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Introduction

The existence of brownfields may become an undesirable commodity if it represents not only risks for health and the environment, but also becomes an eyesore, which may have a negative impact on the value of property in the vicinities of these abandoned facilities. This loss in value can be translated into a decrease in the price of land, increased unemployment, defense expenditures or the costs of the cleaning up processes.

Such localities are mostly affected by the former uses to which the site and the surrounding land were put; They are derelict and unused; and may have real, or perceived, contamination problems; can be situated mainly in developed urban areas; and may require intervention to redeem them [1]. Such intervention is usually pursued through an adequate remedial process.

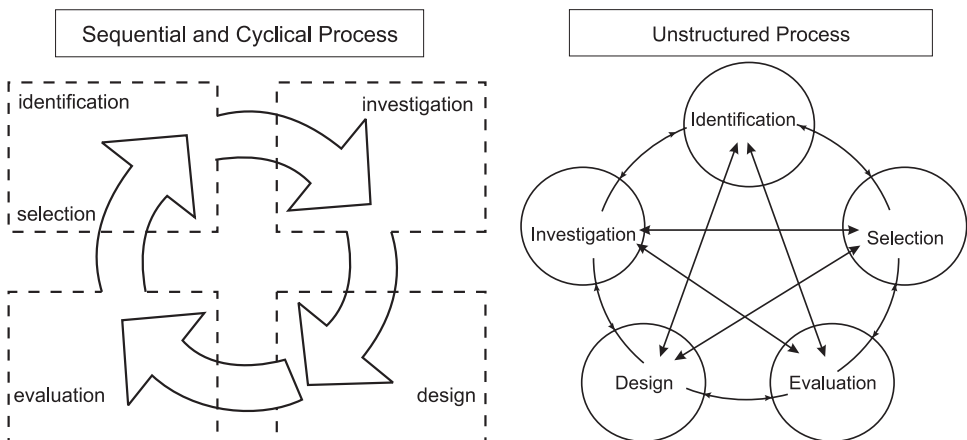
This paper presents a recapitulation of studies concerning the applications of decisions and the stakeholder theory for the solution of environmental problems focusing mainly on brownfield issues. The decision making process for the management of contaminated land in the Czech Republic has been also analyzed.

The main objective of this work has been to gather ideas from the local and international context, and to adapt them to the actual decision making process of management of historical contamination in the Czech Republic.

1 Decision Theory and Brownfield Management

The laws and principles of making decisions have been analyzed from different perspectives and with the use of different methodologies by scientists from such branches as philosophy, law, economics, and sociology [10]. Modern decision theory is an area of discrete mathematics that studies the key factors and methodologies for an effective (optimal) decision making process. Thus, it is a normative decision theory that indicates how decisions should be made. The positive field of work – the descriptions of how decisions are actually made – involves the knowledge and application of disciplines such as probability, and statistics. Hansson [10] also identifies „social decision theory“ as the aggregation of individual preferences (choices) into collective preferences

Fig. 1 Decision Process. Types and Phases



Source: Adapted from Mintzberg et al.[16]

(choices). Decision processes can be divided into different phases including identification, investigation, design, evaluation, and selection. The way of the process can be seen as sequential or cyclical or „unstructured“, which allows for more flexibility during the revision of specific steps and a closer representation of real situations [16]. Fig. 1 illustrates these ideas .

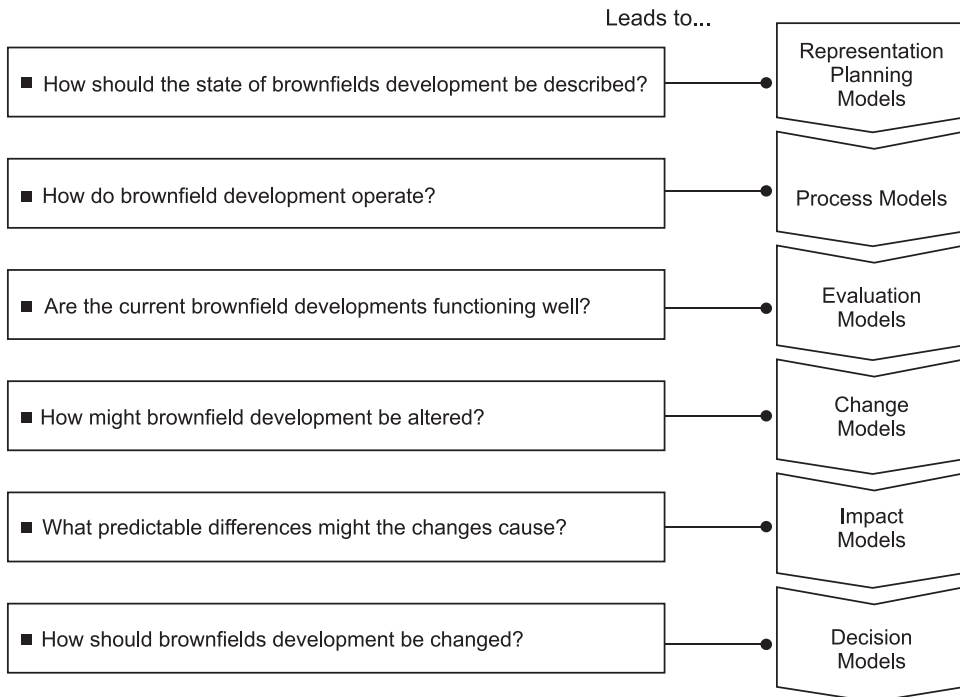
Results from the application of the decision theory can serve as a complementary tool for economic assessments of environmental issues. Its central subject of observation should be focused on a specific problem whose solution can stem from more than one alternative, and can affect other subjects (stakeholders). Thus, environmental conflicts might become attractive for the application of decision support tools.

