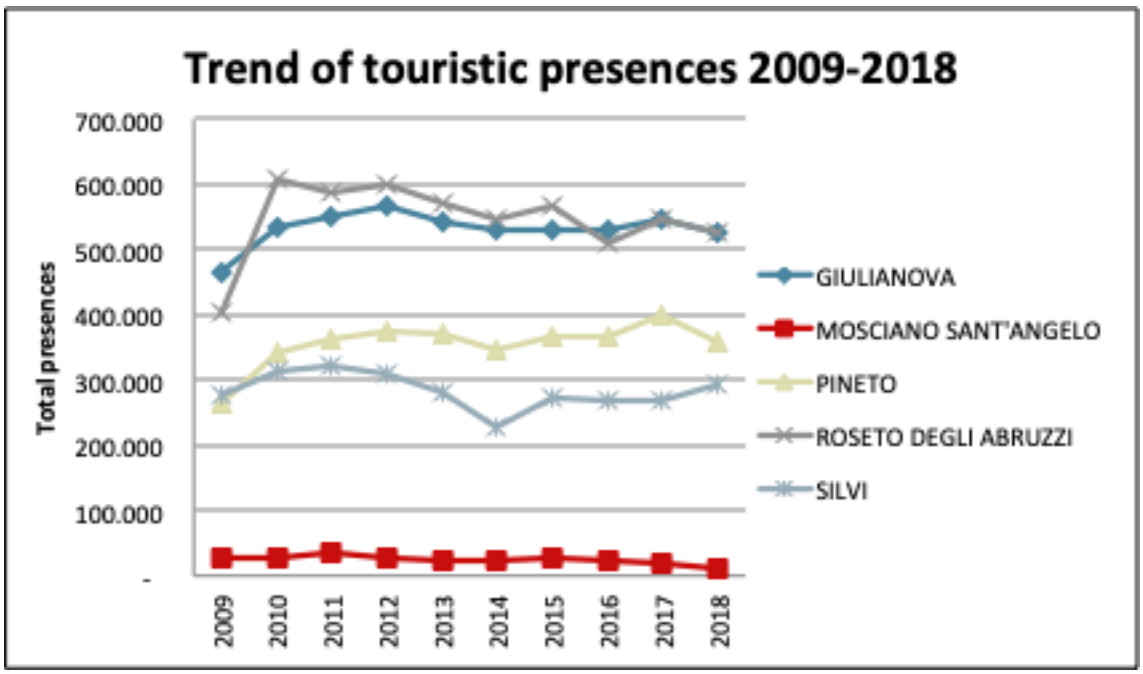
Picture 32: Qgis elaboration – Areas at high (P3) flood risk for target area 1 and focus on Castilenti and Castiglione Messer Raimondo territories – Source of GIS maps: Abruzzo Region and ISPRA – Elaboration by AGENA



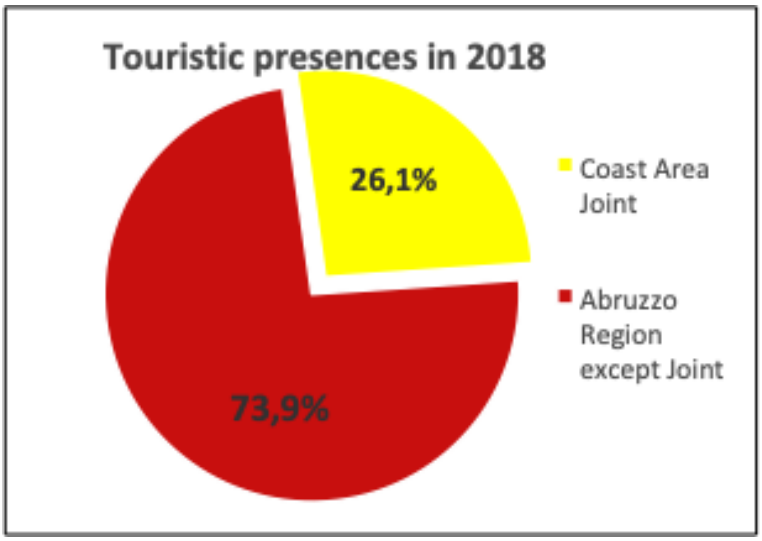
Picture 33: Qgis elaboration – Areas at high (ALTO) and medium (Medio) risk of forest fire for target area 1 and focus on Castilenti and Elice territory – Source of GIS maps: Abruzzo Region – Elaboration by AGENA



Picture 34: Qgis elaboration – Areas at high (ALTO) and medium (Medio) risk of forest fire for target area 2 and focus on Pineto territory – Source of GIS maps: Abruzzo Region – Elaboration by AGE

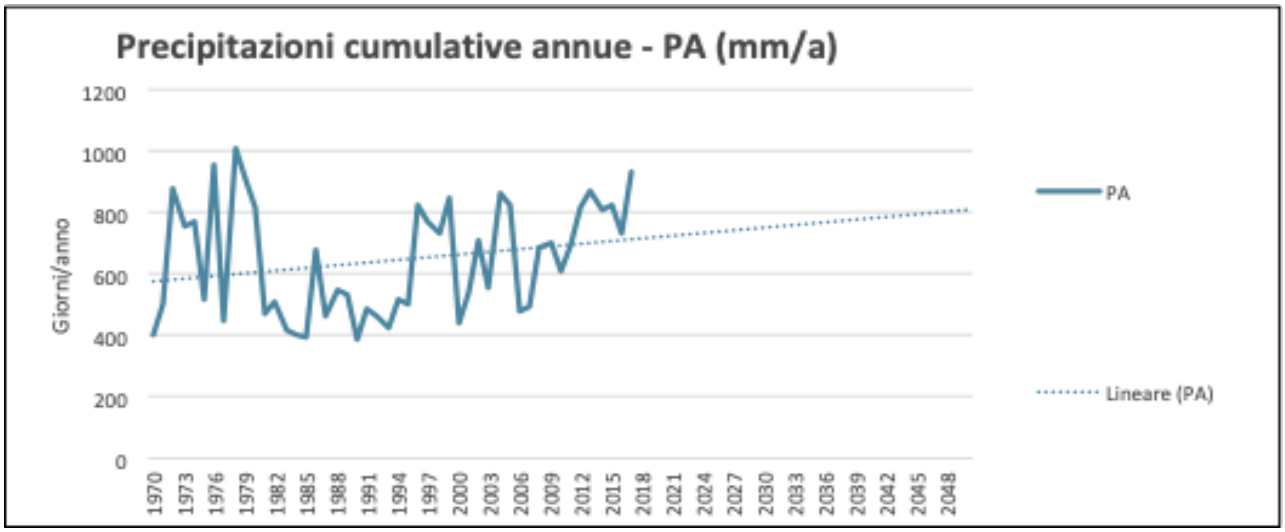


Graph 1: Trend 2009-2018 of nights spent in an accommodation in target area 2– Source of data: Abruzzo Region

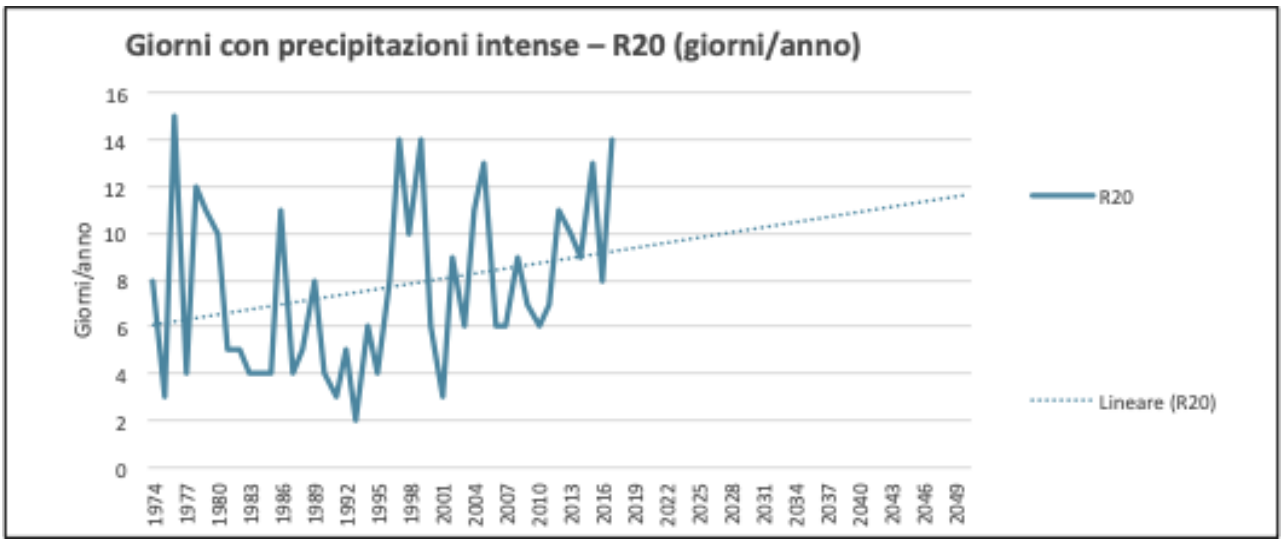


Graph 2: % of nights spent in an accommodation in target area 2 compared to the regional value – Source of data: Abruzzo Region

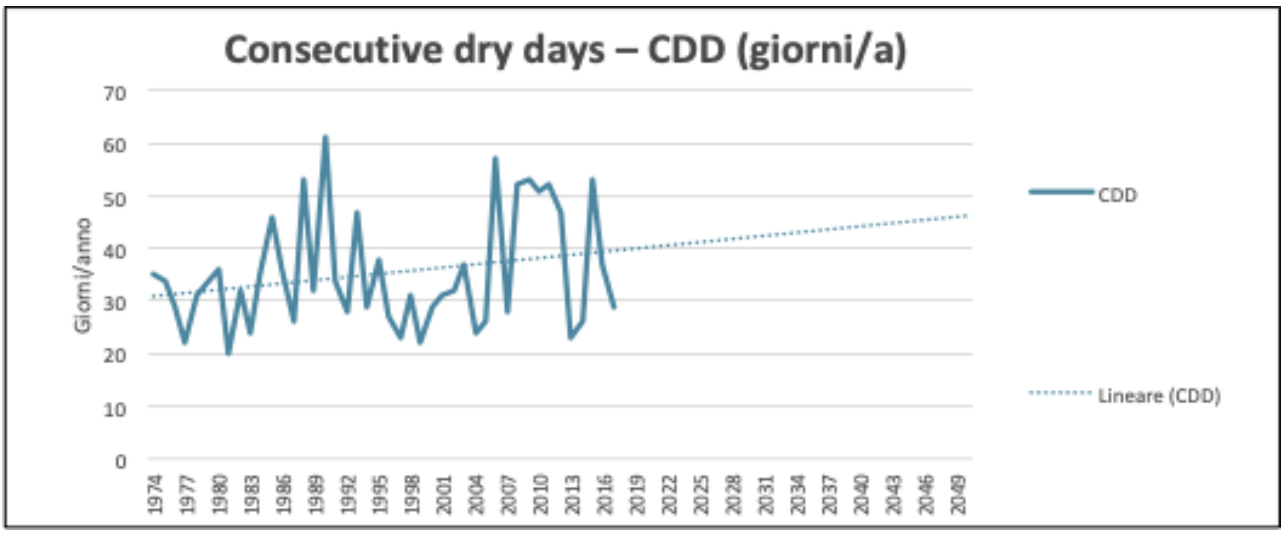
Concerning past and current climate trend, some graphic specific for the target area will also be shown. Here we present some examples.



Graph 3: Annual cumulative precipitation (mm/year) in the target area 2 during the period 1970-2017 – Source of data: Abruzzo Region – Elaboration by AGENA



Graph 4: Precipitations > 20mm/day in the target area 2 during the period 1974-2017 – Source of data: Abruzzo Region – Elaboration by AGENA



Graph 5: Consecutive dry days (days/year) in the target area 2 during the period 1974-2017 – Source of data: Abruzzo Region – Elaboration by AGENA

Due to the COVID-19 pandemic, instruments used to present the data and the related information were not available during the making of this report.

2.4 [PP4] MUNICIPALITY OF PESCARA

Summary

The Risk and Vulnerability Assessment analysis was coordinated by the municipality of Pescara, supported by prof. Paolo Fusero and prof. Piero Di Carlo, as external consultants.

The impact chains initially identified were 4, but during data analysis and retrieval one of them was not considered because not relevant for the target area in terms of climatological data, even if it was highlighted by stakeholders and may be important in other sites.

The process was started in December 2019 and was concluded in May 2020.

The stakeholders involved to collect information and data for this assessment were the representatives of the municipal technical offices, the Abruzzo Region Hydrographic Office, the Abruzzo Agency for the Protection of the Environment, citizens' associations, local trade associations, local action group, nonprofit organizations.

Some difficulties were encountered to get data and information mainly from other municipalities of the target area and from local trade associations. Another problem was to downscale the results at municipality or sub-municipality level since some data were not available for all the municipalities, therefore in these cases we assumed the average data for all the context target area.

M1-Preparing the risk assessment

The context area includes 6 neighboring Municipalities: Pescara, Chieti, Montesilvano, Francavilla, Spoltore, San Giovanni Teatino. These cities and towns are part of the metropolitan area of the valley of Pescara river with similar climatological characteristics, same issues in terms of air quality, traffic and river flooding. Moreover, the cities and town of target area share common infrastructures such us main roads, public transport services and, finally, with they have similar vulnerability due to climate change.

This module was developed starting from the analysis of climate adaptation policies, plans, measures and funding sources performed to fill in the deliverable A3.2.1. The most useful local documents, plan and database in terms of source of information were:

The Italian National Institute of Statistics (ISTAT);

The Consorzio di Bonifica Centro[7], which is a public institution responsible of local water management, defense and treatment;

Guidelines for the Regional Climate Change Adaptation Plan (Abruzzo Region);

[7] https://www.bonificacentro.it/#attivita

The Statistical office of the Abruzzo Region;

The Regional Environmental Protection Agency (ARTA);

The Hydrographic Office of the Abruzzo Region;

Ministry of Economy and Finance (MEF);

General Accounting Office of the State (RGS).

Following the approach of the municipality of San Benedetto del Tronto, the consultation of stakeholders and representatives of the municipalities of the Target Area was carried out asking to fill in a questionnaire (based on that arranged by San Benedetto del Tronto) to identify the most important impacts of climate change from a list suggested by the National Plan Climate Change adaptation (PNAC). Moreover, was asked to rank the impacts on a scale that goes from 1 (not important) to 5 (highly significant) for different economic sectors, health and ecosystems. From the impacts were retrieved the related risks of climate change.

We incurred in some delay in this phase since the involvement of the stakeholders was difficult. Even if the questionnaire was sent after contacting directly the stakeholders by phone to give an overview of the survey and to highlight the importance of their responses and feedbacks, some of them did not replied and most of them sent back the filled questionnaires late.

M2-Developing impact chains

Climate change triggers different events either directly or indirectly with several impacts on human health, ecosystems and infrastructures. To develop the impact chains were selected the most important events that stakeholders identified more relevant for the territory and for the people leaving in the target area.

The events more hazardous chosen for the initial assessment were:

- Extreme precipitation events: heavy rainfall and hailstorms

- Heat waves

- Whirlwinds and sandstorm events

- Drought

Based on the selected hazards, four impact chain were developed related to the following risks:

a. Risk of damage to economic activities, infrastructures and people due to flooding and hailstorms (Figure 35).

b. Risk for human health due to heat waves (Figure 36).

c. Risk for transports, economic activities and people due to whirlwinds and sandstorm events (Figure 37).

d. Risk for energy production and agriculture due to drought (Figure 38).

The development of the impact chains was carried out on two steps. At the beginning, since the results of the stakeholders' consultation were slowly available, was taken into account plans, documents and reports concerning climate change adaptation to select most common and general impacts. During the progress of the impact chains, as stakeholders' inputs become available, changes were made to tune the impact chains to the perception of stakeholders and to adapt them to the local territory and target area.

The main difficulty in the impact chains development was to connect the different vulnerability and exposure to the impacts of each hazard since some of the vulnerability and exposure are related to more than one impact. Another difficulty was to distinguish direct and indirect connections between impacts and vulnerability and exposure.

The exposures and vulnerability related to the risk of damage to economic activities, infrastructures and people due to flooding and hailstorms are listed in Table 19. Among the 4 exposure factors identified, the factors most important in the vulnerability assessment are rivers and water management. Regarding vulnerability 5 factors were selected, the main concerns evinced are related again to rivers in terms of activities and infrastructures situated close river.

Component	**Factor**
Hazard	Extreme precipitation events Heavy rainfall and hailstorms
Exposure	People living, properties in flood prone areas
	Farming activities and cultivation in flood prone areas
	Critical infrastructures in flood prone areas
	Store and shop in flood prone areas
Vulnerability	Inadequate maintenance of the green and river banks
	Store a shop too close to the Pescara and Saline river banks
	Water bodies canalization
	Lack of river management and financial resources
	Lack of urban planning and regulations (buildings along the river banks)

Table 19: List of exposures and vulnerabilities related to the hazard extreme precipitation events heavy rainfall and hailstorms

The exposures and vulnerability related to the risk for human health due to heat waves are listed in Table 20. The exposure includes 5 factors. People more vulnerable such as elders and those with diseases are those more exposed especially if living in urban areas. For the vulnerability, 6 factors are more important and urban areas are those more vulnerable particularly due to building efficiency and urban planning of green areas that can mitigate heat waves and can give healthier zones for people during heat waves events.

Component	**Factor**
Hazard	Heat waves
Exposure	People living, in urban area
	Elderly citizen
	People with respiration and cardiovascular disease
	Fishing economy
	Tourism economy
Vulnerability	Urban heat island
	Marine and river pollution
	Energy production
	Lack of buildings efficiency: thermal, water recycle
	Lack of marine and river management
	Lack of energy production diversification

Table 20. List of exposures and vulnerabilities related to the hazard heat waves

The exposures and vulnerability related to the risk for transports, economic activities and people due to whirlwinds and sandstorm events are list in Table 21. Five exposure factors are selected. Airport activities and those close to zones impacted by sand storms are more exposed. Roads and vegetation are the factors more vulnerable among the 5 factor identified.

Component	**Factor**
Hazard	Whirlwinds and sandstorm events
Exposure	Ecosystems and protected city park
	Airport in the windswept areas
	Critical infrastructures in sandstorm areas
	Companies located in sandstorm areas
	Farming activities and cultivation in windswept areas
Vulnerability	Inadequate pruning of the trees
	Roads too close to the beach
	No wind tolerant crops
	Lack of green management and financial resources
	Lack of urban planning and regulations

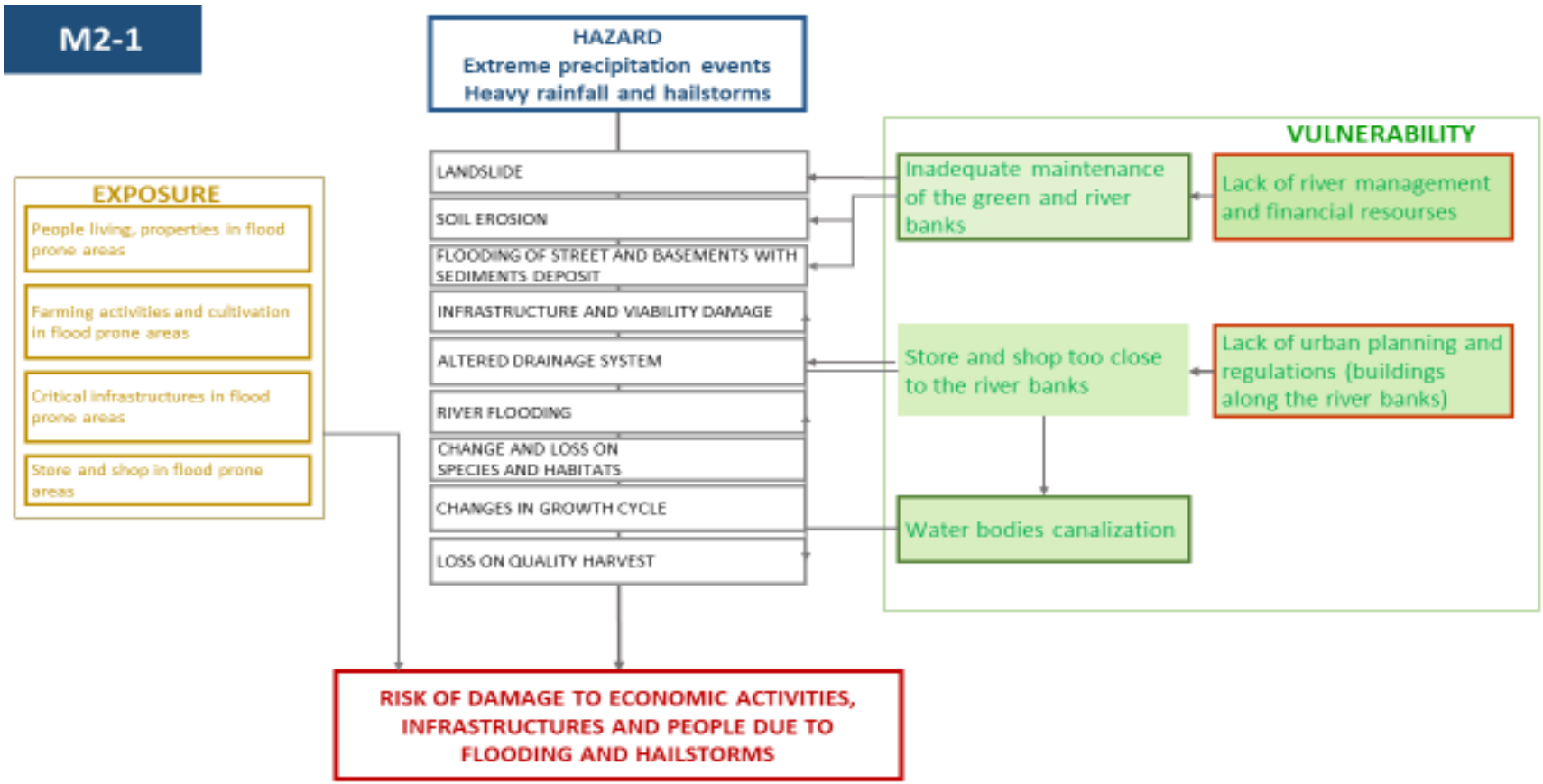
Table 21. List of exposures and vulnerabilities related to the hazard whirlwinds and sandstorm events

The exposures and vulnerabilities related to the risk for energy production and agriculture due to drought are list in Table 22. Three exposure factors were identified. Besides the exposure for people leaving in zones with problems with water distribution and scarcity, parks and activities that need constant availability of water are those more exposed. Among the 3 vulnerability factors, water recycling and reuse is more important.

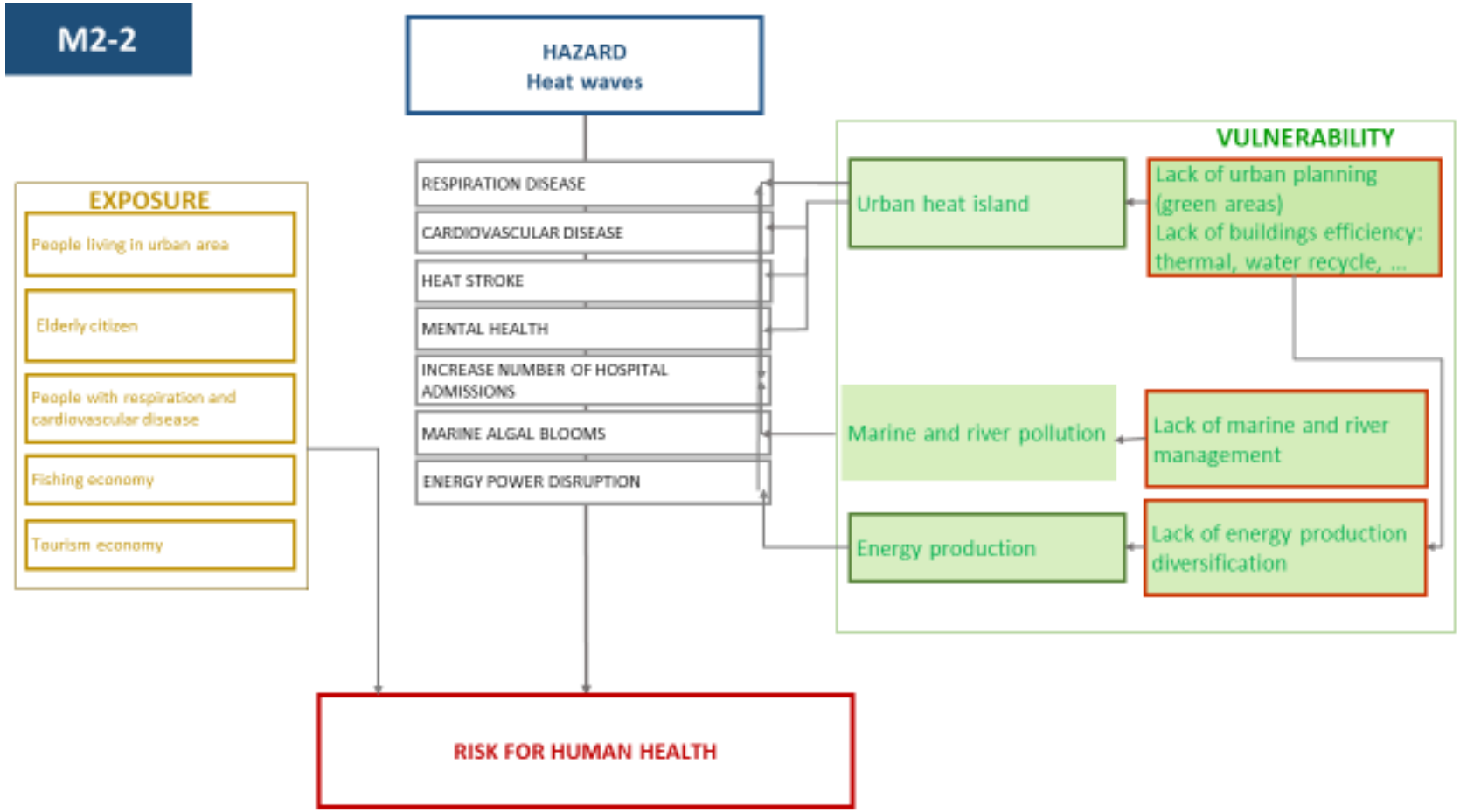
Component	Factor
Hazard	Drought
Exposure	People living in areas suffering of water scarcity
	Farming activities and cultivation
	Aquatic parks, and swimming pool activities
Vulnerability	Water distribution efficiency
	Rainwater runoff
	Water recycle and reuse
	Lack of water system planning
	Soil sealing
	Urban planning rule for irrigation system

Table 22. List of exposures and vulnerabilities related to the hazard drought

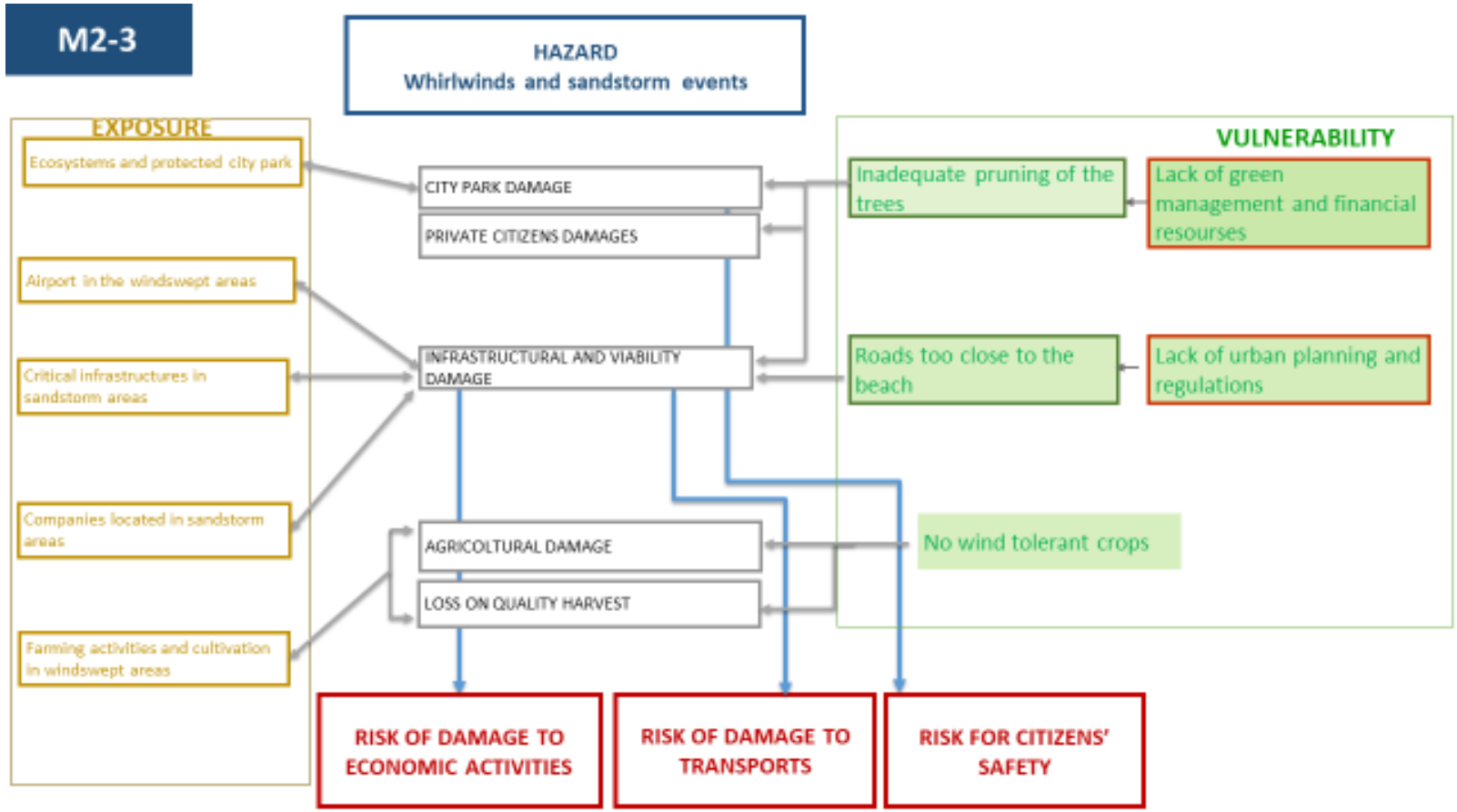
The impact chain was developed by external consultants, supported by the staff of the Municipality of Pescara, following the methodology suggested in the project tutorial by the LP.



