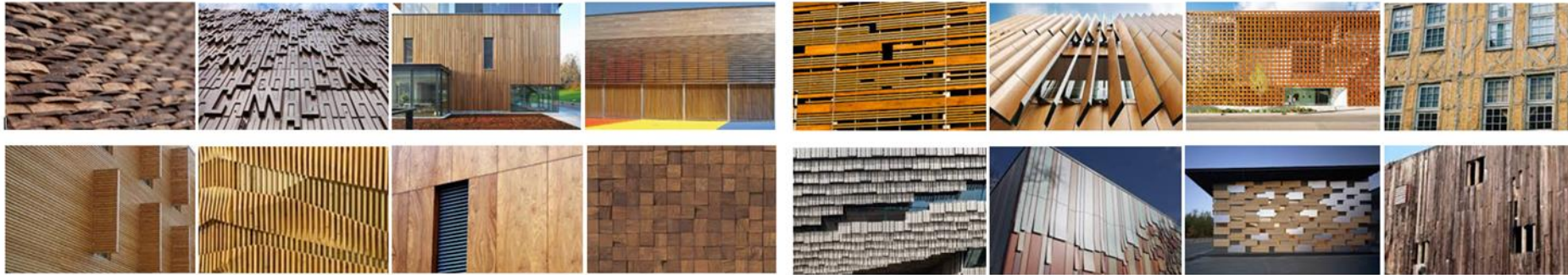


Strengthening the confidence in bio-based building materials

BIO4ever project approach



Anna Sandak, Jakub Sandak, Marta Petrillo, Paolo Grossi

Today's building sector

- ▶ The **EU's population is gradually increasing** through a combination of natural growth and net migration (currently 508 million)
- ▶ To accommodate this population increase, **many new buildings will be erected in the near future** to provide housing, services, and recreation
- ▶ It is desired that the **renovation and construction of buildings/infrastructure will be made to high resource efficiency levels already by 2020.**
- ▶ Whenever possible, **further development of novel construction materials should rely predominantly on renewable resources.**

Architectural challenges



Urbanization - density

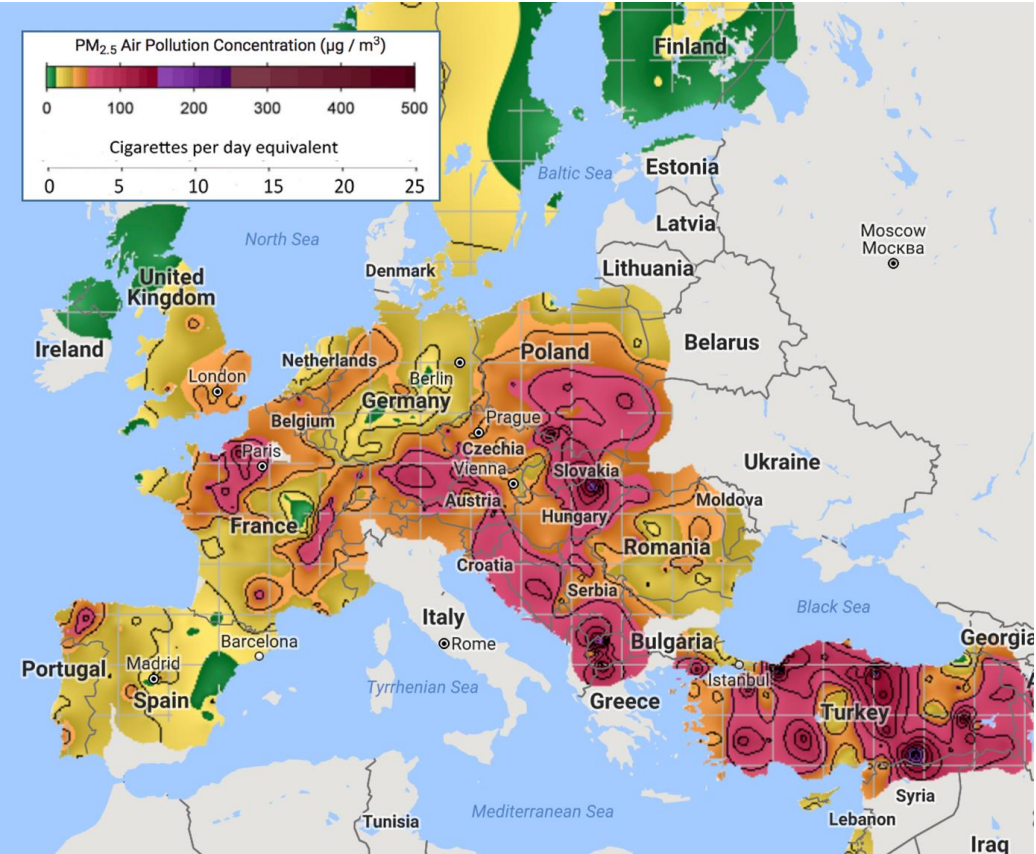
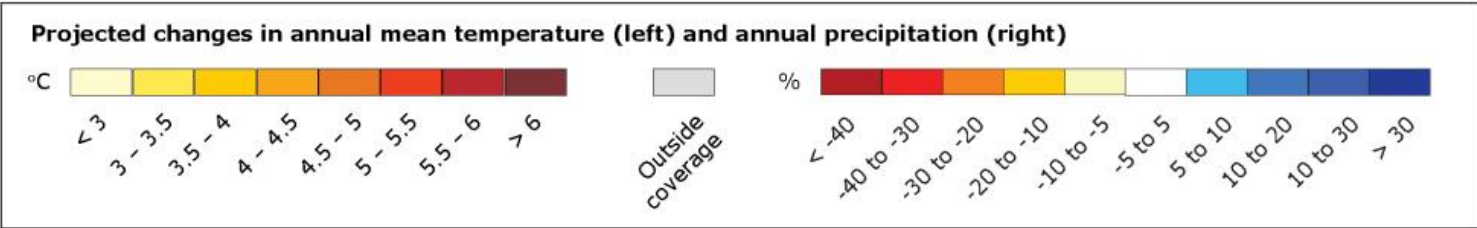
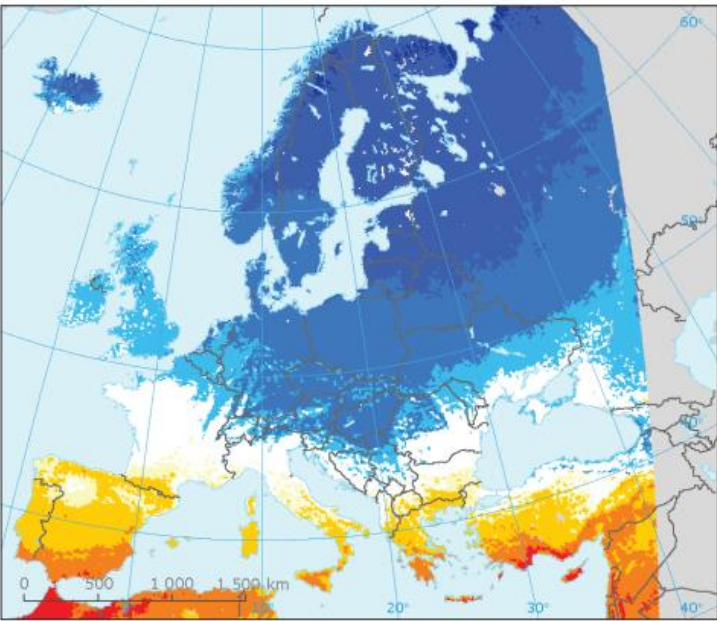
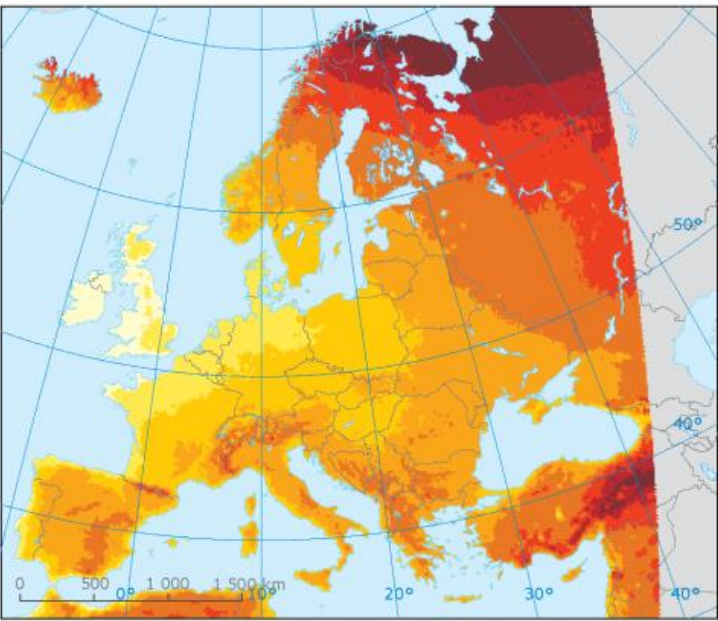
Climat change



