Supplementary Material

Towards a wildfire vulnerability index using expert judgement

M. Papathoma-Köhle[A,*], *D. Hausharter*[B], *M. Schlögl*[A,C] and *S. Fuchs*[A]

[A]Department of Civil Engineering and Natural Hazards, BOKU University, Vienna, Austria

[B]Austrian Service for Torrent and Avalanche Control, Villach, Austria

[C]Department for Climate Impact Research, GeoSphere Austria, Vienna, Austria

*Correspondence to: Email: maria.papathoma-koehle@boku.ac.at

A WildfireVunerability Index for Buildings in Austria

QUESTIONNAIRE

Dear Experts,

We focus on the development of a **physical vulnerability index for buildings** located in the WUI (Wildland Urban Interface) that are subject to wildfire. Building characteristics and features of the building surroundings that have a significant influence on the extent of the damage caused by forest fires, the so-called **vulnerability indicators,** have been selected through literature review. These indicators will be weighed using expert judgment and the Analytic Hierarchy Process (AHP) and aggregated into a wildfire vulnerability index (WVI) for buildings. This index may support decision-making processes in the field of risk management as well as possible climate change adaptation measures.

We would appreciate your assistance in weighing these selected vulnerability indicators. The indicators are divided into three categories:

- Building environment
- Building exterior
- Building characteristics

The indicators must be compared **pairwise** for each category. Please indicate your preference in the questions below. The survey should take approximately 5 minutes to complete.

If you have any questions please contact:
Dr. Maria Papathoma-Köhle
maria.papathoma-koehle@boku.ac.at

We thank you in advance for your effort and time.

INSTRUCTIONS: Please indicate with one choice (X) for each pair (strong, moderate, slight, and equal importance) which of the two possible indicators (left or right) has a stronger impact on the vulnerability of a building to wildfire. Please consider also the two open questions in the last page.

1. **Building environment**

<table>
<tr><td colspan="9" align="center">IMPORTANCE</td></tr>
<tr><td></td><td>strong</td><td>moderate</td><td>slight</td><td>equal</td><td>slight</td><td>moderate</td><td>strong</td><td></td></tr>
<tr><td>Building density</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Distance to neighbouring buildings</td></tr>
<tr><td>Building density</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Watersources</td></tr>
<tr><td>Building density</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Mixed vegetation (single trees, closed forest stand)</td></tr>
<tr><td>Building density</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Forest type (Coniferous, etc.)</td></tr>
<tr><td>Building density</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Protective strips or firebreaks in the adjacent forest</td></tr>
<tr><td>Distance to neighbouring buildings</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Watersources</td></tr>
<tr><td>Distance to the neighbouring building</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Mixed vegetation (single trees, closed forest stand)</td></tr>
<tr><td>Distance to the neighbouring building</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Forest type (Coniferous, etc.)</td></tr>
<tr><td>Distance to the neighbouring building</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Protective strips or firebreaks in the adjacent forest</td></tr>
<tr><td>Watersources</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Mixed vegetation (single trees, closed forest stand)</td></tr>
<tr><td>Watersources</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Forest type (Coniferous, etc.)</td></tr>
<tr><td>Watersources</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Protective strips or firebreaks in the adjacent forest</td></tr>
<tr><td>Mixed vegetation (single trees, closed forest stand)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Forest type (Coniferous, etc.)</td></tr>
<tr><td>Mixed vegetation (single trees, closed forest stand)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Protective strips or firebreaks in the adjacent forest</td></tr>
<tr><td>Forest type (Coniferous, etc.)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Protective strips or firebreaks in the adjacent forest</td></tr>
</table>

2. **Building exterior**

IMPORTANCE							
	strong	moderate	slight	equal	slight	moderate	strong	
Combustible materials and objects (dead wood, garden furniture)								Ground covering
Combustible materials and objects (dead wood, garden furniture)								Property boundary (material)
Combustible materials and objects (dead wood, garden furniture)								Terrain slope
Combustible materials and objects (dead wood, garden furniture)								Type of vegetation in the property
Combustible materials and objects (dead wood, garden furniture)								Distance of tree crones/vegetation from the building (touching or overhanging)
Combustible materials and objects (dead wood, garden furniture)								Distance to forest edge
Ground covering								Property boundary (material)
Ground covering								Terrain slope
Ground covering								Type of vegetation in the property
Ground covering								Distance of tree crowns/vegetation from the building (touching or overhanging
Ground covering								Distance to forest edge
Property boundary (material)								Terrain slope