The history of theory and practice of brownfields redevelopment is divided into three main phases according to Kirkwood [14]. The first one is called the scientific model and focuses on environmental cleanup; the second phase is oriented towards the economic development of

the site. The last phase is characterized by its integrated planning towards large-scale regeneration. According to the author, the third phase is rapidly developing and should follow a “Brownfields Planning Framework” (BPF). This framework was inspired by an existing framework for theory and practice in landscape planning called the „Steintiz Framework“. The methodology is based on the formulation of six sequential questions that should lead, at the end, to the optimal decision for brownfield development. The answers to the questions are identified as determinate models, whose results are the origin of the following steps (questions). (See Fig. 2). Kirkwood [14] mentions the importance of the redefinition of brownfield issues through the application of this framework and points out that methodological failures in building up the first five steps of the framework will just prevent optimal final decisions from being made.

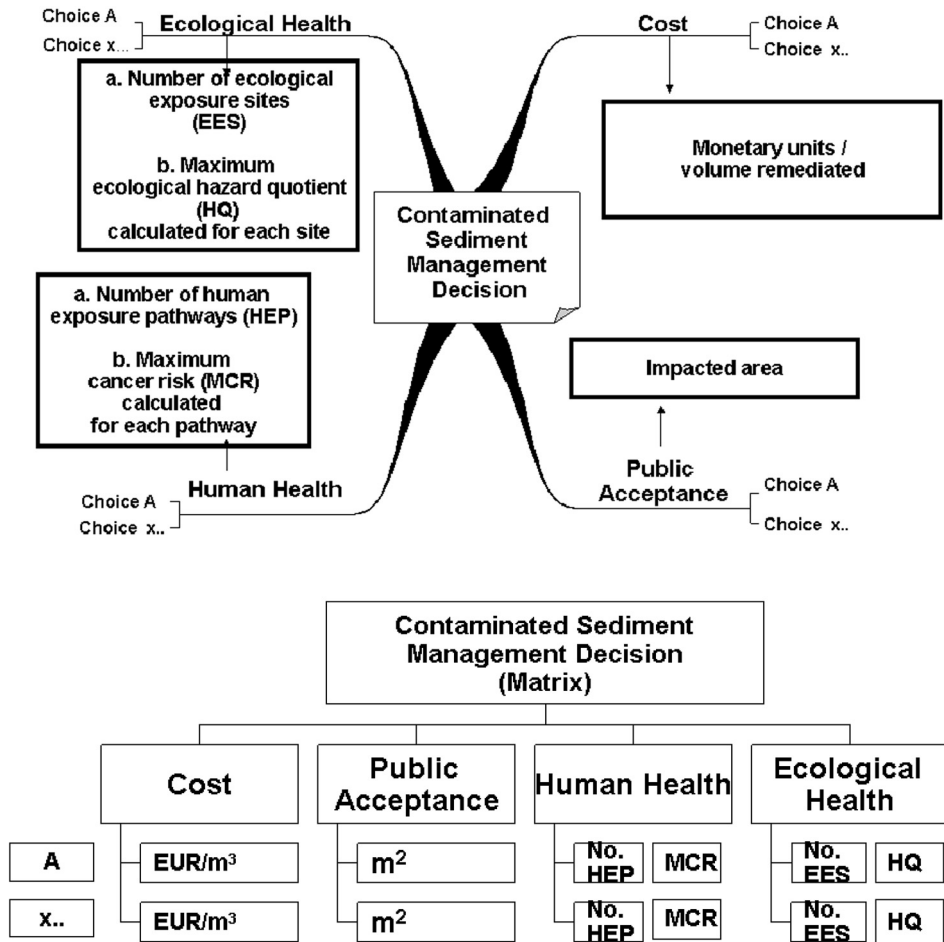
The most common multicriteria decision analysis tools (MCDA) applied in the USA and Europe for cleaning up processes are summarized by

Fig. 2 : The Brownfield Planning Framework - BPF



Source: Adapted from Kiker et al.[14]

Fig. 3 : Contaminated Sediment Management Projects. Decision Criteria and Decision Matrix



Source: Adapted from Jackson et al.[13]

Kiker et al. [13]. Fig. 3 illustrates the results of feasibility studies for Superfund projects in the USA, showing four criteria for each choice; (Superfund is the common name for the United States environmental policy officially known as the Comprehensive Environmental Response; Compensation, and Liability Act). The final individual, or group, decision will depend on their objectives, the outputs of each criteria in a decision matrix, and their relative weight (priorities), considering the characteristics of particular sites (limited budget, level of ecological awareness, public participation, etc).

