

SuPeRBE Training Material

Macro Area of Expertise 10:

Risk Assessment At Building Scale

Hazard: FLOODS (B)

Area of Expertise AD5.5:

Building Element: FAÇADE (B4)

Risk Category: Façade Openings (B4.2)

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:

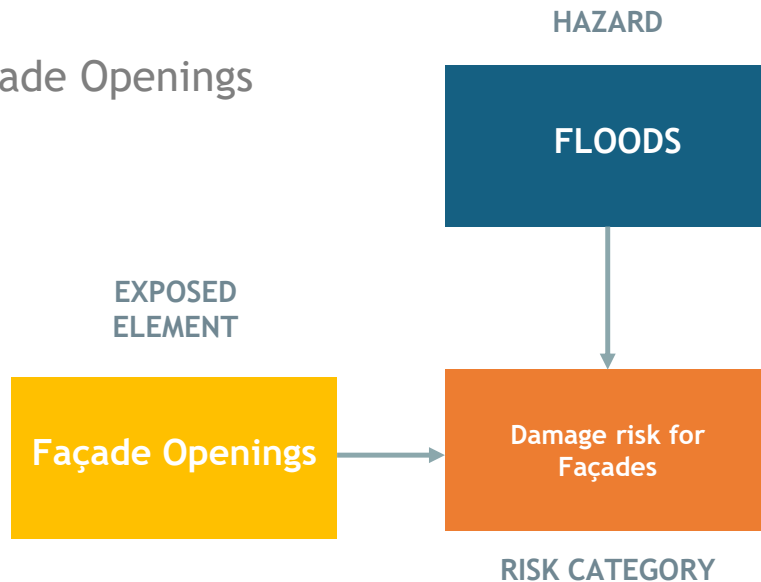
- **Water infiltration**, through façades, windows, basements, and ground level opening
- **Deterioration of building loading capacity**, through the water infiltration on structural system (walls, columns, piles, foundations)
- **Sewer backflow**, re-entering buildings through floor drains.
- **Disruption 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.



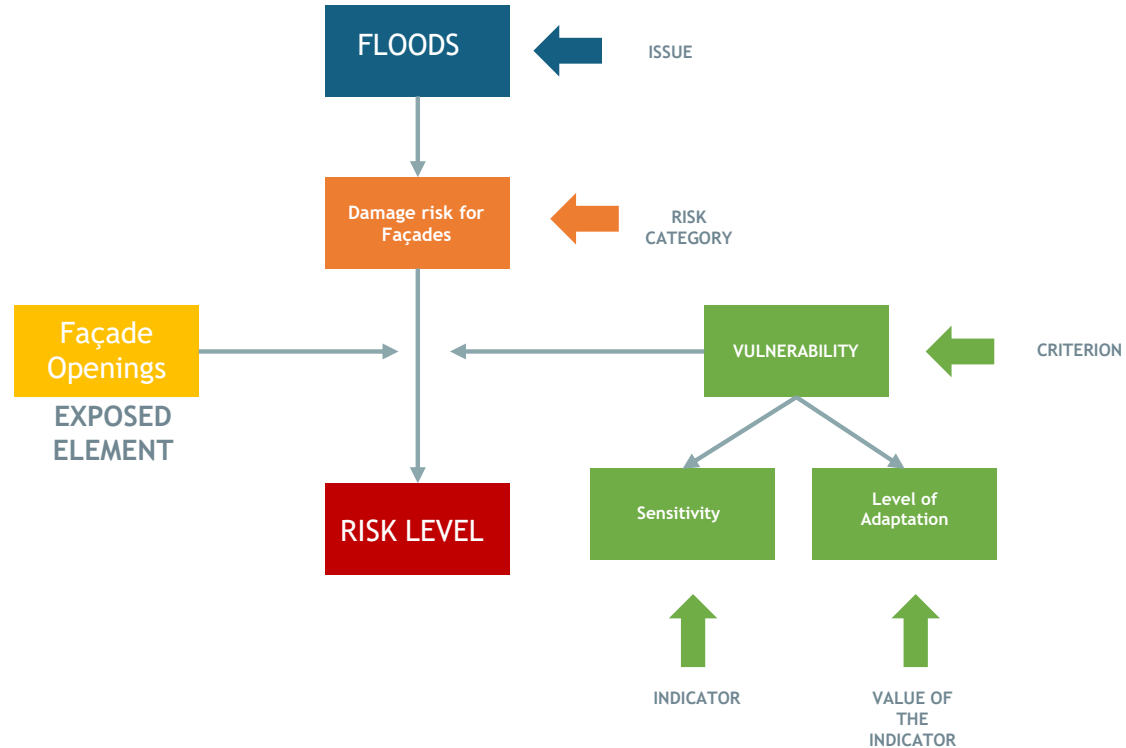
RISK ASSESSMENT FOR THE HEALTH OF INHABITANTS

