

SuPeRBE Training Material

Macro Area of Expertise 6:

Risk Assessment At Small Urban Scale

Hazard: Drought (D)

Area of Expertise 6.1:

Urban Sector: Water (D4)

**Risk Category: Damage Risk for Water Supply
Network(D4.2)**

Level of competence: 3

DROUGHT

General Information

- “A period of abnormally dry weather long enough to cause a serious hydrological imbalance.” (source: <https://www.ipcc.ch/sr15/chapter/glossary/>)
- Natural phenomenon
- Intensified in recent decades by climate change and unsustainable land practices
- Human-induced climate change has contributed to increases in droughts due to increased atmospheric evaporative demand induced by increased temperature, decreased relative humidity, and increased net radiation
- More regions are affected by drought with increasing global warming



TYPES OF DROUGHT

- **Net water availability** - caused by precipitation deficits and changes in evapotranspiration
- **Agricultural drought** - caused by a lack of sufficient soil moisture and increased atmospheric evaporative demand
- **Ecological drought** - caused by a lack of sufficient soil moisture and increased atmospheric evaporative demand
- **Hydrological drought** - caused by a lack of runoff and surface water



AFFECTED URBAN SYSTEMS

- Water supply system
 - Damage risk for water treatment plants
 - **Damage risk for the water supply network**
- Environment & biodiversity
 - Damage risk for urban green spaces
 - Damage risk for street trees
- Health
 - Health risk for the population
- Emergency services
 - Efficiency risk for the fire brigade
 - Efficiency risk for emergency medical services

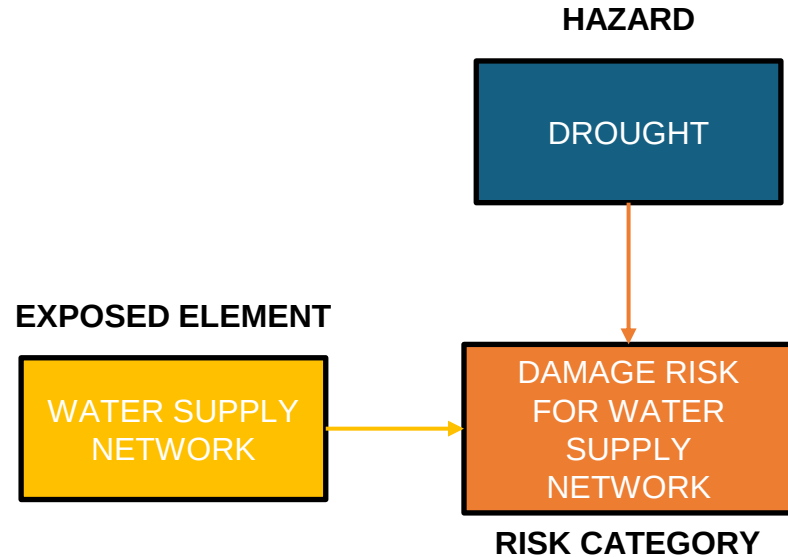
WATER SCARCITY

- Seasonal, annual, or multi-annual water stress condition
- Occurs when water demand frequently exceeds the sustainable supply capacity of the natural system in river basins
- Driven by:
 - Supply reduction and source limitations
 - Increased water demand
 - Water quality degradation (pollution)
 - Infrastructure and operational stress

