



# Policy integration for brownfield regeneration: An analytical tool

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## ABSTRACT

Fragmentation of policymaking within government structures and hierarchies can often impede the formulation and implementation of sustainable urban policy. This fragmentation is apparent in complex issues such as the remediation and redevelopment of brownfields. This paper addresses integration across multiple policy domains using brownfield regeneration as a vehicle. Building on the logic and principles of Environmental Policy Integration (EPI), we present a structured analytical tool (namely Policy Integration for Brownfields- PIB) to aid in a systematic analysis of brownfield policy across different regimes at different stages of policy development. We demonstrate the utility of PIB with examples from the USA, Europe, UK, Japan, and China to highlight the critical factors essential to ensure brownfield regeneration meets the overarching aim of making cities more sustainable. The findings suggest a need for balance between often conflicting environmental and non-environmental goals in multiple phases of brownfield policymaking and practice, both between levels of government (horizontally) and across sectoral interests (vertically).

## 1. Introduction

The organizational structure of government normally includes boundaries designed to focus policymaking and assist with complexity and pressures from wide-ranging interests. Whilst specific organizational frameworks can assist in problem definition and resolution, they are also a source of difficulties. Hence, the location of power and responsibility across multiple sectors and layers of government is of great significance in policymaking (Leiren and Jacobsen, 2018). Achieving United Nations Sustainable Development Goal (SDG) 11 (UN, 2015), to make cities more sustainable, poses particular policy challenges, given its multiple dimensions. A classic problem of governance derives from the existence of policymaking silos in the form of distinct departments with specific responsibilities, for example Health, Housing, Economic Development, Environment and Planning. These horizontal siloed departments tend to operate autonomously, and do not always share information or work collaboratively which often lead to policies that do not align or complement each other (Lægrend and Rykkja, 2014). The fragmentation of policy decisions resulting from organisational silos with differing sectoral interests, historical regulations, and jurisdictional structures can pose obstacles to the implementation of policy. To break down barriers across different policy areas, it is essential to establish

cooperative interaction between disparate administrative functions. Cross-sectoral domains such as finance and environment are prime examples.

The siloed nature of government may be viewed as a horizontal functional problem. When faced with multi-dimensional problems, particularly those relating to sustainability, a second problem of governance often derives from its hierarchical organisation, which may be viewed as a vertical integration problem. Distinct national, state/regional, and local levels of government are common in most countries and whilst local circumstances vary, policy integration, jurisdictional responsibility, resource allocation and political alignment are all areas where problems can occur. For example, in Australia, the recent COVID pandemic has highlighted the differing responsibilities, political attitudes and policy imperatives of federal and state governments (Downey and Myers, 2020). A third generalised problem of governance relates to policy focus. Often this may be discerned as a political reflection of right- and left-wing perspectives, with the right supporting liberal non-interventionist stances which focus on the private sector as the driver of economic development in contrast to a more socially oriented approach from left wing governments, who tend to view development in broader terms than simply economic. Cultural and economic contexts can also be important, with long held societal values playing an

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important role in determining where policy focus is placed (Bell and Oakley, 2014). For instance, as most developed world countries recognise that a shift away from high carbon fuels such as coal is critical for future sustainability, Australia, the world's largest exporter of coal, continues to argue for its production and use. Therefore, policy in different regions often differs in content and emphasis, despite addressing common global aims such as SDGs.

The problems outlined above are relevant in the formulation and implementation of sustainable urban policy. In particular, the fragmentation of policy involving separate departments with disparate objectives at different levels of governments can pose obstacles to the recycling of urban brownfields. The term brownfield has been widely used in academic literature and policy documents since the 1990s. At present, there are different interpretations of the brownfield concept worldwide which often leads to a misunderstanding of what sites may be categorized or not as brownfields (Jacek et al., 2022; Loures and Vaz, 2018). The United States Environmental Protection Agency (USEPA, 1996) first introduced the term brownfield as an abandoned, idled, or underutilised land that involves *“the presence or potential presence of a hazardous substance, pollutant, or contaminant.”* However, several countries, e.g. the UK, Germany and France, have labelled brownfield more broadly as a Previously Developed Land (PDL) that represents both contaminated and non-contaminated derelict land (Rey et al., 2022; Rizzo et al., 2015). In the light of this variation in definitions, for the purpose of this research, brownfield is discussed as *“previously developed land (excluding agricultural land) that is currently unoccupied or not in productive use and is known or suspected to be contaminated”*.

Brownfield sites often lie derelict for long periods as a result of low demand stemming from health concerns and high remediation costs. Over the past few decades, increasing importance has been attached to brownfield policy across different countries owing to the closure of polluting industries and growing marketability of land to increase housing supply (Dixon, 2007a; McCarthy, 2009; Adams et al., 2010; Sarni, 2009; De Sousa, 2021). The economic potential of these underutilised sites, accompanied by environmental, spatial, and social considerations demand a coordinated approach to land recycling across the brownfield policy arena. Brownfields are still not fully recognized for their potential for redevelopment, primarily because the ecological expertise is marginalized in the decision-making process (Cox and Rodway-Dyer, 2023). The polarity of motivations for site redevelopment, coupled with variances in the linkages between environmental and non-environmental domains are distinct when it comes to making decisions about brownfield development processes.