The mathematical representation of the decision matrix can also be found in [2] as a multiattribute model. It shows the results of the combined additive value of remedial alternatives and weights representing human judgment.

As we can find in the work of Kiker et al. [13], effective environmental decision making demands the right consideration of (multi)criteria derived from environmental, ecological, technological, economic and socio-political factors; this also makes the process „multi-objective“.

The multi-attributive utility theory (MAUT) has been found to be more frequently applied for the

selection of remedial technologies. The method applied through MAUT transforms the diverse criteria into a scale of utility or value (typically 0-1). It relies on the assumption that the decision maker would prefer absolutely more utility/value than less (principle of rationality).

According to research carried out by Kiker et al. [13], the most common decision support tools in environmental management can be found in the application of the analytical hierarchy process (AHP) in combination with the geographic information system (GIS); for the prioritization of sites, environmental resource management and environmental impact assessment. AHP is based on the comparison of criteria rather than utility functions. It implies that decision makers tend to make relative judgments than absolute ones.

A methodology for the ex-ante evaluation of projects oriented on the revitalization of economically depressed areas can be found in [20]. (According to Rydvalová [19], there is a positive correlation between the existence of brownfields with economically depressed areas. In other words, economically depressed areas are locations where the existence of brownfields is more probable). The methodology is presented through a process in 3 steps (see Fig. 4). According to the methodology, the evaluation of contents should take into account the impact of the project

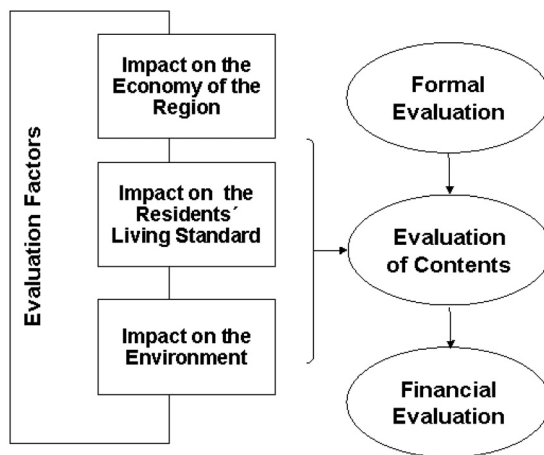
on three factors (economy, people, environment). The decision of whether or not the project is in accordance with the contents, is taken by a commission which gives values to specific criteria of the factors. In order to increase objectivity and transparency, Rydvalová et al. [20], suggest that the commission should be integrated into separated groups for each factor. The members of the commission should be representatives of the different sectors of the society.

The „REC“ model was created by Okx [17], which produces three indices for each clean-up option: risk reduction, environmental merit and costs. Together, these indices summarize the overall performances of each option. The selection of the best option will therefore, depend on the most suitable combination of the indices in accordance to the specific objectives of the decision maker.

2 Brownfields, Risks and Decisions

One way to differentiate brownfields according to their risks can be based on the combination of two factors: their location and level of pollution [12]. The first type can be brownfields situated in attractive and favourable locations for economic activities, where there is no condition to be

Fig. 4: Methodology for Evaluation of Projects. Proposal for the Revitalization of Economically Depressed Areas



Source: After Rydvalová et al.[20]

Fig. 5: Brownfield Sites Classified according to Environmental Risks

Type of Brownfield Site	Level of Pollution and Hazard for People and Biotopes	Economic Activities that can be pursued before or during Remediation.
Extreme Risk	Very high concentration of toxic pollution	None is recommended.
High and Middle Risk Localities	High concentration of pollution.	Agriculture and Industrial Work just for short and/or alternate periods of time.
Low Risk Areas	Pollution within acceptable limits; it may be hazardous.	Residential activities not recommended.
Unknown Risk/ No Risk Areas	No environmental risks.	Any.

Source: Adapted from Jackson et al.[12]

fulfilled other than to wait for the market forces to work and “take charge” of the redevelopment. According to Kraft [15], brownfield redevelopment might become more feasible not only due to favourable market conditions (where the demand for land for new investments is greater than its supply), but also to the possibility of the use and development of “greenfields” (If greenfield development is not an option, there will be greater probability of brownfield redevelopment). In the second case, the brownfield can be located in a less attractive area, where more support for its remediation and reincorporation might be needed [15][19]. The third type is mainly localities without commercial characteristics. This kind of brownfield could be more adequate for the purposes of environmental protection supported by instruments such as national and regional grants. The last type in this category would correspond to brownfields in a very serious stage of damage. Due to less probability that such areas may be attractive for private investors, it is usually the case that the redevelopment of brownfields with environmental risk and damages is often financed by taxes and public sources. (In other words, this kind of area might be managed by public administration when the market forces don't work properly [18]). Classifications may be known by the level of pollution identified, and can range from “extreme risk area” to “low risk area” or “none/ unknown environmental risks”. “Extreme risks” are characteristic because of high concentrations of toxic pollution, that leads to severe human health problems and/or to irreversible damages to biotopes. Locations with such risk,