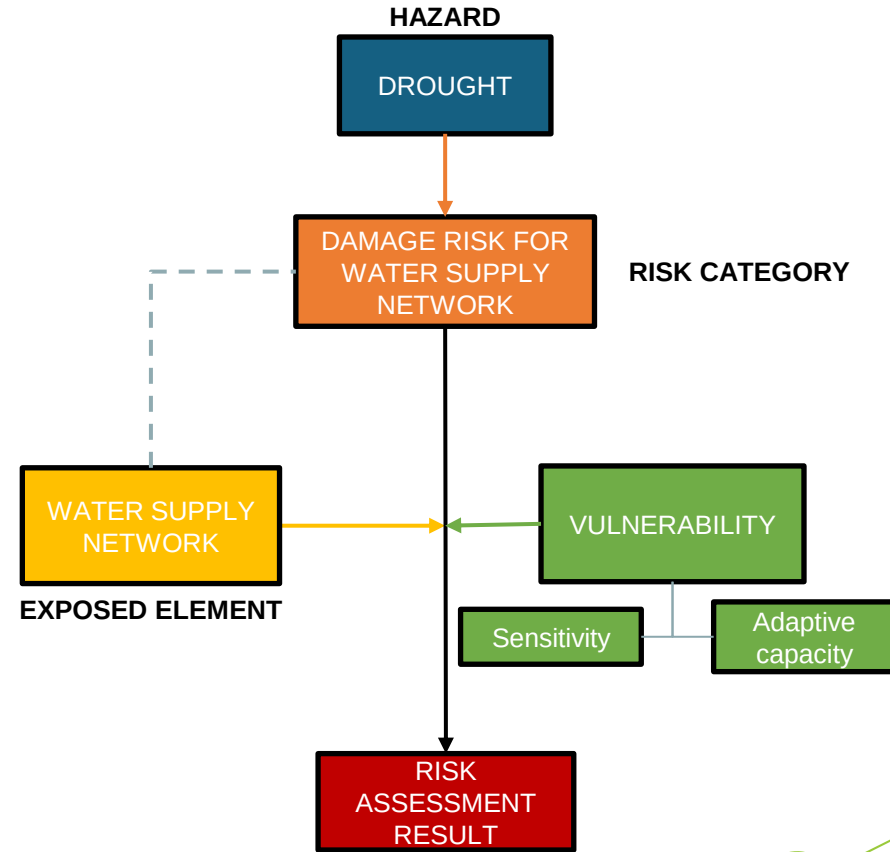


RISK ASSESSMENT FOR DAMAGE RISK FOR WATER SUPPLY NETWORK

- Hazard: drought
- Exposed element: Water supply network

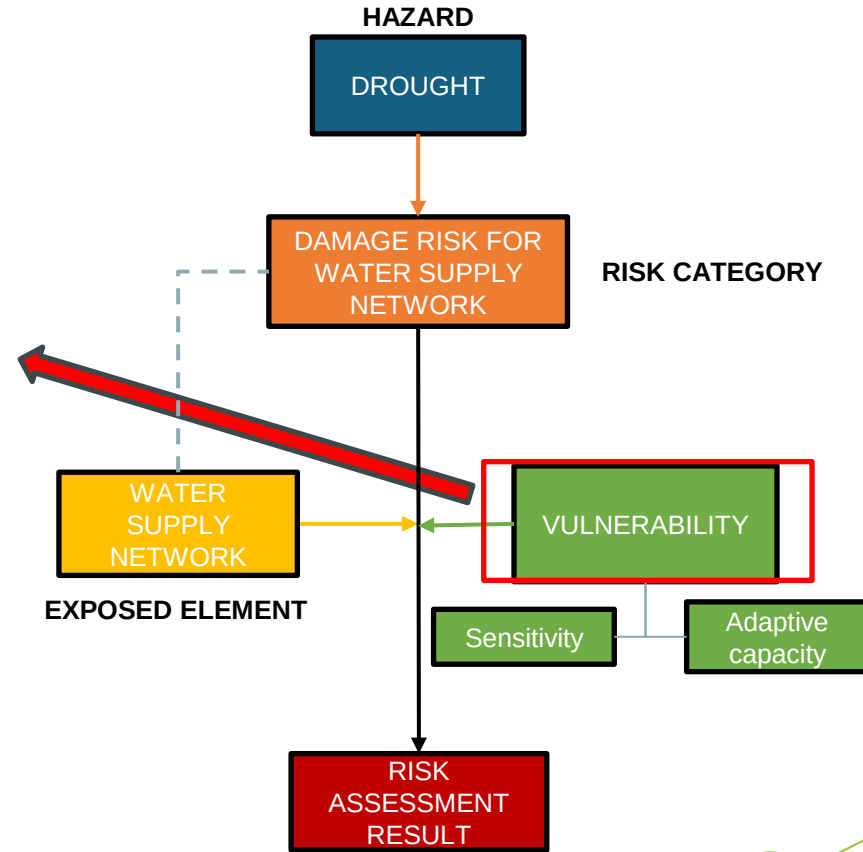


IMPACT CHAIN



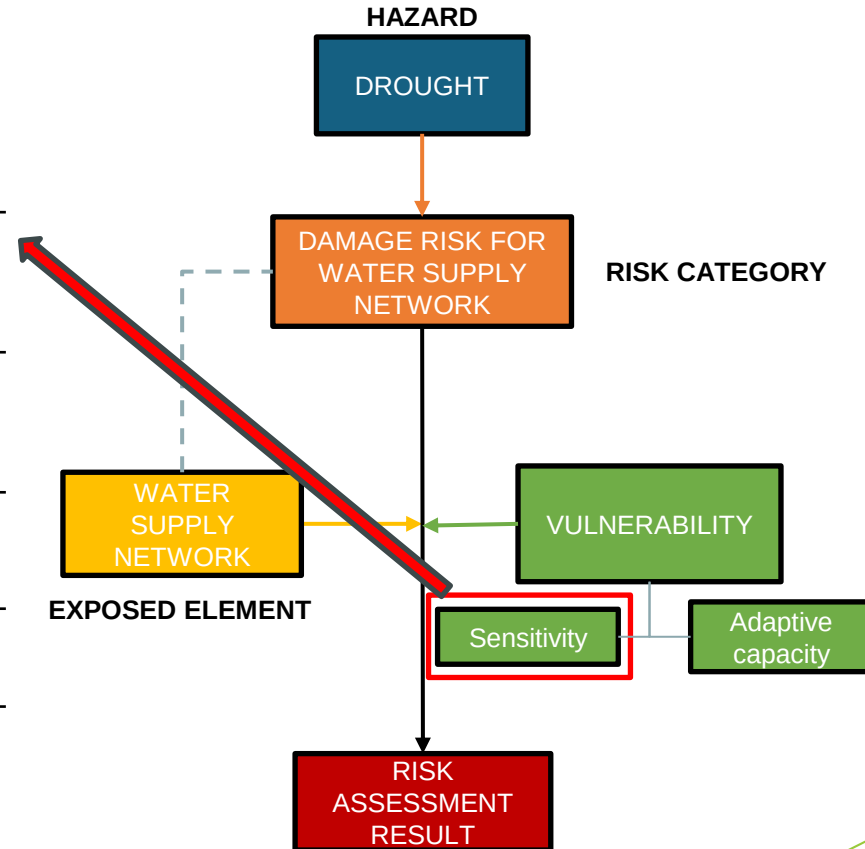
VULNERABILITY CRITERIA

- Consumption
- Water consumption during the tourist season
- Regional competitiveness index
- Water loss



VULNERABILITY ASSESSMENT

CRITERION	INDICATOR
Consumption	Water consumption per capita
Water consumption during the tourist season	Water consumption compared to average consumption during the tourist season (households)
Water consumption during the tourist season	Water consumption compared to average consumption during the tourist season (industry)
Regional competitiveness index	Regional competitiveness index
Water loss	Losses in the water supply network



D4.2.1 WATER CONSUMPTION PER CAPITA

Description:

The indicator measures the average volume of water supplied and consumed per person through the urban water supply network in the selected area (L/capita/day). It reflects the demand load placed on the network's infrastructure and resources, relative to the population it serves.

Objective:

To quantify the pressure on the water supply network. To identify consumption patterns that may increase vulnerability during droughts, and to provide a baseline for evaluating efficiency of water use.

Relevance:

Higher consumption per capita = higher vulnerability