Hazard: Floods

Exposed Element: Façade Openings

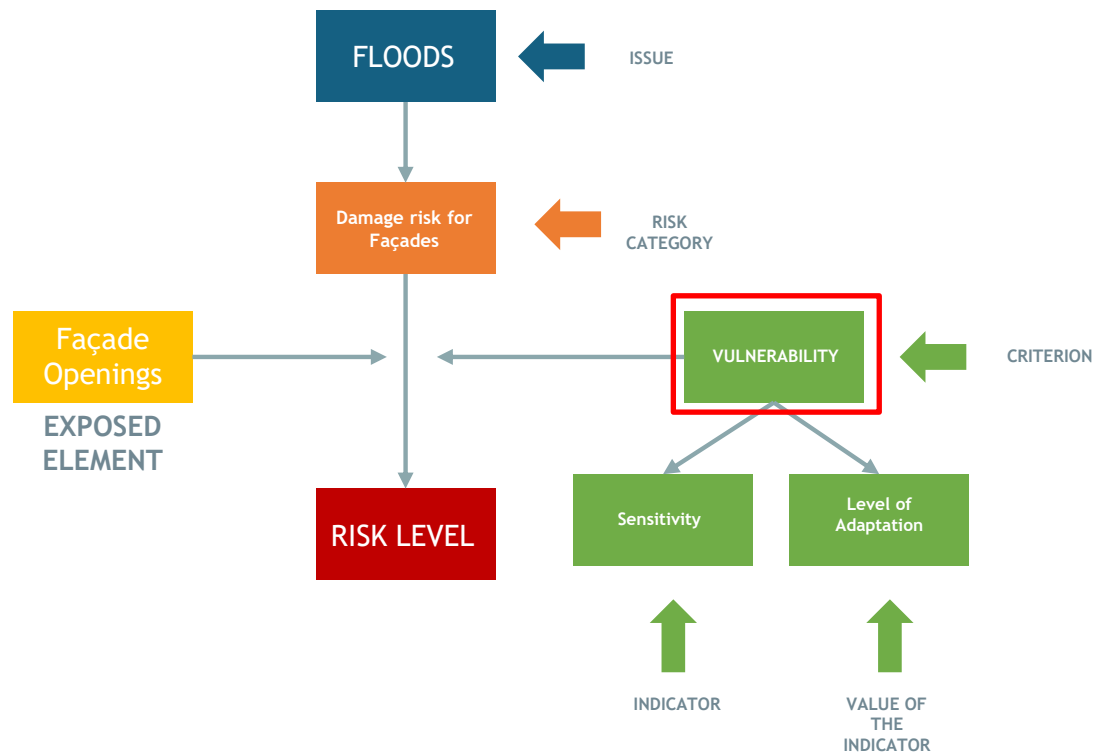


IMPACT CHAIN



VULNERABILITY CRITERIA AND INDICATORS

Code	Criterion	Indicator
B4.2.1	Safe Windows and Shutters	Share of windows protected against hail.
B4.2.2	Sealing Effectiveness	Share of openings with effective water/air infiltration protection.



B4.2.1. Safe Windows and Shutters

Description:

This indicator evaluates the percentage of windows equipped with hail-resistant glazing, shutters, or protective screens designed to withstand hail impact.

Objective:

To assess the building's ability to reduce damage from hail events by evaluating the percentage of windows equipped with hail-resistant glazing, shutters, or protective screens designed to withstand hail impact without loss of performance or safety function.

