

**WUFI®**

# **Guideline for Assessing the Risk of Mould Growth with WUFI®**

**Date: March 2026**

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# Basics: Mould Growth in and on Components

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Mould growth in occupied dwellings has the following effects on the occupants, among others:

- Aesthetic concerns
- Hygienic concerns
- Potential health hazards due to the production and dissemination of harmful substances



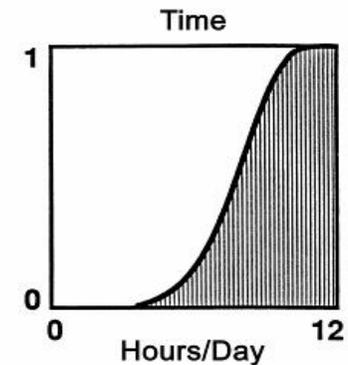
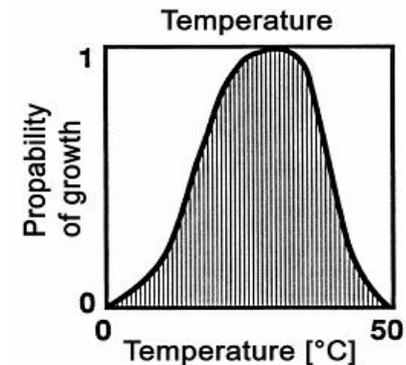
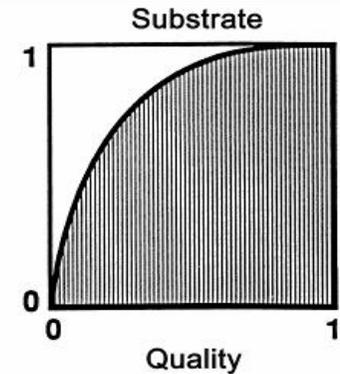
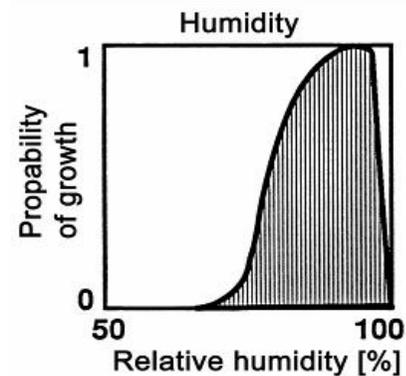
# Basics: Factors Influencing Mould Growth

<u>Influencing Factor</u>	<u>Reality</u>	<u>Consideration</u>
Moisture	Most important influence	<p>Can be influenced or determined by the planner through construction and material selection respectively through consideration of real usage.</p> <p>(These factors are also considered in WUFI® Bio)</p>
Temperature	Strong influence	
Time	Strong influence	
Substrate	Nutrients from substrate and contaminated surfaces	
pH-value	Is influenced by the fungi themselves – difficult to predict	<p>Mostly difficult to predict – should in doubt be considered favourable.</p> <p>(These factors cannot be considered in WUFI® Bio)</p>
Light	Growth also possible without light	
Oxygen	Normally available	
Presence of spores	Normally available everywhere	
Surface roughness	Lighter contamination	
Biological interactions	unavoidable	

# Basics: Factors Influencing Mould Growth

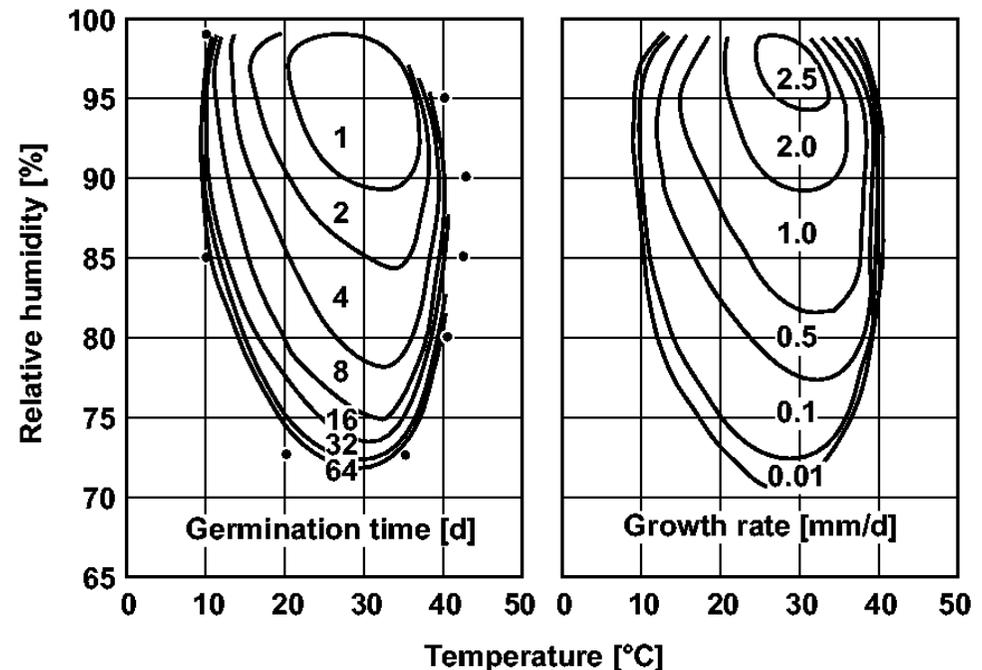
## Growth requirements for mould:

Reduction to the essential influencing factors temperature and humidity, their combined exposure time as well as the substrate quality.



## Germination and growth conditions of single mould species:

- Mould spores are exposed to different combinations of temperature and relative humidity, and the times needed for germination are plotted in a temperature-humidity diagram. The curves of equal germination time are called isopleths.
- Isopleth systems for germination time and growth rate of *Aspergillus restrictus* (Smith\*):

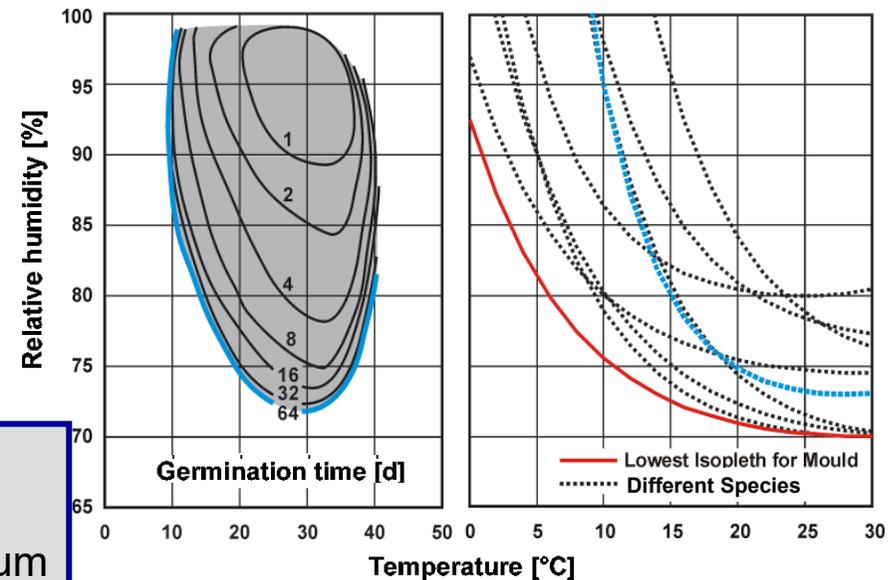


Smith, S. L.; Hill, S. T.: Influence of temperature and water activity on germination and growth of *Aspergillus restrictus* and *Aspergillus versicolor*. Transactions of the British Mycological Society Vol. 79 (1982), H. 3, S. 558 - 560.

## Combination of the lowest growth conditions to LIM-Curves:

- The lowest germination isopleth (left figure – blue curve) separates the diagram into the region where ambient conditions allow the spore to germinate and the region where germination is not possible.
- For all practically relevant mould species, the lowest germination isopleths are combined into one diagram (right figure) and then the lower envelope of this set of curves is defined as generic Lowest Isopleth for Mould growth (LIM, right figure – red curve)

Substrate:  
Optimal  
culture medium



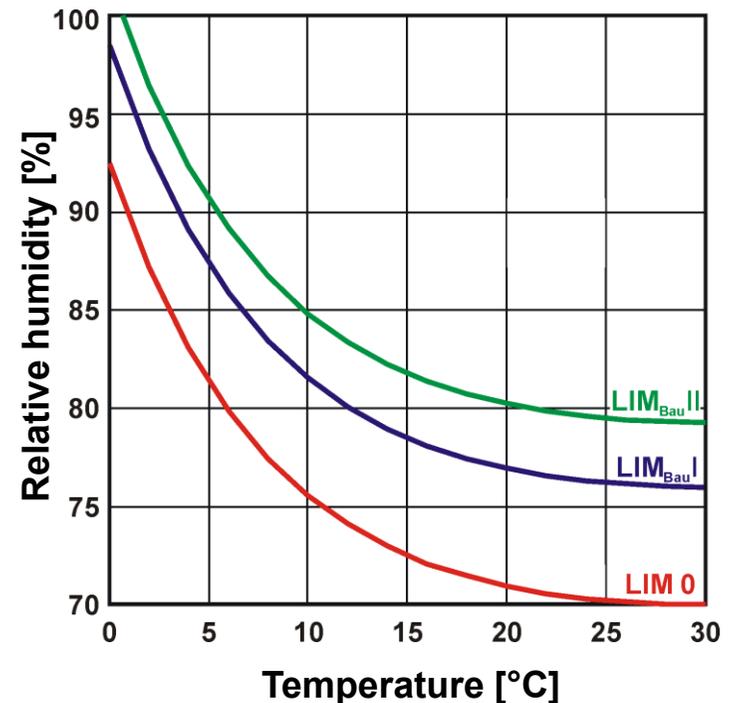
## Adaption of the LIM-curves from optimum substrate to building materials:

- Experimental determination of the isopleth systems by cultivating the mould on a culture medium (biological full medium).
- In buildings generally only substrates with a lower nutrient supply are available → consideration of the nutrient quality by the use of two substrate classes for building materials:

II less bio-utilizable substrates  
(mineral building materials)

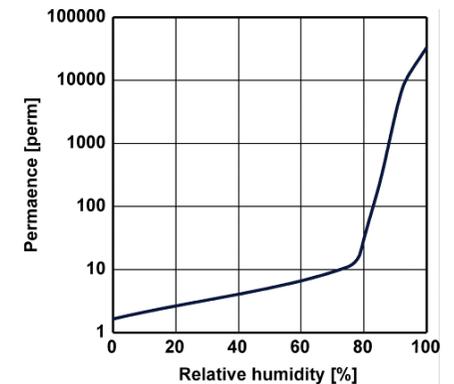
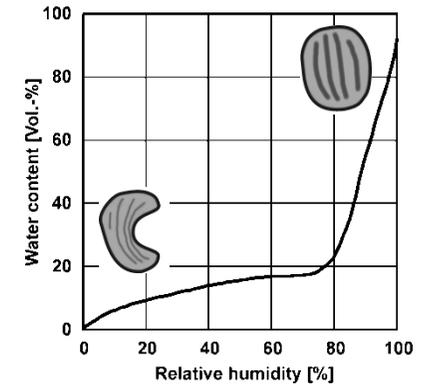
I bio-utilizable substrates  
(wall paper, wood, strongly  
contaminated surfaces)

0 optimum substrate  
(biological full medium)

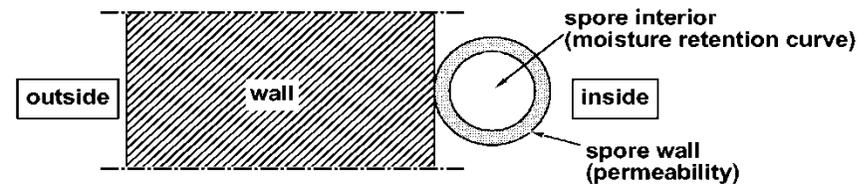


## Calculation of a generic model spore:

- A mould spore has a certain osmotic potential which enables it to take up water from its environment  
→ mathematically this potential can be described by a moisture storage function.
- The spore wall has a moisture-dependent diffusion resistance, which delays the moisture exchange with the environment.
- With changing ambient temperature and humidity the water content in the spore also changes  
→ by reaching a certain critical water content, the spore germinates.



model spore



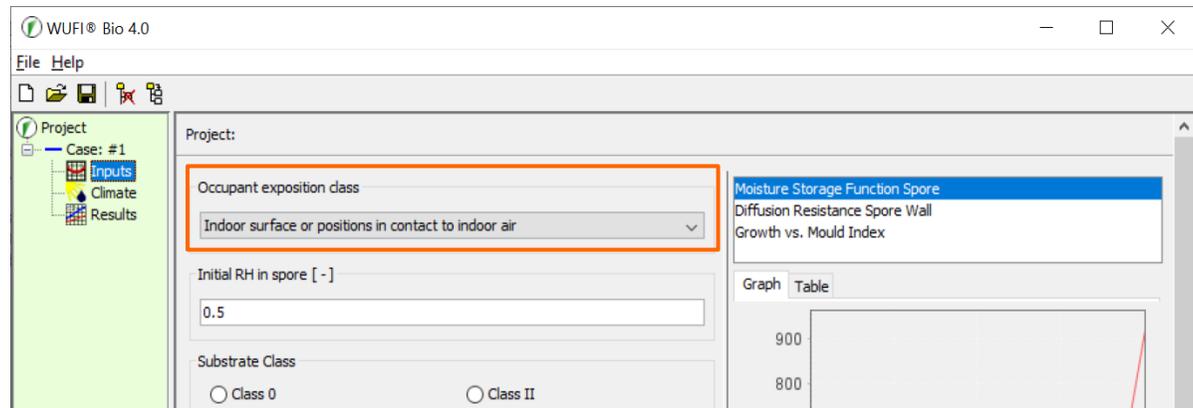
1. Comparison of the calculated conditions with the LIM curves shows whether temperature and humidity combinations occur, in which long-term germination of the spore would be expected.
2. If so, evaluation of the position with WUFI® Bio and calculation of the temperature-dependent water content in the model spore.
3. If the limit water content is exceeded in the spore, the spore germinates and mycelium growth starts.
4. The expected growth is then given according to the growth isopleths and summed up.
5. The traffic light helps assess the risk.