Cities with higher average consumption per person will face greater stress during drought as they have less flexibility before shortages occur. Comparing per capita use across districts helps to identify areas of inefficiency and prioritize demand management interventions. Water supply network is under more stress if the average consumption is higher due to higher pumping needs and higher stress in the network.

D4.2.1 WATER CONSUMPTION PER CAPITA

CALCULATION: STEP-BY-STEP EXAMPLE

- The local water supply company might have this information already available; otherwise:
- In the local water supply company, obtain the information about the average amount of water consumed in the selected area in a month (if that is not available, use average yearly consumption and divide it by 365 days to get average monthly consumption)
- Identify the number of citizens in the selected area

Average daily consumption: 10.461.600 L/month

Number of citizens: 1.453

- Divide the average monthly consumption by the number of citizens to get the average consumption per capita

$$\text{Water consumption per capita} = \frac{\text{Average consumption for the whole area}}{\text{Number of citizens}} = 7200 \text{ L/capita}$$

Normalisation

Normalization is a crucial step in this process, as it transforms diverse indicator values into a common scale, typically ranging from 0 to 1. This ensures that each indicator contributes proportionately and comparably to the overall resilience score, regardless of its original unit or magnitude. By applying normalization, we enable meaningful synthesis of data, facilitate benchmarking across different contexts, and support more transparent and objective decision-making in resilience evaluations.