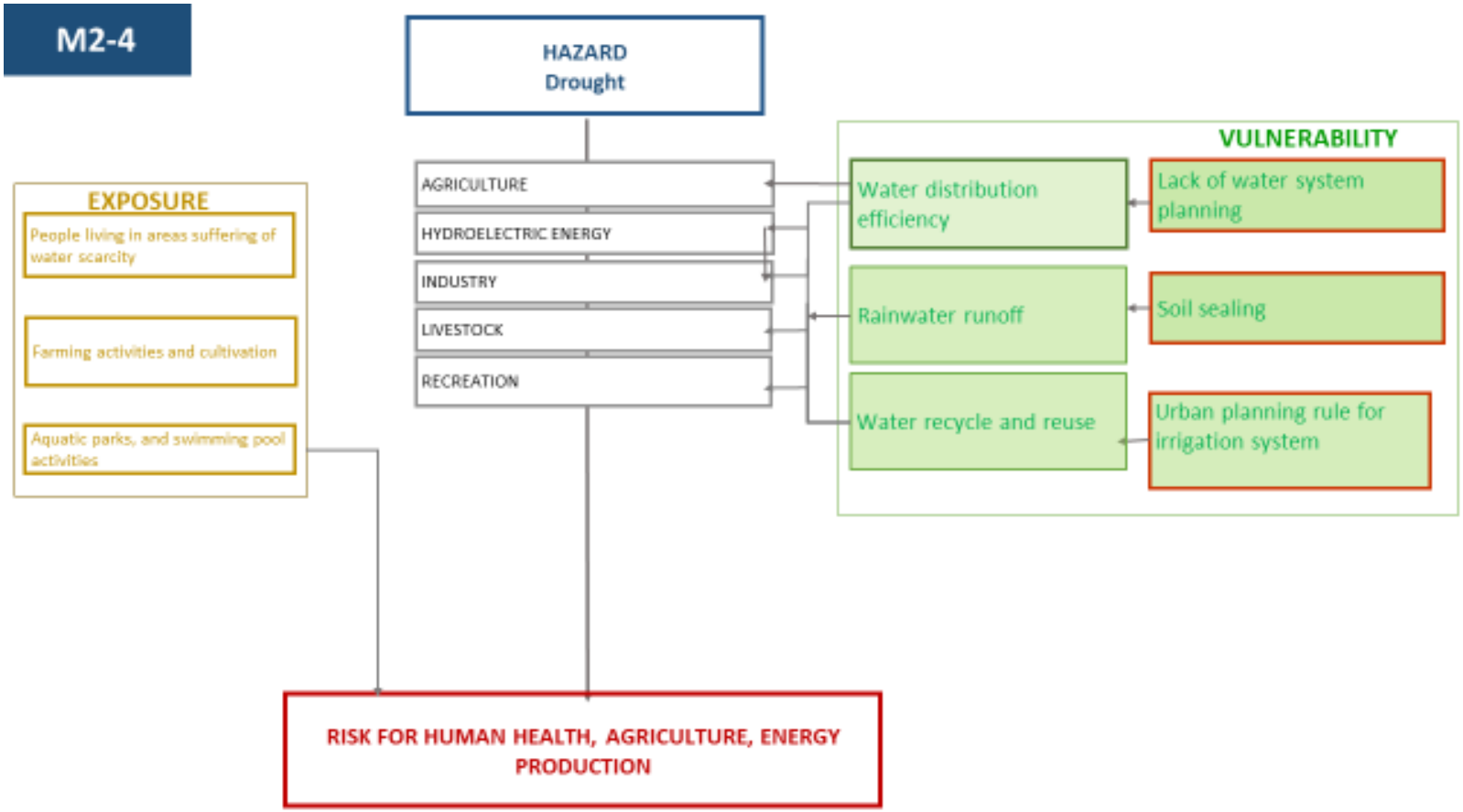
Picture 35: Pescara M2 Impact Chain – Risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation



Picture 36: Pescara M2 Impact Chain – Risk for human health due to heat waves



Picture 37: Pescara M2 Impact Chain – Risks for economic activities, transports and citizens' safety due to whirlwinds and sandstorm events



Picture 38: Pescara M2 Impact Chain – Risk of for human health, agriculture and energy production due to drought

M3-Identifying and selecting indicators, M4-Data acquisition and management

The selection of indicators for each exposure and vulnerability was carried out considering reports, database documents and plans reported in the paragraph M1, whereas the guidelines of the World Meteorological Organization (WMO) and IPCC, were used for the selection of indicators of the hazards and for the choice of threshold values of climatological parameters. In Table 23 are reported in detail the indicators for each hazard. The indicator more controversial is that for heat waves, since there are different definitions and parameters that can be used. It was decided to use the index approved by the WMO that consider a head wave event when five or more days show temperatures above the 90th of percentile of the average temperature of the season. This choice, compared to a threshold based on a fixed temperature, allows to take into account latitudinal, geographical and altitude difference of each observational site.

Hazard	**Indicator**
Extreme precipitation events Heavy rainfall and hailstorms	No. of days with precipitation> 100mm
Heat waves	5 or more consecutive days with temperature > 90th percentile average temperature of the area and season
Whirlwinds and sandstorm events	No. of days with wind velocity > of 50 km/h
Drought	More than 15 consecutive days none of which receive at least 0.25 mm

Table 23: List of Indicators related to the identified hazards

After the selection of the hazard indicators a prelaminar list of indicators for exposure and vulnerability factors was identified considering those that can describe more properly each factor: they are shown in figure 39 to figure 42. The following activity was the quantification of the indicators in terms of quantitative and qualitative data to have numbers to quantify, score and compare the indicators.

Data finding and recovery of the indicator for each exposure and vulnerability was carried out consulting open-source database (i.e. ISTAT) or data available in sites and repositories (The Consorzio di bonifica Centro, Statistical office of the Abruzzo Region, ARTA, Hydrographic Office of the Abruzzo Region, MEF, RGS). All the data used in this module were free of charge.

The analysis of the hazard indicators (Table 23) showed that among the 4 hazards preliminary identified only 3 are relevant for the target area. In fact, the hazard 'Whirlwinds and sandstorm events', even if was

considered to be relevant according to stakeholders and other analysis, looking at the historical data of wind velocity in the target area the highest velocity recorded was 15 km/h, much lower of the WMO threshold of 50 km/h. Therefore, the hazard 'Whirlwinds and sandstorm events 'was not considered in the further analysis of the risk and vulnerability assessment. During data finding and retrieval some indicators were changed due to data not available or impossible to get. Regarding 'the Risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation' two indicators were changed: 1) for the vulnerability 'Inadequate maintenance of the green and river banks', the preliminary indicator 'Number of fluvial street rehabilitation and re-naturalization interventions' was replaced with 'Number of fluvial hydraulic engineering'; 2) for the vulnerability 'Lack of urban planning and regulation', the preliminary indicator 'Number of (unauthorized) buildings next to the river banks' was substituted with 'Index of (unauthorized) buildings'. Finally, the indicator '% of commercial area next to the river banks' were not considered in the indicators value retrieval since, even if searched and requests in different database and sites, was impossible to have these data. Regarding the risk for human health due to heat waves, all the preliminary indicators were confirmed in the phase of data analysis, since all the needed data were available and retrieved, with exception of the factor 'Lack of urban planning (green areas)-Lack of building efficiency (water recycling and thermal efficiency)' since was impossible to get data for this indicator. Finally, for the risk of for human health, agriculture and energy production due to drought, some changes of indicators were made due to data not available. In Table 24 are reported the preliminary indicators and in Table 25, the final indicators considered, in red are highlighted those changed.

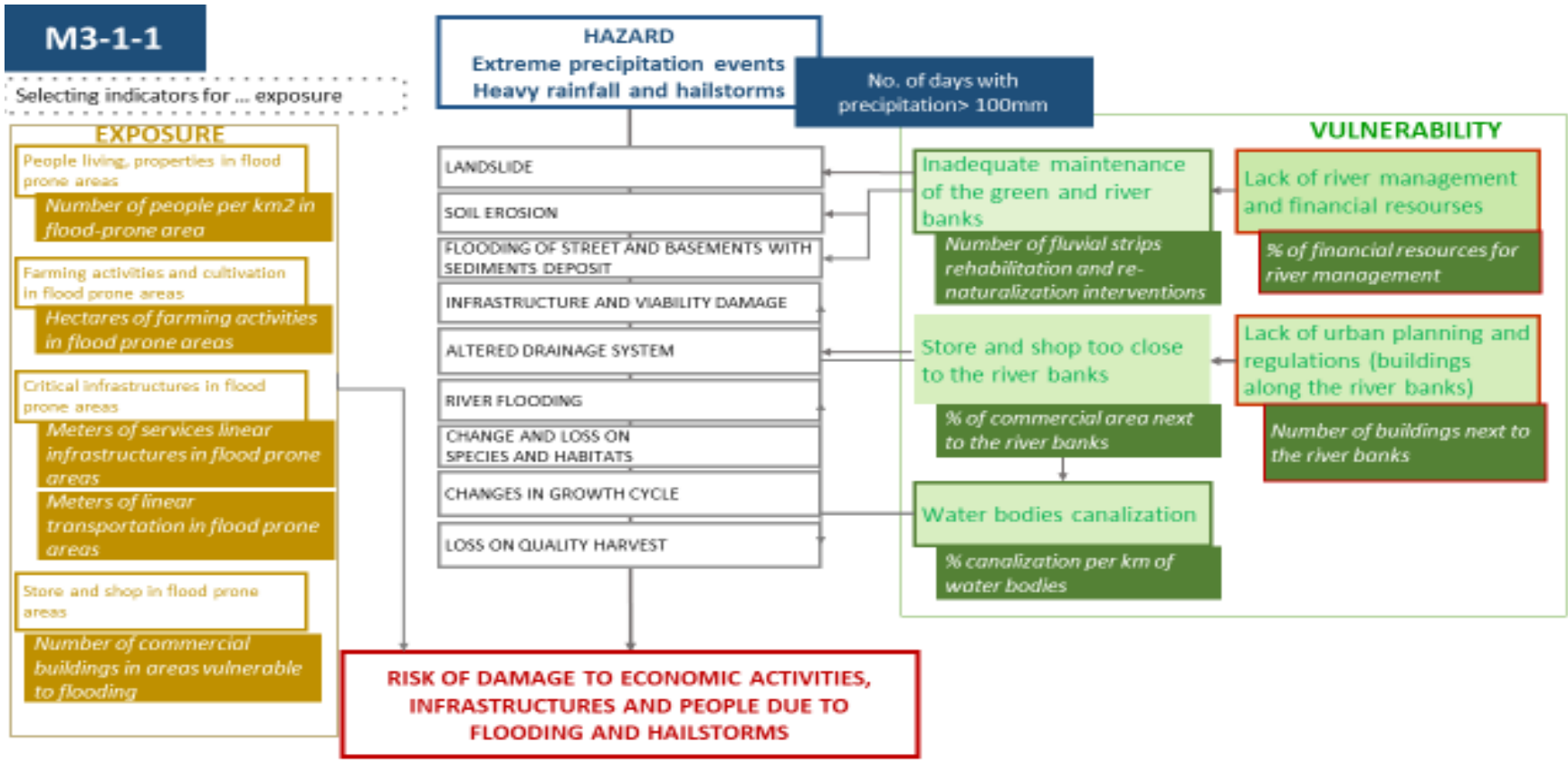
Hazard	**Drought**	
	Factor	**Indicator**
Exposure	People living in areas suffering of water scarcity	Number of people per km2 in areas suffering of water scarcity
	Farming activities and cultivation	Hectares of farming activities in areas suffering of water scarcity
	Aquatic parks, and swimming pool activities	Number of aquatic parks and swimming poll in areas suffering water scarcity
Vulnerability	Water storage capacity	m3 of water storage per habitants
	Rainwater runoff	% of urbanized area per km2
	Water recycle and reuse	% of public and private building with water recycle and reuse system
	Lack of water system planning	% of financial resources for water storage systems
	Soil sealing	% of financial resources for urban soil restoration and unsealing
	Urban planning Rule for buildings	% of financial resources for buildings efficiency

Table 24: List of the preliminary indicators for the risk of for human health, agriculture and energy production due to drought

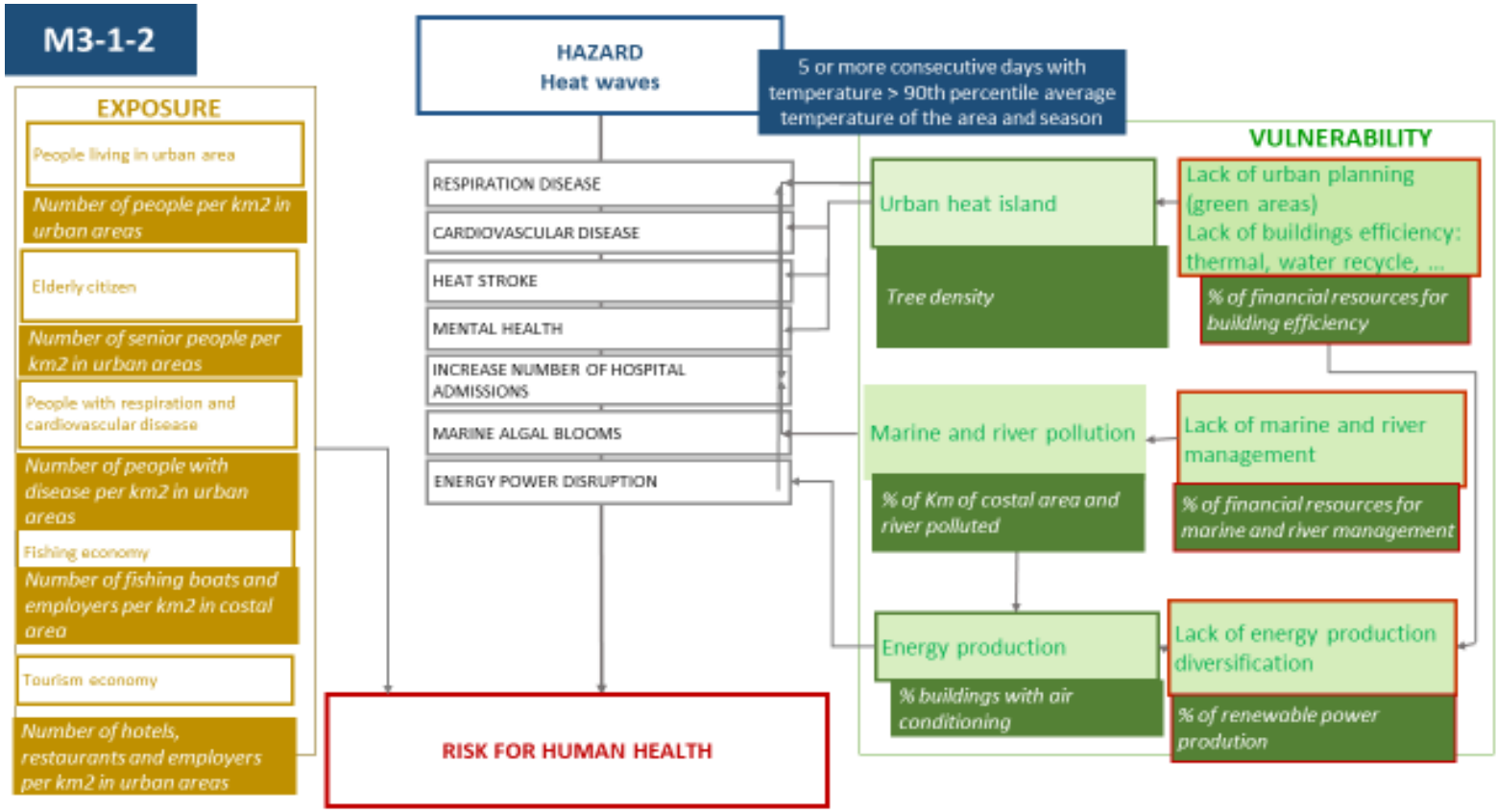
	Factor	Indicator
Exposure	People living in areas suffering of water scarcity	Number of people per km2 in areas suffering of water scarcity
	Farming activities and cultivation	Hectares of farming activities
	Aquatic parks, and swimming pool activities	Number of aquatic parks and swimming poll in areas
Vulnerability	Water storage capacity	Dispersion of water supply
	Rainwater runoff	% of sealing area per km2
	Water recycle and reuse	% of public building with water recycle and reuse system
	Lack of water system planning	% of financial resources for hydraulic infrastructures
	Soil sealing	% of financial resources for urban soil restoration
	Urban planning Rule for irrigation system	% of financial resources for maintenance to the irrigation works

Table 25: List of the final indicators for the risk of for human health, agriculture and energy production due to drought, in red are highlighted those changed due to data not available

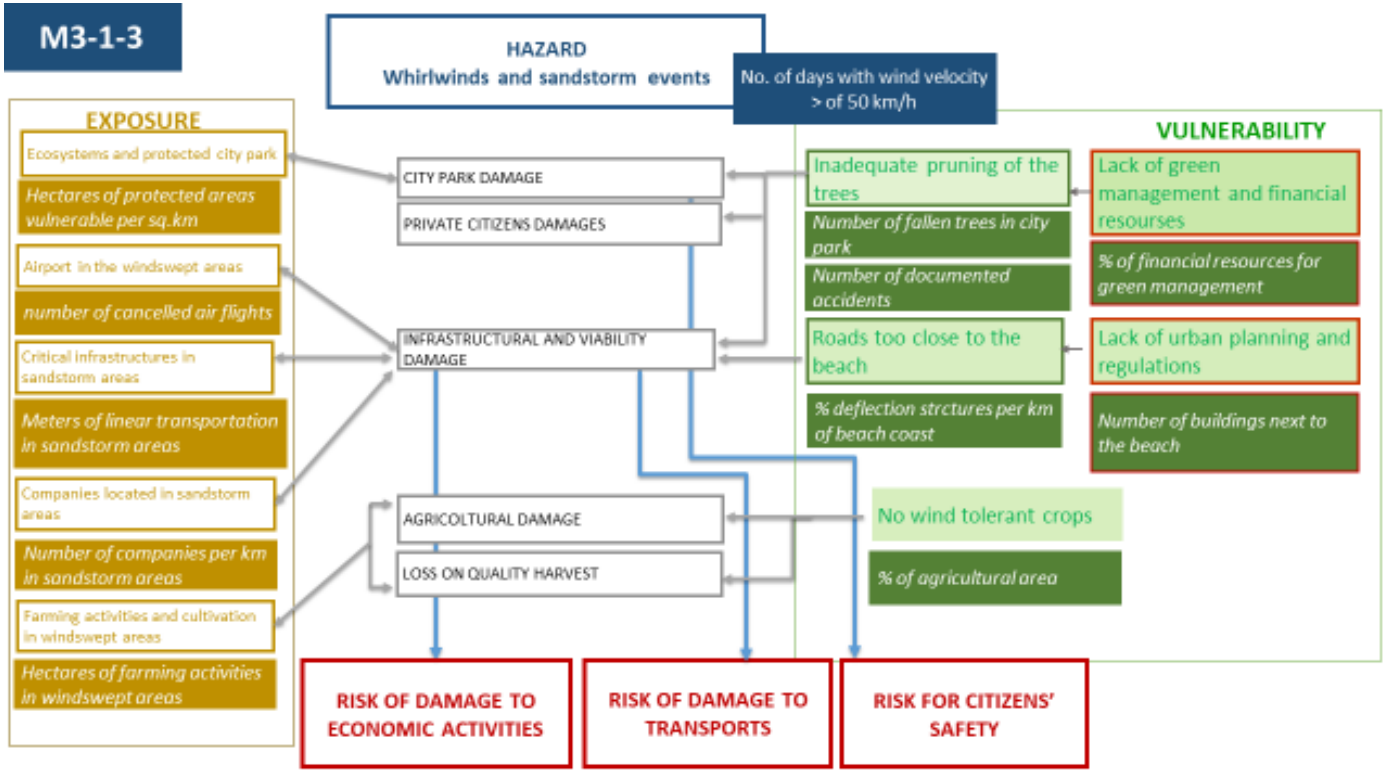
Issues related to data acquisition and management: Since most of the data of exposure and vulnerability were not available for each municipality of the target are, but most of them are the average data of the area, therefore all the analyses done are a mean picture of the target area. This means that a downscaling at municipality level was impossible.



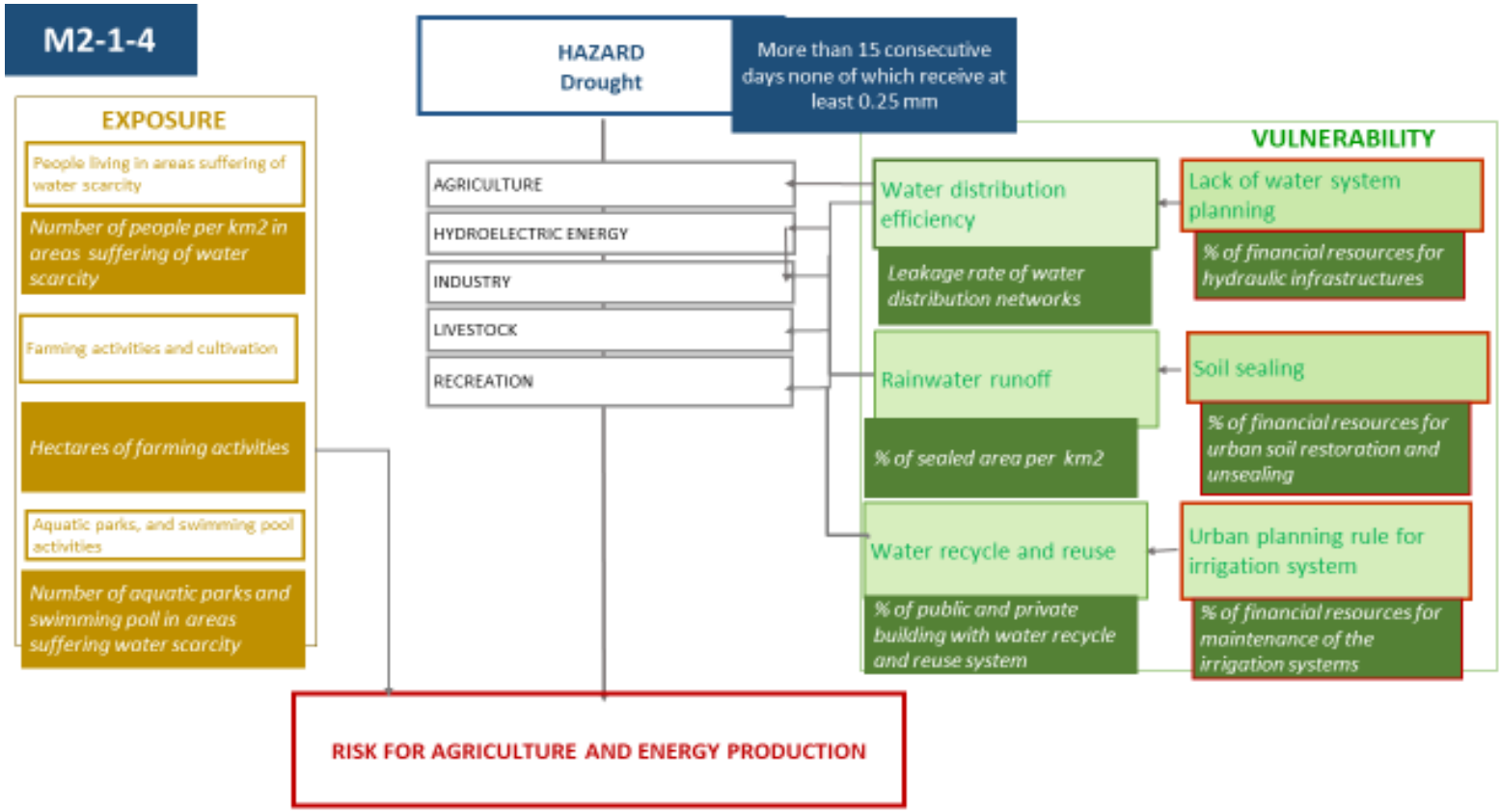
Picture 39: Indicators for each exposure and vulnerability of the Pescara M2 Impact Chain – Risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation



Picture 40: Indicators for each exposure and vulnerability of the Pescara M2 Impact Chain – Risk for human health due to heat waves



Picture 41: Indicators for each exposure and vulnerability of the. Pescara M2 Impact Chain – Risks for economic activities, transports and citizens' safety due to whirlwinds and sandstorm events



Picture 42: Indicators for each exposure and vulnerability of the Pescara M2 Impact Chain – Risk of for human health, agriculture and energy production due to drought

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

Following the suggested guidelines (Fritzsche, et al.: The Vulnerability Sourcebook: Concept and guidelines for standardized vulnerability assessments 2014), all the indicator data are mathematical normalized on the 0-1 scale, that for numerical indicators means to subtract to each value the minimum score and divide the result by the range of the score (difference between the maximum and minimum).

For 'Weighting and aggregating of indicators' the approach was to use the stakeholder feedback and suggestions. For the 'Risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation' all the exposures and vulnerabilities were weighted 1, apart from 'Farming activities and cultivation in flood prone areas' that was weighted 0.5.

Exposure Factor	**Indicator**	**Normalised value**	**Composite Indicator**
People living, properties in flood prone areas	Number of people per km2 in flood-prone area	0.047637123	0.426488728
Farming activities and cultivation in flood prone areas	Hectares of farming activities in flood prone areas	0.411764706	
Critical infrastructures in flood prone areas	Meters of services linear infrastructures and transportation in flood prone areas	0.5	
Store and shop in flood prone areas	Number of commercial buildings in areas vulnerable to flooding	0.739191074	
Vulnerability Factor	**Indicator**	**Normalised value**	**Composite Indicator**
Inadequate maintenance of the green and river banks	Number of fluvial strips and re-naturalization interventions	0.46	0.549487805
Water bodies canalization	% canalization per km of water bodies	0.230769231	
Lack of river management and financial resourses	% of financial resources for river management	0.847	
Lack of urban planning and regulations (buildings along the river banks)	Number of buildings next to the river banks	0.341463415	

Table 26: List of values and indicators related to risks of economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation.

For the 'Risk for human health due to heat waves' all the factors are weighted 0.5, whereas 'Elderly citizen', 'People with respiration and cardiovascular disease', 'Urban heat island' and 'Marine and river pollution were weighted' were weighted 1. In Table 27 a detail of the normalized value for each factor and the composite indicator.

Exposure Factor	**Indicator**	**Normalised value**	**Composite Indicator**
People living, in urban area	Number of people per km2 in urban areas	0.23815347	0.253727763
Elderly citizen	Number of senior people per km2 in urban areas	0.501538462	
People with respiration and cardiovascular disease	Number of people with disease per km2 in urban areas	0.155653451	
Fishing economy	Number of fishing boats and employers per km2 in costal area	0.033557047	
Tourism economy	Number of hotels, restaurants and employers per km2 in urban areas	0.19	
Vulnerability Factor	**Indicator**	**Normalised value**	**Composite Indicator**
Urban heat island	Tree density	0.5	0.501337942
Marine and river pollution	% of Km of costal area and river polluted	0.266666667	
Energy production	% buildings with air conditioning	0.462365591	
Lack of marine and river management	% of financial resources for marine and river management	0.847	
Lack of energy production diversification	% of renewable power production	0.666666667	

Table 27: List of values and indicators related to risks for human health due to heat waves

For the 'risk of for human health, agriculture and energy production due to drought' all the factor of exposure and vulnerability were weighted 0.5, whereas only that of 'Water distribution efficiency' were weighted 1; in Table 28 the list of the normalized factors and composite indicators for exposure and vulnerability.

Exposure Factor	**Indicator**	**Normalised value**	**Composite Indicator**
Farming activities and cultivation	Hectares of farming activities	0.018980908	
Aquatic parks, and swimming pool activities	Number of aquatic parks and swimming poll in areas suffering water scarcity	0.285714286	
Exposure Factor	**Indicator**	**Normalised value**	**Composite Indicator**
Water distribution efficiency	Leakage rate of water distribution networks	0.2	0.383443892
Rainwater runoff	% of sealed area per km2	0.5	
Lack of water system planning	% of financial resources for hydraulic infrastructures	0.611111111	
Soil sealing	% of financial resources for urban soil restoration	0.589552239	
Urban planning Rule for irrigation system	% of financial resources for maintenance of the irrigation systems	0.2	

Table 28: List of values and related to risks for the risk of for human health, agriculture and energy production due to drought.