**Download-Link WUFI Bio: [WUFI® Add-ons | WUFI \(en\)](#)**

- The biohygrothermal model is an assessment of the risk of mould growth, it is not necessarily a realistic simulation of the growth processes in all points.
- Usually, the predicted spore germination times may be shorter, or the growth rates may be higher than they are under real conditions (safe side)!
- It is assumed that mycelium growth stops when the moisture content in the spore falls below a critical water content, and instantly resumes when the critical water content is exceeded again.
- The biohygrothermal model is only applicable for interior surfaces. In the case of differing boundary conditions (for example in the construction or on exterior surfaces) it must be considered in individual cases, whether the model can be used. Maybe other effects can impede the growth: heating through solar radiation, disinfection through UV radiation or washing-off through rain. However, comparative evaluations can also be carried out at these positions. We recommend to use the model only on the warm side in the construction.

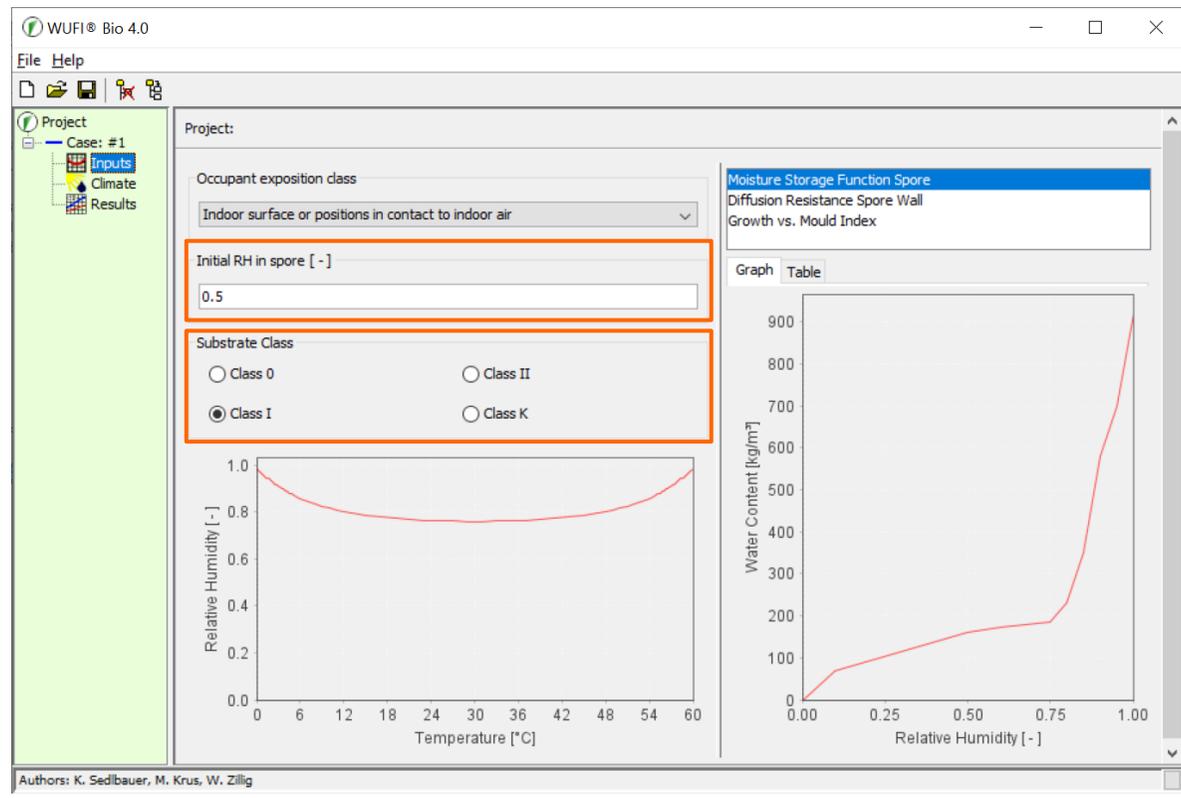
## Input data:

- Specification of the occupant exposition class. This indicates the extent to which the user gets into contact with the evaluated position of the component (respectively with the mould or spore).
- Three classes are available:
  - Indoor surface or position in contact to indoor air  
(e.g. interior wall surface, installation layer, etc.)
  - Surface inside construction without direct contact to indoor air  
(e.g. unused roof space, outside ventilated cavity of a wall, etc.)
  - No impact on occupants expected  
(e.g. perimeter insulation, cavities in multi-layered, rendered masonry, etc.)



## Input data:

- Specification of the initial humidity in the simulated spore. This only affects the early stages of the simulation. After a while, the water content in the spore will be dominated by the ambient conditions. (recommendation: 0.5)
- Selection of the substrate class:
  - Class 0
  - Class I
  - Class II
  - Class K(growth properties of species critical to health)

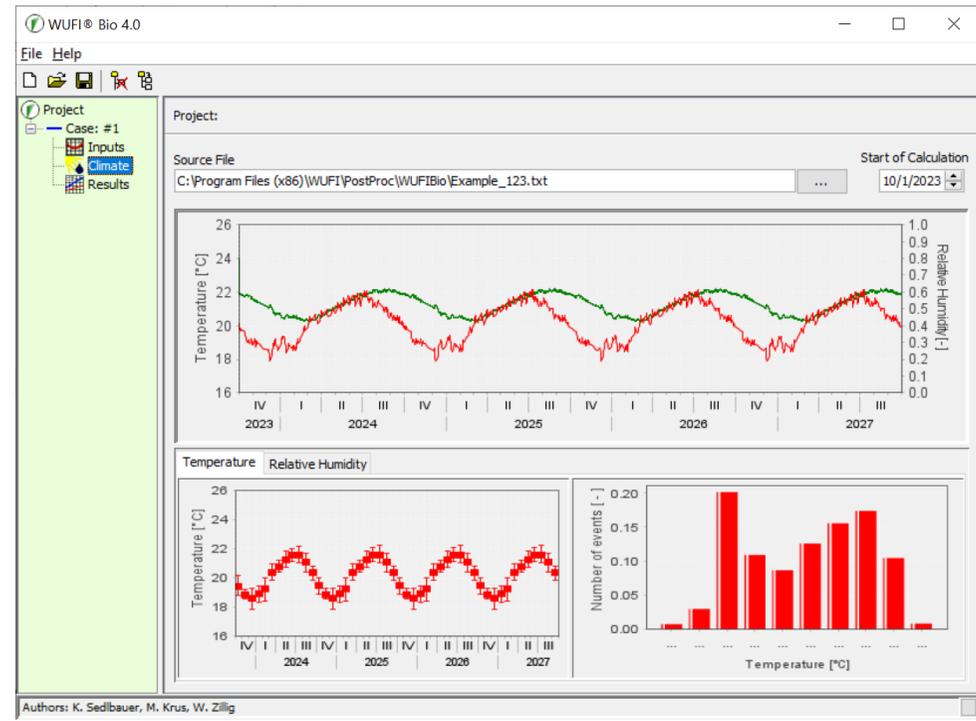


## Input data:

- Specify the climatic conditions to which the model spore is exposed.
- If you have started WUFI® Bio directly out of WUFI® or Animation1D, the climate conditions will automatically be transferred to WUFI® Bio and displayed in this dialog.

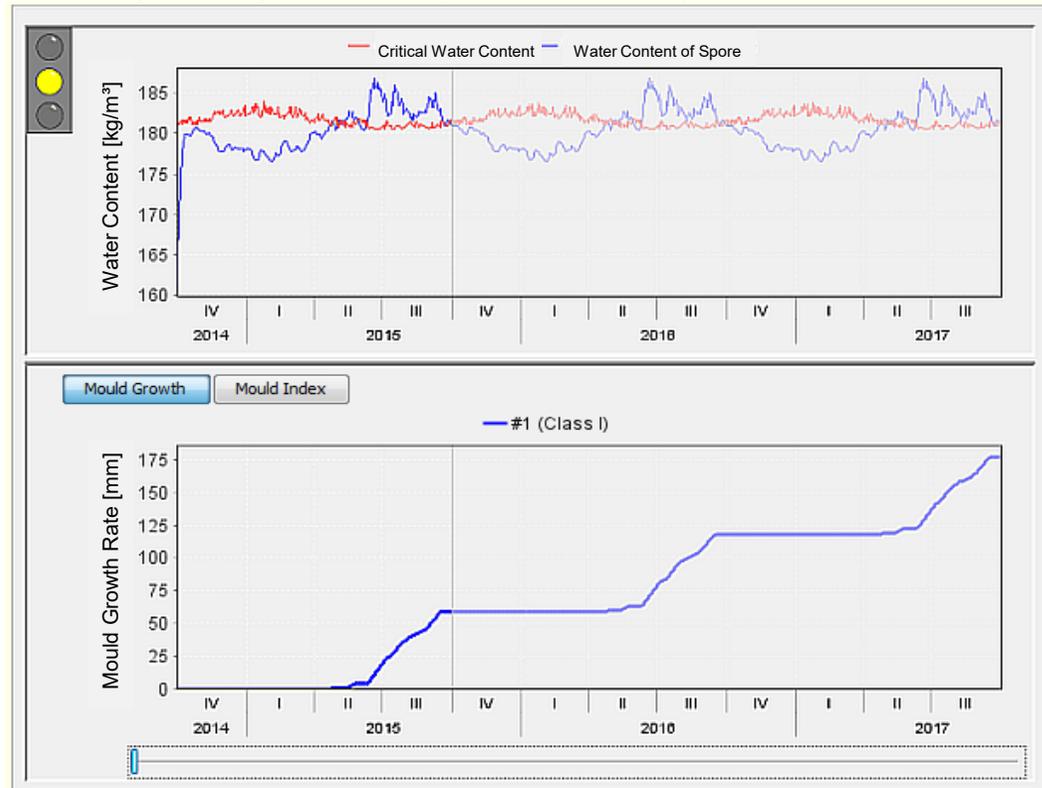
**Note:** If WUFI® Bio is started directly out of WUFI®, only the climate conditions of the interior surface are shown. To evaluate a different position, WUFI® Bio must be started from Animation1D. Here you can select any grid element.

- Otherwise, climate data can be imported manually (e.g. measurement data).



