SUBR:IM Conference

March 1st 2005

Flett Theatre
Natural History Museum, London

Programme

0915 – 0945	Registration and Coffee
	JOINED UP REGENERATION OF BROWNFIELDS
0945 – 1000	SUBR:IM Concept and Present Position – *Dr Tim Dixon, College of Estate Management*
1000 – 1030	Evidence Base for Decisions – *Ian Gibson MP, Invited Speaker, Chair of the House of Commons Select Committee on Science and Technology*
	REGENERATION
1030 – 1100	Actors and Drivers: Who and What Makes the Brownfield Process go Round? – *Mr Joe Doak, University of Reading and Dr. Tim Dixon, College of Estate Management*
1100 – 1130	Interlocking Process?: Monitoring and Policy Making for Brownfield Regeneration – *Prof. John Henneberry, University of Sheffield and Dr. Walter Wehrmeyer, University of Surrey*
1130 – 1200	Practises: Delivering Brownfield Regeneration: From Problem Places to Opportunity Spaces – *Dr Mike Raco, University of Reading*
1200 – 1400	**Lunch & Poster Session**
	REMEDIATION
1400 – 1430	Greening of Brownfield Land – *Dr Andy Moffat, Forest Research*
1430 – 1500	Technical Sustainability of Brownfield Land Remediation – *Mr Michael Harbottle and Miss Sinéad Smith, University of Cambridge*
1500 – 1530	Acid Tar Lagoons: Risks, and Remediation in an Urban Context – *Mr Simon Talbot, Greater Manchester Geological Unit*
1530 – 1600	Discussion Session: Where is Research Needed?– *Prof. David Lerner, University of Sheffield*
1600 – 1615	**Close**

This Conference has been sponsored by the following organisations:
ARUP CIRIA The Land Restoration Trust Scott Wilson

Biographical Note

Dr Tim Dixon

Dr Tim Dixon is Director of Research at The College of Estate Management in Reading. With more than 20 years experience in real estate research and education, he is a chartered surveyor, a member of the Higher Education Academy, and a member of the Editorial Boards of five leading, international academic real estate journals. He is also a member of the EPSRC Infrastructure and Environment Strategic Advisory Team and RICS Research Policy Committee. Working with Professor David Lerner he co-championed the successful EPSRC SUBR:IM bid for funding. He heads up a team of six researchers in a specialist research unit focusing on funded research projects with themes ranging from urban regeneration and environmental issues through to technology impacts in real estate. E-mail: t.j.dixon@cem.ac.uk Web: www.cem.ac.uk

SUBR:IM

SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

Introduction to SUBR:IM

Tim Dixon (CEM, Reading)

The University of Sheffield
The University of Reading
The College of Estate Management
Forest Research
University of Cambridge
The University of Manchester
UniS University of Surrey
BRE
GMGU

EPSRC Engineering and Physical Sciences Research Council

Programme of Day

- Morning:
  - Introduction
  - Ian Gibson MP
  - 'Regeneration' sessions
- Lunch and Poster Session
- Afternoon
  - 'Remediation' sessions
  - Discussion
- Finish 4.15pm

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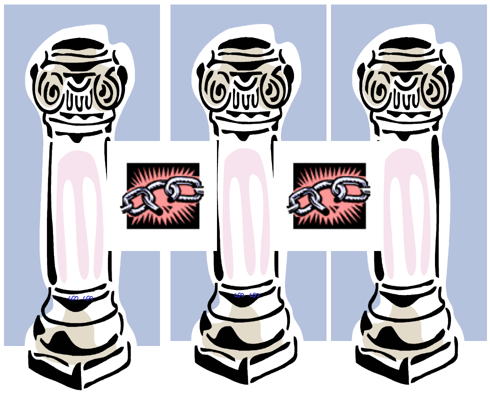
Sustainable development

Environmental **Social** **Economic**



T – E – N – S – I – O – N - S ?

EPSRC SUE

- Cluster One – *Urban and Built Environment*
- Cluster Two – *Waste, Water and Land Management* (SUBR:IM)
- Cluster Three – *Transport*
- Cluster Four – *Metrics, Knowledge Management and Decision Making*.

Facts and figures

- What does SUBR:IM mean?
- Programme Director: Professor David Lerner (Sheffield)
- Investigators: 22
- Research staff: 11
- Research students: 10
- Steering group: 16
- Active collaborators: 41

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Why is brownfield regeneration important?

- **Environmental**
  - Removal of contaminants
  - Environmental quality
- **Economic**
  - Competitiveness of cities
  - Employment/job opportunities
- **Social**
  - Improved life quality
  - Removal of threats to health and safety

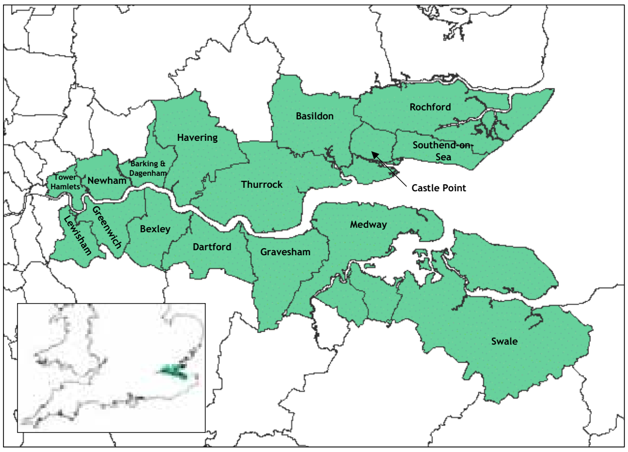
SUBR:IM *(adapted from Canadian National Brownfield Strategy)*

Case studies: the regional context

Thames Gateway

c3,300 ha PDL

19 sites



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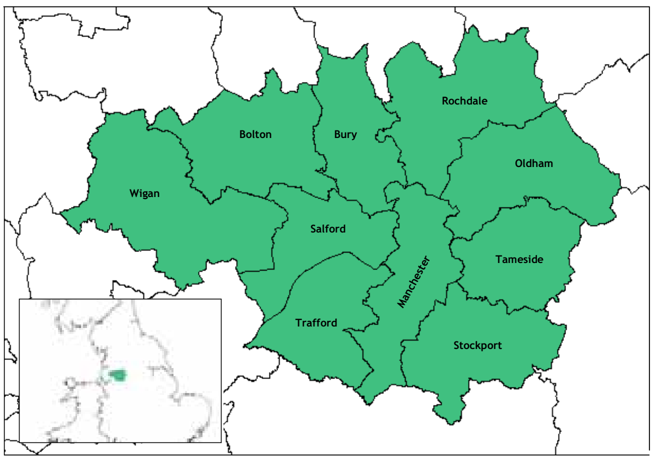
Case studies: the regional context

Greater Manchester

1,900 ha PDL

11 sites



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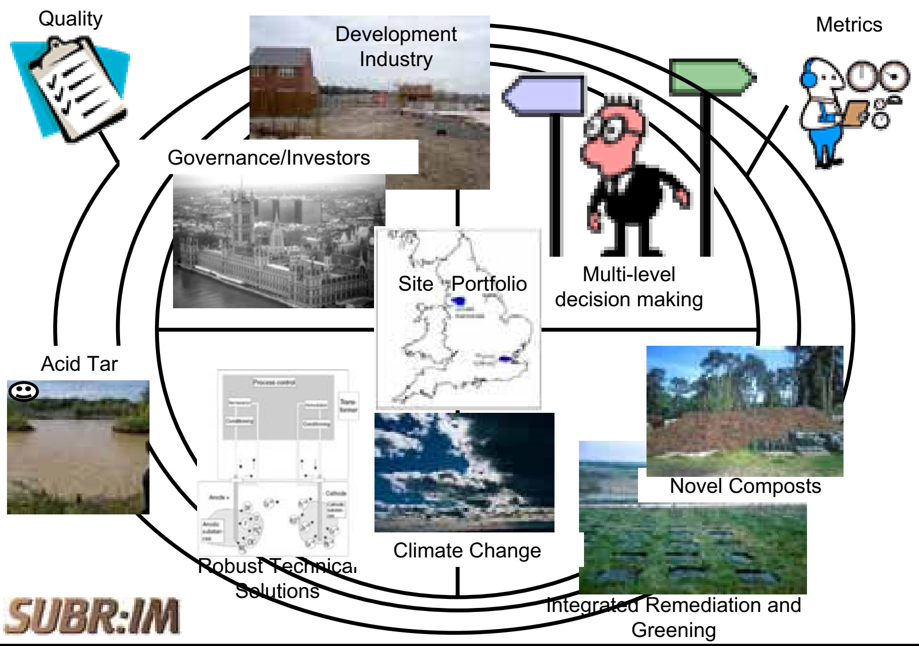
The Work Programme



‘Tell me something I didn’t know!’

- **Best environmental practice…**
  - Acid tar lagoons?
  - Sustainable remediation techniques?
  - Greening and brownfield regeneration?
  - Climate change and brownfield contamination?
- **Extended knowledge…**
  - Developers/investors and brownfield regeneration / sustainability issues?
  - Impact of regeneration (and clean-up) on local economies and communities?
- **International benchmarks/indicators…**
  - How can we best measure quality and sustainability in schemes?

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Dr Tim Dixon

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Mr Joe Doak

Joe Doak is Director of Postgraduate Planning Programmes in the Department of Real Estate and Planning. Before coming to Reading in 1992, he lectured at South Bank University and was a senior planning officer in Humberside and the London Borough of Islington. At Reading he has undertaken research for central government departments examining sustainability and economic development (for the Habitat II Conference); the planning and environmental implications of the disposal of redundant defence estate; and the operation of the Crichel Down Rules. He is currently leading the SUBRI:IM project researching the role of private sector investment in brownfield development. He is also actively involved on the Editorial Board of the journal *Planning Practice and Research.*

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SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

Actors and Drivers: Who and What Makes the Brownfield Regeneration Process Go Round?

Joe Doak
Department of Real Estate and Planning
The University of Reading Business School

Dr. Tim Dixon
College of Estate Management
Reading

The University of Reading Business School

THE COLLEGE OF ESTATE MANAGEMENT

SUBR:IM Research Objective 2

To increase the knowledge base of investors, developers, planning agencies, local authorities, the public, scientists and other stakeholders involved in brownfield development, to integrate their needs within a sustainable framework and seek to encourage investment.

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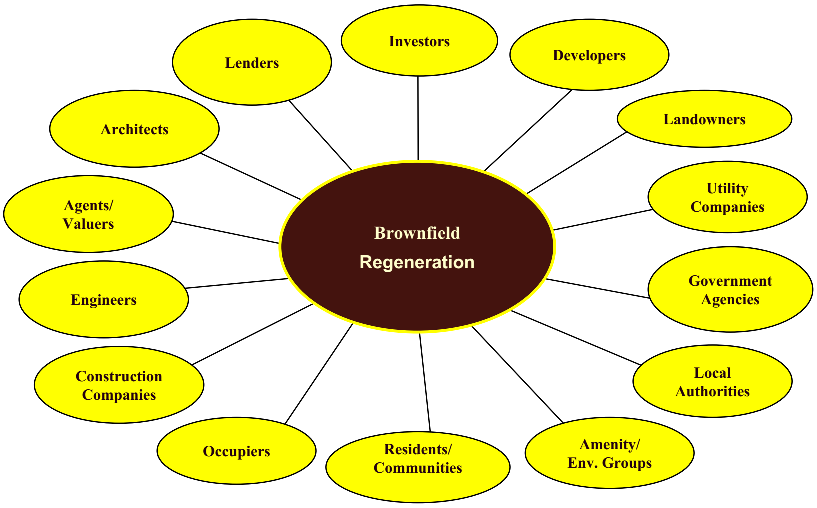
Key Actors Involved in Brownfield Regeneration



Driving Forces Structuring the Brownfield Regeneration Process

Economic
- Demand/Supply
- Market Institutions
- Accumulation Imperative
- Development Costs

Political
- State Institutions
- Other Institutions of Governance
- Policy Processes
- Policy Objectives
- State Powers and Resources

Legal
- Property Rights
- Citizenship Rights
- Legislation
- Case Law
- Legal Challenge

Ideological
- Values
- Political Ideas
- Conceptions of Justice

Cultural
- Professional Norms/Codes
- Forms of Knowledge
- Language

SUBR:IM SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

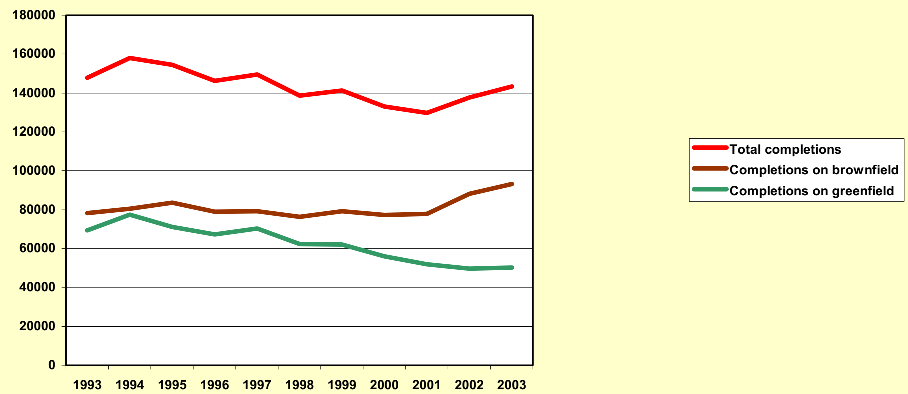
Actors and Drivers: The Approach of the Housebuilding Industry to Brownfield Development

Tim Dixon, College of Estate Management

The University of Reading Business School

THE COLLEGE OF ESTATE MANAGEMENT

Brownfield housebuilding targets (England)



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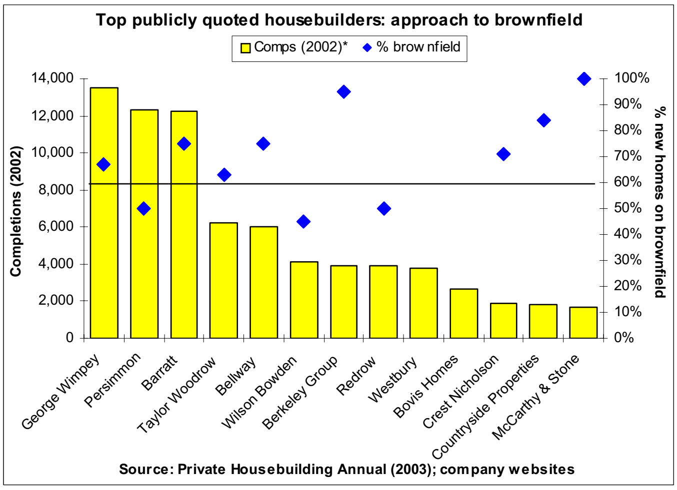
How are housebuilders approaching brownfield development?



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Influences on housebuilder strategy

- Government policy
- Competitive advantage
- Market conditions
- Growing corporate social responsibility agenda

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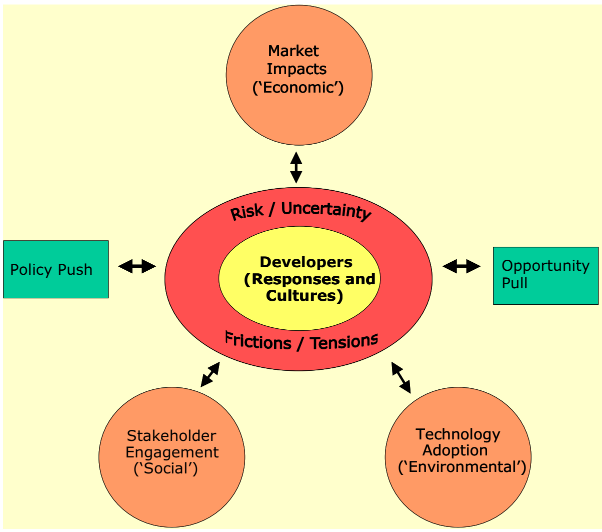
Conceptual framework



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Research questions

- Developer engagement in brownfield development and how this varies by company type & size
- What is driving brownfield development?
- Attitudes towards developing on contaminated land
- Knowledge of remediation techniques
- Integration of 'sustainability' into the development process

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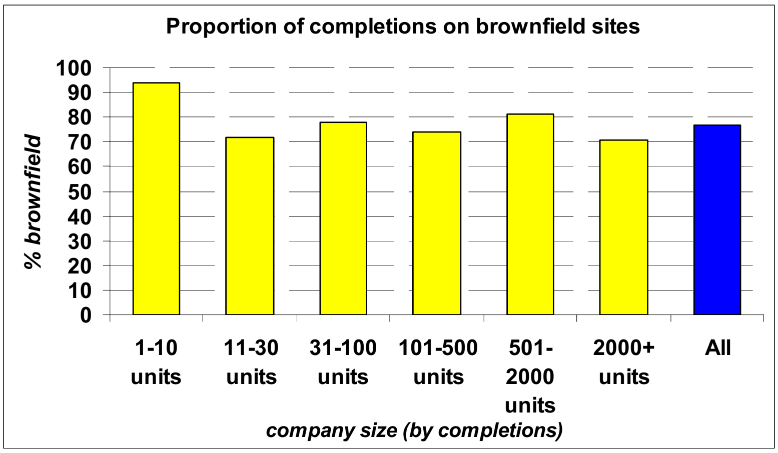
The survey

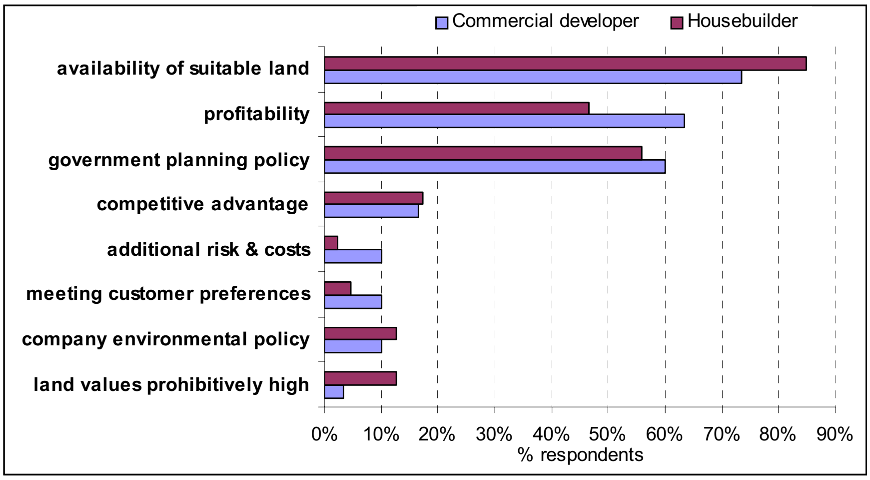
- Questionnaire pre-tested with industry steering group
- Small-scale pilot
- Sample size: c300 commercial developers

  c700 residential developers
- 16% response rate (represents nearly 30% volume output of UK)

Extent of brownfield development



Reasons for moves to brownfield



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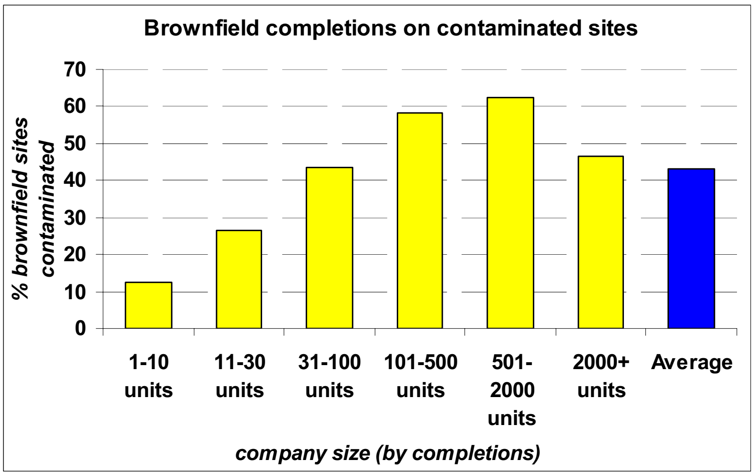
Experience of developing on contaminated sites



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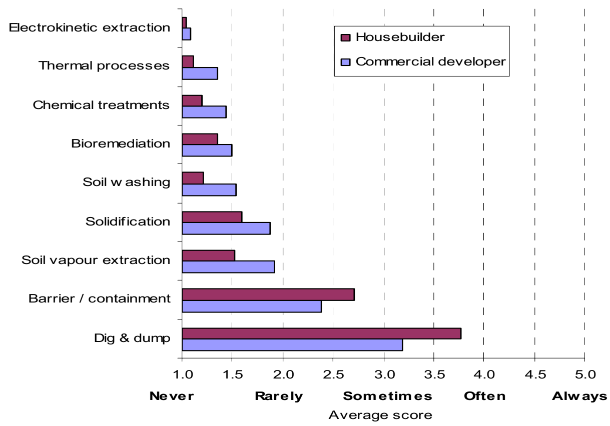
Remediation technology



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Impact of EU Landfill directive

More likely to discourage housebuilders than commercial developers from developing on contaminated sites:

	Housebuilders	Commercial developers
Would discourage	44%	18%
Not sure	5%	18%

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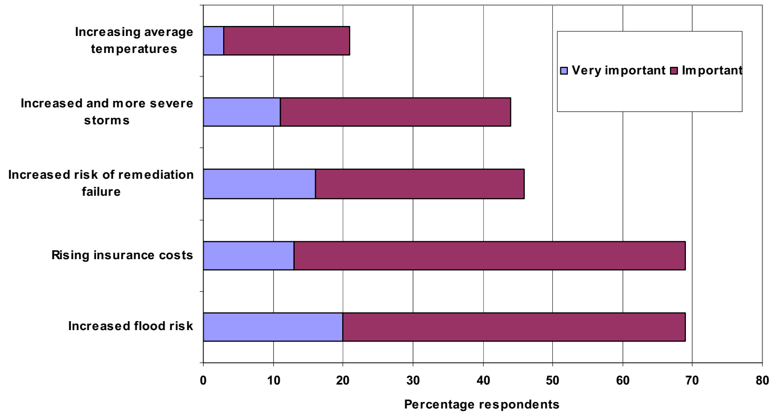
Response to climate change impacts



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Next steps

- Follow up interviews – to pursue key themes from surveys and examine innovation in the development process
- Analysis of land & property markets - in Thames Gateway & Greater Manchester
- Case study research –detailed investigation of specific developments with key stakeholders

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Actors and Drivers:
Who and What Makes the Brownfield Regeneration Process Go Round?