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1
Hazard	Extreme precipitation events Heavy rainfall and hailstorms	Number of days with precipitation Max or = 100 mm	Cumulative rain in mm	0,80
	Heat waves	5 or more consecutive days with temperature > 90th percentile average temperature of the area and season	Air temperature in °C	0,46
	Drought	More than 15 consecutive days none of which receive at least 0.25 mm	Cumulative rain in mm	0,77
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**
Exposure	People living, properties in flood prone areas	Number of people per km2 in flood-prone area	Number of people/km2	0,05
	Farming activities and cultivation in flood prone areas	Hectares of farming activities in flood prone areas	km2	0,41
	Critical infrastructures in flood prone areas	Meters of services linear infrastructures and transportation in flood prone areas	km	0,50
	Store and shop in flood prone areas	Number of commercial buildings in areas vulnerable to flooding	Number of shop	0,74
	People living in urban area	Number of people per km2 in urban areas	Number of people/km2	0,24
	Elderly citizen	Number of senior people per km2 in urban areas	Number of elderly people/km2	0,50
	People with respiration and cardiovascular disease	Number of people with disease per km2 in urban areas	Number of people with disease/km2	0,16
	Fishing economy	Number of fishing boats and employers per km2 in costal area	Number	0,03
	Tourism economy	Number of hotels, restaurants and employers per km2 in urban areas	Number	0,19
	Farming activities and cultivation	Hectares of farming activities	km2	0,02
	Aquatic parks, and swimming pool activities	Number of aquatic parks and swimming poll in areas suffering water scarcity	Number	0,29
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**
Vulnerability	Inadequate maintenance of the green and river banks	Number of fluvial strips and re-naturalization interventions	Number	0,46
	Store a shop too close to the Pescara and Saline river banks	% of commercial area next to the river banks	(Number of Store and shop in flood prone)/km2	0,00
	Water bodies canalization	% canalization per km of water bodies	km	0,23
	Lack of river management and financial resourses	% of financial resources for river management	Euro	0,85
	Lack of urban planning and regulations (buildings along the river banks)	Number of buildings next to the river banks	Percentage	0,34
	Urban heat island	Tree density	Percentage	0,50
	Marine and river pollution	% of Km of costal area and river polluted	Percentage	0,27
	Energy production	% buildings with air conditioning	Percentage	0,46
	Lack of marine and river management	% of financial resources for marine and river management	Euro	0,85
	Lack of energy production diversification	% of renewable power production	Percentage	0,67

Area target 1: Pescara Coast

Table 29: Municipality of Pescara list of all indicators and indicator values

Impact chain - RISK OF EXTREME PRECIPITATION			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,80	*1*	
Exposure			
	0,43	*1*	*0,59*
Vulnerability			
	0,55	*1*	

Impact chain - RISK OF HEAT WAVES			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	*0,8*	
Exposure			
	0,25	*1*	*0,39*
Vulnerability			
	0,50	*0,8*	

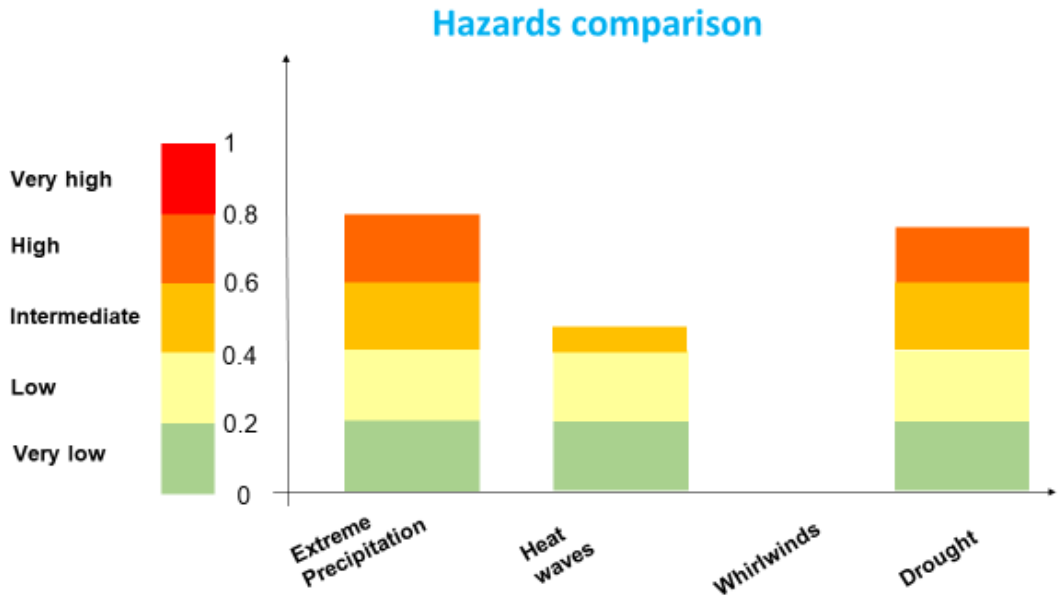
Impact chain - RISK OF WHIRLWINDS			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,13	*1*	
Exposure			
	0,07	*1*	*0,29*
Vulnerability			
	0,70	*1*	

Impact chain - RISK OF DROUGHT			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,77	*0,8*	
Exposure			
	0,15	*0,5*	*0,48*
Vulnerability			
	0,38	*0,8*	

Table 30: Municipality of Pescara final risk values by impact chain and target are

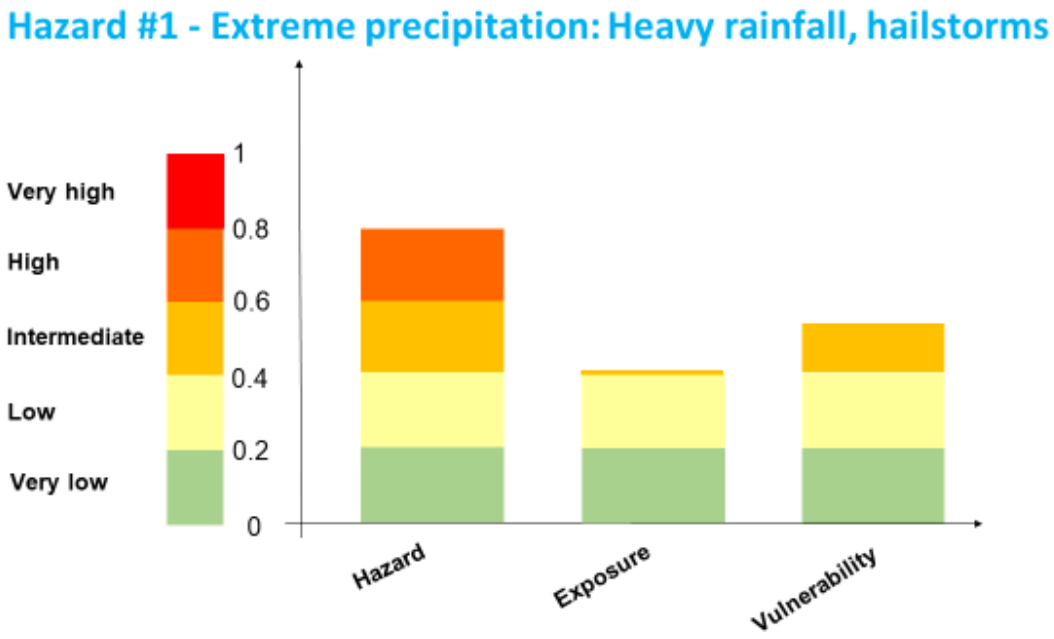
M8-Presenting the outcomes of your risk assessment

The risk assessment of the Target Area that includes the Municipalities of Pescara, Chieti, Montesilvano, Francavilla, San Giovanni Teatino e Spoltore, is presented in terms of 5 risk classes: 1) 'very low' for risk class values between 0 and 0.2, 2) 'low' for risk class values between 0.4 and 0.4, 3) 'intermediate' for risk class values between 0.4 and 0.6, 4) 'high' for risk class values between 0.6 and 0.8, 5) 'very high' for risk class value between 0.8 and 1. In Graph 6 is reported a comparison of the hazards for the target area. Extreme precipitation and drought are those more relevant with a score 'high', whereas heat waves scores 'intermediate'. Whirlwind is not reported since the WMO threshold for the wind velocity of 50km/h, is never observed in the meteorological station of the target area.

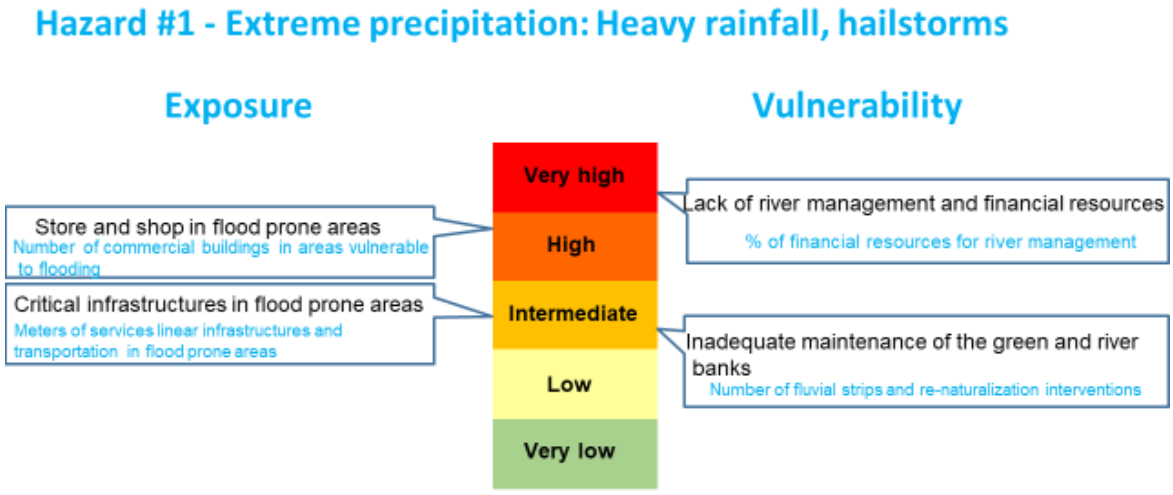


Graph 6: Comparison of the 4 hazards identified. Whirlwinds not reported since it is not evaluated because the WMO threshold was never reached in the target area

For the 'risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation' in Graph 7 are summarized the exposure and vulnerability, both score as intermediate. In Picture 43 are reported the more important factors (those with score above intermediate) of exposure and vulnerability the 'risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation'.

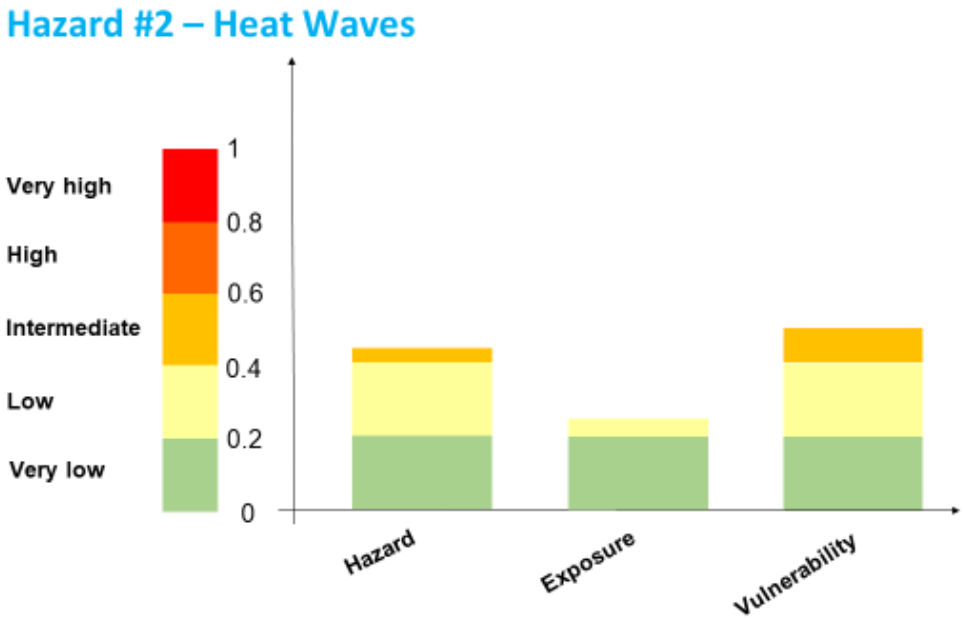


Graph 7: Summary of the risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation

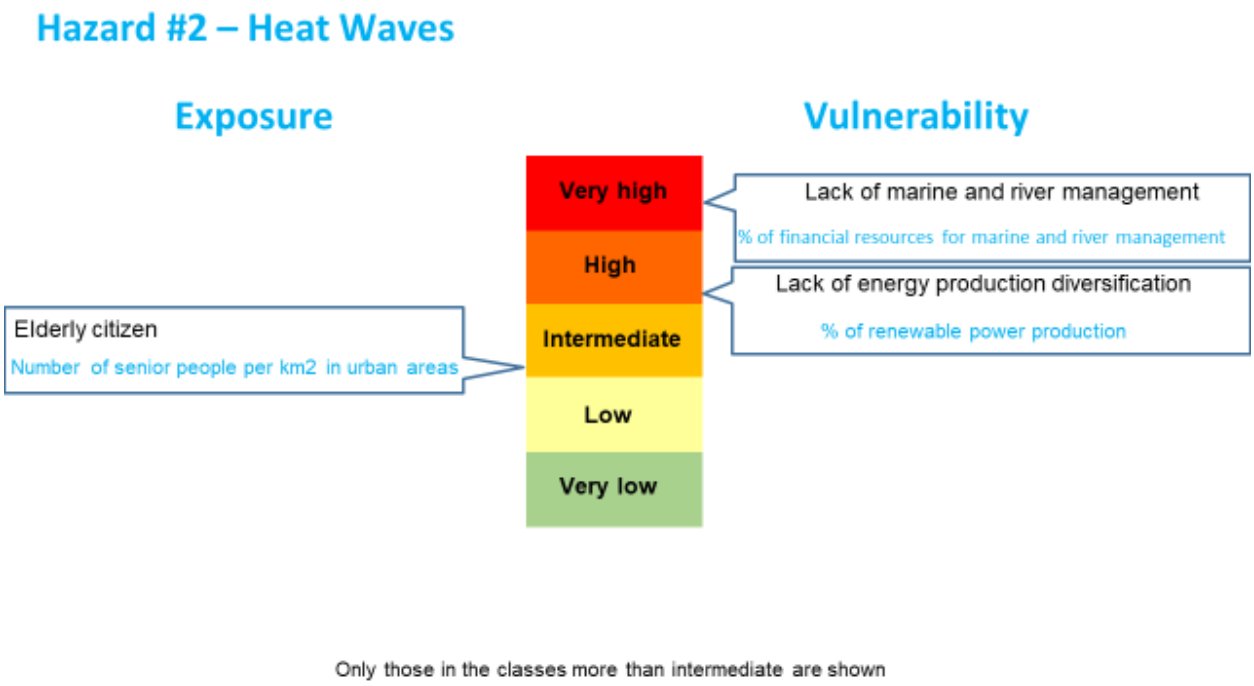


Picture 43: Exposure and vulnerability factor with higher score (at least intermediate) for the risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation

For the 'risks for human health induced by heat waves' in Graph 8 are summarized the exposure and vulnerability, the first scores low, the latter intermediate. In Picture 44 are reported the more important factors (those with score above intermediate) of exposure and vulnerability for the risks for the risks for human health due to heat waves.

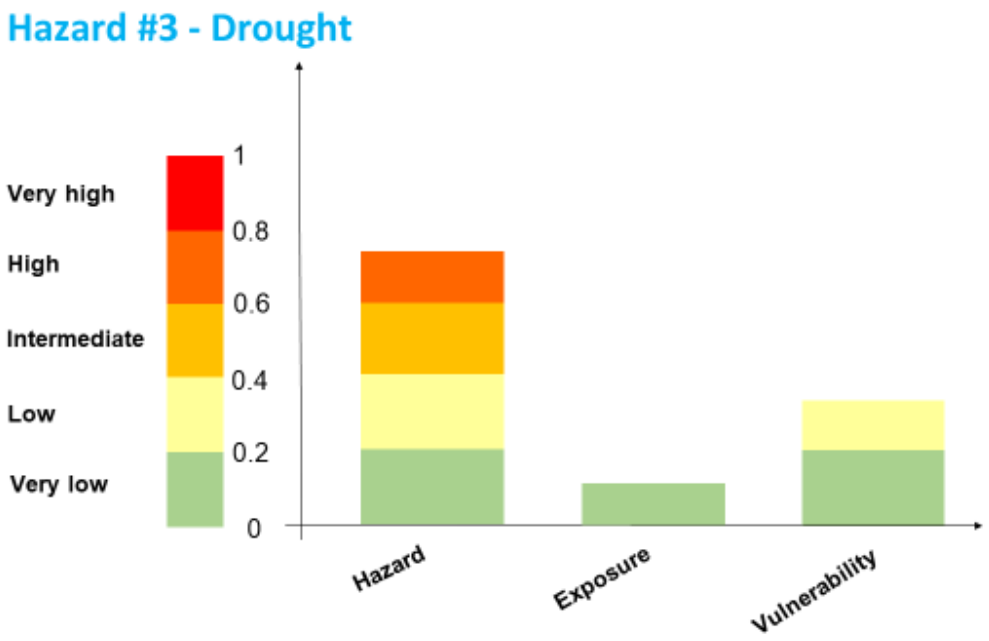


Graph 8: Summary of the risks for human health due to heat waves

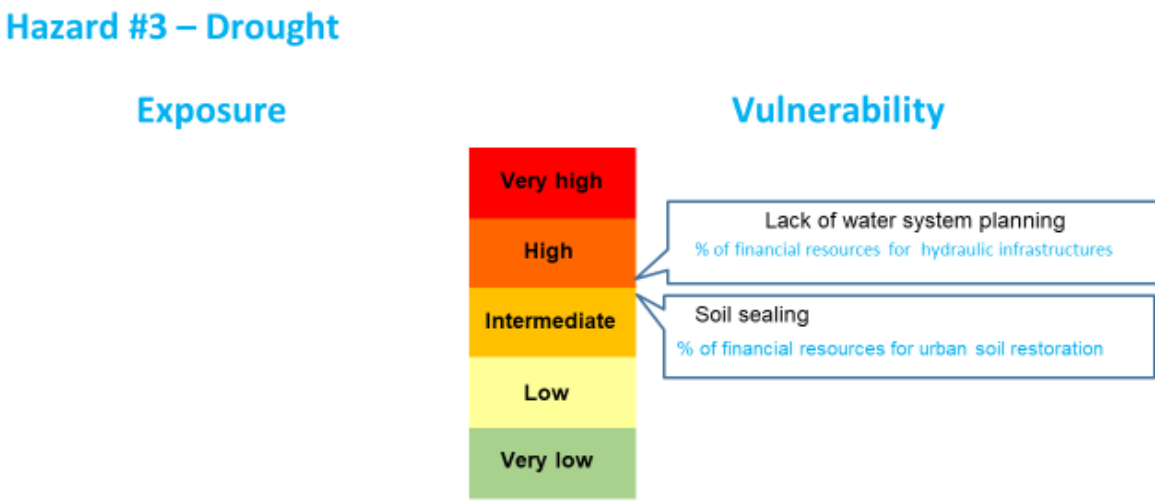


Picture 44: Exposure and vulnerability factor with higher score (at least intermediate) for the risks for human health due to heat waves.

For the 'risks of for human health, agriculture and energy production due to drought' in Graph 9 are summarized the exposure and vulnerability, the first scores very low, the latter low. In Graph 10 are reported the more important factors (those with score above intermediate) of exposure and vulnerability for the risk of for human health, agriculture and energy production due to drought.

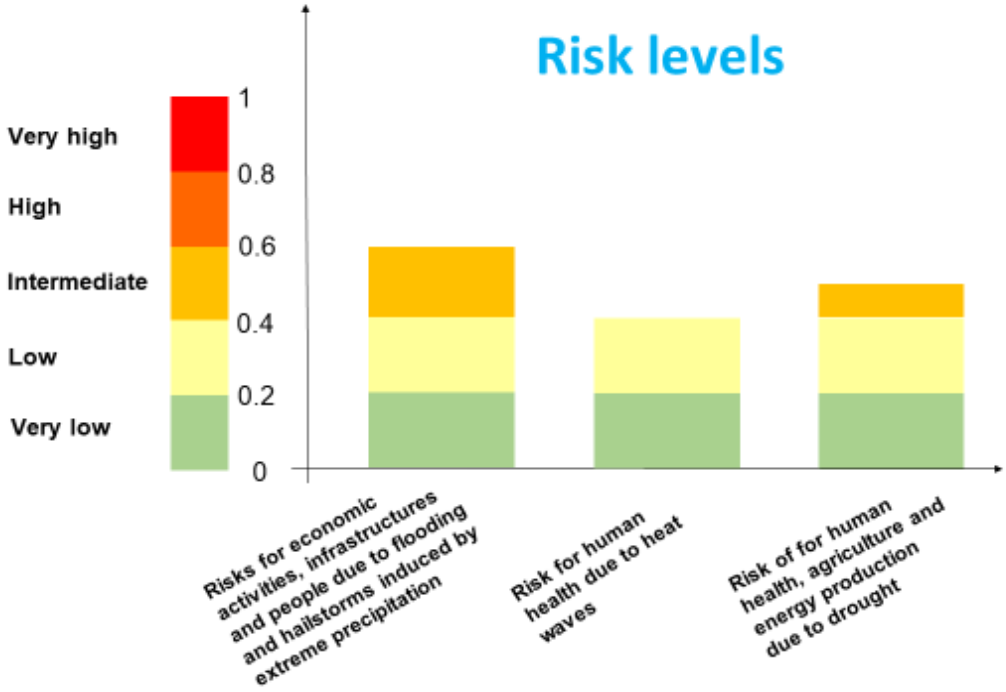


Graph 9: Summary of the risk of for human health, agriculture and energy production due to drought



Graph 10: Exposure and vulnerability factor with higher score (at least intermediate) for the risk of for human health, agriculture and energy production due to drought.

The level of risk is the result of the combination of hazard, exposure and vulnerability for each of the identified risk. In Graph11 is reported the outcome of this retrieval, in detail: the risk for human health due to heat waves scores low (0.39), whereas the risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation scores intermediate (0.59) and, finally, the risk of for human health, agriculture and energy production due to drought scores also intermediate, but with a value of 0.48.



Graph 11: Composite Risk levels

2.5 [PP5] SDEWES CENTRE - INTERNATIONAL CENTRE FOR SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

Summary

The Risk and Vulnerability assessment analysis was coordinated by PP5 – SDEWES Centre with consortium of companies led by Energo-data d.o.o that also included: RKS energo opreme d.o.o , Udruga EU Centar and EU Centar Adriatic as the consultant. The process of the assessment started in October 2019 and was completed in February 2020.

Group of stakeholders and key actors included: local municipalities, Dubrovnik-Neretva County, DUNEA-Dubrovnik-Neretva County Development Agency and DURA- Development Agency of City of Dubrovnik and State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service.

The impact chains include the following risks: medium risk of drought for agriculture sector, medium risk of drought in water supply sector, medium risk of heat stokes for health sector and medium risk of high temperatures and precipitation for economic activity in tourism sector.

No additional difficulties were reported during the assessment development. The results of the assessment process, carried out for the agriculture, health, water supply, tourism, fisheries and coastal sectors, include simulations of the future climate which indicate an increase in air temperature, number of hot days, hot nights and an extension of the duration of warm periods in the target area, while in the precipitation domain, the results depend on the climate model (possible increase or decrease of precipitation, prolongation or shortening of the duration of dry periods). The fisheries and coastal sectors are assumed to have the same level of vulnerability estimated at national level. The level of data availability for these sectors indicates the need for further targeted research and improvements in the availability of information itself.

Although the overall risks were assessed as intermediate, further activities are needed to improve the condition of all risk components, i.e. to reduce sensitivity and exposure and to increase adaptability. One of the most important stakeholders in this adaptation process are municipalities and regions, who's strategic and development plans for climate change adaptation require increasing attention.

M1-Preparing the risk assessment

The covered territory includes City of Dubrovnik and municipalities of Konavle, Župa dubrovačka, Dubrovačko primorje and Ston. They are all parts of Dubrovnik-Neretva County, the most southern part of Croatia. They were identified and confirmed at the beginning months of the project.

During the preparation of assessment, existing local SEAPs for municipalities and SECAP for City of Dubrovnik were reviewed. The local and county development strategies were also taken in consideration.

The main stakeholders included the target area local city and municipal governments, but other stakeholders were also contacted in order to provide data for the assessment. Other stakeholders were local and county development agencies, local municipal companies and State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service. The stakeholders involved were very cooperative, so no difficulties regarding stakeholder involvement was noted.

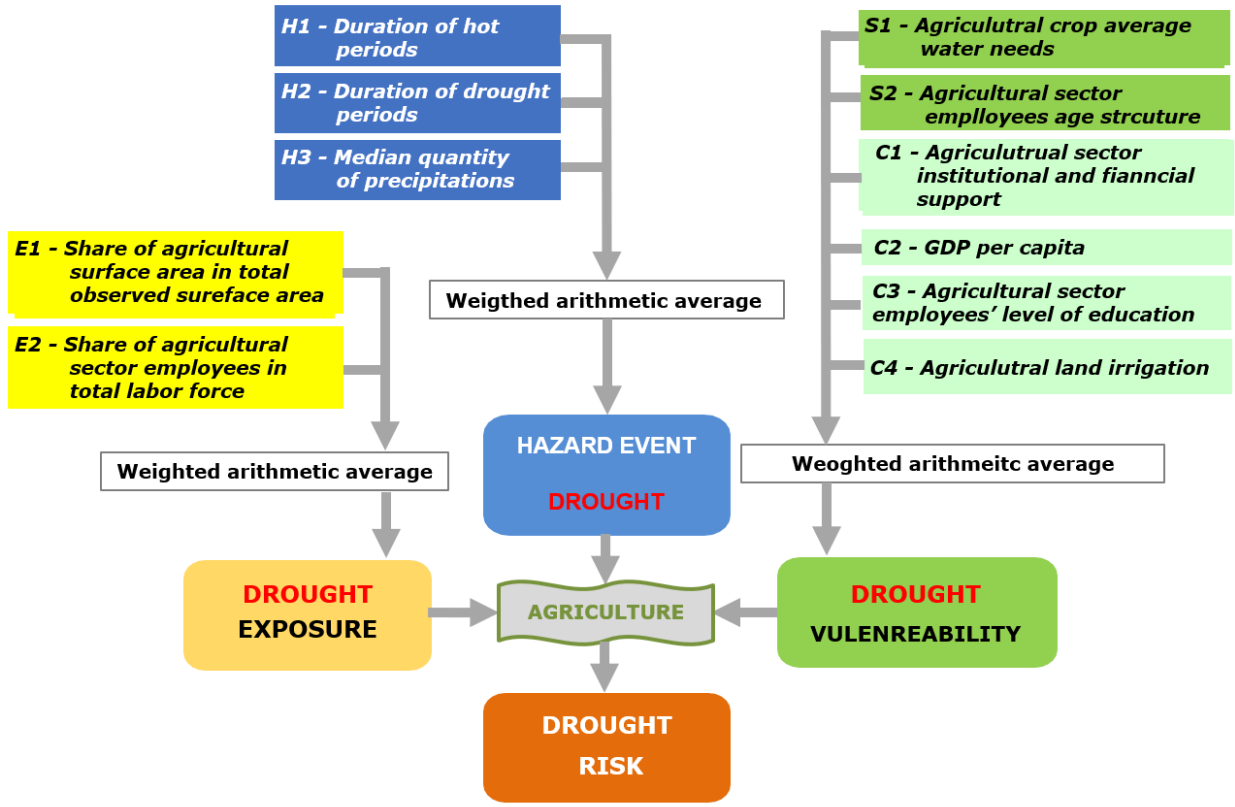
M2-Developing impact chains

The hazards chosen for the assessment include extreme drought events, heat stroke hazard, increase in average temperatures and extreme precipitation as the events with the highest probability for occurrence and the greatest factors for potential influence related to climate changes.

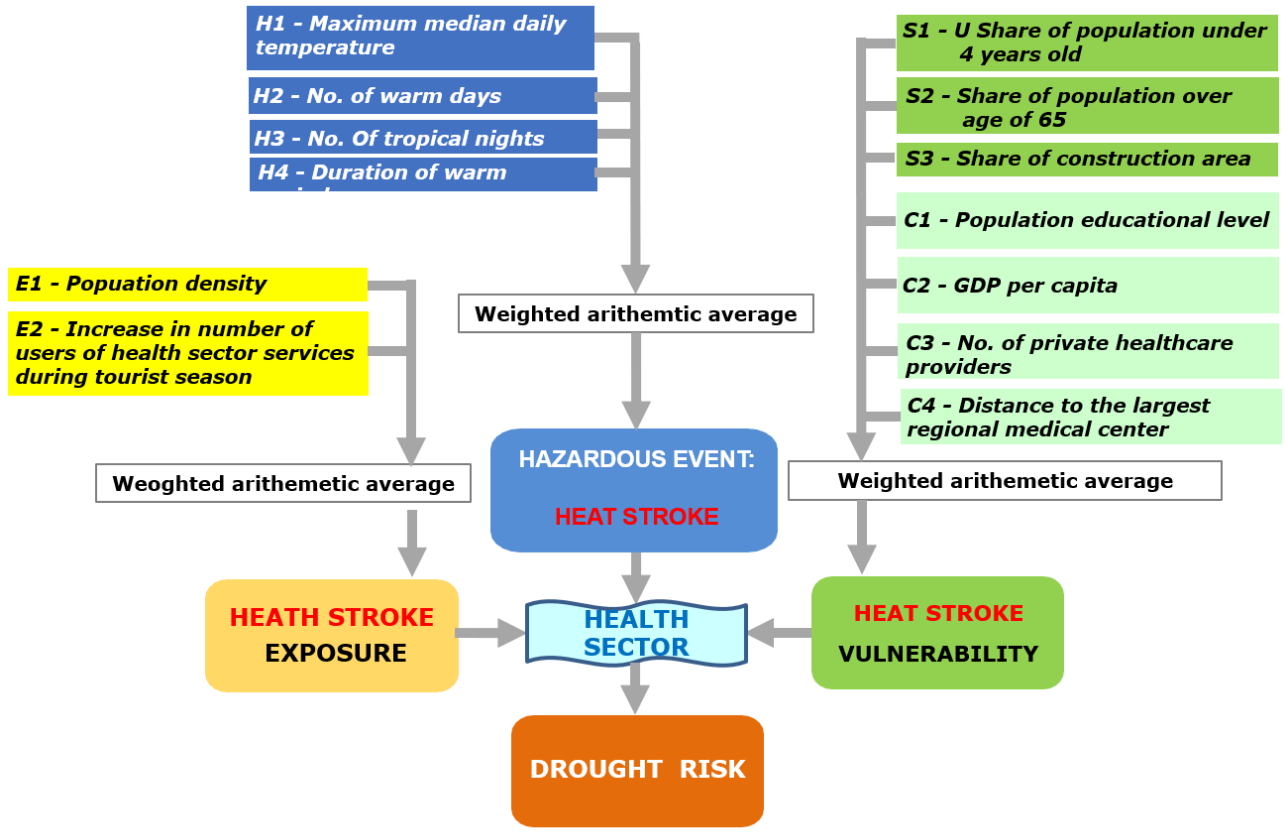
The identified and developed impact chains include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat strokes in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. All listed impact chains were finalized and included in the assessment. The impact chains were developed by the external consultant Energo-data d.o.o and other members of the consortium, while the M2 module was developed in cooperation with the project partner SDEWES Centre.