The economic potential of brownfields, accompanied by environmental, spatial, and social considerations demand a coordinated approach across various governmental departments with distinct sector-specific priorities. This paper contributes to the existing literature by developing a structured analysis tool, named Policy Integration for Brownfields (PIB). PIB is adapted from the concept of “Environmental Policy Integration (EPI)” to address policy areas that span multiple sectors and strategic goals. Originating in Europe in the late 1980s, EPI was developed as an effective approach to the development of area-oriented environmental policy in a range of political and scientific contexts. So far, no attempt has been made to articulate EPI in the context of brownfield regeneration. The PIB tool offers a way of interrogating brownfield policy and practice, regardless of political or regional context. The aim is to craft a framework for evaluating brownfield regeneration policies which is flexible and adaptable to changing circumstances. To test the efficacy of the tool, we examine five cases, namely the US, Europe, UK, Japan, and China. Each regime's approach to brownfields is viewed through the analytical lens of PIB. This approach allows insight into the challenges and opportunities facing different policy systems in addressing land recycling and reuse as part of achieving objectives set by SDG 11.

The paper is organized as follows. First, we review the existing literature on brownfield policy in different contexts. Drawing on this

review, we outline the key elements of a successful brownfield governance model with sustainable and resilient urban development (SDG 11) as the overarching goal. Following an explanation of the criteria for case selection and the data collection methods, we provide an overview of the theoretical lens through which the cases are analysed. Here we introduce the PIB tool and show how it has evolved from EPI. Building on this explanation, we then test the selected cases against the dimensions set out in the tool. This analysis allows us to conclude with some insights into brownfield policymaking. By this means, the paper underlines the pervasive problem of government silos, using brownfields as the vehicle to show how policy can be formulated and applied where there are multiple levels of hierarchy across multiple departments with sectoral interests.

## 2. Varying approaches to brownfields

Over the past three decades, brownfield policy has progressed in different countries with different emphases. Inner-city revitalization and public health protection represent two key themes (Syms, 1999; Nathanail and Bardos, 2005; Thornton et al., 2007; Alexandrescu et al., 2016; Pizzol et al., 2016; Limasset et al., 2018). Generally, brownfield regeneration policies aim at sustainable development with three strategic goals; (1) area based socio-economic regeneration, (2) improving the environmental conditions of specific sites, and (3) relieving development pressure on greenfields (Dixon, 2006; Mehdipour and Rashidi Nia, 2013). Legislation and policy concerning brownfield regeneration are widely discussed in respect of soil remediation, land use planning, environmental technology, economic policy, public health, and community development. The literature suggests that different countries, at different stages of urban development and with different socio-economic characteristics, set different priorities and use different policy approaches depending on how they perceive the problem and the different policy goals they are seeking to meet.

The policy response to brownfields in many European countries is encapsulated in regional planning strategy concerned with sustainable urban regeneration. The regeneration/land recycling agenda in Europe is a powerful driver of policy development. However, given growing concerns over environmental and public health issues in recent years, soil contamination has become of paramount importance to brownfield policy and practice across Europe (Nathanail et al., 2007; Vanheusden, 2009; Rizzo et al., 2015; Bardos et al., 2016). In response to growing spatial and environmental concerns in Europe, the European Union (EU) and European Environment Agency (EEA) have developed significant structural programs to encourage brownfield regeneration across member states. The EU has been proactive in the formulation of integrated support system for sustainable soil management practices. The most recent proposal for a Directive on Soil Monitoring and Resilience is a notable example that puts in place a solid monitoring framework for contaminated soils. As outlined in the proposal (EC, 2023), soil is still not subject to a coherent set of regulations in several states in Europe due to the lack of comprehensive and harmonized soil monitoring schemes. At present, only a small number of European countries (e.g. Netherlands, France, Germany) have legislation specific to protection, management, and sustainable use of soil (Panagos et al., 2013; Morar et al., 2021).

In the US, brownfield policy is increasingly set in the context of environmental aspects of land development and environmental justice issues. This can be justified on the grounds of environmental-driven recognition of brownfield issues amongst the various stakeholder groups, e.g. policymakers, developers, investors, landowners, and operators, involved in the regeneration of brownfield sites (Heberle and Wernstedt, 2006). Nevertheless, the economic potential of brownfields is also an overriding criterion for subsequent development of distressed, but well located, urban sites (Lee and Mohai, 2012). Since the mid-1990s, a range of studies has examined the effectiveness of brownfield policy in both decontamination and marketability of land at

different levels (Eisen, 1996; De Sousa, 2005, 2021; Jones et al., 2010; Hollander et al., 2010). To address growing concerns over environmental and economic issues, US federal and state governments have adopted collaborative approaches to area-wide brownfield remediation and redevelopment. The EPA's Brownfields Program (or Superfund) and state Voluntary Clean-up Programs (VCPs) provide widespread environmental liability exemptions for non-responsible purchasers and developers as well as economic incentives, such as low-interest loans, land value tax abatement and clean-up tax credits. These economic incentives have leveraged contributions from private developers, business communities, and non-profit organizations.

In addition to extensive discussion of brownfield policy in the US and Europe, there is a growing literature in other countries, such as Canada (De Sousa, 2003, 2006), Australia (Newton, 2010; Wu and Chen, 2012), China (Cao and Guan, 2007; Xie and Li, 2010; Liu et al., 2014), and Japan (Miyagawa and Nakayama, 2003; Otsuka and Abe, 2008; Dixon et al., 2011). In some, such as China, brownfield is regarded as a new agenda engaging urban land use and environmental law (Xie and Li, 2010). Complexity is introduced due to the lack of any legal definition of what constitutes brownfields in China. Where policy is poorly developed, the literature tends to understate the extent of the problem. Several studies (Miyagawa and Nakayama, 2001; Otsuka and Abe, 2008; Dixon et al., 2011; Adams et al., 2010) review brownfield regeneration policies through a comparative analysis of different countries. For example, Miyagawa and Nakayama (2001) make a comparison of national Acts on treating land contamination in Japan, the Netherlands, Germany, and the UK, and Adams et al. (2010) evaluate how brownfield policy has developed in Canada, the US, England and Scotland. Table 1 presents a summary of the literature on brownfield regulation and planning policy.

