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WOOD FOR THE FUTURE:
INTEGRATING SUSTAINABILITY ACROSS INDUSTRIES

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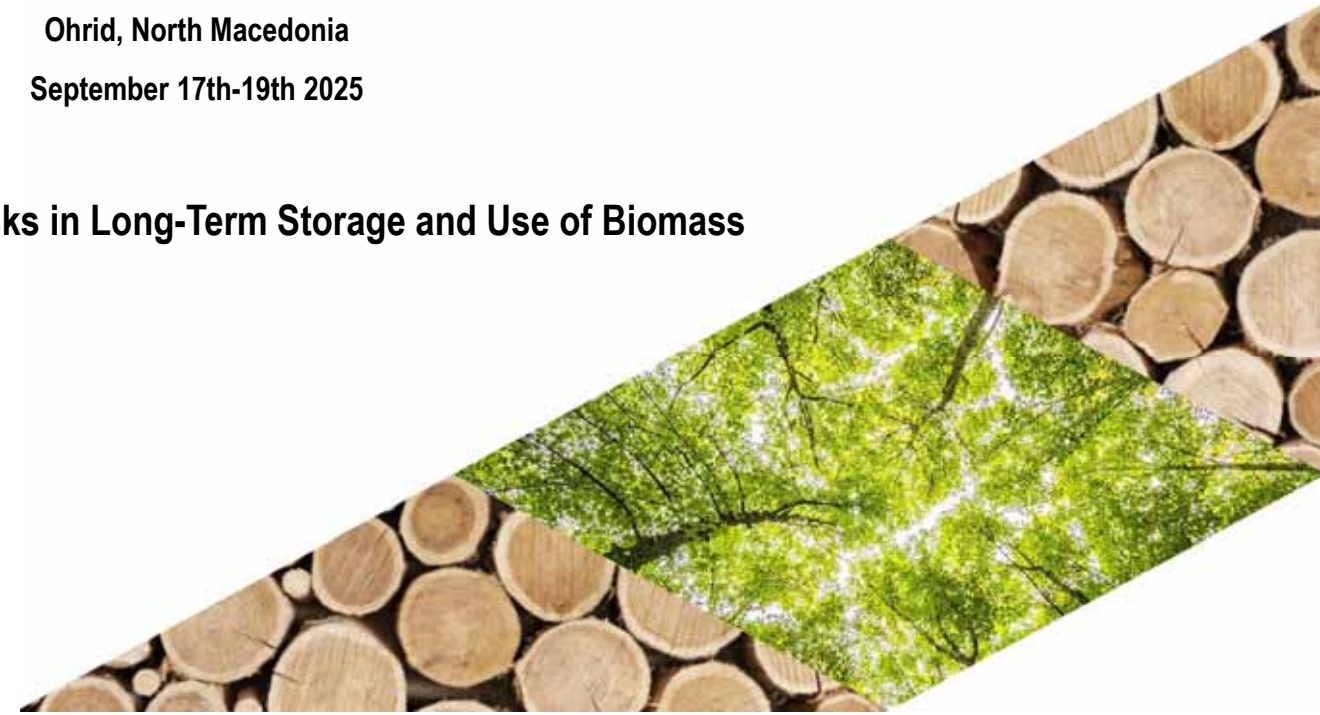

Title of the paper: Economic Calculation of Health Risks in Long-Term Storage and Use of Biomass

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- This article builds upon the research presented at last year's WoodEMA conference in Sofia, where we explored the topic *Selected Economic and Health Risks in the Process of Production and Storage of Biomass for Energy Purposes*.
- We presented a proposal for applying model financial data **to calculate the risks of occupational diseases** and their consequences - such as **severance payments or compensation for illness-related damages for employees** of forestry and wood-processing companies working with biomass.