Tim Dixon[1], Joe Doak[2]

[1]*College of Estate Management, Reading, UK*
[2]*Department of Real Estate and Planning, University of Reading, UK*

Email : t.j. dixon@cem.ac.uk, a.j.doak@reading.ac.uk;

INTRODUCTION

One of the three main research objectives of the SUBR:IM consortium is:

> *To increase the knowledge base of investors, developers, planning agencies, local authorities, the public, scientists and other stakeholders involved in brownfield development, to integrate their needs within a sustainable framework and seek to encourage investment*. (SUBR:IM, 2003)

These actors are both the 'clients' of the research consortium and the 'objects' of study. The above objective is not necessarily straightforward as it implies an uncontentious (single?) view of knowledge and seeks to integrate potentially conflicting interests within a framework of 'sustainable development' which is open to some debate and interpretation. However, there is no doubt that these 'actors' remain central concerns of the research, as do the 'driving forces' which they create and respond to. This short introductory paper seeks to map out the key actors and drivers that are being explored within the SUBR:IM consortium and begin to examine the inter-linking relationships between these actors and between them and the 'structuring' forces that strongly influence the processes and outcomes of the brownfield regeneration process.

Although the lead-work on analysing actors and drivers is being undertaken by the 'social' scientists involved in the consortium, it is important to realise that all forms of knowledge generated by the consortium can be used and deployed by these actors as they seek to realise their own objectives and interests, construct their strategies and (re)structure the regeneration process along existing lines or in new innovative ways. If information is power, then SUBR:IM is part of the politics of brownfield regeneration. An awareness of the diverse range of actors and driving forces will help us fully understand the 'real world' issues we are engaging with here!

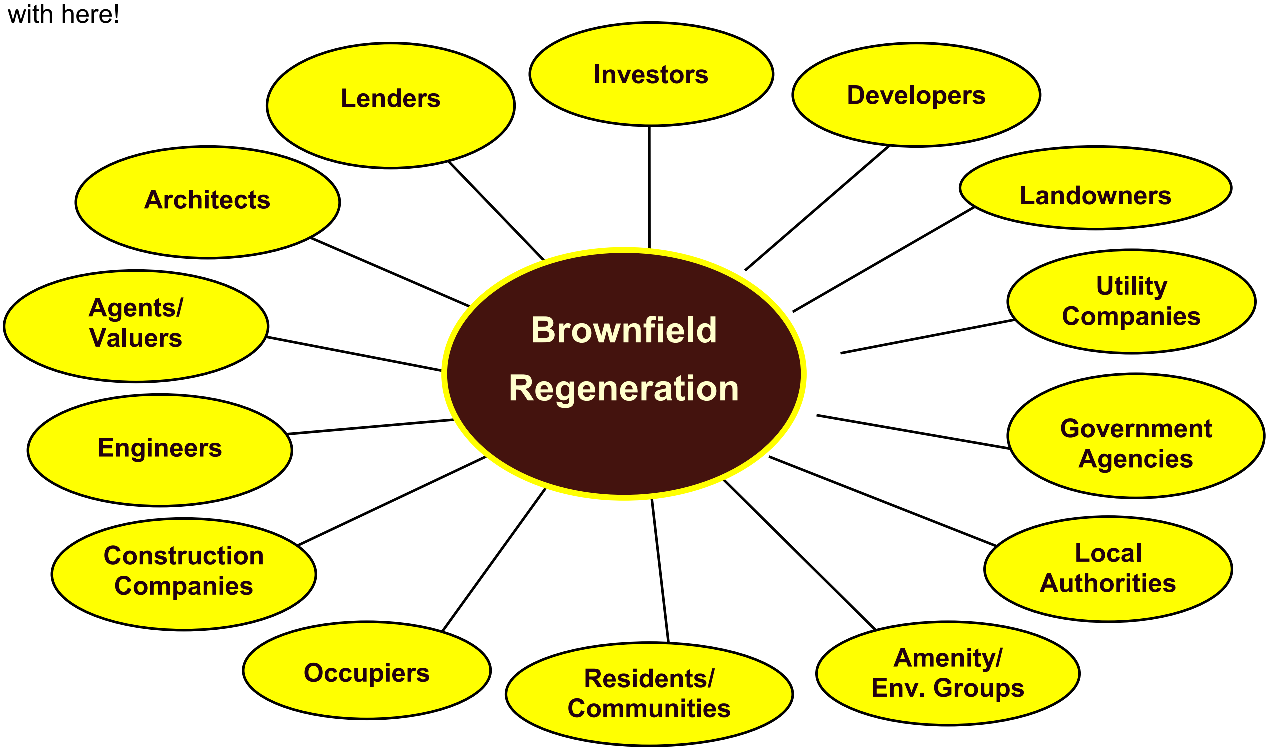

Figure 1: The (simplified!) network of actors around brownfield regeneration

MAPPING-OUT THE KEY ACTORS

At the risk of excluding some participants in the conference, Figure 1 attempts to illustrate the diverse range of potential actors in brownfield regeneration. These are certainly the actors and interests we are encountering in our research work and they 'come to the table' with an equally disparate range of goals, demands, perceptions, requirements, resources, strategies and constraints. Many of these actors often need to be deconstructed a little further (e.g. developers as traders and/or investors, and national, regional or local; Government agencies include English Partnerships, Regional Development Agencies, Urban Development Corporations, Environment Agency, English Heritage, CABE, etc.). Often they form coalitions or partnerships of some kind, or bring other actors into the process (e.g. engineers and others might draw on the knowledge and expertise of scientists whilst local environmental groups can utilise the experience and advice of national and international networks). This formal or informal 'networking' will cement some actors into 'actor-networks' or 'sub-networks', and these can be significant in taking brownfield regeneration forward in certain ways. However, they can also exclude other actors.

All the social science based projects within SUBR:IM are exploring these inter-linkages, inter-relations and networks in various ways. But these inter-relationships do no take place in a vacuum: the actors do not operate as totally free agents in their activities.

IDENTIFYING THE KEY DRIVING FORCES

As suggested above, the actors involved in brownfield regeneration influence, constrain and (indeed) facilitate each other in various ways. They are also influenced by wider 'driving forces' that provide an important (often determining) context for their actions. Figure 2 illustrates the main drivers that structure the action of actors. Again this is a relatively simplistic (?!) picture, which individual researchers are developing in different, but compatible, ways.

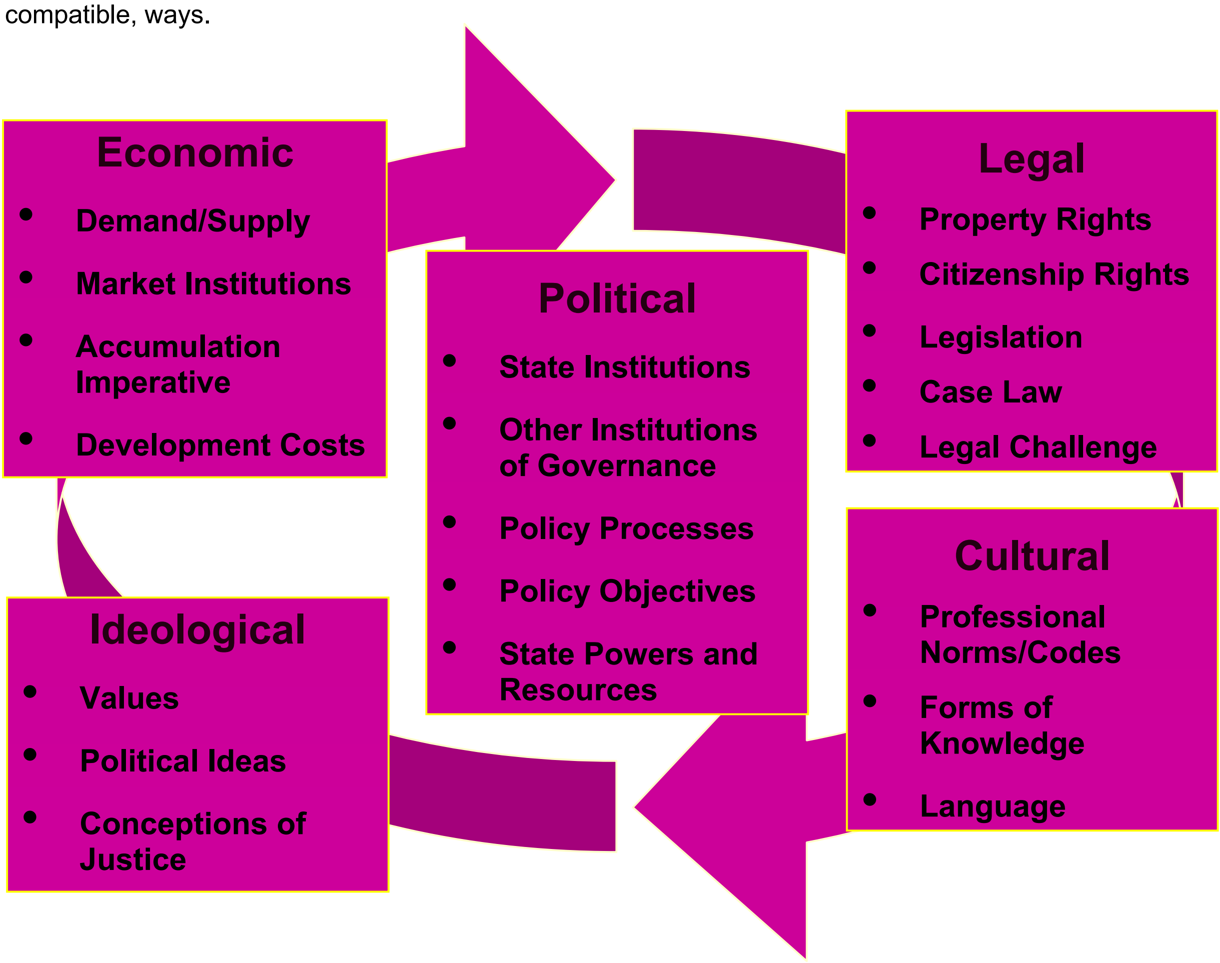

Figure 2: The main driving forces structuring the brownfield regeneration process

Again, the circling arrow emphasises the inter-relationship between these drivers, suggesting that these structural forces might be mutually reinforcing (e.g. state/legal support for private property rights and ideology help facilitate market institutions and relationships; the political and cultural challenge of the environmental movement has led to take-up of sustainable development policy by political parties and state institutions, and contributed to emergence of the idea of 'environmental justice' and role for 'corporate social responsibility' in market processes). These forces or drivers don't just 'sit above' the actors in some abstract way, but they are made and remade on a daily basis in all the little things the actors do. In that sense, these 'drivers' are socially constructed by the actors (produced, reproduced and/or changed) as the brownfield regeneration process unfolds.

To illustrate some of these inter-relationships, particularly between government policy, development actors and market mechanisms, we can report on some initial results coming from our work on the development industry. The subsequent papers/ presentations on 'processes' and 'outcomes' also explore similar issues given the centrality of the actors and drivers to these aspects of brownfield regeneration.

THE LINKAGE BETWEEN ACTORS AND DRIVERS: THE EXAMPLE OF THE UK DEVELOPMENT INDUSTRY

Background and context

Property is bought and sold widely, and so it plays a dual role in the economy, not only as a means of production and physical regeneration, but also as a means of wealth ownership (BPF, 2003). There is a huge amount of capital tied up in residential and non-residential property in the UK. The UK property development sector, comprising financial institutions such as pension funds, insurance companies and property companies (including investor/developers and housebuilding companies) therefore has the power and capacity to influence patterns of economic activity, as well as affect wealth and income distribution through engagement in urban regeneration. Recently the importance of the role of the housebuilding sector has been recognised and scrutinised by the Barker review (2003; 2004). In many ways the review takes a fairly critical view of the housebuilding industry's attitude towards brownfield development. With housing completions at an historic, low ebb, as the review stated:

> *"Developers do not undertake sufficient brownfield development from the point of view of social costs and benefits. This is not caused by risk, but it may be exacerbated by it. Building on brownfield land has clear external benefits; it aids in regeneration of cities in particular, and reduces the need to use additional greenfield land, reducing the environmental impact of development. These positive externalities are not signalled to housebuilders or landowners, as their profits from brownfield developments will not reflect them. This suggests that there is a possible market failure in the provision of brownfield land for development".*

In Barker's view, which adopts a market-led, 'behavioural' approach to understanding housebuilder strategies in relation to brownfields, the fundamental problem is perceived as being the low value of brownfield land resulting from relatively high development costs, coupled with high existing use values, which may prevent redevelopment. This is also often exarcerbated by contamination issues and other mitigation works which reduce land value, and may even result in a negative value. In short, both market and site-specific risk can increase 'housebuilders' aversion to brownfield development'.

The developer response to brownfield: a brief overview

Against this backdrop, how is the development industry performing in terms of brownfield regeneration? At a national level current statistics show that the brownfield land total is about 66,000 ha in England, with some 16,500 ha comprising 'hardcore' sites (English Partnerships, 2003). The Government's national target is that by 2008, 60% of new dwellings should be provided on previously-developed land, and through conversion of existing buildings. In 2003, provisional estimates suggested that 67% of new dwellings were built on previously-developed land including conversions (the same percentage as 2002), compared with 56% in 1993 (ODPM, 2004).

So headline figures such as these seem to suggest targets are being met, but how are developers reacting on the ground to the challenges of brownfield development? This was the subject of a major survey of commercial and residential developers carried out in mid-2004, and which forms Stage 1 of a two and half year EPSRC-funded project, based at The College of Estate Management in Reading (Shephard and Dixon, 2004).

Brownfield development is widespread… The survey results confirm that brownfield development is now widespread throughout the housebuilding industry. For example, more than 80% of the sample developed entirely on brownfield sites. It was already apparent that brownfield development was no longer the preserve of specialists and had been adopted by volume housebuilders (i.e. larger housebuilders were building some 50-74% of their units on brownfields). Findings from the survey also show that smaller and medium-sized operators have also clearly shifted their output towards brownfield.

Given the policy emphasis on brownfield development it is not surprising that housebuilders of all sizes are undertaking schemes on previously developed land, to a greater or lesser degree. Maintaining output on greenfield sites has become increasingly difficult in the recent planning climate. Indeed, 'the availability of land' or 'government policy' (which underpins the former) were the key reasons given by the majority of developers for increasing their output on brownfield over recent years. However, the move towards brownfield development has not been solely policy-driven; a significant proportion of developers – both commercial and residential – viewed it as an opportunity for profitable development in what has been a relatively buoyant property market.

At present, there appears to be a clear intention amongst developers to continue to increase the amount of brownfield development they are undertaking and for housebuilders this was supported by the composition of their land banks in which brownfield accounted for, on average, 70% of total plots.

Contaminated sites still hold problems…Developing on sites with contamination is likely to become increasingly important if the brownfield target is to be sustained. The survey findings show that developers in both the commercial and residential sectors are clearly not averse to developing on contaminated sites. Practically all the survey respondents were prepared to undertake development on sites requiring remedial treatment and around three-quarters had actually developed on contaminated sites over the past year. Smaller developers are less likely to undertake schemes on contaminated sites; this is not unexpected given that they may not have the resources, the specialist knowledge or the financial reserves to carry the additional risks involved. A majority of housebuilders (59%) were prepared to hold contaminated sites in their land banks. Attitudes towards contaminated land clearly appear to have changed as housebuilders have gained more experience of developing on brownfield sites.

The readiness of the development industry to tackle contaminated sites could, however, be threatened by the impact of the EU Landfill Directive[1]. Over two-fifths of housebuilders were likely to be discouraged from undertaking development on sites with contamination following the implementation of the Directive. This was particularly true of smaller housebuilders and those without experience of commercial development. Commercial developers were less likely to be dissuaded from building on contaminated sites, but the Directive is clearly causing some uncertainty in the industry, because 'dig and dump' is still the most frequently used method of dealing with contamination. There is, however, evidence that in-situ treatments are being used, most commonly barrier methods and containment. Commercial developers typically had a greater awareness of alternative remediation techniques than housebuilders and were more likely to have experimented with them, particularly solidification / stabilisation and soil vapour extraction. Other techniques were generally used much less frequently.

The EU Directive does appear to have stimulated some interest in exploring alternatives to landfill; just over half of all developers said they were doing this. Of the remainder, around half stated that they were also likely to continue developing on contaminated land, suggesting that they already have sufficient knowledge of alternatives to landfill. In terms of access to independent sources of information on remediation treatments, the majority of developers did not consider this to be a problem. Smaller housebuilders were less likely to share this view and this could suggest that there is a greater role for government bodies such as the Environment Agency to publicise and disseminate information more widely.

Growing awareness of climate change… There also appears to be a growing awareness in the development industry about the potential impacts of climate change. Consideration of possible effects is regarded as particularly important at the building design stage, probably at least partly a result of continuing changes to the Building Regulations. The impacts of most concern to developers are the possibility of rising insurance costs and increased flood risk.

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[1] From 16th July 2004 the Directive banned the co-disposal of hazardous and non-hazardous waste resulting in a radically reduced number of sites permitted to accept hazardous waste. The aim of the Directive is to encourage waste reduction and wider adoption of more sustainable methods of dealing with contamination.

So what can we conclude?
Government policy seems to have been successful in shifting the pattern of development towards brownfield sites, but conflicting policy aims may start to create difficulties and threaten the continued success of the regeneration agenda. For example, the attempt to reduce the amount of contaminated material going to landfill sites may slow down the development of brownfield sites, as alternative methods of remediation have to be sourced and implemented and costs of disposal rise. Higher costs for dealing with contamination may therefore threaten the viability of some brownfield redevelopments thus increasing reliance on public sector intervention. There also appears to be a greater need for the public sector to take the lead in disseminating and publicising the information that is available on alternative remediation treatments. It is clear from the first stage of our research therefore that the EU Landfill Directive, and the recent, European Court of Justice *van der Walle* case (C-1/03 (Van der Walle and others), can exacerbate tensions which already exist between existing brownfield and contaminated land policy 'layers'. Nonetheless, more sustainable methods of remediation may be promoted as a result, and it may be the case that the sustainable development agenda really does now become a main focus for debate within the property industry, as other environmental directives and legislation start to bite.

