

Workgroup A

BioBricks

The Fate and Effects of Sewage Sludge-Based Bricks on Human Health and Water Resource Quality



ABSTRACT

The overall project goal is to prevent water pollution in the River Basin of the Danube's stretch crossing Croatia, Serbia and Hungary, coming from the use of sewage sludge-based bricks in house construction, which despite representing a solution to the ever increasing problem of waste management and determining a reduction of the clay needed for construction, may pose environmental and health dangers if not properly used, due to leaching of toxic substances and heavy metals into the waters. The project aims at creating a comprehensive database on SSBB environmental and health effects; developing a guideline for SSBB manufacturers on standardised SSBB production, and increasing the awareness and knowledge of manufacturers and consumers on possible negative effects and the proper handling/use of SSBBs.

KEYWORDS

sewage sludge-based bricks
waste management
toxic leaching
database

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GLOBAL CHALLENGE CONSIDERED

Inclusive, Innovative and Secure Societies

DANUBE RIVER BASIN CHALLENGE CONSIDERED

No more risk from toxic chemicals
Healthy and sustainable river systems

BACKGROUND INFORMATION

PROBLEM DEFINITION

The production of sewage sludge-based bricks (SSBB) represents a solution to the ever increasing problem of waste management, but if treated improperly this innovative technology may pose harmful environmental and health effects.

On the one hand, the use of sewage sludge for brick manufacturing will reduce the amount of waste and will reduce the amount of clay needed for brick production.

On another hand, the use of sewage sludge-based bricks (further on – SSBB) may pose negative externalities on the environment and the people. The presence of heavy metals in the sludge may be a problem in case a construction is made without a facade that serves as a protective shield against the rain and prevents heavy metals from leaching. In that case the leaching of toxic substances into the waters of the Danube River Basin can cause negative effects on the aquatic flora, fauna, and the human health.

The application of dewatered sewage sludge for production of bricks started on a commercial scale in mid 80s, with the sludge content in manufactured bricks ranging from 10 % to 80 %. According to manufacturers these bricks satisfy all technical requirements but there are still contradictory data regarding the safety of SSBB, especially if they are not properly protected.

The supply side – production of sewage sludge-based bricks should comply with the technical requirements and environmental and health safety norms; on the demand side, the people using SSBB for private or commercial construction, should be aware of the rules of proper handling of these bricks and be stimulated to apply them.

PROJECT LINK TO THE DANUBE RIVER BASIN SUSTAINABILITY CHALLENGE

The Danube river basin represents the foundation of the Black Sea Ecological Network, and as such its sustainable development is of the outmost importance for the social-economic wellbeing and environmentally sound development of the countries forming part of this river basin.

This project will be implemented in the Danube River region of the three selected countries – Croatia/Serbia/Hungary. The project area of the three chosen countries enjoys a protection status, e.g. Special Nature reservation “Gornje Podunavlje” in Serbia; Nature Park “Kopacki Rit” in Croatia; and National Park “Danube-Drava” in Hungary.

The project results and findings, however, can be extended onto the entire Danube region since waste management and water pollution issues are of high relevance for the entire Danube river basin. Specifically, apart from the formal project objectives an extra value-added of this international collaboration will be the dissemination of the project findings onto the Danube river basin, specifically the guidelines on the improved SSBB production technologies, and the creation of an international ecological network that will share data from biomonitoring studies conducted in the Danube River Basin area.

The project will significantly increase the awareness of SSBB producers and consumers on the issues involved in the proper use of these bricks, and it will promote the ecological and sustainable development of the selected parts of the Danube river basin, with a follow-up replication onto the entire Danube region.

The areas of expertise required for the project implementation will be geography, chemistry, biology, toxicology, public health, civil engineering, architecture, ecology, policy, economics and public relations.

PROJECT GOAL AND OBJECTIVES

GOAL

The overall project goal is to prevent water pollution in the Danube River Basin, particularly on the Danube stretch in Croatia/Serbia/Hungary, coming from the use of sewage sludge-based bricks in the house construction.

OBJECTIVES

1. Create a comprehensive database on environmental and health effects of the sewage sludge-based bricks used in the construction of houses in the Danube River Basin on the territory of Croatia/Serbia/Hungary.
2. Develop a guideline for sewage sludge-based brick manufacturers of Croatia/Serbia/Hungary on the standardized sewage sludge-based brick production.
3. Increase by 50% the awareness of the sewage sludge-based brick manufacturers and the residents of Croatia/Serbia/Hungary of the Danube River Basin on the possible negative effects of the sewage sludge-based bricks and their knowledge on the proper handling/use of the sewage sludge-based bricks.

Below are the maps displaying the geographical coverage of the project (taken from the internet):



Figure 1. Maps of the Danube River basin with a focus on the project areas – Croatia (Slavonia area), Serbia (Vojvodina area) and Hungary (Southern area) highlighted by the circle

PROJECT OBJECTIVES IN DETAIL

Objective 1: Create a comprehensive database on environmental and health effects of the sewage sludge-based bricks used in the construction of houses in the Danube River Basin on the territory of Croatia/Serbia/Hungary.