### Regulatory factors in brownfield regeneration

As discussed earlier and summarised in Table 1, policy emphasis on brownfield regeneration varies across jurisdictions driven by political, cultural, and economic factors. These factors influence how governments and stakeholders approach and prioritize brownfield regeneration efforts. While these efforts reflect general trends and motivations, they may not apply uniformly the same country or region, especially for large countries like US and China. For example, in the US, brownfield regeneration is guided by a wide range of federal and state-level programs that aim to facilitate the redevelopment of contaminated sites.

**Table 1**  
Summary of the brownfield regulation and policy-based literature.

Context	Scope of Studies	Notable Refs.
UK	- Broad dimensions of land recycling and reuse policy and planning approach, e.g., housing supply, property development, land ownership issues - Overview of the government policy on contaminated land and knowledge required for environmental management	(Tallon, 2010; Adams et al., 2010; Rey et al., 2022; Raco and Henderson, 2006; Dixon, 2006, 2007b, 2007a; Tiesdell and Adams, 2004; Nathanail and Bardos, 2004; Rey et al., 2021)
EU	- The analysis of the EU-wide brownfield regeneration networks (e.g., CABERNET, CLARINET, and NICOLE) - The operational implication and application of the EU policy framework in member states - Market Demand for Adaptive Reuse	(Nathanail et al., 2007; Vanheusden, 2009; Rizzo et al., 2015; Bardos et al., 2016; Panagos et al., 2013; Morar et al., 2021; Thornton et al., 2007; Sessa et al., 2022; Hammond et al., 2021)
US	- Decision support system for remediation of contaminated land focusing on public health concerns and environmental justice issues - Marketability of land at different levels through collaborative public-private partnership - Superfund and its serial state expansion (VCPs)	(Eisen, 1996; Geltman, 2000; Davis, 2002; Simons et al., 2003; Collins, 2003; McMorrow, 2004; Alberini et al., 2005, De Sousa, 2005, 2021, Wernstedt et al., 2006a 2006b, Jones et al., 2010, Heberle and Wernstedt, 2006, Lee and Mohai, 2012, Hollander et al., 2010)
Other Contexts *	- Overview of the current brownfield decision-making process and analysis of the condition - Development of a new legislative or regulatory language in the light of international experience - Economic viability and environmental responsibility - Risk identification and analysis	(De Sousa, 2003, 2006; Newton, 2010; Miyagawa and Nakayama, 2003; Xie and Li, 2010; Cao and Guan, 2007; Otsuka and Abe, 2008; Dixon et al., 2011; Wu and Chen, 2012; Liu et al., 2014; Song et al., 2018; Li et al., 2017; Orderud et al., 2020; Zhang et al., 2023)

\* Such countries as Australia, Canada, Japan and China, where brownfields have acquired recent political significance.

However, the implementation and approach at the local level can vary considerably across different cities and states (Jacek et al., 2022). Factors such as funding availability, level of community engagement, planning strategies, and the presence of local resources and expertise all play a part in the diverse range of approaches adopted for brownfield regeneration. Similarly, in China, while the central government has been proactive in promoting brownfield regeneration, local policies and practices can differ due to variations in regional economic development, land use demand, and regulatory conditions (Liu et al., 2023). The variation in policy emphasis on brownfield regeneration reflects the nuanced interplay of political and socioeconomic dynamics within each jurisdiction. Given the multiplicity of motivations and jurisdictional interests, the interaction between different horizontal and vertical government sectors is complex and can result in differing approaches to brownfield regeneration even within the same regions and political domains. An effective reform of a nation's approach to brownfield regeneration requires an integrated policy model, which must include a range of factors including:

- Consideration of economic viability.
- Integration with spatial planning policy.
- Recognition of public health and safety concerns.
- Protection of the environment.
- Policy and action at appropriate levels of government.
- Legal recognition and regulation of brownfields.
- Monetary and regulatory programs, incentives and tools.
- Attention to environmental liability issues.
- Clear policy and practice in respect of redevelopment.
- Addressing socio-cultural stigma attached to land contamination.

### 3. Research method

Through the lens of the PIB, we seek to explain the processes of successful brownfield regeneration. Drawing on the idea of policy integration originating from EPI, we conceptualize PIB as an analytical tool to examine brownfield governance through comparing multiple cases. The study considers five international cases, including the USA, EU, UK, Japan, and China. The selection of case studies for this research has been largely based upon an analytical framework using the representative method (Seawright and Gerring, 2008). Each case represents a unique experience in respect of brownfields policy and practice. The literature review summarized in Table 1 serves as a basis to determine

which cases were appropriate. As suggested by the literature, the US brownfield policy reflects pioneering initiatives mainly for contaminated lands driven by environmental and public health concerns. By contrast, the UK and EU experiences represent well-developed regional strategies associated with brownfield redevelopment under the umbrella of urban regeneration. The selection of Chinese and Japanese cases was largely motivated by the desire to examine the legal and regulatory framework in developing and developed countries with low level of maturity regarding brownfield regeneration. Such diversity of cases helps to establish the replication logic for the analysis of brownfield governance across different regions and political regimes.

