

Róbert Németh
Dimitrios Tsalagkas
Miklós Bak

COST FP1407
1st Conference
August 25-26.
Koper, Slovenia



UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING,
WOOD SCIENCES AND APPLIED ARTS

**Changes in the modulus of elasticity of beeswax
impregnated wood
during soil contact**



Introduction

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- The demand for timber is continually increasing, especially in slower growing hardwood and tropical species. Such species often offer a greater durability and higher aesthetic qualities than many of the faster growing softwood species.



<http://www.golftribute.com/shop/soft-touch-brass-flange/>



<http://www.wood-database.com/lumber-identification/hardwoods/american-beech/>



http://sterrittlumber.com/product_category/poplar



Introduction

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- It is well known that there are grave ecological and environmental concerns over current 'virgin timber' demands, and various attempts are underway to prevent the demise of many of the biologically diverse regions where these timbers originate.





Introduction

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- A greater emphasis is now being placed in sustainable harvesting of timber species, though the slow growth of many species means a slow turnover in materials and profits. Thus it is necessary to encourage the use of faster growing timbers which may be readily gained from such sustainable plantations.
- But the durability of these materials is usually very low.



http://milstory.blog.hu/2011/05/09/266_virtualis_jarorszolgalat



<http://enfo.agt.bme.hu/drupal/en/node/1498>



Introduction

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- Many traditional protection treatments currently exist to prevent these deteriorations, but often they are based on toxic materials.
- Apart from the risks involved in using such materials for treatments, there is increasing concern over the problems arising in the disposal of the timbers after the end of their commercial lifetime.



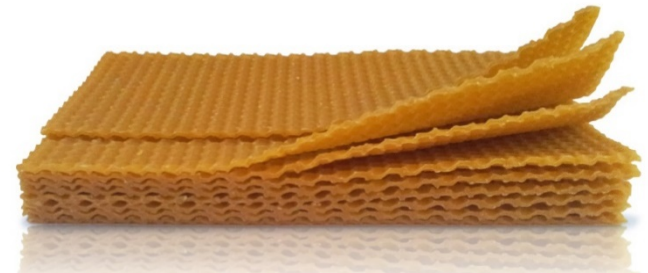
<http://www.valleybox.com/green-business/wood-scrap-recycling/>



Introduction

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- The advantage of beeswax is its biological origin and its nontoxic nature, but it is in general not biologically stable.
- Beeswax is often used as conservation agent for wooden artifacts → under appropriate conditions beeswax is suitable for wood protection
- Water repellent
- Another advantage of wax impregnation is the improvement of mechanical properties (e.g. hardness)
- Effectiveness of beeswax impregnation against the degradation of less durable wood materials?





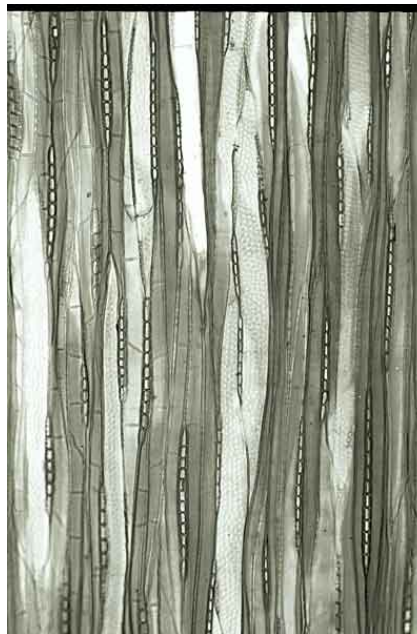
Materials and Methods

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- Focus on hardwood species (resistance class 5, easy to impregnate)
- Plantation grown timber → poplar (*Populus × euramericana* cv. Pannonia)