NORMALISATION INTERVAL

Normalisation values	Description
0.0-0.2	Optimal (no improvement necessary)
>0.2-0.4	Rather positive
>0.4-0.6	Neutral
>0.6-0.8	Rather negative
>0.8-1.0	Critical (could lead to severe consequences)

D4.2.1 WATER CONSUMPTION PER CAPITA

BENCHMARKING

Critical value (1) = National minimum (monthly consumption)

Optimal value (0) = National maximum (monthly consumption)

Range of values: lower is better (LIB)

D4.2.1 WATER CONSUMPTION PER CAPITA NORMALISATION

Indicator

Water consumption per capita: 7200 L/capita

Critical value (1) = 9000

Neutral value (0,5) = 6000

Optimal value (0) = 3000

Normalised value: **0.7**

Vulnerability Level: **RATHER NEGATIVE**

D4.2.2 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (HOUSEHOLDS)

Description:

This indicator measures the variation in household water consumption during the tourist season compared to the annual average household consumption. It reflects the additional stress placed on the urban water supply network by seasonal tourism peaks, which often cause demand surges in residential areas (e.g., households hosting guests, short-term rentals, or second homes).

Objective:

To capture seasonal demand fluctuations in water consumption linked to tourism activity, to identify the degree of vulnerability of the water supply network to sudden increases in household demand, to support planning of water supply operations (e.g., storage, pumping, treatment) during peak tourist months, and to enable utilities and municipalities to anticipate shortages, pressure drops, or rationing needs during high-demand periods.

Relevance:

During drought, baseline water availability is reduced. A surge in household demand from tourism further strains the water supply network. Networks serving tourist areas often face peak loads that can exceed design capacity, leading to pressure drops, intermittent supply, or service failures. Tourist-season consumption may reduce the availability of resources for permanent residents, thereby increasing social vulnerability and inequity risks. If consumption rises only modestly compared to the average, the network is more resilient. Large spikes indicate low adaptive capacity and a higher risk of drought-driven disruption.

D4.2.2 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (HOUSEHOLDS)

CALCULATION: STEP BY STEP

Step 1: Identify which months are considered to fall under the tourist season

Step 3: Calculate the average monthly consumption in households only during the tourist season

Step 2: Calculate the average monthly consumption in households only outside of the tourist season

Step 4: Divide the average monthly consumption during the tourist season by the average monthly consumption outside of the tourist season

$$\frac{\text{Average monthly consumption during tourist season}}{\text{Average monthly consumption outside of the tourist season}} = \frac{45.000.000}{8.000.000} = 5,6$$

D4.2.2 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (HOUSEHOLDS)

BENCHMARKING

Critical value (1) = Consumption more than 7 times higher

...

0,7 = 5 times higher

...

0,3 = 2 times higher

...

Optimal value (0) = Same average consumption

Range of values: lower is better (LIB)

D4.2.2 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (HOUSEHOLDS)

NORMALISATION

Indicator

Water consumption compared to average consumption during the tourist season (households): 5,6

Normalized Value: 0,7

Vulnerability Level: RATHER NEGATIVE

D4.2.3 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (INDUSTRY)

Description:

This indicator measures the variation in industry water consumption during the tourist season compared to the annual average industry consumption. It focuses on how seasonal tourism activity influences industrial demand for water (e.g., food & beverage production, hospitality-linked laundries, service industries, cooling systems, entertainment facilities).

Objective:

To capture seasonal demand fluctuations in water consumption linked to tourism activity, to identify the degree of vulnerability of the water supply network to sudden increases in industry demand, to support planning of water supply operations (e.g., storage, pumping, treatment) during peak tourist months, and to enable utilities and municipalities to anticipate shortages, pressure drops, or rationing needs during high-demand periods.

Relevance:

During drought, baseline water availability is reduced. A surge in industry demand from tourism further strains the water supply network. The industry becomes economically vulnerable if the water supply is restricted. High seasonal industrial demand can exacerbate conflicts over water allocation between industrial, residential and ecological needs. If consumption rises only modestly compared to the average, the network is more resilient. Large spikes indicate low adaptive capacity and a higher risk of drought-driven disruption. Helps identify where water efficiency measures are most needed during drought periods.