Both secondary and primary data are used in this paper. The data for the context of US, EU and UK are entirely secondary including government reports, policy directives, and academic literature. These secondary resources are systematically identified for review based on their comprehensiveness, credibility, and relevance to the subject matter. The immaturity of brownfield policy in Japan and China necessitated the collection of primary data in addition to the secondary sources. Primary data was collected through interviews with city officials, professionals, public development agencies, academics, and urban researchers. Overall, 24 semi-structured face-to-face interviews were undertaken in Japan and China between 2017 and 2021 including interviews with 13 urban researchers and academics, 9 government officials, and 2 public development agencies. The emphasis of the interviews was on identifying the traditional policy drivers and hierarchy of planning approaches to brownfield regeneration adapted by both countries in light of their political and socio-economic structure. A 'Snowball Sampling Method' (also known as chain sampling or referral sampling) was used to identify interview participants. To access hard-to-reach people and data, this method proves beneficial by soliciting recommendations from participants for acquaintances who may be eligible for participation (Miller and Brewer, 2003). The participants were identified based on their expertise, experiences and affiliations of different development agencies. Selected participants were directly or indirectly related to brownfield regeneration and sub-study areas. For participants from government, senior officials of the organisations were selected for interview which include both urban development and environmental protection bureaucrats at different levels of governance. Respondents have been anonymized in reporting the interview data. As the interviews were semi-structured in nature, only those data relevant to addressing the research objectives have been considered for this study.

#### 4. Theoretical framework

The idea of policy integration lies at the heart of this paper. We use EPI as the theoretical framework to develop a novel analytical tool, named PIB, through the lens of which the phenomenon of brownfield regeneration can be examined in detail. Below we provide a background to EPI and explain the development of PIB.

##### 4.1. Environmental Policy Integration (EPI)

Environmental Policy Integration (EPI) was introduced by the European Commission (EC) in the late 1980s to heighten environmental awareness across the policy development and implementation process. The concept of sustainable development promoted under the European Community's first Environmental Action Plan in 1973 (Lafferty and Hovden, 2003) demanded joined-up policy delivery across disparate actors and sectors, but also across the EU Member States. Since the late 1990s the EU has further developed mechanisms and policymaking tools offering an evaluation framework and administrative process for application of EPI. In 2005, the European Environment Agency (EEA) published two important technical reports (EEA, 2005a, 2005b; Dixon, 2007b). These reports address policy and practice instruments to deliver EPI across European legislation using market-based, spatial planning, and environmental management instruments to ensure environmental

concerns are reflected within all non-environmental policy sectors.

EPI has received widespread scientific support (Lenschow, 2002; Nilsson and Persson, 2003; Lafferty and Hovden, 2003; Persson, 2004; Jordan and Lenschow, 2010; Runhaar et al., 2014). In defining EPI, there is unanimous agreement on strong intra-governmental relationships across disparate actors and sectors. To foster potential relationships between departments and levels of governance, (Lafferty and Hovden, 2003) have developed the idea of EPI in two dimensions, one horizontal and one vertical. Vertical Environmental Policy Integration (VEPI) refers to "the extent to which a particular governmental sector has taken on board and implemented environmental objectives as central in the portfolio of objectives that the sector continuously pursues". Horizontal Environmental Policy Integration (HEPI), on the other hand, stands for "the extent to which a central authority has developed a comprehensive cross-sectoral strategy for EPI" (Lafferty and Hovden, 2003). The VEPI dimension addresses siloes i.e. ministerial sectors, whereas HEPI relates to the responsibility of one central authority i.e. central government (cabinet) or particular legal body or commission in respect of sustainability (Fig. 1).

##### EPI in land use planning and policy

Environmental factors play a fundamental role in addressing sustainable development goals in cities. However, sustainable land use planning must also address socio-economic viability and spatial quality in cities (Berke, 2002). Thus, the integration of environmental policies in spatial planning requires the application of process-oriented and interdisciplinary approaches to address all three dimensions of sustainability. This requires a common language and mutual understanding amongst urban planners and environmentalists in all phases of decision-making and action. The seminal contribution to the rigorous analysis of spatial-environmental policy integration was made by (Simeonova and van der Valk, 2009). They argued EPI be implemented in the urban planning process by constructing consensus-building and interactive dialogues between relevant spatial and environmental actors with minimal hierarchical relations (Fig. 2). Drawing primarily on their comprehensive analysis of various approaches, they conclude that a "Communicative Approach" is most likely to achieve EPI in the context of urban land use planning.

The case for joint decision-making and robust communication between specialized governmental departments is similarly strong for brownfield regeneration governance. In addition to environmental aspects, international experience shows that the integration of economic policy in all phases of brownfield decision-making is equally important. If the sole policy aim is environmental restitution, then opportunities to involve the private sector in urban regeneration and save on public resources may be lost, resulting in weak demand for contaminated sites from developers. As such this represents an inefficient and unsustainable use of public resources. Similarly, public health represents a cross sectoral concern that must be integrated into brownfield policy.

##### 4.2. Development of PIB in the light of EPI's principles

We build on the underlying logic of EPI to introduce a tool for analysing brownfield regeneration processes which we call Policy Integration for Brownfields (PIB). The PIB tool aims to explain the brownfield phenomenon from both policy and practice perspectives and can be applied in different political or regional contexts. The tool identifies policy differences and gaps in specific nations' policies using a horizontal and vertical framework for the analysis. We frame the PIB tool in three analytical dimensions, including the (1) policy and legislative drivers, (2) policy actors and domains, and (3) critical elements in the brownfield development process (as depicted in Fig. 3). The first two derive from the logic of EPI, the third derives from the literature specific to brownfields.