cannot allow any working and productive activity. “High and middle risks localities” allow people to work there but just for short periods of time; this kind of area can be used for agricultural purposes, with the potential for becoming habitable zones for the population in the future. “Low risks areas” can be almost compared with localities that fulfil the limits required of pollutants. However, they are also not recommended for habitation and long term working purposes. Brownfields classified as having unknown risks are comparable to those with no risks; therefore, any human activity can be pursued without considering the appearance of environmental risks. Fig. 5 summarizes these ideas.

The establishment of remedial goals is suggested by Gossen et al. [9], on the basis of an assesment of risks (AR) related to human health, the ecology, economy, public relations, or personal and corporate liability. Gossen et al. [9] point out that the AR is a key factor in the remedial decision process. It may follow the analysis of sources of pollution and its diverse pathways to their potential victims (receptors).

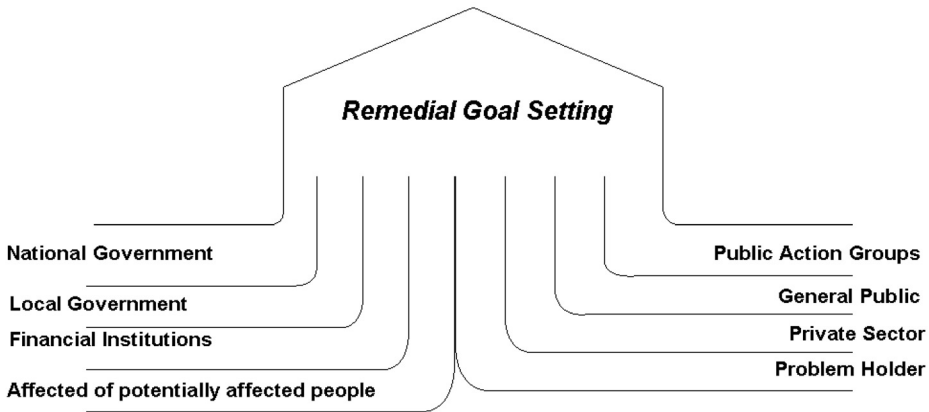
3 Integrating Stakeholder Analysis into Remedial Decision Making

The origins of the stakeholder theory can be found in Freeman [8]. It attempts to formulate ideas that can replace the neoclassical concept of the firm. According to Van Rooyen [22], conventional management theory did not originally consider natural sources protection as one of its main subjects of interest. The term „stakehol-

der“ is clearly in contrast to „stockholders“ and „shareholders“. The stakeholder theory is based on the idea that the private sector can become much more efficient if managerial efforts take into account the concerns of various interest groups.

enced by different stakeholders as shown in Fig. 6. Hardisty et al.[11], include the selection of the remedial method as the second part of the decision making process (See Fig. 7). After the definition of the goal, he suggests applying analysis

Fig. 6: Remedial Goal Setting. Involved Stakeholder



Source: Adapted from Hardisty et al. [11]

According to Scholl [21], instrumental stakeholder theory is rather descriptive and belongs to organizational studies and applies, for instance to combined methods from the agency theory and the network theory. On the other hand, the business ethics stream focuses on normative issues attempting to formulate correct managerial behavior. The practice of corporate social responsibility (CSR) is an example of the application of the stakeholder theory's normative approach.

Analysis of stakeholders' roles and participation in brownfield management are frequently used as an integrated part of the whole decision making process. For instance, Hardisty et al.[11], point out the basic elements to consider in the selection of remedial technologies for the problem holder. He integrates stakeholder analysis as a supporting tool for setting the remedial goals. The second step follows the principles of decision analysis in order to select the best remedial method. Hardisty et al. [11], also stress the importance of a clear specification of the remedial goal which mainly depends on the current policy (corporate or public) and regulations, and is influ-

enced by different stakeholders as shown in Fig. 6. Hardisty et al.[11], include the selection of the remedial method as the second part of the decision making process (See Fig. 7). After the definition of the goal, he suggests applying analysis tools in order to compare the options that could lead to the achievement of the objective(s). In addition to the use of the conventional analytical tools (cost-benefit analysis – CBA; cost-effectiveness analysis – CEA; qualitative analysis – QA); the problem holder/decision maker considers the risks involved with the probability of (not)achieving the goals and should pursue a screening analysis of constraints in time; physical access restrictions and sensitive issues that may appear during the remediation process, thus following a continuous retroalimination of the process (e.g. residences or ecosystems whose existence could be a barrier for the completion of the remedial process, because of noise, hazardous leakage etc.).

The case presented by Williams et al. [23], reflects how generally oriented policies are not able to “encourage” companies to achieve “general goals”. The observations made by the authors, conclude that the limitations regarding the sustainability of brownfield development correspond mainly to characteristics of stakeholder participation.

