Interdisciplinary approach for brownfields

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Abstract

The topic of "Remediation of previously used sites" occupies professional engineers in the field of Geo-Technology, Civil Engineering, Process Engineering and Mining, Engineering Geologists, Biologists and Micro-Biologists, Geologists specialized in Hydrology and Geo-Chemistry, Physicists and Chemists, Town Planners, Landscape Architects and, beside those disciplines of technology and design, the property sector, banks, insurance sector and politics including planning authorities and environmental Legislation. The central position, of course, is taken up by the land owner, respectively the investor.

The complexity of the subject requires a successful approach with the aim of "re-use", taking into account and mastering risks and many obstacles. This calls for ideas which demonstrate solutions and innovative concepts. An interdisciplinary Competence Centre for remediation, that concentrates various activities, is being established at the Freiberg University of Mining and Technology by the author and three colleagues covering Geotechnique, Economics and Business Administration, especially Construction Business Management, and Public law.

The relevance of the theme is underlined by the loss of open land and a large number of urban brownfields, that in many German regions represent in equal parts a structural, planning and environmental handicap. A systematic approach to the management of land with local and regional involvement is a prime prerequisite for the management of property development in open areas as well as for the mobilization of urban brownfields. Activities throughout the European Unity, under the banner "City of Tomorrow", will set standards for indicators of sustainability - including the strongly propagated concept of "land consciousness".
Regional land management including used sites is in need for an interdisciplinary remediation. The successful adoption of land management has to consider the property sector and thus associated financial models, their risk potential and avoidance. The insurance sector offers solutions to mitigate these stumbling blocks to investment.

The paper will cover above topics and will focus on the rehabilitation of former mining sites - open pit mines.

1 Introduction

"Land recycling is the use-related re-incorporation of plots of land in the economic and natural cycle which have lost their former function or use ... by means of planning, environmental or economic policy measures."

The interdisciplinary recycling of land acts as a useful instrument to limit the development of greenfield land in order to shape the necessary structural changes, which have resulted from the demise of traditional industrial sectors, together with political decision makers.

Interdisciplinary land recycling serves the re-integration of previously used real estate into the economic cycle. Redevelopment under such circumstances requires the practical applications of risk rating and management as well as financial modelling. Our Competence Centre for Interdisciplinary Land Recycling is a partner for institutions, public sector agencies, trade organisations and companies, which are concerned with such topics as technology, construction, economics, ecology, risk rating, environmental law and project management as well as with the management of public sector bodies. Research and development focus the named objectives in co-operation with private and public sector partners from a federal, state and local level as well as with the mining and construction sectors, real estate, financial and insurance sectors. In addition to the technical solution of a practical redevelopment the criteria of property owners and investors in respect of project realisation of inner city real estate, rehabilitation of open cast mining areas and "conversion areas", are important for the success of an all embracing approach to land recycling in order to prevent the continuing development of greenfield sites (Azzam, Heinrich, Klapperich, 2001).

2 Sustainable Development

Urban planning in Central Europe means dealing with limitations but also taking chances for developing different types of "land".

Environmental impact assessment and also regarding environmental legislation and policy in progress the sustainable development is meanwhile an excepted goal and so far a prominent overall issue.

Prof. Thoenes in his contribution "Bodenreflexionen in unserer Gesellschaft und der Beitrag des Flächenrecyclings" (Reflections about land in our society and the contribution that land recycling makes) describes the values of land.
Quote:

"The strategies for the mobilisation of land consciousness with the help of land recycling include the analysis of proposals for the further development of economic regulations with a real estate component. This concerns the proposal of a combined real estate value and land tax as an incentive and control instrument for the development of land. Expert discussions express time and again the idea that there will not be any old burdens in twenty years time, but more contaminated soil and land and in twenty years it will not be soil limiting values that govern the situation, but land-use values that have to be achieved. It should be straight away that long term strategies are developed in respect of these future developments." (Thoenes (1998))

Following the regulation for the groundwater-protection, now soil has gained an equivalent status due to the Soil Protection Act, which passed German Parliament in 1998.

The management of brownfields in Germany is mainly influenced by the legal regulations;

- the Federal Soil Protection Act (with its sub legal regulation) and

The Federal Soil Protection Act and the accompanying Federal Soil Protection Ordinance do not claim explicitly the reuse of brownfields instead of greenfields. They contain however the requirements which have to be met if contaminated sites shall be reused. Warding off dangers is required.