The first dimension of PIB allows analysis of policy and legislative drivers to brownfield decisions in different regimes. The factors driving



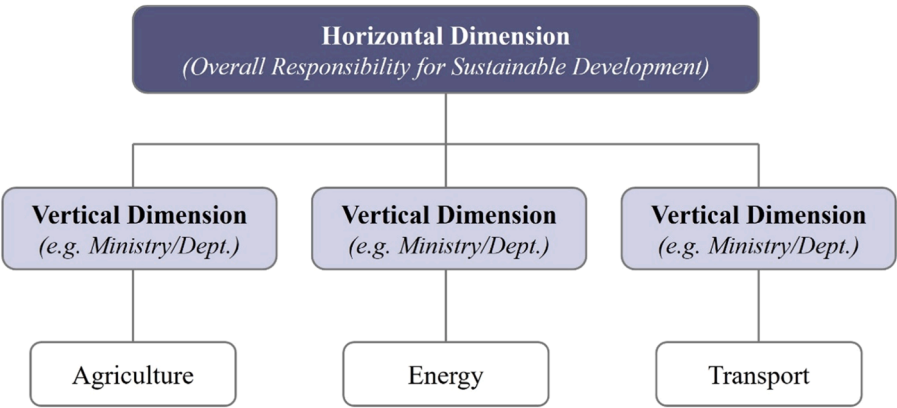


Fig. 1. Horizontal and vertical dimensions of EPI (Source: adapted from (Lafferty and Hovden, 2003)).

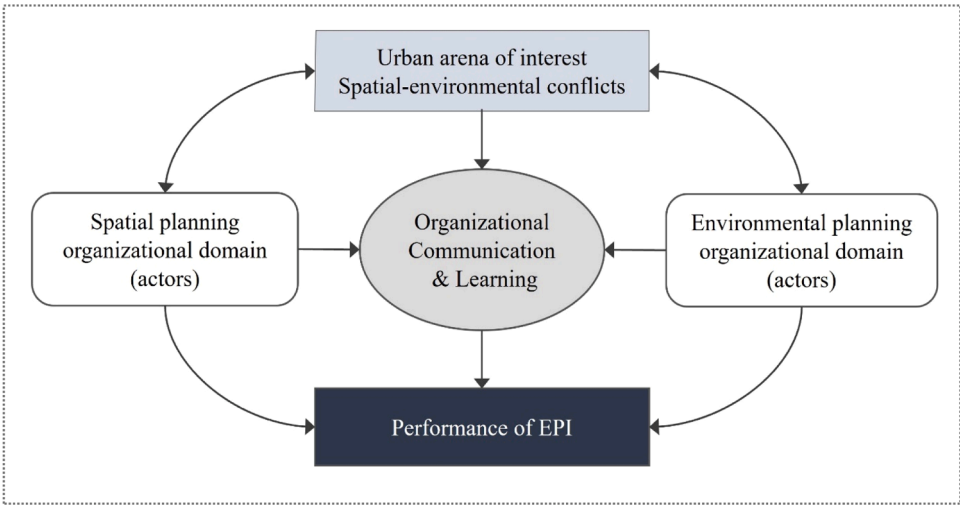


Fig. 2. Structure of the communicative approach to EPI in urban land use planning (Source: adapted form Simeonova and van der Valk 2009).

the development of brownfield policies tend to be justified on the grounds of economic growth, spatial planning, public health and safety, and environmental protection. Countries, such as the US and Japan, view brownfield recycling and reuse from an environmental standpoint, whereas many countries in Europe are predominantly driven by spatial planning and sustainability priorities when considering brownfield regeneration.

The primary objective of both EPI and PIB is to recognize the policy and sectoral relationships which need to be integrated. Achieving this objective relies heavily upon coherent cross-sectoral communication and action at different levels of government, including the national, state/regional and local levels. The second dimension of PIB addresses organizational relationships, including ‘environmental protection organization’ and ‘spatial planning organization’ as major policy domains in brownfield regeneration. Often, these domains appear to act as silos. Building on the EPI framework, we argue that a successful brownfield governance model should be capable of being translated and implemented simultaneously along two dimensions of policy actors and domains, namely, Horizontal Environmental Policy Integration for Brownfields (HPIB) and Vertical Environmental Policy Integration for Brownfields (VPIB). The former underlines the overall responsibility for sustainable development and environmental consideration- which is often done by the national cabinet-, whilst the latter maps environmental challenges across various ministerial sectors and their composite departments.

Based upon the success factors derived from the literature (Section

2.1), the third dimension of PIB includes a series of elements necessary to successful brownfield regeneration. In practice, as outlined below, these elements are variable in both quantity and quality across different regimes. However, in order to meet SDG 11, all of the factors listed in Section 2.1 are required in a holistic brownfield policy regime.

5. Testing five cases through the lens of PIB

Having introduced PIB as an analytical tool to explore brownfield governance and policy regimes, we now test its applicability and efficacy. To do so, we examine brownfield policy in the USA, Europe, UK, Japan, and China, using the three analytical dimensions set out above. This analysis allows us to assess the performance of brownfield regeneration approaches across the five cases. The data for the analysis was essentially derived from secondary sources (i.e. academic literature, and policy documents), accompanied by the semi-structured interviews conducted in Japan and China. Using the literature and interviews as a base, we scored the variables across the three analytical dimensions on a six-point scale (using - and + symbols) to build a comparative perspective on brownfield policy (see Fig. 4).