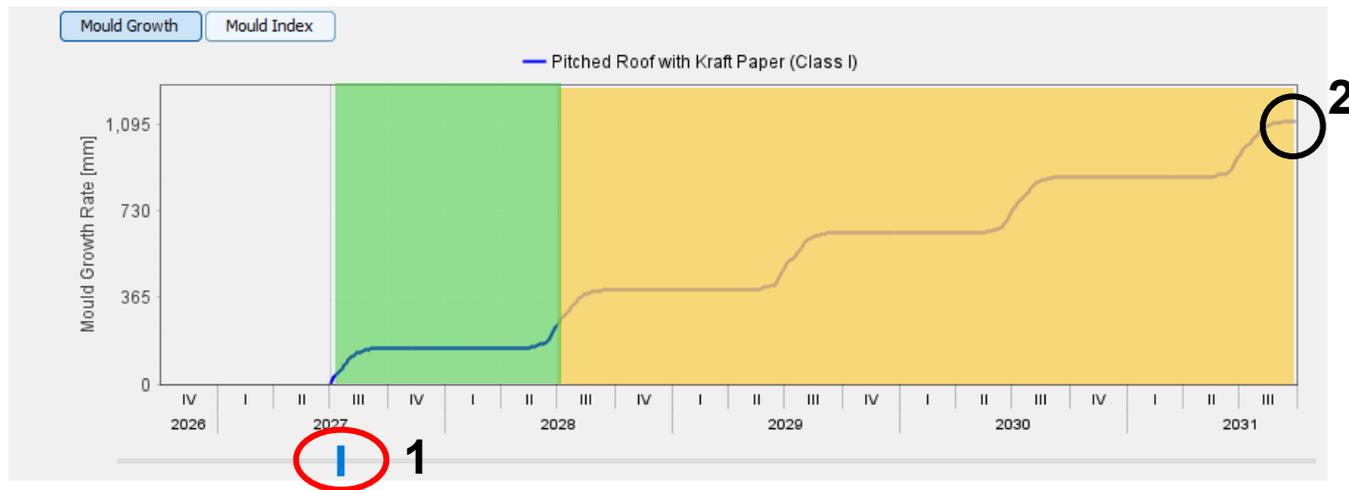
## Evaluation of the results:

- Top diagram: calculated water content in the spore (blue) and the critical water content (red).
- Bottom diagram: mycelium growth (in mm) to be expected after germination.
- Growth rate:  
Describes by how many millimeters the edge of the infested area moves outward over time; the total growth is then the radius of a mould blotch (in a petri bowl).
- Alternatively:  
Result of the evaluation can be expressed in terms of the "mould index".



## Evaluation of the results: Mould Growth Rate [mm]

- The starting point of the evaluation can be adjusted within the calculation period using the slider (1). Each evaluation period covers one year (green area).
- The growth predicted for the following period (green and orange area) represents a forecast starting from the selected evaluation point.
- When slider (1) is moved, both the start date of the growth analysis and the maximum expected growth at the end of the evaluation period (2) change.



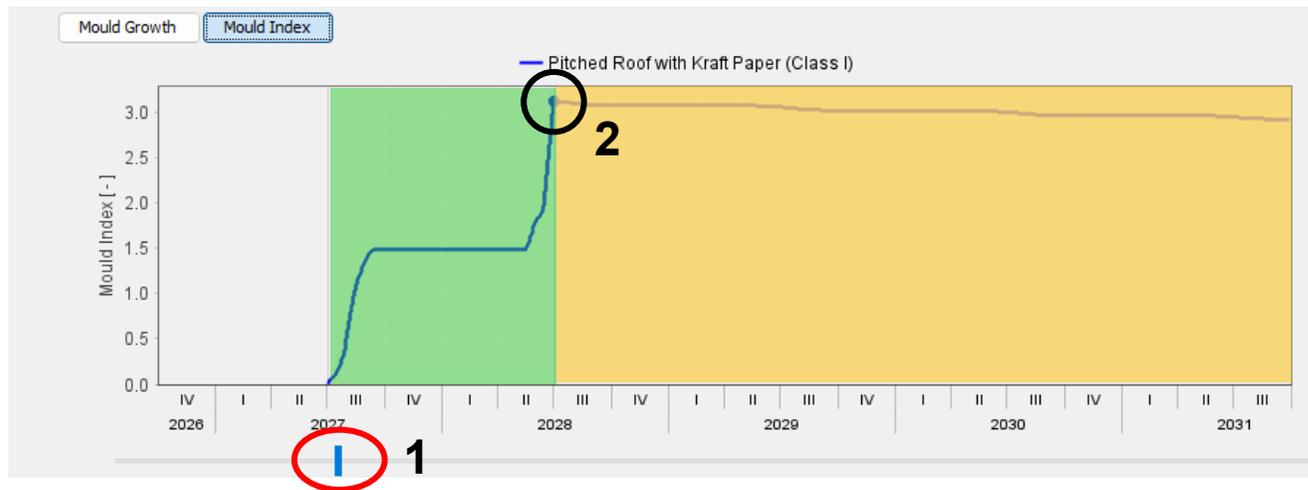
## Evaluation of the results: Mould Index

- The Viitanen model uses a six-level “Mould Index” describing the intensity and spread of the growth.
- Since the “Mould Index” can be interpreted more easily, WUFI® Bio's mould growth can automatically be translated into the “Mould Index”.

Index	Description
0	no growth
1	some growth visible under microscope
2	moderate growth visible under microscope, coverage more than 10%
3	some growth detected visually; thin hyphae found under microscope
4	visual coverage more than 10%
5	coverage more than 50%
6	tight coverage, 100%

## Evaluation of the results: Mould Index

- The one-year evaluation period can be shifted within the calculation period using the slider (1) (green area). The value at the end of this one-year period (2) is used for the assessment.
- Each point in the following period (orange area) represents the predicted end state of the preceding one-year evaluation period.
- When slider (1) is moved, both the start date of the evaluation and the corresponding mould index value at the end of the one-year period (2) change.



## Evaluation of the results:

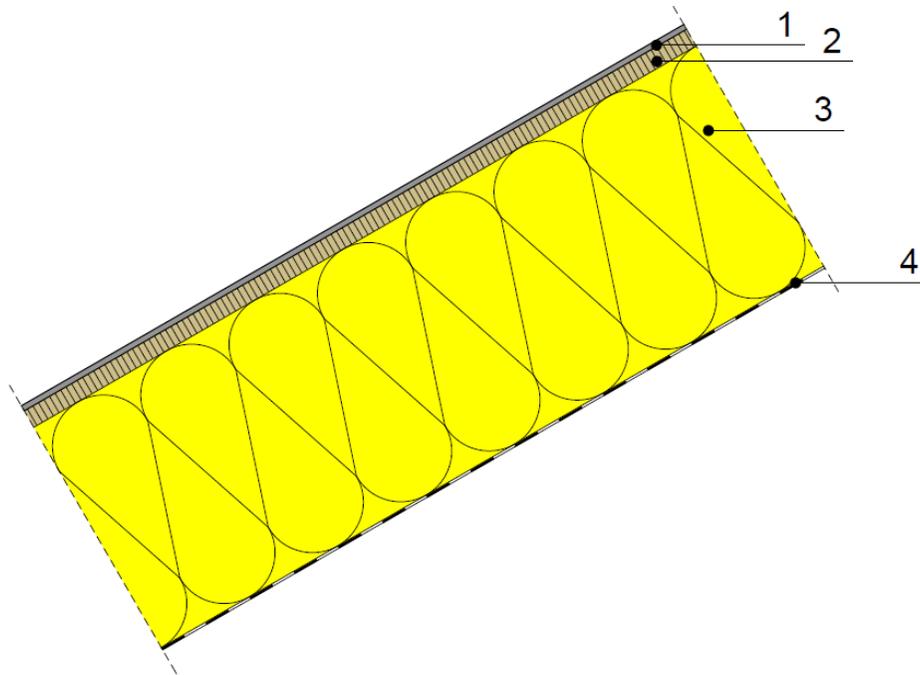
- The signal light presents a general assessment of the mould growth risk.

		Occupant exposition class		
		Indoor surface or position in contact to indoor air	Surfaces inside constructions without direct contact to indoor air	No impact on occupants expected
	Mould Growth ( $g_m$ )	(< 129 mm/year)	(< 176 mm/year)	(< 239 mm/year)
	Mould-Index ( $MI$ )	< 1	< 2	< 3
	Assessment	Usually acceptable.		
	Mould Growth ( $g_m$ )	(129 ≤ $g_m$ < 176 mm/year)	(176 ≤ $g_m$ < 239 mm/year)	(≥ 239 mm/year)
	Mould-Index ( $MI$ )	1 ≤ $MI$ < 2	2 ≤ $MI$ < 3	≥ 3
	Assessment	Additional criteria or investigations are needed for assessing acceptability.		
	Mould Growth ( $g_m$ )	(≥ 176 mm/year)	(≥ 239 mm/year)	
	Mould-Index ( $MI$ )	≥ 2	≥ 3	
	Assessment	Usually not acceptable.		
		Calculation period is less than 1 year. No assessment possible.		

## Examples: Problem Description

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Using the example of a pitched roof with metal sheet and two different interior vapour retarders, the procedure for assessing mould risk is explained.



- 1 Metal roofing (zinc)
- 2 Wooden sheathing
- 3 Insulation
- 4 Vapour retarder

**Note:** It is assumed that the wooden sheathing has an increased initial moisture content!

## Examples: Component Assembly

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### Assembly (from outside to inside):

- Zinc roofing ( $s_d = 50$  m)
- Wooden sheathing (Softwood) 0.02 m
- Mineral Wool (heat cond.: 0.04 W/mK) 0.14 m
- Case 1: Kraft Paper ( $s_d = 3$  m)  
Case 2: PA-Membrane (moisture-variable)

## Examples: Boundary Conditions

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### Boundary Conditions:

- Pitched roof (50° to the North)
- Zinc surface ( $a = 0.6$ ;  $\varepsilon = 0.4$ )
- Outdoor Climate: Holzkirchen
- Indoor Climate: EN 15026 with medium moisture load +5%
- Air tightness of the der building envelope:  $q_{50} = 3 \text{ m}^3/\text{m}^3\text{h}$
- Stack height: 5 m
- Initial moisture in the wooden sheathing: 25 % by mass

## Example: Evaluation Matrix

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### Evaluation Matrix:

The following matrix shows the evaluation criteria relevant to this design.

	Criteria
1) Numerics	No or only small differences in balances (especially in the case of convergence failures)?
	Consistent, periodic course of total water content?
2) Evaluation parameters	Total water content reach dynamic equilibrium or decreases?
	Risk of wood decay in the wooden sheathing? (limit values according to DIN 68800 or WTA 6-8)
	Risk of mould growth behind the membrane / paper?

# Case 1: Component

Input: Component - Assembly

**Case 1:  
Kraft Paper**

The screenshot shows the WUFI Pro 7.1 software interface. The main window displays the 'Edit Assembly by Table' view for a component assembly. The assembly is defined by three layers:

- Layer: Softwood (formwork, thin layers) with a Thickness [m] of 0.02.
- Layer: Mineral Wool (heat cond.: 0,04 W/mK) with a thickness of 0.14 m.
- Layer: Kraft Paper (partially visible on the right).

The interface also shows a grid view of the assembly and a summary table at the bottom:

Geometry Properties	Total Thermal Performance
Total Thickness [m]: 0.161	R-Value (dry) [m <sup>2</sup> K/W]: 3.72
Number of Layers: 3	U-Value (dry) [W/m <sup>2</sup> K]: 0.256
	R-Value (at 80% RH) [m <sup>2</sup> K/W]: 3.69
	U-Value (at 80% RH) [W/m <sup>2</sup> K]: 0.258

**Input the roof assembly without metal sheet  
if necessary: adapt thickness of the layers**

# Case 1: Infiltration Source

Input: Component – Assembly

*Infiltration source according to EN 15026 in the wooden sheathing*

WUFI Pro 7.1

Project Run Outputs Database Result Analysis Help

Project

- Case: 1 Pitched Roof with Kraft Paper
  - Component
    - Assembly
    - Initial Conditions
    - Boundary Conditions (exterior)
    - Boundary Conditions (interior)
    - Control
    - Results

Layer: Softwood (formwork, thin layers) Thickness [m]: 0.02

Exterior (Left Side) Interior (Right Side)

Softwood (for... 0.02 m Mineral Wool (heat cond.: 0,04 W/mK) 0.14 m Kraft paper 0.002 m

+ New Layer Duplicate Delete Materials Material Data Constructions Save

Grid and Sources

Select infiltration source

- Infiltration Source
- Rain Source
- Heat Source
- Moisture Source
- Air Change Source

Grid Setting Automatic (II) 200 Elements Geometry Setting cartesian

Geometry Properties

Total Thermal Performance

Total Thickness [m]: 0.161	R-Value (dry) [m <sup>2</sup> K/W]: 3.72	U-Value (dry) [W/m <sup>2</sup> K]: 0.256
Number of Layers: 3	R-Value (at 80% RH) [m <sup>2</sup> K/W]: 3.69	U-Value (at 80% RH) [W/m <sup>2</sup> K]: 0.258

# Case 1: Infiltration Source

Input: Component - Assembly

Moisture source  
in the interior 5 mm  
of the wooden sheathing.