The Federal Soil Protection Act so far contributes substantially to an ecologically sound use-related remediation, but it does not guide to a minimization of land consumption.

The Federal Building Code however lays down that land cover has to be limited to the necessary extent and that the utilization of land has to be carried out in a careful and sparing way. Furthermore the possibility is given to remove buildings in order to unseal land.

Waste-land recycling is a challenge between formal-legal request and informal administration practice.

Sustainable developments in remediation of contaminated sites is to be achieved by the interaction of all involved parties including public-private partnership.

3 Real properties - plant and land - mine remediation

The ecological advantages that a remediation brings are obvious to all, whereas the benefits of reintegration of land into the economic cycle and their reuse needs to be marketed more strongly, also from an economic and social perspective for the re-invigoration of cities. Tailor-made development scenarios and model solutions are activities undertaken at our Competence Centre.
4 Brownfield Sites: Assessment, Rehabilitation and Development

The relation between real properties, plant and land as well as the interaction between use - notional use - chance of use and e.g. sale is illustrated in Fig. 1. For mine remediation a special situation is given in Germany with respect to the abandonment under BbergG (federal mining law) - Fig. 2.

4 Economic assessment

Economic assessment of ecological burdens on the criterion of reduction of useful value plays an important role for the decision how to use the land and properties - especially for companies or owners with large real estate. Reasons are: creation of legal security, establishment/check of securing/refurbishment requirement, creation of basis for financial future planning by assessing the assets for balance sheets and other lists of assets, Determination/check of possible provisions for contaminated sites, Creation of planning security for investment projects, Determination of important information as the basis for successful portfolio management.

Some definitions:

- Ecological burdens in the context of real properties assessment are all environmentally relevant matters which reduce the useful value of a property.
- Contaminated sites are abandoned waste disposal facilities and plots of land where waste is treated, stored or dumped (former dumps) and plots of land for abandoned plants and other plots of land on which environmentally hazardous substances have been handled (former sites).

Fig. 3 shows the interaction of contaminated sites and ecological burdens considering mandatory clearance.
Real properties, plant and land
inspecting, advising, planning

Land under ownership
- Environmental inspection and assessment
- Appraisal and engineering planning in the case of contaminated sites and environmental damage
- Valuation
- Value development

Notional use
- Stocktake
- Need analysis
- Technical and economic feasibility analysis
- Financing concept

Planning of new construction project
- Building land appraisal
- Foundation consultancies
- Building land improvement
- Construction controlling
- Building construction planning

Real properties

Sale
- Environmental inspection and assessment
- Valuation
- Surveying

Demolition
- Stocktake
- Environmental appraisal
- Demolition planning
- Building rubble recycling and disposal management

Use
- Building damage analysis
- Pollutants in interior spaces
- Maintenance management

Change of use
- Technical and economic feasibility analysis
- Engineering and environmental remediation
- Project management

Fig. 1
Mine remediation
Abandonment under BBergG (mining law): preventing hazards, ensuring restoration for use

Mining → Re-use

- Stocktake
- Environmental appraisal
- Demolition planning
- Technical demolition management
- Building rubble recycling and disposal management

Notional use
- Stocktake
- Need analysis
- Surveying
- Post-use concept/post-mining landscape
- Technical and economic feasibility analysis
- Financing concept

Underground mine structure
- Stocktake
- Stability assessment
- Subsidence analysis
- Groundwater - flooding forecast - water treatment - drainage
- Appraisal and planning of conservation measures
- Disposal concept
- Monitoring

Inspection
Appraisal
Planning
Monitoring

Spoilt tips
Dumping facilities
Other areas
- Stocktake
- Appraisal and planning of: ⇒ stability ⇒ securing and remediation - covering, - sealing, - surface drainage
- Monitoring

Recultivation
- Appraisal and planning for:
  ⇒ post-mining landscape
  ⇒ landscape structures
  ⇒ support plan for landscape conservation

Fig. 2
Assessment of ecological burdens

Definitions

Fig. 3

As outlined in Fig. 1 following aspects have to be considered: hazard control, new use (own need), form of use ≤ prior use, form of use > prior use, new use (sale), sale without preparation, sale with preparation - fit for use -.

As an example for the valuation of expenditure - related site factors, the topic location is outlined in Fig. 4.