<http://www.woodanatomy.ch/>



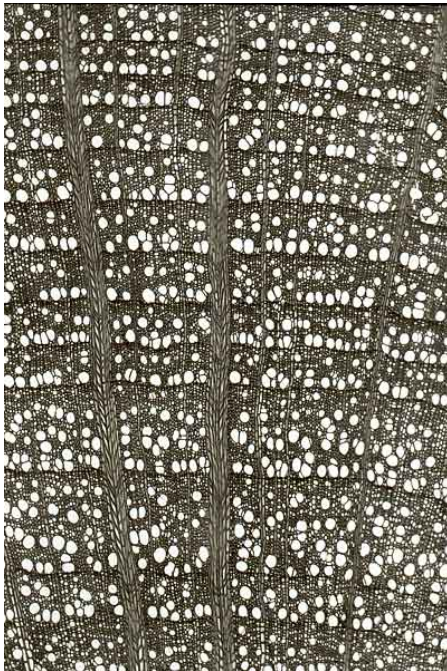
www.abh-system.hu



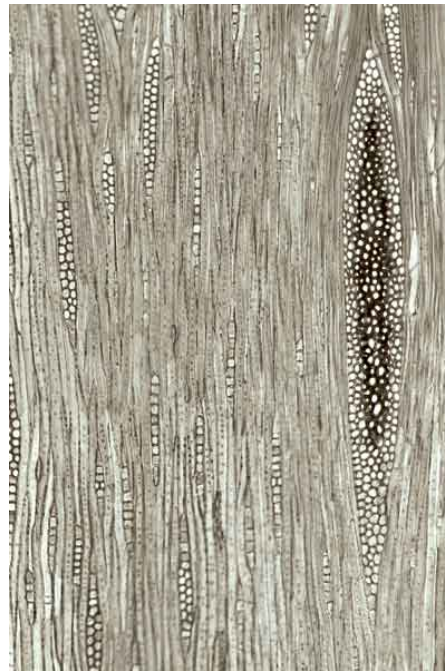
Materials and Methods

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- Commonly used timber → beech (*Fagus sylvatica*)



<http://www.woodanatomy.ch/>



<http://www.wood-database.com/lumber-identification/hardwoods/american-beech>



Materials and Methods

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS



- Impregnation at 80°C (over melting point)
- Sample MC: 0%
- Samples separated to 3 groups according to the calculated degree of pore saturation (DPS)

Group	Poplar1	Poplar2	Poplar3	Beech1	Beech2	Beech3
DPS (%)	20-40	40-55	55-70	60-75	75-90	90-100



Materials and Methods

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

Bending Test

- Standard 3-point bending method was used.
- Sample dimension was 20×20×300 mm.
- Modulus of elasticity (MOE) was determined before soil contact both on the unimpregnated and impregnated samples.
- MOE was determined at a defined load. 400N for poplar and 600N for beech.
- After 1 month in soil MOE determination with the same loads
- After 18 months in soil MOE determination with 300N load for poplar and beech as well.



Materials and Methods

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- Laboratory conditions (based on ENV 807/2001).
- Soil in plastic boxes → samples into soil to a depth of its 2/3 length.
- Boxes were seal up with plastic foil.