The data used to develop the impact chains included data taken from the Agency for Payments in Agriculture, Fisheries and Rural Development Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (*The Vulnerability Sourcebook, Risk Supplement to the Vulnerability Sourcebook, 2017.),* State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service, Ministry of Environment and Energy (*Climate Change Adaptation Strategy Draft in Republic of Croatia up to 2040 period with a 2070 projection*), *Rural Development Program of the Republic of Croatia for the period 2014 - 2020*, Central Bureau of Statistics (*2011 Population Census*), city, municipal and county development strategies and strategic documents, tourist board data, local and county economic data as well as previous version of SECAP for City of Dubrovnik and SEAP for other municipalities.

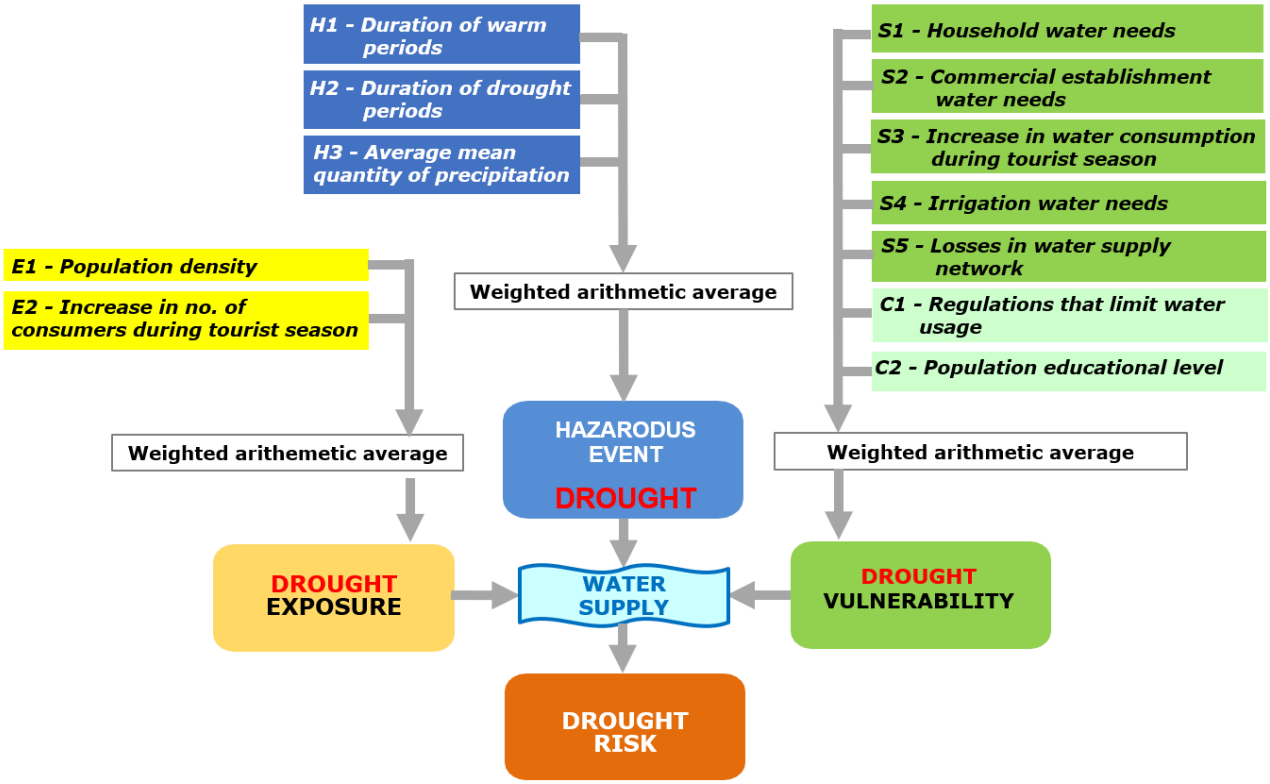
The methodology described in the tutorial, including the Vulnerability Sourcebook and the Risk Supplement files consistent with IPCC AR5 Synthesis Report, was used for the assessment. No difficulties were noted in the impact chain development process.



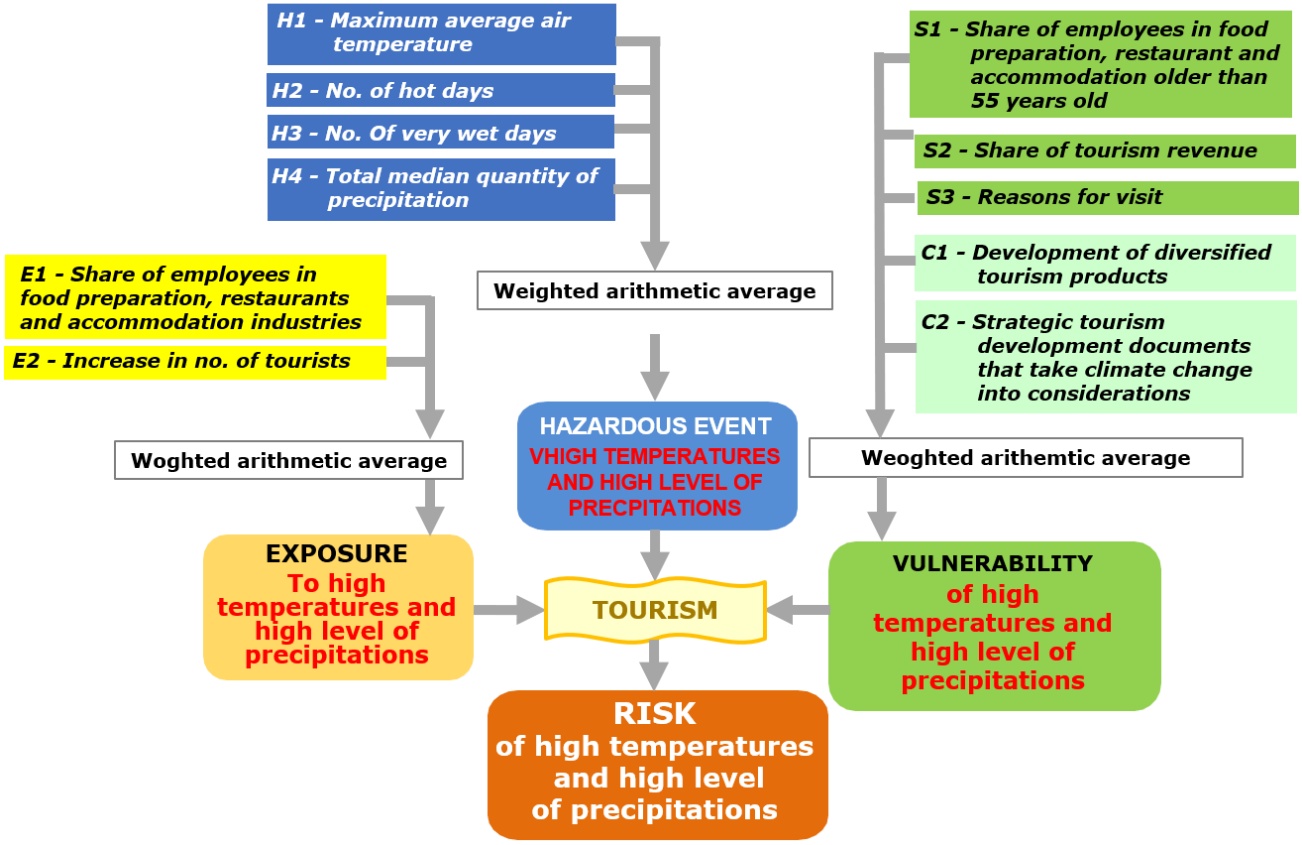
Picture 45: SDEWES M2 Impact Chain – Risk of damage for the agricultural sector



Picture 46: SDEWES M2 Impact Chain – Risk of damage for the health sector



Picture 47: SDEWES M2 Impact Chain – Risk of damage for the water supply sector



Picture 48: SDEWES M2 Impact Chain – Risk of damage for tourism sector

M3-Identifying and selecting indicators, M4-Data acquisition and management

The following risk factors and indicators were identified during M3 development:

Risk of damage to agricultural sector due to extensive drought periods includes 11 identified factors and 13 selected indicators. The risk of increasing interventions related to heat strokes in health sector includes 14 identified factors and 15 selected indicators, while the risk of damage to water supply sector due to extensive drought periods includes 12 identified factors and 12 selected indicators. The risk of economic damage to the tourist sector includes 11 identified factors and 12 selected indicators. There is always at least 1 indicator for each factor.

The indicators were developed by the external consultant consortium led by Energo-data d.o.o., while the module was developed jointly with project partner SDEWES Centre. Some issues included inaccessibility of data from the State Hydrometeorological Institute, certain local municipal companies, local governments and certain national agencies.

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

The instruments used for weighting and aggregating data included the extrapolation of data through the excel tables provided by the Lead Partner. The normalization of data was done with min-max method for metric and 5 class evaluation scheme for categorical indicator values. The normalization, weighting and aggregation of data was performed by the external consultant and later adjusted for the provided excel tables by the coordinator.

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1
Hazard	Heat waves	Warm spell duration index (WSDI) - annual or seasonal count of days with at least 6 consecutive days when the daily maximum T exceeds the 90th percentile for the calendar day in the reference period (days/year)	Number of days	0,35
	Annual precipitation	Medium total precipitation amount (mm/year)	mm/year	0,57
	Drought period duration	consecutive dry days - consecutive days receiving less than 1 mm of precipitation (days/year)	Number of days	0,52
	Medium maximum daily air temperature	°C	°C	0,44
	Hot days	Number of days with a maximum daily temperature > 30°C	°C	0,36
	Tropical nights	Number of days with a minimum air temperature > 20°C	°C	0,35
	Warm period duration	Warm spell duration index (WSDI) - annual or seasonal count of days with at least 6 consecutive days when the daily maximum T exceeds the 90th percentile for the calendar day in the reference period	Number of days	0,35
	Very rainy days	Number of days with daily precipitaion amount ≥ 20 mm	Number of days	0,44
	Medium total precipitation amount	mm/year	mm/year	0,43
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**
Exposure	ARKOD area	Share of ARKOD area in the total city/municiplaity area	ha	0,87
	Employed in agriculture	Share of employees in agriculture in total number of employees	Number of employees	0,13
	Population density	inhabitants / km2	inhabitants / km2	0,26
	Increase of temporary population - touristic intensity	Number of touristic nights spent per capita	Number of touristic nights spent per capita	0,75
	Employed in tourism sector	Share of employees in tourist sector in total number of employees	Number of employees	0,56
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**
Vulnerability	Irrigation priority areas (C)	County specific areas prioritized for irrigation (ha)	ha	0,86
	Age structure of employees in agriculture sector (S)	Share of agriculture employees older than 65 years in total number of employees in this sector	Number of employees	0,04
	Irrigation needs (S)	Average needs for irrigation in agriculture (m³/ha/year	m³/ha/year	0,24
	Institutional and financial support to farmers (C)	Existence of institutions providing e.g. guidance, support, advice, financial incentives etc.	None (descriptive classes)	0,50
	Education level (C)	Share of farmers with minimally high school education level in total number of family farm owners	Number of farmers	0,50
	Young population (S)	Share of population < 4 years of age	Number of people	0,68
	Elderly population (S)	Share of population > 65 years of age	Number of people	0,98
	Built up area (S)	Built up area per capita	ha	0,74
	Education level (C)	Population share with minimally high school education level	Number of people	0,50
	GDP per capita	GDP per capita	GDP per capita	0,40
	Healthcare coverage	Number of inhabitants per each healthcare practitioner (general medicine professional)	Number of people	0,25
	Distance to closest regional health institution	Time period needed to reach the regional healthcare institution either by plane or boat	Minutes	0,75
	Water supply needs - households (S)	Comparison of water supply needs and available water resources (m3/year)	m3/year	0,59
	Water supply needs - comercial (S)	Comparison of water supply needs and available water resources (m3/year)	m3/year	0,18
	Water supply needs - irrigation (S)	Comparison of water supply needs and available water resources (m3/year)	m3/year	0,24
	Losses in the water supply network (S)	% of losses	m³/ha	0,72
	Regulations that limit water consumption (C)	Existence of specific regulation on county level	Number of employees	0,50
	Employed in tourism sector older than 55 years (S)	Share of employees in tourist sector older than 55 years of age in total number of employees	Number of employees	0,45
	Tourism beneficiaries (S)	Share income coming from tourism	HRK (Croatian Kuna)	0,88
	Main reason for visits (S)	E.g. sun&sea, yachting, nature etc.	None (descriptive classes)	0,50
	Touristic diversity (C)	Existence and range of diverse activities offered to tourists apart from sea and sun (bicycling, hunting, health tourism, wine&dine, festivals etc.)	None (descriptive classes)	0,56
	Planning and development documents for the tourism sector (C)	Perception of climate change issues in the documents	None (descriptive classes)	0,74

Area target 1: Dubrovnik area

Table 31: SDEWES list of all indicators and indicator values

Impact chain - Impact of drought on agriculture sector			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
Example	0,48	1	
Exposure			
Example	0,50	1	0,44
Vulnerability			
Example	0,35	1	

Impact chain - Impact of heat waves on health sector			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
Example	0,37	1	
Exposure			
Example	0,51	1	0,50
Vulnerability			
Example	0,64	1	

Impact chain - Impact of drought on water supply sector			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
Example	0,48	1	
Exposure			
Example	0,59	1	0,49
Vulnerability			
Example	0,41	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
Example	0,42	1	
Exposure			
Example	0,65	1	0,54
Vulnerability			
Example	0,55	1	

Table 32: SDEWES final risk values by impact chain and target area

M8-Presenting the outcomes of your risk assessment

The data from the risk assessment was presented through excel methodology modules and finally through the deliverable summary report. The finalized documents are available on the official web page of the project and project partner.

2.6 [PP6] PRIMORJE - GORSKI KOTAR COUNTY

Summary

The risk and vulnerability assessment process was coordinated by the external expert (Regional energy agency Kvarner), which was also in charge for technical elaboration. The process of the assessment started in October 2019 and was completed in March 2020. Groups of stakeholders and key actors involved include City of Kastav, City of Opatija, Municipality of Čavle, Municipality of Matulji, Municipality of Viškovo, Croatian Bureau of Statistics (Državni zavod za statistiku) and Croatian Meteorological and Hydrological Service, Meteorological Research and Development Sector (Državni hidrometeorološki zavod, Sektor za meteorološka istraživanja i razvoj).

Impact chains were developed for three defined sectors which are: water supply systems, health and tourism and are composed of risk components- hazard, vulnerability, exposure and underlying factors which are graphically displayed in the Section 2 of this document. The impact chains developed include Risk of damage to water supply sector due to extensive draught periods, Risk of increasing interventions related to heat strokes in health sector, Risk of economic damage in tourism sector due to extreme weather conditions.

The results of the assessment process, carried out for the water supply, health, tourism, include simulations of the future climate which indicate an increase in air temperature, number of hot days, hot nights and an extension of the duration of warm periods in the target area, while in the precipitation domain, the results depend on the climate model possible increase or decrease of precipitation, prolongation or shortening of the duration of dry periods.

Apart from climate-related factors, importance lies also on some non-climate factors, such as the social and economic developments and economic trends in the target area (e.g. the GDP per capita may decrease the level of risk). Tourism is also considered important for this area since it has great impact, not only in terms of income, but also because of increasing in number of tourists. One of the most important indicators in context area is population density, which can increase the level of risk.

During the process, external experts were encountered with difficulties in collecting of specific data from some of municipalities involved in development of assessment because they are small and they don’t have department for each target sector.

M1-Preparing the risk assessment

The table shows context area, specifying the municipalities that agreed to take part in the project:

Municipality	Area (km^2)	No of inhabitants (2011 Census)
Opatija	66	11.659
Kastav	11	13.746
Čavle	84	6.749
Matulji	176	10.544
Viškovo	19	14.495

Table 33: Primorje-Gorski Kotar County context area

All selected municipalities have developed Sustainable Energy Action Plans (SEAPs) on local level that were considered during the preparation of the assessment, as well as parallel ongoing regional energy and climate strategies (for example Primorje-Gorski Kotar County Development Strategy for the 2016-2020 period. Air protection program, ozone layer, climate change and climate adoption in Primorje-Gorski Kotar County for the 2019-2022 period, Primorje-Gorski Kotar County Energy Efficiency Action Plan for the 2017-2019 period).

This module was developed jointly with the representatives of municipalities who participated in the process by providing the necessary data for the assessment as requested by the external experts. There were difficulties in collecting of specific data in some of municipalities, which are small and don't have departments for each target sector, and generally there is lack of data which were defined to be important as selected indicators.

M2-Developing impact chains

Hazards were chosen based on three direct climate impacts in Croatia:

- The increase of temperature;
- Precipitation level decreasing
- Extreme weather conditions (storms, heat stroke and droughts)

Finally, based on hazards detected, appropriate adaptation measures will be proposed. Following hazards are outlined:

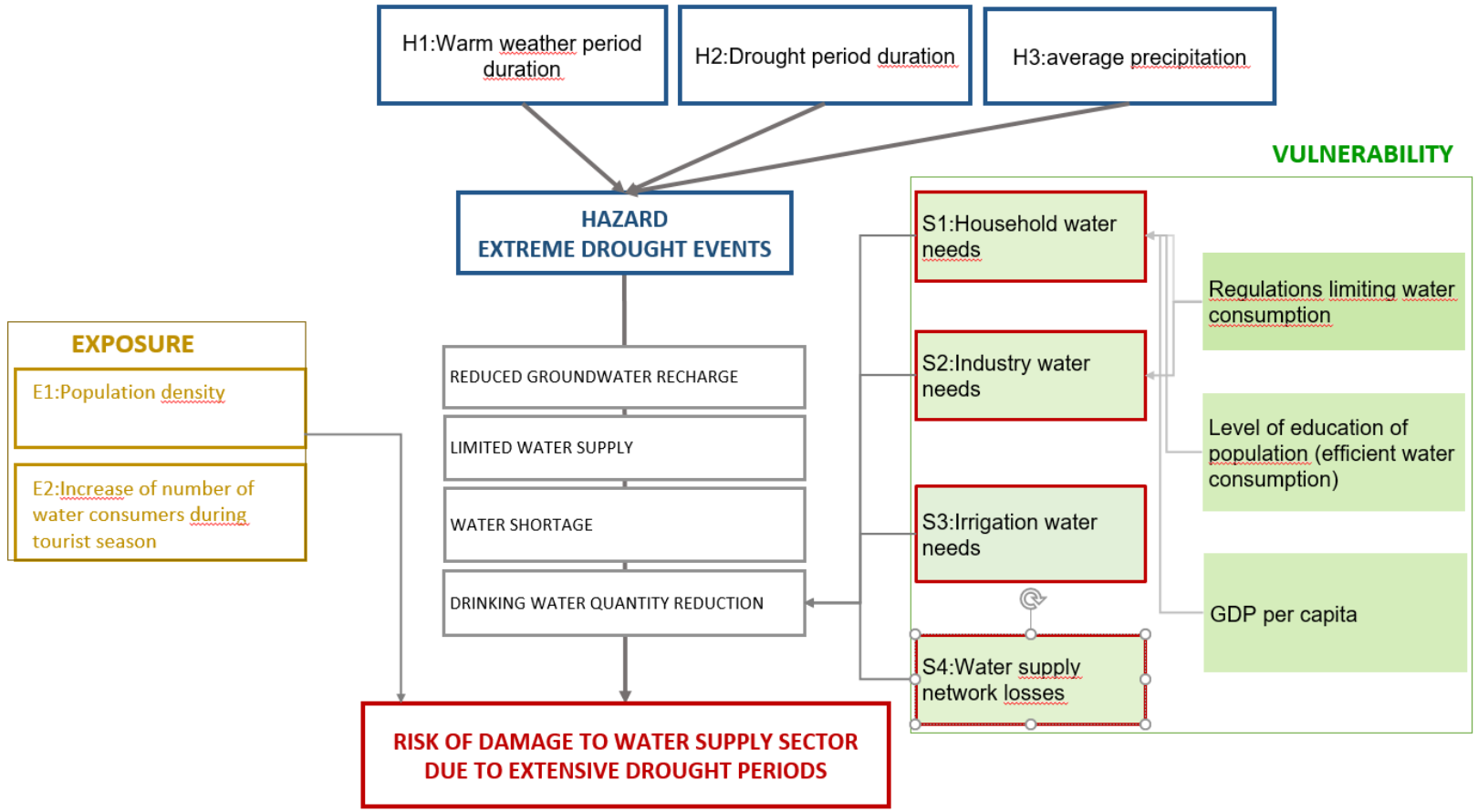
- Having impact on water supply: warm weather period duration, drought period duration, average precipitation

- Having impact on the health: number of extremely hot days, maximum air temperatures, warm period duration

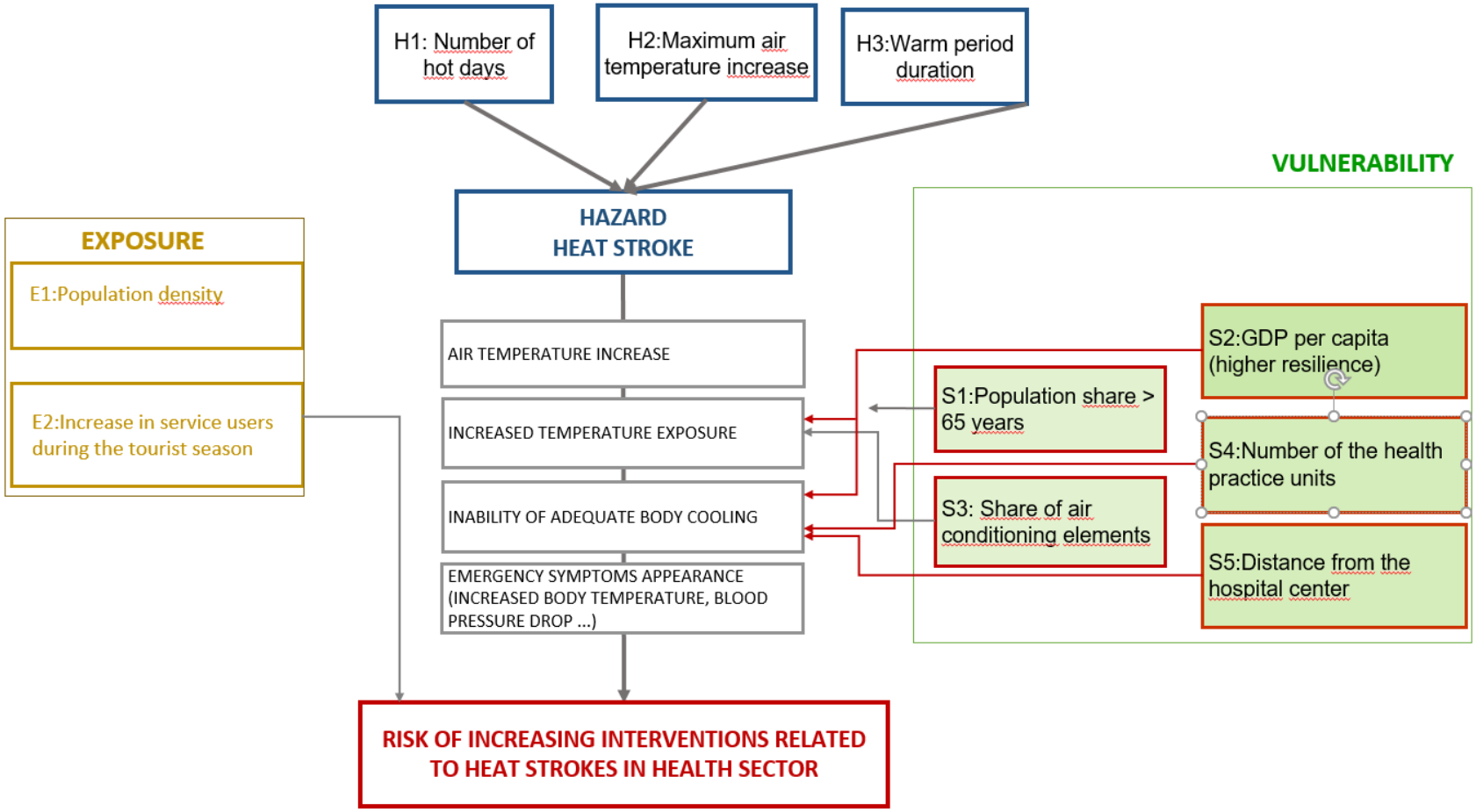
- Having impact on tourism: number of extremely hot days, maximum daily temperatures, average precipitation level, number of very humid days

The impact chains developed include Risk of damage to water supply sector due to extensive draught periods, Risk of increasing interventions related to heat strokes in health sector, Risk of economic damage in tourism sector due to extreme weather conditions.

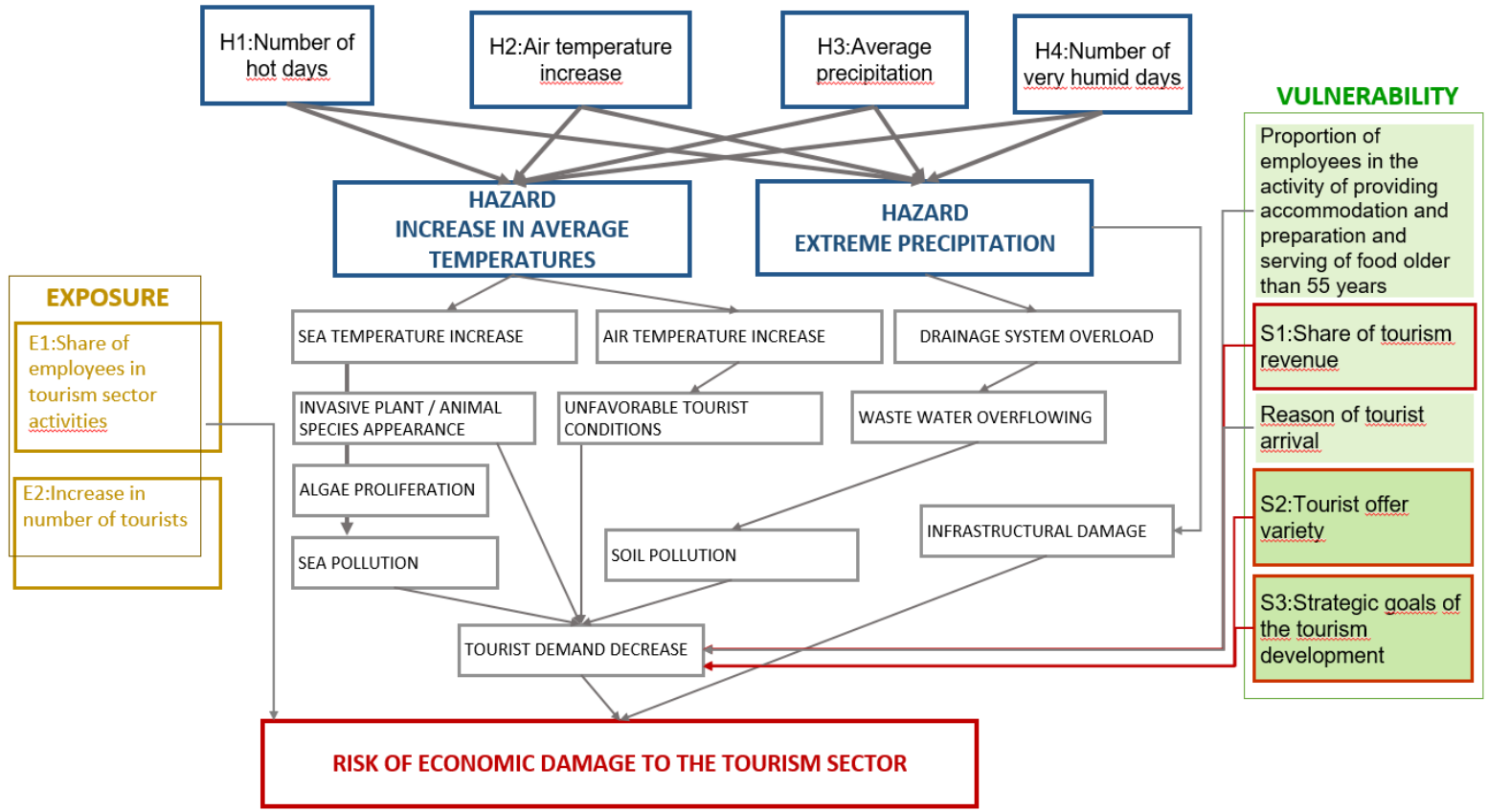
Impact chains are composed of risk components - hazard, vulnerability, exposure and underlying factors which are graphically displayed in the following pictures.



Picture 49: Primorje-Gorski Kotar M2 Impact Chain – Risk of damage to water supply sector



Picture 50: Primorje-Gorski Kotar M2 Impact Chain – Risk of damage to health sector



Picture 51: Primorje-Gorski Kotar M2 Impact Chain – Risk of damage to tourism sector

Impact chains were developed by external expert Regional energy agency Kvarner in cooperation with municipality representatives. Most of data were collected by Croatian bureau of statistics and Croatian Meteorological and Hydrological Service, Ministry of Environment and Energy, The institute for physical planning of Primorje-Gorski Kotar County, Teaching Institute of Public Health, Croatian Chamber of Commerce, utility companies for water supply, Primorje-Gorski Kotar County - Department of tourism, entrepreneurship and rural development.

Difficulties were which data can be collected as a specific number, and which need to be collected from the surveys and then interpolated.