But clearly this survey is a snapshot and is an aggregated view. More research is needed to determine how developers are tackling sites at a local level and to what extent 'market failure' is an issue. The next stage of our research aims to examine how developers approach brownfield issues, and their engagement with other stakeholders, in more closely-defined local and key regional contexts, such as Thames Gateway and Greater Manchester.

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Biographical Note

Professor John Henneberry

John Henneberry, MA, MA, MRICS, MRTPI is Professor of Property in the Department of Town and Regional Planning at the University of Sheffield. John's research interests are in the structure and behaviour of the property market and its relationships with the wider economy and the state regulatory system. He has extensive research experience, undertaking funded work for the ESRC, the EPSRC, the European Commission, the Office of the Deputy Prime Minister, the Land Development Studies Trust, the RICS Education Trust, the Building Research Establishment, South Yorkshire Passenger Transport Executive, local authorities and private sector property consultants. He is a Member of the ESRC Research Grants Board and of the ODPM Planning Research Network, Management Board. He is joint (founding) editor of the RICS / Blackwell's book series 'Issues in Real Estate' and a member of the Editorial Board of the Journal of Property Research.

Dr Walter Wehrmeyer

Walter Wehrmeyer MA PhD MIEMA FRSA is Senior Lecturer in Environmental Business Management at the Centre for Environmental Strategy of the University of Surrey. His research interests includes participatory approaches to decision-making, in particular processes regarding the Regeneration of Brownfield sites, the participatory development of Sustainability Indicators and foresighting / backcasting as national strategies for developing countries. His research interests and activities also cover corporate environmental strategies and corporate social responsibility within the context of sustainable development. He is also Adjunct Professor at the Graduate School of Business of Curtin University of Technology, Perth, WA, is full Member of the Institute of Environmental Management and Assessment, general editor of *Greener Management International*, member of the editorial board of *Journal of Industrial Ecology* and *Environment, Development and Sustainability.*

SUBR:IM SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

Regeneration

Interlocking Processes?

Monitoring and Policy-making for Urban Brownfield Regeneration

John Henneberry and Walter Wehrmeyer

Interlocking Processes

- Urban brownfield sites at nexus of many processes.
- Contamination and its treatment; physical redevelopment; property investment; governance, policy and regulation.
- Interactions and outcomes depend on characters of processes and contexts of relations.

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Two processes related to the remediation of contaminated brownfield sites

- Policy-making
- Monitoring

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The contaminated land policy process

- The way that a problem is construed conditions the way that a (policy) solution is developed.
- ‘Development-managerialism’ underpins UK contaminated land policy.

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Development-managerialism

- recognises that contamination poses health and environmental problems, but
- frames the issue primarily in economic terms, as an obstacle to economic progress and urban (re)development;
- emphasises minimisation of urban blight, protection of economic interests and use of market-led development processes to bring contaminated land back into productive use; and
- is pragmatic and cost effective.

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Policy process: 1

Part IIA

- Local authority surveys of potentially contaminated sites
- Identify/register ‘contaminated land’ (significant harm/potential)
- Either: take action itself to break the source/pathway/receptor linkages; or
- propose the site for listing as an EA 'special site‘.

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Policy process: 2

The planning system

- Remediation of all land that is not 'contaminated land'
- Framework established by Supplementary Planning Guidance
- Implemented through development control process
- Developer must ensure that the land is fit for the proposed use

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Key features of UK policy

- the application of a specific definition of ‘contaminated land’
- the 'suitable for use’ doctrine
- risk assessment based decision making
- liability is the original polluter’s and/or the current owner’s
- decentralized, primarily locally implemented character
- most sites remediated as part of normal development process

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Strengths of policy

- stronger national guidance and standards
- obligatory surveys by every local authority
- harnesses local knowledge and can be adapted to local circumstances
- allows (local) strategic priorities to be developed at two levels: register and special sites
- controls costs and needless 'over remediation'
- uses the development process continuously to monitor land and to mobilize resources for remediation

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Weaknesses of policy

- ‘contaminated land' is defined in very narrow terms
- does not allow for change (physical contamination should be recorded even if a 'pathway' is not now operative)
- modelled risks may not correspond to 'real world’ risks
- public access to data is restricted
- liability regime – does the polluter actually pay?
- are responsible authorities adequately resourced?

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Interaction of policy processes

Part IIA

- proactive
- (partly) publicly funded and operated
- focuses on dealing with ‘contaminated sites’ for which there is no immediate prospect of development

The planning system

- reactive (to development proposals)
- achieves privately funded treatment of contamination through public regulation
- deals with most contaminated land

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Interaction of policy processes

Former toxic dump

- Capped and surrounded by 3m fence
- No pathway
- Not ‘contaminated land’
- Not dealt with by Part IIA

Proposed housing site

- Receptor and pathway would exist
- It is now – or would be – ‘contaminated land’
- Dealt with by the planning system

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Monitoring processes

- There is a need to monitor and evaluate the “success” of remediation and whole redevelopment process.
- Brownfield redevelopment shouldn’t be considered as de facto Sustainable.
- Monitoring and evaluation needs to be undertaken using the holistic perspective of Sustainable development.

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Planning processes implementing Sustainability in Brownfield redevelopment projects.

- Sustainability is the core aim of planning!
- PPG’s, PPS, Supplementary planning guidance
- Community Strategies, LDF, UDPs etc
- LA21
- EIA
- Regulations
- Voluntary Sustainability Metrics eg BREEAM

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Policy Monitoring, focusing on the local level

- Implementation and monitoring of sustainability through planning application process.
- Importance of planning gain.
- Issue of trade offs between policies and difficulty in monitoring coordination & information utilisation, especially at local level.
- Plethora of evaluation, criteria, tools, at different levels. (what do we look at first)
- Top down monitoring, the need for participation.

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EIA the potential for implementing and monitoring redevelopment project sustainability.

- EIA process evaluates environmental effects of a proposed development & may include consideration of socio economic effects.
- EIA best practice recommends pre-application consultation as well as post-hoc monitoring (none carried out thus far extensively).
- Not applicable to all redevelopment projects.
- Usually influence stops once planning permission is granted.
- Opportunity to monitor sustainability of projects throughout life cycle.
- Resource implications for both LA & Developers.

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Implementing & monitoring brownfield sustainability through Regulations

- Number of regulations relating to redevelopment projects and licences to be obtained (eg. building regulations).
- Implicitly implement and evaluate sustainability although not able to enforce best practice.
- Regulations are nationally derived with limited public participation, limitations to consideration of local circumstances.

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Voluntary Sustainability Metrics

- Plethora of voluntary sustainability checklists, tools, etc.
- Top down, many are non-participative or site specific.
- None dealing specifically with brownfield redevelopment and looking throughout the life-cycle of a project.
- Need to integrate existing planning and regulatory processes and policies.
- The **Redevelopment Assessment Framework**

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Conclusions

- Different planning and regulatory processes with different implicit or explicit sustainability criteria.
- The need for coordination and development of a framework which incorporates the above processes.
- The need for a wider view of contamination, increased communication, and more holistic view of risk.
- Need to monitor "success" sustainability of projects.
- The need for a framework which will enhance, the participatory nature of sustainability evaluation.
- The need for a framework which integrates risk and its communication and takes into account site specific characteristics.

The need for the RAF

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Interlocking Processes? Monitoring and Policy-making for Urban Brownfield Regeneration

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INTRODUCTION

Urban brownfield land lies at the nexus of a large number of processes: of contamination and of its treatment, of physical redevelopment, of property investment, of governance, policy and regulation, and so on. The way in which these processes interact - and the outcome of these interactions - is contingent upon the character of the various processes and upon the local and wider circumstances bearing on their relations. Consequently, effective management of brownfield regeneration requires public and private actors to be sensitive to the varied ways in which the processes affect one another. In this paper we illustrate this point through a consideration of just two of the processes affecting brownfield land: policy-making and monitoring with respect to contamination and remediation.

THE CONTAMINATED LAND POLICY PROCESS

The policy regime and institutional mechanisms that have emerged in the UK to deal with the problem of contaminated land are structured around a particular construal of the problem. Contaminated land has been viewed through a prism of 'development-managerialism', rather than being approached primarily as an issue of environmental quality or public health. 'Development-managerialism' is a politico/administrative perspective which, while recognising that contamination poses health and environmental problems: frames the problem primarily in economic terms, as an obstacle to economic progress and urban (re)development; and structures the palliative response primarily through the existing administrative apparatus that regulates land use planning. The emphasis is on minimising urban blight, protecting economic interests (of property owners, businesses, local councils, regions, developers, the Exchequer and so on), and harnessing market-led development processes to bring contaminated land back into productive use. Pragmatism and cost effectiveness have therefore been a recurrent theme in how the UK government has sought to deal with the problem.

The evolution and character of the policy regime

Since the establishment of the basis of the current land use planning system in the UK in 1947, the rehabilitation of contaminated (non-agricultural) land has been addressed mainly through the development planning process. In 1976 the government established the first central institutional mechanism to address this issue explicitly: the Inter-departmental Committee on the Redevelopment of Contaminated Land. By the end of the 1980s, the need to address the issue more comprehensively was acknowledged, and provision for registers was included in the Environmental Protection Act 1990. However, the government recognized the flaws in the registry scheme before it could even be implemented. After further consultation, the structure of the current process was enacted in the Environment Act 1995, but the guidelines to local authorities on implementation were not promulgated until 2000. The new approach is now being put in place, with local authorities surveying and registering potentially contaminated sites. However, this is only half of a policy regime that consists of two main elements.

Part IIA. Here, local authorities conduct a survey of potentially contaminated sites. They identify any that match the formal criteria for 'contaminated land' set out in the legislation ('significant harm or significant possibility of significant harm, or pollution of controlled waters'). Sites that meet the criteria are deemed 'contaminated land'. The local authority must either: (a) take action itself to break the source/pathway/receptor linkages and end the 'contaminated land' status of the site; or (b) propose the site for listing as a 'special site' (if it meets the appropriate criteria) to be adopted by the Environment Agency. Under (a) the local authority tries to identify the person(s) responsible for the original contamination and/or current owners to get them to take action, or in urgent cases it acts and bills the responsible parties, or for orphan sites it applies to central government for assistance to fund action.

The planning system. Remediation of all land that contains potentially hazardous contaminants but which does not fall under the legal definition of 'contaminated land', is handled through the planning system. Local planning authorities may impose conditions upon planning permissions that require developers to ensure that the land is fit for the proposed use. Intending applicants must normally carry out investigations and devise proposals for effectively dealing with contamination in accordance with any relevant Supplementary Planning Guidance issued by local authorities. Failure to do this may result in planning permission being refused or granted subject to condition(s) requiring that a risk assessment be carried out prior to the start of development, in order to assess whether the site is contaminated and what remediation will be required.

Key features of the current UK regime for contaminated land are: the application of a specific definition of ‘contaminated land’; the 'suitable for use’ doctrine; risk assessment based decision making; assignment of clean-up liability to the original polluter and/or the current owner; and its decentralized, primarily locally implemented character. In analyzing the features of the current regime, we see both continuity and change. Stable features of the traditional UK approach include the following. The main implementing bodies remain local authorities: they have responsibility for identifying sites, taking action, maintaining registers of action, and proposing sites to be designated as 'special sites'. Most sites where some pollutants are physically present are not formally designated 'contaminated land', but continue to be remediated during the course of the normal development cycle. The emphasis remains on site specific remediation. Liability remains with the original polluter and/or the current owner. Remediation is only required when there is a significant or potentially significant threat to public health or the environment.

Movement away from earlier practices is mainly evidenced by the establishment of a formal and centrally guided regime for managing contaminated land. This includes central policy guidance and supervisory roles for ODPM and DEFRA, the responsibility exercised by the Environment Agency over special sites, the Agency’s approval of any local authority schemes needing central government money, and its provision of advice to local authorities. In addition, central government has developed a more specific definition of 'contaminated land', made a formal commitment to risk assessment procedures, and produced more elaborate formal guidance on toxicity levels that may give rise to significant risk of significant harm.

The strengths and weaknesses of the current policy regime
Overall, there are many positive features of the UK system. It embodies stronger national guidance and standards. It makes obligatory surveys by every local authority. It harnesses local knowledge and can be adapted to local circumstances. It allows strategic priorities to be developed at two levels: an authority can identify priorities as it completes its site inventory; and the 'special site' process identifies key sites needing central attention. It controls costs and needless 'over remediation', by emphasizing 'suitability for use' and applying 'risk based decision-making'. It uses the 'development cycle' continuously to monitor land and to mobilize resources for remediation.

However, there is also a number of potential problems with the current UK regime. ‘Contaminated land' is defined in very narrow terms. Instead a dual approach should have been maintained that recognizes and records physical contamination even if a 'pathway' is not now operative. This is because conditions (including climate, surrounding activity and the state of scientific knowledge) can change. This means that undiscovered pathways may already be operative or new pathways may emerge in the future. Modelled risks may not correspond to 'real world' risks. Records are only kept of 'strategy' and 'registry of remedial actions'. Instead, data on physical contamination in the local authority's area (by substance and original land use) should be maintained. Public access to data is restricted. It is too early to tell whether the introduction of the provisions of the Freedom of Information Act 2000 will ensure that all data held by the local authorities and the Environment Agency will be open to public inspection. There are also risk communication issues. Is it too early to say whether public confidence can be retained by the new system, and whether effective communication lines with potentially concerned local publics exist? With regard to the liability regime, there are doubts about whether the 'polluter pays principle' is actually applied. There are resource issues: do the responsible authorities have the resources needed to carry out their functions?

A final and major question is raised by the interrelations between the Part IIA and the planning elements of the policy regime. These are often portrayed (as above) as distinct but complementary approaches. Part IIA is a proactive, (partly) publicly funded and operated process that focuses on dealing with 'contaminated sites' for which there is no immediate prospect of development. The planning system, on the other hand, is reactive (to development proposals) and achieves privately funded treatment of contamination through the exercise of public regulation (through conditions attached to planning permissions). However, when I propose to build houses on my former toxic dump (that, until now, was not 'contaminated land' because the 3 m. high fence that surrounds it severs the pathway between contaminant source and receptor), my proposal would create 'contaminated land;' that is, land where such a pathway would/could exist. So presumably all the Part IIA criteria apply even though the site is not currently 'contaminated land'?

MONITORING AND METRICS

From this discussion, the clearly-recognised need to monitor and evaluate "success" of the remediation according to pre-set criteria offers a number of significant challenges. To start with, what success is in this field depends on the pre-set criteria for success, which in turn varies whether the criteria emanate from a risk-based paradigm, the 'development-managerialist' paradigm, the regulatory framework or a wider policy framework. The risk-based framework would evaluate the removal of harm from an (eco-) toxicological perspective, the 'development-managerialist' paradigm would assess it in terms of the ability of the new land use to be socially and economically attractive whilst maintaining the removal of risk as *conditio sine qua non*. Likewise, the regulatory framework would assess liability of residual risk, if present, to humans or water courses under Part IIA using the source-pathway-receptor model. However, if remediation success is to be evaluated from a wider perspective, the notion of sustainable development is central, as it not only evaluates more rigorously the efficacy of contaminant removal, but it also places the regeneration project itself under the wider spotlight of economic viability, environmental protection and social acceptability. As this is the most thorough and comprehensive evaluation of success, it will be chosen as the framework for the remainder of this paper. However, as will be shown below, the use of sustainable development itself is not uncontentious, as its meaning is still being discussed, and its embeddedness in planning policy in the UK remains sketchy and not without inconsistencies.

However, there are further initial difficulties with the assessment of the success of contaminant removal as part of redevelopment processes. For instance, the regeneration and site development process involve many different stakeholders active at different stages, but no one covers the entire life-cycle from dereliction of a (contaminated) site via remediation, regeneration, re-use and eventual (new) dereliction. Therefore it is challenging to develop metrices for policy and practice review that can – much like the wand in a relay race – be passed on to the next key agent, especially as in this circumstance, the use of the stick is not limited to handing it over to somebody else, the "passing tool" needs to be used, made sense of and further developed and elaborated. In addition, the policy review using metrices is not traditional in most 'development-managerialist' agents, and it typically requires a site-specific discussion of what the priorities for that site are, which then can and should be evaluated. This links with the notion of sustainable development, which is highly participatory in nature.

From this, it is necessary to review briefly the efficacy with which sustainable development has been incorporated into the planning framework, and how indicators and metrices have so far been used to evaluate urban planning. For the purpose of this paper, the UK definition of Sustainable Development is taken. It is now the central policy aim of (urban) planning and of regeneration, but it is questionable whether the commitment to sustainable development exists beyond the rhetoric and is actually translated into action. A review of urban policy evaluation and monitoring practices shows firstly, that there is not a paucity but a plethora of indicators developed to monitor sustainability at an international, national, regional and local level. Although the importance of these indicators is not disputed the actual use of the information and its dissemination is questioned as well as the integration of the information and focus throughout the different levels. Although brownfield development is a sustainability indicator in itself, the sustainability of such development should not be taken for granted. Considering the wide range of monitoring and participatory decision-making that already takes place, it appears to be appropriate to identify ways of contributing participatory sustainability indicators to existing monitoring processes; specifically with regard to brownfield development, to understand what actually happens in practice and if there truly is progress towards sustainability. Existing community strategies should be a central part in this as they inform the Local Development Frameworks under the reformed planning system.

Sustainable development has also been promoted through the adoption of Local Agenda 21, which should provide the direction and indicators to monitor progress. However, LA21 is voluntary and does not hold legal or statutory weight especially in land use planning and development control. Furthermore, Planning Policy Guidance Notes (PPGs), circulars and best practice publications, which are presented as proof of the incorporation of sustainable development are often compartmentalised, departmentalised and detached. There is no one specific PPG with regard to implementing sustainability, but different policies relate to sustainability within each PPG and are evaluated against different criteria. It is clear that urban policy evaluation is undertaken at different levels but even today it remains top-down and strictly regulated by the government. With these conceptual considerations in the background, sustainability of brownfield regeneration can therefore be made beyond proper land use design through participative planning or benefit sharing of mutually-accomplished planning gain. The design of appropriate metrices should follow the general principles of sustainability indicators, as exemplified by the Bellagio Principles. Within the current planning framework outlined above, such sustainability metrices can, in turn, either be developed as part of the regulatory process, via the widening of the Environmental Impact Assessment (EIA) process or as part of an integrated, bespoke system of sustainability monitoring.

Implementation and monitoring of brownfield sustainability using EIA

EIA is a process, which evaluates the environmental effects of a proposed development with information from many sources such as the developer, the local authority, statutory consultees and third parties. Although the focus is mainly on environmental impacts, social impacts are also considered, when stipulated in the scoping study, albeit with differing success. Furthermore, EIA requires public participation, and EIA Best Practice recommends a monitoring process to assess the efficiency of mitigation measures, making it particularly suitable here. Even though not all brownfield developments require an EIA, it still is a potentially very beneficial process. In a way, EIA could be seen not as a narrowly-defined technical requirement to review the environmental impact of a development, but as the nucleus of a statutory review of the social, environmental and economic performance of a site. In this, it should not stop at the decision to grant planning permission, but should be a means to obtain good triple bottom-line management over the life of the project. This is recommended here.

Implementing and monitoring brownfield sustainability through regulations

During the planning application process a developer will have many matters to consider with regard to regulation and obtaining licences, either for the construction, remediation or operation of the development. There is a whole variety of regulations, covering issues such as energy efficiency, accessibility and so on, and thus it could be considered as a way of implementing sustainability. Specifically with regard to brownfield sites, in the case that there is contaminated ground the number of regulations and licences required is substantially larger, and thus so is the potential for sustainability implementation. However, there are limitations to the ability of regulators to improve the sustainability of developments: Although stipulations could be made through regulations, for example with regard to water emissions, regulators do not have authority to stipulate the means to achieve that objective. Furthermore, regulations are not locally derived but national and therefore local circumstances cannot be taken into consideration. Community participation is very limited in this process, which is also another indicator of the inflexibility of the review process.