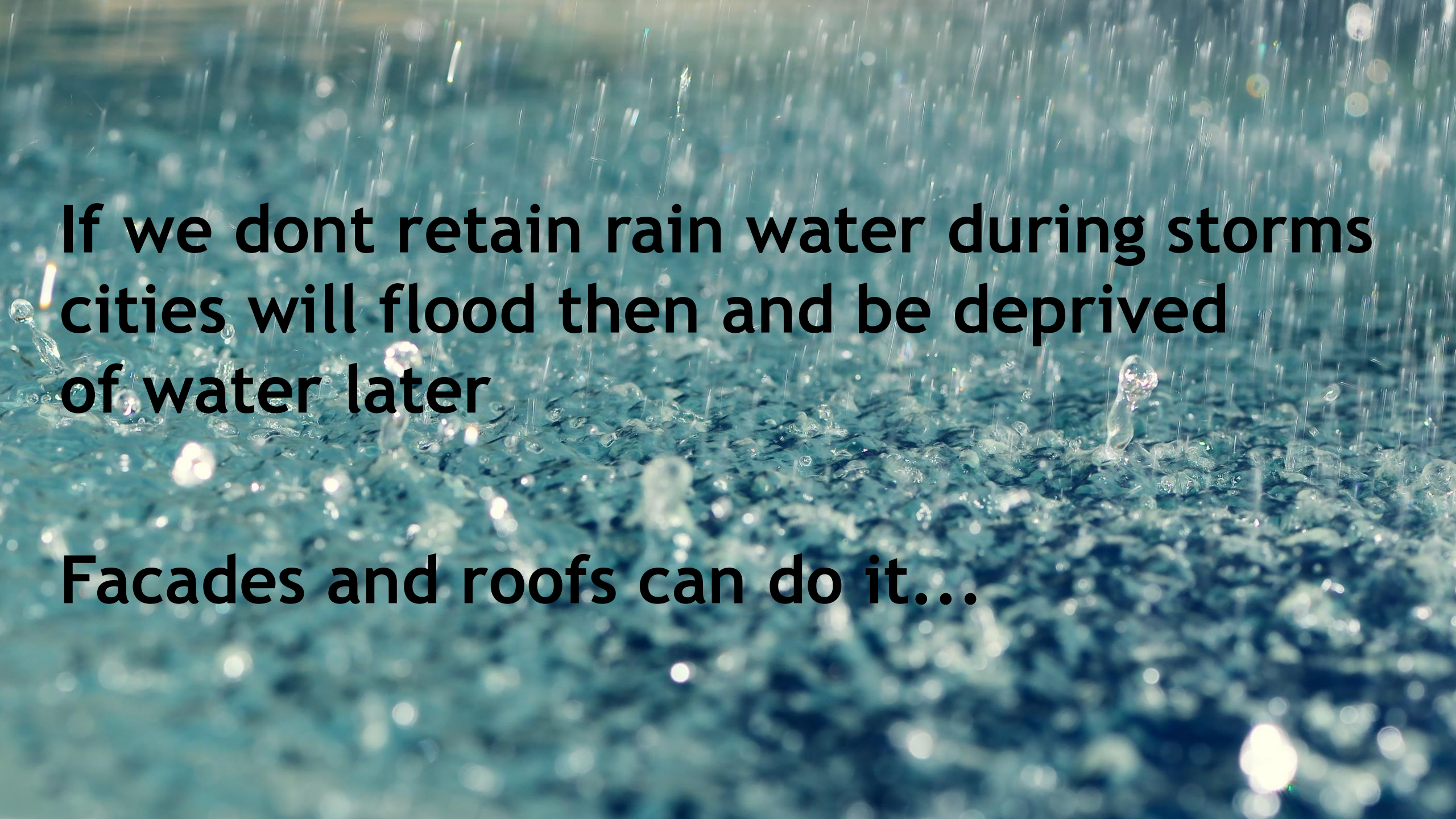
Urbanization

- ▶ **For the first time in human history, most of us live in urban settlements:** 28 megacities of 10-20 million, 417 medium-sized cities of 1-5 million and 525 smaller settlements of between 0.5-1 million people (data from 2014)
- ▶ **Our current urban population of around 3.9 billion is expected to grow to around 6.34 billion by 2050**, out of a total global population of at least 9.5 billion.
- ▶ If the urban population and long-term densification trends continue, **the area of the planet covered by urban settlements will increase to more than 3 million sq km by 2050**
- ▶ **Continued urbanisation in its current form will be problematic for global food supplies** - the food production is already not keeping up with population growth...

Climate change & pollution



<https://www.eea.europa.eu/soer-2015/europe/climate-change-impacts-and-adaptation>



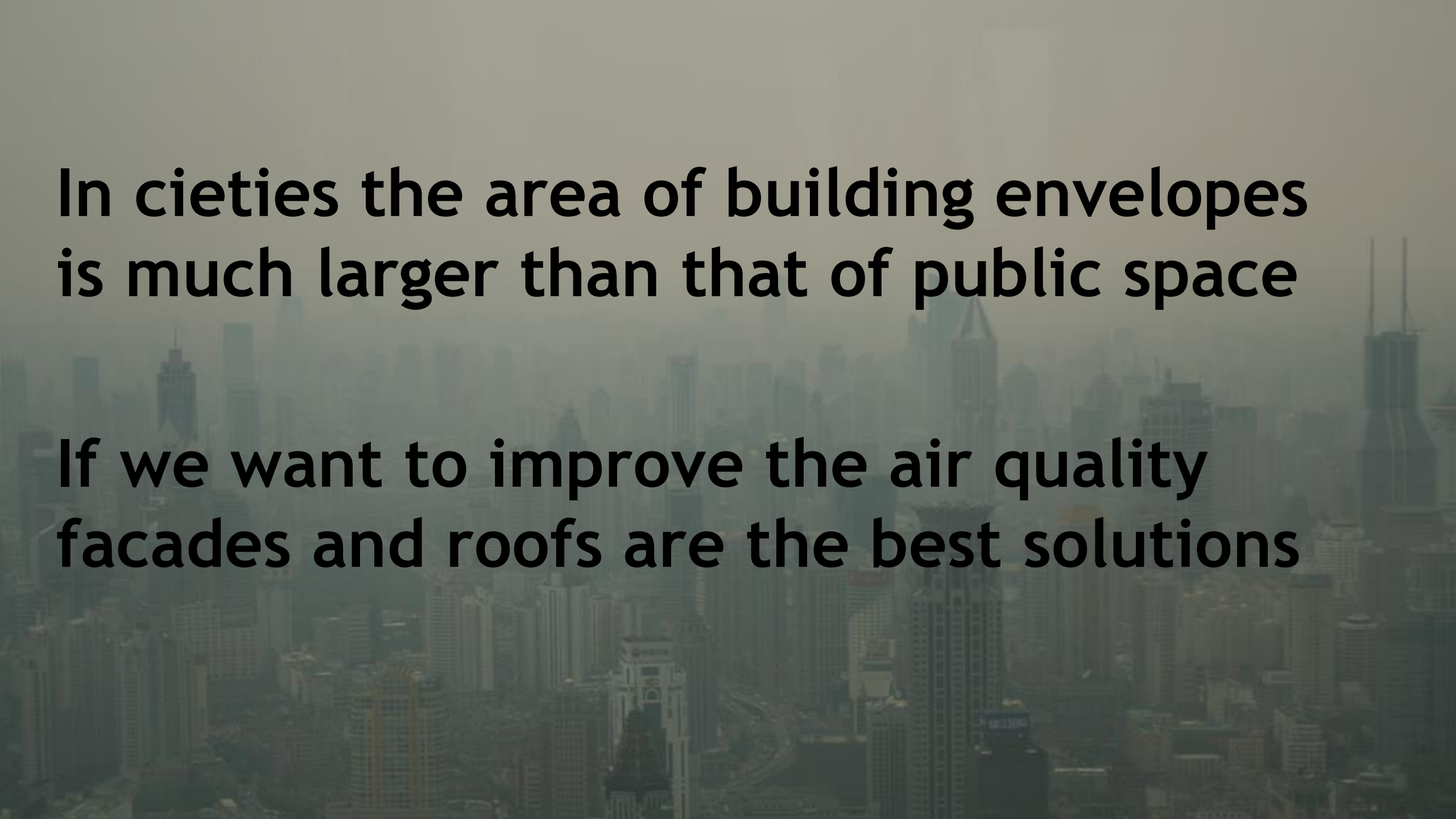
**If we dont retain rain water during storms
cities will flood then and be deprived
of water later**

Facades and roofs can do it...

A city skyline is visible in the background, with various skyscrapers and buildings. The sky is a deep orange and yellow, indicating a sunset or sunrise. A bright sun is positioned in the upper left quadrant of the image, casting a glow over the scene.

If we don't take away urban heat in summer many cities will be unliveable

Facades and roofs can do it...