Impact chains were developed in compliance with the Risk Supplement to the Vulnerability Source book in 4 Steps:

Step 1) Identify climate impacts and risk

Step 2) Determine hazard and intermediate impacts

Step 3) Determinate vulnerability

Step 4) Determinate exposure

M3-Identifying and selecting indicators, M4-Data acquisition and management

List of identified and selected indicators are:

Risk component	**Factor**	**Possible indicator**
RISK OF DAMAGE TO WATER SUPPLY SECTOR **DUE TO EXTENSIVE DROUGHT PERIODS**		
Hazard	*Dry period*	Warm weather period duration
	Period without precipitation	Drought period duration
		Average precipitation
Vulnerability	*Water use*	Household water needs

		Industry water needs
		Irrigation water needs
		Water supply network losses
Exposure	*Population density*	Population density
	Arrival of tourists	Increase of number of water consumers during tourist season
RISK OF INCREASING INTERVENTIONS **RELATED TO HEAT STROKES IN HEALTH SECTOR**		
Hazard	*Dry period*	Number of hot days
	High temperatures	Maximum air temperatures increase
	Warm periods	Warm period duration
Vulnerability	*Population age*	Population share>65 years
	Economic impact	GDP per capita (higher resilience)
	Using refrigeration systems	Share of air conditioning elements
	Health system	Number of the health practice units
		Distance from the hospital center
Exposure	*Population density*	Population per m^2 (population density)
	Arrival of tourists	Increase in service users during the tourist season
RISK OF ECONOMIC DAMAGE TO THE TOURISM SECTOR		
Hazard	*Dry period*	Number of hot days
	High temperatures	Air temperature increase

	Precipitation	Average precipitation
	Wet days	Number of very humid days
Vulnerability	*Tourism sector*	Share of tourism revenue
		Tourist offer variety
		Strategic goals of the tourism development
Exposure	*Tourists*	Share of employees in the tourism sector activities
		Increase in number of tourists

Table 34: Primorje-Gorski Kotar list of indicators

Number of indicators are as followed:

	Hazard	***Vulnerability***	***Exposure***
RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS	3	4	2
RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR	3	5	2
RISK OF ECONOMIC DAMAGE TO THE TOURISM SECTOR	4	3	2

Table 35: Primorje-Gorski Kotar indicators structure

Indicators were developed by external expert Regional energy agency Kvarner in cooperation with municipality representatives. *Difficulties were which data can be collected as a specific number, and which need to be collected from the surveys and then interpolated.*

Details of levels for each indicator are shown in table:

Territorial/regional level	6
District level (i.e. Joint SECAP target area)	9
Municipal/local level	13
Sub-municipal level	/

Table 36: Primorsko – Goranska County administrative level details

Both qualitative and quantitative indicators were used as shown in following table:

	Qualitative	**Quantitative**
Number of indicators	9	19

Table 37: Primorje-Gorski Kotar qualitative and quantitative indicators

An excel database with all the indicators and relevant metadata was created. GIS systems were not used in this phase.

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

Methods and instruments used for normalization, weighting and aggregation of data were used based on the tutorial provided by the Lead Partner.

The normalization, weighting and aggregation of data was performed by the external expert- Regional energy agency Kvarner and the results are displayed in the following table:

Risk component	Indicator	Normalized value
RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS		
Hazard	Warm weather period duration	0,45
	Drought period duration	0,7
	Average precipitation	0,3
Vulnerability	Household water needs	0,45
	Industry water needs	0,42
	Irrigation water needs	0,4
	Water supply network losses	0,35
Exposure	Population density	0,85
	Increase of number of water consumers during tourist season	0,80
RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR		
Hazard	Number of hot days	0,43
	Maximum air temperatures increase	0,5
	Warm period duration	0,45
Vulnerability	Population share>65 years	0,5
	GDP per capita (higher resilience)	0,1
	Share of air conditioning elements	0,4
	Number of the health practice units	0,9
	Distance from the hospital center	0,5
Exposure	Population per m^2 (population density)	0,85

	Increase in service users during the tourist season	0,80
RISK OF ECONOMIC DAMAGE TO THE TOURISM SECTOR		
Hazard	Number of hot days	0,43
	Air temperature increase	0,5
	Average precipitation	0,3
	Number of very humid days	0,25
Vulnerability	Share of tourism revenue	0,7
	Tourist offer variety	0,6
	Strategic goals of the tourism development	0,3
Exposure	Share of employees in the tourism sector activities	0,5
	Increase in number of tourists	0,8

Table 38: Primorje-Gorski Kotar indicator details

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1
Hazard	Dry period	Warm period duration	Number of days	0,45
	Period without precipitation	Drought period duration	Number of days	0,70
	Period without precipitation	Average precipitation	Milimetres (mm)	0,30
	High temperatures	Maximum air temperatures increase	Degrees Celsius (°C)	0,50
	Warm period	Warm period duration	Number of days	0,45
	Dry period	Number of hot days	Number of days	0,43
	Wet days	Number of very humid days	Number of days	0,25
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**
Vulnerability	Water use	Household water needs	Square metres (m3)	0,45
	Water use	Industry water needs	Square metres (m3)	0,42
	Water use	Irrigation water needs	Square metres (m3)	0,40
	Water use	Water supply network losses	Percentage (%)	0,35
	Population age	Population share>65 years	Percentage (%)	0,50
	Economic impact	GDP per capita (higher resilience)	Gross domestic product, GDP (in HRK)	0,10
	Using refrigeration systems	Share of air conditioning elements	Percentage (%)	0,40
	Health system	Number of the health practice units	Number of units	0,70
	Health system	Distance from the hospital center	Kilometers (km)	0,50
	Tourism sector	Share of tourism revenue	Percentage (%)	0,70
	Tourism sector	Tourist offer variety	Number of offers	0,60
	Tourism sector	Strategic goals of the tourism development	Number of goals	0,30
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**
Exposure	Population density	Population density	People per km2	0,85
	Arrival of tourists	Increase of number of water consumers during tourist season	Number of tourists	0,80
	Arrival of tourists	Increase in service users during the tourist season	Number of users	0,80
	Tourism sector	Share of employees in the tourism sector activities	Percentage (%)	0,50

Area target 1: Primorje - Gorski Kotar County

Table 39: Primorje – Gorski Kotar County list of all indicators and indicator values

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard			
Example	*0,48*	*1*	
Exposure			
Example	*0,41*	*1*	*0,57*
Vulnerability			
Example	*0,83*	*1*	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard			
Example	*0,46*	*1*	
Exposure			
Example	*0,44*	*1*	*0,58*
Vulnerability			
Example	*0,83*	*1*	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURISM SECTOR			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	**Weighting factors**	**RISK**
Hazard			
Example	*0,37*	*1*	
Exposure			
Example	*0,53*	*1*	*0,52*
Vulnerability			
Example	*0,65*	*1*	

Table 40: Primorje – Gorski Kotar County final risk values by impact chain and target area

M8-Presenting the outcomes of your risk assessment

In the following table there are shown the results of final risk assessment, for each of sector.

RISK	**WATTER SUPPLY**	**HEALTH**	**TOURISM**
Numerical	0,57	0,58	0,52
Descriptive	intermediate	intermediate	intermediate

Table 41: Primorje-Gorski Kotar risk assessment results

Although the risks are estimated as intermediate, further activities are necessary to improve all risk components, to reduce sensitivity and exposure and to increase adaptability.

2.7 [PP7] SPLIT - DALMATIA COUNTY

Summary

The Risk and Vulnerability assessment analysis was coordinated by PP7 Split – Dalmatia County with a consortium SENSUM ltd./Umium Ltd. as the technical supervisor/consultant and contractor. The process of the assessment started in December 2019 and was completed in March 2020.

Groups of stakeholders and key actors involved included the following:

- Agency for Payments in Agriculture, Fisheries and Rural Development (*Agencija za plaćanja u poljoprivredi, ribarstvu i ruralnom razvoju*),
- State's Bureau of Statistics (*Državni zavod za statistiku*),
- Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture (*Uprava za stručnu podršku razvoju poljoprivrede i ribarstva Ministarstva poljoprivrede*),
- Institute for Physical Planning of Split – Dalmatia County (*Zavod za prostorno uređenje Splitsko-dalmatinske županije*),
- Institute of Public Health of the Split – Dalmatia County (*Zavod za javno zdravstvo Splitsko-dalmatinske županije*),
- Split – Dalmatia County Tourist Board (*Turistička zajednica Splitsko-dalmatinske županije*),
- Ministry of Environment and Energy (Ministarstvo zaštite okoliša i energetike),
- State Hydrometeorological Institute, Meteorological Research and Development Division (*Državni hidrometeorološki zavod, Sektor za meteorološka istraživanja i razvoj, Odjel za klimatsko modeliranje, praćenje klimatskih promjena i biometeorologiju*)
- All municipalities and cities of island Brač (Sutivan, Supetar, Milna, Bol, Nerežišća, Postira, Pućišća, Selca)

The impact chains developed include:

- Risk of damage to agricultural sector due to extensive drought periods,
- Risk of increasing interventions related to heat waves in health sector,
- Risk of damage to water supply sector due to extensive drought periods and
- Risk of economic damage to the tourist sector due to extensive precipitation and/or very high temperatures

No additional difficulties were reported during the assessment development. The results of the assessment process carried out for the agriculture, health, water supply, tourism, fisheries and coastal sectors, include simulations of the future climate. These indicate an increase in air temperature, number

of hot days, hot nights and an extension of the duration of warm periods in the target area, while in the precipitation domain, the results indicate in general increase of precipitation and increase of very rainy days while the duration of drought periods is expected to either be prolonged or shortened (depends on the climate model).

The fisheries and coastal sectors are assumed to have the same level of vulnerability estimated at national level. The level of data availability for these sectors indicates the need for further targeted research and improvements in the availability of information itself.

Although the overall risks were assessed as intermediate, further activities are needed to improve the condition of all risk components, i.e. to reduce sensitivity and exposure and to increase adaptability. One of the most important stakeholders in this adaptation process are certainly the local and regional self-government units, whose strategic and development plans for climate change adaptation require increasing attention.

M1-Preparing the risk assessment

The context area consisting from the administrative units of City of Supetar as well as municipalities Sutivan, Bol, Milna, Selca, Nerežišća, Postira and Pučišća was identified and confirmed at the beginning months of the project. The M1 module was developed jointly with the local stakeholders who actively participated in the process and provided the necessary data for the assessment as requested by the contractor and coordinator. Already in December 2019, a stakeholder meeting was organized and held in Nerežišće on island Brač. The Technical consultant presented the assessment to be done, the methodology, data needed and discusses important issues with the stakeholders. This is considered as one the most important steps not only in the risk assessment preparation phase but overall.

The main stakeholders included the target area administrative units of City of Supetar as well as municipalities Sutivan, Bol, Milna, Selca, Nerežišća, Postira and Pučišća. In addition to the latter, other stakeholders were also contacted in order to provide data for the assessment. Other stakeholders were the Agency for Payments in Agriculture, Fisheries and Rural Development (*Agencija za plaćanja u poljoprivredi, ribarstvu i ruralnom razvoju*), Bureau of Statistics (*Državni zavod za statistiku*), Croatian Agricultural Agency (*Hrvatska poljoprivredna agencija*), Croatian Chamber of Commerce (*Hrvatska Gospodarska Komora*), Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture (*Uprava za stručnu podršku razvoju poljoprivrede i ribarstva Ministarstva poljoprivrede*), Institute for Physical Planning of Split-Dalmatia County (*Zavod za prostorno uređenje Splitsko-dalmatinske županije*), Institute of Public Health of the Split-Dalmatia County (*Zavod za javno zdravstvo Splitsko-dalmatinske županije*), Local Action Group LAG Brač (*Lokalna akcijska grupa LAG Brač*), Brač Water supply Ltd. (V*odovod Brač d.o.o.*), Split-Dalmatia County Tourist Board (*Turistička zajednica*

Splitsko-dalmatinske županije), Ministry of Environment and Energy (*Ministarstvo zaštite okoliša i energetike*), State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service (*Državni hidrometeorološki zavod, Sektor za meteorološka istraživanja i razvoj, Služba za klimatološka istraživanja i primijenjenu klimatologiju*), Institute for Tourism (*Institut za turizam*), Institute for Adriatic cultures and karst melioration (*Institut za jadranske kulture I melioraciju krša*), Centre for integral development of middle Adriatic islands – CERADO Ltd)(*Centar za integralni razvoj srednjodalmatinskih otoka - CERADO d.o.o.*). The stakeholders involved were very cooperative, so no difficulties regarding stakeholder involvement was noted.

M2-Developing impact chains

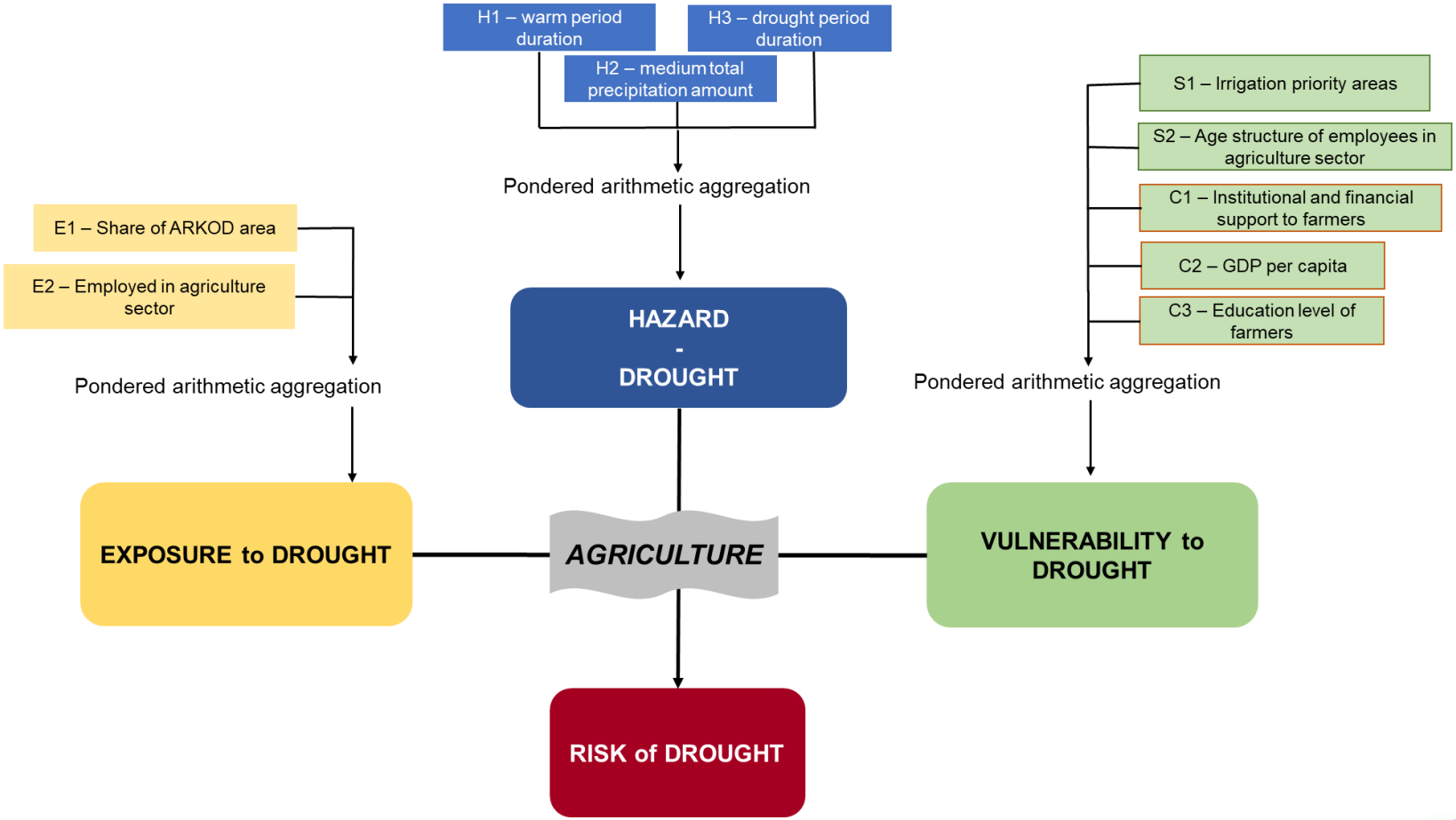
The hazards chosen for the assessment include extreme drought events, heat waves, increase in average temperatures and extreme precipitation as the events with the highest probability for occurrence and the greatest factors for potential influence related to climate changes.

The identified and developed impact chains include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat waves in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. All listed impact chains were finalized and included in the assessment. The impact chains were developed by the external consultant – consortium SENSUM ltd/Umium Ltd.

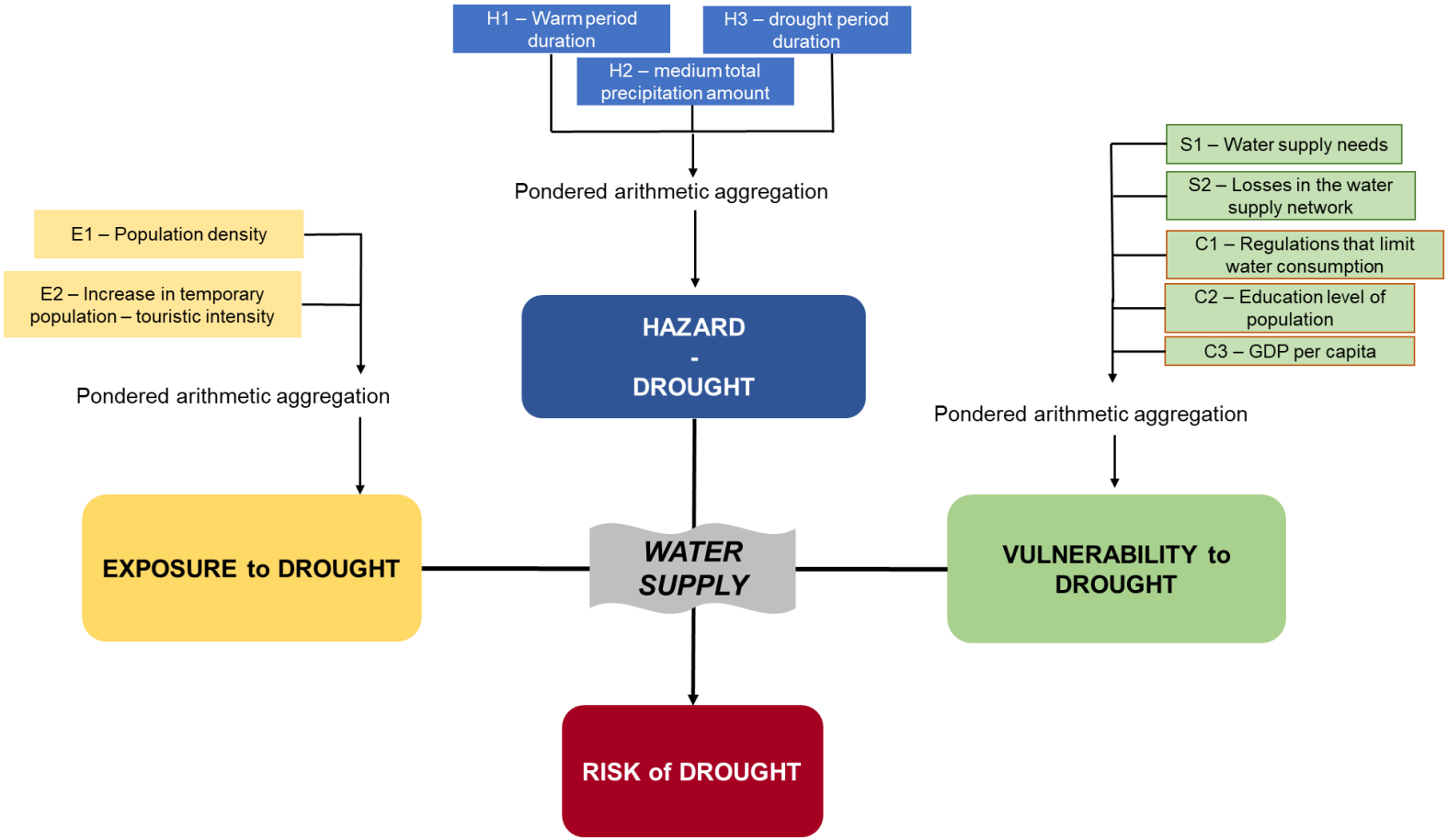
The data used to develop the impact chains included data taken from the Agency for Payments in Agriculture, Fisheries and Rural Development (*Farmers' Register_agricultural economy no.2018_31.12.2018.; ARKOD number and area display by settlements and type of agricultural land use_31_12_2018.*), Institute of Public Health of the Split – Dalmatia County (*2017 Health Statistics Report for Split – Dalmatia County*), Split – Dalmatia County Water Supply (*Water Supply Plan of the Split – Dalmatia County*), Split – Dalmatia County Tourist Board (*Tourist arrivals and overnights in Split – Dalmatia from 2009-2018*), Croatian Chamber of Commerce (*Estimation of population increase in tourist season, 2018.*), Institute for Physical Planning of Split – Dalmatia County (*County Spatial Plan),* Spatial Plans of all municipalities and the City of Supetar, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (*The Vulnerability Sourcebook, Risk Supplement to the Vulnerability Sourcebook, 2017.),* State Hydrometeorological Institute, Meteorological Research and Development Division (*Results of regional climate modelling for the area of island of Brač, 2020*), Ministry of Environment and Energy (*Climate Change Adaptation Strategy in Republic of Croatia up to 2040 period with a 2070 projection – draft version*), *Rural Development Program of the Republic of Croatia for the period 2014 – 2020*, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture – consulting packages, Central Bureau of Statistics (*2011 Population Census*), Croatian Agricultural Agency (*Livestock number on 31-12-2019*), Local Action Group LAG Brač (*Local Development Strategy of LAG Brač 2014-*

2020), Institute for tourism (*Tourism capacity study for Split-Dalmatia County, 2018; Tourism Master Plan 2017 with the strategic and operative marketing plan, 2018*), Institute for Adriatic cultures and karst melioration (*Irrigation Plan for the Split – Dalmatia County, 2006*), Croatian Waters Ltd (*Water Supply plan for the Split – Dalmatia County, 2008), Split – Dalmatia County Fire and Technological Explosion Risk Assessment (2018), Major accident risk assessment for Bol, Nerežišća, Pučišća, Supetar, Postira, Sutivan and Nerežišća, Development Plan for the City of Supetar, Strategic development programme for Selca, Postira, Pučišća, Sutivan and Bol municipality.*

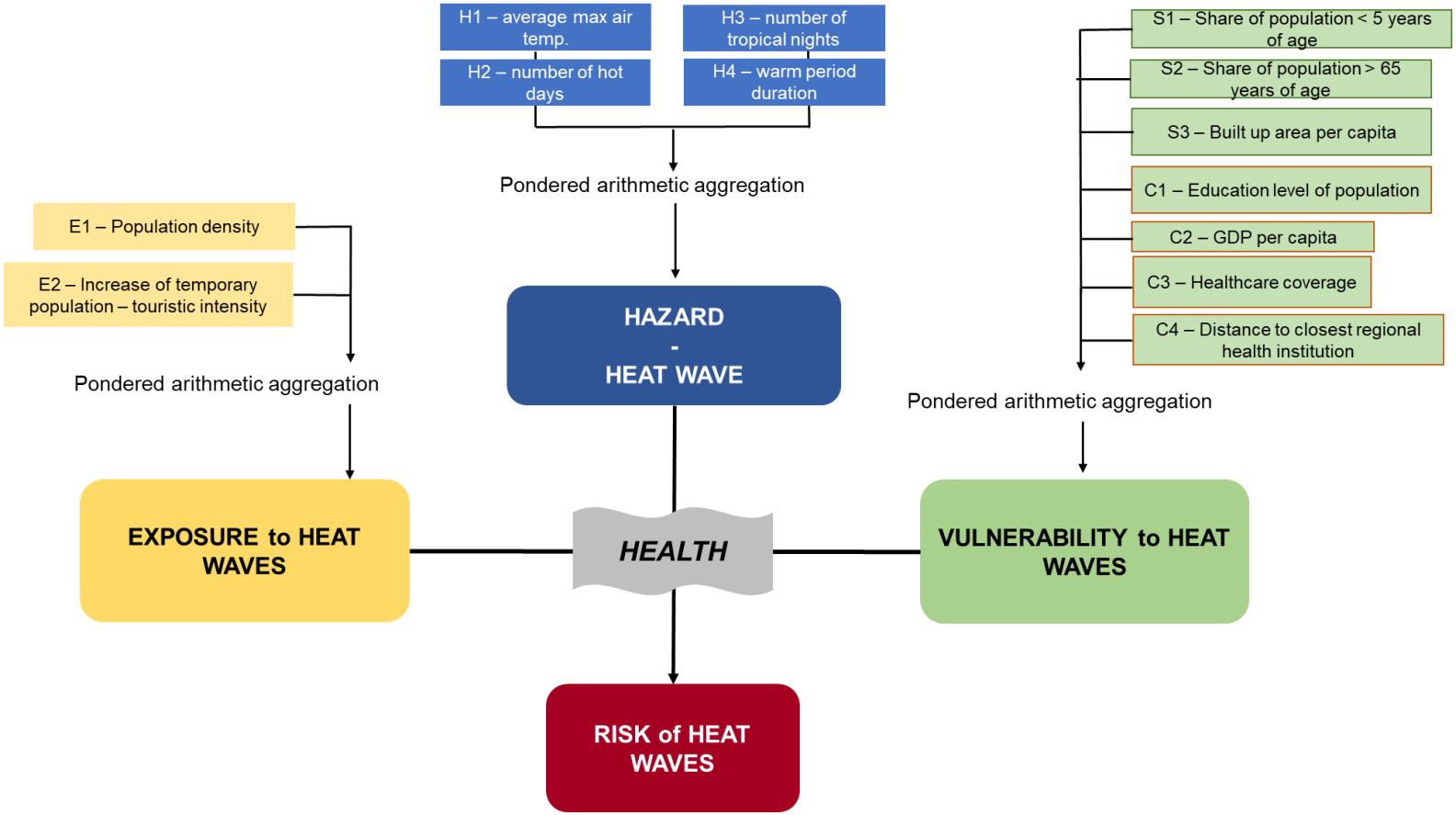
The methodology described in the tutorial, including the Vulnerability Sourcebook and the Risk Supplement files consistent with IPCC AR5 Synthesis Report, was used for the assessment. No difficulties were noted in the impact chain development process.



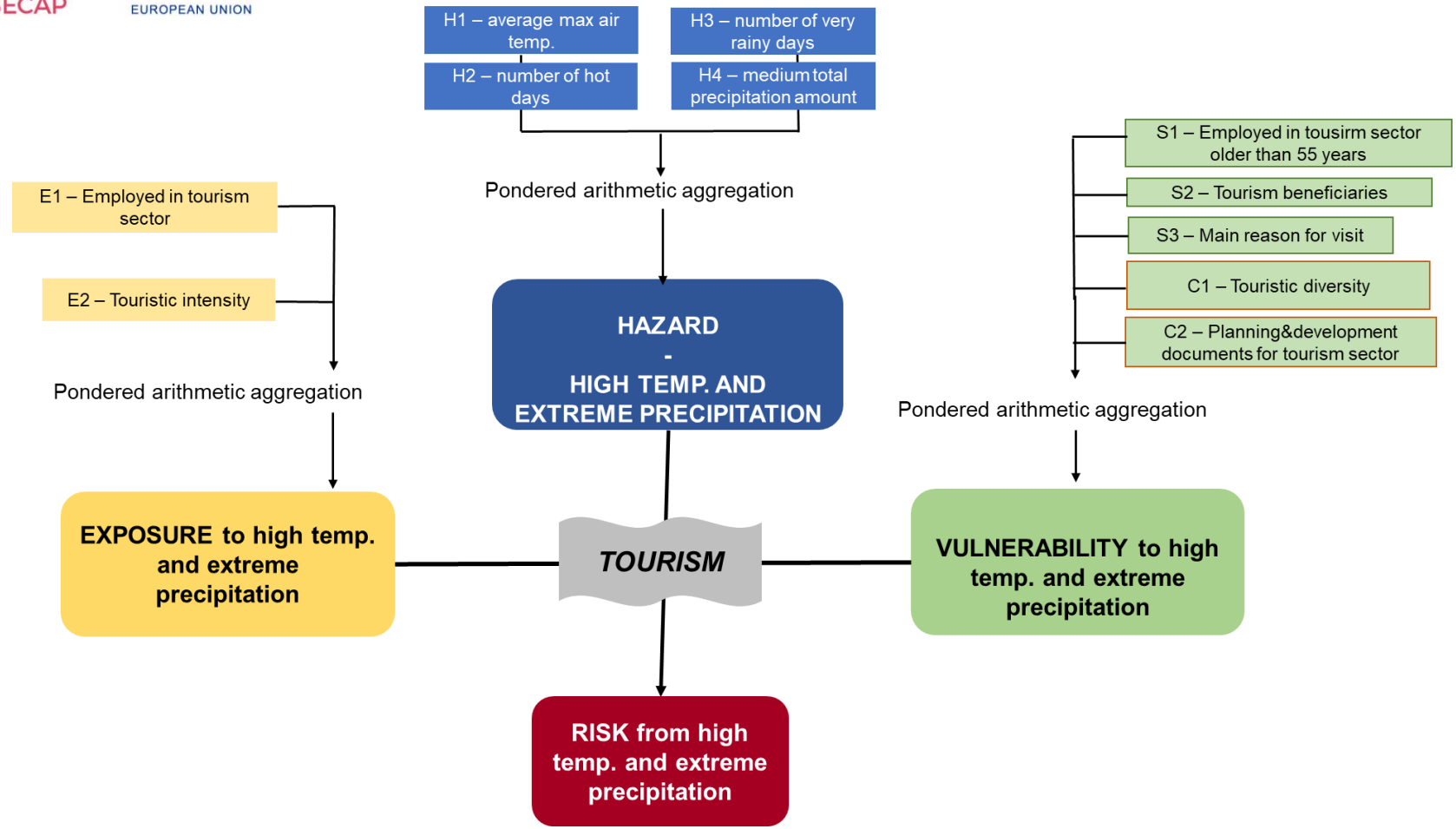
Picture 52: Split – Dalmatia County M2 Impact Chain – Risk of damage to agricultural sector



Picture 53: Split – Dalmatia County M2 Impact Chain – Risk of damage to water supply sector



Picture 54: Split – Dalmatia County M2 Impact Chain – Risk of damage to health sector



Picture 55: Split – Dalmatia County M2 Impact Chain – Risk of damage to tourism sector

M3-Identifying and selecting indicators, M4-Data acquisition and management

Regarding the climate change factors in the listed impact chains of M3 module, Risk of damage to agricultural sector due to extensive drought periods includes 11 indicators, Risk of increasing interventions related to heat waves in health sector includes 13 identified and selected indicators, Risk of damage to water supply sector due to extensive drought periods includes 10 identified and selected indicators and Risk of economic damage to the tourist sector includes 11 identified and selected indicators. There is a minimum of 1 indicator per each risk component (hazard, vulnerability, exposure).