A tailor-made sustainability metrics

The most comprehensive and most site-specific solution to the complex problem of what is sustainability of a site, and how can it be evaluated across the life-cycle of a site, is to develop and manage an evaluation framework that is specifically designed for such a purpose. It also is likely to be the most expensive and most voluntary way in which planning can be evaluated. Whilst such a cost effective system has been described elsewhere, its use represents an inevitable trade-off, where its obviously benefits include high site-specificity, participatory design that offers social and managerial inclusion, demonstrable sustainability, policy and practice review across its life-cycle has to be balanced against costs, lack of generalisation due to varying specificity of the range of indicators, and the nexus difficulties of the efficacy of evaluating sustainability in a site-specific manner without adequate inclusion of neighbouring sites. The latter is perhaps the most significant issue that remains to be tackled, as sustainability itself is a regional concept neatly transgressing property boundaries, and most planning gains that stem from urban regeneration arise from increased synergies with neighbouring sites.

CONCLUSIONS

This paper has presented some of the intrinsic complexities that arise from the efforts of obtaining simultaneous objectives with diverging policy tools. Part IIA is a proactive regulatory process that improves 'contaminated sites', the planning system reacts to development proposals from the private sector. Together they (*inter alia*) aim to remediate sites and to add value to future land use through the regeneration process. Ideally they should be supported by a comprehensive set of sustainability indicators which cover not only the short-lived and relatively minor remediation and reconstruction phase, but also the entire life-cycle of a site in a way that is meaningful and acceptable to all parties in this often highly politicised decision-making process. Whilst this may sound easy in theory, the practical complexities are manifold, ranging from the idiosyncratic source-pathway-target model which makes it legally possible to "create" contamination (and liability for it) by removing a fence, to the planning problems of having no effective way of objecting to a proposed development unless it violates pre-set rules, to a planning system that has sustainable development as the key strategic objective, but has no practical way of evaluating a proposed development for its sustainability (nor any way to refuse its implementation on these grounds).

The interrelations discussed here – between the regulatory, planning and monitoring processes for the sustainable regeneration of contaminated brownfield land - appear conjoined at face value but become highly fragmented and diverging after closer consideration. Further research is needed on ways in which these processes can be integrated. In particular, on how site-specific planning and re-development gains can be balanced with the need to provide appropriate synergies across neighbouring sites; on how risk communication and sustainable development can be integrated into participatory public planning processes; on how the proactive regulatory system, the reactive development control system and the normative umbrella of sustainable development can be integrated and what possible trade-offs may be implied; as well as on how the regulatory approach of Part IIA should (or could) fit with the more participatory and deliberative sustainability evaluation process.

Given the comparative novelty of sustainable development as a guiding principle for all planning processes, such an ambitious research programme is also likely to yield significant practical insights of benefit to all stakeholders and, most importantly, to improved land use and more efficaciously remediated sites.

Biographical Note

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SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

From Problem Places to Opportunity Spaces: The Practices of Sustainable Urban Regeneration

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Introduction

- The complexities of regeneration practice
- Balancing objectives
- Different types of knowledge and the regeneration process
- Key factors in regeneration practice
- The regeneration of Salford Quays, Manchester

Knowledge and regeneration

- Knowledge combinations
- *Practical knowledge* is defined as 'involving, or concerned with experience of actual use; not theoretical…adapted or adaptable for use'.
- *Theoretical knowledge* is defined as 'lacking practical application or actual existence, hypothetical…impractical'.
- Regeneration practice as the **interface**

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Key factors in regeneration practice

- The growth of the local agenda
- Institutional roles and responsibilities
- Timetables and strategies
- Sustainability and continuity
- Liabilities and commitments
- Policy co-ordination
- Funding regimes
- Staffing, personnel and partnerships
- Governance and accountability
- Place factors and development boundaries

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The Regeneration of Salford Quays

- The decline of Salford Docks
- New visions, new developments
- A ‘successful’, ‘sustainable’ urban regeneration project
- 200 businesses, 200,000 sq feet office space
- 10,000 jobs

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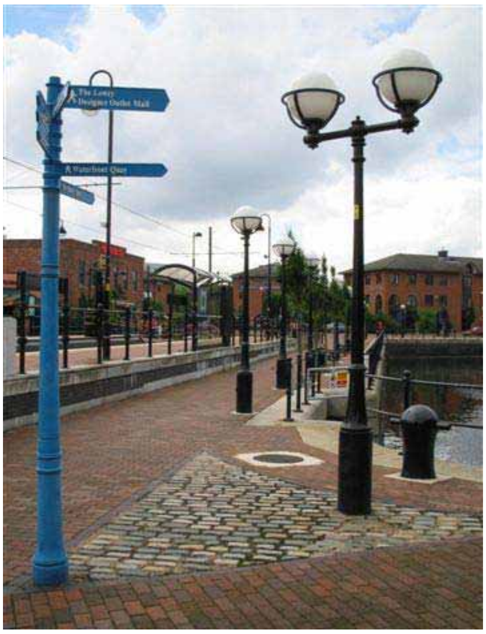

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Assessing the Development Process in Salford Quays

- Visions, realities, and practices
- The evolution of development programmes – building ‘confidence’
- National, regional and local support
- Social infrastructure and sustainable development
- The embedded nature of development?
- The difference that sustainability makes

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Conclusions

- Knowledge, practice and sustainable urban regeneration
- Regeneration as the interface of theory and practice
- From problem places to opportunity spaces

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From Problem Places to Opportunity Spaces: The Practices of Sustainable Urban Regeneration

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INTRODUCTION

Practicing sustainable urban regeneration is a complex and challenging task. Regeneration always requires development agencies to answer key questions such as:

- How do you define a 'problem place'?
- What would make it a better place?
- Who are the target groups that regeneration is aimed at (*e.g.* developers, investors, house buyers, local communities etc.)?
- How should regeneration plans be formulated and implemented?
- What constitutes a successful, sustainable regeneration project?

At the same time the institutional, political and economic contexts within which development programmes are initiated are subject to frequent change and contestation so that answers that seem appropriate in one context at a particular time, can quickly become out-dated or seen (ironically) as a 'problem' at a later date. This brief paper outlines the key elements involved in the practices of urban regeneration. It begins by defining what practice involves and highlights its relationship to different types of theoretical knowledge and development visions. It then goes on to outline some of the key dimensions and tensions involved in the delivery of regeneration policy before briefly turning to some of the early lessons to emerge from one of SUBR:IM's case studies, the Salford Quays development in Greater Manchester.

PRACTICES AND THE DELIVERY OF SUSTAINABLE URBAN REGENERATION

The delivery of any regeneration policy involves a **combination** of different types of knowledge. It is often assumed that there is a significant difference between theoretical or academic knowledge and the implementation of policy through practice. These divisions are reflected in linguistic definitions that see practice and theory as separate. For example, in the Collins English Dictionary:

- *Practical knowledge* is defined as 'involving, or concerned with experience of actual use; not theoretical…adapted or adaptable for use'.
- *Theoretical knowledge* is defined as 'lacking practical application or actual existence, hypothetical…impractical'.

In practice, regeneration programmes represent the **interface** between different types of knowledge. The delivery of regeneration and its impacts on people and places are directly related to the imaginations and visions that are established before policy is initiated. These visions, in turn, are created through a combination of theoretical and academic knowledge, often gained through an understanding of practice from elsewhere and an assessment of the specific local contexts that exist in a development area. 'Best practice' guidance has to be seen in this light, as something that on the one hand can guide visions and policy objectives whilst on the other being contextualised to reflect the diverse geographies that exist in different urban areas.

Since the 1970s regeneration policy in the UK has become increasingly focused on *local initiatives* or so-called 'bootstraps' programmes. Local initiatives are seen as being more 'in touch' with local communities, flexible enough to respond to local needs and opportunities, and able to mobilise local resources to tackle local problems. It is claimed that they provide a sense of local empowerment and ownership; utilise latent skills and resources; give citizens a greater say in the ways in which they are governed; and bring local knowledge to regeneration agendas, thereby improving their effectiveness, sharing benefits amongst a wider range of local people, and enhancing policy efficiency and effectiveness. Moreover, the new approach also places greater emphasis on local entrepreneurialism and economic development with localities taking greater responsibility for the 'success' (or otherwise) of initiatives.

Research on urban regeneration has identified a number of factors that are essential to successful policy practice in the context of this localism. These represent the interface between different types of knowledges and development contexts.

- Most significantly there needs to be a *clear definition of institutional roles and responsibilities* so that local programmes are embedded in a wider set of development practices. *Duplication and overlap* between different development agencies needs to be minimised. All too often development practice becomes confused between different agencies each with their own targets, resources and priorities. These may or may not be mutually inclusive and at worst, as a number of examples have shown, can be flatly contradictory.
- There also needs to be clearly defined and realistic *timetables* of action based on guaranteed state funding and clear longer-term *strategies*. As Cochrane (1999) notes, urban policy has been plagued by a circular policy process in which new programmes are constantly initiated with the understanding and expectation that earlier rounds of policy *will have failed*. All too often development practice becomes dominated by short-termism as partnerships and project leaders look to sustain their own funding streams, rather than thinking about how regeneration practice can best be put together (see Raco *et al*, 2003). In some cases, particularly in EU-funded projects, organisations look to attract new funding for themselves (and their staff), rather than focusing on what is required to bring about wholesale regeneration
- Effective development practice, therefore, raises broader questions over the *sustainability and continuity* of local regeneration efforts. For example, as the physical elements of a regeneration project begin to wind down it may be necessary to turn attention and resources towards community-building measures and projects that seek to support social initiatives that equip local people with new skills and capacities. Whilst, a resource-intensive approach over a sustained period is a key element in enabling local institutions to develop long term agendas, there is an inherent danger that development objectives become fossilised even if the circumstances that underpinned their establishment have changed significantly. Policy *learning* is, therefore, an essential element of delivery with organisations benefiting from the adoption of more reflexive and adaptable ways of working.
- This also draws attention to the ways in which development agencies tackle wider questions over the *liabilities and commitments* that have to be accounted for. For instance, the Urban Development Corporations that existed in many English cities in the 1980s and 1990s left a range of complex technical, political and economic legacies for local authorities and partnerships to pick up. Given that one of the rationales for local regeneration is that programmes can generate and mobilise support from local communities and demonstrate state commitment to a deprived area, their removal can also be politically divisive.
- On a broader scale the powers and responsibilities of different agencies need to be thought through and *co-ordinated*. In many cases development agencies possess limited powers and resources and are unable to effect change. For example, it is common for urban regeneration bodies (including local authorities) to possess limited autonomy over funding and little responsibility for factors that directly and indirectly impact on the local economy (such as housing, transport, health and so on). However, a balance needs to be struck between the prescription of clear roles and responsibilities from 'above' (*i.e.* ODPM) and allowing local agencies to be flexible in developing their own programmes, local networks and priorities of action from 'below'. Evidence suggests that where local agencies have been designated appropriate powers, resources and responsibilities regeneration projects have been at their most effective.
- The form and character of *funding regimes* underpins all development practice. The stability and scale of funding shapes contours of policy. Short term funding has frequently limited the longer-term effectiveness and sustainability of projects. If organisations have to constantly meet tight targets then their ability to engage in (local and wider) longer term strategic objectives may be circumscribed. Agendas can become focused on matching targets for their own sake. Long-term, committed funding does enable development agencies to expand and develop a range of programmes of action, to plan ahead, and to embark on programmes that may require heavy short-term investment to generate significant long term gains. However, it also requires a strong, sustained financial commitment from funding agencies, something that is increasingly difficult to guarantee as public sector funds reflect broader political trends and programmes. Regeneration

has been more successful where local projects have benefited from the existence of the broad range of public agencies that operate on a city-wide or regional scale. Conversely, where levels of public sector support for such projects is not as great, developing sustainable funding streams may be extremely difficult.
- Secure funding also has an impact on *staffing and personnel* and the capacity for local organisations to build *local partnerships*. Attracting and retaining appropriate staff at the local level is a key consideration. In championing a local area, personnel have to work in and through bi-lateral and partnership relations with other public sector agencies. They also have to be in a position to negotiate with private sector developers. Having experienced, established staff in such senior positions can assist in the development of such networks. Ensuring the security and continuity of staff is critical in the development of such relations. Frequent staff turnover and short term contracts can undermine such relationships.
- Development practice is also related to broader questions of *governance and accountability*. During the 1980s and 1990s centrally-imposed quango agencies were increasingly used to develop and implement urban policy. Such organisations were criticised for being detached from local communities and locally unaccountable for their actions (see Imrie and Thomas, 1999). Since the late 1990s local *community engagement* has been championed as a core element of development practice underpinned by new forms of local governance in which people and communities take greater responsibility in developing schemes to benefit their neighbourhoods (see Raco, 2003). However, in practice the mobilisation of communities is a complex task and the extent to which it takes place is still a highly contingent matter. In many cases executive decisions are still taken by management officers and other senior, highly-skilled executive officers. Urban regeneration is still dominated by such professionals – indeed there is some evidence that the emergence of partnership-governance has enabled new officer-dominated and less accountable forms of governance to be established.
- The significance of *place factors and boundaries* is critical in influencing the effectiveness of local practice. Development boundaries should be designated in such a way that they are 'coherent and logical'. There can be a tension between functional boundaries and those of local community imaginations and place 'association'. Defining problem places and where development boundaries should be drawn is essential to the implementation and effectiveness of development programmes. There is a danger of creating 'cliff edges' within cities between included and excluded places.

The final section of the paper will briefly examine how these themes have been evident in one of our case study sites, Salford Quays in Greater Manchester.

REGENERATING SALFORD QUAYS: FROM PROBLEM PLACE TO OPPORTUNITY SPACE

The regeneration of Salford Quays has been one of the most significant and overtly successful brownfield redevelopment of its kind in Western Europe. Salford Docks suffered from gradual decline in the post-war period. At its height 3,000 people were directly employed in the Docks but by the mid-1980s they had completely closed down. The situation facing Salford City Council was one of rising levels of unemployment. In regenerating the Salford Docks, the Council faced a combination of difficulties, including the large size of the development area [150acres of land and 75acres of water], significant water pollution, inner-city decline in neighbouring areas, a lack of developer interest/confidence; and a limited track record in economic regeneration. Despite the limited soil contamination developer interest in the site was nil. In response, Salford City Council purchased the docks from the then Manchester Ship Canal Company in 1983, and in conjunction with various private sector interests, notably Peter Hunter from Shepheard, Epstein and Hunter, established a development plan for what was then labelled 'Salford Quays'. First released in May 1995, the development plan was underpinned by three key objectives: exploiting the surrounding water as an asset; providing roads and services; and improving public access and landscape It was more of an infrastructure plan in that it outlined key circular roads, under which key services would be provided, and emphasised the need for key vistas and tree-lined pedestrian paths. The original decision-makers set upon the notion of an equal balance between work, residential and leisure. Leisure activities in particular were considered a vital part of the development vision and complex engineering work was carried out to reclaim contaminated land and to aerate the local water system so that it could be used for new activities.

Rather than simply establishing the Council's vision for the site's redevelopment, the plan formed two additional functions. It was the basis upon which private sector confidence could be uplifted, and it represented a coherent strategy which could be promoted with a view to obtaining national government funds, particularly through the urban programme and through derelict land grants. Between 1985 and 1996 public sector investment in Salford Quays amounted to £40million, leading to an investment £300million investment from the private sector.

Over the last 20 years the development has come to be seen as a successful, flagship regeneration. The land within the development area under the ownership of Salford City has now been transformed. Whilst there remains land under the guidance of the 1985 plan still to be developed, this represents a small percentage compared to the overall Salford Quays area, falling under the ownership of Peel Holdings. Success can also be seen visually through the way that the desired balance between housing, employment and leisure has been achieved. From a leisure perspective significant achievements include the construction of the £100m Lowry Centre and the water sports centre. For earlier decision-makers the holding of an annual International Triathlon Union event was noteworthy because with people now swimming in the Quays, it exceeded their initial expectations of surface water sports. Success can also be seen in terms of the rising height of residential apartments - an indicator that the confidence of investors and developers has increased, and that they are now willing to invest more significantly in the area. Other notable successes include that there are now 150-200 businesses on the Quays, approximately 2000 dwellings built or in the pipe-line and nearly 200,000 sq ft of office space. The fact that there are now over 10,000 people employed in the Quays is similarly viewed as an important accomplishment, particularly when compared to the number employed on the Docks during their heyday.

However, as interviewees acknowledged delivering what has become Salford Quays has not been an easy process, nor has it been an unbridled success. Based on a preliminary analysis of interviewee responses, a number of lessons can be drawn for development practice elsewhere:

- In Salford Quays, the vision was vital for encouraging investment in an area that had become a wasteland, and within a local government area which had no history of large-scale mixed-use regeneration projects. This aside, the Council's confidence that the site was destined for success is reflected in the decision to financially underpin one of the earliest developments: the Copthorne Hotel.
- In addition to promoting the site as an investment opportunity, the Council adopted the pragmatic view that early development quality may not be outstanding, but that obtaining early successes were critical if the development was to achieve the desired momentum. The construction of new buildings, on a largely flattened development area, would encourage greater confidence in the site and in the Council's ability to deliver their vision. As the development process kicked into full swing, there was the expectation that the quality of development would improve. This is perhaps evident today in Salford City Council's request for more recent developments to be subject to international architectural competitions.
- Support from national and regional government has been critical for the development's success. In Salford Quays because of substantial financial requirements in terms of clearing the derelict site, improving water quality and introducing new infrastructure the Council benefited through a rolling programme of government grants, which provided greater investment certainty, and reduced the need to engage in annual bidding rounds. Support for the site's development is also seen in terms of the high quality finish that has been achieved. For many interviewees this enhanced the sustainability of the site, because whilst buildings and land-uses may come and go in the future, the initial infrastructure as outlined in the early development plan would remain. This will become more evident in the near future, as market pressure will encourage the reconstruction of some of the early developments at not just a high density, but at a higher architectural quality.
- However, with hindsight interviewees suggested that there was a lack of attention to the services that future residents would require, or how the new residential community on Salford Quays would interact and function. Somewhere in the strategy of maintaining the development's momentum, by encouraging new residential developments, and holding competitions for new commercial spaces, the allocation of land for community services or facilities was overlooked. In providing an enclave of owner occupied housing in a sea of public sector housing across Salford, there was the intention of fuelling the desires and expectations of the populous. Yet whether it will remain a desirable place to live remains a key future concern. At the present time like other inner-city residential developments, it is not viewed as a space for families with children.

- In terms of how the redevelopment area links to its immediate surrounds results have been mixed. Clearly it could be argued that the area's success can be seen in the way that development pressure has spilled out of the development area, and how more distantly located commercial establishments have incorporated Salford Quays into their branch or business name. and yet, despite their close connections to Salford Docks when they were operational, there is now a distinct lack of ownership and sense of detachment within local communities over the changes that have happened. The new (wealthier) communities that have moved into Salford Quays have not mixed with existing neighbourhoods and there has been limited trickle-down.
- In fairness to Salford City Council considerable effort was given towards ensuring that the history of Salford Docks was incorporated into Salford Quays, through feature names, physical reminders and art work. Attention was also given to forging links with the local community, particularly in terms of a generating a workforce to deliver the required infrastructure, but also in terms of links to early employers, notably the Copthorne Hotel. Links to the businesses and firms that have located on Salford Quays have not been as strong, nor has there been a committed effort to develop these links through specific training or educational programmes. In a sense it represents the more widespread problem of how to transform an industrial orientated labour force into the emerging service economy. One downside of this failure to integrate the development with the surrounding area was the suggestion that crime has been an on-going concern for businesses and residents on Salford Quays. Commercial theft has been managed more successfully in recent years through the creation of a specialist security operation: Quay Watch. Looking into the future, whilst Salford City Council and local educational institutions are active in seeking to enhance the aspirations and skill levels of residents, such that stronger links can be forged, there remains considerable room for outreach work by local businesses. With the Council's development plan nearing completion, an important concern relates to the ownership of Salford Quays, here again there is a concern as to how committed businesses are to the area, particularly in terms of who takes responsibility for on-going maintenance. Ultimately, Salford City Council cannot turn its back on Salford Quays, as it represents the city's international quarter, and an area in which it actively promotes tourism, but there remains the question of the potential for future business co-ordination within the development area.
- Finally, time scales and spatial dimensions are critical in terms of urban regeneration. In the 20 years since the development plan was released, Salford Quays has experienced the full swing of the market. During this period various key events have helped to spur renewed investment activity, most notably the arrival of Manchester's Metrolink and the construction of the Lowry centre. Looking at the development today, it is hard to imagine that it has gone from problem space, to an opportunity space in the eyes Salford City Council to a now nearly complete development. But in a sense for Salford City Council, in seeking to regenerate inner-city Salford the job is half done. Yes the Salford Docks have experienced a physical transformation, but for Salford Quays to be labelled a truly successful flagship development links need to be improved not only with neighbouring communities but with other areas within the inner-city or what is known as Central Salford. Not only does this involve existing neighbourhood regeneration strategies, integrating better with Salford Quays, but considerable onus will fall on the future Central Salford Urban Regeneration Company. Currently promoted by agencies such as Salford City Council, North West Development Agency and English Partnerships, it is anticipated that it will be one of the first of the next generation of Urban Regeneration Company's to be established. In terms of the future therefore, the ability of the Central Salford URC, working in conjunction with its many partners, to forge stronger links with Salford Quays, not least in terms of employment and improved public transport, will be need to be critically monitored.