D4.2.3 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (INDUSTRY)

CALCULATION: STEP BY STEP

Step 1: Identify which months are considered to fall under the tourist season

Step 3: Calculate the average monthly consumption in the industry only during the tourist season

Step 2: Calculate the average monthly consumption in the industry only outside of the tourist season

Step 4: Divide the average monthly consumption during the tourist season by the average monthly consumption outside of the tourist season

$$\frac{\text{Average monthly consumption during tourist season}}{\text{Average monthly consumption outside of the tourist season}} = \frac{15.000.000}{10.000.000} = 1,5$$

D4.2.3 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (INDUSTRY)

BENCHMARKING

Critical value (1) = Consumption more than 7 times higher

...

0,7 = 5 times higher

...

0,3 = 2 times higher

...

Optimal value (0) = Same average consumption

Range of values: lower is better (LIB)

D4.2.3 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (INDUSTRY)

NORMALISATION

Indicator

Water consumption compared to average consumption during the tourist season (industry): 1,5

Normalized Value: 0,2

Vulnerability Level: RATHER POSITIVE

D4.2.4 REGIONAL COMPETITIVENESS INDEX (RCI)

Description:

The Regional Competitiveness Index (RCI) measures the ability of a region to offer an attractive and sustainable environment for businesses and residents to live and work. It combines multiple dimensions such as economic performance, infrastructure, innovation capacity, governance quality, and environmental sustainability.

Objective:

To evaluate the adaptive capacity of a region, to integrate socio-economic resilience factors, and to identify regional disparities that may amplify vulnerabilities, since regions with a lower competitiveness index may struggle financially.

Relevance:

Regions with a high competitiveness index are typically better positioned to finance drought mitigation measures, and they can attract private and public investment into water infrastructure upgrades, reducing vulnerability to drought. A strong RCI often correlates with better governance, efficiency, and capacity to implement relevant policies and respond to crisis, and they have better capacity to adapt.

D4.2.4 REGIONAL COMPETITIVENESS INDEX

CALCULATION: STEP BY STEP

Step 1: Find the value of the regional competitiveness index for your area (national data or from https://ec.europa.eu/regional_policy/information-sources/maps/regional-competitiveness_en)

D4.2.4 REGIONAL COMPETITIVENESS INDEX BENCHMARKING

Higher is better

Critical value (1) = National minimum

Optimal value (0) = National maximum

D4.2.4 REGIONAL COMPETITIVENESS INDEX

NORMALISATION

Indicator - example

Regional competitiveness index: 0,5

National maximum: 0,75

National minimum: 0,35

Normalized Value: 0,625

Vulnerability Level: **Rather negative**

D4.2.5 WATER LOSS

Description:

Average percentage of water lost in the water supply network in a year. Amount of water delivered to the household (charged) in m³ compared to the amount of water that left the water reservoir (m³). It reflects the efficiency and integrity of the water supply network.

Objective:

To quantify the inefficiency of the water distribution system, it is necessary to determine the amount of water lost before it reaches consumers. To assess the vulnerability of the network to drought impact by determining how much available supply is wasted. To support maintenance prioritisation and investment planning for network renewal, leak detection, and metering improvements. And to strengthen the operational resilience of the water supply system by minimising losses and optimising resource use during scarcity.

Relevance:

High water loss reduces the actual amount available for users, and leaks indicate old and poorly maintained infrastructure, which is prone to failure during dry and high-demand periods. Networks with low losses have higher resilience.

D4.2.5 WATER LOSS

CALCULATION: STEP BY STEP

Step 1: Identify the average monthly amount of water leaving the water supply plant or pumping station (in case the water supply company is buying the water from another company you can use the amount of water bought) - produced water

Step 2: Identify the average monthly amount of water delivered to the end users (can be based on the bills)

Step 3: Divide the difference between the water produced and delivered with the produced water

$$\frac{\text{Produced water} - \text{Delivered water}}{\text{Produced water}} = \frac{40.000 - 27.000}{40.000} = 0,325 = 32,5\%$$

D4.2.2 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (HOUSEHOLDS)

BENCHMARKING

Critical value (1) = More than 50% losses

...

0,75 = 40%

...

0,5 = 30%

...

0,25 = 20%

...

