

SuPeRBE Training Material

Macro Area of Expertise 10:

Risk Assessment At Building Scale

Hazard: FLOODS (B)

Area of Expertise AD5.5:

Building Element: Sanitary Systems (B10)

Risk Category: Drainage Systems (B10.4)

Level of competence: 3

FLOODS

General Information

Floods happen when water overflows onto normally dry land, caused by heavy rain, river overflow, storm surges, or melting snow and ice. They are one of the most frequent and damaging climate-related hazards.

Why does it happen?

- **More extreme rainfall** from climate change overwhelms rivers and drainage.
- **Sea-level rise** increases coastal flooding and storm surge impacts.
- **Urbanization** (paved surfaces, poor drainage) makes cities more flood-prone.
- **Deforestation and land use change** reduce natural water absorption.



How frequent or severe?

Floods are happening **more often** and are becoming **more intense**, affecting millions of people annually. Some regions see Floods with **1-in-100 year intensity** occurring far more frequently.

FLOODS AND BUILDINGS

Exposure to floods can lead to:

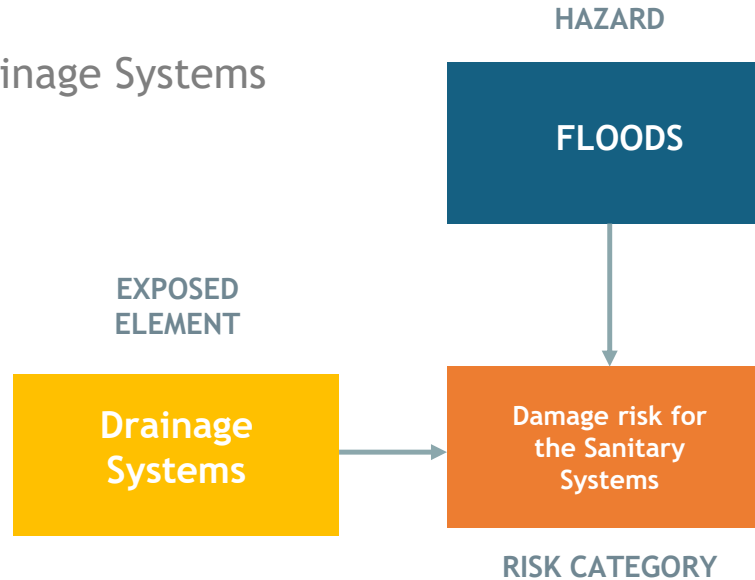
- **Water infiltration**, through façades, windows, basements, and ground level opening
- **Deterioration of building loading capacity**, through the water infiltration on structural system (walls, columns, piles, foundations)
- **Sewer backflow**, re-entering buildings through floor drains.
- **Disruption of building operation**, including temporary closure or limited access to some areas, and disruption in electricity and clean water services.
- **Damage to stored items**, materials, appliances, personal belongings.
- **Temporary displacement of residents or workers**
- **Impacts on public health due to derived issues**, such as mold exposure, chronic respiratory conditions, and economic hardship that worsens health inequalities.