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Biographical Note

Dr Andy Moffat

Dr Andy Moffat is Head of the Environmental and Human Sciences Division in Forest Research, the research agency of the Forestry Commission. He graduated in Geography and Soil Science from the University of Reading, and took a PhD in Geography from the University of London in 1980. Following a period in the Soil Survey of England and Wales, he joined Forest Research in 1985 as the Project Leader in Land Reclamation Research. He has followed this interest in a range of projects for sponsors such as DoE, British Coal, ODPM, Yorkshire Forward and several mineral, organic waste and landfill companies as well as the Forestry Commission. He has published land reclamation guidance for various Environmental Ministries and the Forestry Commission. He became Head of Division in 2004. He is a Principal Investigator in four of the SUBR:IM work packages.

SUBR:IM SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

Remediation

Greening of brownfield land
Andy Moffat

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Presentation overview

- Why 'green' brownfield land?
- Sustainable and 'positive' greening
- SUBR:IM research - to date
  - next phase
- Conclusions
- Acknowledgements

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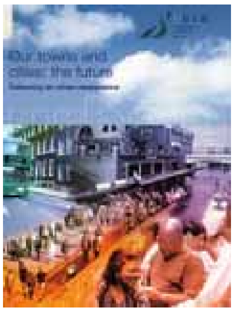
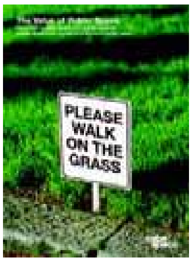
Why green brownfield land?





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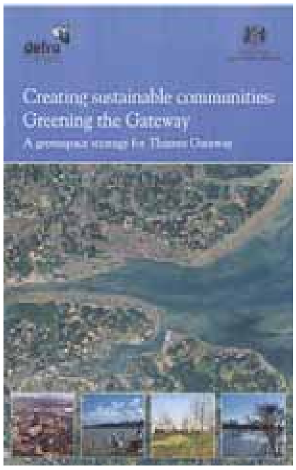
SUBR:IM research area green initiatives



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Environmental drivers

- Environmental Protection Act 1990
- The Landfill Regulations 2002
- England forestry strategy
- England biodiversity strategy

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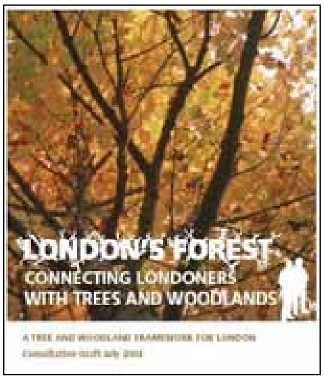
Other initiatives



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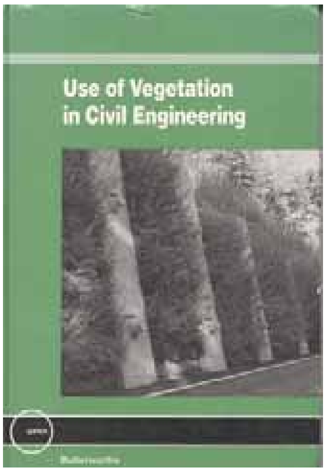
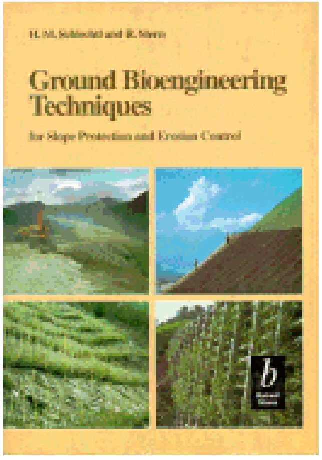
Greening and civil engineering – are they compatible?





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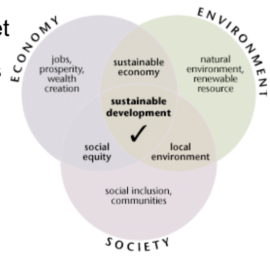
Sustainable greening

Land reclamation/remediation demands acceptable budget

Greening solution demands acceptable maintenance/management budget



Vegetation has normal life 'expectancy'

Vegetation helps, not exacerbates pollution control

Vegetation deliver other environmental benefits

Greenspace valued by community

Greenspace poses no danger to community

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Positive' greening

Environmental benefits:

e.g. heat island reduction, atmospheric pollutant interception, urban biodiversity

evapotranspiration

rainfall interception

Public benefits:

e.g. economic regeneration, landscape improvement, sport/recreation, provision of shade

Phytostabilisation; contaminant break down

use of organic wastes

Waste minimisation through re-use of brownfield 'soil' or remediated materials

Reduced leaching to surface and groundwater

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SUBR:IM greenspace research

Work Package F

Integrated remediation and greening

To investigate how greenspace creation can be compatible with, and support, land remediation

Work Package K

Novel special-purpose composts for the sustainable remediation of Brownfield sites

To investigate how combined zeolitic and organic materials can both remediate and provide nutrients for greening

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Integrated urban remediation and greening project areas

- A literature review of remediated soils and their role in urban greening.
- A survey of practitioner's attitudes to urban greening (in collaboration with projects based at Cambridge, Reading and Surrey Universities).
- Experimental research programme investigating suitability of bioremediated and thermally remediated materials for use in urban greening.
- Detailed field survey of 6 brownfield sites that have been restored to urban greenspace.

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Urban greening review

- Benefits of urban greening in context of brownfield land development
- Application of greening as technical complement to *in situ* and *ex situ* remediation strategies
- Recommendations for further development

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Questionnaire survey

- In conjunction with Work Package E
- 2000 questionnaires were sent out. 200 replies with positive information.
- 35 respondents had restored land to a soft end use and 17 had restored land to '*public open space'*
- Bio remediation was the technique that most had used or had experience of
- Soil Washing and Soil Vapour Extraction formed the next highest category

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Experimental programme

(a) The ability to grow trees, grass and wildflowers in remediated 'soils', with and without compost amelioration

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Experimental programme

Two tree species:
- Poplar
- Alder

Two amenity grass mixes:
- Sandy substrate
- Clay substrate

Two wildflower/grass mixes:
- Sandy substrate
- Clay substrate

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Experimental programme

Five soil treatments:

(a) Sand (control)

(b) Unremediated material containing organic contaminants

(c) Above material, thermally remediated

(d) Bioremediated sandy loam material formerly contaminated with organic contaminants (BioCardiff)

(e) Bioremediated clay material formerly contaminated with organic contaminants (BioCTRL)

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Experimental programme

Three compost treatments:

	No compost	***Low rate***	***High rate***
Trees	yes	25% v/v	50% v/v
Grasses	yes	25mm depth surface application incorporated to 150 mm material depth	50mm depth surface application incorporated to 150 mm material depth
Wildflower/ grass mix	yes	10mm depth surface application incorporated to 150 mm material depth	25mm depth surface application incorporated to 150 mm material depth

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Analysis of materials

Analysis	**Material**				
	Control	**Contaminated**	**Thermal remediation**	**Bio remediation (BioCardiff)**	**Bio remediation (BioCTRL)**
pH	**6.5**	**8.1**	**7.5**	**7.9**	**8.9**
Available P (mg l^{-1})	**4.8 (0)**	**10.3 (1)**	**7.9 (0)**	**40.8 (3)**	**24.2 (2)**
Available K (mg l^{-1})	**27 (0)**	**164.9 (2-)**	**152.4 (2-)**	**169.4 (2-)**	**257.8 (3)**
Available Mg (mg l^{-1})	**18 (0)**	**120.5 (3)**	**293.7 (5)**	**90.2 (2)**	**105.3 (3)**
Total N (% w/w)	**0.04 (Very low)**	**0.26 (Medium)**	**0.55 (High)**	**0.16 (Low)**	**0.07 (Very low)**
% organic matter	**0.2 (Very Low)**	**9.1 (Medium)**	**10.2 (Medium)**	**2.4 (Very low)**	**2.2 (Very low)**
Soil texture	**Sand**	**Clay loam**	**Sandy loam**	**Sandy loam**	**Clay loam**
Main contaminants		**Mercury, Sulphates, PAHs, Cyanides, Benzenes, Xylene**	**Copper, Zinc, Lead, Mercury, PAHs, Sulphates, Cyanides**	**Benzenes**	**Mercury, Benzenes, Sulphates**

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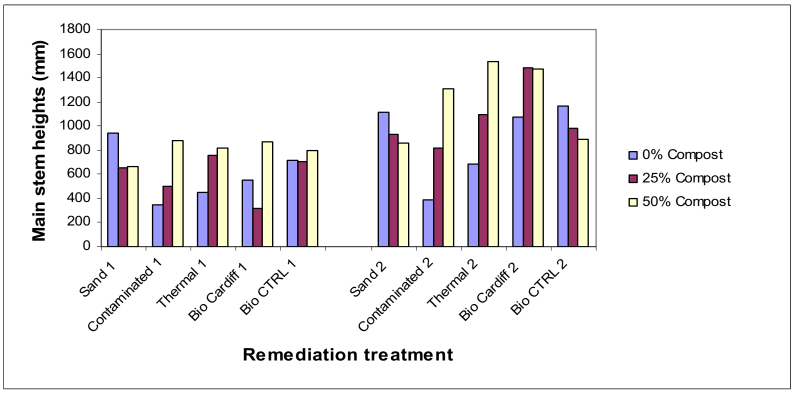
Results (1)

Average height of main stem for alder (1) and poplar (2)



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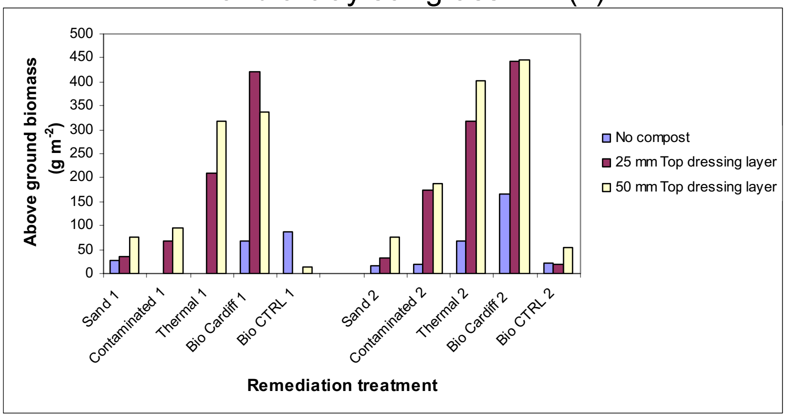
Results (2)

Above ground biomass for a sandy soil grass mix (1), and a clay soil grass mix (2)



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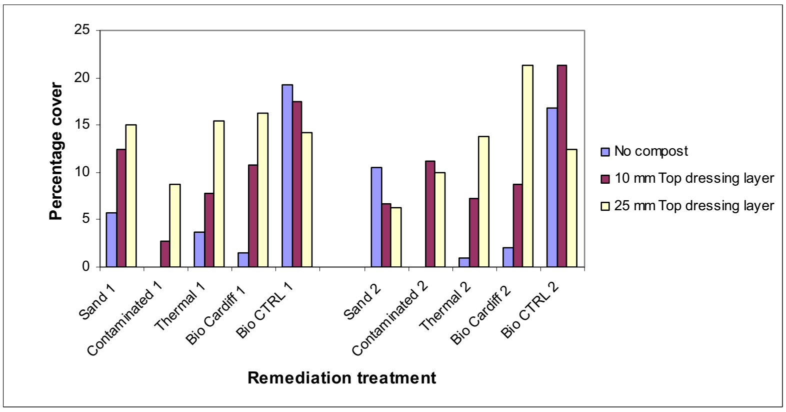
Results (3)

Wildflower percentage ground cover in the wildflower/grass mix for a sandy soil mix (1) and a clay soil mix (2)



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Preliminary conclusions

- Plant growth is possible on certain remediated materials and this is improved with the addition of compost.
- Growth in contaminated material was reduced compared to remediated material
- Adding compost at the lower rate improved growth in all treatments for trees, grass and wildflower/grass mix.
- Adding compost at the higher rate did not produce any further significant improvements over the lower rates for the amenity grass mixes.
- It is not clear whether compost improvements were due to improved nutrient levels or whether it is due to the organic matter binding up organic contaminants and making them less available for plant uptake.

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Experimental Programme

(b) The effect of bentonite and zeolite treatment to contaminated soil, with and without amelioration with compost, and effect on growth of poplar

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Zeolite experimental treatments

Soils	Compost	Soil/ compost ratio	Mineral concentration in the compost: None	Bentonite (%) 7	14	20	Clinoptilolite (%) 7	14	20	Grand Total
High cont.	No Compost	0%	1							1
	Greenwaste compost	7%	1	1	1	1	1	1	1	7
		14%	1	1	1	1	1	1	1	7
		20%	1	1	1	1	1	1	1	7
	Sewage-sludge compost	7%	1	1	1	1	1	1	1	7
		14%	1	1	1	1	1	1	1	7
		20%	1	1	1	1	1	1	1	7
Low cont.	No Compost	0%	1							1
	Greenwaste compost	7%	1	1	1	1	1	1	1	7
		14%	1	1	1	1	1	1	1	7
		20%	1	1	1	1	1	1	1	7
	Sewage-sludge compost	7%	1	1	1	1	1	1	1	7
		14%	1	1	1	1	1	1	1	7
		20%	1	1	1	1	1	1	1	7
			14	12	12	12	12	12	12	86

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Zeolite experiment - preliminary results and conclusions

- Positive effect for compost on highly contaminated soil
- Sewage sludge compost has the best effect on biomass production
- Zeolite are a useful addition to sewage sludge compost
- There is a limit in the amount of compost to be added

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Field and survey programme to review success and failure of greening

- Land acquisition process - financial, legal, liabilities, management
- Site investigation process
- Remediation
- Establishment practice - identifying failure and success
- Long term management practice - technical and financial/resourcing
- Benefits vs costs? - water quality, noise abatement, soil quality, biodiversity, green corridors, public usage, attracting investment, public health, aesthetic value etc.

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Field investigations – site selection

Eastbrookend Country Park (over 10 years old): Large country park

Russia Dock ecology park

Thames Barrier Park (8 years old) formal park

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Current and future research
Integrated remediation and greening

In progress:
Evaluation of

- chemical and botanical aspects of nursery experiment
- questionnaire survey results to determine attitudes towards Integrated Remediation and Greening

Future:

- Evaluation of remediation treatments in terms of use within greening schemes through nursery and laboratory analysis
- Field and survey programme to review success and failure (indicators and/or causes) and…….
- Construct ‘sustainability indicators for greenspace on brownfield land
- Guidance and scientific papers

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Current and future research
Novel special-purpose compost project

In progress:

•Determination of effects on :
a) contaminant movement and bioavailability
b) nutrient enhancement and effects on vegetation growth

•Technical review and appraisal of ‘novel composts’

•Development of novel techniques (MRI) to track contaminants

Future:
•Development of improved mixtures to improve vegetation growth, reduce contaminant mobility and availability

•Planning of field testing

•Development of constraints model for the technology

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    Abir Al-Tabbaa (UoC)
    Mike Johns (UoC)

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Greening of Brownfield Land

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INTRODUCTION

Modern redevelopment of brownfield land must include an element of greenspace. Urban landscape design has learnt the concrete 'jungle' lesson, and many government departments and agencies, and NGOs, are committed to the establishment of greenspace as an integral part of new developments. Such organisations include ODPM, Forestry Commission, English Partnerships, CABE Space, Groundwork, English Nature as well as Regional Development Agencies and local authorities. Notable greenspace initiatives in the SUBR:IM research areas include the NEWLANDS (New economic environments through woodlands) project in north-west England and the Green Grid proposal in Thames Gateway. Greenspace is seen as essential for several reasons including landscape improvement and economic regeneration, provision of recreational and sport opportunity, connection with nature, and flood defence. Other societal claims for urban greenspace include enhancement of urban biodiversity, atmospheric pollution mitigation, reduction of the urban heat island effect and carbon sequestration.

Whilst greenspace provision has become such a clear policy objective of brownfield development, there are conflicting views, and practices, over how to achieve sustainable greenspace in the context of land remediation. Often, the remediation and vegetation establishment phases of land reclamation are considered separately, and opportunities for re-use or recycling of 'soil-forming materials' in which to establish vegetation are lost. Contaminated sites are all too often cleaned up to generic levels (i.e. the standard of remediation is the same for different end-usage) and the formation of the final landscape occurs in isolation of the remedial process. In addition, the value of different forms of vegetation to provide breaks in the source-pathway-receptor linkage is ignored or misunderstood to the extent that some vegetation types are prohibited from forming the after-use of the site.

Potential synergies also occur in the use of waste materials in the remediation and reclamation processes. Organic wastes like sewage sludge and, more recently, composts, have been used in land reclamation to enhance fertility, but there are opportunities to develop materials partly derived from these wastes to control the environmental fate and availability of both organic and inorganic contaminants, as well as supporting vegetation established on the remediated site. For example, naturally occurring minerals such as clays and zeolites, mixed or combined with organic materials, could interact with metals to form a matrix in which the bioavailability of the metals is significantly reduced.

Within the SUBR:IM consortium, two Work Packages have been designed to deal directly with the issues raised above. 'Integrated remediation and greening' (Work Package F) has five objectives:

- To review existing information on integrated remediation and greening systems,
- To assess the sustainability of a sample of existing integrated remediation and greening systems and their design methods,
- To develop environmental, economic and social sustainability criteria for urban greening,
- To develop improved and new integrated remediation and greening solutions designed to meet the developed sustainability criteria,
- To provide technology transfer on achieving integrated sustainable urban greening.

'Novel special-purpose composts for the sustainable remediation of Brownfield sites' (Work Package K) has a similar set of objectives:

- To develop a novel sustainable remediation technique that will rely on the use of waste produced materials (composts) combined with naturally occurring minerals (clays, zeolites) to enhance the biodegradation and immobilisation capability of the compost.
- To select from the SUBR:IM portfolio, appropriate sites for investigation, soil sample collection and detailed characterisation in order to identify the nature of contaminants for remediation.
- To perform nursery-based trials to evaluate the effectiveness of the technology by monitoring the bio-availability of the contaminants of concerns to plants under specific experimental conditions
- To perform field trials on a selected site subject to external support and funding.

Table 1 summarises the component parts of a conceptual model for integrated remediation and urban greening, and identifies those that Work Packages F and K will consider during the SUBR:IM programme.

Components of integrated remediation for greening	Considered within current SUBRIM projects
Stakeholder attitudes towards greening of brownfields	
Identification of barriers and incentives	
Re-use of remediated materials	✓
Minimisation of site waste	✓
Incorporation of waste materials	✓
Development of novel materials	✓
Development of new integrated technologies	✓
Identification of causes of success and failure	✓
Appraisal of socio-economic and environmental benefits and costs	
Develop sustainability indicators	✓

Research to support these objectives began in November 2003. This paper reviews progress, presents some preliminary results and identifies research directions for the forthcoming year.