Results – visual inspection

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

Unimpregnated (left) and impregnated (right) poplar samples after 18 months



Unimpregnated

- completely decayed
- cross sections decreased markedly



Impregnated

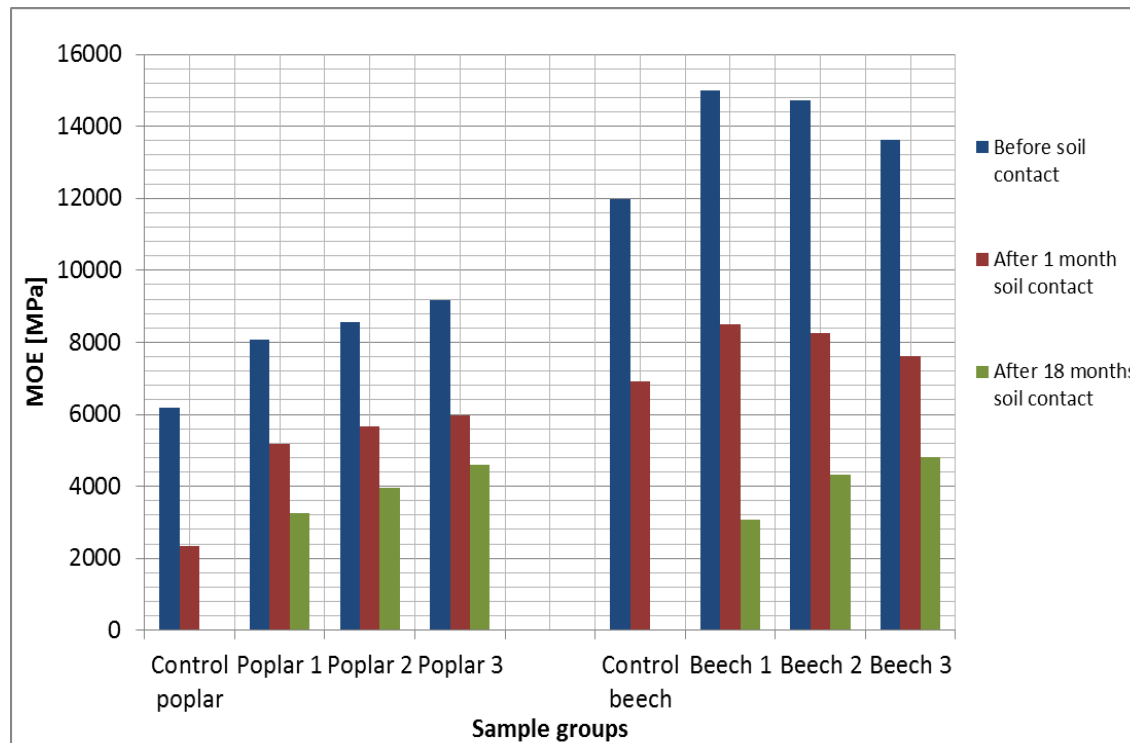
- only surface decay could be observed
- cross sections remained almost unchanged



Results – MOE

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

MOE of poplar and beech samples in the investigation periods



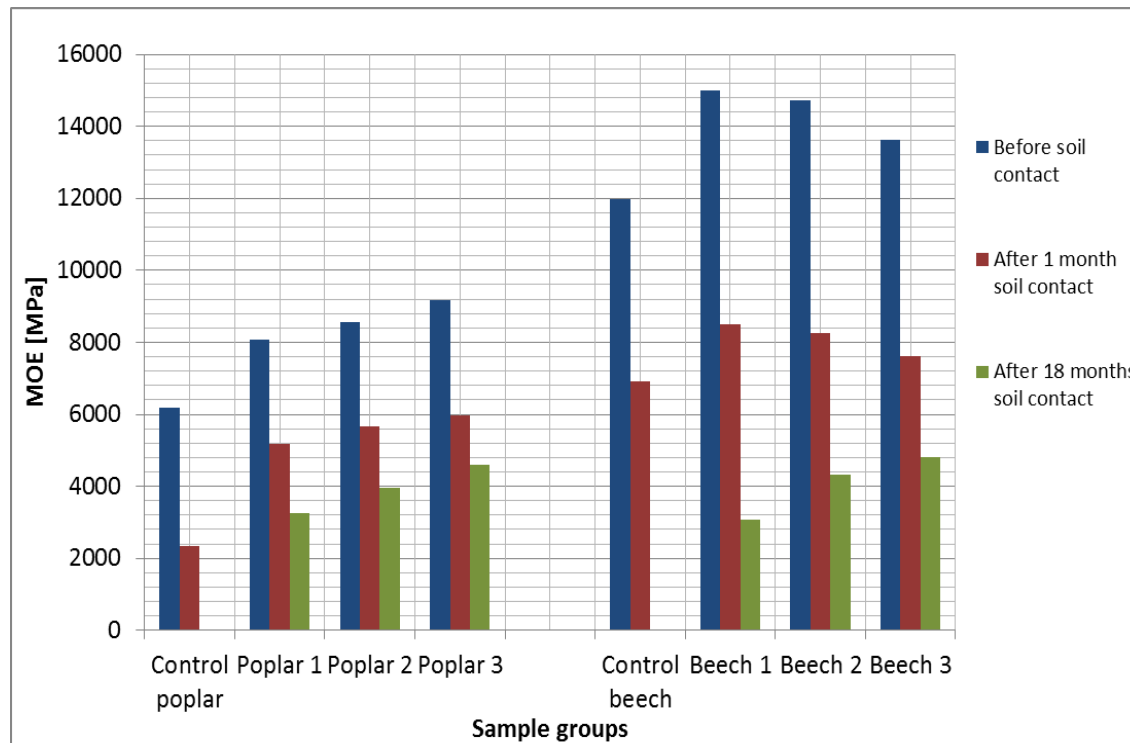
- Initially, MOE increased markedly, depending on the impregnation efficiency (theoretical maximum of MOE)
- A strong decrease (30 to 60%) in the MOE after 1 month of soil contact
- Increase in the moisture content - MOE under utilization conditions
- No fungal decay visible