**In cities the area of building envelopes
is much larger than that of public space**

**If we want to improve the air quality
facades and roofs are the best solutions**

Challenges for building skin:

- ▶ Localizing (functionality, local context)
- ▶ Safety (selected materials, sensors, safety codes)
- ▶ Flexibility (modular design, adaptability, buildability, design for disassemblage, multifunction)
- ▶ Lifespan (indoor climate)
- ▶ Comfort (temperatures, day light, responsive, dynamic)
- ▶ Communication (sensors, screens, surveillance)
- ▶ Economy and sustainability

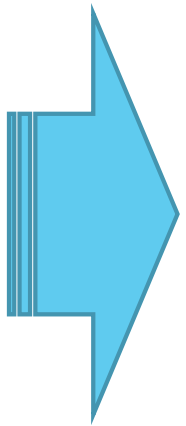
Building envelopes

- ▶ Most complex building component
- ▶ Highest level of innovation in last 25 years
- ▶ Sustainability drives technology and innovation

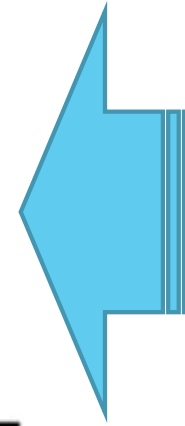


What next?

€



Safety
Health & comfort
Sustainability
Zero energy
Weather changes



aesthetics

Why biomaterials?

“The 18th century was about brick,
the 19th about steel,
the 20th about concrete,
and the 21st century is about wood.”

Alex de Rijke

The bio-based building materials are surely attractive alternative for modern construction sector...

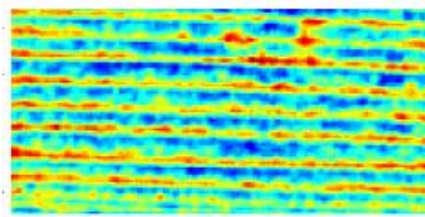
... however the confidence regarding their proper selection and maintenance should rely on validated service life performance models

BIO4ever project approach

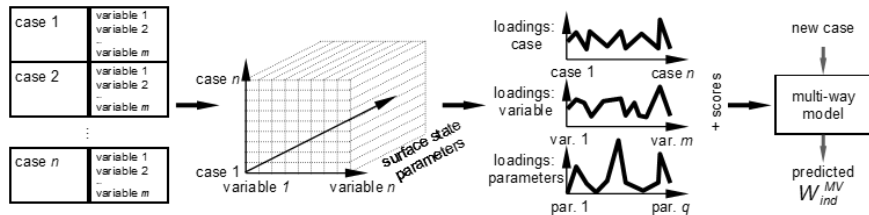
120 facades bio-based materials provided by 31 companies from 17 countries