INTEGRATED REMEDIATION AND GREENING (WORK PACKAGE F)

Experimental research

To date, the largest research element has been in the setting up and monitoring of a set of nursery experiments to test the ability of different types of vegetation to survive and grow on thermally (*Thermal*) and bioremediated (*Bio Cardiff* and *BioCTRL*) 'soil' materials, with and without organic compost materials, in comparison with uncontaminated (*Sand*) and unremediated contaminated (*Contaminated*) treatments. Trees, grasses and grass/wildflower mixtures have been tested in this way. Measurements have been made of growth and foliar chemistry, and samples of water leachate have been taken to study the extent to which the soil-plant system can prevent pollutant pathways for remaining contamination. As examples, Figure 1 shows the average height of the main stem for alder (*Alnus cordata*) (1) and poplar (*Populus trichocarpa*) (2), Figure 2 shows grass biomass, and Figure 3 the percentage wildflower ground cover after one growing season.

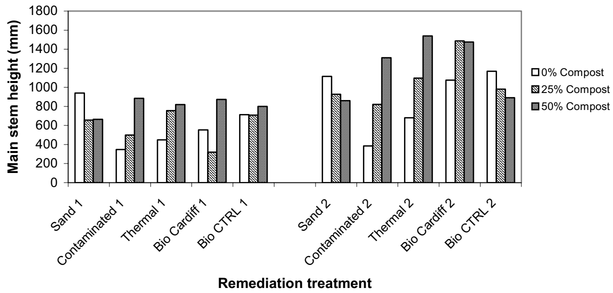

Figure 1. Tree heights after one growing season for alder (treatments 1) and poplar (treatments 2). For further explanation of treatments, see text. Bars = least significant difference.

Average tree height results for alder (Figure 1) indicated trees grown in no compost and in the 25% compost application rate were significantly shorter ($p \leq 0.05$) than the 50% compost rates. For poplar, mean height was significantly lower in the contaminated soils than in the remediated treatments ($p \le 0.05$). Height was increased by adding 25% compost ($p \le 0.05$) and further increased by adding 50% ($p \le 0.05$). There was a significant interaction between the compost treatment and the soil treatment ($p<0.001$): compost rate very significantly affected tree height in the contaminated soil, thermal treatment and BioCardiff treatment but had little effect on the control or the BioCTRL treatment.

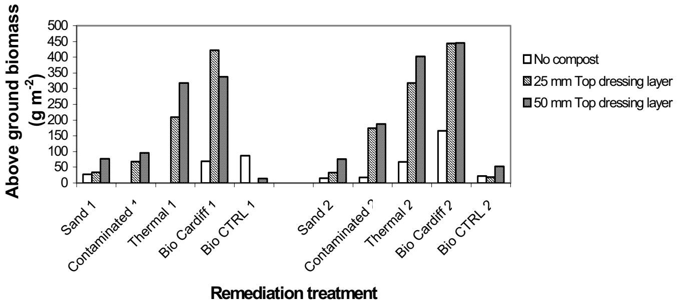

Figure 2. Grass biomass after one growing season for a sandy soil grass mix (1) and a clay soil grass mix (2). For further explanation of treatments, see text. Bars = least significant difference.

The results for above-ground grass biomass (Figure 2) showed that for the sandy soil grass mix there was a significantly greater yield from the BioCardiff material than on other materials ($p \le 0.05$) and yield from the thermally remediated material was significantly lower than all other treatments ($p \le 0.05$). Compost addition had a significant effect on all treatments, but at the high rate produced no further significant increase in yield. Yields were significantly greater using the clay soil grass mix ($p = 0.004$) and adding compost at the low rate produced a significantly higher above-ground biomass on thermally remediated soil. The BioCardiff soil produced the greatest above-ground biomass with all compost treatments, but the control and BioCTRL soil showed no significant change. There was no additional benefit from adding compost at the high rate.

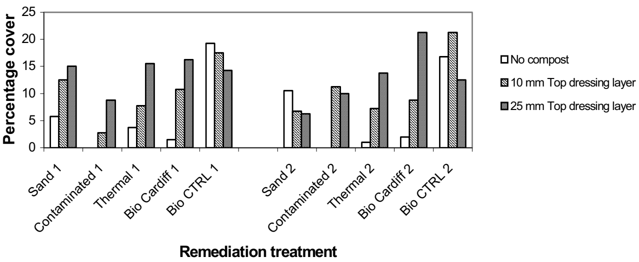

Figure 3. Percent wildflower ground cover for a sandy soil mix (1) and a clay soil mix (2) after one growing season. For further explanation of treatments, see text. Bars = least significant difference.

Wildflower cover on both soil mixes (Figure 3) was significantly lower on the contaminated soil compared to any of the other soil treatments ($p \le 0.05$) and was significantly greater on the BioCTRL soil. ($p \le 0.05$). Adding compost to the soils significantly improved growth for both mixes ($p \le 0.001$), and without it, there was no wildflower growth on the contaminated soil for either mix. Only the thermally remediated material and the BioCardiff soil benefited from additional compost treatment to enhance wildflower cover with the clay soil wildflower mix.

Review of remediation techniques

A questionnaire survey mailed to over 2000 recipients revealed important UK experience in using remediated soil materials for soft-end use, notably those from bioremediation, soil washing and soil vapour extraction. For each major remediation process, evidence is being gathered to allow a better understanding of the effects on principal soil properties (physical, chemical, biological), and thus the limitation(s) of these materials to promote vegetation growth. Using results and experience gained from the experimental work, together with expert opinion from practitioners and published research, a matrix of information has been assembled which attempts to ‘bridge the gap’ between the considerations of the remediation engineer concerned with reducing contaminant exposure and the plant ecologist or landscape architect who needs to establish vegetation on remediated materials. Table 2 is an example of a small part of this WP F output, which is still under development.

Table 2. Effect of selected remediation technologies on some important soil properties.

Technique	pH	AWC	Nutrients	Organic Matter
Thermal desorption	pH raised as base cations released from organic matter. This can lead to the binding up of any P that is left and non availability of micronutrients such as Fe, Mn, Zn and Cu	Available water capacity will be reduced due to the absence of OM and reduced pore size.	Most major nutrients either mineralised or destroyed, in particular N	Loss of organic matter leading to poor soil structure, nutrient retention and reduced AWC
Bio-remediation	pH may not necessarily be affected but the correct pH is vital for microbial activity. Below about pH 6 the microbial activity is curtailed so low pH substrates need to be amended to raise the pH.	As microbial and faunal activity proceeds then OM will be created and soil fauna such as earthworms will increase. This should lead to improved available water capacity.	Bacterial activity, such as nitrogen fixation will improve N levels. However, bacteria degrading contaminants may require more nutrients than are available, especially N. Nutrient levels may have to be supplemented for bacterial activity to be optimised.	Organic matter will increase over time through microbial activity and possible faunal activity, but will depend on the time the soil spends being bio remediated.
Chemical extraction	If acidic solvents used then pH may drop considerably. Below 5.5, nutrient availability is restricted and bacterial activity curtailed. Low pH will destroy clay mineral structure and organic matter. Cation leaching will increase. At low pH, compounds are in a reduced state which can increase toxicity.	If soil structure is destroyed by strong REDOX acidic or organic reagents then AWC will be reduced through the collapse of pore space and size.	If the soil becomes acidified by the reagents used then nutrient availability will be reduced. There will also be increased loss through leaching as nutrient cations such as P, K and Ca become displaced and solubilised by H^+.	Organic matter can be reduced as it is destroyed by decreasing pH and by the use of organic solvents.

NOVEL SPECIAL-PURPOSE COMPOSTS (WORK PACKAGE K)

Work under this work package also concentrated on nursery research, using rye grass (*Lolium perenne*) and poplar (*Populus trichocarpa*) as vegetation indicators. Heavy metal (mainly zinc and cadmium) contaminated soil and a low contaminated soil from Avonmouth were treated with different composts at 4 levels (0, 7, 14, 20% compost). The tested composts were: compost produced from sewage sludge or green waste, both composts treated by addition of bentonite or zeolite at four levels (0, 7, 14, 20% of the weight of the compost).

Contamination had a profound effect on both plant indicators. However, the addition of compost did not show a uniform result. Rye grass performed clearly and significantly better in soil treated with sludge compost while poplar had a significantly better performance in soil treated with green waste compost. For low contaminant level soil no significant effect of compost addition was observable for poplar while rye grass obtained a better height in soil treated with sludge compost but a lower biomass in soil treated with green waste compost. For both plants an increase in the compost addition to low contaminant level soil resulted in a lower biomass. Disappointingly, little effect was observed for the addition of minerals to the composts. Biomass and water consumption of rye grass growing in soil treated with sewage sludge compost significantly improved with zeolite addition, but there were no effects with bentonite.

FUTURE PLANS

Work Package F

The nursery experiments will continue for at least one more growing season; current work on this research component will focus on assembling and analysing soil, soil water and plant tissue chemistry data. The major part of 2005 will be spent in examining the interactions between remediation and greening at a field scale, concentrating research at six selected study sites in the SUBR:IM portfolio. Research will examine the nature of the greening projects at these sites, and how they can be evaluated in terms of 'sustainability criteria'. The quality of the greening projects will also be assessed, and the environmental and social benefits scoped.

Work will continue on a PhD entitled 'Use of charcoal for the in situ remediation of contaminated land' in association with the University of Surrey.

Work Package K
Further compost-mineral mixtures for the treatment of heavy metal contaminated soils will be tested using nursery trials and leaching tests, on a wider variety of polluted soils. Magnetic Resonance Imaging (MRI) will be used to study metal uptake and compartmentalisation into plants using hydroponically grown plants.

DISCUSSION

Our results so far have shown that products of *in situ* remediation technologies can be transformed into 'soils' with suitable amendment with organic materials taken from the waste stream. Taken together, the preliminary results of the two nursery experiments suggest that various forms of vegetation can be established on a range of contaminated substrates or remediated contaminated materials. Amelioration with composts can be beneficial, but it is important to match type and amount to the substrate and vegetation type. Addition of specific minerals (bentonite, zeolites) seems to have little direct effect on plant growth, but further work will elucidate how effective these components have been in adsorbing heavy metal contaminants, and reducing loss in leachate. Considerable chemical analysis is planned during 2005, but the first year has been valuable in establishing that given appropriate amelioration, vegetation can be grown comparatively successfully on a range of remediated materials.

These results could present major implications and cost benefits to the remediation and landscape engineering industries in terms of minimising the amount of pre- or post-remediation material needing to go to landfill. Furthermore our results may create an outlet to both local authorities and the waste industry for utilising waste materials within remediation and reclamation processes and so could contribute strongly to waste recycling targets. The questionnaire survey identified that the majority of environmental consultants are most concerned with the cost of remediation, the required duration of the remediation, the operation window and residual liabilities. We will attempt to consider what the industry's attitudes to reusing materials are when taken against such strong opinion.

We feel we have made good progress but there are many questions yet to be answered. We are yet to investigate what the main barriers and drivers to successful greenspace development on brownfield sites are. Our 2005 field survey campaign will enable a technical appraisal of remediation and greening practices. We also have plans to assess public usage of urban greenspace and compare these to development and management costs. We are amongst the first to recognise the wider public benefits of greenspace establishment especially within urban areas in terms of environmental quality, urban biodiversity, noise and air pollution abatement, flood control, public health and levels of inward investment etc. We are keen to attract further research funding to examine these when considered at the strategic planning level for schemes such as the Thames Gateway Green Grid.

A take home message which hasn't come from statistical interpretation or good experimental design is that the remediation industry as a whole is exceptionally keen to collaborate. We feel that above all of the other results this demonstrates the combined will of the industry to develop sustainable solutions through integration of technologies.

Acknowledgements
This research was undertaken by Geoffrey Sellers (WP F) and René van Herwijnen (WP K), under the management of Abir Al-Tabbaa and Mike Johns (University of Cambridge), Tony Hutchings and Andy Moffat (Forest Research) and Sabeha Ouki (University of Surrey).

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Mr. Michael Harbottle

Michael Harbottle is a Research Associate at Cambridge University Engineering Department. After completing his M.Eng degree in at the University of Oxford, he worked for three years for Fugro Ltd, performing offshore site investigations and offshore installation design. He returned to the University of Oxford in 2000 to study for a D.Phil, in conjunction with the NERC Centre for Ecology and Hydrology (Oxford), and the title of his thesis is: 'The Use of Electrokinetics to Enhance the Degradation of Organic Contaminants in Soils'.

Ms. Sinéad Smith

Sinéad Smith is a PhD student at Cambridge University Engineering Department. She completed an M.Eng. in Civil Engineering, at the University of Edinburgh in 2002. She then spent a year in industry working with consulting engineers Mouchel Parkman, specialising in contaminated groundwater remediation scheme design, before returning to academia to study for a PhD.

SUBR:IM

SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

Remediation

Technical Sustainability of Brownfield Land Remediation

Work Packages E and I

Michael Harbottle and Sinéad Smith
Cambridge University Engineering Department

UNIVERSITY OF CAMBRIDGE

Are currently used remediation technologies sustainable?

- Reuse of land is a sustainable practice
- Impacts of remediation technologies can be significant…
- …but these aren't often considered

SUBR:IM

Objectives of Work Package E – Robust Sustainable Technical Solutions to Contaminated Brownfield Sites

- Assess and compare the sustainability of some currently used remediation technologies (using past remediation projects)
- Investigate potential improvements to these technologies through experimentation, concentrating on durability and long-term behaviour

SUBR:IM

Literature Review

- Increasing emphasis on wider effects (especially environmental) in current guidance (e.g. EA reports, CLR11) although unclear on transfer to industry
- Encouragement for bringing 'sustainability' into remedial option selection (e.g. CLARINET reports), although no consensus on how to go about this practically
- 11 case studies on assessment of remediation techniques have been identified.

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Sustainability Criteria

1. Future benefits outweigh cost of remediation
2. Environmental impact of the implementation process is less than the impact of leaving the land untreated
3. Environmental impact of the remediation process is minimal and measurable
4. Timescale over which the environmental consequences occur, and hence intergenerational risk, is part of the decision-making process
5. Decision-making process includes an appropriate level of engagement of all stakeholders

SUBR:IM

Sustainability Assessment Method

- Criterion 1: Multi-criteria analysis (MCA) – based on EA method

Category	Criterion	Onsite, during		Offsite, during		Onsite, after		Offsite, after		Category weight	Category score
		Score	Criterion weight	Score	Criterion weight	Score	Criterion weight	Score	Criterion weight		
Global environment	Air quality (greenhouse gas)	-87	1	0	1	9	1	0	1	1	-83
	Use of natural resources	-5	1	0	1	0	1	0	1		
	Non-recyclable waste	0	0.8	0	0.8	0	0.8	0	0.8		

- Criteria 2-4: Examination of individual impacts

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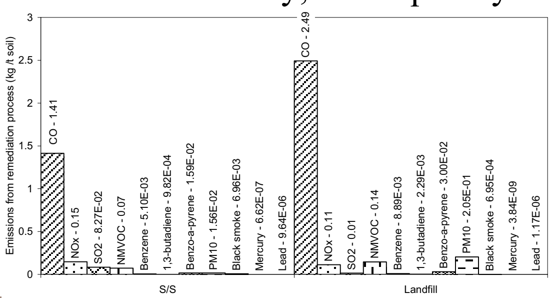
Case study – S/S vs. dig & dump

- Stabilisation/Solidification (S/S) and dig & dump (on the same site)
- MCA indicates that S/S performed better than dig & dump on criterion 1
- S/S also had less impact than leaving the land untreated (the 'no action' option)

SUBR:IM

Case study – S/S vs. dig & dump

- Relative impacts (criteria 2-4):
  - S/S emits more greenhouse gases, but produces less waste and uses less transport
  - Containment in both cases, but with S/S the soil is reused more effectively, more quickly



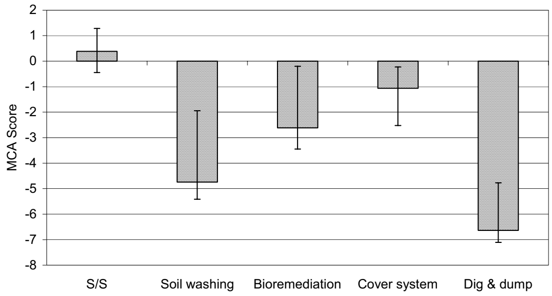
(Harbottle *et al*, 2005)

SUBR:IM

Case study – comparison of five technologies (preliminary results)

- S/S, soil washing, bioremediation, cover system and dig & dump (on different sites)
- MCA score indicates that S/S performs better under criterion 1

(although deleterious effect of offsite disposal in all but S/S)



SUBR:IM

Case study – comparison of five technologies (preliminary results)

- Relative impacts (criteria 2-4):
  - S/S : low transportation, low waste production, but high greenhouse gas emissions and energy consumption
  - Soil washing: high emissions, high energy use
  - Bioremediation: low emissions, low material use
  - Cover system: low waste production, low duration, low material use
  - Dig & dump: high transportation, high material use, high waste production

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Laboratory and site work

- Stabilisation/solidification
  - Properties of novel cements
- S/S with bioremediation
  - Encouragement of biodegradation within solidified matrix
  - Use of novel cements combined with addition of nutrients and other additives

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Laboratory and site work

- Barrier walls
  - Use of innovative materials to improve durability
- Deep soil mixing with bioremediation
  - Soil mixing to encourage biodegradation at depth
- Site trials in Thames Gateway

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WP E and WP I – durability of remediation

- Both WP E and WP I address long-term performance and durability
- An important aspect of long-term performance and durability is the potential impact of a changed climate
- Adaptation of current remediation methods may be required

SUBR:IM

Objectives of Work Package I – Impact of Climate Change on Pollutant Linkage

- Quantify the short- and long-term impact of climate change on contaminated land and containment systems, through experimentation (CUED)
- Evaluate the effect of climate change on pollutant linkage (FR)
- Develop any required adaptation design strategies (BRE)
- Examine adaptive response of key brownfield stakeholders (CEM/UoR)
- Integration into guidance document

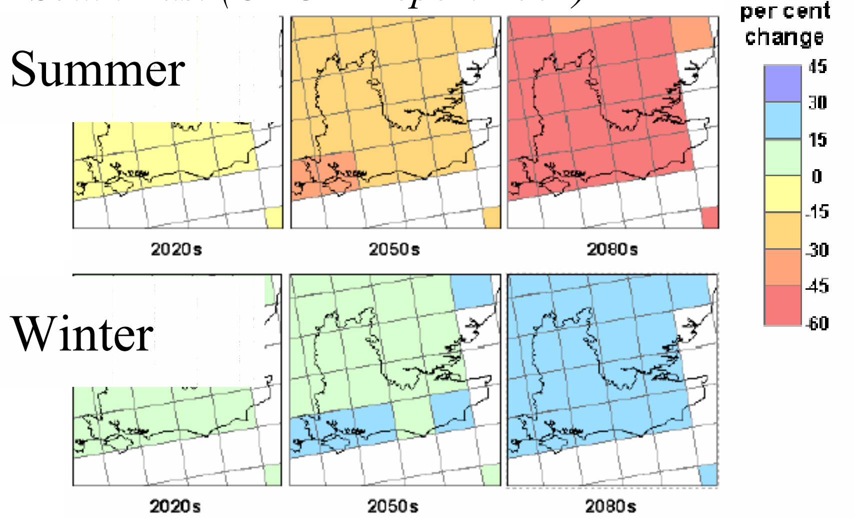
SUBR:IM

Changes to the UK climate

- UK Climate Impacts Programme has produced climate scenarios for the 21st century
  - Hotter, drier summers
  - Warmer, wetter winters
  - Increased storminess, heavier rainfall
- Increased risk of pollutant linkages forming

SUBR:IM

Changes to seasonal precipitation in the South East (UKCIP Report 2002)