- In the event of an **occupational disease, it is necessary to account for a 2.8% increase in the selling price** as part of the cost calculation.
- This adjustment reflects the potential **financial impact of compensation payments**, ensuring that the pricing structure adequately **covers health-related risks** associated **with biomass production.**

THE ECONOMIC RISKS ARISING FROM HEALTH DAMAGE IN BIOMASS PRODUCTION AND STORAGE... - **CALCULATION**

The frequency of occurrence and the risk of financial compensation for an occupational disease can vary for each company and may not align with proposed calculated values (CR_{SP} and CR_{PD}). From our perspective, it is necessary to calculate these risks of occupational disease at the level 1%) = **€ 34,000/year.**

This fact needs to be incorporated into the overhead cost calculation proposal

model cost structure:
direct cost €800,000 = allocation base, overhead cost €400,000, profit €50,000
profit margin based on Return on Cost = ROC 4.17%, overhead cost surcharge % OCS = 50%).

$$\Delta OCS = \frac{Differ.in\ overhead\ cost\ by\ calculation\ risks}{Allocation\ base} x100\ (\%)$$

$\Delta OCS = 4{,}25\%$

$\Delta PM = \Delta OCS\ x\ ROC/100 = 0{,}177\ \%$

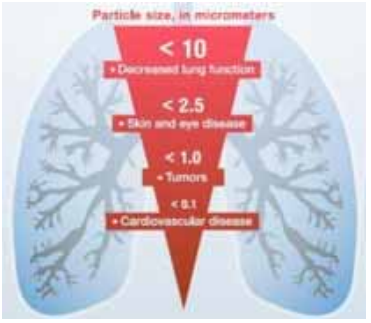
$$\Delta SP = \frac{\frac{\Delta OCS + \Delta PM}{100}\ x\ allocation\ base}{selling\ price} x100 = 2{,}8\%$$

mark-up method of calculation :

Direct cost (materials, wages, others direct cost)
+ Overhead cost (% surcharge with using of Δ OCS)
= Total own cost
+ Profit margin (with using of % ROS and Δ PM)
= Selling price without VAT (with determination Δ SP)

Risk 1% = in the calculation, it is necessary to add 2,8 eurocents for every €1 of the selling price

- When biomass is used as a renewable energy source, most facilities are located close to the end users of the generated thermal or electrical energy, often directly within urban areas.
- The most significant threats to human health are posed by fungal and mold activity within the chip piles, resulting from natural biological processes, and the inhalation of wood dust during chip handling.
- Biological processes associated with natural biological degradation also cause heating of the inner layers of biomass, which is stored mainly in large-volume piles. These facts significantly increase the risk of fire, which can cause damage to property and human health.
- The aim of the work is also the economic calculation of the mentioned risks (especially the burden of PM 2.5 and PM 10 dust particles and phytopathogens), especially from the perspective of the burden on the health and social system, due to the occurrence of occupational diseases and long-term respiratory diseases in the Slovak healthcare system.