Optimal value (0) = Less than 10% losses

Range of values: lower is better (LIB)

D4.2.3 WATER CONSUMPTION COMPARED TO AVERAGE CONSUMPTION DURING THE TOURIST SEASON (INDUSTRY) NORMALISATION

Indicator

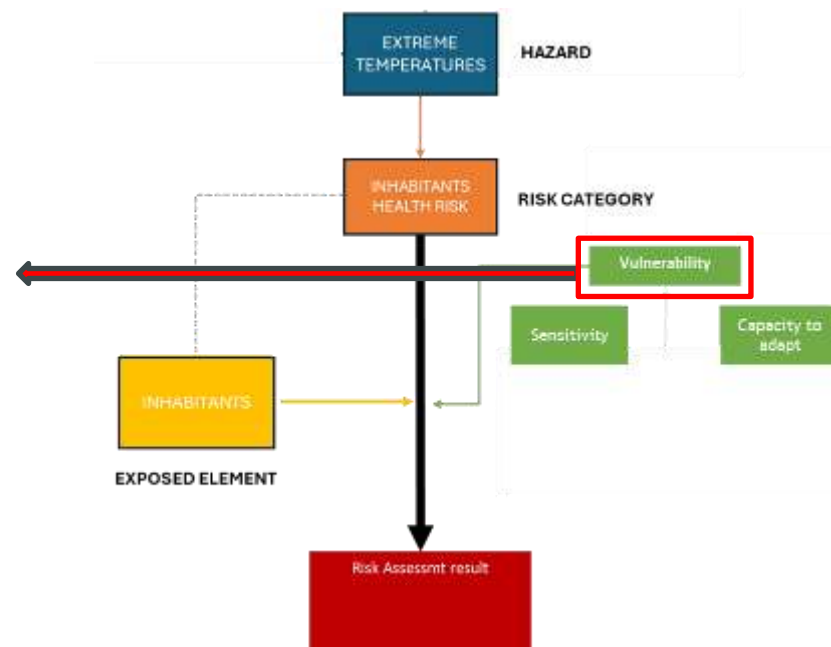
Water losses: 32,5%

Normalised Value: 0,56

Vulnerability Level: **Neutral**

OVERALL VULNERABILITY

Criterion	Normalised value
Water consumption per capita	0,7
Water consumption compared to average consumption during the tourist season (households)	0,7
Water consumption compared to average consumption during the tourist season (industry)	0,2
Regional competitiveness index	0,625
Water lossess	0,56



OVERALL VULNERABILITY

Criterion	Normalised value	Weight
Water consumption per capita	0,7	0,25
Water consumption compared to average consumption during the tourist season (households)	0,7	0,2
Water consumption compared to average consumption during the tourist season (industry)	0,2	0,15
Regional competitiveness index	0,625	0,15
Water lossess	0,56	0,25

TOTAL = 1 (100%)

OVERALL VULNERABILITY (VULNERABILITY VALUE - VV)

Normalised score

Weight

$$VV = \sum_{i=1}^n (I_i \times W_i)$$

Criterion	Normalised value	Weight
Water consumption per capita	0,7	0,25
Water consumption compared to average consumption during the tourist season (households)	0,7	0,2
Water consumption compared to average consumption during the tourist season (industry)	0,2	0,15
Regional competitiveness index	0,625	0,15
Water lossess	0,56	0,25

$$VV = 0.7 \times 0.25 + 0.7 \times 0.2 + 0.2 \times 0.15 + 0.625 \times 0.15 + 0.56 \times 0.25 = 0,58$$

Vulnerability Value (VV) = 0,58

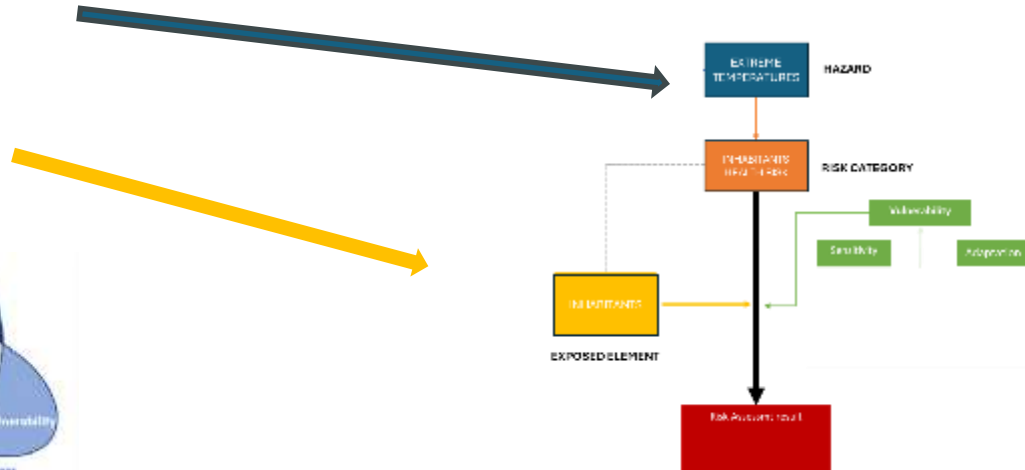
Vulnerability Level = **RATHER
NEGATIVE**