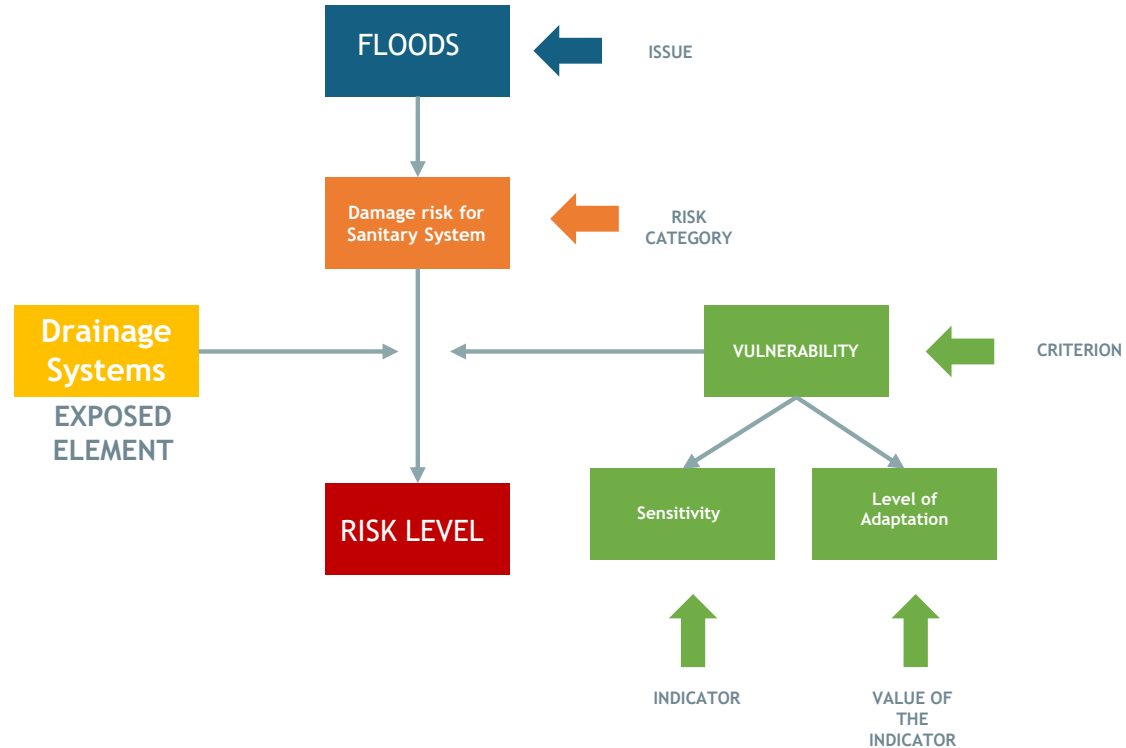
RISK ASSESSMENT AT THE BUILDING SCALE

Hazard: Floods

Exposed Element: Drainage Systems

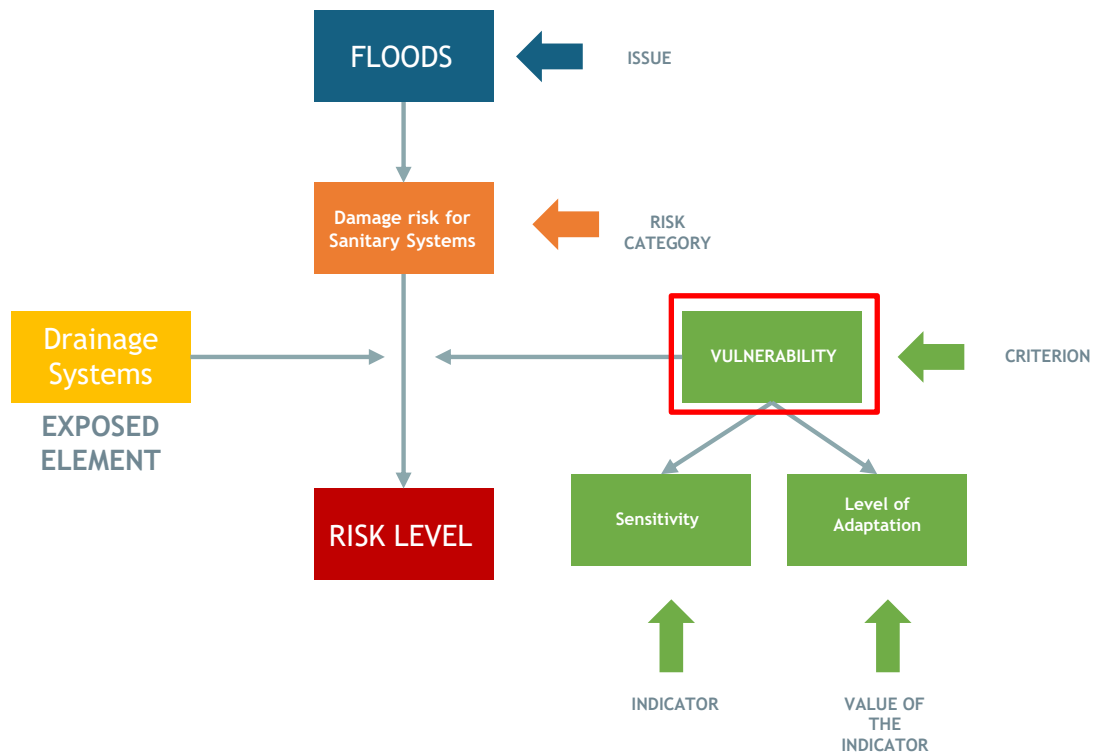


IMPACT CHAIN



VULNERABILITY CRITERIA AND INDICATORS

Code	Criterion	Indicator
B10.4.1	Ground Level Hydrostatic Flood Vents	Size of ground level hydrostatic flood vents



B10.4.1. Ground Level Hydrostatic Flood Vents

Description:

This criteria measures the size and number of ground-level hydrostatic flood vents designed to equalize water pressure and reduce structural damage during flooding.

Objective:

To assess whether the total size and number of ground-level hydrostatic flood vents are sufficient to equalize water pressure between the interior and exterior of enclosed spaces during flooding, thereby reducing structural stress and damage..

Relevance:

It is critical for building flood resilience, as properly sized hydrostatic flood vents help prevent wall failure, foundation damage, and costly structural repairs. By allowing controlled water entry and pressure equalization, the indicator supports safer building performance during flood events, reduces post-flood recovery needs, and ensures compliance with flood-resilient design standards and regulations..



B10.4.1. Ground Level Hydrostatic Flood Vents

Indicator

Size of ground level hydrostatic flood vents

Type of value: High value is better

Units: m² of flood vent area per m² of enclosed area

Critical value (1) = 0

Optimal value (0) = 0.01 m² of flood vent opening per 1 m² of enclosed



B10.4.1. Ground Level Hydrostatic Flood Vents

CALCULATION: STEP BY STEP