METHODOLOGY

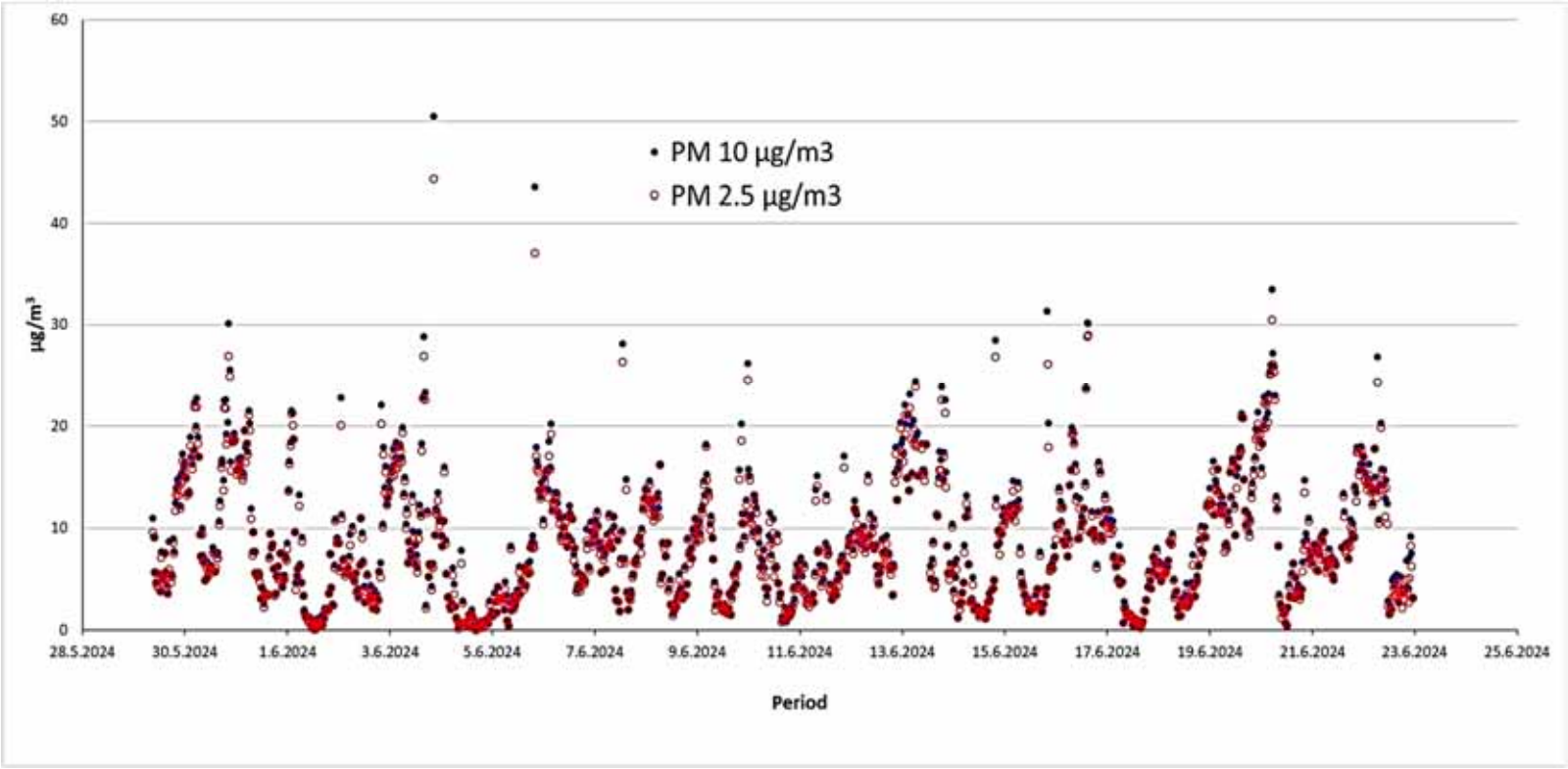
- For the analysis of the environmental impacts of biomass storage, an urban-type heating plant located in the built-up area of the town of Hriňová, in the Banská Bystrica Self-Governing Region, was selected.
- Long-term measurements of particulate matter (PM) with diameters of 2.5 µm (PM2.5) and 10 µm (PM10) were conducted from May 29 to June 23, 2024.
- This period was deliberately chosen outside the heating season to eliminate the influence of biomass combustion emissions and to isolate dust particles generated exclusively from biomass storage and handling activities.
- According to the World Health Organization (WHO, 2021), the recommended average annual concentration limit for PM2.5 is **5 µg/m³**, and for **PM10, 15 µg/m³**.
- The recommended average daily concentrations should not exceed **15 µg/m³** for **PM2.5** and **45 µg/m³ for PM10**. For the measurements, an AirNore device from Blue was used.