5.1. Policy and legislative drivers

The PIB tool assumes that brownfield regeneration is essentially driven by four factors, namely economic viability, spatial planning, environmental protection, and public health and safety. Amongst these

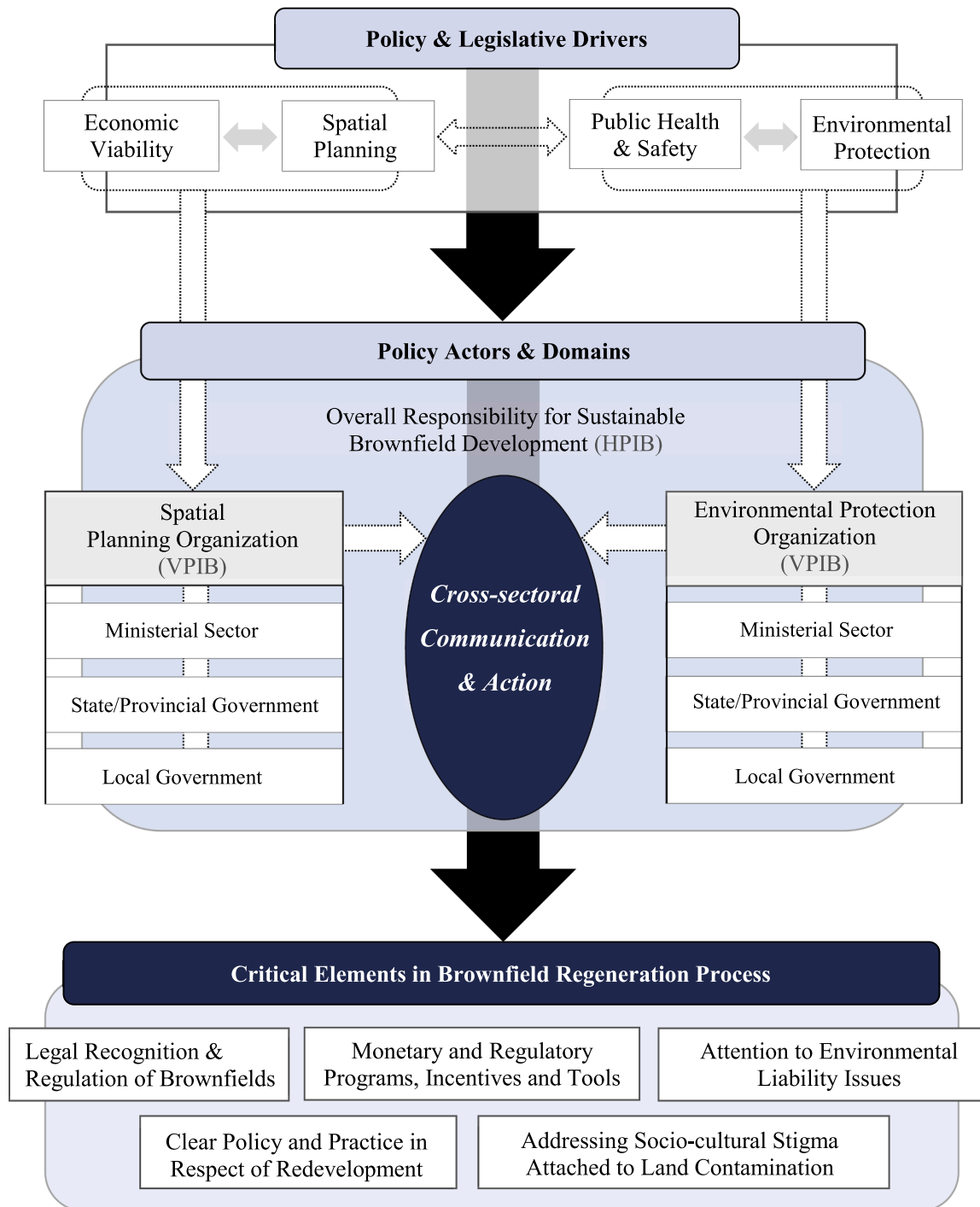
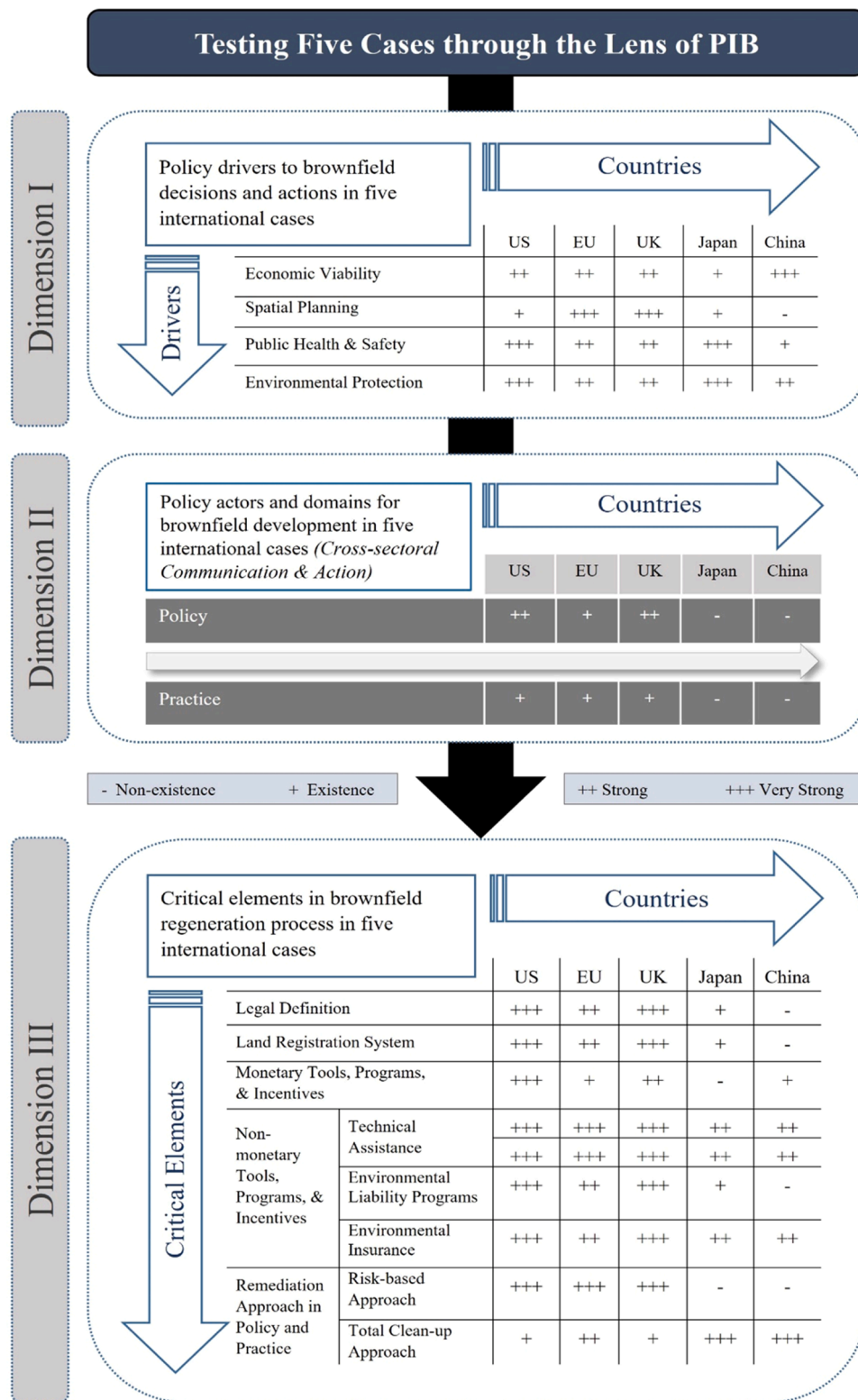