Natural & artificial weathering in different configurations



Multi-sensor and multi-level characterization



Regression, dose-response and multi-way models

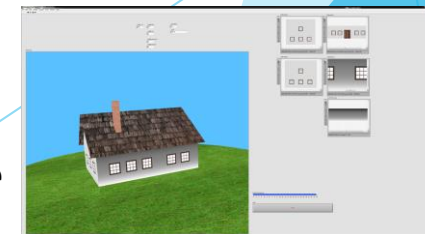


Alternative end-of life transformation solutions

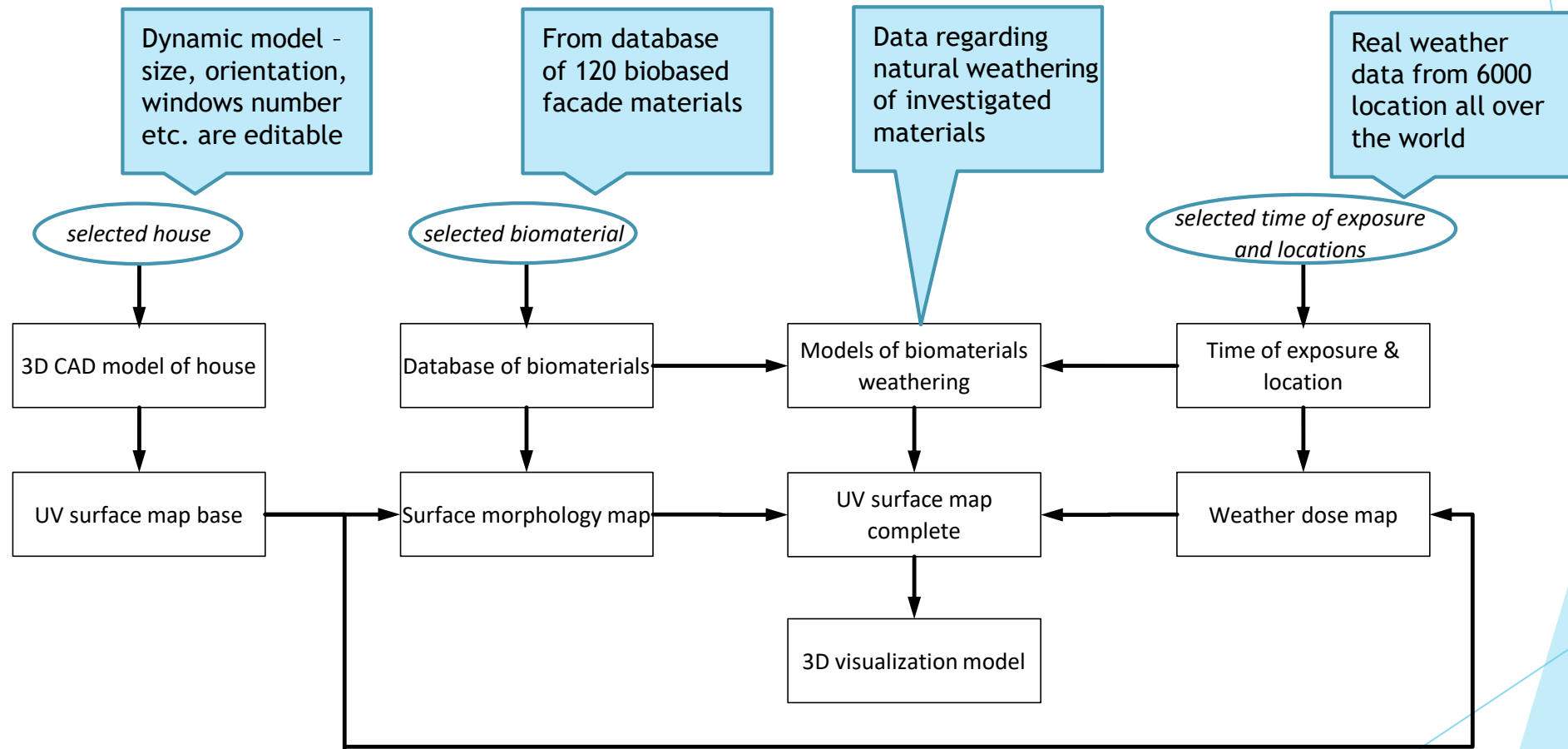


Customer satisfaction/preferences measurements

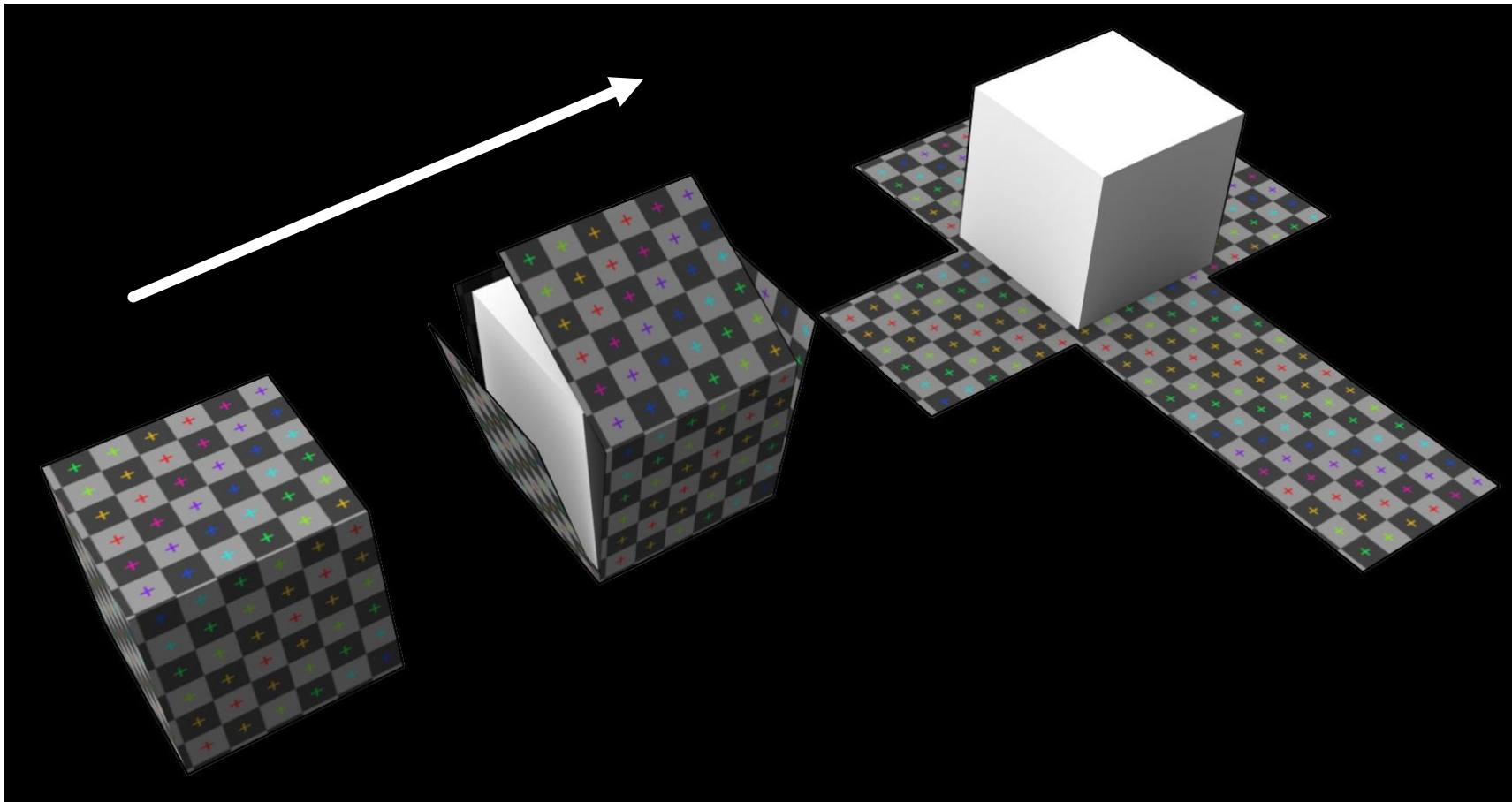
