

**Title: TIMBRE EXPERT SYSTEM FOR CHOOSING
SUSTAINABLE SOLUTIONS OF RISK BASED APPROACHES AND TECHNOLOGIES FOR
BROWNFIELD REHABILITATION**

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Abstract.

Brownfield regeneration plays a key role in sustainable land use management. The project TIMBRE (Tailored Improvement of Brownfield Regeneration in Europe), funded by the 7th Framework Programme, starts from the observation that many useful and innovative remediation technologies as well as methods to support risk assessment and decision making processes for an optimized brownfield regeneration have been developed, but are only rarely applied using their full potential. Identified obstacles for an effective regeneration are (i) the abundance of strategies, tools, documented case studies and remediation technologies available at the EU level as well as (ii) the difficulties in adapting them to cultural, regional and site-specific requirements.

One of TIMBRE's main objective is to overcome these barriers by providing brownfields' owners, local authorities and stakeholders with a web-based and target-oriented customizable Expert System that can be at the same time a collector and provider of all available information related to the main phases of the risk-based regeneration process and sustainable management of contaminated sites and brownfields. This Expert System, enriched with information provided not only by TIMBRE partners, but also by selected stakeholders, will provide access to proven state-of-the-art solutions for brownfield regeneration. This requires the collection, analysis and classification of accessible literature, methodologies and tools.

The first step for the development of the TIMBRE Expert System consisted in the definition of a shared framework for the collection of information about brownfield regeneration, where the main phases of the risk-based regeneration process correspond to information categories used to guide the organization and the consultation of available materials. The definition of the framework started with the analysis of the available contaminated sites/brownfields rehabilitation frameworks developed in

previous programmes and projects (e.g., RESCUE, 2005; COM (2006) 231 final; NORISC, 2001-2003; Sanja et al., 2000) and led to the identification of all contaminated sites rehabilitation phases (i.e. characterisation, risk assessment, remediation technologies selection, decision making processes, deconstruction and re-use of existing structures and bulk materials, socio-economic assessment, etc.). In order to achieve a wide acceptance of the proposed framework among stakeholders, local stakeholders collaborating to TIMBRE case-studies have been involved through an international participatory process. Specifically, stakeholders have been asked to evaluate the proposed framework during ad-hoc sessions of three stakeholders workshops organized by TIMBRE project in Hunedoara (Romania), Szprotawa (Poland) and Ostrava (Czech Republic). Moreover, in order to verify and assure the adaptability of the framework to real situations and its suitability to end-users' requirements, also external stakeholders and experts from Germany, Czech Republic, Italy, Romania and Poland have been involved through the administration of an on-line questionnaire.

The shared framework constitutes the fundamental structure of the TIMBRE Expert System and will guide the end-users in the consultation of the materials collected in its web-database and in the upload of new information. Moreover, the Expert System will offer a multi-criteria methodology for the evaluation and ranking of the collected information providing end-users with the most suitable instruments for each phase of the brownfield regeneration process. Results will be tailored to the site-specific needs taking the local priorities and requirements into account. This approach will involve local experts, site owners, public authorities and engineering companies in the definition of evaluation criteria.

1. Introduction.

Brownfield regeneration is essential for sustainable land management in European Member States and in the last decades many EU research projects and initiatives focused on the development of approaches, tools and technologies aimed at supporting an effective and sustainable rehabilitation and redevelopment of contaminated sites and brownfields. Nevertheless this variety of products had and still has a limited practical impact on brownfield revitalization success, because they are too often not used in their entire potential. This is due to their scarce visibility, so that often site managers, experts, decision-makers are not aware of the possibility to apply such useful, innovative and already available approaches and tools. Moreover, because of the specificity of local and regional administrative structures and because of the variety of stakeholders' attitudes, there may be significant difficulties in adapting such products to cultural, regional and site-specific requirements.

This situation makes the success in brownfield regeneration often unsatisfying in terms of financial, eco-efficiency or social acceptance and highlights the need to improve the access to available information and to support the selection of the most sustainable and suitable solutions based on actual stakeholders' needs.