Fig. 3. Brownfield regeneration explored through PIB.

drivers, ‘environmental protection and public safety’ are often closely paired as are ‘economic viability and spatial planning’ (Fig. 3). Policy impacts from all these drivers can affect the well-being of surrounding communities. Drivers of brownfield policy are usually a combination of the factors depicted in Fig. 3 and the relative weight ascribed to each is variable.

Policy and legislative drivers of brownfield regeneration differ significantly across different regimes. In the US and Japan, for example, environmental concerns and public health issues are the key drivers in the formulation of brownfield regeneration policy. For these countries, soil contamination is the trigger and accordingly environmental protection agencies are the key actors. It is important to note that the

environmental policy driver is often accompanied by strong economic motives in respect of clean-up and redevelopment of contaminated sites. For example, in the US, the emphasis of brownfield policy has been placed on the provision of environmental liability programs, remediation tools and economic incentives for stakeholders interested in redeveloping contaminated sites (Eisen, 1996; Alberini et al., 2005). In Japan, however, the economic perspective of development has been overshadowed by the environmental and social problems created by high-risk brownfields (Mehdipour, 2020). Perhaps for this reason, unlike in the US case, the Japanese government has not yet established a strong mechanism to leverage private investment from real estate markets in brownfield projects.



## 5.2. Policy actors and domains

Successful brownfield regeneration requires effective collaboration at all levels of governance, including the national (central or federal), state and local. Two policy sectors at the highest-level of governance (i. e. environmental protection and spatial planning ministries) tend to play crucial roles in multiple phases of brownfield redevelopment projects (see Fig. 3). To achieve long-term brownfield planning goals, spatial and environmental sectors need to develop a coherent structure based on shared and mutual authority, despite their individual sectoral goals. The PIB tool helps explain both the differences between regimes in respect of different agencies and governance structures and how a modified approach might assist in addressing communication and policy integration issues. In Japan, for instance, institutional barriers and differing directions within environmental planning visions (outlined by Ministry of Environment) and land use planning visions (outlined by Ministry of Land, Infrastructure, Transport and Tourism) have led to serious inconsistencies between brownfield-related policies, ending in failure in several redevelopment practices (Dixon et al., 2011). The most famous example is the relocation project of Tsukiji Fish Market in Tokyo. In 2008, soil and groundwater under the proposed new site for the market were found to be highly contaminated (Yamamoto, 2017). The relocation scheme has been delayed for over a decade, mainly due to the lack of communicative approach adopted by high-ranking officials during the decision-making process for construction and decontamination work of the site.

Furthermore, successful brownfield activities demand collaboration between levels of government. Generally, the national government develops holistic regeneration mechanisms and resources, based on which state and local government jurisdictions pursue plans for brownfield projects. But this is not always the case. In Japan and China, as suggested by interviews, the management authority and control of brownfield regeneration is vested in municipal governments. In China, for example, local municipalities have authority over land use planning and environmental regulation of brownfields, with limited connectivity to the central government (Mehdi pour, 2020). In the Chinese context, the local government often deals with key issues associated with brownfield development, such as setting practice guidelines for assessment and remediation of contaminated land. Conversely, the US and UK governments have taken a conventional top-down approach to tackling brownfield issues. By this means, the policy and funding challenge of brownfield regeneration in these cases normally involves federal and state governments, whilst local government deals with on the ground regeneration.