Software simulating changes of functional and aesthetic performance



Flowchart of the data for 3D visualization of the building exposed to natural weathering



A representation of the UV mapping of a cube



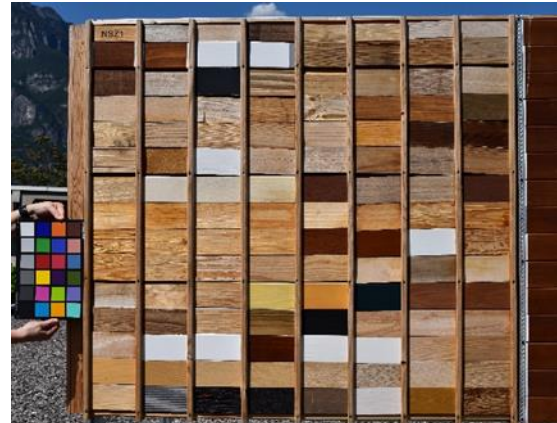
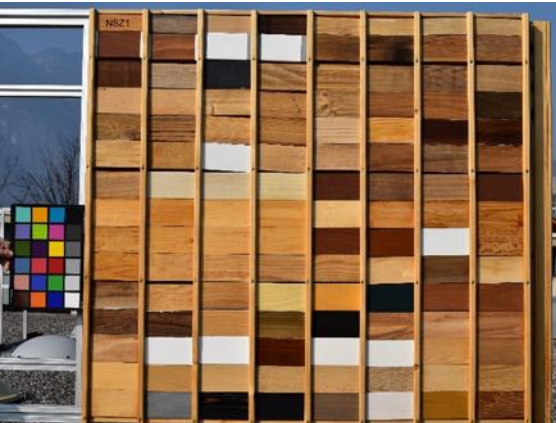
Texture #1 image representing distribution of latewood (dark) and earlywood (light)