Location

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<tr>
<th>Influence costs</th>
<th>Uncertainties/ need for investigation</th>
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<td>Geology</td>
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Fig. 4
5 Remediation - in situ, ex situ securing

The input of contaminants into soil and groundwater may lead to a persistant pollution. The methods for the remediation of the environmental compartments contaminated with organic contaminants comprise besides physical and chemical also biological technologies. The technologies are subdivided into ex situ and in situ methods. Ex situ means the excavation of the soil and subsequent treatment at the site (on-site) or elsewhere (off-site). In situ means that the soil remains in its natural condition during treatment. Generally, in situ technologies comprise also ex situ components, e. g., water or vapor treatment plants.

The goal of in situ technologies is to mineralize the contaminants microbiologically.

In soil decontamination the field of biodegradation and thereby bioremediation has experienced a dynamic evolution and remarkable developments over the past few years. It seems to have entered its most interesting and intense phase yet. The isolation and characterization of new microorganisms with novel catabolic activities continues unabated, and the use of plants and plant-microbe associations in bioremediation is expanding strongly. The continuously growing knowledge on catabolic pathways and critical enzymes provides the basis for the rational genetic design of new and improved enzymes and pathways for the development of more performant processes.

There exist different commercially methods of in situ and ex situ bioremediation, including advanced strategies proposing to use the abilities of plant-microbe associations called phytoremediation, and the enhancement of natural attenuation processes, especially biostimulation and bioaugmentation, and, last but not least, the potential of genetic modifications of the microorganisms applied (J. Klein (2000)).

One has to consider that each site has to be investigated not only for its geological, hydrogeological, and contaminant situation, but also for the site-specific degradability.

One thing that all procedures have in common is that the success of the remediation work can be directly controlled to a greater or lesser extent and that direct adjustment to the needs and follow-up use is possible. But this has to be set against the securing measures, where the decision regarding effectiveness and safety - discussed by way of preparation in the context of a feasibility study - is taken by the owner of the land or the investor with due consideration of the costs involved.

Regardless of the follow-up use, hazard prevention alone gives rise to constant cost. But the proceeds from the sale of the land depend to a crucial extent on the quality of the practicable form of use. Follow-up use for residential housing will certainly create the highest market value for the land. This may mean that the balance sheet for a piece of land may also be negative, if for example provisions of the development plant stipulate only industrial or purely commercial forms of use for the whole area. In terms of its perspective, planning law must become more flexible here so that investors will be willing to conduct more than a mere hazard prevention on their own site.
Surface confinement technique
A combined surface confinement technique using soil/geosynthetics is a perspective drawing in order to seal the contaminated subsoil in a cost effective way and creating a foundation level for housing or new industrial areas. Fig. 5 shows the DMT-GEOsafe-system with the sandwich construction including the different geosynthetic-elements for the purposes of sealing and reinforcement of the soil. The different drainage systems are aiming for the safety of the structure above as well as for the overall goal which means the protection of the groundwater (Genske et al (1993), Klapperich (1999), Klapperich, Azzam (2000 & 2001)).

Perspective drawing

![Perspective drawing of the DMT GEOsafe system](image)

Fig. 5

6 Commercial real property and environmental issues

There only exist a few environmental issues which have captured the imagination of so many business, government and community interests as BROWNFIELDS.

The overall picture shows - above and beyond the immediacy of cleanup of contamination, that brownfields are closely related with economic redevelopment, job creation, community restoration and re-use of developed areas to counter urban sprawl.

The role of financing of real property transactions needs a wide understanding of so many concerns related to environmentally distressed property. Risk assessment is defently a key issue.
6.1 Financial and business strategies

From the perspective of a real estate developer there are following topics to consider:

- Motivation of a developer in respect of brownfields with an understanding economic decision making processes
- Overall Pro Forma financial analysis with control loop of land acquisition, return on investment - financial viability and resalability of completed projects.

The banks as well as property developers have been sting in the past and quite often avoid contaminated land like the plague.

In the U.S. there exists since several years the "Environmental Bankers Association" which aims to identify common factors on redevelopment of brownfields through a consistent understanding and to recognize that environmental constraints are only one of many issues that restrict redevelopment including security, infrastructure, access and transportation as well as administrative and political factors and - to make positive contributions.

Restructuring and corporate real estate means analysing market evaluations and potential for increasing value and developing strategies of revitalisation - one of our key issues. This needs "planning security" which needs to be established in case of old buildings and contamination so that one expects a yield when investing in real estate.