METHODOLOGY

- At the selected facility, biomass samples were collected between 2019 and 2024 to analyze the presence of phytopathogens. For each sampling period, three samples were taken from the surface of the pile at different locations.
- All samples were subjected to microbial analysis for phytopathogenic presence at the accredited laboratory of the Regional Public Health Office in Poprad.
- The economic analysis focused primarily on allergic and immunodeficiency-related respiratory diseases, which may develop during the logistical processes of biomass production and handling. Specifically, data on patient visits to immunoallergology outpatient clinics and the number of hospitalized patients, regardless of age, were examined for the period 2013–2023 in the Banská Bystrica Self-Governing Region. In addition, data on the number of reported occupational diseases in the relevant category were analyzed.
- The economic assessment of these diseases was based on valid legislation (Act No. 437/2004 Coll.), databases from the National Health Information Centre (NCZI), and regulations issued by the Social Insurance Agency. Economic data from previous research were also incorporated (Gejdoš & Potkány, 2024).

RESULTS

Particulate Matter analysis



During the monitoring period, the WHO-recommended daily limit for PM10 was exceeded only once. However, the limit for PM2.5 was exceeded on several occasions, specifically in more than 14% of the recorded cases.

RESULTS

Fungi spores analysis

Year	Sample 1	Sample 2	Sample 3	Total
2019	110 000	34 000	7 700	151 700
2020	12 000	5 800	11 000	28 800
2021	12 000	50	920 000	932 050
2022	46 000	350 000	3 100 000	3 496 000
2023	31 007 500	167 650	43 010 850	74 186 000
2024	50 000	26 000	358 350	434 350

Table 1. Number of phytopathogen spores in analysed samples from wood chip pile surface in heating plant storage during period 2019-2024 (in CFU.g^{-1})

The most frequently identified genera were Penicillium and Aspergillus. Both are known to cause serious respiratory conditions, including respiratory and skin allergies, pulmonary diseases, and potentially even carcinogenic effects.

RESULTS

Burden of the health and social system

Year	Nr. of visits Imunology and Allergology Surgery	Nr. of specific diseases connected with air quality	Nr. of new patients with specific immunotherapy admitted to treatment
2013	106 105	88 443	4473
2014	125 129	110 395	3141
2015	132 715	83 505	3375
2016	127 396	94 650	3371
2017	125 866	84 715	3288
2018	124 106	84 011	3392
2019	124 467	82 853	3266
2020	113 430	77 455	3125
2021	110 514	73 153	3230
2022	120 431	75 303	3369
2023	109 178	68 496	3468

Table 2. Number of Cases in imunology and allergology treatment in Banská Bystrica Self-Governing Region for years 2013-2023 (NHIC, 2025)

The average reimbursement for an extended and controlled examination at an immunoallergological outpatient clinic, according to the largest Slovak health insurance provider, is €10.72. Over the period 2014–2023, the total burden on the healthcare system due to poor air quality in the Banská Bystrica Self-Governing Region exceeded €9 million. In the most recent year analyzed, 2023, this burden amounted to over €734,000.

RESULTS

Burden of the health and social system

Based on the identified risks associated with the production, storage, and use of biomass, the following diseases—classified according to the national system for occupational illnesses and health damage—were selected for analysis: 1. Allergic respiratory diseases; 2. Occupational dermatoses.

The economic values associated with these diseases were derived from Slovak legislation and are detailed in our previous study (Gejdoš & Potkány, 2024) (see Table 3).

Year/Dis.	2023	2022	2021	2020	2019	2018	Together	Costs in €
1	1				2	2	5	260,800
2				1	1		2	83,456
Together	1	0	0	1	3	2	7	344,256

Table 3. Registered diseases in the Slovak Republic in the agriculture, forestry, and wood processing sector in 2019-2023 and their economic value in €

Table 3 shows that over the past 7 years, the selected diseases with the greatest economic impact were allergic respiratory diseases, recognized occupational diseases in the forestry and timber sector. This fact is, of course, influenced mainly by increased dustiness in processing operations during the production of sawn timber and further mechanical processing of wood.

CONCLUSIONS AND FUTURE WORK

In addition to the production of phytopathogens and molds, resulting from biological processes in stored biomass, air quality in the vicinity of storage sites is adversely affected not only by biomass combustion but also by its handling (including chipping, which sometimes occurs directly within heating plant premises).