EXPOSURE OF INHABITANTS

AFTER ASSESSING VULNERABILITY, IT IS NECESSARY TO QUANTIFY TWO ADDITIONAL FACTORS TO DETERMINE THE LEVEL OF RISK:

-HAZARD

-EXPOSURE



HAZARD LIKELIHOOD

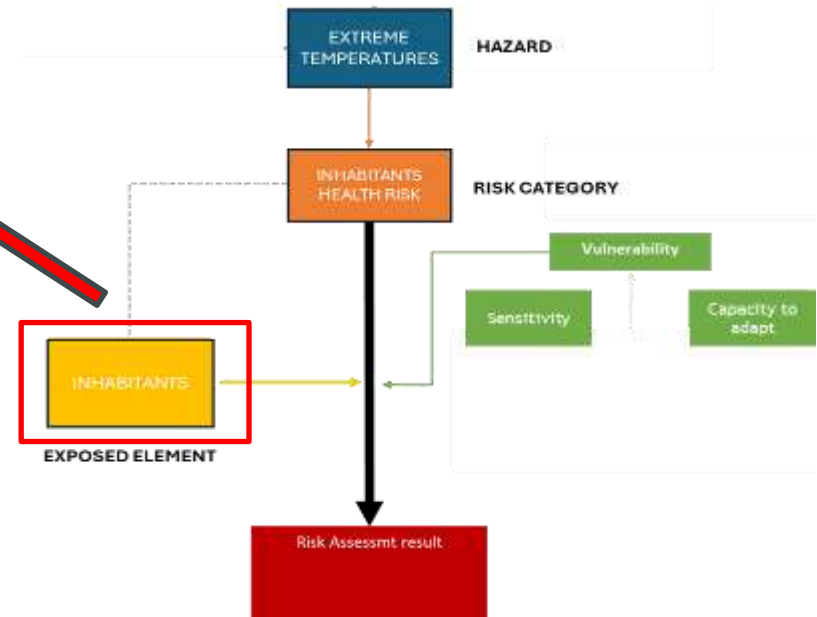
Hazardous event		Slow-onset process		Hazard Value (HV)
Frequent	Likely to occur often in a lifetime (every 10 years)	Very likely	Very likely to occur in the next ten years	1-0.9
Probable	Likely to occur several times in a lifetime (every 25 years)	Likely	Likely to occur in the next 10 years	0.89-0.66
Occasional	Likely to occur sometime in a lifetime (every 50 years)	As likely as not	As likely as not to occur in the next 10 years	0.65-0.33
Remote	Unlikely but still possible to occur in a lifetime (100 years)	Unlikely	Unlikely to occur in the next 10 years	0.32-0.0

Hazard Value (HV) = 0.7 (Probable)

THIS INFORMATION IS PROVIDED BY SECAPs

NETWORK AT RISK

CODE	CRITERION	INDICATOR
D4.2-E1-E1	Network at risk	Length of water supply network



EXPOSURE OF INHABITANTS

Extend of the exposure	Exposure Value (EV)
Minor	0.01 – 0.10
Low	0.11 – 0.20
Moderate	0.21 – 0.30
Critical	0.31 – 0.50
Major	0.51 – 1.00

Length of water supply network = 54 km

Critical value (1) = 100 km and more

Optimal value (0) = Less than 20 km

Normalised value (Exposure Value - EV) = 0,425

Exposure Level: **CRITICAL**

RISK ASSESSMENT

Risk Category: Water (D4)
Exposure: Water supply network

- Hazard Value = 0,8
- Exposure Value = 0,425
- Vulnerability Value = 0,58

- W_{HV} weight of HV  0,5
- W_{EV} weight of EV  0,25
- W_V weight of VV  0,25

$$HV^{W_{HV}} \times EV^{W_{EV}} \times VV^{W_V}$$



RISK LEVEL = 0.66
RATHER NEGATIVE