The European project TIMBRE (Tailored Improvement of Brownfield Regeneration in Europe), funded by the 7th Framework Programme, starts from the above mentioned observations and aims to overcome these barriers by providing brownfields' owners, local authorities and other stakeholders with customised problem- and target-oriented packages of approaches, technologies and tools.

The main objective of TIMBRE Work Package 1 (WP1), coordinated by the University Ca' Foscari of Venice (UNIVE), is to provide stakeholders with an Expert System (ES) that can be at the same time a collector and provider of all available information related to the main phases of the risk-based regeneration process of brownfields.

This ES, enriched with information provided not only by TIMBRE partners, but, once the tool will be publicly available, also by stakeholders, will allow access to a variety of state-of-the-art solutions for brownfield regeneration. The ES will give the possibility to users to find, among a wide collection of information and tools, the most tailored and sustainable solutions they are looking for, according to their specific needs and to local and specific environmental and socio-economic aspects which are crucial when dealing with brownfield management. This will require the collection of accessible literature, legislation, methodologies and tools and the development of a ranking methodology able to select and provide tailored information to the end-users.

2. The TIMBRE Framework.

The first step for the development of the TIMBRE ES consisted in the definition and development of a framework for the collection of information about brownfield regeneration, where the main phases of the risk-based regeneration process correspond to "information categories" used to guide the collection/organization and the consultation of the available materials.

The definition of the framework started with the analysis of the available contaminated sites/brownfields rehabilitation schemes developed in previous programmes and projects (e.g., RESCUE, 2005; COM (2006) 231 final; NORISC, 2001-2003; Sanja et al., 2000) and led to the identification of all brownfields rehabilitation phases.

The literature review on previous programmes and projects showed that many frameworks concerning brownfield regeneration are available in the international context, but none of them fully covers in a comprehensive way all phases of the rehabilitation process: these frameworks are indeed more focused on some aspects of the process, but (partially or fully) neglect others.

Within TIMBRE, in order to elaborate a comprehensive framework and to achieve a wide acceptance of it, local stakeholders, collaborating to the project's case-studies, have then been involved through an international participatory process. Specifically, stakeholders have been asked to evaluate the proposed framework during ad-hoc sessions of stakeholders and experts workshops organized by the TIMBRE project in Romania, Poland and Czech Republic. Moreover, in order to verify and assure the adaptability of the framework to real situations and its suitability to end-users' requirements, an on-line questionnaire has been developed to involve stakeholders and experts from Germany, Czech Republic, Italy, Romania, Poland and Austria. The questionnaire has been translated into five languages (Czech, German, Italian, Polish, Romanian) in order to overcome possible linguistic barriers due to the use of English language.

The final version of the framework for the collection of information on brownfield regeneration is composed of thirteen "information categories" (Figure 1), corresponding to the different idealised steps of the brownfield regeneration process, and it is implemented in the TIMBRE ES. Moreover, the

developed framework, representing the fundamental structure of the TIMBRE ES, will guide end-users in the consultation of the collected material and in the upload of new information.

- Strategic planning
- Investigation (preliminary/detailed)
- Risk assessment (qualitative(quantitative))
- Remediation strategies and options
- Remediation technologies evaluation and selection
- Building and infrastructure documents
- Deconstruction/re-use of structures and materials
- Waste management
- Requalification plan development
- Implementation, control, monitoring (land back to market)
- Socio-economic assessment
- Funding and financing
- Decision making and communication

Figure 1. Information categories of the TIMBRE framework.

3. The TIMBRE Expert System.

Starting from the framework and selecting one of the information categories included in it, end-users can access the different sections of the TIMBRE web database, that is one of the main components of the ES and is aimed at containing a wide collection of web-links to material and information on brownfield regeneration. The end-users of the envisioned ES will also have the possibility to create their own tailored framework, based on the process of their specific case, by selecting the framework information categories of interest and ordering them considering their needs.