The screenshot shows the 'Hygrothermal Sources' dialog box with the following settings:

- Name:** Infiltration 1
- Spread Area:**
  - Grid Element
  - Area (right-fixed)
  - Whole Layer
- Thickness [m]:** 0.005
- Source Type:**
  - Transient from File
  - Fraction of incident Driving Rain
  - Air Infiltration model IBP
  - Constant Monthly Moisture Load
- Source Term Cut-Off [kg/m³]:**
  - No Cut-Off
  - Cut-Off at Max. Water Content
  - Cut-Off at Free Water Saturation
  - User-Defined
- Envelope Infiltration q50 [m³/m²h]:**
  - Value: 3
  - Dropdown: Air Tightness Class B (DIN 4108, tested <= 3 m³/m²h)
  - Stack Height [m]: 5
  - Mechanical Ventilation Overpressure [Pa]: 0

Buttons: Delete source, OK, Cancel, Help

Adapt infiltration source

# Case 1: Initial Conditions

## Input: Component – Initial Conditions

WUFI Pro 7.1

Project Run Outputs Database Result Analysis Help

Project

- Case: 1 Pitched Roof with Kraft Paper
  - Component
  - Assembly
  - Initial Conditions**
  - Boundary Conditions (exterior)
  - Boundary Conditions (interior)
  - Control
  - Results

**Initial Temperature** ?

Constant across Component Initial Temperature in Component [°C] 20

Manual settings

**Initial Moisture** ?

Same relative humidity in all layers (e.g. lightweight constructions and fabric)

Assign typical built-in moisture (e.g. solid constructions and new buildings)

Manual settings

- In each Layer
- Read from File

Initial Conditions in Different Layers

No.	Material Layer	Thickness [m]	Temperature [°C]	Rel. Humidity [-]	Water Content [kg/m³]	Typical Built-I... [kg/m³]
1	Softwood (formwork, thin layers)	0.02	20	0.93	100.0	60
2	Mineral Wool (heat cond.: 0,04 W/mK)	0.14				87
3	Kraft Paper	0.001				18

Softwood (formwork, thin layers): Water Content ✖

Mass-%

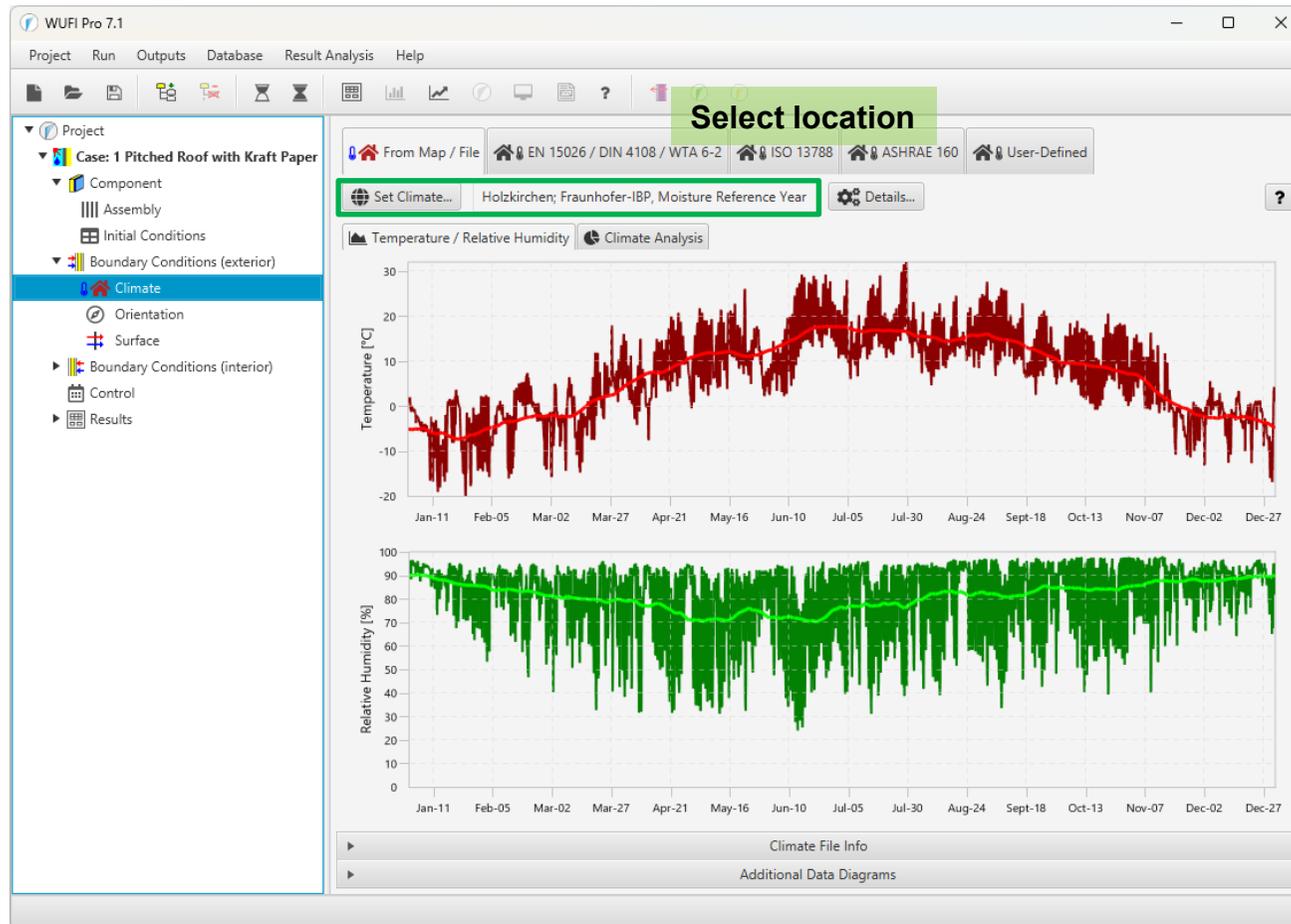
Volume-%

kg/m³

Initial water content in the wooden sheathing: 25 % by mass

# Case 1: Outdoor Climate

Input: Boundary Conditions (exterior) – Climate



# Case 1: Orientation / Inclination

Input: Boundary Conditions (exterior) – Orientation

The screenshot displays the WUFI Pro 7.1 software interface. The left sidebar shows a project tree with 'Orientation' selected under 'Boundary Conditions (exterior)'. The main window is divided into three panels:

- Orientation:** A compass rose showing cardinal directions (N, S, E, W) and intercardinal directions (NE, SE, SW, NW). A red arrow points North. A dropdown menu below the compass is set to 'North'.
- Inclination:** A diagram of a roof with a sun icon above it. The roof is tilted at an angle of 50°. Below the diagram, there are two input fields: 'Inclination [°]' with a value of 50 and ' [%]' with a value of 119.18.
- Building Height / Driving Rain Coefficients:** Two radio buttons are present: 'Rain load calculation according to WUFI model' (selected) and 'Rain load calculation according to ASHRAE Standard 160'. Below these are two input fields: 'R1 [-]' with a value of 1 and 'R2 [ s/m ]' with a value of 0. A 'Note: Rain Load =' label is at the bottom.

A green callout box at the bottom right of the interface contains the text: **Adapt orientation and inclination**

# Case 1: Surface Transfer Coefficients (exterior)

Input: Boundary Conditions (exterior) – Surface

WUFI Pro 7.1

Project Run Outputs Database Result Analysis Help

Project

- Case: 1 Pitched Roof with Kraft Paper
  - Component
    - Assembly
    - Initial Conditions
    - Boundary Conditions (exterior)
      - Climate
      - Orientation
      - Surface
    - Boundary Conditions (interior)
    - Control
    - Results

**Heat Transfer**

Heat Transfer Coefficient [W/m<sup>2</sup>K] 19 Roof

long-wave radiation parts Heat Transfer Coefficient [W/m<sup>2</sup>K] 6.5

wind-dependent

Wind-dependence formula

**Vapour Transfer**

Additional diffusion resistance (e.g. coating), sd-Value [m] 50.0 Metal roofing (incl. seams)

Note: This setting does not affect rain absorption.

**Radiation**

Short-wave absorptivity, e.g. solar radiation [-] 0.6 User-Defined

Radiative overcooling  Note: Explicit Radiation Balance, includes radiative cooling due to long-wave emission.

Long-wave emissivity, e.g. nighttime radiative cooling [-] 0.4

Additional radiation parameters

Reduction factors

**Rain**

Simulation takes rain into account

Rain parameters

Heat transfer coefficient (from list: Roof)

$s_d$ -value metal roofing (from list:  $s_d = 50$  m)

Absorptivity = 0.6

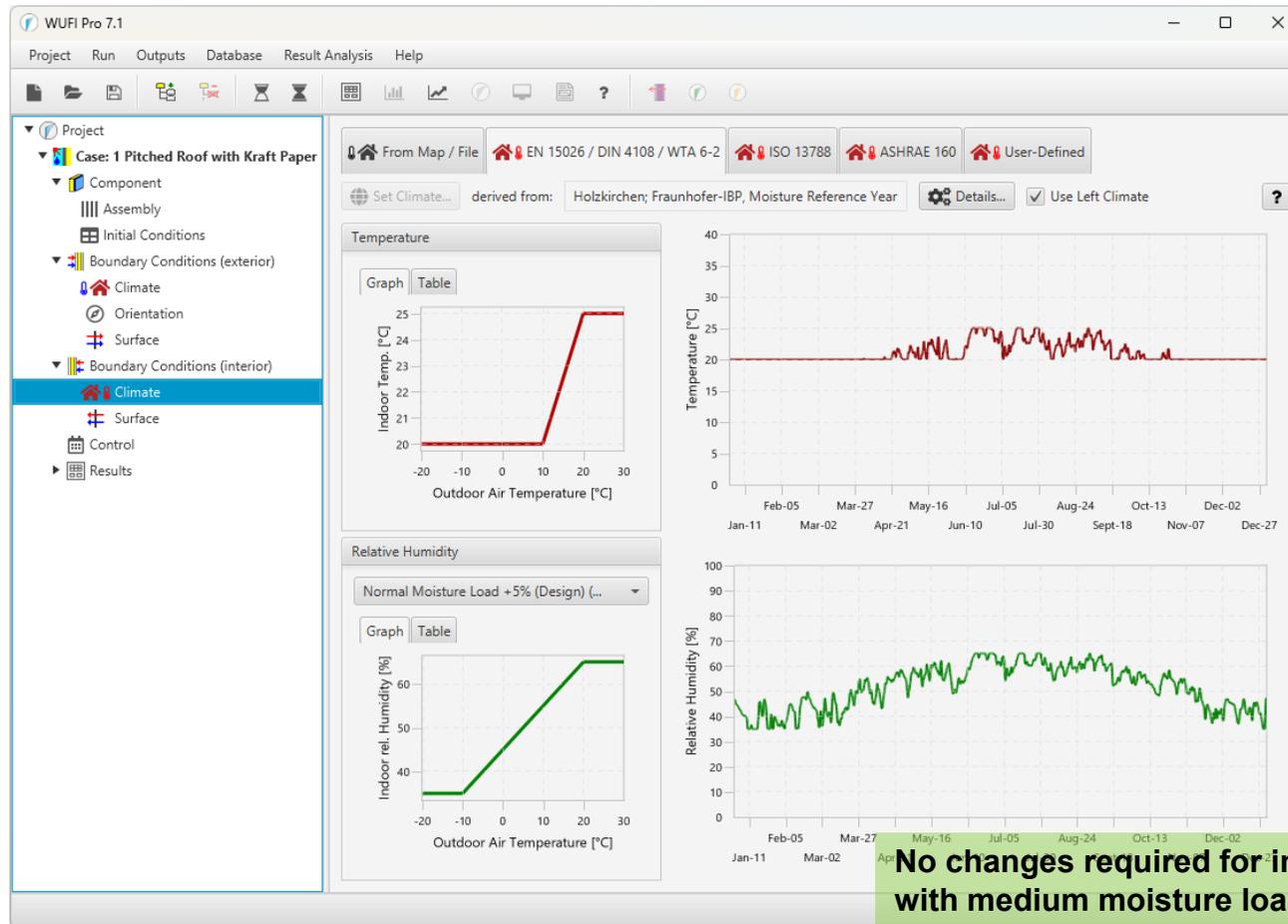
Consider radiation overcooling; Emissivity = 0.4

No rainwater absorption

Adapt surface transfer coefficients!