Indicator = Size of ground level hydrostatic flood vents

Step 1: Data Collection

- Retrieve the design floorplans and drawings of the analysed building
- Review design drawings and specifications to verify planned size and number of hydrostatic flood vents

e.g. Veneria Reale, Piedmont, Italy
Primary school

Number of flood vents: 8
Total flood vent area: 0.9 m²

Step 2: Indicator Calculation

- Evaluate the total size (sum) of existing hydrostatic flood vents in the building of analysis
- Compare this area value with the enclosed area of the building of analysis
- Evaluate if the building meet resilience standards.

Building's enclosed area: 110 m²
Compared to the proposed optimal value: 6 m

Indicator:

$$\frac{0.9}{110} = 0.0082$$

0.0082 m² of flood vent per m² of building's enclosed area

B10.4.1. Ground Level Hydrostatic Flood Vents

CALCULATION: STEP BY STEP

Step 3: Normalize the result

- The value is normalised applying the following formula (For Indicators where High Value is Better):

$$X_{norm} = \frac{x_{max} - x_i}{x_{max} - x_{min}}$$

where:

x_i : value of the indicator

x_{max} = optimal indicator's value (corresponding to score 0)

x_{min} = critical indicator's value (corresponding to score 1)

e.g. Veneria Reale, Piedmont, Italy
Primary school

Period of study - January 2025

$$X_{norm} = \frac{0.01 - 0.0082}{0.01 - 0} = 0.18$$

$$X_{norm} = \mathbf{0.18}$$

**Rather Positive -
Optimal**

Normalisation values	Description
0.1	Optimal (No improvement necessary)
0.3	Rather positive
0.5	Neutral
0.7	Rather negative
0.9	Critical (Could lead to severe consequences)