The web-links are classified, within the ES, according to the information categories and also to the typology of documentation they include (i.e., regulations, technical manuals, tools and case studies).

The categories of potential end-users of the ES are considered to be quite wide, including all people involved in at least one step of the brownfield regeneration process, such as consultants, remediation technology providers, site owners, representatives of local/regional/national authorities, scientific community and researchers, public interest groups, etc..

The web database, and thus the ES, is expected to become a “living system” which will rely on direct end-users inputs, updates and evaluations and, for this reason, each end-user who wants to include/modify or evaluate the collected information will be asked to create his/her own account to register to the system.

With the aim of guiding end-users among the variety of available information according to their specific requirements and needs, the TIMBRE ES will implement a multi-criteria methodology for the evaluation and ranking of the collected information, able to provide end-users with the most suitable instruments for each phase of the brownfield regeneration process.

According to end-users specifications, results will thus be tailored to site-specific and personal needs, taking the local priorities and requirements into account.

The tool will be further developed with the use by new stakeholders, whose participation is thus essential for a successful development of the tool. On one hand, indeed, they are asked to share their knowledge by uploading new web-links in the web database and, on the other hand, by performing searches in the ES and by evaluating the results they will “feed” the tool with new information useful for refining the ranking of future outputs.

Once a preliminary version of the ES will be ready, it will be presented to stakeholders involved in TIMBRE case-studies, in order to collect their suggestions and feedbacks and to improve the tool functionalities according to their opinions.

The ES will form one of the core parts of the unique TIMBRE online Tool Suite Platform, that will provide customisable information and tools for brownfield regeneration. This web platform will be an open centre allowing the access to the set of tools and methods (and related documentation) developed in TIMBRE project.

4. Conclusions.

The TIMBRE ES will represent an innovative tool for increasing and improving the access to available information about sustainable brownfield redevelopment, thus trying to overcome the barriers which actually hamper the optimal and effective use of available approaches, technologies and tools across different Countries in sustainable land use management.

The active involvement of stakeholders in the different stages of the TIMBRE ES development, encompassing the framework and the evaluation of the available information collected in the ES, represents a strong guaranty that the scientific process will produce useful and shared results.

5. References.

Carlou, C., Critto, A., Ramieri, E., Marcomini, A. (2006) DESYRE: Decision Support System for the Rehabilitation of Contaminated Megsites. *Integrated Environmental Assessment and Management*; 3: 211-222.

COM (2006) 231 final. Communication from the Commission to the Council, the European Parliament, the European economic and social Committee and the Committee of the Regions. Thematic Strategy for Soil Protection. Brussels, 22.9.2006.

Contaminated Land Rehabilitation Network for Environmental Technologies – CLARINET (2002) *Brownfields and Redevelopment of Urban Areas*. Federal Environment Agency, Austria
www.cluin.org/wales/download/3CLARINET_brownfields_report.pdf.

NORISC project information available at the web site: <http://www.norisc.com/fabout.htm>.

RESCUE. 2005. Best Practice Guidance for Sustainable Brownfield Regeneration.

Edwards, D., Pahlen, G., Bertram, C. and Nathanail, C.P. Land Quality Press on behalf of the RESCUE consortium, Nottingham. ISBN 0-9547474-0-2.

Sanja Vranes, E.Gonzalez-Valencia, A.Lodolo and S.Miertus, (2000) "Decision support systems: application in remediation technology evaluation and selection", in NATO/CCMS Pilot Study Evaluation of Demonstrated and Emerging Technologies for the Treatment and Clean Up of Contaminated Land and Groundwater, NATO, Wiesbaden, Germany, pp. 42-57.

Swartjes, F.A., Carlon, C., de Wit, N.H. (2008) The possibilities for the EU-wide use of similar ecological risk-based soil contamination assessment tools. *Science of the Total Environment*; 406: 523-529.

TIMBRE project information available at the web site: <http://www.timbre-project.eu>.