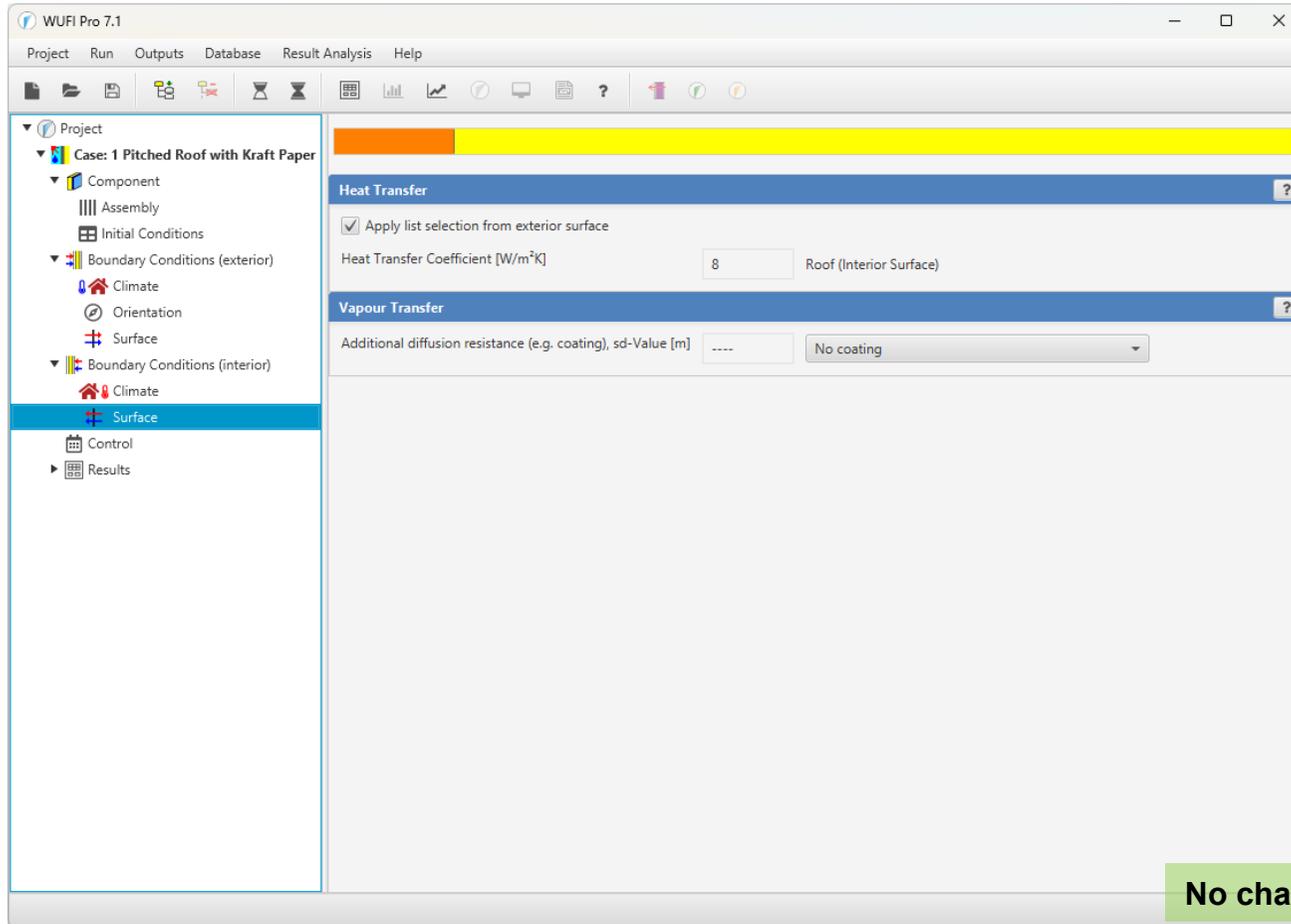
# Case 1: Indoor Climate

## Input: Boundary Conditions (interior) – Climate



# Case 1: Surface Transfer Coefficients (interior)

Input: Boundary Conditions (interior) – Surface



The screenshot displays the WUFI Pro 7.1 software interface. The left sidebar shows a project tree with 'Case: 1 Pitched Roof with Kraft Paper' expanded to 'Boundary Conditions (interior) > Surface'. The main window shows the 'Heat Transfer' and 'Vapour Transfer' settings for the selected surface. The 'Heat Transfer' section has a checked box for 'Apply list selection from exterior surface' and a text input field for 'Heat Transfer Coefficient [W/m²K]' with the value '8' and the label 'Roof (Interior Surface)'. The 'Vapour Transfer' section has a text input field for 'Additional diffusion resistance (e.g. coating, sd-Value [m])' with the value '....' and a dropdown menu set to 'No coating'. A green callout box in the bottom right corner of the software window contains the text 'No changes required'.

# Case 1: Calculation Period

## Input: Control

WUFI Pro 7.1

Project Run Outputs Database Result Analysis Help

Project

- Case: 1 Pitched Roof with Kraft Paper
  - Component
    - Assembly
    - Initial Conditions
  - Boundary Conditions (exterior)
    - Climate
    - Orientation
    - Surface
  - Boundary Conditions (interior)
    - Climate
    - Surface
  - Control**
  - Results

**Period of Calculation** ?

Start of Calculation 12 Feb 2026

Calculation Period 5.0 years

Define profiles

**Adaptive Time Step Control** ?

Enable

Adjust options

**Numerics** ?

Mode of Calculation

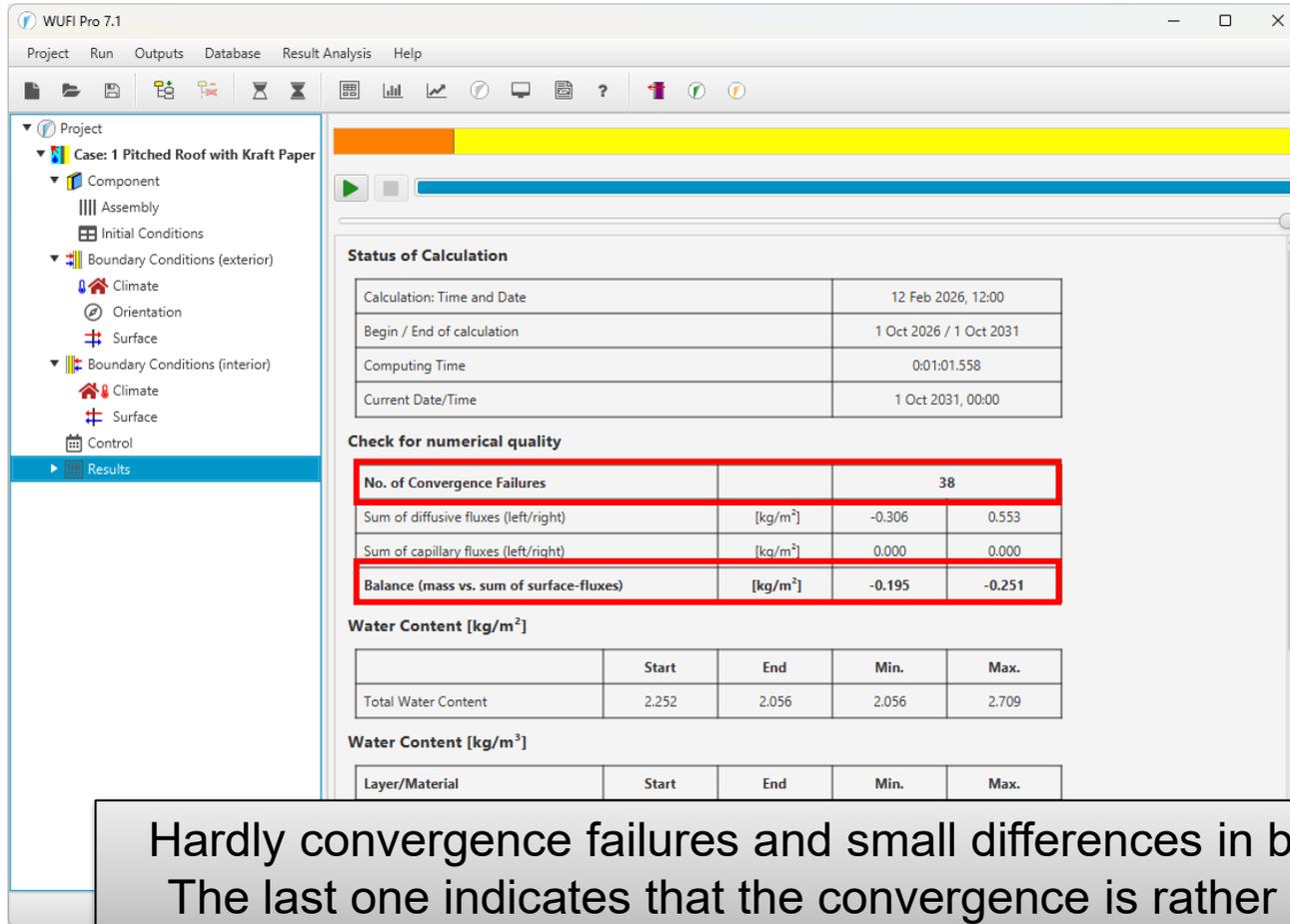
Hygrothermal Special Options

Numerical Expert Settings

Adapt calculation period if necessary

# Case 1: Evaluation – Check for numerical quality

## Evaluation:



The screenshot displays the WUFI Pro 7.1 software interface. The left sidebar shows the project structure for 'Case: 1 Pitched Roof with Kraft Paper'. The main window is divided into several sections:

- Status of Calculation:** A table showing calculation details.
- Check for numerical quality:** A table with three rows, where the first and last rows are highlighted with red boxes.
- Water Content [kg/m<sup>2</sup>]:** A table showing water content values.
- Water Content [kg/m<sup>3</sup>]:** A table showing water content values by layer/material.

**Check for numerical quality**

<b>No. of Convergence Failures</b>			<b>38</b>
Sum of diffusive fluxes (left/right)	[kg/m <sup>2</sup> ]	-0.306	0.553
Sum of capillary fluxes (left/right)	[kg/m <sup>2</sup> ]	0.000	0.000
<b>Balance (mass vs. sum of surface-fluxes)</b>	<b>[kg/m<sup>2</sup>]</b>	<b>-0.195</b>	<b>-0.251</b>

**Water Content [kg/m<sup>2</sup>]**

	Start	End	Min.	Max.
Total Water Content	2.252	2.056	2.056	2.709

**Water Content [kg/m<sup>3</sup>]**

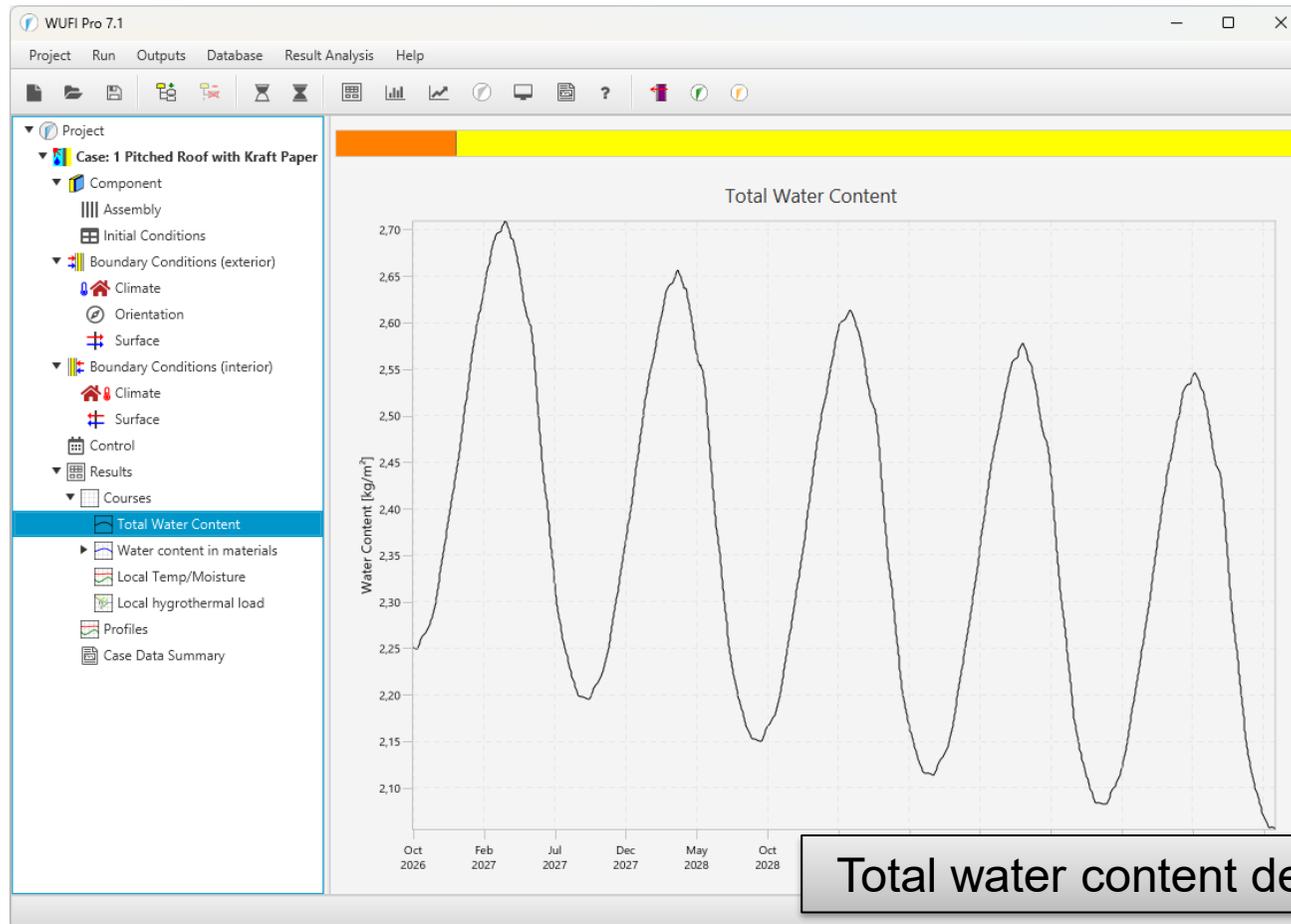
Layer/Material	Start	End	Min.	Max.
----------------	-------	-----	------	------

Hardly convergence failures and small differences in balances!  
The last one indicates that the convergence is rather difficult.