The "Identify and Use Potential" leads to categories of properties with and without development potential regarding location, use, size, contamination and miscellaneous like legal frame work conditions.

Fig. 6 and 7 show objectives for the one or the other under consideration of influencing factors.

Fig. 6

- minimising action and cost, still observing legal obligations
- securing or redevelopment exclusively upon authority instructions
- short-term sale of the property if possible
In an international comparison, there are very different tools and instruments to promote the redevelopment. One of the basic reasons are that the laws for Brownfields cleanup and remediation are quite different among countries and states. When we look at the financial aspect of Brownfield projects in the USA there are six basic tools being used to increase the potential possibility for Brownfield redevelopment. These are: bank, insurance, real estate, tax, loan funds and grants. Among them bank, insurance and real estate are more market-based tools, instead, tools such as tax, loan funds, grants are more policy-orientated. The latter ones are targeted especially for initiation of the recycling projects, while the market-based tools are targeted mainly for reducing the projects risks, meanwhile, setting up standard financial operation systems for the long-run. In Germany there aren’t so many types of financial tools used for Brownfield remediation projects. Funds are the mostly common financial resource for Brownfield projects in Germany. In general remediation projects could be financed by loan funds through the programs of Federal State, German Federal Republic and European Union. In addition, there are also some kinds of environmental insurances used for remediation projects in Germany. However other types of financial instruments are still need to be defined and developed. Public programs can help to leverage private brownfield financing by reduce lenders risk, reduce borrower's costs, improve the borrower's financial situation and provide resources directly. To enhance the climate for investment there are non-cash financing tools that also cities can promote. A prominent role plays the "Environmental Insurance" - a tool which is under wide use in the US and Great Britain and now developing
6.2 Inter-related commercial lending risks - risk evaluation of brownfields & safety concepts

There are three main risks which can be quantified, diminished or eliminated - focusing on a greater ability to manage the collective risk:

- Business or economic risk implications are embodied in the concept of brownfields investment
- Technical risk
- Legal risk implications are inherent in the overall context but particularly embodied where perceived contamination carries as much concern as real contamination.

Further use of contaminated land and brownfield areas is an urgent task to reduce the consumption of virgin land. When redeveloping such areas as assessment of unacceptable risks has to be carried out and, if necessary, remedial action has to be taken. The aim of risk assessment normally is focused on criteria of human health.

As it is known from technological risks, also remedial measures cannot absolutely avoid future risks. The reasons are the scientific, technological and economic limits of knowledge, according to the state-of-the-art of identification, assessment, remediation and containment of contaminants in soil under real conditions.

In addition to risks which are quantifiable or can be evaluated by quantifiable parameters also non-quantifiable risks have to be considered. They may be important for the acceptance of a certain further usage.

In addition to risks which are quantifiable or can be evaluated by quantifiable parameters also non-quantifiable risks have to be considered. They may be important for the acceptance of a certain further usage.

Property development risks, be they on greenfield or brownfield sites, will inevitably materialise in financial costs. Brownfield development brings with it added uncertainties in the identification of below surface contamination, and the potential consequences that this presents. These uncertainties need to be considered in a phased approach, with inherent risks at each stage offering different challenges. Mistakes in the calculation of remedial costs for known contamination are compounded by short and long term consequences of unknown and unidentified risks. Secondly, in a time of constantly changing environmental legislation, provision must be incorporated in the remedial strategy in the event that more stringent regulations are imposed. Liability associated with each phase is critical, and a clear statement of responsibilities is crucial if a remediation programme is to be completed to the benefit of all parties.
Management tools and practices have been developed to tackle the most complex sites, as well as risk transfer vehicles and the part they play in the process. "Risk Management" and "Risk Sharing" as a significant tool led to "Insurance Innovations" a prominent part in financing for brownfield development. For the "Risk Evaluation of Brownfields" there are safety concepts in development. Examples are environmental remediation insurance, stop-loss coverage and pollution legal liability insurance (D. Mehrhoff, 2000).

7 Conclusion

New solutions are needed to accelerate the process of redevelopment of contaminated sites - for sure an interdisciplinary approach. Research topics are defined to finally provide a mechanism for evaluating new approaches and technologies and as a follow up to transfer this to all parties involved.

"Green Brownfields" means a multidisciplinary task to solve for the benefit of our environment and society.

*Land-recycling is a market!*

References

[8a] Jacob, D., *Financial and Business Strategies form the Perspective of a Real Estate Developer*.