Source data

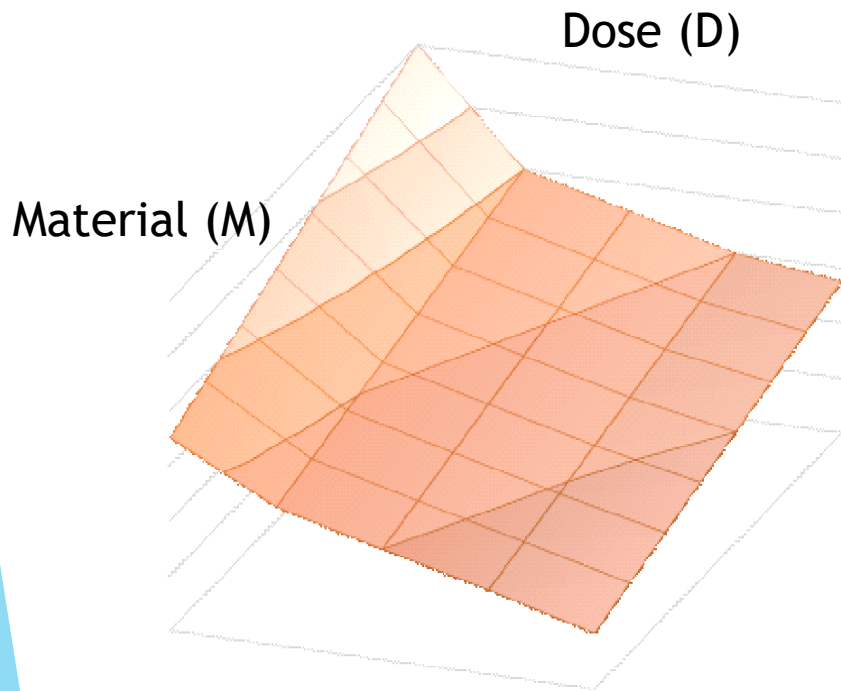


Natural spruce,
1 year of exposure South



Bio4ever samples,
5 months of exposure South

Numerical model for determination of the morphological map (texture #1) on the base of material definition (8-bit) and weather dose D (integer number from 0 to infinity)



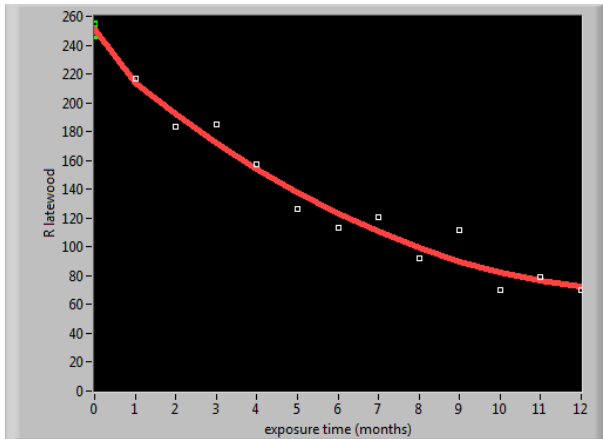
The same principle will be implemented to model following attributes:

- ▶ R colour coordinate: $R=f(D, M)$
- ▶ G colour coordinate: $G=f(D, M)$
- ▶ B colour coordinate: $B=f(D, M)$
- ▶ Surface gloss: $P=f(D, M)$
- ▶ Surface roughness: $S=f(D, M)$

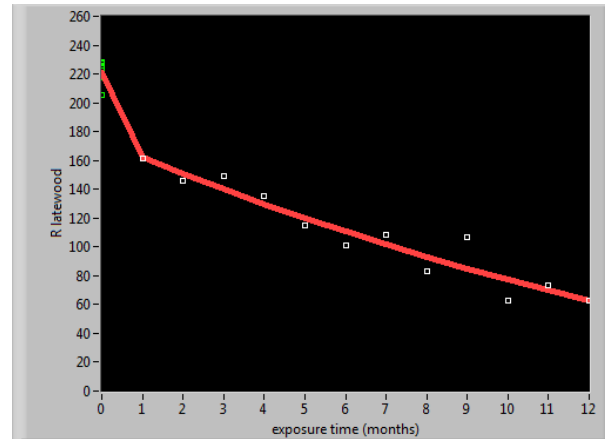
Curves of the RGB colour changes for early and latewood in one year weathering