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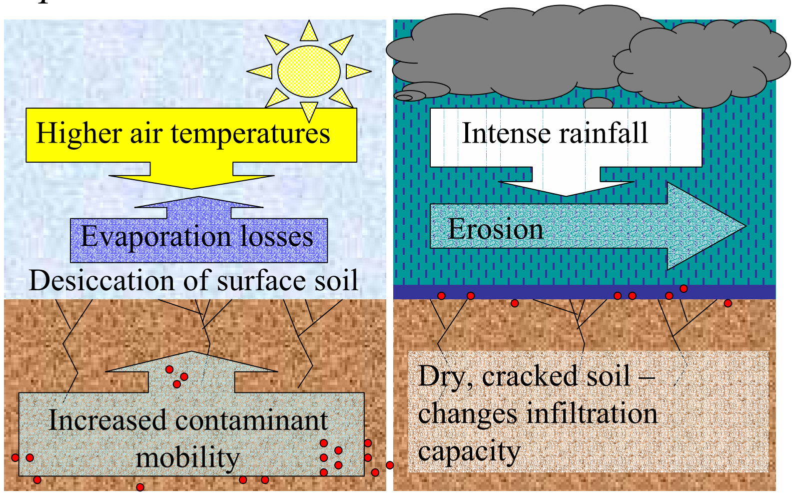
Impacts

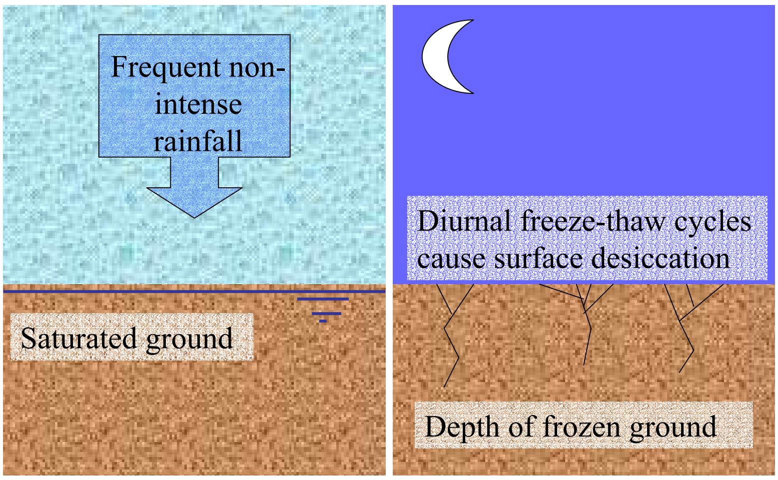


Hot dry weather

Infrequent, intense rain storms

SUBR:IM

Impacts

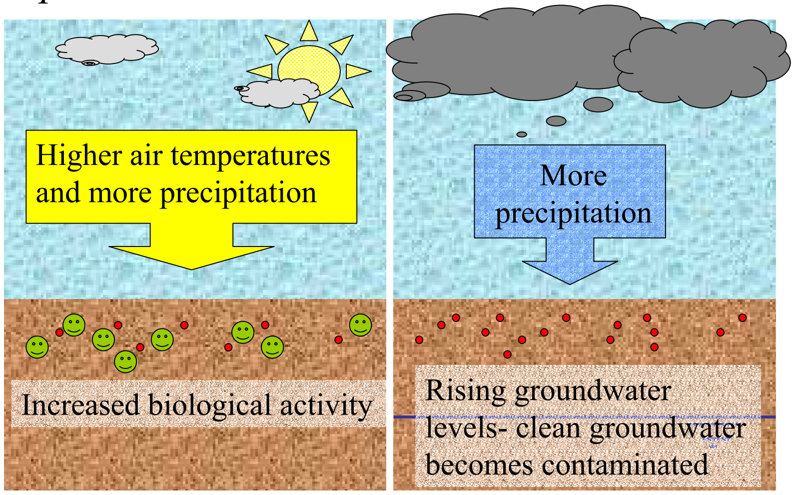


Warm wet weather

Diurnal freeze-thaw cycles

SUBR:IM

Impacts



Warm wet weather   Fluctuating groundwater

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Impacts on contaminated soils and containment systems

- Both positive and negative impacts are expected
- Net result depends on magnitude of impact and severity of climate conditions
- Aim of investigation:
  - Identify the most damaging climate scenarios
  - Apply scenarios to contaminated soils and containment systems
  - Hence develop any required adaptation design strategies

SUBR:IM

Lab work – climate scenarios

- Temperature extremes
  - Summer: 2050 (27°C) and 2080 (31°C)
  - Winter: 2050 (0°C) and 2080 (2°C)
- Precipitation
  - Summer: no rainfall, infrequent high rainfall, frequent low rainfall
  - Winter: saturated conditions (i.e. flooding)
- Cyclic wet-dry and freeze-thaw conditions

SUBR:IM

Lab work – soils and containment systems

- Real contaminated site soils
- Typical low-permeability cover system
  - Compacted sand-bentonite
  - Compacted clay
- Stabilised/solidified contaminated soil
- Soil from a bioremediated site
- Contaminated soil remediated with combined immobilisation (with compost-zeolite binder) and bioremediation (bioaugmentation)

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Lab work – short- and long-term scenarios

- Short-term scenario: 2 years of extreme conditions in real time
  - Site and model soil
  - Soil aged to 2050 and 2080
  - Various accelerated ageing methods used depending on system
- Long-term scenarios: applied during accelerated ageing process
  - Samples aged by approx. 15 years in 6 months
- Analysis of samples for physical, mechanical, chemical and biological properties

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Conclusions

- WP E and WP I both aim to improve understanding of sustainability
- WP E aims to find ways to reduce impacts of remediation techniques and addresses their long-term performance
- WP I is investigating impacts of climate change and any adaptation measures required

SUBR:IM

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SUBR:IM

Technical sustainability of brownfield land remediation

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ABSTRACT

The work presented in this paper relates to two work packages within the SUBR:IM consortium namely, Work Package E: Robust sustainable technical solutions to contaminated brownfield sites and Work Package I: Impact of climate change on pollutant linkage. WP E uses information on previous remediation projects to develop an assessment of the sustainability of a number of commonly used remediation techniques. WP I investigates the impacts of climate change on contaminated land and containment systems and examines any adaptation strategies required. Experimentally both work packages address the issue of long-term performance and durability in order to provide the much lacking information on this aspect of the sustainability of remediation techniques. The outcome of both projects will be to develop a better understanding of the sustainability of remediation techniques and to contribute to future remediation projects.

INTRODUCTION

The process of remediating contaminated land is usually considered to be sustainable, as it allows the recycling of land and the redevelopment of previously derelict sites. However, a study of the potential impacts of remediation technologies in use today would indicate that this is not necessarily the case, as the technologies themselves can and do have significant impacts environmentally, socially and economically. Aspects of sustainability are increasingly being taken into account when a remediation technology is being considered for use. These relate particularly to environmental and technical aspects for which information is available. For example, the Environment Agency has produced guidance on the selection of remediation methods which allows the inclusion of effects on soil, water, air and ecosystems/habitat due to the remediation process (Postle *et al*, 1999). The inclusion of all potential impacts in an integrated assessment process is rare, however, although tools to perform integrated assessment are emerging (Pollard *et al*, 2001).

There is, however, a lack of knowledge on the relative and actual sustainability of different remediation technologies. Jefferis (2002), for example, points out that although certain techniques (such as disposal to landfill) are considered to be less sustainable than others (such as process-based methods), there has been insufficient investigation to validate this. A lack of information on the performance of remediation technologies, however, means that it is often difficult to properly assess the impacts that might occur when a technology is used. Therefore, Work Package E is investigating past remediation projects, for which the largest volume of information is likely to be available, in order that their sustainability and relative sustainability might be assessed and hence the potential impact of various remediation techniques might be assessed in future projects.

A particular lack of information exists regarding the long-term performance and durability of remediation methods, especially containment systems where contamination remains in the ground. Where contamination is not removed, there remains the risk for releases of contamination to develop over time despite the installation of durable containment systems. The durability of remediation is a particular focus of both WP E and WP I. WP E is concentrating on the robustness of a number of remediation techniques, in particular stabilisation/solidification, while WP I is studying the potential effects of climate change on contaminated land and a number of containment systems including cover, barriers and stabilisation/solidification systems. The impact of climate change represents one aspect of the sustainability of brownfield remediation; and is probably the aspect about which the least information is available.

OVERVIEW OF WORK PACKAGE E: ROBUST SUSTAINABLE TECHNICAL SOLUTIONS TO CONTAMINATED BROWNFIELD SITES

The objectives of Work Package E are (i) to carry out an assessment of the sustainability of currently used remediation technologies, based on information from previous remediation projects, enabling the relative sustainability of the different techniques to be determined, and (ii) to carry out laboratory and field experiments to further our understanding of the sustainability and robustness of a number of remediation techniques, highlighting improvements that can be made to remedial solutions. The assessment of the sustainability of remediation technologies has been based on five criteria:

- Criterion 1: Future benefits outweigh cost of remediation.
- Criterion 2: Environmental impact of the implementation process is less than the impact of leaving the land untreated.
- Criterion 3: Environmental impact of the remediation process is minimal and measurable.
- Criterion 4: The time-scale over which the environmental consequences occur, and hence inter-generational risk, is part of the decision-making process.
- Criterion 5: The decision-making process includes proper engagement of all stakeholders.

Criteria 1 to 4 are addressed in Work Package E, which deals with the technical and environmental impacts of remediation. Criterion 5 is being addressed as part of the SUBR:IM social science work packages.

A methodology has been developed which allows the comparison of remediation technologies in terms of their impacts. This currently focuses largely on technical and environmental aspects. The methodology includes two techniques which present the information in different ways. The whole impact of remediation (criterion 1) is investigated using a multi-criteria analysis (MCA) technique based on that presented by Postle *et al* (1999), which scores and weights a number of sub-criteria to develop an overall score for each remediation technology. The basic method has been expanded for the purposes of assessing sustainability, with additional sub-criteria included and scores developed both for the remediated site and also other sites involved (such as landfills, borrow pits etc). In tandem with this, a non-aggregative method has been used for criteria 2 to 4, where impacts are highlighted individually (as used by Blanc *et al*, 2004). Both techniques have been undertaken with a life cycle analysis approach, in that as far as is possible, impacts that occur due to all aspects of the remediation, whether on or off site, during or after remediation, have been taken into account. This method is described in more detail in Harbottle *et al*, 2005, which also describes the comparison of the impacts of two remediation techniques, stabilisation/solidification (S/S) and excavation and offsite disposal on the same site. In brief, the analysis indicates that S/S has less impact overall (based on the MCA analysis), but is not always the better performer, having greater impacts in categories such as greenhouse gas emissions. An example of the comparison of the two techniques in terms of emissions is given in Figure 1. Further studies are in progress, comparing different remediation projects i.e. different remediation techniques on different sites. Although the methodology has been designed only for use within this research work, it is expected that the output will be of use through the presentation of information on the potential impacts of remediation technologies, which will be of interest during the selection process for future remediation projects.

Experimental (laboratory and site) work has recently commenced with the aim of developing improvements on a number of currently used remediation technologies that would help to reduce impacts on sustainable performance. We are focussing on four different areas, chosen based on the experience within the research team:

- Stabilisation/solidification and the use of more sustainable cements.
- A combination of stabilisation/solidification with biodegradation, in order to improve the robustness of the former technique by allowing degradation to occur whilst contaminants are contained.
- The use of innovative materials in in-ground barrier walls.

- Enhancement of biodegradation of contaminants at depth using deep soil mixing techniques.

The laboratory work is concentrating on the robustness and long-term effectiveness of specific aspects of those four remediation techniques. A robust technique is defined as being insensitive to small change, has a small risk of failure and is durable. The long-term effectiveness is assessed using techniques of accelerated ageing. A site trial is currently being planned to take place at the Dagenham Dock site. The trial will address many of the issues investigated in the four techniques listed above. It is planned that coring of site samples will continue over a number of years.

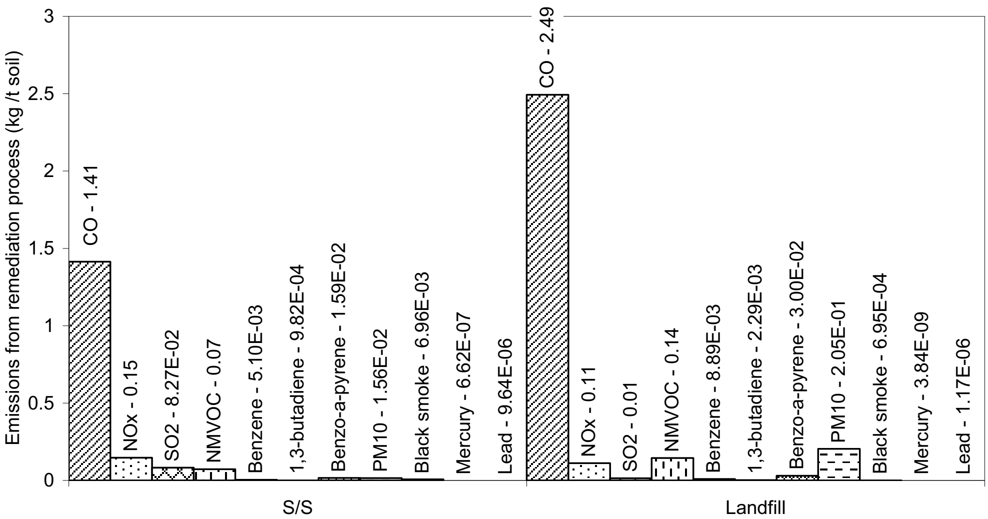

Fig 1. Comparison between emissions from S/S and landfilling (Harbottle *et al*, 2005).

OVERVIEW OF WORK PACKAGE I: IMPACT OF CLIMATE CHANGE ON POLLUTANT LINKAGE

To meet the requirements of sustainability, the regeneration of brownfield land must take account of predicted climate change impacts. Although the precise causes of climate change remain disputed, adaptation of society to climate change impacts will be required (IPCC, 2001). The UK Climate Impacts Programme (UKCIP) has produced climate scenarios for the 21st century in the UK, predicting warmer and wetter winters, hotter and drier summers, rising air temperatures, increased storminess and heavier rainfall (Hulme et al., 2002). The predicted changes to seasonal average precipitation in the South East in the 2020s, 2050s and 2080s are shown in Figure 2. These factors will contribute to an increase in the risk of significant pollutant linkages forming. Sources of contamination, which currently pose little risk to the environment, are likely to become significant in the future. Climate change may require changes to be made in current adaptation strategies for contaminated brownfield sites.

Severe weather conditions are known to have a damaging effect on soils and containment systems. The potential impact on containment systems, e.g. landfills, barriers, cover and S/S systems, is large. Similarly, there are significant potential impacts for any ground contamination, particularly shallow, for example untreated contaminated brownfield sites. In summer, the hot dry weather will cause ground temperatures and evaporation losses from the land surface to increase, causing the soil to crack causing upward capillary suction of water from depth and an increasing risk of exposure of contaminated materials at the ground surface. In addition, summer rainfall will be more likely to occur as infrequent but intense rain storms. Higher intensity rainfall will challenge soil infiltration capacity and increase the risk of soil erosion and particulate spread of contamination. Higher ground temperatures may also increase the mobility and volatility of certain organic contaminants in the ground. In winter, there may be a seasonal rise in groundwater level which may bring clean groundwater in contact with ground contaminants. It has also been suggested that the warmer winter weather will become more cyclic due to diurnal temperature variations around freezing point.

Freeze-thaw cycling is a particularly damaging phenomenon and the hydraulic conductivity of clay can increase by several orders of magnitude after a small number of freeze-thaw cycles (Daniels et al., 2003). Many contaminated sites and containment systems support vegetation, such as trees and wetlands. Ecosystems are sensitive to extremely small climatic variations (IPCC, 2001). It will therefore be necessary to examine the impacts of climate change on both the soils and the vegetation; which will itself be subject to change. The net results of the negative and positive factors will depend on the magnitude of the impact and the severity of the climate change conditions. The study attempts to identify the most damaging climate scenarios that can be anticipated during the design life of a remediated site and to apply these scenarios to investigate the actual sustainability of remediated sites while accounting for the impacts of climate change.

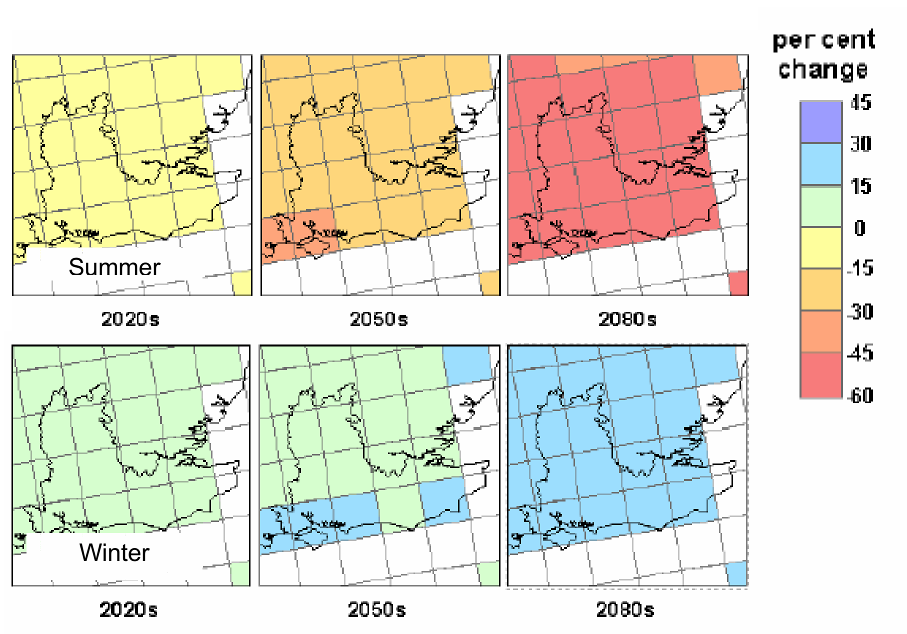

Fig 2. Change in seasonal average precipitation in summer and winter in the South East in the 2020s, 2050s and 2080s compared to the 1961-1990 average (after Hulme et al., 2002).

The objectives of WP I are:

1. To quantify the short- and long-term impact of climate change on contaminated land and containment systems
2. To evaluate the effect of climate change on pollutant linkages
3. To develop any required adaptation design strategies
4. To examine the adaptive response of key brownfield stakeholders
5. To integrate the outcome into a guidance document on the likely effects of climate change on brownfield remediation

Objective 1 is currently being addressed. Objectives 2 to 4 will shortly be addressed by the partners in the work package namely, Forest Research, BRE and University of Reading/College of Estate Management respectively.

Objective 1 involves evaluation of impacts of climate change on contaminated land and a number of containment systems from 2005 to 2080, using the climate prediction data produced by UKCIP (Hulme et al., 2002). The climate change conditions being applied include: (i) temperature for 2050 and 2080 summer extremes (27° and 31°C respectively) and winter extremes (2°C and 0°C respectively), (ii) a range of summer precipitation scenarios, including dry (no rainfall), frequent low rainfall and infrequent high rainfall scenarios, and saturated winter conditions (which also simulates flooding) (iii) cyclic behaviour around freezing point and (iv) wet-dry cycles. The systems currently being addressed include: (i) real contaminated site soils, (ii) typical cover system low permeability layer using both compacted clay and a sand-bentonite composition, (iii) a stabilised/solidified contaminated site soil, (iv) soil from a bioremediated site and (v) a contaminated soil remediated with combined immobilisation (with a compost-zeolite binder) and bioremediation (using bioaugmentation).

These systems are being subjected to short- and long-term climate change conditions. The short term includes two years of extreme climate conditions as detailed above applied in real time. The same conditions are also being applied to samples aged to 2050 and 2080. Different accelerated ageing techniques are being employed depending on the system being tested. Long-term climate change scenarios are being applied to samples during the accelerated ageing process. Samples are being aged by around 15 years in 12 months. Samples from the tested systems are then tested for their physical, mechanical, chemical and biological properties.

CONCLUSIONS

Both Work Packages E and I aim to improve our understanding of factors which affect the sustainability of a number of remediation methods; the former by suggesting ways of reducing the impacts of the techniques, as they are currently performed, and addressing the long-term performance and robustness of a number of remediation techniques and the latter by understanding the impact of climate change on contaminated land and containment systems and investigating any adaptation strategies required in the design of those containment systems.