The indicators were identified and selected by the external consultant - consortium SENSUM ltd./Umium ltd. Efforts were made to express indicators qualitatively which was achieved for the vast majority of them. Only for fisheries and coastal management were the indicators defined in a qualitative manner due to data unavailability. Identified indicators were presented, discussed and agreed upon with the stakeholders during the first stakeholder meeting held in December 2019 on island Brač. An excel database with all the indicators was created.

Data acquisition was performed by the technical consultant - consortium SENSUM ltd./Umium ltd and the Split Dalmatia County which also put high efforts in this phase of risk assessment. Considering this is one of the most important phases, the level of cooperation between the technical consultant and the County was in its peak. A special meeting, dedicated to data collection and management, was organized in Split in February 2020 where external consultant and the County representatives discussed the topic and most efficient steps to execute this phase of RVA.

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

Normalization, weighting and aggregating indicators and risk components was performed by the external consultant, following defined project guidelines. The normalization of data was done with min-max method for metric and 5 class evaluation schemes for categorical indicator values. The aggregated risk based on the provided data was presented with GIS mapping for each target area.

Component	Factor	Indicators	Measurement Unit	Normalised Indicator value for Target Area 1	Normalised Indicator value for Target Area 2	Normalised Indicator value for Target Area 3	Normalised Indicator value for Target Area 4	Normalised Indicator value for Target Area 5	Normalised Indicator value for Target Area 6	Normalised Indicator value for Target Area 7	Normalised Indicator value for Target Area 8
Hazard	Warm period duration	Warm spell duration index (WSDI) - annual or seasonal count of days with at least 6 consecutive days when the daily maximum T exceeds the 90th percentile for the calendar day in the reference period	days	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
	Medium total precipitation amount		mm	0,51	0,51	0,51	0,51	0,51	0,51	0,51	0,51
	Drought period duration	Consecutive dry days - consecutive days receiving less than 1 mm of precipitation	days	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30
	Medium maximum daily air temperature		°C	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39
	Hot days	Number of days with a maximum daily temperature > 30°C	days	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37
	Tropical nights	Number of days with a minimum air temperature > 20°C	days	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38
	Very rainy days	Number of days with daily precipitaion amount ≥ 20 mm	days	0,57	0,57	0,57	0,57	0,57	0,57	0,57	0,57
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalised Indicator value for Target Area 2**	**Normalised Indicator value for Target Area 3**	**Normalised Indicator value for Target Area 4**	**Normalised Indicator value for Target Area 5**	**Normalised Indicator value for Target Area 6**	**Normalised Indicator value for Target Area 7**	**Normalised Indicator value for Target Area 8**
Exposure	ARKOD area	Share of ARKOD area in the total city/municipiality area	%	0,10	0,65	0,20	0,20	0,30	0,20	0,60	0,40
	Employed in agriculture	Share of employees in agriculture in total number of employees	%	0,65	0,20	0,20	0,65	0,50	0,70	0,65	0,10
	Livestock production intensity	Livestock unit per hectare of UAA	Livestock unit / hectare of UAA	0,40	0,10	0,10	0,25	0,25	1,00	0,40	0,40
	Population density	inhabitants / km2	inhabitants / km2	0,18	0,67	0,33	0,14	0,17	0,05	0,16	0,10
	Increase of temporary population - touristic intensity	Number of touristic nights spent per capita	Number of touristic nights spent / capita	0,80	0,65	0,90	0,60	0,50	0,20	0,60	0,20
	Employed in tourism sector	Share of employees in tourist sector in total number of employees	%	0,70	0,90	1,00	0,80	0,60	0,55	0,75	0,60
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalised Indicator value for Target Area 2**	**Normalised Indicator value for Target Area 3**	**Normalised Indicator value for Target Area 4**	**Normalised Indicator value for Target Area 5**	**Normalised Indicator value for Target Area 6**	**Normalised Indicator value for Target Area 7**	**Normalised Indicator value for Target Area 8**
Vulnerability	Irrigation priority areas	County specific areas prioritized for irrigation		0,70	0,00	0,40	0,70	0,40	0,70	0,70	0,40
	Age structure of employees in agriculture sector	Share of agriculture employees older than 65 years in total number of employees in this sector	%	0,85	0,55	0,50	0,80	0,55	0,85	0,80	0,50
	Livestock structure	Share of sensitive livestock categories in total livestock	%	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
	Institutional and financial support to farmers	Existence of institutions providing e.g. guidance, support, advice, financial incentives etc.		0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
	GDP per capita	GDP per capita	GDP per capita	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
	Education level	Share of farmers with minimally high school education level in total number of family farm owners	%	0,57	0,55	0,49	0,43	0,54	0,42	0,47	0,39
	Young population	Share of population < 5 years of age	%	0,39	0,34	0,39	0,23	0,29	0,36	0,39	0,39
	Elderly population	Share of population > 65 years of age	%	0,87	0,70	0,57	1,00	0,96	0,91	0,87	0,73
	Built up area	Share of built up area in total area	%	0,50	0,65	0,40	0,30	0,35	0,30	0,50	0,30
	Education level	Population share with minimally high school education level	%	0,37	0,39	0,38	0,50	0,47	0,57	0,49	0,51
	Healthcare coverage	Number of inhabitants per each healthcare practitioner (general medicine professional)	Number of inhabitants per each healthcare practitioner	0,50	0,70	0,50	0,50	0,50	1,00	0,50	0,70
	Distance to closest regional health institution	Time period needed to reach the regional healthcare institution either by plane or boat	minutes	0,60	0,30	0,90	0,30	0,30	0,30	0,60	0,50
	Water supply needs	Comparison of water supply needs and available water resources		0,71	0,71	0,71	0,71	0,71	0,71	0,71	0,71
	Losses in the water supply network	% of losses	%	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
	Regulations that limit water consumption	Existence of specific regulation on county level		0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65
	Employed in tourism sector older than 55 years	Share of employees in tourist sector older than 55 years of age in total number of employees	%	0,19	0,29	0,29	0,10	0,11	0,14	0,58	0,15
	Tourism beneficiaries	Share of population benefiting from tourism	%	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,82
	Main reason for visits	E.g. sun&sea, yachting, nature etc.		0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85
	Touristic diversity	Existence and range of diverse activities offered to tourists apart from sea and sun (bicycling, hunting, health tourism, wine&dine, festivals etc.)		0,80	0,50	0,40	0,80	0,90	0,90	0,80	0,90
	Planning and development documents for the tourism sector	Perception of climate change issues in the documents		0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60

Area target 1: Island Brač - Sutivan; Area target 2: Island Brač - Supetar; Area target 3: Island Brač - Bol; Area target 4: Island Brač - Milna; Area target 5: Island Brač - Selca; Area target 6: Island Brač - Nerežišće; Area target 7: Island Brač - Postira; Area target 8: Island Brač - Pučišća

Table 42: Split – Dalmatia County list of all indicators and indicator values

Impact chain - Impact of drought on agriculture sector - Island Brač - Sutivan			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,38	1	0,47
Vulnerability			
	0,60	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Supetar			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,32	1	0,39
Vulnerability			
	0,43	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Bol			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,17	1	0,35
Vulnerability			
	0,48	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Milna			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,37	1	0,45
Vulnerability			
	0,57	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Selca			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,35	1	0,42
Vulnerability			
	0,50	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Nerežišće			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,63	1	0,54
Vulnerability			
	0,58	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Postira			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,55	1	0,51
Vulnerability			
	0,58	1	

Impact chain - Impact of drought on agriculture sector - Island Brač - Pučišća			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,30	1	0,39
Vulnerability			
	0,47	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Sutivan			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,49	1	0,48
Vulnerability			
	0,56	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Supetar			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,66	1	0,53
Vulnerability			
	0,54	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Bol			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,62	1	0,52
Vulnerability			
	0,55	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Milna			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,37	1	0,42
Vulnerability			
	0,50	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Selca			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,34	1	0,41
Vulnerability			
	0,51	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Nerežišće			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,13	1	0,37
Vulnerability			
	0,59	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Postira			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,38	1	0,45
Vulnerability			
	0,58	1	

Impact chain - Impact of heat waves on health sector - Island Brač - Pučišća			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,40	1	
Exposure			
	0,15	1	0,36
Vulnerability			
	0,55	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Sutivan			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,49	1	0,50
Vulnerability			
	0,61	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Supetar			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,66	1	0,56
Vulnerability			
	0,61	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Bol			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,62	1	0,55
Vulnerability			
	0,61	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Milna			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,37	1	0,47
Vulnerability			
	0,63	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Selca			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,34	1	0,46
Vulnerability			
	0,63	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Nerežišće			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,13	1	0,39
Vulnerability			
	0,65	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Postira			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,38	1	0,47
Vulnerability			
	0,63	1	

Impact chain - Impact of drought on water supply sector - Island Brač - Pučišća			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	
Exposure			
	0,15	1	0,40
Vulnerability			
	0,63	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector- Island Brač - Sutivan			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,75	1	0,62
Vulnerability			
	0,65	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Supetar			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,78	1	0,61
Vulnerability			
	0,61	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Bol			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,95	1	0,66
Vulnerability			
	0,59	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Milna			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,70	1	0,59
Vulnerability			
	0,63	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Selca			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,55	1	0,55
Vulnerability			
	0,66	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Nerežišće			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,38	1	0,49
Vulnerability			
	0,66	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Postira			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,68	1	0,62
Vulnerability			
	0,73	1	

Impact chain - Impact of extreme temperatures and precipitation on tourism sector - Island Brač - Pučišća			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	
Exposure			
	0,40	1	0,50
Vulnerability			
	0,66	1	

Table 43: Split – Dalmatia County final risk values by impact chain and target area

M8-Presenting the outcomes of your risk assessment

The data from the risk assessment was presented through excel methodology modules, GIS maps and finally through the deliverable summary report. The finalized document is available on the official web page of the Split-Dalmatia County and is freely accessible at all times.

2.8 [PP8] Municipality of Vela Luka

Summary

The Risk and Vulnerability assessment analysis was coordinated by PP8 – Municipality of Vela Luka with the support of SENSUM ltd. as the technical supervisor and contractor. The process of the assessment started in December 2019.

The impact chains developed include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat strokes in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of increasing temperatures and precipitation to the tourist sector. No additional difficulties were reported during the assessment development. The results of the assessment process, carried out for the agriculture, health, water supply, tourism, fisheries and coastal sectors, include simulations of the future climate which indicate an increase in air temperature, number of hot days, hot nights and an extension of the duration of warm periods in the target area, while in the precipitation domain, the results depend on the climate model (possible increase or decrease of precipitation, prolongation or shortening of the duration of dry periods). The fisheries and coastal sectors are assumed to have the same level of vulnerability estimated at national level. The level of data availability for these sectors indicates the need for further targeted research and improvements in the availability of information itself.

Although the overall risks were assessed as intermediate, further activities are needed to improve the condition of all risk components, i.e. to reduce sensitivity and exposure and to increase adaptability. One of the most important stakeholders in this adaptation process are certainly the local and regional self-government units, who's strategic and development plans for climate change adaptation require increasing attention.

M1-Preparing the risk assessment

For PP8 – Municipality of Vela Luka the assessment and the project activities includes area of the Island of Korčula. The Island of Korčula is governed by 5 local self-sustained municipalities as follows: City of Korčula, Municipality of Lumbarda, Municipality of Smokvica, Municipality of Blato, and Municipality of Vela Luka. All together they cover area of 279 km2 with 16.182 inhabitant (58 inhabitants per km2). All municipalities share same characteristics and a logical reason for definition of the target area.

The basis for the analysis was done by describing the context and characteristics of territory (localization of the area, climate macro-region, island specifics, natural resources, etc.), social framework (population and structure, density, main economic activities, etc).

Local and territorial plans were considered while preparing the assessment starting from existing SEAPs. All municipalities except for the Municipality of Lumbarda have developed individual SEAP signed in 2013. The development of those SEAPs was an action within the project MESHARTILITY under EU program Intelligent Energy Europe (IEE/11/984/SI2.615951). In addition, local strategic and action documents were included such as municipalities' development strategies, LAG and FLAG development strategies and else. On regional level, the reference documents were Energy Efficiency Action Plan for Dubrovnik and Neretva County for the period 2017.-2019., and Dubrovnik and Neretva Development Strategy for the period until 2020. In addition, other regional and national available plans are included already analysed in previous project action.

Local stakeholders were involved in the process of development of RVA together with the regional and national ones. Local stakeholders are island's municipalities and its services and agencies, local action groups (LAG and FLAG) and NGOs. Previously, at the beginning of the project implementation the Municipality of Vela Luka gathered all other municipalities from the Island to sign the cooperation agreement on climate change actions within the project. The agreement proves commitment of the key stakeholders to the actions proposed. All municipalities appoint coordinator as a support to the project partners' team. Other stakeholders from local as well as regional level are institutions with power to take actions and the ones that support those actions (environment protection institution, spatial planning departments, etc.).

Due to the limited human resources necessary to deliver the activity result, Municipality of Vela Luka contracted technical external expert. Following the public procurement procedure, the contract was signed with SENSUM llc. SENSUM had proven their knowledge and experiences in development of RVAs and similar actions.

All stakeholders are introduced to the actions prior its implementation. As soon as the technical external expert was contracted, we all started to develop RVA. It was planned to design the draft material based on the available information and data. For that purpose, Municipality of Vela Luka purchased the package of data and information from the State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service (DHMZ). After the first draft it was planned to actively involve stakeholders by sharing the draft materials and the findings for open discussion, corrections, and comments. Due to COVID-19 closeout and limited operations of the stakeholders, the consultations part of the development of RVA is missing in its full potential. Instead, all stakeholders are noticed about the actions and the draft documents are shared. Up until now, there were no comments on the developed material and the RVA development process is concluded.

M2-Developing impact chains

There were 4 hazards chosen to be examined. The decision for each chosen hazard was based on the results of the analysis and the comparison within available strategic, planning, and scientific documents. The list of the hazards is as follows:

- Extreme drought,
- Forest fire,
- Extreme heat,
- Extreme precipitation.

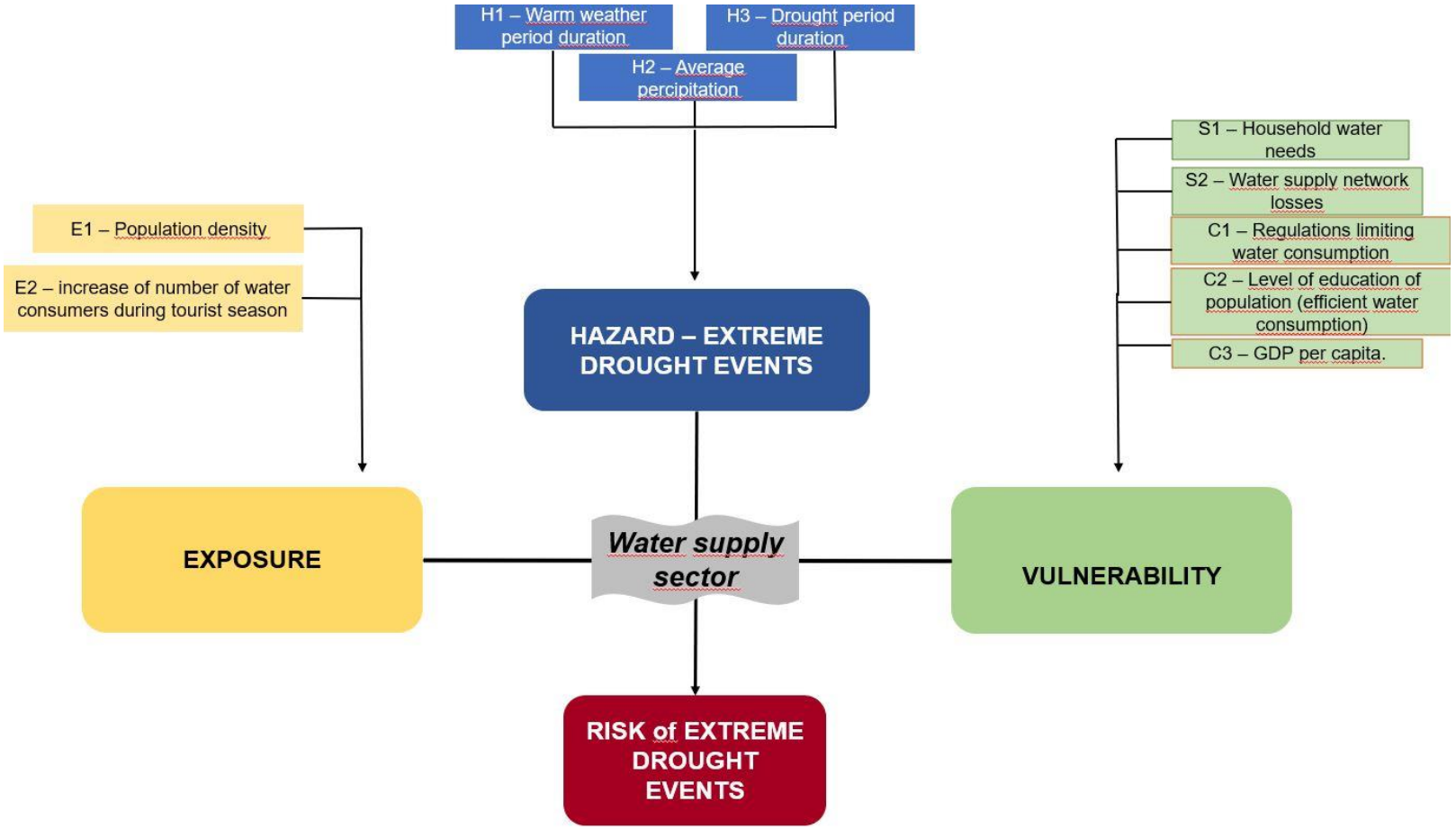
The assessment lead to impact chains identified and developed by external experts from SENSUM ltd., finalized and included in the assessment:

- Impact of extreme drought on agriculture,
- Impact of extreme drought on water supply system,
- Impact of forest fire on wild forest,
- Impact of extreme heat on public health,
- Impact of high temperatures and extreme precipitation on tourism.

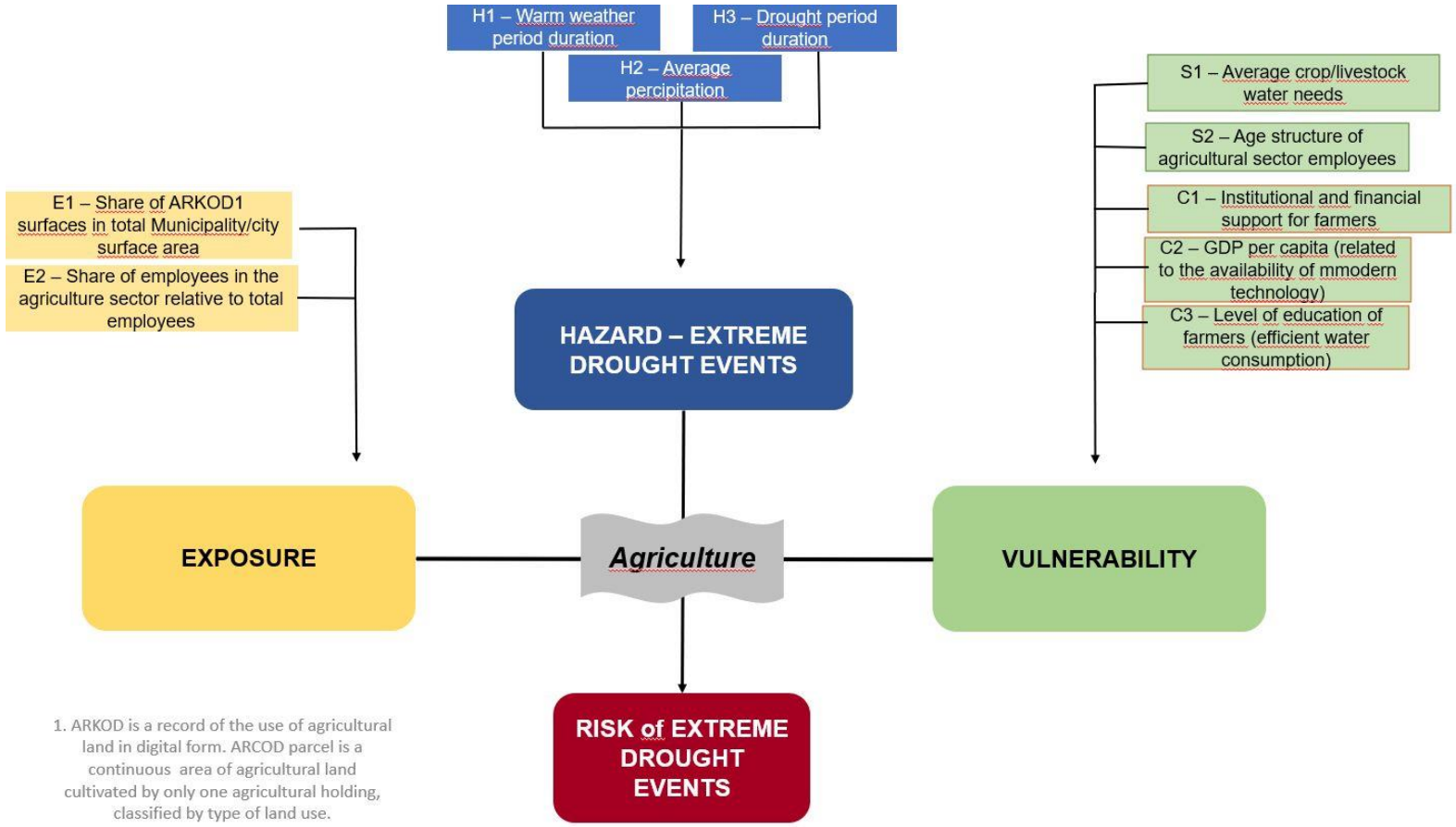
Those events are with the highest probability to occur and with the greatest factors for potential impact on climate changes. Out of the listed impact chains until now the events of extreme drought in the agriculture sector and water supply sector are defined. Other impact chains and the sectors will be delivered in addition as a part of the final version of the Assessment. The material is developed by the key expert contracted for the climate changes adoption issues SENSUM ltd. together with the rest of the core team and key stakeholders.

The data used to develop the impact chains included data taken from the Agency for Payments in Agriculture, Fisheries and Rural Development (Farmers' Register agricultural economy for 2019.; ARKOD number and area display by settlements and type of agricultural land use for 2019.), Croatian Chamber of Commerce (Estimation of population increase in tourist season, 2019.), Ministry of Environment and Energy (Climate Change Adaptation Strategy Draft in Republic of Croatia up to 2040 period with a 2070 projection), Rural Development Program of the Republic of Croatia for the period 2014 – 2020, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture – consulting packages, Central Bureau of Statistics (2011 Population Census), Dubrovnik and Neretva County (Guidelines for Risk Assessment for Dubrovnik and Neretva County, 2017.), (County Development Strategy 2016.-2020.), (Tourism Development Strategy 2012.-2022.), (Human Resources Development Strategy 2016.-2020.), (Environmental Protection Program for Dubrovnik and Neretva County).

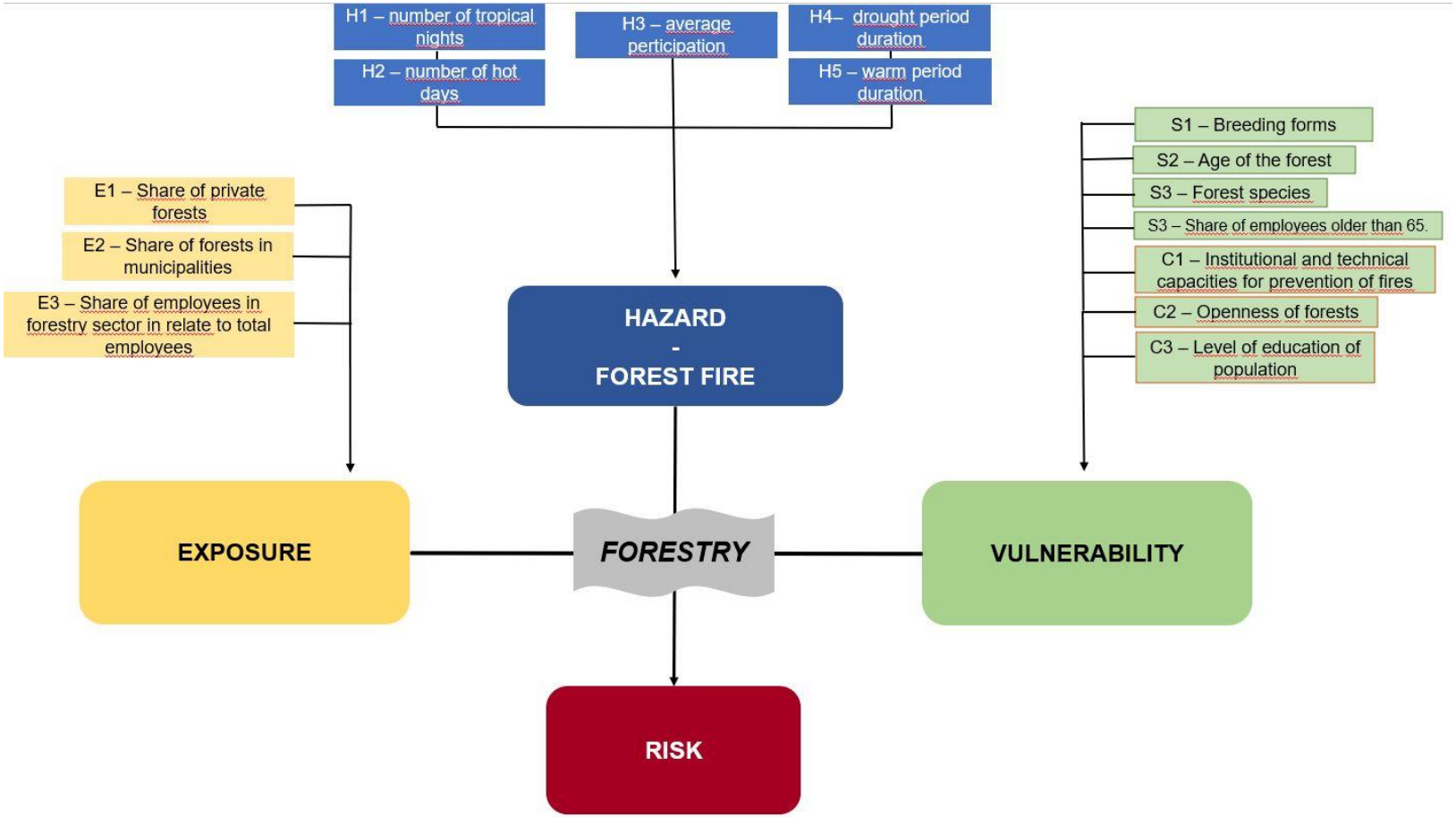
The methodology described in the tutorial, including the Vulnerability Sourcebook and the Risk Supplement files consistent with IPCC AR5 Synthesis Report, was used for the assessment. No difficulties were noted in the impact chain development process.