earlywood

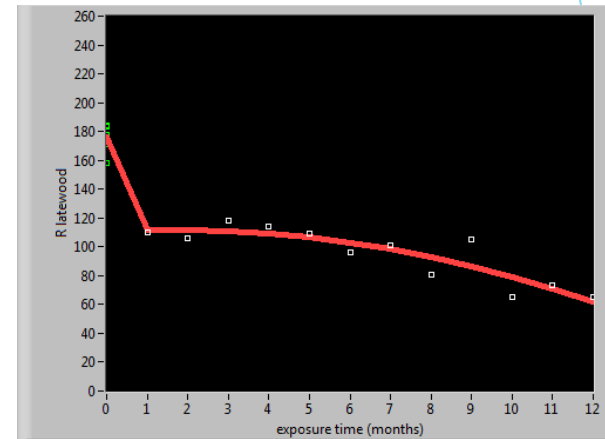
R



G

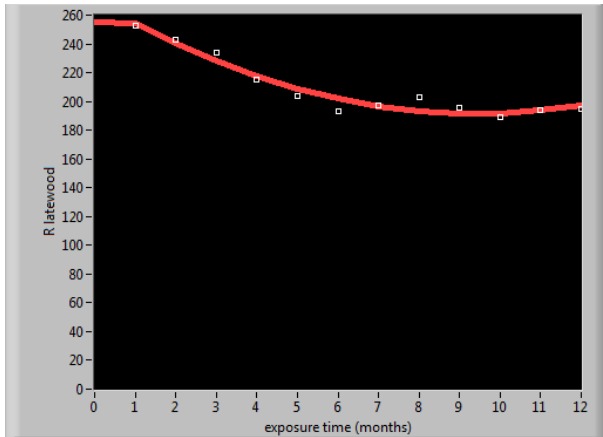


B

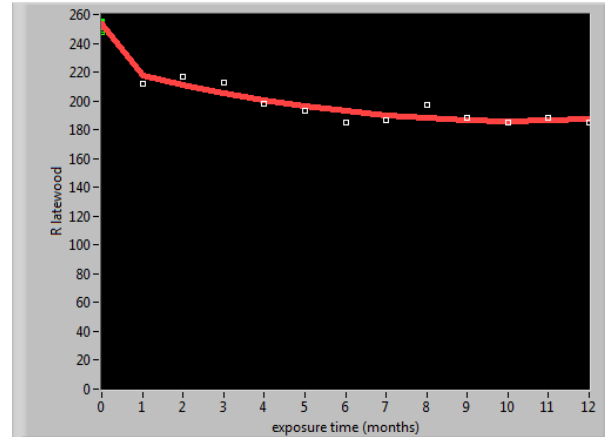


latewood

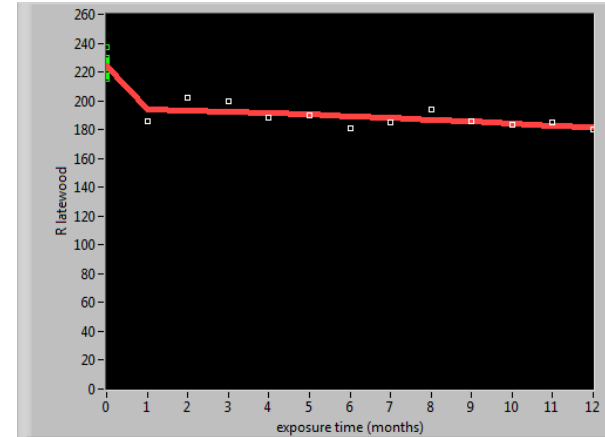
R



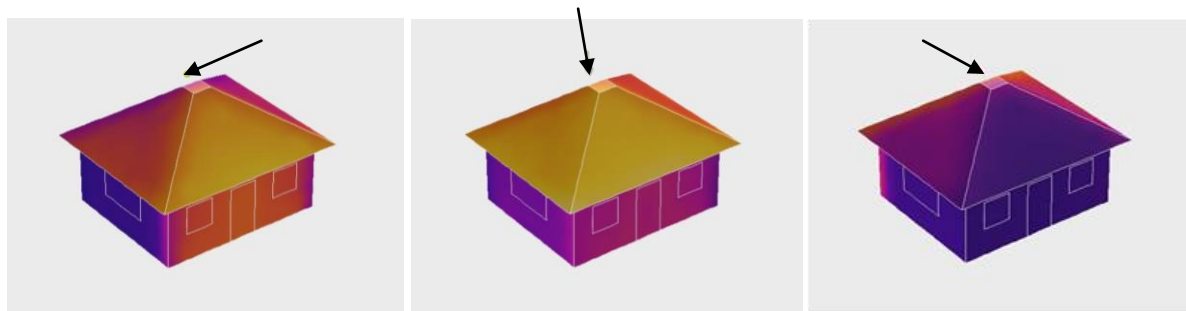
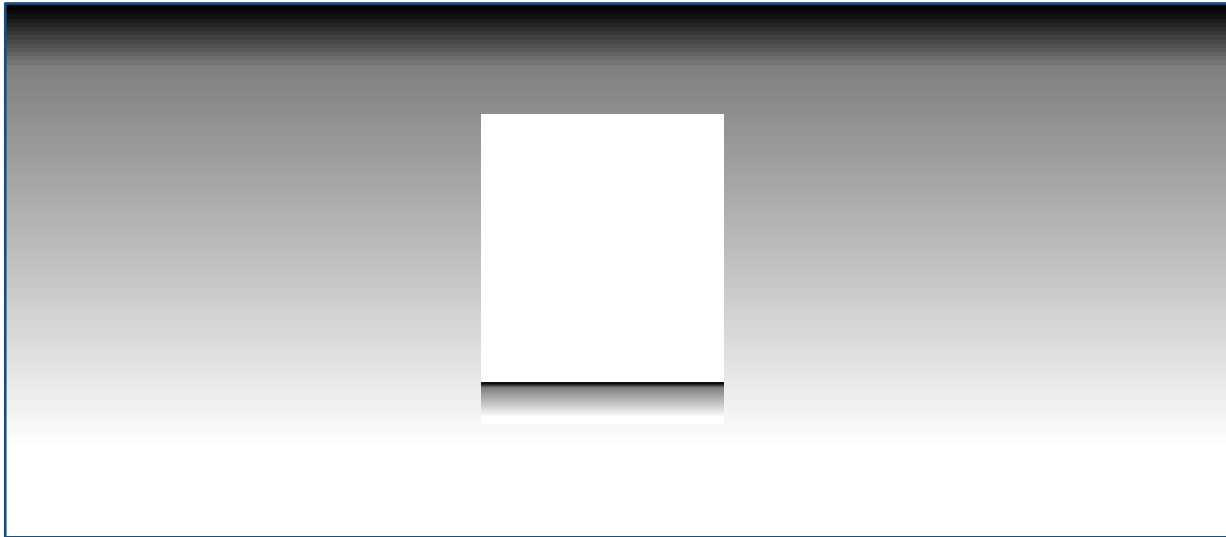
G