# Case 1: Evaluation – Total Water Content

## Evaluation:

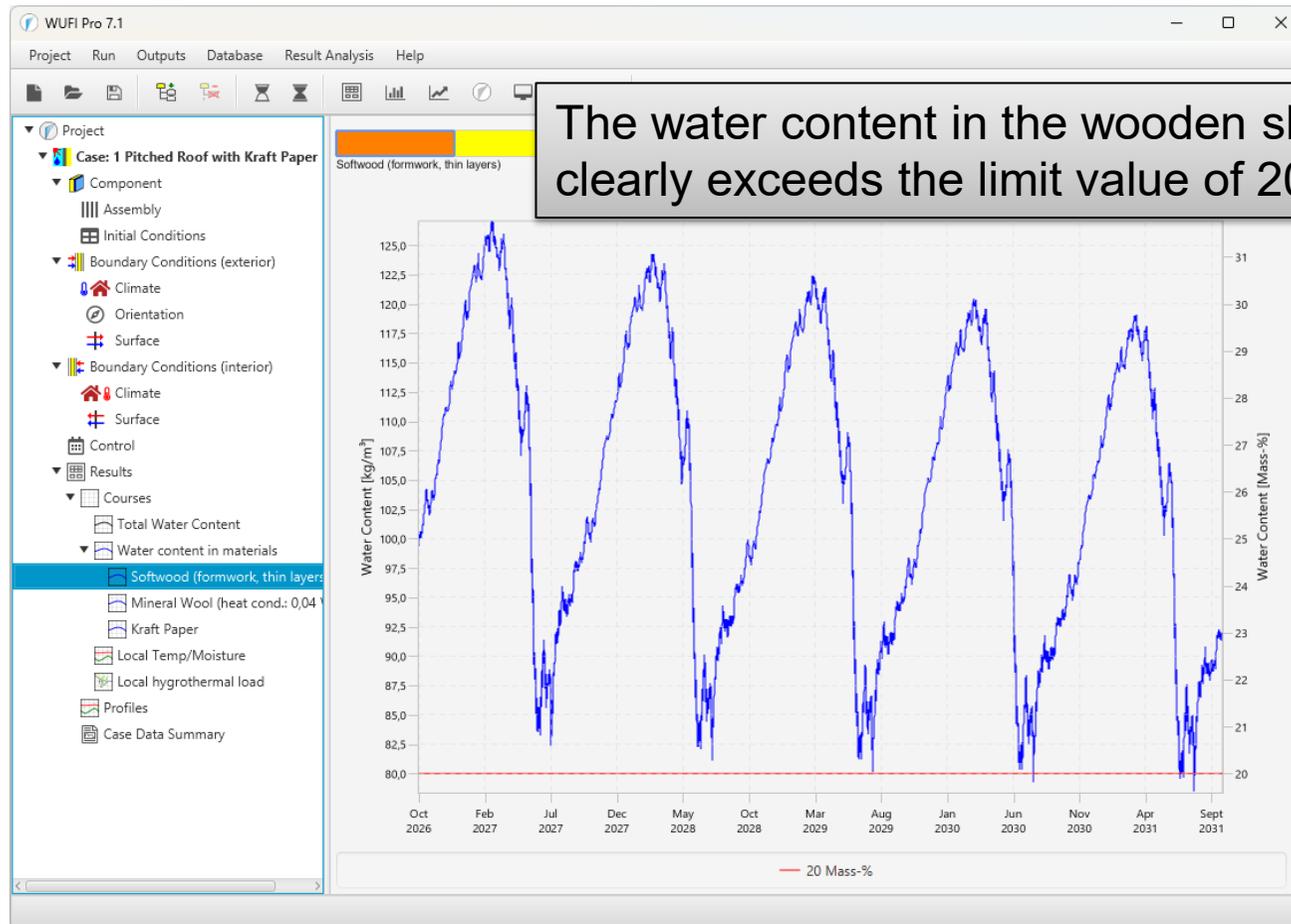
### Total water content



# Case 1: Evaluation – Wooden Sheathing

## Evaluation:

### Water content in the wooden sheathing

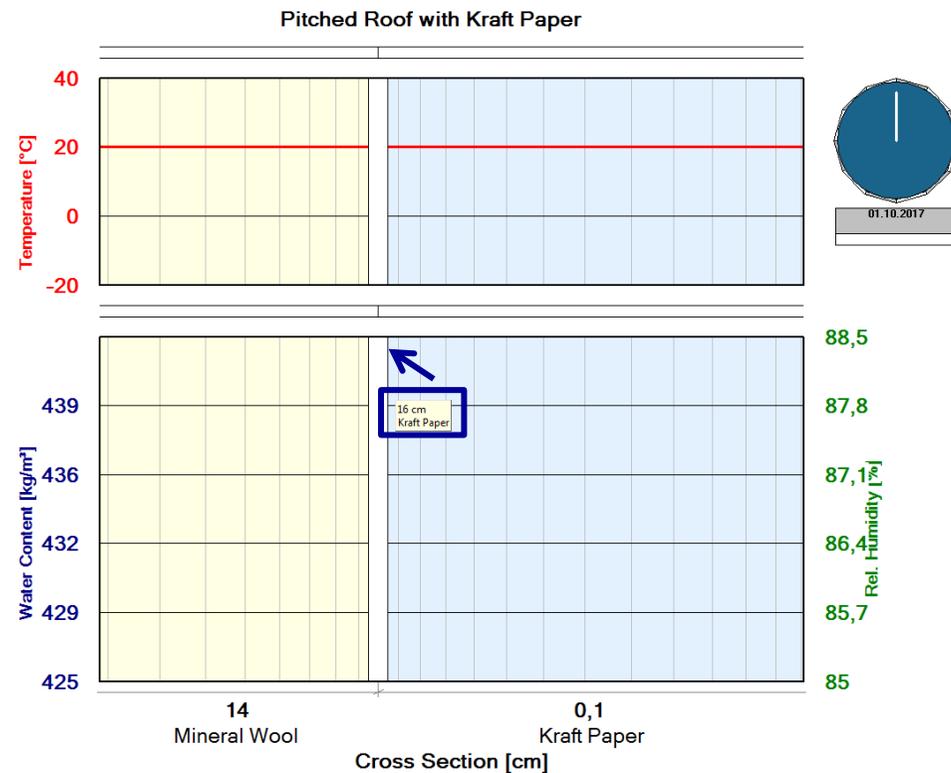


# Case 1: Evaluation – mould growth behind vapour retarder

## Evaluation:

Mould growth risk behind the vapour retarder

- Open WUFI® Animation
- Zoom in the boundary layer mineral wool / vapour retarder (while pressing the left mouse button: pull a box from the upper left to the lower right)
- Press the WUFI® Bio-Button  in the taskbar and select the outermost element of the kraft paper.



# Case 1: Evaluation – mould growth behind vapour retarder

## Evaluation:

Mould growth risk behind the vapour retarder

The screenshot shows the WUFI Bio 4.0 software interface. The 'Project' panel on the left shows 'Case: Case 1: P' with sub-items for 'Inputs', 'Climate', and 'Results'. The main settings area includes:

- Occupant exposition class:** A dropdown menu set to 'Indoor surface or positions in contact to indoor air'. A green callout box points to this menu with the text 'Select Occupant Exposition Class: Indoor surface or position in contact to indoor air'.
- Initial RH in spore [-]:** A text input field containing '0.5'.
- Substrate Class:** Radio buttons for 'Class 0', 'Class I' (selected), 'Class II', and 'Class K'.

Two graphs are displayed:

- Moisture Storage Function Spore:** A line graph showing 'Relative Humidity [-]' on the y-axis (0.0 to 1.0) versus 'Temperature [°C]' on the x-axis (0 to 60). The curve shows a minimum relative humidity around 30°C.
- Diffusion Resistance Spore Wall:** A line graph showing 'Water Content [kg/m³]' on the y-axis (0 to 900) versus 'Relative Humidity [-]' on the x-axis (0.00 to 1.0). The curve shows an exponential increase in water content as relative humidity approaches 1.0.

A green callout box on the left side of the graphs contains the text: 'Select Substrate Class: Kraft Paper corresponds to Substrate Class I due to the usable organic constituents.'

At the bottom of the window, the authors are listed as 'K. Sedlbauer, M. Krus, W. Zillig'.

# Case 1: Evaluation – mould growth behind vapour retarder

## Evaluation:

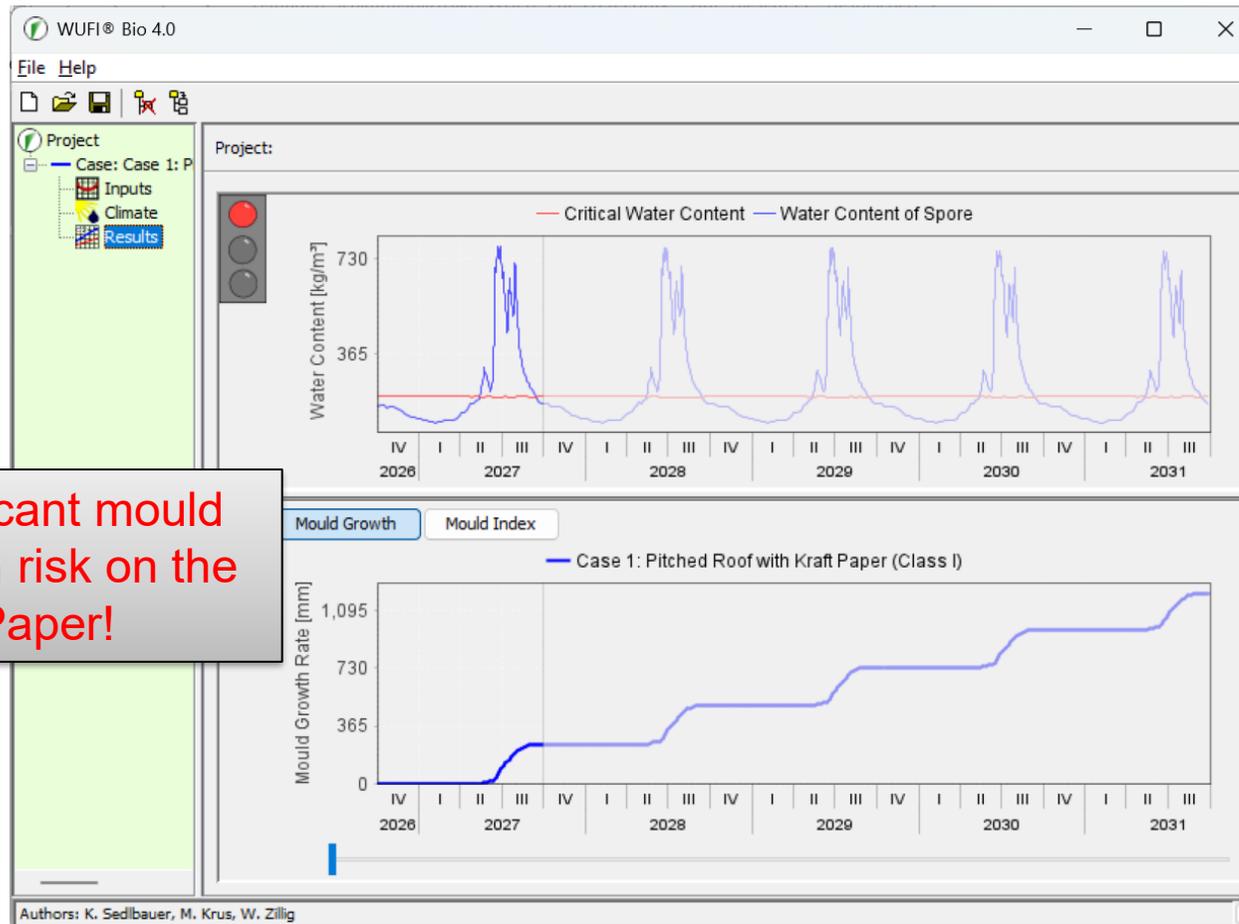
Mould growth risk behind the vapour retarder