Results – MOE

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

MOE of poplar and beech samples in the investigation periods



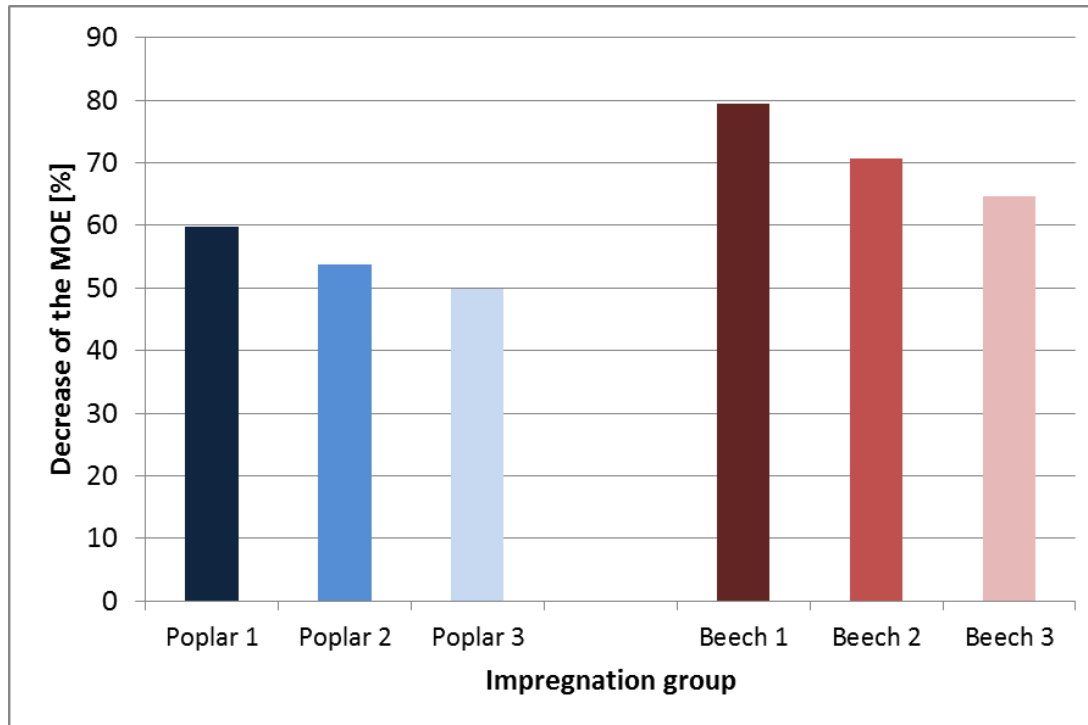
- Untreated beech and poplar specimens lost their load-bearing capacity completely
- Some load-bearing capacity of the impregnated beech and poplar specimens remained
- Higher DPS for both beech and poplar specimens resulted in a higher MOE



