EDITORIAL

Advancing Chemical Safety, Climate Resilience, and Circularity in Construction Sector

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The construction industry is a major contributor to national gross domestic product (GDP) in the Baltic Sea Region (BSR), but at the same time it contributes to environmental degradation due to hazardous chemicals, carbon emissions, and excessive waste. Many studies indicate that indoor air pollution, caused by chemicals in building materials, is a significant health risk (Mansouri et al., 2022; Saedi et al., 2024).

Project "Reducing hazardous substances in construction to safeguard the aquatic environment, protect human health and achieve more sustainable building" (NonHazCity 3) integrates efforts to reduce these impacts by promoting non-toxic, climate-resilient, and circular practices throughout the building lifecycle, aligning with the goals of the European Green Deal (EC, 2021). Central to NonHazCity 3's approach is the strategic development of criteria for "tox-free, circular, and climate-friendly buildings" tailored to decision-making processes at public authority levels. The project particularly focuses on procurement as a key instrument, helping municipalities define and enforce criteria for selecting safer materials and products in construction and renovation projects.

1 **Stakeholder engagement.** Through workshops and consultations, NonHazCity 3 engages municipalities, builders, and residents, emphasizing sustainable practices involving non-toxic, low-carbon, and recyclable materials. These sessions target public-sector decision-makers, supporting them in adopting criteria that align with circular economy principles, climate resilience, and chemical safety. This follows similar engagement models proposed by Tabas et al. (2024) and Kujala et al. (2023), in circular economy initiatives.
2 **Tools empowering change.** The project offers several tools designed to help in the selection of materials that meet chemical safety and sustainability standards. Check-ED app, tailored for private households, assists users in assessing indoor exposure risks from building materials, providing guidance on safe materials for flooring, insulation, and interiors (NHC3_APP, 2023). The BVB (Byggvarubedomningen) tool, a procurement assessment instrument originally from Sweden, is adapted for broader use across the Baltic Sea Region through NonHazCity 3, helping municipalities evaluate the toxicity and circularity of construction materials (NHC3_BVB, 2023). Such digital tools may be critical for smaller enterprises and public organizations in implementation of the sustainability programs (Neri et al., 2024; Arenas and Shafique, 2023).
3 **Pilot projects.** NonHazCity 3's pilot projects focus on implementing procurement protocols and tendering criteria that promote non-toxic, climate-friendly, and circular construction practices. These pilots highlight how setting sustainability criteria in public contracts can drive broader adoption of environmentally friendly building standards. These projects prioritize non-toxic material selection as an add-on to standard energy-saving criteria and align with best practices described by Yadav and Agarwal (2021) on sustainable building material use and utilization.
4 **Policy advisory.** A significant aspect of NonHazCity 3 is its commitment to connecting chemical safety, circu-

larity, and climate resilience within policy frameworks. The project works with local governments to integrate these criteria into construction policies, linking construction material regulations with broader chemical safety and climate policies, such as the Zero Pollution Action Plan and the Circular Economy Action Plan. By advocating for cross-sectoral regulatory coherence, NonHazCity 3 supports the creation of sustainable construction standards that apply consistently across the European Union (EU). Selected policy frameworks are also modeled on approaches that emphasize sustainability across building lifecycles (Chen et al., 2024).

Snapshots from the Baltic Sea Region

The Report on occurrence of substances of concern in BSR buildings, construction materials and sites (NHC3_REP, 2024) has examined hazardous substances from building materials across five Baltic Sea cities, identifying pollutants in construction materials, stormwater, indoor dust, air, and wastewater. Findings revealed significant organic pollutants, including PFAS (per- and polyfluoroalkyl substances) and biocides, with stormwater acting as a key pathway between urban and natural environments. The results highlighted variations across locations and building types, emphasizing the need for more data to understand long-term effects and to develop strategies for reducing exposure and contamination.