B

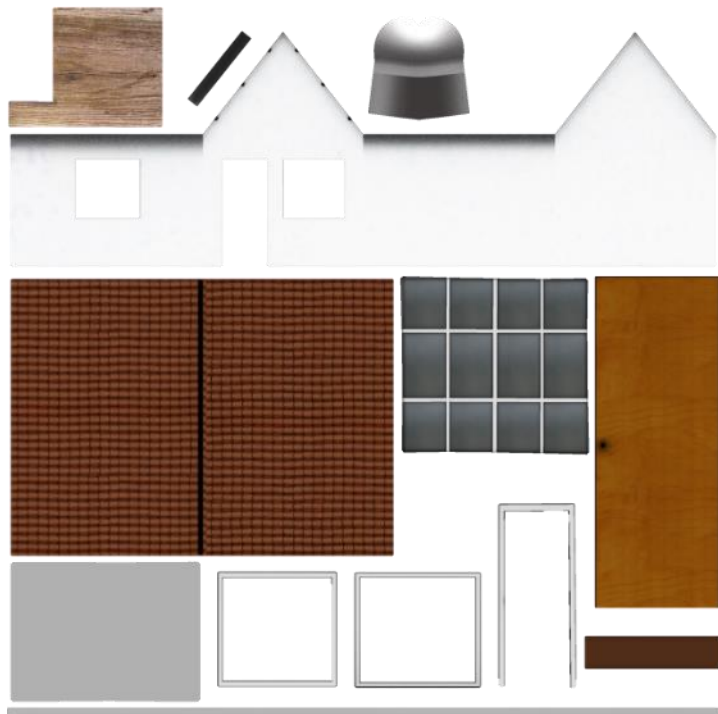


Texture #2 image representing distribution of weather dose D absorbed by the surface

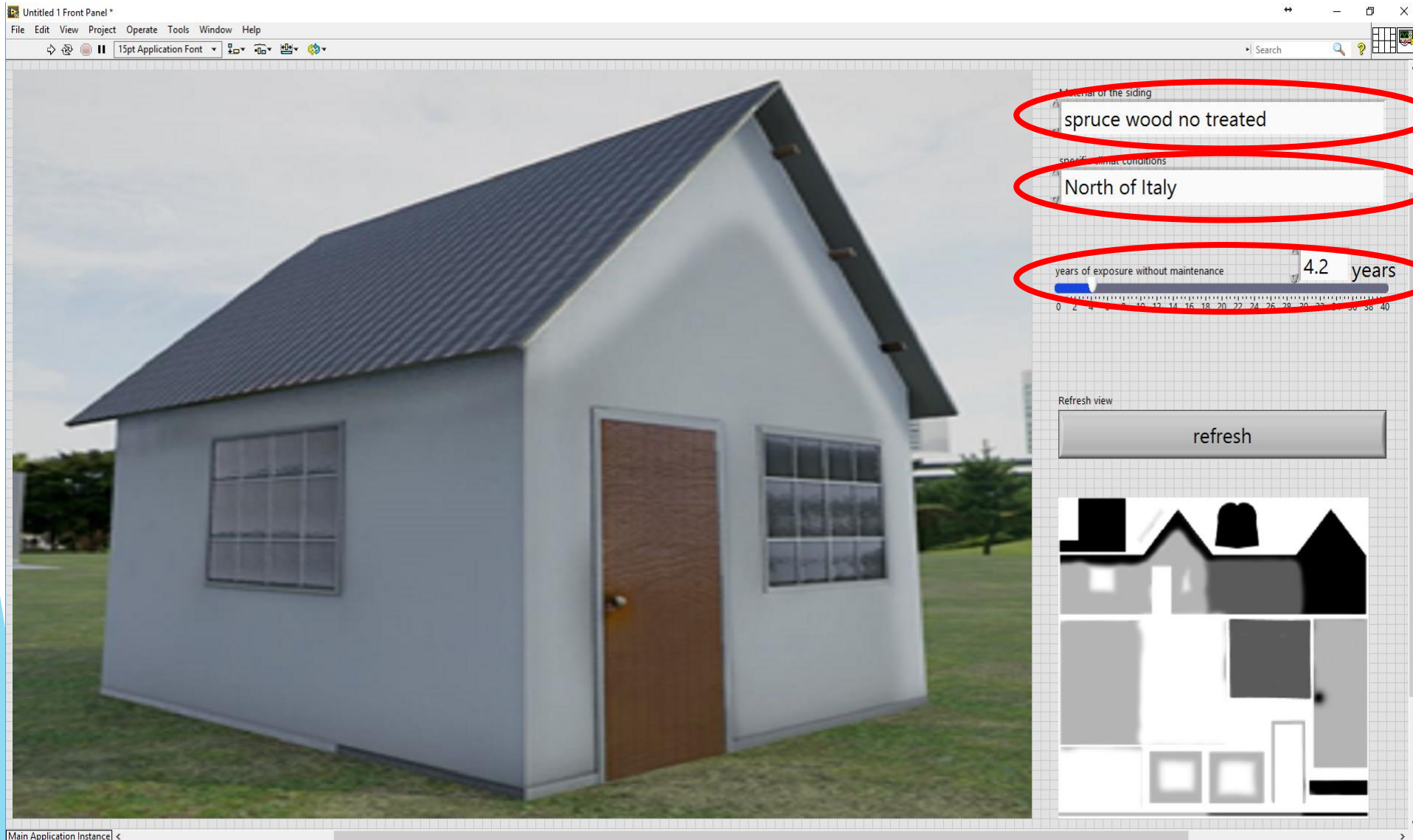


- COMSOL Multiphysics® Version 5.2 - Heat transfer module
- Historical data for over 6000 different weather stations
- Temperature on the surface, RH close to the surface, total solar radiation
- By entering the location and the time of day, the software will automatically recompute the orientation of the incident sunlight over the course of the day

3D model (right) reconstructed on the base of 2D diffuse texture map (left)



BIO4ever software



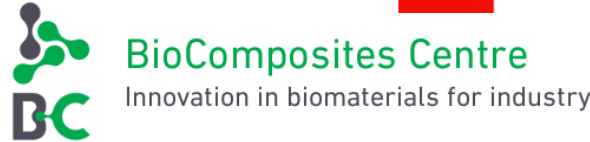
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www.bio4everproject.com