Results – MOE

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

MOE decrease of beech and poplar samples after 18 months



- Compared to the absolute dry state, after 18 months of soil contact exposure, the MOE of beech and poplar wood decreased from 65 to 80% and from 50 to 60%, respectively
- But in opposite with the untreated wood, remarkable load bearing capacity remained

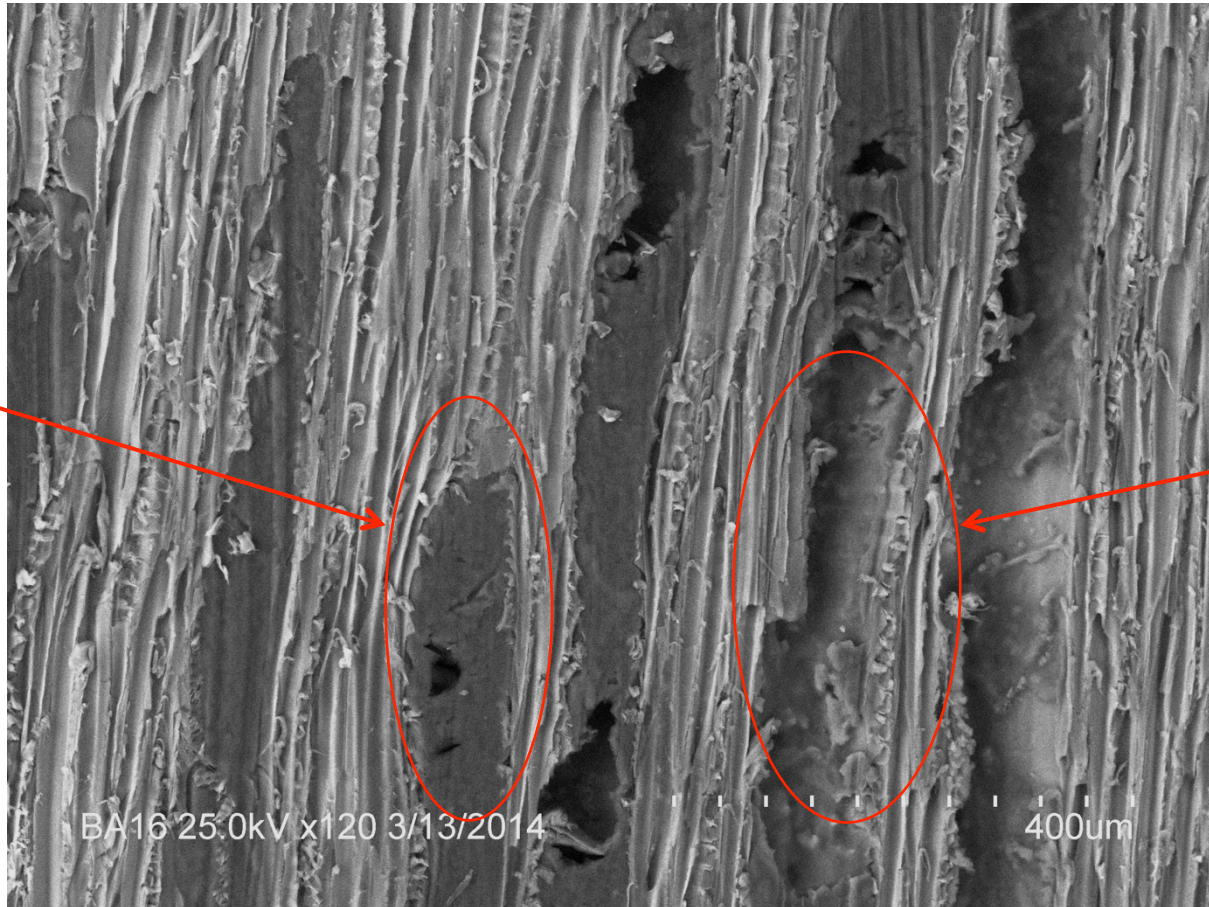


Results – SEM

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

Beeswax in the cell lumens of poplar wood

Lumen
filling



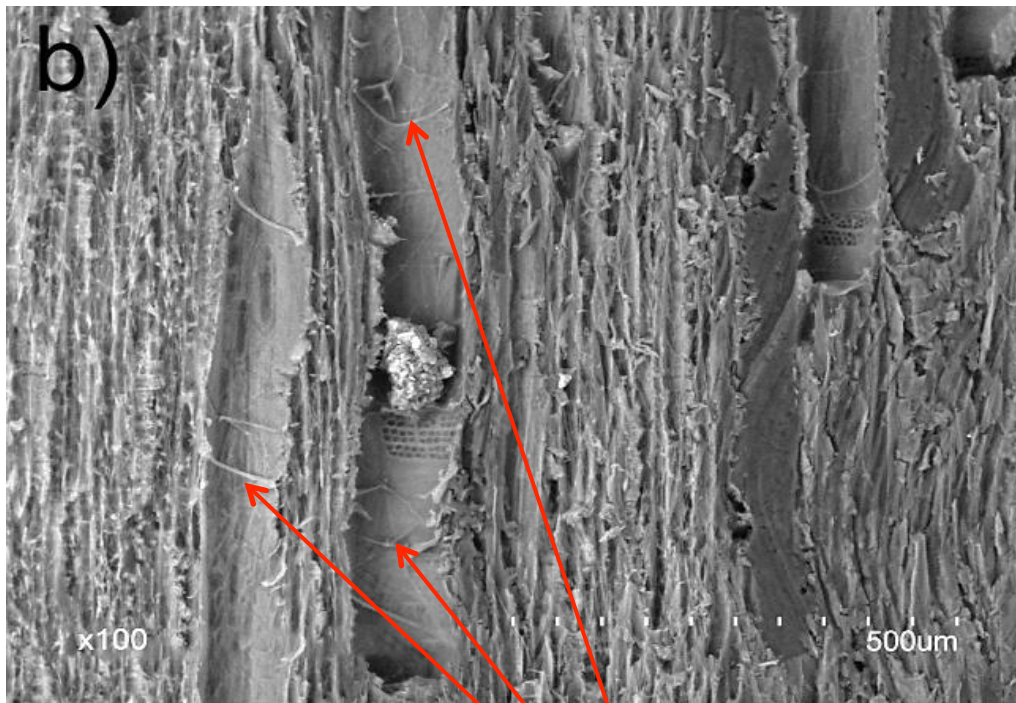
Only on the
lumen
surface



Results – SEM

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

Hyphae in a beeswax free cell lumen of poplar wood



- The areas with proper impregnation of the lumens were untouched by decay
- If there was one or more empty vessel near the filled vessels, the hyphae could have spread through the cell walls in the direction of the impregnated cells and started the decomposition

Hyphae – only
in the open
lumens present



Conclusions

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- Beeswax impregnation increased MOE of beech and poplar wood
- Unimpregnated beech and poplar samples were decomposed completely during the 18 months soil contact.
- Damage of the impregnated samples was significantly lower.
- Remarkable remaining MOE of impregnated samples after exposure.



Conclusions

UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

- Higher DPS resulted in lower decrease of the MOE during the investigated period.
- Beeswax fills the lumens and separates the most of the cell walls from the hyphae, which slows the spreading of the fungi in the wood.
- Beeswax impregnation could only slow the decay.
- Promising environment friendly preservation method for wood, but mainly for applications without soil contact



UNIVERSITY OF WEST HUNGARY
SIMONYI KÁROLY FACULTY OF ENGINEERING, WOOD SCIENCES AND APPLIED ARTS

Thank you for your attention!

Acknowledgement: This research was supported by the
ERFARET Nonprofit Kft.