The catalogue of building material for tox-free construction (NHC3_CAT, 2023) addresses the urgent need for sustainable construction by eliminating hazardous substances, promoting circularity, and achieving climate neutrality. It involves over 22 institutions working together to develop and test solutions that support non-toxic, recyclable, and low-emission building materials. Through a comprehensive catalogue, it guides stakeholders, from municipalities to do-it-yourself (DIY) enthusiasts, in making informed, sustainable choices, highlighting chemical content, eco-certifications, and legislative insights to foster healthier, circular, and climate-conscious construction practices.

Integrating chemical safety, climate, and circularity

Addressing climate change requires more than just switching to renewable energy; it also involves managing the chemical industry, which contributes nearly 6% of global greenhouse gas emissions. Although shifting to CO_2-neutral energy can mitigate part of this, a substantial share of emissions stems from chemical production processes. Reducing petrochemical use and adopting a circular economy, where raw materials are reused and recycled, is crucial. However, the contamination of recyclates with harmful substances poses challenges, making it essential to eliminate pollutants to enable effective recycling and achieve climate goals. Additionally, certain chemicals, like F-gases and VOCs (volatile organic compounds), directly exacerbate global warming.

The NonHazCity 3 initiative addresses the interlinked issues of chemical safety, climate resilience, and circular economy principles. Research suggests that using bio-based and recyclable materials can significantly reduce carbon footprints and enhance material recovery (Fauziet al., 2024). The adoption of safer, non-toxic materials also improves quality of environment and human health, which is indicated in health-focused studies in green building practices (Weschler et al., 2020).

Additional tools empowering change

Procurement and building standards. These set critical foundations for municipalities in the Baltic Sea Region to prioritize non-toxic, circular, and climate-neutral practices. NonHazCity 3 has developed draft guidelines, set to be finalized in spring 2025, offering a comprehensive framework for municipalities to implement strategic procurement standards.

- **Training programme for municipal officers.** The programme includes four main modules on toxic-free, circular, and climate-neutral building, specifically crafted to support municipalities (their relevant desk officers who deal with construction, as well as architects) in executing NonHazCity 3 standards in construction and renovation projects (NHC3_EDU, 2024). Module One introduces participants to the types of harmful substances found in building materials and construction processes, emphasizing the importance of reducing exposure for human health. Module Two provides tendering officers with essential concepts, tools, and methods to steer their procurement practices toward minimizing toxic substances in public projects. Building on these foundations, Module Three delves into Green Public Procurement (GPP), guiding municipalities in incorporating sustainability and safety criteria directly into their tendering processes. Finally, Module Four is specifically tailored for architects, equipping

them with strategies to navigate and interpret the extensive information on toxic materials, enabling them to support municipalities effectively in achieving sustainable building standards.

- The DIY guide on toxic-free, circular and climate-friendly renovation of a home is intended to serve private users who want to carry out renovation or construction work themselves. The guide provides lists of different building materials (e.g., flooring, paints) and their risk potential regarding hazardous substances, as well as information on circularity and climate aspects. In addition to the material lists, the guide includes advice on safer renovation, legal, health and environmental aspects, indoor air quality, energy efficiency and waste management (NHC3_DIY, 2024).

Policy implications and conclusions

NonHazCity 3's policy recommendations underscore the need for regulatory synergies between chemical safety, climate resilience, and circular economy principles in construction. The project aligns with broader EU policy initiatives, such as the Renovation Wave, New European Bauhaus, and Ecodesign Regulation, advocating for uniform guidance on zero-pollution construction materials that applies across industries. NonHazCity 3 works to engage EU policymakers to foster these cross-sectoral solutions, supporting a more sustainable construction landscape. By integrating chemical safety with climate and circularity measures, the frameworks developed mirror broader EU policy objectives (Kylili and Fokaides, 2017; Gervasio and Dimova, 2018), ensuring practical and enforceable regulations that incentivize the use of safe, low-emission, and recyclable material.

NonHazCity 3 represents an integrated approach to sustainable construction by addressing chemical safety, climate resilience, and circularity. Continued collaboration across sectors, innovation in tools and practices, and effective policy frameworks are key to scaling these efforts throughout the Baltic Sea Region and beyond, ultimately enhancing environmental and public health outcomes.

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