ACKNOWLEDGEMENTS

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Biographical Note

Mr. Simon Talbot

Simon Talbot has been director of the Greater Manchester Geological Unit (GMGU) since 1998, specialising in engineering & environmental geology, contaminated land, reclamation, minerals & waste planning, and project management. He has a BSc in Geology from the University of Manchester, and an MSc in Engineering Geology, from the University of Leeds. He is a Chartered engineer and Fellow of the Geological Society, with extensive experience gained in the UK and overseas in mineral exploration, geotechnical and geo-environmental site investigations, foundation design, land reclamation, contaminated land remediation, ground stabilisation, minerals and waste planning. He also has active interests in undergraduate, post-graduate, CPD training, and contaminated land remediation research.

SUBR:IM SUSTAINABLE URBAN BROWNFIELD REGENERATION: INTEGRATED MANAGEMENT

Remediation

Acid tar lagoons: risks and sustainable remediation in an urban context

Simon Talbot

Legislative compliance

- **Part II A of the Environmental Protection Act 1990**
- **LAs duty to inspect and identify contaminated land**
- **Special sites**
- **EAs regulatory duties**

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Acid Tar Lagoons - introduction

- **"Special Site" under Part II A.**
- **Acid tars are waste residue of petrochemical processes - a complex mixture of hydrocarbon, sulphuric acid and water, mixed with co-disposed materials.**
- **Acid tars are acidic (pH<2), viscous, and of greater density than water (~1050-1440 kg/m^3).**
- **Major contaminants: PAHs, phenols, benzene, toluene, xylene (BTEX), acid heavy metals and sulphate.**

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Acid Tar Lagoons - introduction

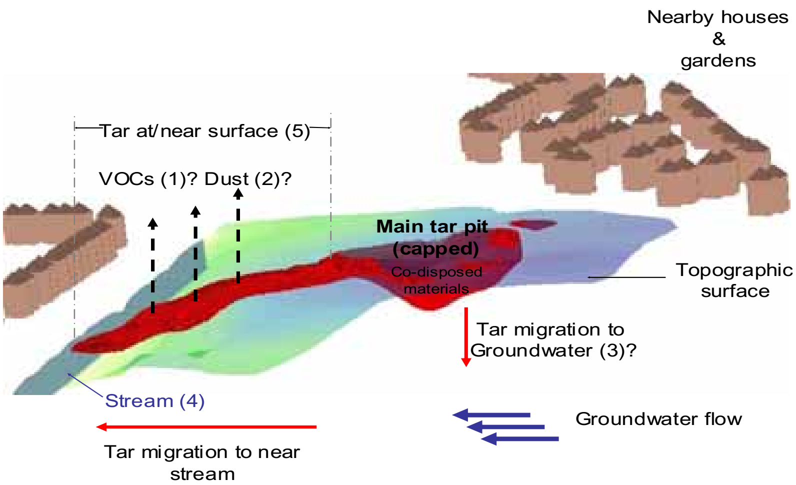
Historically, tars were dumped in worked out quarries, clay or gravel pits --- Acid Tar Lagoons.

SUBR:IM

Acid Tar Lagoons - introduction

•**Problems: fluidity lead to bulk tar migration through fissures and weathering at exposed surface.**


Acid Tar Lagoons – 3D model



Acid Tar Lagoons – risks

Label	Environmental risks	Examples of contaminants involved (anticipated)	Receptor
1	Volatiles from liquid tar (significantly exacerbated if tar is disturbed)	Benzene, sulphur dioxide	Site users, residents of adjacent properties
2	Dust blowoff from exposed and weathered tar surfaces	PAHs, lead	Site users, residents of adjacent properties
3	Subsurface contaminant leaching from tar into groundwater	Sulphuric acid, heavy metals, phenol	Groundwater, major/minor aquifer
4	Leaching from tar into surface water (e.g. water ponding over tar body, or migration of tar into a stream)	Sulphuric acid, heavy metals, phenol	Nearby water course
5	Direct contact with tar migrating out of contained (e.g. fenced or capped) site.	Acid burns, ingestion of PAHs, lead,	Site users, residents of adjacent properties

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Acid Tar Lagoons – Samples of risks

Volatiles from liquid tar

SUBR:IM

Acid Tar Lagoons – risks

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1	Volatiles from liquid tar (significantly exacerbated if tar is disturbed)	Benzene, sulphur dioxide	Site users, residents of adjacent properties
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Acid Tar Lagoons – Samples of risks

Dust blowoff from exposed and weathered tar surfaces

SUBR:IM

Acid Tar Lagoons – risks

Label	Environmental risks	Examples of contaminants involved (anticipated)	Receptor
1	Volatiles from liquid tar (significantly exacerbated if tar is disturbed)	Benzene, sulphur dioxide	Site users, residents of adjacent properties
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Acid Tar Lagoons – Samples of risks

Leaching from tar into surface water

SUBR:IM

Acid Tar Lagoons – risks

Label	Environmental risks	Examples of contaminants involved (anticipated)	Receptor
1	Volatiles from liquid tar (significantly exacerbated if tar is disturbed)	Benzene, sulphur dioxide	Site users, residents of adjacent properties
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5	Direct contact with tar migrating out of contained (e.g. fenced or capped) site.	Acid burns, ingestion of PAHs, lead,	Site users, residents of adjacent properties

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Acid Tar Lagoons – Samples of risks

Direct contact with tar migrating out of contained site

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Stakeholders- internal

In the know but divorced from full effects

- **Site owner/s**
- **Local Authority.**
- **Environment Agency**
- **Health protection agency/Primary care trust**
- **Health and safety officers**
- **Restoration consultants**
- **Restoration contractors**

- **Researchers**

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Stakeholder- external

Subjected to effects but invariably not fully informed and with reduced influence

- **Local politicians**
- **Media**
- **Local community**
- **Wider community**

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Assessing risk to human health

- Development of conceptual model
- Hazard identification
- Risk estimation
- Risk evaluation

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Risk assessed versus risk perceived

- Public perception of risk at odds with professional
- Over-estimation of risk- fright factors
- Underestimation of risk- familiarity

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Acid Tar Lagoons remediation options

Options include:

- Engineered cap
- Stabilization/solidifcation
- Removal and treatment for use as fuel
- Do nothing
- Full containment
- Restrict access to site

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Issues affecting local residents:

1)Removal based techniques: release of volatiles, odour, transportation issues.

2)On-site treatment: treatment plant, emissions, transportation issues.

3)Stabilization/solidification: transportation issues, import of material and significant volume increase in the final lagoon site.

4)Simple fencing off: loss of amenity for residents, does not lower the risk of dust blow off and vapours.

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Risk communication- why

- Public have a legal right to know
- Familiarity lowers perception of danger and unfamiliarity increases perception of danger
- Public participation in remediation process (Århus Convention)

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Risk communication- how

- Overcome low trust in agencies
- Informed
- Inclusive
- Transparent
- Avoid rhetoric
- Avoid alarm

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Integrating technical and socio-economic issues- risk assessment

- Site specific
- Precautionary principle
- Protect public from acute risk
- Warn public of chronic risk

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Integrating technical and socio-economic issues remediation strategies

- Remediation process impacts on the public
- Plan for current and future end uses

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Conclusions

- **Appreciation and understanding of risk is increasing**
- **Sustainable remediation acceptable to all stakeholders requires a multi-disciplinary approach**

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Acid tar lagoons: risks and sustainable remediation in an urban context

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INTRODUCTION

This paper will explore the challenges posed by the deposition of acid tars in the urban environment. It will consider the broad legislative framework before examining the techno-scientific and human issues that arise in the process of remediating land contaminated by this by-product.

Part IIA of the Environmental Protection Act 1990 provides a legislative framework for the identification and remediation of contaminated land in England, Wales and Scotland. It imposes a duty on local authorities to inspect their areas to identify contaminated land. Statutorily defined contaminated land is only that which meets the source/pathway/receptor definition contained within the act. There is a certain sub section of contaminated sites which will be further designated as special sites for which the Environment Agency will be the regulator. These include certain water pollution, industrial and defence cases and the description of these is set out in the regulations. Acid tar lagoons are one such industrial activity that fall within the definition of special sites (regulation 2(1)(b) Contaminated Land (England) Regulations 2000).

Once a site is designated as statutory contaminated land (and then a special site) there is a requirement to inform the local community living adjacent to such sites or those who frequent the site. It is important that the regulator involves the local community in the decision making process as they are subject to the consequences of the decisions. Once designated the regulator will then ensure that the site is remediated thereby removing all identified risks so that the site is suitable for (re)use.

ACID TAR AND RISKS FROM ACID TAR LAGOONS

The remediation of acid tar lagoons raises significant techno-scientific challenges. The origin and nature of acid tars has been described previously (e.g. Smith et al. 2004, Talbot et al. 2004). In brief, acid tar is a waste residue of petrochemical processes which are now mostly abandoned. Acid tars are a complex mixture of hydrocarbon, sulphuric acid, and water typically mixed with a range of co-disposed materials. They are acidic (pH often <2) and viscous with black color and oily smell, and of greater density than water (~1050-1400 kg/m^3). The major contaminants within acid tar are PAHs, phenols, benzene, toluene, ethylbenzene, xylene (BTEX), acid, heavy metals and sulphate. Historically, a common disposal route has been to dump the tars in worked out quarries, clay or gravel pits, capped or opened. At first sight acid tars can appear relatively solid, but they are able to slowly flow significant distances (>20m) through fissures or on the surface. At exposed surfaces, the tar weathers into different forms, depending on temperature, moisture and other conditions. As geological, topographical, and environmental conditions differ from site to site, each site may present a specific environmental impact problem.

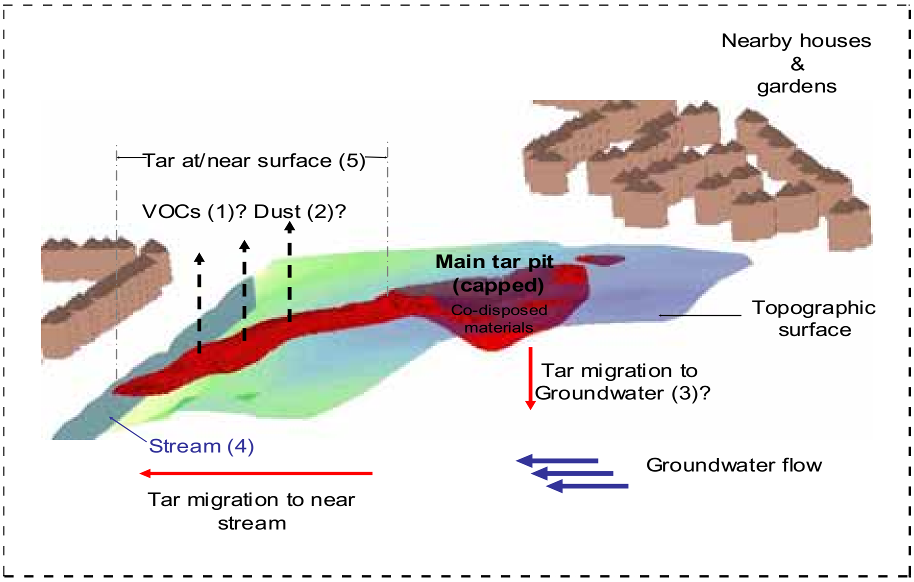

Fig.1. Study site acid tar body (label numbers refer to Table 1).

One of the study sites under investigation by the SUBR:IM project is a capped site located in North West England. Site investigation data has been collated to produce a 3D model of the tar body. A 2-D projection of this model is presented in Fig 1, and illustrates a range of environmental interactions of concern. It should be noted that in general the capping appears to be acting as a reasonably viable separating layer between the tar and the surface, however it has also pressurized the tar and caused it to migrate to the surface on at least one location and then slowly flow down-gradient in thin layers. The main risks, based on current levels of knowledge, are summarized in Table 1. However more data is needed concerning the properties and environmental behaviour of acid tars.

From the point of view of a local resident or site user, while the acid tar lagoon itself is not visible, the surface tar migrations can be seen but are fenced off and may look like weathered areas of an old tarmacadam surface. Odour is present but not usually to a significant degree. Contaminated dust blow-off or presence of weathered tar in adjacent parts of the site (due to construction/demolition works) is likely but will not generally be perceived. Data on ground and surface water contamination is as yet inconclusive.

Table 1. Principal risks associated with acid tar lagoons

Label	*Environmental risks*	*Examples of contaminants involved (anticipated)*	*Receptor*
1	Volatiles from liquid tar (significantly exacerbated if tar is disturbed)	Benzene, sulphur dioxide	Site users, residents of adjacent properties
2	Dust blowoff from exposed and weathered tar surfaces	PAHs, lead	Site users, residents of adjacent properties
3	Subsurface contaminant leaching from tar into groundwater	Sulphuric acid, heavy metals, phenol	Groundwater, major/minor aquifer
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5	Direct contact with tar migrating out of contained (e.g. fenced or capped) site.	Acid burns, ingestion of PAHs, lead	Site users, residents of adjacent properties

Assessing risk to human health
The standard methodological approach to a human health risk assessment from contaminated land follows four sequential stages:

a) Development of the Conceptual Model which discusses the sources of contamination (contaminants of potential concern) within the site, the location of the contaminants within the site, the pathways and the receptors.
b) Hazard identification, which provides an overview of hazards associated with contaminants identified in, or on, the site.
c) Risk estimation, as a site specific and activity specific numerical risk assessment. A conceptual exposure model provides time-weighted values for key parameters such as bodyweight, skin surface area exposed, specific activities including leisure activities, indoor and outdoor exposure levels, a full range of exposures associated with inhalation, ingestion and dermal contact. Both chronic and acute exposure will be considered.
d) Risk evaluation considers significant pollutant linkages, uncertainty in the source data and exposure and provides conclusions and recommendations.

In the case of acid tar lagoons, tar could migrate to adjacent areas outside of the site under consideration. Thus, humans could be exposed to soils, a hazard such as fire, or the aerial transport of contaminants from these adjacent areas. Any meaningful human health risk assessment needs to give due regard to the entire population affected by the tar.

Integrating these techno-scientific challenges with the aspirations and concerns of local stakeholders requires close collaboration between physical and social scientists.

Risk assessed versus risk perceived
Public perceptions of risk in the case of acid tar lagoons may be divergent from expected reactions and/or the professional assessment of risk. How the risks from contamination are perceived by the public is obviously of interest to those charged with managing contaminated brownfield sites. Not only are members of the general public stakeholders in the future development of a site, they bear most risk from contamination and their cooperation may be required in the remediation of the site and the mitigation of any risks from it.

A large body of research has shown that the public's perceptions of risk can often be at odds with professional assessments of risk. Additionally, even if the public assessment of risk, per se, matches an expert assessment of risk, the public reaction to that risk can be disproportionate with respect to their response to other comparable risks. Hence it is reasonable to conclude that we cannot predict the public's response to the risks of contamination by acid tar without investigation of the specifics of a particular site and the publics' involvement with it. Indeed acid tar presents factors which may cause the public to either over estimate or to under estimate the risks from contamination.

Will the risks from acid tar lagoons be over estimated by those living near-by? Bennett (1997) emphasises eleven 'fright factors' which make a risk more worrying and less acceptable to the public. These are if the risks are perceived:

1. to be involuntary (e.g. exposure to pollution) rather than voluntary (e.g. dangerous sports or smoking)
2. as inequitably distributed (some benefit while others suffer the consequences)
3. as inescapable by taking personal precautions.
4. to arise from an unfamiliar or novel source
5. to result from man-made, rather than natural sources
6. to cause hidden and irreversible damage, e.g. through onset of illness many years after exposure
7. to pose some particular danger to small children or pregnant women or more generally to future generations
8. to threaten a form of death (or illness/injury) arousing particular dread
9. to damage identifiable rather than anonymous victims
10. to be poorly understood by science
11. as subject to contradictory statements from responsible sources (or, even worse, from the same source).

Worryingly for those tasked with managing risk communication strategies, all eleven of these factors are potentially present in the case of acid tar contaminated brownfield sites.

However other factors may lead members of the public to make an underestimation of the risks from acid tar. Expert assessments of risk can be disregarded in situations where people feel able to make their own assessment of risk (for example that of using mobile phones while driving J. Richard Eiser & White, 2003). Although the public will by-and-large be unfamiliar with the chemical composition of acid tars and the risks associated with them (see Table 1), those who live in proximity to sites contaminated by acid tar may feel 'familiar' which it (cf. fright factor 4 in Bennett's list). Additionally, experience of risks with low probability and/or delayed effect– such as health effects caused by contamination- tends to produce an underestimation of the risk posed (Eiser, 2004; Hertwig, Barron, Weber & Erev, 2004). In this context acid tar can be seen, walked near, etc without any noticeable ill-effects. This experience could lead people to feel a need to disregard expert warnings of dangers from acid tar.

On a more positive note, nearly all of the 'fright factors' which may prompt a disproportionate reaction from the public can be moderated by the way risk from acid tar is communicated. Similarly, if familiarity has bred contempt for the risks of acid tar, education about its properties could alter the mental model people hold of the risks associated with it. This volatility in the outcomes of any risk communication attempt, combined with the general uncertainty about which direction the public response to risk may diverge from professional assessment, highlights the importance of assessing public feelings for the appropriate management of acid tar lagoons.

REMEDIATION OPTIONS

Remediation options for acid tar lagoons will seek to control the contamination linkages to acceptable levels, and will depend on which linkages are demonstrated to be currently unacceptable. Some UK sites appear to be relatively stable and 'do nothing' may be the preferable option. Other sites have more significant problems and intervention is required. Intervention may take the form for example of an engineered cap, full containment, stabilization/solidification, or removal and treatment for use as a fuel.

Full cost benefit analysis (including durability) is required for each option, and is beyond the scope of this paper to examine in detail. Instead some of the issues that would affect the local residents are outlined:

- Disturbance of the lagoon by tar removal or mixing is likely to result in significant release of volatiles. Odour may be a significant problem and capture and filtering of the vapours may be required to prevent atmospheric pollution.
- Removal and treatment may require on-site treatment plant with concerns over emissions and a significant number of heavy truck journeys through residential streets.
- Stabilisation/solidification may require a significant number of heavy truck journeys through residential streets to import material and a significant volume increase in the final lagoon site.
- Simple fencing off would be lowest cost, but would reduce scope for site use by residents. Weathered surface upwellings would still need to be controlled if risk of dust blow off was significant, or they posed a risk to trespassers.

RISK COMMUNICATION

Developing an integrated approach to dealing with acid tar lagoons requires effective communication strategies.

i. Why communicate "possible" risk to the general public?

The general public invariably has little understanding of the risks associated with contaminated land. Familiarity with risk lowers the perception of danger and because the risk of contaminated land is perceived to have arisen involuntarily, people expect lower levels of risk than for other forms of pollution or danger with which they may be more familiar.

Under Part IIA of the Environmental Protection Act 1990 the public have a legal right to all information on remediation notices. Individual rights of access to information under the Freedom of Information Act 2000 came into force across all public authorities in January 2005. Furthermore, the UN Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (The Århus Convention), which requires compliance by member states by February 2005, also includes the rights of citizens and environmental organisations to participate in environmental decision-making from an early stage.

ii. How to communicate to the public?

The public is concerned with perception and economics as much as with technical issues, they will invariably know more than the site owners, authorities and remediation agencies realise. Thus, the debate needs to be informed, inclusive and transparent. Failure to do so may result in distrust and prove counter-productive to the overall remediation effort. Whilst public trust in agencies is low, transparency and openness in communication is nevertheless an imperative and communicating risk to the wider public is much about getting people involved in the remediation process. The public must feel to be in control of the risk and issues such as property blight and lack of amenity can be at least as important to the public as health and safety.

DISCUSSION

The production processes from which acid tar was a by-product ceased in the UK in the mid 1980's but the legacy continues to pollute the environment and to pose a risk to human health. Our appreciation of risk is now greater than it used to be and current environmental legislation would not permit the disposal of material such as acid tars into open lagoons without prior treatment. It is clear that, particularly in instances when disposal sites are near to human habitation, progress is required in establishing the best practical technical solution and environmental option which will also protect the health and the concerns of the general public. Emissions released by hitherto popular 'remediation' methods such as mixing with quick lime or burning makes them no longer acceptable. The SUBR:IM project aims to link science and social science disciplines to tackle brownfield problems and the remediation of acid tar lagoons in the urban environment requires the integration of several disciplines within the project: robust technical solutions, multi-level decision making processes, risk communication and quality in remediation management. The challenge is to find sustainable remediation options acceptable to all stake-holders.

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