Relevance:

Windows protected with hail-resistant materials or impact-tested shutters significantly decrease the risk of glass breakage, interior water infiltration, and costly post-event repairs during severe hailstorms. Ensuring robust window protection enhances occupant safety, safeguards interior assets, and preserves building functionality during extreme weather conditions. Increasing the share of protected windows strengthens overall building resilience, helps maintain property value, and supports climate-adaptive design in areas susceptible to frequent or intense hail events.



B4.2.1. Safe Windows and Shutters

Indicator

Share of windows protected against hail

Type of value: High value is better

Units: %

Critical value (1) = 0%

Optimal value (0) = 100%



$$Indicator = \left(\frac{\text{Number of protected windows}}{\text{Total number of windows}} \right) \times 100$$

B4.2.1. Safe Windows and Shutters

CALCULATION: STEP BY STEP

$$Indicator = \left(\frac{\text{Number of protected windows}}{\text{Total number of windows}} \right) \times 100$$

Step 1: Data Collection

- Get the information about the number of protected windows of the investigated building during the year of assessment: hail-resistant or impact-resistant glazing, certified shutters or storm panels, protective external screens designed for hail impact. (Numerator)
- Get the information about the total number of windows of the investigated building during the year of assessment (denominator).

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

Period of study - January 2025

Number of protected windows: 44

Total number of windows: 120

$$\left(\frac{44}{120} \right) \times 100 = 36,6\% \text{ of protected windows in the building}$$

Step 2: Indicator Calculation

- Divide the number of protected windows by the total number of windows, and multiply by 100

B4.2.1. Safe Windows and Shutters

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)

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)

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

Period of study - January 2025

$$X_{norm} = \frac{100 - 36,6}{100 - 0} = 0,63$$

$$X_{norm} = \mathbf{0.63}$$

Neutral

B4.2.2. Sealing Effectiveness

Description:

This indicator measures the percentage of building openings (e.g. windows, doors, vents) equipped with effective seals, gaskets, or membranes to prevent water and air infiltration.

Objective:

To assess how effectively the building envelope limits unwanted water and air infiltration through its openings. Its goal is to verify the presence of protective measures that reduce infiltration risks and support building resilience and energy efficiency.

Relevance:

Proper sealing of openings is essential for protecting the building against climate-related hazards such as wind-driven rain, humidity, and strong winds. Effective seals and gaskets help prevent moisture penetration, mold formation, and indoor air leakage, improving structural durability and indoor comfort. Furthermore, limiting infiltration reduces uncontrolled heat exchange, supporting thermal performance and decreasing energy demand for heating and cooling. This indicator directly contributes to safer, healthier, and more energy-efficient buildings, particularly in areas exposed to heavy rain, storms, or temperature fluctuations.



B4.2.2. Sealing Effectiveness

Indicator

Share of openings with effective water/air infiltration protection

Type of value: High value is better

Units: %

Critical value (0) = 0%

Optimal value (1) = 100%



$$\text{Indicator} = \left(\frac{\text{Protected openings to infiltration}}{\text{Total openings}} \right) \times 100$$

B4.2.2. Sealing Effectiveness

CALCULATION: STEP BY STEP

$$\text{Indicator} = \left(\frac{\text{Protected openings to infiltration}}{\text{Total openings}} \right) \times 100$$

Step 1: Data Collection

- Get the information about the number of protected openings of the investigated building during the year of assessment: effective seals, gaskets, or membranes to prevent water and air infiltration.. (Numerator)
- Get the information about the total number of openings of the investigated building during the year of assessment (denominator).

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

Period of study - January 2025

Number of protected openings: 60

Total number of openings: 230

$$\left(\frac{60}{230} \right) \times 100 = 26\% \text{ of protected openings in the building}$$

Step 2: Indicator Calculation

- Divide the number of protected openings by the total number of openings, and multiply by 100

B4.2.2. Sealing Effectiveness

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)

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)

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

Period of study - January 2025

$$X_{norm} = \frac{100 - 26}{100 - 0} = 0,74$$

$$X_{norm} = \mathbf{0.74}$$

Rather negative