	strong	moderate	slight	equal	slight	moderate	strong	
Property boundary (material)								Type of vegetation in the property
Property boundary (material)								Distance of tree crowns/vegetation from the building (touching or overhanging)
Property boundary (material)								Distance to forest edge
Terrain slope								Type of vegetation in the property
Terrain slope								Distance of tree crowns/vegetation from the building (touching or overhanging)
Terrain slope								Distance to forest edge
Type of vegetation in the property								Distance of tree crowns/vegetation from the building (touching or overhanging)
Type of vegetation in the property								Distance to forest edge
Distance of tree crowns/vegetation from the building (touching or overhanging)								Distance to forest edge

3. Building Characteristics

	IMPORTANCE							
	strong	moderate	slight	equal	slight	moderate	strong	
Number of floors								Building material
Number of floors								Facade/Cladding
Number of floors								Roof material

Number of floors	Roof shape (complexity)
Number of floors	Roof overhang
Number of floors	Shutters/roller blinds
Number of floors	Door/window material
Building material	Facade/Cladding
Building material	Roof material
Building material	Roof shape (complexity)
Building material	Roof overhang
Building material	Shutters/roller blinds
Building material	Door/window material
Facade/Cladding	Roof material
Facade/Cladding	Roof shape (complexity)
Facade/Cladding	Roof overhang
Facade/Cladding	Shutters/roller blinds
Facade/Cladding	Door/window material
Roof material	Roof shape (complexity)
Roof material	Roof overhang
Roof material	Shutters/roller blinds
Roof material	Door/window material
Roof shape (complexity)	Roof overhang
Roof shape (complexity)	Shutters/roller blinds
Roof shape (complexity)	Door/window material
Roof overhang	Shutters/roller blinds
Roof overhang	Door/window material
Shutters/roller blinds	Door/window material

OPEN QUESTIONS:

1. In your opinion, are there indicators in the above questionnaire that **should not be considered** in the development of a wildfire vulnerability index for buildings?

2. In your opinion, should we consider **additional indicators** and if yes, which ones?

GLOSSARY FOR THE SELECTED INDICATORS

The indicators have been selected following a thorough international literature review of papers focusing on the vulnerability of buildings to wildfire, and the description of damage patterns.

1. **Building environment** (information related to the settlement the building is located in and the adjacent forest)

Building density: the building density of the settlement where the building is located in.
Distance to neighbouring building: distance to the closest neighbouring building
Water sources: natural (e.g. stream) or man-made (e.g., fire hydrant) water sources in the vicinity of the building
Vegetation density: the form of the nearby forest (single trees, groups of trees, dense forest)
Forest type: dominant type of trees in the forest (coniferous, deciduous, or even specific species like pines, firs, etc.)
Protective strips or firebreaks in the adjacent forest: the existence of these features in the nearby forest.

2. **Building exterior** (immediate surroundings of the building)

Combustible materials: natural (e.g., dead wood) and objects (e.g. garden furniture) in the property/surrounding garden).
Ground covering: what is the covering of the ground in the land plot where the building is located (e.g., bare ground/soil, dry grass, man-made, etc.)
Property boundary: the material of the surrounding wall or fence of the land plot if any (wood, brick, stone, or no boundary).
Terrain slope: the slope angle of the land plot where the building is located.
Type of vegetation on the property: type of vegetation surrounding the building within the property (e.g. pot plants, bushes, trees). (Not necessarily the type of vegetation of the adjacent forest)
Distance of tree crowns/vegetation from the building: are the surrounding trees adjacent to the building? Do the crowns touch the building or are they overhanging?
Distance to the forest edge: how far the house is located from the adjacent forest.

3. **Building Characteristics** (information related to the building itself)

Number of floors: ground floor or multiple floors
Building material: The dominant material of the building (e.g., brick, concrete, stone, wood)
Facade / Cladding: the existence of additional material for cladding on the facade of the building may be combustible and may increase its vulnerability to wildfire
Roof material: The material of the roof (wood, brick, metal, etc.)
Roof shape (complexity): the shape of the roof (flat, arched, etc.) and/or the complexity of this shape.
Roof overhang: The length of the roof overhang (the part of the roof that hangs over the walls) may help the fire spread from a lower level to the roof of the building.
Shutters/(external) roller blinds: the existence of these features on the building.
Door/window material: material of the window frames and doors (wood, plastic, metal).