As a result of the project work a database on the temporal and special distribution of SSBB in the area of Croatia, Serbia, and Hungary in the Danube River basin will be developed and regularly updated by the participating project partner institutions. A detailed distribution of the already existing SSBB houses in the area of Croatia (Slavonia area), Serbia (Vojvodina area) and Hungary (Southern area) will be identified and mapped in order to obtain detail information on the usage of this type of bricks for house construction in the villages and cities of the selected area.

The following types of scientific analyses will form part of this database:

1) *A chemical analysis of the SSBB and surrounding surface water, ground water and soil*

The aim of this type of an analysis is a detailed chemical characterization of the sewage sludge used for brick manufacturing to determine the chemical composition and the bulk elemental concentration of heavy metals present in the sludge.

In order to determine possible leaching of heavy metals from the bricks they will be exposed to precipitation in control laboratory conditions to determine the amount of heavy metals after the precipitation. To examine a possible contamination of the surrounding surface water, ground water and soil with heavy metals we will collect samples around the houses already built with this type of a material and we will also conduct a biomonitoring study of the watercourses with transplants of the aquatic moss (*Rhynchostegium riparioides* Hedw.). Mosses are excellent bioaccumulators of trace elements and can solve problems like detection limits of instruments as the concentrations of trace elements in water are often below the instrumental limit of detection (LOD) or they rapidly change in space and time, as for example, in case of intermittent pollution sources.

2) *In vivo cyto/genotoxicity study on plant and animal model*

The aim of this analysis is a detailed cytotoxicity and genotoxicity study on plant and animal model that would be done in vivo on duck weed (*Lemna minor* L.) and fresh mussel (*Unio pictorum*). Fresh mussel is commonly liv-

ing in the Danube River as a bioindicator of exposure since the mussels are filtering harmful substances. Additionally study will be done on zebra fish (*Danio rerio*) model that is widely used as a model in toxicity studies. Zebra fish study will be done on two generation to see the impact on the offspring on blood, liver, gill and gonad cells, and in embryos, larvae, juvenile and adult stage to have the results on developmental toxicology.

3) *In vitro cyto/genotoxicity study on human model*

Studies will be conducted in vitro on primary human blood cells (human peripheral blood lymphocytes, HPBLs) since those cells are sensitive bio-markers of exposure to toxins.

OBJECTIVE 2: Develop a guideline for sewage sludge-based brick manufacturers of Croatia/Serbia/Hungary on the standardized sewage sludge-based brick production.

The following will feed this objective:

1) *Development of new technologies in SSBB production to reduce the toxic effect of the final product*

This part aims to develop new purification methods of sewage sludge in order to have a more purified material for brick production. New technologies will be introduced to minimize the leaching of potentially toxic elements. Standards on the raw materials that can be used in the production will be set to be applied on the entire project territory. Specifically, the production of bricks will be optimized taking into account the optimum ratio of sewage sludge and clay material, preparation of raw material, proper brick molding and drying procedures and sintering in order to obtain sustainable bricks with a minimal toxic content.

2) *Legal framework amendment*

A regulation on the sewage sludge-based brick production for SSBB manufacturers, and a policy on compliance of the SSBB manufacturers and users with the environmental and health safety norms will be developed and proposed to decision-makers.

OBJECTIVE 3: Increase by 50% the awareness of the sewage sludge-based brick manufacturers and the residents of Croatia/Serbia/Hungary of the Danube River Basin on the possible negative effects of the sewage sludge-based bricks and their knowledge on the proper handling/use of the sewage sludge-based bricks.

To achieve this objective the following activities will be carried out:

1) *A baseline awareness survey*

This study will be carried out to assess the current level of awareness of the sewage sludge-based brick manufacturers and the residents of Croatia/Serbia/Hungary of the Danube River Basin on the possible negative effects of the sewage sludge-based bricks and their knowledge on the proper handling/use of the sewage sludge-based bricks. It will be carried out via structured questionnaires and meetings with stakeholder groups. The survey findings will serve as reference data to evaluate the awareness increase of the project target population at a later stage.

2) *Media coverage*

Mass media will be involved to ensure the project publicity and visibility among the project target population (SSBB manufacturers, SSBB house owners and potential owners, scientific community) via creation of a project website, regular publications and press-conferences, media field trips).

3) *Scientific community exchange*

Participation at scientific conferences, organization of scientific workshops and publications in the targeted research papers in environmental, toxicology and civil engineering journals (PubMed, Scopus, Google Scholar)

4) *Educational campaigns*

Educational events (seminars, workshops, field trips) will be carried out for SSBB manufacturers, constructors and people living in the identified SSBB house areas. Information events will also be carried out at the schools of the project area.

PROJECT MANAGEMENT

The project management will be carried out by a subcontracted agency, that will be responsible for the overall administration and financial transactions of the project; coordination of work among the project partners and implementing institutions-organizations. This agency will carry out an overall supervision and monitoring of the project progress, and will serve as a link among the project partners/ implementing organizations and the funding agency.

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