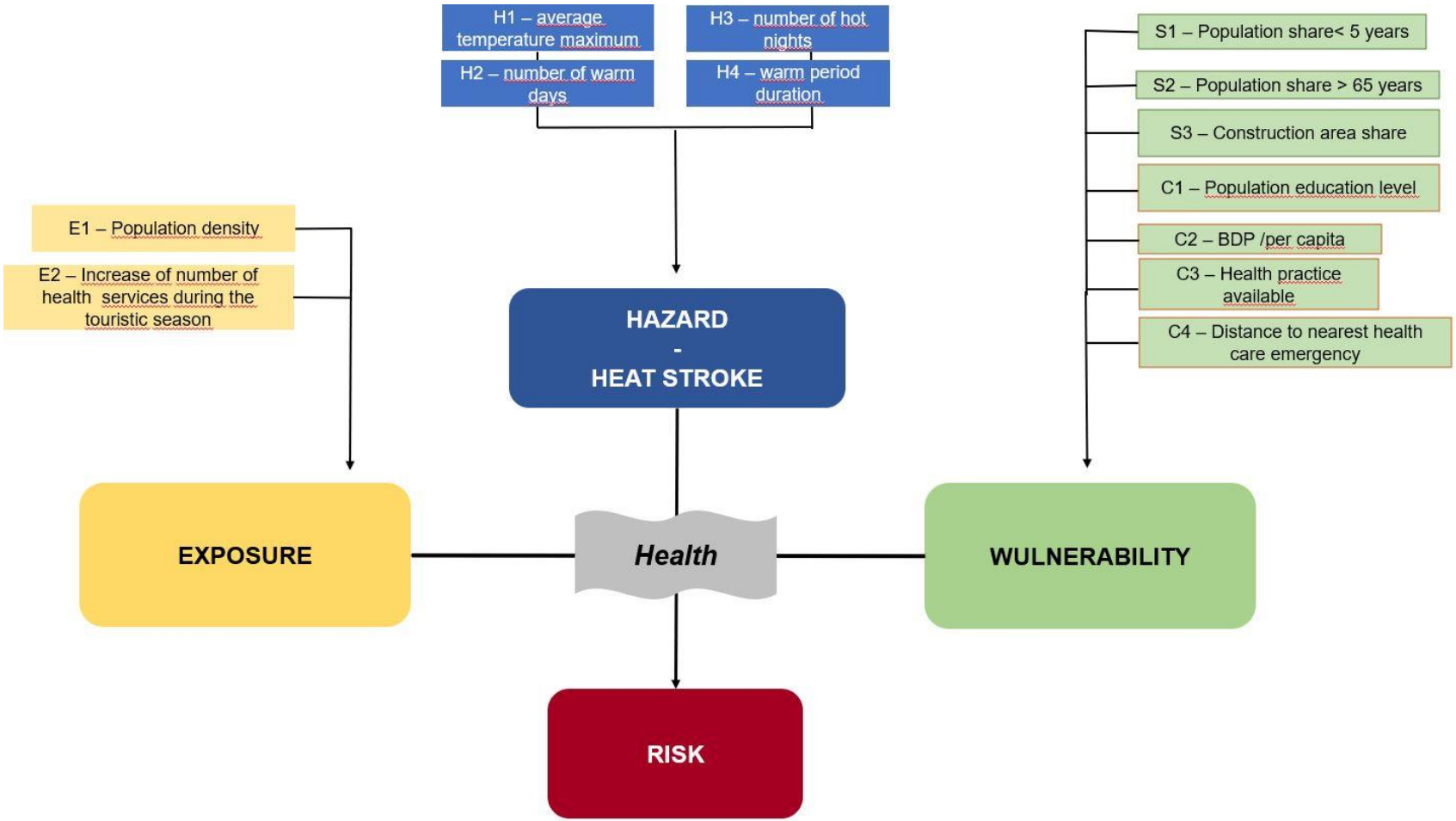
Picture 56: Vela Luka M2 impact chain – Risk of extreme drought events in water supply sector



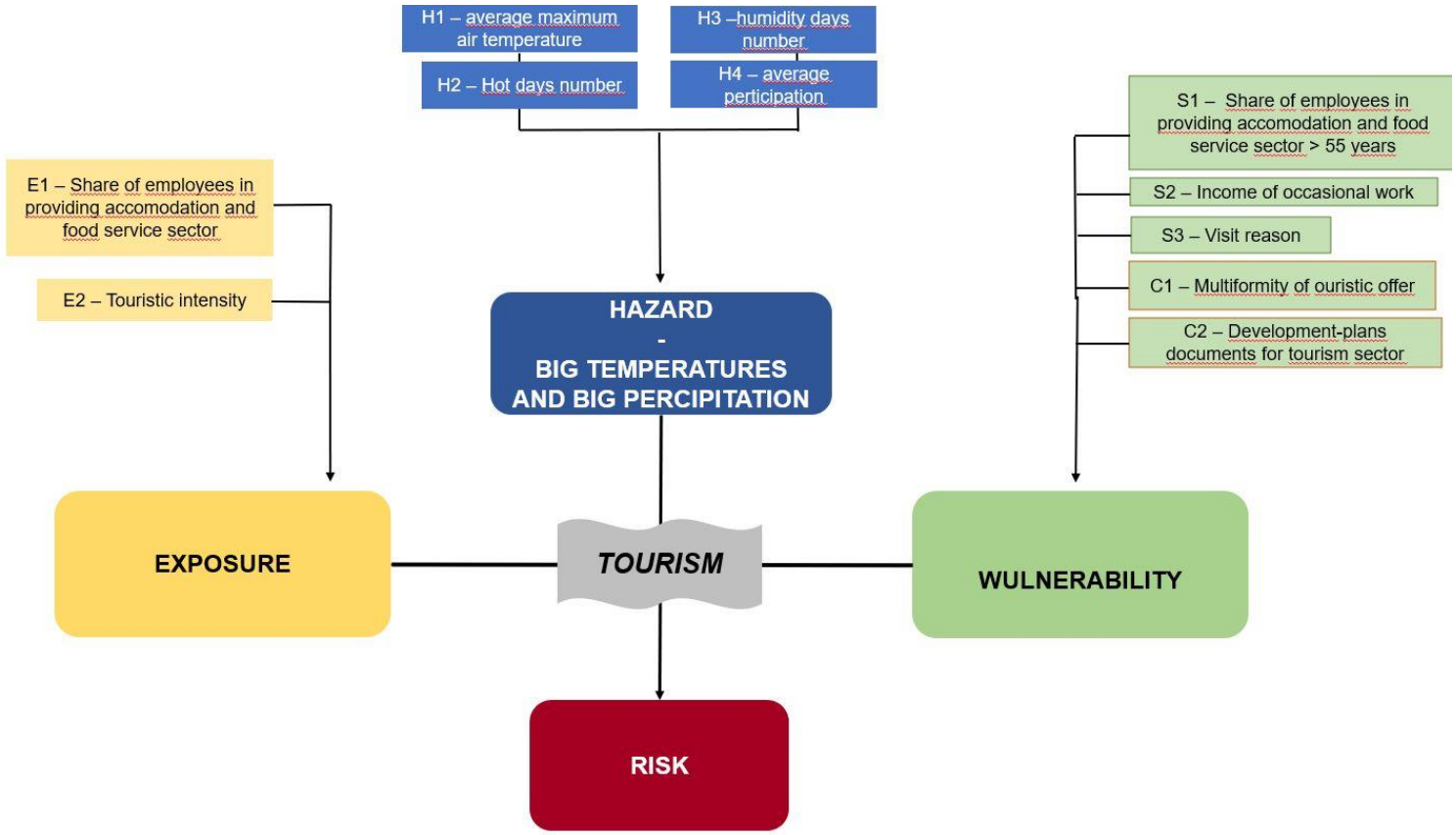
Picture 57: Vela Luka M2 impact chain – Risk of extreme drought events in agriculture sector



Picture 58: Vela Luka M2 impact chain – Risk of forest fire events in forestry sector



Picture 59: Vela Luka M2 impact chain – Risk of heat stroke events in health sector



Picture 60: Vela Luka M2 impact chain – Risk of high temperatures and precipitation events in tourism sector

M3-Identifying and selecting indicators, M4-Data acquisition and management

The following indicators were selected:

Component	Indicator
Hazard	H1 – Warm weather period duration
	H2 – Average precipitation
	H3 – Drought period duration
	H4 – Number of tropical nights
	H5 – Number of hot days
	H6 – Average temperature maximum
	H7 – Number of hot nights
	H8 – Number of humidity days
Exposure	E1 – Population density
	E2 – Increase of number of water consumers during tourist season
	E3 – Share of ARKOD1 surfaces in total area
	E4 – Share of employees in the agriculture sector relative to total employees
	E5 – Share of private forests
	E6 – Share of forests in municipalities
	E7 – Share of employees in forestry sector in relate to total employees
	E8 – Increase of number of health services during the touristic season
	E9 – Touristic intensity
Vulnerability	S1 – Household water needs
	S2 – Water supply network loses
	S3 – Average crop/livestock water needs

	S4 – Age structure of agricultural sector employees
	S5 – Breeding forms
	S6 – Age of the forest
	S7 – Forest species
	S8 – Share of employees other than 65.
	S9 – population share < 5 years
	S10 – Population share > 65 years
	S11 – Construction area share
	S12 – Share of employees in providing accommodation and food service sector > 55 years
	S13 – Income of occasional work
	S14 – Visit reasons
	C1 – Regulations limiting water consumption
	C2 – Level of education of population (efficient water consumption)
	C3 – GDP per capita
	C4 – GDP per capita (related to the availability of modern technology)
	C5 – Level of education of farmers (efficient water consumption)
	C6 – Institutional and technical capacities for prevention of fires
	C7 – Health practice available
	C8 – Distance to nearest health care emergency
	C9 – Multiformity of touristic offer
	C10 – Development plans documents for tourism sector

Table 44: Vela Luka list of selected indicators

The indicators were developed by the external consultant SENSUM ltd. in cooperation with the project team from Municipality of Vela Luka. Due to COVID-19 situation the other key stakeholders could not fully participate the process of development and defining the indicators.

M5-Normalization of indicator data, M6-Weighting and aggregating of indicators, M7-Aggregating risk components to risk

The instruments used for weighting and aggregating data. The normalization of data was done with min-max method for metric and 5 class evaluation schemes for categorical indicator values. The normalization, weighting and aggregation of data was performed by the external consultant and later adjusted for the provided excel tables by the coordinator. The aggregated risk based on the provided data will be presented with GIS mapping for each target area.

Component	Factor	Indicators	Measurement Unit	Normalized Indicator value for Target Area 1	Normalized Indicator value for Target Area 2	Normalized Indicator value for Target Area 3	Normalized Indicator value for Target Area 4	Normalized Indicator value for Target Area 5
Hazard	Warm weather period duration	Number of days in periods of at least 6 consecutive days with a maximum air temperature> 90th percentile of the maximum air temperature for a calendar day in the reference period	°C	0,30	0,30	0,30	0,30	0,30
	Drought period duration	Sequence of days with daily precipitation of Rd <1 mm	mm	0,60	0,60	0,60	0,60	0,60
	Mean total average precipitation	Number of days with daily rainfall ≥ 20 mm and consecutive days with daily rainfall Rd <1 mm	mm	0,39	0,39	0,39	0,39	0,39
	Number of hot days	Number of days with a maximum daily air temperature of ≥ 30 ° C	°C	0,40	0,36	0,36	0,36	0,36
	Number of hot nights	Number of days with a minimum air temperature > 20 ° C	°C	0,50	0,48	0,48	0,48	0,48
	Mean maximum daily air temperature	Number of days with maximum daily air temperature ≥ 30 ° C + number of days with minimum air temperature > 20 ° C	°C	0,43	0,40	0,40	0,40	0,40
	Change in number of hot days	Number of days with a maximum daily air temperature of ≥ 30 ° C	°C	0,36	0,40	0,40	0,40	0,40
	Rainy days >20mm R20		mm	0,50	0,50	0,50	0,50	0,50
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalized Indicator value for Target Area 2**	**Normalized Indicator value for Target Area 3**	**Normalized Indicator value for Target Area 4**	**Normalized Indicator value for Target Area 5**
Exposure	Share of ARKOD surfaces in total Municipality/City surface area	% of agricultural land in the total area of the selected area	km^2	0,10	0,40	0,40	0,10	0,40
	Share of employees in the agriculture sector relative to total employees	% of workers in the agriculture, forestry and fisheries sectors	Number of persons employed	0,65	0,70	0,60	0,70	0,85
	Share of private forests in total all forests	% of private land in the total area of the selected area	km^2	0,70	0,60	0,60	0,60	0,90
	Share of forests in the area of local self-government	Number of nights per capita	Number of overnight stays	0,90	0,60	0,60	0,55	0,70
	Share of employees in forestry	% of workers in the forestry sector	Number of persons employed	0,65	0,70	0,70	0,60	0,70
	Population density	Population per km2 in the selected area	Number of people/km^2	0,37	0,82	0,70	0,39	0,15
	Increase of number of water consumers during tourist season	Number of nights per capita	Number of overnight stays	0,55	0,70	0,40	0,40	0,50
	Increasing health service users during the tourist season	Number of nights per capita	Number of overnight stays	0,55	0,70	0,40	0,40	0,50
	Share of employees in tourism sector activities	% of employees in accommodation, food preparation and service activities	Number of persons employed	0,70	0,80	0,30	0,30	0,30
	Increase in number of tourists during tourist season	Number of nights per capita	Number of overnight stays	0,60	0,80	0,50	0,50	0,50
Component	**Factor**	**Indicator**	**Measurement Unit**	**Normalized Indicator value for Target Area 1**	**Normalized Indicator value for Target Area 2**	**Normalized Indicator value for Target Area 3**	**Normalized Indicator value for Target Area 4**	**Normalized Indicator value for Target Area 5**
Vulnerability	Institutional and financial support for agricultural workers	Measures of the Rural Development Program for Republic of Croatia for the 2014 - 2020 period	None (descriptive classes)	0,40	0,40	0,40	0,40	0,40
	Level of education	% with a minimum of secondary education	None (descriptive classes)	0,70	0,60	0,60	0,60	0,70
	Institutional and technical capacities for fire prevention, management and remediation		None (descriptive classes)	0,65	0,65	0,65	0,65	0,65
	Forest openness	% of forests in the area	km2	0,50	0,50	0,50	0,50	0,50
	Regulations restricting water consumption (for example, in summer - dry periods) or the adoption of provisions that promote water saving	Applicable regulations at nationaland regional level	None (descriptive classes)	0,65	0,65	0,65	0,65	0,65
	The amount of GDP per capita	GDP/Capita	HRK (Croatian Kuna); EUR (Euro)	0,50	0,50	0,50	0,50	0,50
	Health protection coverage - number of inhabitants / family medicine doctor	number of medicine workers in relation to number of inhabitants	Number of people	0,53	0,00	0,56	0,64	0,40
	Distance to largest regional healthcare facility	Number of minutes from the selected area to Pula General Hospital	Minutes	0,60	0,40	0,40	0,60	0,90
	Tourist offer variety	Amount of investment in diversification of tourist offer	None (descriptive classes)	0,70	0,80	0,70	0,80	0,80
	Planning and development documents for the tourism sector & climate	Number of strategic planning documents for tourism development that take climate change into account	m^3/year	0,75	0,75	0,75	0,75	0,75

Area target 1: Korčula; Area target 2: Lumbarda; Area target 3: Vela Luka; Area target 4: Blato; Area target 5: Smokovica

Table 45: Vela Luka list of all indicators and indicator values

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - City of Korčula			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,46
Exposure			
	0,38	1	
Vulnerability			
	0,60	1	

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Lumbarda			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,52
Exposure			
	0,55	1	
Vulnerability			
	0,59	1	

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Smokvica			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,55
Exposure			
	0,63	1	
Vulnerability			
	0,60	1	

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Blato			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,48
Exposure			
	0,40	1	
Vulnerability			
	0,63	1	

Impact chain - RISK OF DAMAGE TO AGRICULTURAL SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Vela Luka			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,50
Exposure			
	0,50	1	
Vulnerability			
	0,59	1	

Impact chain - RISK OF WILD FIRES IN FORESTRY SECTOR - City of Korčula			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	0,62
Exposure			
	0,75	1	
Vulnerability			
	0,70	1	

Impact chain - RISK OF WILD FIRES IN HEALTH FORESTRY SECTOR - Municipality of Lumbarda			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	0,59
Exposure			
	0,63	1	
Vulnerability			
	0,73	1	

Impact chain - RISK OF WILD FIRES IN HEALTH FORESTRY SECTOR - Municipality of Smokvica			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	0,58
Exposure			
	0,63	1	
Vulnerability			
	0,70	1	

Impact chain - RISK OF WILD FIRES IN HEALTH FORESTRY SECTOR - Municipality of Blato			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	0,63
Exposure			
	0,77	1	
Vulnerability			
	0,71	1	

Impact chain - RISK OF WILD FIRES IN HEALTH FORESTRY SECTOR - Municipality of Vela Luka			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,42	1	0,55
Exposure			
	0,57	1	
Vulnerability			
	0,69	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - City of Korčula			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,46
Exposure			
	0,46	1	
Vulnerability			
	0,51	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Lumbarda			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,57
Exposure			
	0,76	1	
Vulnerability			
	0,54	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Smokvica			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,42
Exposure			
	0,33	1	
Vulnerability			
	0,52	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Blato			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,44
Exposure			
	0,40	1	
Vulnerability			
	0,51	1	

Impact chain - RISK OF DAMAGE TO WATER SUPPLY SECTOR DUE TO EXTENSIVE DROUGHT PERIODS - Municipality of Vela Luka			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,41	1	0,49
Exposure			
	0,55	1	
Vulnerability			
	0,51	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - City of Korčula			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,39	1	0,47
Exposure			
	0,46	1	
Vulnerability			
	0,56	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Municipality of Lumbarda			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,39	1	0,54
Exposure			
	0,76	1	
Vulnerability			
	0,49	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Municipality of Smokvica			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,39	1	0,45
Exposure			
	0,33	1	
Vulnerability			
	0,65	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Municipality of Blato			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,39	1	0,46
Exposure			
	0,40	1	
Vulnerability			
	0,61	1	

Impact chain - RISK OF INCREASING INTERVENTIONS RELATED TO HEAT STROKES IN HEALTH SECTOR - Municipality of Vela Luka			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,39	1	0,51
Exposure			
	0,55	1	
Vulnerability			
	0,59	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - City of Korčula			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	0,62
Exposure			
	0,65	1	
Vulnerability			
	0,75	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Municipality of Lumbarda			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	0,68
Exposure			
	0,80	1	
Vulnerability			
	0,79	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Municipality of Smokvica			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	0,53
Exposure			
	0,40	1	
Vulnerability			
	0,71	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Municipality of Blato			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	0,52
Exposure			
	0,40	1	
Vulnerability			
	0,70	1	

Impact chain - RISK OF ECONOMIC DAMAGE TO THE TOURIST SECTOR - Municipality of Vela Luka			
Area target or sub Area target -RISK SCORE			
	Composite indicator (TOTAL)	Weighting factors	RISK
Hazard			
	0,46	1	0,50
Exposure			
	0,40	1	
Vulnerability			
	0,63	1	

Table 46: Vela Luka final risk values by impact chain and target are

M8-Presenting the outcomes of your risk assessment

It was planned to present the outcomes of the activity through the live workshops/presentation with possibility for open discussion, and in addition a small local event presenting the final outcome to decision makers, media and general public. The material will be distributed among the stakeholders prior the presentation in order to early engage and achieve active participation of the stakeholders during the presentation. The participants will have the opportunity to see report and all accompanied maps, diagrams, tables and chards, and other.

3 Comparation of risk and vulnerability

3.1 Introduction

In order to properly assess each step of the risk and vulnerability process, each module will be evaluated individually for all included partners. This approach will hopefully simplify the general analysis and find similarities to be extrapolated and compared in each category, which should enable a better understanding of the process and provide a useful outline to be used in future activities related to the same process.

3.2 M1 Preparing the risk assessment

The preparation of the risk assessment module is designed to show the initial preparation procedure of each partner for the risk assessment document. Based on the answers taken from the partners, it was possible to compare the similarities and differences of each partners' procedure.

The context area to be used in the project was identified and confirmed in the proposal for all partners. For IRENA, the administrative units of Brtonigla - Verteneglio municipality, Novigrad - Cittanova city and Buje - Buie city were identified and confirmed at the beginning months of the project. For San Benedetto del Tronto, the module for the target area consisting of 4 neighboring municipalities San Benedetto del Tronto, Grottammare, Cupra Marittima and Monteprandone was developed starting from the analysis of climate adaptation policies, plans, measures and funding sources performed to fill in the deliverable A3.2.1. Abruzzo region defined two areas, first one consisting of 4 Municipalities: Penne, Elice, Castilenti and Castiglione Messer Raimondo and the second one consisting of 5 Municipalities: Giulianova, Roseto degli Abruzzi, Pineto, Silvi and Mosciano S.Angelo. For both areas, the context areas have been extended as compared to the proposal. In particular, for area target 1, the municipalities of Elice, Castilenti and Penne were added; for area target 2, the municipality of Giulianova was added. The context area for the municipality of Pescara includes 6 neighboring municipalities: Pescara, Chieti, Montesilvano, Francavilla, Spoltore and San Giovanni Teatino. These cities and towns are part of the metropolitan area of the valley of Pescara river, and as San Benedetto del Tronto, their module was developed starting from the analysis of climate adaptation policies, plans, measures and funding sources performed to fill in the deliverable A3.2.1. The territory selected by SDEWES Centre was identified and confirmed at the beginning months of the project and includes City of Dubrovnik and municipalities of Konavle, Župa dubrovačka, Dubrovačko primorje and Ston. They are all parts of Dubrovnik-Neretva County, the most southern part of Croatia. Primorje – Gorski Kotar County's process of the assessment started in October 2019 and was completed in March 2020, and includes the municipalities of Opatija, Kastav, Čavle, Matulji and Viškovo. The context area for Split – Dalmatia County was confirmed at the beginning months of the project and consists from the administrative units of City of Supetar as well as municipalities Sutivan, Bol, Milna, Selca, Nerežišća, Postira and Pučišća. The process of the assessment for the municipality of Vela Luka started in December

2019 with gathering, organizing, and informing the key stakeholders about the actions to be conducted. The context area includes the the Island of Korčula, municipality of Vela Luka, municipality of Blato, municipality of Smokvica, municipality of Lumbarda and city of Korčula, which committed by signing the Cooperation Agreement at the very beginning of the project implementation. We can conclude that all the project partners have identified and confirmed their context areas from the proposal (although some areas were modified) and have selected adleast 3 territorial units to be used in the project. This ensured a safe and reliable start of the project and minimized any chance of delays related to context area definition.

Local or territorial plans that were already active and were considered while preparing the assessment include the following: for IRENA, the existing local/territorial plans during the preparation of the assessment included SEAP revisions and SECAPs done for several cities in Istrian County in the scope of project EMPOWERING (Horizon 2020), as well as parallel ongoing local and regional energy and climate strategies (for example Energy Efficiency Action Plan for Istrian County for the 2019. - 2021. period, Local development strategy for Central Istria for the 2014 - 2020. period, Istrian County Development Strategy until year 2020 etc.). For San Benedetto del Tronto, the most interesting local plan in terms of source of information were LL 1. Local development participatory strategy for the SOUTHERN MARCHE Fishery Local Action Group, LL3. Civil Defence Municipal Plans and LL6. Water services management plan “ATO 5”, while the most interesting territorial plans in terms of source of information were NL1. National Climate Change Adaptation Strategy and Plan, NL 3. Central Apennines’ Hydrographic District Management Plan, NL 4. Central Apennines’ Hydrographic District Flood Management Plan, RL 3. Regional Water Safeguard Plan and RL 4. Integrated Coastal Zones Management Plan. For Abruzzo region, individual Sustainable energy action plans from the municipalities involved in the project were used. Concerning the territorial plans, all regional plans were taken into consideration, but the most considered ones were the regional climate profile, Regional Plan for the coastal defence, Regional plan for the forecasting, prevention and active fight against forest fires, Hydrogeological plan (PAI), Flood defence plan (PSDA) and Management Plan of flood risk (PGRA). At municipal level, the emergency municipal plans were considered. Both anthropic and natural risks are dealt with in the emergency planning. For the Municipality of Pescara, the most useful local documents, plan and database in terms of source of information were the Italian National Institute of Statistics (ISTAT), the Consorzio di Bonifica Centro, Guidelines for the Regional Climate Change Adaptation Plan (Abruzzo Region), the Statistical office of the Abruzzo Region, the Regional Environmental Protection Agency (ARTA), the Hydrographic Office of the Abruzzo Region, Ministry of Economy and Finance (MEF) and General Accounting Office of the State (RGS). SDEWES Centre used existing local SEAPs for municipalities and SECAP for City of Dubrovnik during the preparation of the risk assessment. The local and county development strategies were also taken in consideration. Primorje – Gorski Kotar County considered the local level Sustainable Energy Action Plans (SEAPs) as well as parallel ongoing regional energy and climate strategies (for example Primorje-Gorski Kotar County Development Strategy for the 2016-2020 period,, Air protection program, ozone layer, climate change and climate adoption in Primorje-Gorski Kotar County for the 2019-2022 period, Primorje-Gorski Kotar County Energy Efficiency Action Plan for the 2017-2019 period). The municipality of Vela Luka considered local and territorial plans while preparing the assessment starting from existing SEAPs. All municipalities except for the Municipality of

Lumbarda have developed individual SEAP signed in 2013. In addition, local strategic and action documents were included such as municipalities' development strategies and LAG and FLAG development strategies. On regional level, the reference documents included Energy Efficiency Action Plan for Dubrovnik and Neretva County for the period 2017.-2019. and Dubrovnik and Neretva Development Strategy for the period until 2020. In addition, other already analysed regional and national available plans included in previous project actions were used.

Therefore, each partner used previous relevant documentation related to the topic of climate change in order to become better accustomed to the topic and to build a reliable framework for future project activities.

For IRENA, the M1 module was developed jointly with the local stakeholders who actively participated in the process and provided the necessary data for the assessment as requested by the contractor and coordinator. The main stakeholders included the target area administrative units of Brtonigla - Verteneglio municipality, Novigrad - Cittanova city and Buje - Buie city, but other stakeholders were also contacted in order to provide data for the assessment. Other stakeholders were the Agency for Payments in Agriculture, Fisheries and Rural Development, Bureau of Statistics, Croatian Chamber of Commerce, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture, Fund for Development of Agriculture and Agritourism of Istria, In Konzalting ltd., Institute for Physical Planning of Istria County, Institute of Public Health of the County of Istria, Istrian County Water supply, Istrian County Tourist Board, Jaić Consulting ltd., Ministry of Environment and Energy, State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service and Urbanex ltd.

For San Benedetto del Tronto, stakeholders' consultation was limited to the representatives of the technical office in the four municipalities included in the target area. They were asked to fill in a questionnaire to identify which climate change risks are perceived as the most relevant in each context in order to decide which ones deserve to be further developed as impact chains.

Impacts were considered as the most easy-to-understand starting point to collect stakeholders' perception about climate risks, for this reason the questionnaire was structured as a list of impacts prepared starting from the list of potential impacts per sector contained in the National Plan Climate Change adaptation. Municipal staff was asked to rank such climate change related impacts according to a 1-5 scoring system and to provide a justification referring to past events, specific information sources, local news and including spatial details whenever possible. Abruzzo region involved around 50 stakeholders in the selection of risks and development of impact chains based on their competence or interest in the selected sectors. Stakeholders were provided with questionnaires developed by CRAS, the technical consultant of the municipalities of San Benedetto, while impacts were considered as the easier-to-understand starting point to collect stakeholders' perception about climate risks.

The questionnaire was sent by mail and had to be filled specifically for each target area. Additional information from local administrator of the municipalities of the target areas were collected during the meeting in Pescara on the 3rd October 2019. Municipality of Pescara involved representatives of the municipal technical offices, the Abruzzo Region Hydrographic Office, the Abruzzo Agency for the Protection of the Environment, citizens' associations, local trade associations, local action group and nonprofit organizations in information and data collection activities. The main stakeholders for SDEWES Centre included the target area local city and municipal governments, but other stakeholders such as local and county development agencies, local municipal companies and State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service were also contacted in order to provide data for the assessment. The M1 module for Primorje Gorski Kotar County was developed jointly with the representatives of municipalities who participated in the process by providing the necessary data for the assessment as requested by the external experts. Groups of stakeholders and key actors involved include City of Kastav, City of Opatija, Municipality of Čavle, Municipality of Matulji, Municipality of Viškovo, Croatian Bureau of Statistics and Croatian Meteorological and Hydrological Service, Meteorological Research and Development Sector. The main Split – Dalmatia County stakeholders included the target area administrative units of City of Supetar as well as municipalities Sutivan, Bol, Milna, Selca, Nerežišća, Postira and Pučišća. In addition to the latter, other various stakeholders were also contacted in order to provide data for the assessment (Agency for Payments in Agriculture, Fisheries and Rural Development, Bureau of Statistics, Croatian Agricultural Agency, Croatian Chamber of Commerce, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture, Institute for Physical Planning of Split-Dalmatia County, Institute of Public Health of the Split-Dalmatia County, Local Action Group LAG Brač, Brač Water supply Ltd., Split-Dalmatia County Tourist, Ministry of Environment and Energy, State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service, Institute for Tourism, Institute for Adriatic cultures and karst melioration, Centre for integral development of middle Adriatic islands – CERADO Ltd). The municipality of Vela Luka included local stakeholders who actively participated in the process and provided the necessary data for the assessment as requested by the core team. The stakeholders included outside of the target area were the Agency for Payments in Agriculture, Fisheries and Rural Development, Bureau of Statistics, Croatian Chamber of Commerce,, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture, Institute for Physical Planning of Dubrovnik and Neretva County, Institute of Public Health of the Dubrovnik and Neretva County, NPKLM County Water supply, Blato County Water supply, Dubrovnik and Neretva County Tourist Board, Tourist Board of Vela Luka, Tourist Board of Blato, Tourist Board of Smokvica, Tourist Board of Lumbarda and Tourist Board of Korčula, Ministry of Environment and Energy and State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service. Therefore, all the project partners included various local actors and stakeholders in the risk assessment activities based on their interest, role and importance and closely collaborated with them during the making of the risk assessment.

Regarding the difficulties related with involving the key actors in the project activities, some partners reported some minor issues, but no major difficulties were reported for this module. San Benedetto Del Tronto had some delays in collecting the questionnaires from the stakeholders and to obtain detailed justifications, Abruzzo region difficulties referred to the delay with respect to the deadline in the receipt of some questionnaires and consequently, the processing of data to identify the significant impacts for the target areas. The municipality of Pescara had delays in this phase because of difficulties involving the questionnaires' feedback from stakeholders.

3.3 M2 Developing impact chains

For the development of risk assessment impact chains, the partners had to select certain climate risk hazards. Climatic hazards are linked to the occurrence of extreme weather events, which in turn are related to a number of physical variables such as temperature, precipitation, or wind. Extreme weather events can lead to well-known natural hazards such as river and coastal floods, droughts, forest fires, heat and cold waves, windstorms; these climatic hazards have a direct impact on people's well-being and on a number of economic sectors such as agriculture, energy, transport, health, tourism, etc. Other effects of climate change can lead to hazards that are not directly linked to extreme weather but more to longer-term processes such as sea level rise, which will directly affect coastal cities. The hazards chosen for the assessment by IRENA include extreme drought events, heat stroke hazard, increase in average temperatures and extreme precipitation as the events with the highest probability for occurrence and the greatest factors for potential influence related to climate changes. The considered hazards for San Benedetto del Tronto include concentration of precipitation in few intense events, decrease in average precipitation and increase in average temperatures, which were selected as the most relevant climate change phenomena according to the perception of the involved stakeholders. The climate hazards for Abruzzo region were identified as critical states in order to facilitate the risk assessment and the preliminary list of climate hazards was taken from the Covenant of Mayors template. The climate hazards chosen for the assessment are intense precipitation days, precipitation, rise in water level, consecutive dry days and summer days. The selected indicators are a small part of the indicators used for the Italian National Adaptation Plan, for the study of recent changes in the frequency and intensity of the extremes of temperature and precipitation in Italy. Assessment of the impacts of climate change requires updated estimates of trends of both average values and extremes of temperature and precipitation. All the data was provided by the Functional center and hydrographic office of Abruzzo Region (Centro Funzionale e Ufficio Idrografico Regione Abruzzo). For municipality of Pescara, the hazardous events chosen for the initial assessment are extreme precipitation events, heavy rainfall and hailstorms, heat waves, whirlwinds and sandstorm events and drought. The hazards chosen for the assessment for SDEWES Centre include extreme drought events, heat stroke hazard, increase in average temperatures and extreme precipitation as the events with the highest probability for occurrence and the greatest factors for potential influence related to climate changes. For Primorje – Gorski Kotar County, hazards were chosen based on three direct climate impacts in Croatia: the increase of temperature, precipitation level decrease and extreme weather

conditions (storms, heat stroke and droughts). Split – Dalmatia County selected extreme drought events, heat waves, increase in average temperatures and extreme precipitation as the events with the highest probability for occurrence and the greatest factors for potential influence related to climate changes. For municipality of Vela Luka, the selected hazards include extreme drought events, heat stroke hazards, increase in average temperatures and extreme precipitation.