Williams et al. [23], identified the five “main barriers” as the following:

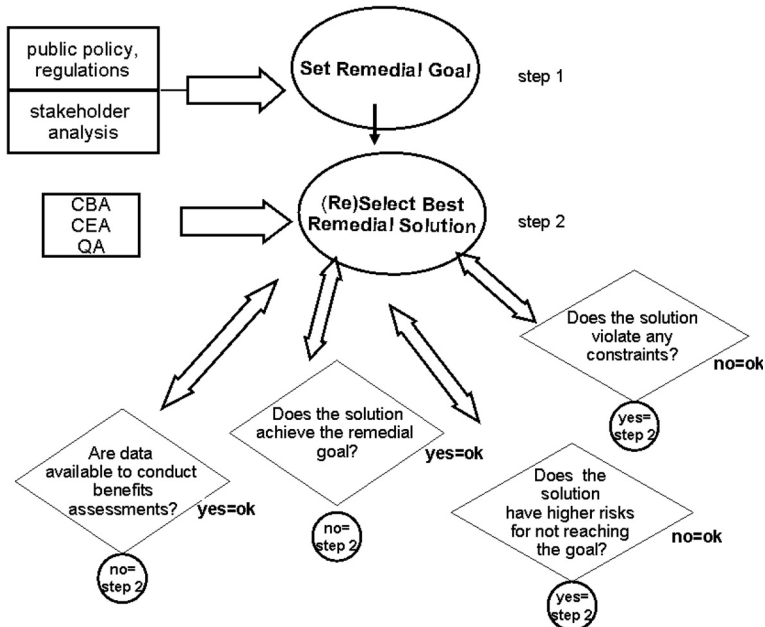
- Stakeholders' omission of sustainability as an element of a 'successful' project;
- Inadequate participation by the relevant stakeholders;
- Inappropriate timing of stakeholders' participation;
- Lack of powers to enforce the increase of sustainability options.
- Resistance to the use of sustainable technologies and materials.

government, the private sector, labour, non-governmental organisations and communities, and has promoted environmental awareness.

4 Brownfields in the Czech Republic and Proposal for the Decision Making Process in Historical Contamination

One of the main reasons for the existence of brownfields in Czech territory corresponds to

Fig. 7: Remedial Decision Making Process



Source: Adapted from Hardisty et al. [11]

It can be interpreted from this study that the decision making process entered in conflict of goals definition, since the undertaking to achieve the general goals has not been reflected within the firms responsible for the cleaning-up operation[s].

Stakeholder theory can also be applied in the public sector. Van Rooyen [22], presents integrated environmental management (IEM) as a holistic approach to the planning and implementation of brownfield development programmes through case studies where IEM was applied. This approach has resulted in strong partnerships between

socio-economic changes specially since the last decade of the 20th century. Dynamic processes such as changes in lifestyles and standards of living may also play a role in the search for better living and working conditions. The National Strategy for Brownfield Regeneration in the Czech Republic is a relatively new program. Its goals are focused on the socio-economic development of devastated areas, on the revitalization of brownfields rather than the development of greenfields, and on preserving the historical, urban and social value of localities [6]. At the end

of the first semester of 2007, there were found 2,355 sites with an area of 10,326 ha, and with an area of 4,206 thousand m² which was built upon. The results show that the majority of the sites are owned privately and are concentrated in municipalities with less than 2,000 inhabitants. Another interesting fact is that more than the half (52%) of the observations do not report ecological damage [3].

There is a type of brownfields identified as “environmental burdens of the past” or “historical contamination”, which, in the case of the Czech Republic, corresponds to all the brownfields originated before the process of privatization in the 1990’s as a consequence of the decay of the socialist regime. This classification is not included as a subject of interest of the national strategy of Brownfield redevelopment.

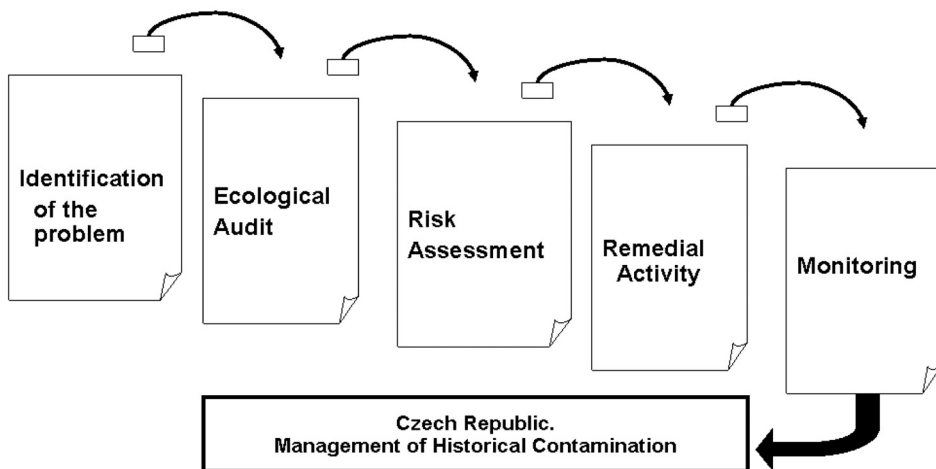
This branch is divided into different groups. An example of such a group is the one containing the sites left by the former soviet army during its occupation of Czech territory before 1989. Another group we can find are the remnants of former mining activities and mineral extraction.