# Case 1: Evaluation – mould growth behind vapour retarder

## Evaluation:

Mould growth risk behind the vapour retarder



## Case 1: Evaluation Matrix

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### Evaluation Matrix:

	Criteria	Kraft Paper
1) Numerics	No or only small differences in balances (especially in the case of convergence failures)?	✓
	Consistent, periodic course of total water content?	✓
2) Evaluation parameters	Total water content reach dynamic equilibrium or decreases?	✓
	Risk of wood decay in the wooden sheathing? (limit values according to DIN 68800 or WTA 6-8)	✗
	Risk of mould growth behind the membrane / paper?	✗

# Case 2: Replacement of the Vapour Retarder

Input: Component - Assembly

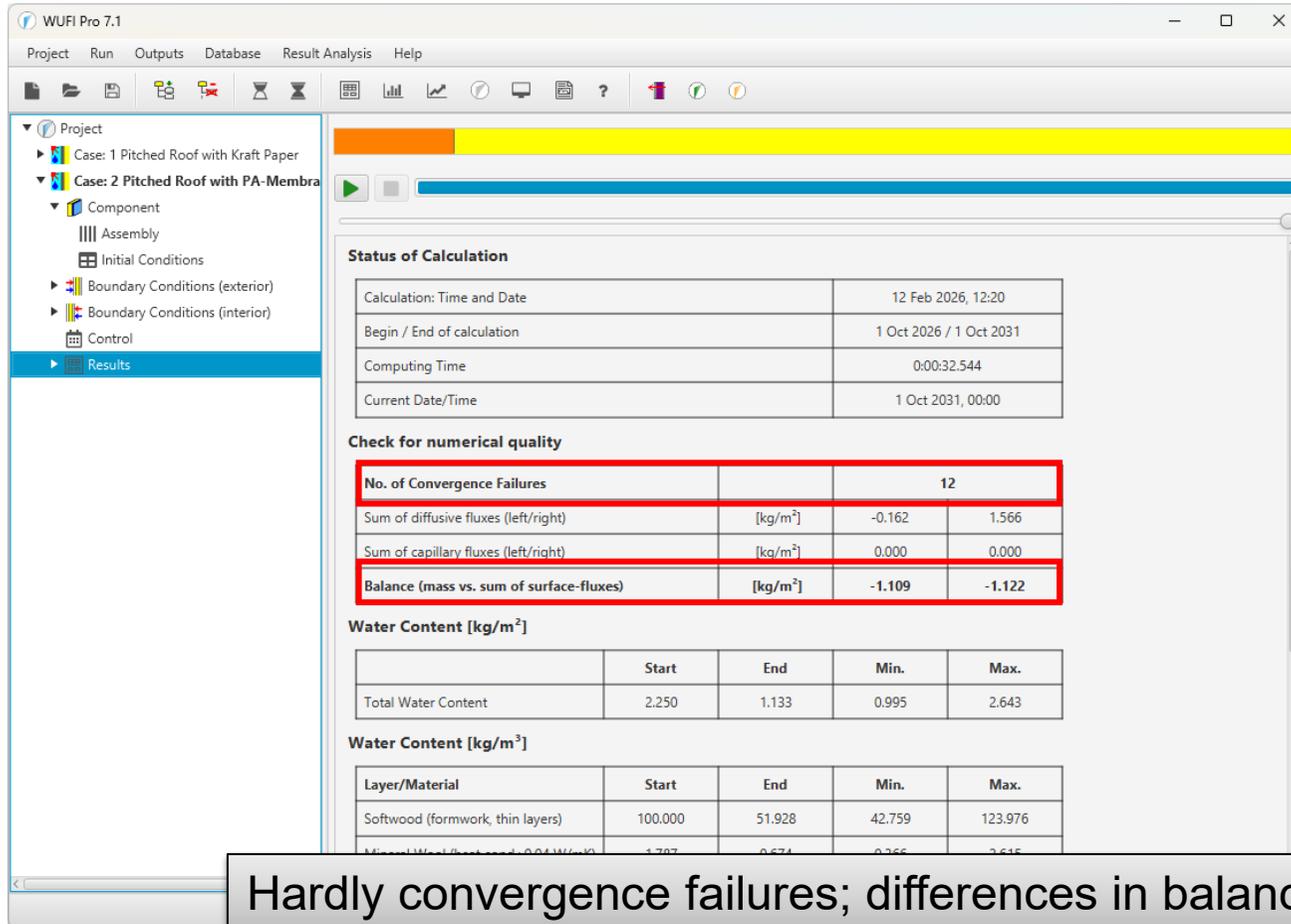
**Case 2:  
PA-Membrane**

The screenshot displays the WUFI Pro 7.1 software interface. The main window shows the assembly configuration for Case 2: PA-Membrane. The assembly is composed of three layers: a 0.02 m thick Softwood layer on the exterior (left side), a 0.14 m thick Mineral Wool layer (heat cond.: 0.04 W/mK) in the middle, and a PA-Membrane layer on the interior (right side). The PA-Membrane layer's thickness is set to 0.001 m, which is highlighted with a green box. The interface also shows a grid and sources view, and a bottom panel with thermal performance data.

Geometry Properties	Total Thermal Performance	
Total Thickness [m]: 0.161	R-Value (dry) [m <sup>2</sup> K/W]: 3.72	U-Value (dry) [W/m <sup>2</sup> K]: 0.256
Number of Layers: 3	R-Value (at 80% RH) [m <sup>2</sup> K/W]: 3.69	U-Value (at 80% RH) [W/m <sup>2</sup> K]: 0.259

# Case 2: Evaluation – Check for numerical quality

## Evaluation:



The screenshot displays the WUFI Pro 7.1 software interface. The left sidebar shows a project tree with 'Case 2 Pitched Roof with PA-Membra' selected. The main window shows the 'Status of Calculation' and 'Check for numerical quality' sections. The 'Check for numerical quality' section contains a table with the following data:

Check for numerical quality			
No. of Convergence Failures			12
Sum of diffusive fluxes (left/right)	[kg/m <sup>2</sup> ]	-0.162	1.566
Sum of capillary fluxes (left/right)	[kg/m <sup>2</sup> ]	0.000	0.000
Balance (mass vs. sum of surface-fluxes)	[kg/m <sup>2</sup> ]	-1.109	-1.122

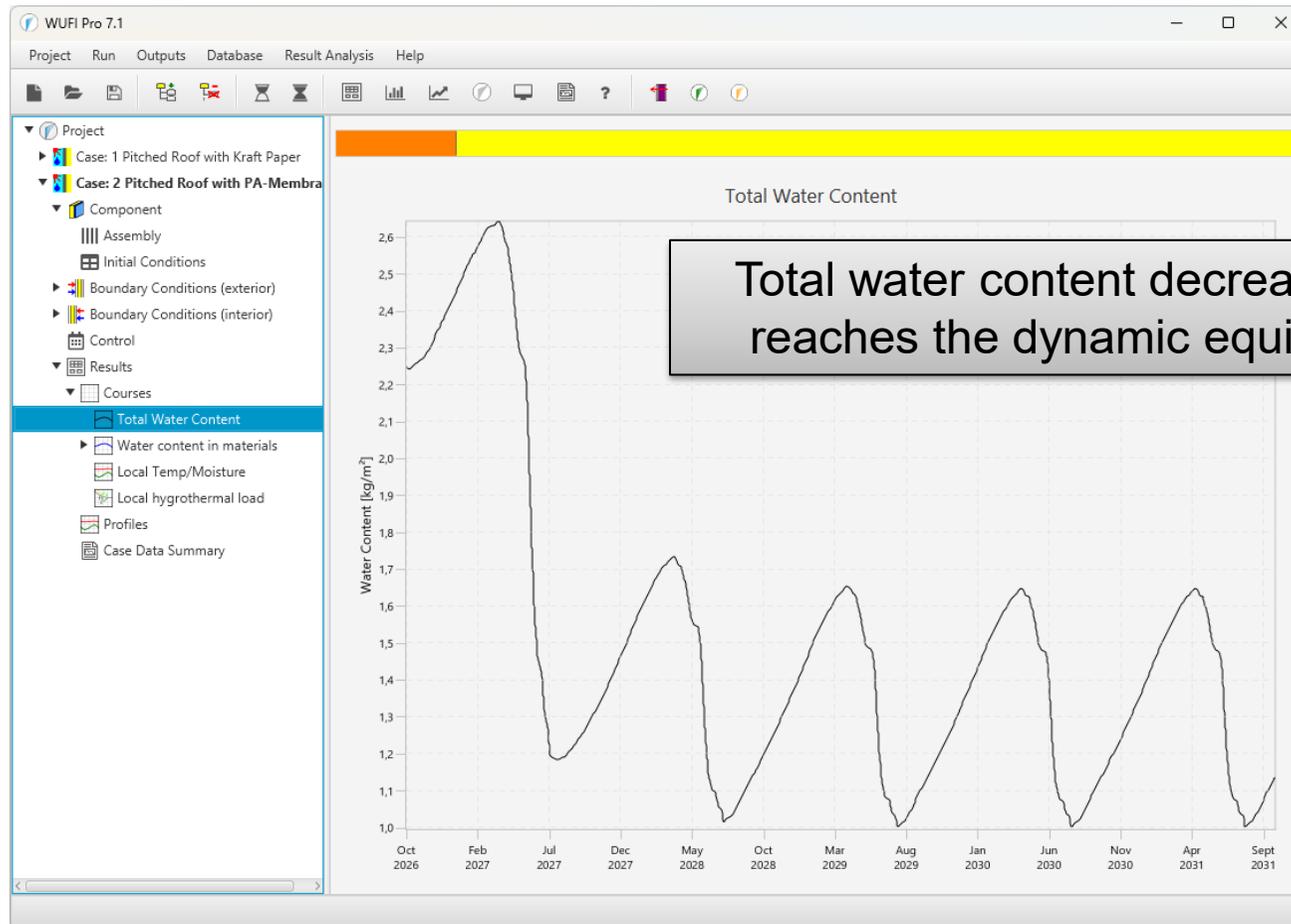
Below this table, there are two more tables showing 'Water Content [kg/m<sup>2</sup>]' and 'Water Content [kg/m<sup>3</sup>]'. The 'Water Content [kg/m<sup>2</sup>]' table has columns for Start, End, Min., and Max. The 'Water Content [kg/m<sup>3</sup>]' table has columns for Layer/Material, Start, End, Min., and Max.

Hardly convergence failures; differences in balances OK!