For IRENA, the identified and developed impact chains include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat strokes in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. All listed impact chains were finalized and included in the assessment. San Benedetto del Tronto developed four impact chains related to the following risk: Risk of damage to urban structures and people from consequences of extreme weather events, Risk of economic damage for the tourist sector, Risk of economic damage for the farming sector and Risk of losing residual coastal/wetland habitats due to erosion and alteration of ecosystems. At a later stage, it was decided to focus on the first risk which was considered the broadest and able to converge the interests of the four municipalities. As the original impact chain was too complex to be developed in analytical terms, it was split it into 4 different impact chains describing the impacts consequent to the same climate hazard namely “the concentration of precipitation in few very intense events accompanied by high winds”: Risk of river flooding, Risk of urban flooding, Risk of coastal flooding and Risk of landslide.

For Abruzzo region, the identification of the impact chains involved two phases: a preliminary phase in which the impacts for the two target areas were identified and a phase of improvement in which the impact chains were "adapted" in order to be populated by indicators for any factor of hazard, exposure and vulnerability. For each target area, four impact chains were identified and developed and all have been finalized and included in the assessment. The selected impact chains for Abruzzo included Risk of damage to economic activities, infrastructures and people due to flooding and hailstorms, Risk for human health due to heat waves, Risks for economic activities, transports and citizens’ safety due to whirlwinds and sandstorm events and Risk of for human health, agriculture and energy production due to drought. For municipality of Pescara, four impact chain were developed related to the following risks: Risk of damage to economic activities, infrastructures and people due to flooding and hailstorms, Risk for human health due to heat waves, Risk for transports, economic activities and people due to whirlwinds and sandstorm events and Risk for energy production and agriculture due to drought. The identified and developed impact chains for SDEWES Centre include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat strokes in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. All listed impact chains were finalized and included in the assessment. For Primorje – Gorski Kotar County, the developed impact chains include Risk of damage to water supply sector due to extensive draught periods, Risk of increasing interventions related to heat strokes in health sector, Risk of economic damage in tourism sector due to extreme weather conditions.

The identified and developed impact chains for Split – Dalmatia County include Risk of damage to agricultural sector due to extensive drought periods, Risk of increasing interventions related to heat waves in health sector, Risk of damage to water supply sector due to extensive drought periods and Risk of economic damage to the tourist sector. All listed impact chains were finalized and included in the assessment. For the municipality of Vela Luka, the assessment lead to the following impact chains: Impact of extreme drought on agriculture, Impact of extreme drought on water supply system, Impact of forest fire on wild forests, Impact of extreme heat on public health and Impact of high temperatures and extreme precipitation on tourism.

Regarding the responsibility of the impact chains development, the impact chains for IRENA were developed by the external consultant SENSUM ltd, while the M2 module was developed in cooperation with the coordinator IRENA. The impact chains for San Benedetto del Tronto were developed by external consultants, supported by the staff of the Municipality of San Benedetto del Tronto. The impact chains were developed based on the results of the stakeholders' consultation for what concerns the selection of most relevant impacts; on existing planning tools for what concerns the description of phenomena and the cause-effect relationships; on past researches for what concern the climate baseline and projections. The M2 module was only partially developed jointly with local key actors/stakeholders: impact chains were developed also basing on the information gathered through the questionnaires mentioned at the previous module. The impact chains of Abruzzo region were developed by external consultants of Abruzzo Region in close collaboration with the Abruzzo Region. The impact chains for the Municipality of Pescara was developed by external consultants, supported also by the staff of the Municipality of Pescara. For SDEWES Centre, the impact chains were developed by the external consultant Energo-data d.o.o and other members of the consortium, while the M2 module was developed in cooperation with the project partner SDEWES Centre. The impact chains for Primorje – Gorski Kotar County were developed by external expert Regional energy agency Kvarner in cooperation with municipality representatives. The impact chains for Split – Dalmatia County were developed by the external consultant – consortium SENSUM ltd/Umium Ltd., and the impact chains for the municipality of Vela Luka were identified and developed by external experts from SENSUM ltd.

Regarding the data used to develop the impact chains, for IRENA the data included information taken from the Agency for Payments in Agriculture, Fisheries and Rural Development, Fund for Development of Agriculture and Agritourism of Istria, Institute of Public Health of the County of Istria, Istrian County Water supply, Istrian County Tourism Master Plan for 2015 - 2025 period, Istrian County Tourist Board, Croatian Chamber of Commerce, Institute for Physical Planning of Istria County, Major accident risk assessment for the Municipality of Brtonigla - Verteneglio, 2018., In Konzalting ltd, HDC ltd, Urbis 72 ltd, Jaić Consulting ltd, Official Gazette of the Municipality of Brtonigla - Verteneglio, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (The Vulnerability Sourcebook, Risk Supplement to the Vulnerability Sourcebook, 2017.), State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service, Ministry of Environment and Energy, Rural Development Program of the Republic of Croatia for the period 2014 – 2020, Central Bureau of Statistics, Istrian County Development strategy until 2020, IGH ltd., Istrian County major accident risk assessment, 2018., Major accident risk assessment – Buje City, 2018., Buje – Buie City development

strategic plan 2016 – 2020, Urbanex ltd., City of Buje-Buie Spatial plan Major accident risk assessment - Novigrad – Cittanova City, 2018., Overall development program for the City of Novigrad - Cittanova 2015-2020., TENEO and Official Gazette of the City of Novigrad – Cittanova. The impact chain developed for San Benedetto del Tronto were based on the results of the stakeholders' consultation for what concerns the selection of most relevant impacts; on existing planning tools for what concerns the description of phenomena and the cause-effect relationships; on past researches for what concern the climate baseline and projections. In order to develop the impact chains for Abruzzo region, the main used sources refer to the methodology "Vulnerability and risk assessment" proposed by the lead partner, the questionnaires from the stakeholders for the identification of the relevant sectors, the additional information collected during the meeting in Pescara on 3rd October 2019, the National Plan for Adaptation to climate change, for the identification of intermediate impacts and vulnerabilities of the individual socio-economic and environmental sectors, the Vulnerability Sourcebook Concept and guidelines for standardized vulnerability assessments and Risk-Supplement-to-the-Vulnerability-Sourcebook, by GIZ and Risk and vulnerability assessment – part 2 of Guidebook "How to develop a Sustainable Energy and Climate Action Plan" by JRC. The sources used by the municipality of Pescara include the Italian National Institute of Statistics (ISTAT), The Consorzio di Bonifica Centro, guidelines for the Regional Climate Change Adaptation Plan (Abruzzo Region), the Statistical office of the Abruzzo Region, the Regional Environmental Protection Agency (ARTA), the Hydrographic Office of the Abruzzo Region, Ministry of Economy and Finance (MEF) and General Accounting Office of the State (RGS). SDEWES Centre used data from the Agency for Payments in Agriculture, Fisheries and Rural Development, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (The Vulnerability Sourcebook, Risk Supplement to the Vulnerability Sourcebook, 2017.), State Hydrometeorological Institute, Meteorological Research and Development Division, Climatological Research and Applied Climatology Service, Ministry of Environment and Energy, Rural Development Program of the Republic of Croatia for the period 2014 - 2020, Central Bureau of Statistics, city, municipal and county development strategies and strategic documents, tourist board data, local and county economic data as well as previous version of SECAP for City of Dubrovnik and SEAP for other municipalities. *For Primorje – Gorski Kotar Couty, most of data was collected by Croatian Bureau of Statistics and Croatian Meteorological and Hydrological Service, Ministry of Environment and Energy, The institute for physical planning of Primorje-Gorski Kotar County, Teaching Institute of Public Health, Croatian Chamber of Commerce, utility companies for water supply and Primorje-Gorski Kotar County - Department of tourism*, entrepreneurship and rural development. The data used to develop the impact chains for Split – Dalmatia County included information taken from the Agency for Payments in Agriculture, Fisheries and Rural Development, Institute of Public Health of the Split – Dalmatia County, Split – Dalmatia County Water, Split – Dalmatia County Tourist Board, Croatian Chamber of Commerce, Institute for Physical Planning of Split – Dalmatia County, Spatial Plans of all municipalities and the City of Supetar, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (The Vulnerability Sourcebook, Risk Supplement to the Vulnerability Sourcebook, 2017.), State Hydrometeorological Institute, Meteorological Research and Development Division, Ministry of Environment and Energy, Rural Development Program of the Republic of Croatia for the period 2014 – 2020, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture – consulting packages, Central Bureau of Statistics, Croatian Agricultural Agency, Local Action Group LAG Brač, Institute for

tourism, Institute for Adriatic cultures and karst melioration, Croatian Waters Ltd, Split – Dalmatia County Fire and Technological Explosion Risk Assessment (2018), Major accident risk assessment for Bol, Nerežišća, Pučišća, Supetar, Postira, Sutivan and Nerežišća, Development Plan for the City of Supetar, Strategic development programme for Selca, Postira, Pučišća, Sutivan and Bol municipality.Data used for the municipality of Vela Luka was taken from the Agency for Payments in Agriculture, Fisheries and Rural Development, Croatian Chamber of Commerce, Ministry of Environment and Energy, Rural Development Program of the Republic of Croatia for the period 2014 – 2020, Department for Expert Support to Agriculture and Fisheries Development of the Ministry of Agriculture – consulting packages and Central Bureau of Statistics, Dubrovnik and Neretva County.

In regards to the module development participation, for IRENA the impact chains data used in the model was developed by the external consultant with active participation from stakeholders included in the project. IRENA acted as a coordinator of activities and later produced the module based on data provided in the Risk assessment by the external consultant. For San Benedetto del Tronto, the impact chains were developed using local key actors/stakeholders and basing on the information gathered through questionnaires, while Abruzzo Region involved local actors and stakeholders in the selection of relevant sector for the development of impact chains through the compilation of the questionnaires. For the municipality of Pescara the impact chain was developed by external consultants, supported by the staff of the Municipality. The impact chains for SDEWES Centre were developed by the external consultant Energo-data d.o.o and other members of the consortium, while the M2 module was developed in cooperation with SDEWES Centre. For Primorje – Gorski Kotar County, impact chains were developed by external expert Regional energy agency Kvarner in cooperation with municipality representatives. The impact chains for Spit – Dalmatia County were developed by the external consultant – consortium SENSUM ltd/Umium Ltd. and for the municipality of Vela Luka, they were coordinated by the municipality with the support of SENSUM ltd. as the technical supervisor and contractor. All the partners actively included relevant stakeholders in the process and cooperated with their external experts during the module production.

Regarding the difficulties in the impact chain development, partners reported the following: San Benedetto del Tronto encountered some difficulties in distinguishing risks and impacts and identifying the related factors. Therefore, first of all a full list of exposure and vulnerability factors was prepared and then the single impact chains were prepared grouping the relevant factors from such list. Abruzzo Region encountered difficulties representing the complexity of environmental phenomena graphically and clearly. Another major difficulty was linked to the need to find parameters able to assess in a reliable and credible way the risk components and able to be measured with temporal and spatial resolution. For the municipality of Pescara, some difficulties were encountered to get data and information mainly from other municipalities of the target area and from local trade associations. Another problem was to downscale the results at municipality or sub-municipality level since some data was not available for all the municipalities, therefore in these cases the average data for all the context target area was assumed. The main difficulty in the impact chains development was to connect the different vulnerability and exposure to the impacts of each hazard since some of the vulnerability and exposure are related to more than one impact. Another difficulty was to distinguish direct and indirect connections between impacts

and vulnerability and exposure. Primorje – Gorski Kotar County reported difficulties in determining *which data can be collected as a specific number, and which need to be collected from the surveys and then interpolated.*

All the partners used the methodology described in the tutorial, including the Vulnerability Sourcebook and the Risk Supplement files consistent with IPCC AR5 Synthesis Report. Schemes of the impact chains can be found in the previous chapter of this report.

3.4 M3 Identifying and selecting indicators and M4 Data acquisition and management

The following section is related to the M3 and M4 modules produced in the project.

	No. of climate change factors (single factors within Exposure and Vulnerability	No. of indicators
PP1 - IRENA	29	38
PP2 – S.B.D. TRONTO	18	38
PP3 – ABRUZZO REGION	25	19
PP4 – PESCARA	33	37
PP5 – SDEWES	26	34
PP6 – PRIM-GOR COUNTY	8	22
PP7 – SPLIT – DALM COUNTY	26	31
PP8 – VELA LUKA	20	23

Table 47: Number of climate change factors and indicators by partner

In the table, we can see a brief comparison of the number of used indicators in the modules by all partners. All the partners have selected at least one indicator associated to each factor.

Regarding the indicators used from other reports, for San Benedetto del Tronto, some of the vulnerability indicators were developed by others, in particular: the indicator related to soil sealing (imperviousness

index) was developed by EEA. Abruzzo region considered the indicators provided by ISPRA in the report "Landslides and floods in Italy: hazard and risk indicators" (2018) for the population in landslides and flooding areas. It provides an updated overview on landslide and flood hazard over the Italian territory and contains risk indicators related to population, families, buildings, industry and services, and cultural heritage. For the municipality of Pescara, the selection of indicators for each exposure and vulnerability was carried out considering reports, database documents and plans reported in the paragraph M1, whereas the guidelines of the World Meteorological Organization (WMO) and IPCC, were used for the selection of indicators of the hazards and for the choice of threshold values of climatological parameters.

Specific indicators were developed for the San Benedetto del Tronto partner where all the composite indicators were developed on purpose. For instance, the indicator concerning the social vulnerability was developed to reproduce a complex indicator used by the Italian institute of statistics and available only at municipal scale. The indictors concerning the number/kind of obstacles to river flow, railway underpasses, sensitive locations, beach facilities were developed autonomously. For Abruzzo Region, the specific indicator created concerns the number of municipal emergency plans existing and updated in the target areas. This indicator is easy to collect, but at the same time it's very important, because it represents the coping capacity of the municipality to address, manage and overcome adverse conditions in the short and medium term. Another specific indicator for Abruzzo Region is the financial resources from Abruzzo region for hydrological instability over the years. The indicator for now refers only to resources allocated between 2013 and 2017 by order of the head of the civil protection department. It would be interesting to broaden the monitoring of these resources also by integrating them with others from other programs (European, national and regional). Another specific indicator for the target areas concerns the number of municipalities of the target area affected by alien species (Rhynchophorus ferrugineus), which has the palm as target species.

For IRENA, the indicators were developed by the external consultant SENSUM ltd., while the module was developed jointly with coordinator (IRENA). For San Benedetto del Tronto, indicators were developed by external consultants, supported by the staff of the Municipality of San Benedetto del Tronto. The indicators for Abruzzo Region were developed in close collaboration between Abruzzo Region and external consultants. For the municipality of Pescara, the analysis was coordinated by the municipality of Pescara, supported by prof. Paolo Fusero and prof. Piero Di Carlo, as external consultants. The indicators for SDEWES Centre were developed by the external consultant consortium led by Energo-data d.o.o., while the module was developed jointly with project partner SDEWES Centre. Primorje – Gorski Kotar indicators were developed by external expert Regional energy agency Kvarner in cooperation with municipality representatives. For Split – Dalmatia County the indicators were identified and selected by the external consultant - consortium SENSUM ltd./Umium ltd. and for the municipality of Vela Luka the indicators were developed by the external consultant SENSUM ltd. in cooperation with the project team from Municipality of Vela Luka.

IRENA developed the modules with the help of previously gathered knowledge and information from the relevant stakeholders and the external expert, and using feedback from the external expert during the development process. For San Benedetto Del Tronto, direct involvement of stakeholders was not

necessary, but some indicators and in particular the more complex ones combining qualitative and quantitative information were discussed with and approved by the staff of the Municipality of San Benedetto del Tronto. Abruzzo Region developed the modules partially with local key actors /stakeholders on the basis of information collected during the meeting. Then Abruzzo Region and external consultants selected the indicators internally in advance to create a limited number and not further burden the work of the municipal technicians/ administrators. At a later stage, the choice of indicators will be shared among municipal staff to support them how to collect and monitor over time. SDEWES Centre included the main stakeholders consisting of the target area local city and municipal governments, but other stakeholders were also contacted in order to provide data for the assessment. Primorje – Gorski Kotar County and Split – Dalmatia County both involved groups of stakeholders and key actors in the development process. For Split – Dalmatia County identified indicators were presented, discussed and agreed upon with the stakeholders during the first stakeholder meeting held in December 2019 on island Brač. Data acquisition was performed by the technical consultant - consortium SENSUM ltd./Umium ltd and the Split Dalmatia County which also put high efforts in this phase of risk assessment. For the municipality of Vela Luka the indicators were developed by the external consultant SENSUM ltd. in cooperation with the project team from Municipality of Vela Luka. Due to COVID-19 situation the other key stakeholders could not fully participate in the process of development and defining the indicators.

Regarding the type of indicators used during this stage of development, most partners used both qualitative and quantitative indicators. IRENA used 8 qualitative and 28 quantitative indicators. San Benedetto del Tronto also used both kind of indicators, in some cases the indicators are composite and combine both qualitative and quantitative information. Abruzzo Region used quantitative indicators and the chains were developed in two stages. The first phase, based on the results of the questionnaires, led to a “more” qualitative impact chains, composed of risk components (hazard, vulnerability, exposure). In the second phase, the impact chains, even maintaining consistency with the questionnaires, had become “more” quantitative, in fact the different factors were identified, in order to quantify, assess and measure the relevant factors. Primorje – Gorski Kotar County used 9 qualitative and 19 quantitative indicators, and Split – Dalmatia Countys indicators were identified and selected by the external consultant - consortium SENSUM ltd./Umium ltd. Efforts were made to express indicators qualitatively which was achieved for the vast majority of them. Only for fisheries and coastal management were the indicators defined in a qualitative manner due to data unavailability.

Obstacles encountered during the module production included inaccessibility of data from the State Hydrometeorological Institute for IRENA, difficulties in obtaining homogeneous climate data at the municipal scale to be used as hazard indicators for San Benedetto del Tronto, while Abruzzo Region reported the selection of indicators to be quite difficult and the first draft list of indicators on the basis of the first impact chains were changed, because above all indicators for sensitivity and adaptive capacity were not always available and easy to access at local level due to resource constraints (time and budget). Regarding the detail level for each indicator considering the administrative jurisdiction, for IRENA the detail level for the indicators includes 16 indicators on national level, 17 indicators on regional level and 3 indicators on local level. For San Benedetto del Tronto, 2 district level indicators were used (hazard), 7 municipal/local level indicators (2 exposure + 4 vulnerability/capacity + 1 vulnerability/sensitivity) and 17

sub-municipal level indicators (11 Exposure + 6 vulnerability/sensitivity). For Primorje – Gorski Kotar County, 6 territorial/regional level, 9 district level and 13 municipal level.

Regarding issues in finding data and populating indicators, San Benedetto del Tronto reported that many of the vulnerability indicators had to be produced, since data at the required scale were not already available and all the composite indicators required an internal weighting that is necessarily questionable. Abruzzo Region reported a scarce availability or lack of continuity of historical data series of climate data in some areas. In addition, data have often been collected by different entities (e.g. Hydrographic and Regional Agrometereological Center) and with different methodologies, generating both a dispersion of data and a difficulty in obtaining data and in processing them in a homogeneous way. Furthermore, if data at local scale sufficient for quality and quantity are available to allow a more detailed and new analysis for the area under study, it should be noted that this entails the risk of having high processing times and resources. This condition is not functional both for the Joint-SECAP project timelines and for future updated and monitored risk analysis management. An issue related to the municipality of Pescara was the impossibility of downscaling at municipality level since most of the data of exposure and vulnerability were not available for each municipality of the target are, but most of them are the average data of the area, and therefore all the analyses done are a mean picture of the target area. Primorje – Gorski Kotar County reported difficulties with determining which data can be collected as a specific number, and which need to be collected from the surveys and then interpolate. All the partners used a database for the assessment, incorporating also a geographic base (GIS). For IRENA, an excel database was created with all the indicators and relevant metadata. San Benedetto del Tronto reported that some metadata are available for each indicator, even if they do not comply with the international metadata standards (INSPIRE). In most cases, the source data also lack the metadata in a complete form. Abruzzo Region provided metadata for each indicator, using existing database at national, regional and municipal level. Primorje – Gorski Kotar County used an excel database with all the indicators and relevant metadata.

3.5 M5 Normalization of indicator data, M6 Weighting and aggregating of indicators and M7 Aggregating risk components to risk

Methods and instruments used to normalize, weigh and aggregate data included for IRENA the extrapolation of data through the excel tables provided by the Lead Partner and was done with min-max method for metric and 5 class evaluation scheme for categorical indicator values. San Benedetto del Tronto used Census section data: arithmetic normalization on a 0-1 scale, adopting as 0 and 1 the lowest and highest values of the data series represented by the 634 census sections; for municipal data: arithmetic normalization on a 0-1 scale, adopting as 0 and 1 the lowest and highest values of the data series represented by the 4 municipality, in certain cases (i.e. the income) the regional maximum and minimum values was assumed as 1-0 in the normalization. Abruzzo Region used methods suggested by the tutorial. In order to elaborate a synthetic global index for each risk component (hazard, exposure,

vulnerability) all the values obtained for the risk component indicators were “normalized” with the purpose to transform the indicators values measured at different scales and in different units into unit-less values on a common scale in order to be compared. Depending on the scale of measurement, (i.e. metric, nominal, ordinal) different methods of normalization were used. For metric indicator values (i.e. precipitations), they were normalized by applying the Min-Max method. The normalization process transformed the indicator values in metric scales to a standardized value range from 0 to 1. For the normalization of ordinal and nominal categories, a five-class evaluation scheme was applied, with the most positive conditions represented by the lowest class and the most negative represented by the highest class. Each indicator value was then allocated to one of the five classes, on the basis of the meaning attributed to the indicator within the context of the assessment. This allocation was supported by the consultants and other reliable sources. The classified values were then transformed into the value range of 0 to 1. The municipality of Pescara, following the suggested guidelines (Fritzsche, et al.: The Vulnerability Sourcebook: Concept and guidelines for standardized vulnerability assessments 2014), used all the indicator data mathematical normalized on the 0-1 scale, which for numerical indicators means to subtract to each value the minimum score and divide the result by the range of the score (difference between the maximum and minimum). For ‘Weighting and aggregating of indicators’ the approach was to use the stakeholder feedback and suggestions. For the ‘Risks for economic activities, infrastructures and people due to flooding and hailstorms induced by extreme precipitation’ all the exposures and vulnerabilities were weighted 1, apart from ‘Farming activities and cultivation in flood prone areas’ that was weighted 0.5. For all the other partners, the normalization of data was done with min-max method for metric and 5 class evaluation scheme for categorical indicator values.

Regarding the normalization, weighting and aggregation of data, for IRENA it was performed by the external consultant and later adjusted for the provided excel tables by the coordinator. For San Benedetto del Tronto. The operations on indicators were developed by external consultants, weighting was discussed and approved by the staff of the Municipality of San Benedetto del Tronto. The normalization for Abruzzo Region was done by external consultants in collaboration with Abruzzo Region. The normalization, weighting and aggregation of data for SDEWES Centre was performed by the external consultant and later adjusted for the provided excel tables by the coordinator. For Primorje – Gorski Kotar County, the normalization, weighting and aggregation of data was performed by the external expert- Regional energy agency Kvarner. For Split – Dalmatia County, normalization, weighting and aggregating indicators and risk components was performed by the external consultant, following defined project guidelines, and for the municipality of Vela Luka, the normalization, weighting and aggregation of data was performed by the external consultant and later adjusted for the provided excel tables by the coordinator. All of the partners have or are planning to elaborate the module data and indicators with a GIS tool.

Reported issues related to these modules include the following:

For San Benedetto del Tronto:

Issue related to multiform-interrelated concept of risk:

The climate stimulus considered as hazard in the impact chain produces different impacts and the resulting risk is quite comprehensive. Since the various exposure and vulnerability factors play a different role regard to each phenomenon/impact of the overall risk (up to be completely irrelevant), it was conceived as a combination of 4 sub-risks related to 4 main impacts: river, urban and coastal flooding and landslide, all consequences of the same hazard, namely "the concentration of precipitation in few very intense events accompanied by high winds". This choice leads to calculate 4 sub-risk and to aggregate the results into the overall risk. May be the same output would be obtained if starting from 4 different impact chains, even if in this way the complexity of internal relationships was not equally expressed.

Issues related to the weighting process

When considering many indicators, their weighting is very important as well as questionable. In the case of the present target area, the selection of all the weights was performed using the technique of "paired comparison" with the support of a panel of 3 experts. The weights assigned to the indicators differ from a sub-risk from the other, since as mentioned before each factor plays different roles within the various phenomena/potential impacts

Issues related to the aggregation formula

As already mentioned the fact that the risk aggregation formula uses the addiction instead of the multiplication may produce inaccurate results. In the case of present target area, during the aggregation of components to risk, a sort of "internal coherence check" was introduced to annul the risk when the exposure to a certain phenomenon was null and the vulnerability was positive, considering the scope of indicators used for sensitivity.

Issues related to the representation per census sections

The choice of the census section as unit of analysis can cause some readability problems due to their different size: highly populated sections are very small, low populated ones can be significantly larger, the indicators are attributed to the entire section even if the part interested by the phenomenon is the minority (i.e. a large census section interested for a small part by river exposure). In the case of the present target area, in addition to the internal coherence check mentioned before, the problem was solved on the maps using a "cover layer" in order to visualize only the areas exposed to each impacts (it allows to see only floodable areas in the case of river flooding risk; the urban areas in the case of urban flooding risk, the coastal areas in the case of coastal flooding risk), a picture is provided to display such perimeters, all derived by planning tools of "official" data source.

Issues related to classification of values on the maps

The method of classification of risk values plays an essential role, and maps resulting from applying a classification per equal count, per equal interval or per natural breaks can be very different in communicative terms, so this choice has a "political" significance. For this reason 2 different versions of the risk maps were produced: one adopts a classification by equal intervals on a 0-1 scale (absolute scale), the other adopts a classification by equal intervals on a min-max scale (relative scale) with indication of the max value of the data series. In both cases null values are grouped as "Not Exposed".

For Abruzzo Region:

Some issues were identified in the definition of minimum and maximum values when dealing with the normalization of metric. When possible, a context-specific knowledge was used in defining appropriately thresholds. However, the results obtained for each target area are not comparable each other, because for the hazard from climate signals, the thresholds were chosen considering the PNACC values in relation to the macroregions. Target area 1 belongs to macroregion 3 and target area 2 belongs to macroregion 2, so the values for the comparison are different.

Moreover, some issues were identified in the weighting procedure because it is quite subjective and weighting can have a major influence on the results and have to be undertaken with care. Also, alignment of indicators and their aggregation represented another challenging step, because of the strong influence they have on the final result and the significance of the whole analysis.

For Vela Luka:

The presentation of outcomes of the activity was planned through the live workshops/presentation with possibility for open discussion, and in addition a small local event presenting the final outcome to decision makers, media and general public. The material will be distributed among the stakeholders prior the presentation in order to early engage and achieve active participation of the stakeholders during the presentation. The participants will have the opportunity to see report and all accompanied maps, diagrams, tables and chards, and other. Due to COVID-19 pandemic crisis, the planed actions were postponed at the time this report was written.

3.6 M8 Presenting the outcomes of your risk assessment

Presentation of the data of the partners' risk assessments was done mostly in Excel, GIS and graph modes. IRENA presented the data through Excel methodology modules and GIS maps, San Benedetto del Tronto mostly through maps, Abruzzo Region will present illustrating through maps, tables and charts the climate vulnerability and risk of the target areas. The municipality of Pescara will use tables and graphs, while SDEWES Centre presented the data through excel methodology modules. Primorje – Gorski Kotar reported using tables, and the data for Split – Dalmatia County and the municipality of Vela Luka was

presented through excel methodology modules and GIS maps.

Regarding the instruments used for data presentation, IRENA relied mostly on public meetings and website data dissemination, SDEWES Centre uploaded finalized documents on the official web page of the project and project partner, and can be accessed freely. Split – Dalmatia County presented the data with GIS mapping for each target area and the municipality of Vela Luka will use accompanied maps, diagrams, tables and charts when the local events will be organised. All the other partners have not reported their mode of data presentation at the time of writing this report.

For IRENA, the data was presented by the co-ordinating authority (IRENA) with internal staff and by the external consultant. In case of public presentation of the results, San Benedetto del Tronto will probably use a mixed group with co-ordinating authority, consultants and stakeholders to present. All the other partners have not reported this part at the time of writing this report.

Regarding district level presentation, the results of the Risk and vulnerability assessment for IRENA were presented to stakeholders by the coordinator and external expert during the meeting held in the Chamber of Commerce in Pula on 27.11.2019. The finalized documents are available on the official web pages of the target area administrative authorities and are freely accessible at all times. The municipality of Vela Luka planned to present the outcomes of the activity through the live workshops/presentation with possibility for open discussion, and in addition a small local event presenting the final outcome to decision makers, media and general public, but the planned actions were postponed due to COVID-19 pandemic crisis. Due to the crisis, instruments used to present the data and the related information for the other partners were not available during the making of this report. No additional issues were reported.

Conclusion

The aim of this report was to showcase the project partners process of collecting and mapping all climate risks and vulnerabilities for the partners' designated target areas and to summarize the collection of the assessments produced in each territory. Based on the information and data delivered by the partners, the general framework for climate risk assessment is available as a reference in the format of this summary. Generally speaking, the context area from the partners' initial proposal was confirmed during the preparation phase of the risk assessment and local and territorial plans relevant to climate change were identified and used in order to facilitate the assessment preparation and implementation. Most of the partners modules were developed with close cooperation and synergy by the external expert, relevant stakeholders and the partners institution closely coordinating each step of the risk assessment process. During the assessment, impact chains were developed as a visual tool for understanding the correlation of various hazards, exposures and vulnerabilities of climate change. These hazards, exposures and vulnerabilities and their respective indicators were selected, identified and/or developed by using existing data, projects and reports and in some cases, using joint cooperation with stakeholders to define the best markers for their pilot areas. The selected data was then normalized, weighted and aggregated according to the prescribed methodology standards in order to be used in the assessment. Presenting the outcomes of the finalized risk assessments was met with certain difficulties during the making of this report, mostly due to COVID-19 imposed restrictions, but the overall final product was achieved by using the methodology defined in the scope of the project tutorial. Therefore, as stated before, this report will serve to provide future interested parties with a general guide and experiences collected from the partners involved in the project Joint_SECAP.

Reference List

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List of Pictures, Tables and Graphs

Graph 10: Exposure and vulnerability factor with higher score (at least intermediate) for the risk of for human health, agriculture and energy production due to drought

Graph 11: Composite Risk levels