The Czech National Property Fund has undertaken the task of eliminating historical contamination financed by its revenues coming from privatization. This is all pursued on the basis of ecological contracts with the new owners of privatized property. The financing is carried out

by the Ministry of Finance, and it is not intended to be extracted from the state budget; it is, rather, the utilization of a certain part of the earnings from the privatization of state property [4]. This is a complex programme which is technically supported, mainly, by the Ministry of the Environment, and The Czech Environmental Inspectorate. All types of brownfields identified share the characteristic that they are mostly located in the vicinities of ecosystems whose environment might be heavily endangered, so their cleaning-up processes may be costly, not only in time, but also in financial terms. Fig. 8 illustrates the current decision making process for remedial activities in sites containing historical contamination in the Czech Republic. The decision making process is in the charge of state institutions, one of them being the Ministry of the Environment.

The current process of resolution of historical contamination in the Czech Republic follows the basic steps for the application of remedial methodologies. It focuses on the analysis of the best technical options oriented towards the remedial goals, and to the costs of remediation [5]. In addition to the main process, a process of the composition of the list of priorities of ecological problems was introduced in 1999 and updated in 2005 for each region, and for issues concerning soil and groundwater aspects. The new proposal for the composition of this list was presented at the request of the Ministry of the

Fig. 8: Czech Republic and Historical Contamination. Current Process of Management



Source: After Czech Ministry of the Environment 2004 [4]

Environment at the end of the year 2005. The decision making criteria of these documents are focused on the revitalization of areas where there exists environmental damage, mainly of water resources. After our review of local and international literature we found that the whole general process could be enhanced with a broader concept of decision making. Therefore we suggest a process that takes into account deeper analyses of goal-setting and the stakeholder approach. The Fig. 9 illustrates in, simplified form, this suggestion.

5 Historical Contamination in the Czech Republic. Description of the Process for Decision Making

A. Specification of the Situation and Problems

The first step should clearly present the situation and describe the supposed problem (which might be redefined during subsequent steps). Relevant to these steps is the inclusion of the general characteristics of the area in question, such as geographical location, type of Brownfield, and identification of the owner(s), among others.

B. Goal Analysis

One of the most important steps is the analysis of objectives. After having identified the area, it becomes necessary to identify, or to define, general goals depending on the type and origin of pressures existing (local and international legislation, private sector, NGO's, etc). Goals can be focused on a combination of economic, ecological, political and social approaches. This analysis helps to set or reshape existing remedial priorities.

C. Environmental Assessment

If it is supposed that the area in question contains risks for ecosystems, and/or for human health, it is imperative to pursue and audit the ecological risk assessment in order to determine the level of pollution of the brownfields and the potential (or real) negative implications for the population of different species (including human beings) in the surroundings.

D. Socioeconomic Assessment

The specification of the area in question can be complemented by a description of the social and economic issues of the human population directly and indirectly affected by the contamination.

The observations can be made based on the composition of the population, its economic

activities (labor) in the past, the present and the trends for the future.

E. Analysis of the Legal Framework

Local and international laws can influence the way in which historical contamination is managed. The legal framework affecting not only brown fields in a direct form, but also local and international directives and acts about soil, water and landscapes protection, as well as land and waste management, should be analysed. A key factor in Brownfield management, whose analysis must not be forgotten, is the definition and assignment of liability for past contamination.

F. Assessment of Damage and Abatement Costs

In addition to health risks as possible results of the ecological audit and risk assessment, there might be other types of risks that arise with the existence of historical contamination. There should be identified the real, perceived and potential damage for different subjects. The damage can be identified as changes in the value of economic and non economic amenities. The evaluation of this damage can be pursued through different evaluation methods mentioned in chapter 2.

As a complementary part for estimating damage is the assessment of abatement costs. For these calculations the expertise of professionals in the field of remedial techniques is required.

The results of step C, combined with the results of damage assessment, can give a broader and more objective understanding of the necessity for remedial action. If the damage identified is outside the range of the goals established in step B, it becomes necessary to consider something close to the "DO NOTHING" option; which means to monitor the natural attenuation process of the contamination and consequently, to redefine the goals.