# Case 2: Evaluation – Total Water Content

## Evaluation:

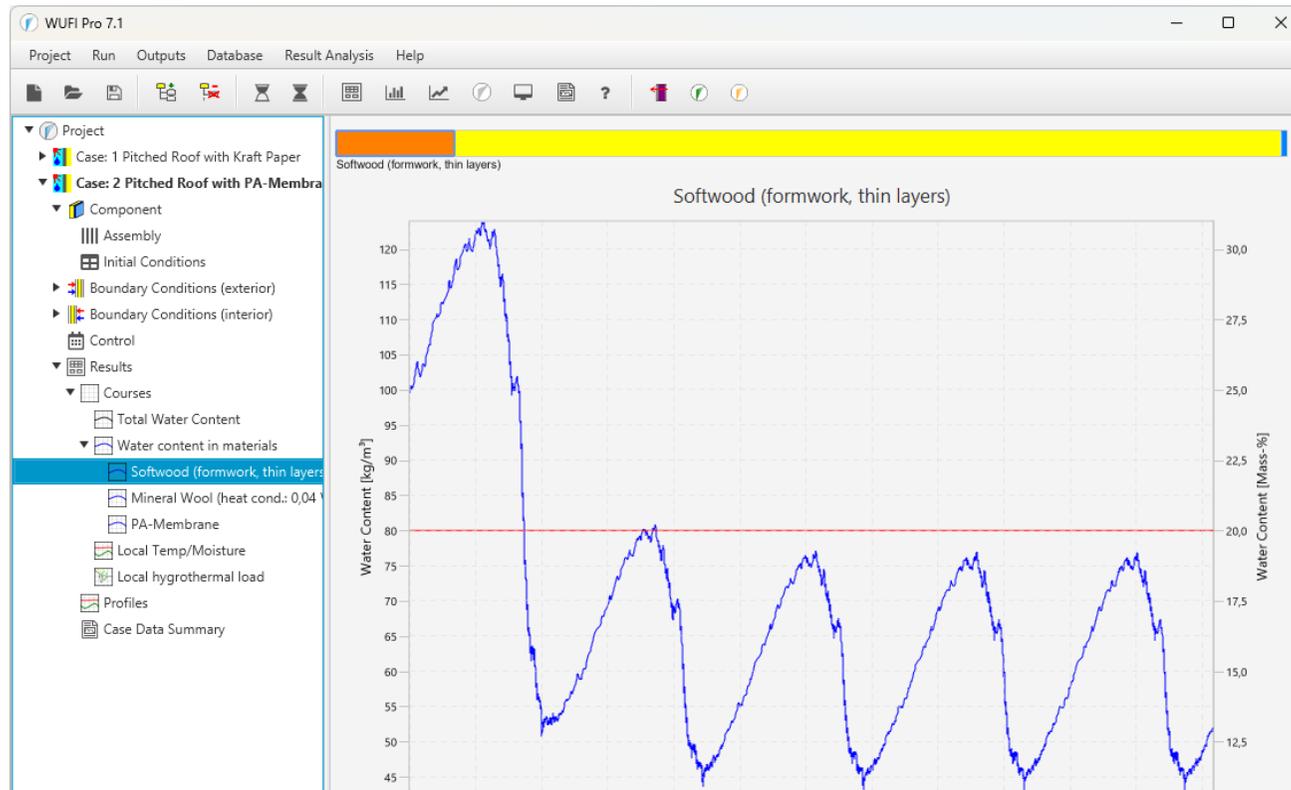
### Total water content



## Case 2: Evaluation – Wooden Sheathing

### Evaluation:

### Water content in the wooden sheathing



After the redistribution of the initial moisture in the first year, the water content in the wooden sheathing remains below the limit value of 20 % by mass!

## Case 2: Evaluation – mould growth behind vapour retarder

### Evaluation:

Mould growth risk behind the vapour retarder

The screenshot displays the WUFI Bio 4.0 software interface. The main window is titled "WUFI® Bio 4.0" and contains a "Project" panel on the left with a tree view showing "Case: Case 1: P" and "Case: Case 2: P", each with sub-items for "Inputs", "Climate", and "Results". The central "Project:" panel is divided into several sections:

- Occupant exposition class:** A dropdown menu is set to "Indoor surface or positions in contact to indoor air". A green callout box points to this section with the text "Select Occupant Exposition Class: Indoor surface or position in contact to indoor air".
- Initial RH in spore [-]:** A text input field contains the value "0.5".
- Substrate Class:** Four radio buttons are present: "Class 0", "Class II" (which is selected), "Class I", and "Class K". A green callout box points to this section with the text "Select Substrate Class: The PA-Membrane is to be classified as a non-biologically usable plastic membrane to Substrate Class II."

On the right side of the interface, there is a list of material properties: "Moisture Storage Function Spore", "Diffusion Resistance Spore Wall", and "Growth vs. Mould Index". Below this list are two graphs:

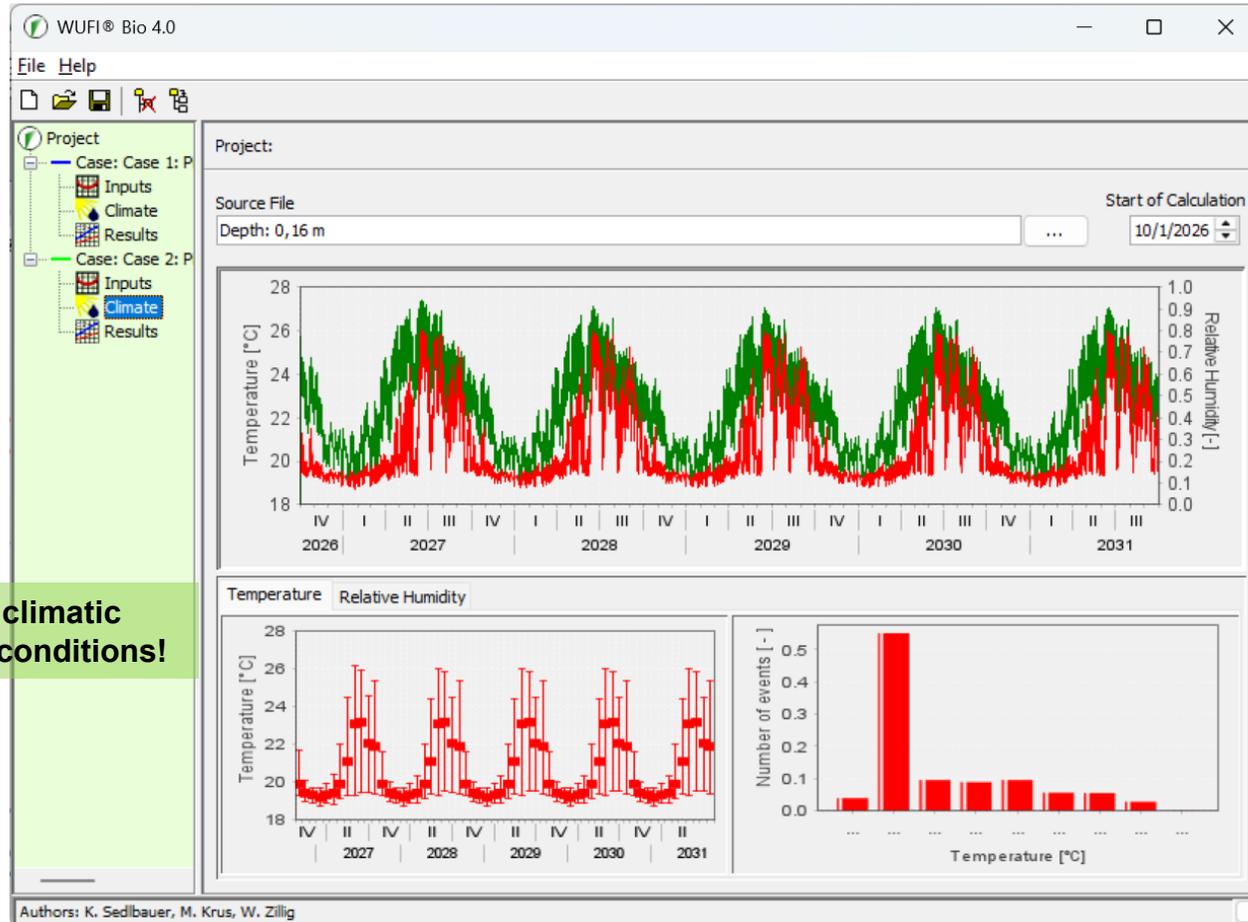
- Graph 1:** A line graph showing "Relative Humidity [-]" on the y-axis (ranging from 0.0 to 1.0) versus "Temperature [°C]" on the x-axis (ranging from 0 to 60). A red curve starts at (0, 1.0), dips to a minimum of approximately 0.4 at 30°C, and then rises back to 1.0 at 60°C.
- Graph 2:** A line graph showing "Water Content [kg/m³]" on the y-axis (ranging from 0 to 900) versus "Relative Humidity [-]" on the x-axis (ranging from 0.00 to 1.0). A red curve starts at (0, 0) and increases to approximately 900 kg/m³ at a relative humidity of 1.0.

At the bottom of the window, the authors are listed as "K. Sedlbauer, M. Krus, W. Zillig".

## Case 2: Evaluation – mould growth behind vapour retarder

### Evaluation:

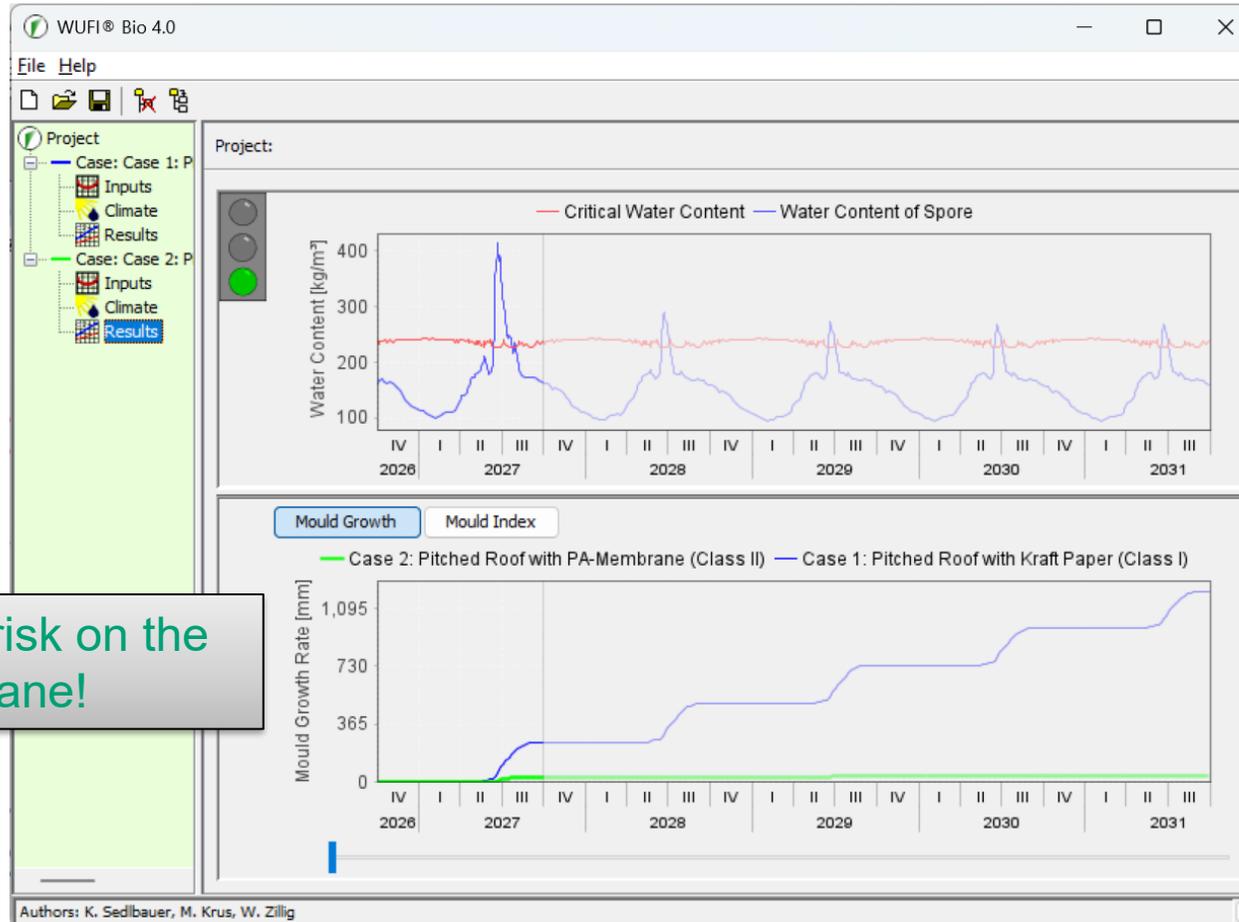
Mould growth risk behind the vapour retarder



## Case 2: Evaluation – mould growth behind vapour retarder

### Evaluation:

Mould growth risk behind the vapour retarder



No mould risk on the PA-Membrane!

## Case 2: Evaluation Matrix

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### Evaluation Matrix:

	Criteria	PA-Membrane
1) Numerics	No or only small differences in balances (especially in the case of convergence failures)?	✓
	Consistent, periodic course of total water content?	✓
2) Evaluation parameters	Total water content reach dynamic equilibrium or decreases?	✓
	Risk of wood decay in the wooden sheathing? (limit values according to DIN 68800 or WTA 6-8)	✓
	Risk of mould growth behind the membrane / paper?	✓