These activities significantly increase the concentration of solid particulate matter in the air, even outside the heating season, as confirmed by our study.

Demonstrating a direct correlation between air pollution and human health remains challenging, primarily because the health effects typically manifest over long-term exposure periods.

Moreover, the process is influenced by a variety of additional factors, including meteorological and topographical conditions, proximity to other emission sources, traffic intensity, and local heating practices in family homes and apartment buildings.

Current legislation primarily focuses on industrial-scale processes and does not adequately account for the negative exposure experienced by populations living near biomass-related operations

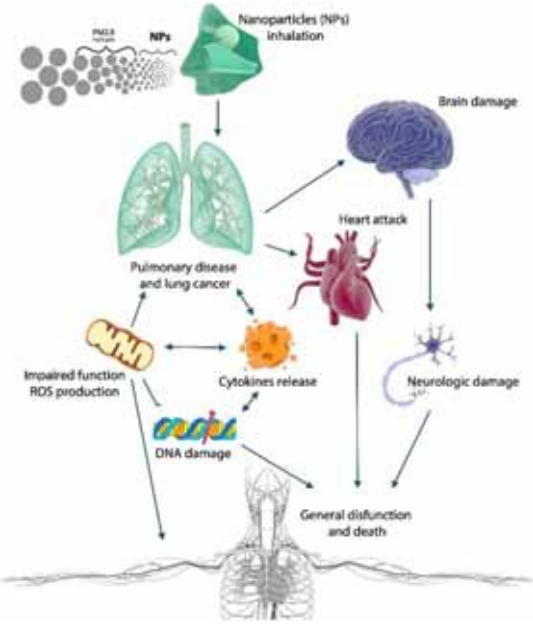
CONCLUSIONS AND FUTURE WORK

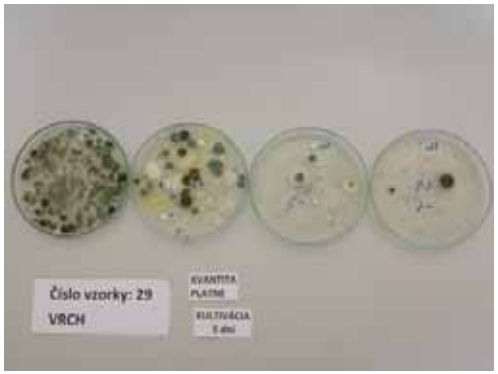
Nano-Particulate Matter Measurement (2025) in Heating Plant – Hriňová

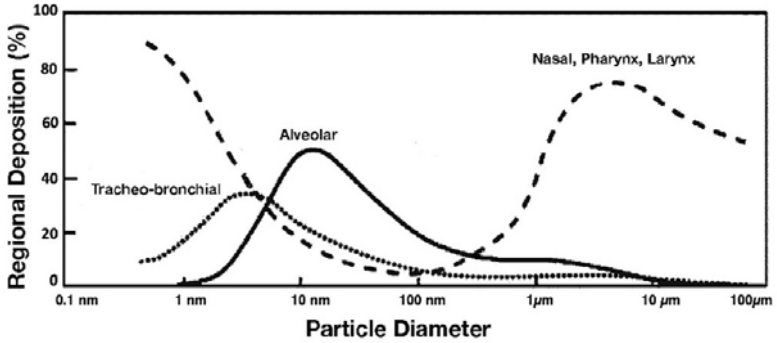
Measurements conducted at outdoor and indoor workplaces under different atmospheric conditions; in cooperation with the Faculty of Ecology and Environmental Sciences – Department of Environmental Engineering.

Continuous Wood Chip Sampling in 3 Municipal Heating Plants (Hriňová, Hnúšťa, Poltár)

Next sampling scheduled for November 2025, in cooperation with the Regional Public Health Office in Poprad – accredited laboratory.







INVITATION

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THANKS FOR PAYING ATTENTION!

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