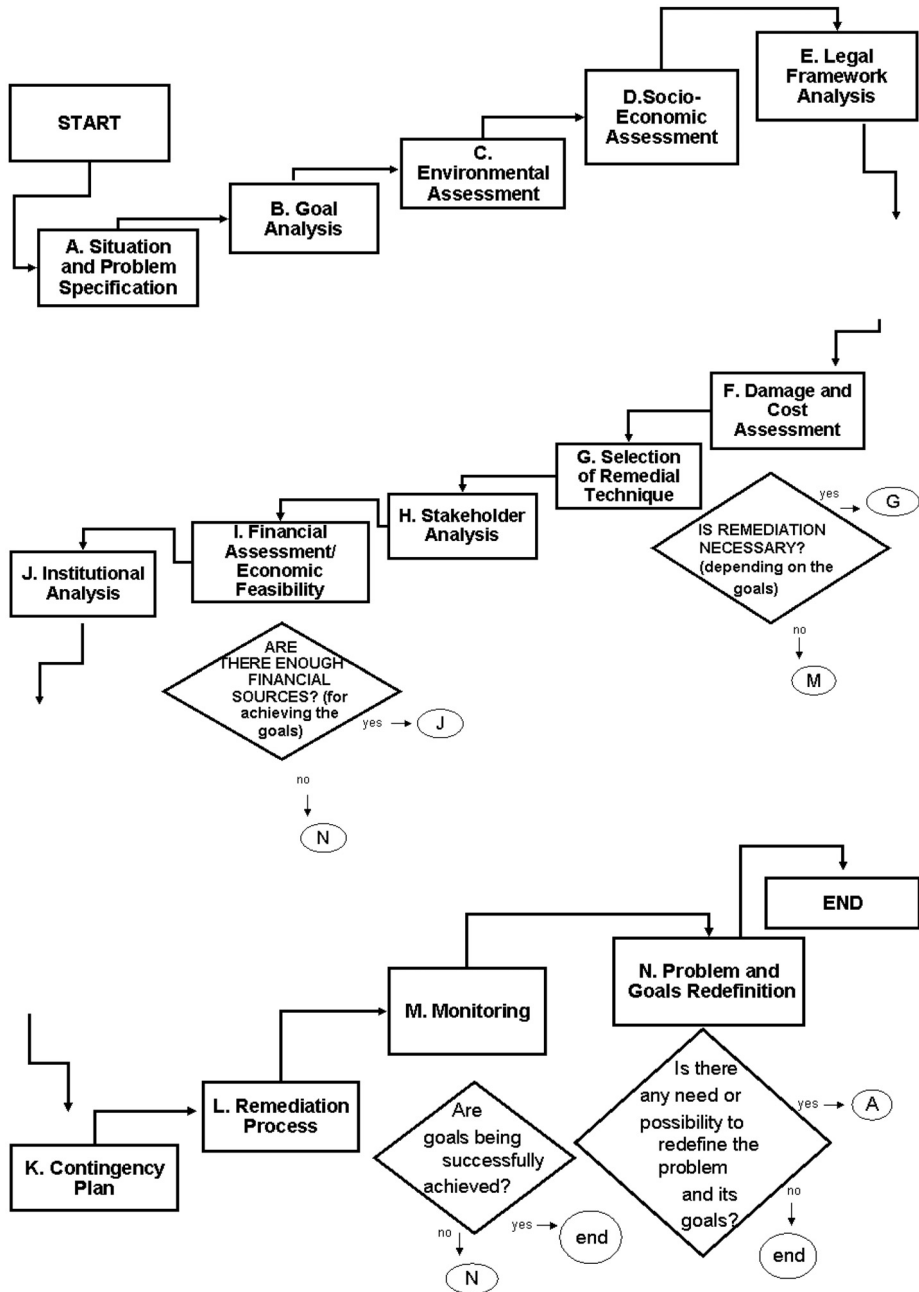
G. Selection of Remedial Technique

The selection of the most suitable remedial technique can be pursued based on the original goals (step B), through different methods such as cost-benefit analysis, cost-effectiveness analysis and multi-criteria analysis. The advantages and limitations of these methods were discussed in chapter two.

H. Stakeholder Analysis

As mentioned in chapter two, stakeholder analysis might bring a wider understanding of the subjects directly and indirectly affected by the

Fig. 9: Historical Contamination in the Czech Republic. Suggested Diagram for Decision Making Process



Source: Author's own

problem. It helps, not only in identifying problem holder (victims) and decision makers, but can also serve to combine the information gathered in step B. about influencing and supporting subjects that might cause different kinds of pressure in order to achieve the goals. These can be NGO's, state and government organizations, public and private sector, and subjects in charge of specific remedial activities such as consulting, technical and health research, protection, control and monitoring.

One inseparable part of stakeholder analysis is the assignment (or identification) of active and passive roles of each participant in the problem.

I. Financial Assessment

The results of the financial assessment show the funding possibilities for the remedial process selected. It is an economic feasibility study that should consider not only the financial sources available at the present time, but also additional alternative sources that might be used, such as grants, loans, funds (revolving), green insurance sources, etc. It might be appropriate, also, to reconsider if traditional funds coming from tax payments could not be replaced by market tools.

The lack of sufficient funding will analogically lead to the decision to just monitor the situation, to the redefinition of goals, or, to the termination of the process.

J. Analysis of Institutions

In addition to financial sources, the existence of certain institutions can be a useful supporting tool for the successful achievement of goals. It should be observed how the available institutional framework can contribute to, or even limit, the healthy course of the whole process. The existence of local, national, regional or international programs and strategies for the development of Brownfield areas can be useful for networking, research and educational purposes. Cultural and historical features of the site in question might become relevant if they can influence the remedial process. Transaction costs and contract analysis of relations within the framework of the decision making process is also a tool that can provide valuable information about the interactions among different institutions, and can complement, or explain in a deeper way, the results of the stakeholder analysis pursued in step H.

K. Contingency Plan

This plan includes the facts that may probably appear during, or after, the remedial process that

could put in danger the successful achievement of the goals. If a sensibility analysis was not included in step G, it becomes extremely important to set a plan with alternative options considering issues related to the appearance of new pollution that can lead to new risks, to serious technical problems, changes in legislation, or, even economic crisis.

L. Remedial Process

This is the operative part of the whole decision making process, which is pursued following the suggestions by experts in remedial techniques.

M. Monitoring

This is the last part of the process. Its aim is to constantly check the results of the remediation process. Due to lack of funding, or because facts related to the definition of goals, the monitoring step serves as an alternative to the evaluation of the natural attenuation process of the contamination, and redefines goals if necessary. It is also the instrument necessary for the implementation of a system of sanctions for the violation of certain rules. Monitoring also represents costs, that is why it is also important to optimize the way it is pursued. There can be obtained a different kind of information from the monitoring process that can be used for further documentary and statistical purposes.

N. Redefinition of Problem and Goals

The redefinition of goals enables decision makers to reconsider aspects that might appear during the planned process, and could put in danger the achievement of the original goals. Redefinition of goals should be oriented towards formulating more realistic goals with regard to the available financial, technical and institutional sources, or also just to reshape the whole decision making process for the management of historical contamination.

Conclusion

The tools provided by the theory of management that are oriented towards setting remedial goals are a key factor in the potential success of brownfield management. The most widely used applications of the theory of management towards brownfields issues are the decision theory and stakeholder analysis. The prevailing point within the theory of management applied to brownfield redevelopment in this work, was the management of conflict.

The decision and stakeholder theories seem to be very useful in order to complement and extend the results of other disciplines and techniques used mainly in economic analyses, such as cost-benefit analysis, hedonic pricing, regression analysis, cost-effectiveness, multicriteria analysis, and qualitative research. The suggestions and practical experience of decision making applied to brownfield management, as shown in this compilation, emphasize the formulation of objectives within multicriterial and sequential frameworks. The decision making processes mentioned in this work are mostly created as ex-ante analysis tools where risk also occupies an important place in the establishment of the future utilization of reclaimed brownfields.

Other findings of this work show that the models applied in the studies for remedial decision making are oriented towards evaluating, in a relative way, the importance of various factors including environmental and people's health, stakeholders' satisfaction, technical aspects and costs.

Each technique tries to approach historical contamination in different ways, but for all of them, brownfields are specific because they are lacking in "original responsible subjects" for the pollution created in the past, which makes the problem a "normal contemporary one".

Our suggestion is to follow a scheme of decision making for the management of historical contamination in the Czech Republic which involves the constant evaluation of objectives and the interests of different stakeholders.

This paper was prepared with the financial assistance of the Czech state budget through the project "Advanced remediation technologies and processes No. 1MO554" from the program „Research Centres PP2-DP01“ of the Ministry of Education Youth and Sports.

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Doručeno redakci: 13. 2. 2009

Recenzováno: 28. 3. 2009; 10. 4. 2009

Schváleno k publikování: 29. 6. 2009

ABSTRACT

DECISION MAKING AND BROWNFIELD MANAGEMENT

Silvia Čiháková Aguilar

The redevelopment of sites with the existence of historical contamination – in some specific cases most commonly known as „brownfields“ – contains still open questions, not only in Central European countries. North and South America have experienced cases which not only suffer from a scarcity of financial resources, but also institutional limitations. The redevelopment of certain old contaminated areas can be attractive, because it might become a potentially lucrative area for redevelopment projects that can also bring interesting job and research opportunities.

The paper presents a recapitulation of studies concerning the application of the decision and stakeholder theories for the solution of environmental problems, focusing mainly on brownfield issues. We also analyzed the decision making processes in the management of contaminated land in the Czech Republic. Brownfield management still lacks legislation in the Czech context; however the treatment of ecological burdens of the past has been regulated within the process of privatization at the beginning of the 1990's. The last part of the work focuses mainly on the remedial decision making for ecological burdens of the past in the Czech Republic.

The main objective of this work has been to gather ideas from the local and international context, and to adapt them to the actual decision making processes of the management of historical contamination in the Czech Republic.

We concluded that the tools provided by the stakeholder theory and the laws governing decision making, which are intended for setting remedial goals, are a key factor for the potential success of brownfield management. At the end of the work there is a suggested solution diagram for the decision making process in the management of historical contamination in the Czech Republic that integrates the main ideas gathered after our recapitulation of studies.

Key words: brownfields, decision making process, historical contamination, stakeholder theory.

JEL Classification: H72, M14, O18, Q24, R52.