## 5.3. Critical elements in brownfield regeneration process

PIB sets out a series of key elements that are typical in the regeneration of brownfield sites. We now analyse these elements at the levels of policy and practice. The key brownfield-related issues in planning policy and practice in US, Europe, UK, Japan, and China are examined in the lens of the following performance factors:

### 5.3.1. Legal recognition and regulation of brownfields

It is clear from examining how brownfields have been defined and tackled in each case that there is a linkage between the concept of brownfield and the legal response to it. Various countries have adopted diverse interpretations of the term "brownfield," leading to its distinct application in land use planning, management, and legislative contexts. In regions with strong environmental values and a robust regulatory framework, such as in the US, there is a greater emphasis on environmental remediation and health risks. In areas where economic growth is a priority, such as China, brownfield sites can be seen as opportunities for fostering economic activity. In the case of US, we observe clarity of definition. USEPA has taken the lead role in formulating remediation programs and historically emphasized addressing contaminated land

through initiatives like the Superfund program since the mid-1990s. Moreover, the EPA's Brownfields National Partnership Agenda (USEPA, 1997) helped to promote multiagency federal activities and build partnerships between different departments at the highest level of governance. Under this agenda and other initiatives, most notably Partnership for Sustainable Communities (USEPA, 2010), the US government has pulled together three national departments, including Department of Transportation (DOT), Department of Housing and Urban Development (HUD) and EPA, to work collaboratively on brownfield projects.

In the UK, given the significance of land use planning, brownfields, which include both contaminated and non-contaminated sites, are often treated as a planning issue falling under the Department for Levelling-Up, Housing and Communities. Successive reorganisations since 2006 have replaced the Department of the Environment, Transport and the Regions (DETR), under which both environmental and land use issues, including brownfields, used to be addressed. Hence, brownfields were dealt with within a single department in the UK but more recently responsibility has split between two departments. This situation contrasts with environmentally driven brownfield regulation in other countries, such as the US and Japan.

### 5.3.2. Monetary and regulatory programs, incentives and tools

Brownfield regeneration often relies upon private investment within real estate markets. To promote regeneration of brownfield sites, policy linkages between the public and private sectors are important. As the US case demonstrates, such linkages are critical where contaminated sites demand expensive remediation. In general, brownfield-related incentive programs are offered by governments in two different forms including: (1) monetary supports (e.g. tax credits, loans and technical assistance grants), and (2) non-monetary supports (e.g. environmental insurance, technical guidelines and liability relief provisions).

The US has been proactive in providing redevelopment tools for brownfield remediation and redevelopment. Over the past two decades or so, a range of financial incentives and environmental liability exemptions have been provided under comprehensive federal and state programs. Most of these tools and fiscal incentives are usually granted through the State Voluntary Clean-up Programs (VCPs) (Wernstedt et al., 2013). Unlike the US experience, in Europe, no direct legislation specifically related to brownfields seems to exist, but brownfields are indirectly regulated within the environment or soil pollution directives or laws (Jacek et al., 2022). Some notable EU initiatives are the comprehensive data management system (ESDAC) and cooperative networks for contaminated lands (e.g. CABERNET, NICOLE), providing a legal liability mechanism (ELD) and allocating a range of structural funding resources (ERDF and CF). Unlike the US and EU cases, land contamination is regarded as a novel agenda in the Japanese and Chinese systems. Policy in these two countries is much less developed. As suggested by interviews, in Japan, despite the designation of general subsidies for landowners who do not have enough financial resources, there is no comprehensive funding mechanism stimulating land remediation and reuse. Similarly, the Chinese government provides no direct funds for regeneration of contaminated sites. However, in both the Japanese and Chinese cases, technical guidelines and environmental standards have been developed to assist landowners and developers in remediation.

### 5.3.3. Attention to environmental liability issues

The risk of legal liability associated with land contamination has always been an important concern for brownfield landowners, developers and authorities. This risk can threaten the feasibility of redevelopment. The Polluter-Pays Principles (PPP) and environmental liability are thoroughly addressed within the US and EU legal and regulatory systems. In the US, many federal legislative programs, particularly the Small Business Liability Relief and Brownfields Revitalization Act, together with the state-driven VCPs provide liability protection for



new land owners, purchasers and developers (Brandon, 2012). In Europe, the Environmental Liability Directive (ELD) offers widespread exemption tools for remediation of brownfield sites (EC, 2006). However, since the enactment of ELD in 2006, the European Commission has faced difficulties matching local soil management legislation in several member states, e.g. Germany, France, and Netherlands, that have had their own long-standing liability systems.

In Japan and China, the liability situation is complex. In these countries, the application of the PPP has become relatively difficult to achieve for two reasons. The first is associated with the existing legal and regulatory system at the national level of governance. As interviews suggest, in both countries, environmental liability is mainly handled by prefectural governments in Japan and municipalities in China (Mehdi-pour, 2020). In Japan, the national regulatory framework addresses the liability issue, albeit vaguely. The Chinese soil remediation system provides no concise guidelines for identification of liability and associated penalties (Xie and Li, 2010). The second reason is pertinent to the rapid pace of development and land use change in such countries, most notably in Japan. Given the compressed timescale between active use and redevelopment of land, in several cases, it is not possible for local authorities to trace the original polluter and, as a result, innocent landowners or developers may be compelled to bear remediation costs.

#### 5.3.4. Clear policy and practice in respect of redevelopment

Approaches to remediation vary between countries. In general, two approaches are often adopted. The first is the 'total clean-up approach', based on which the site is fully decontaminated, irrespective of the type of end use (Kellett, 1999). This is a widely recognized approach, used in many countries, such as Japan, China, and a handful of European states, where remediation projects opt for expensive 'dig and dump' methods (Xie and Li, 2010). Here the policy emphasis is placed on the reason why the land became contaminated, pursuing the primary objective of eliminating the environmental and public health risks associated with brownfields. However, the risk assessment, evaluation and remediation techniques to manage uncertainty and variation in this traditional approach are prohibitively costly, resulting in poor adoption in most nations (Kuppusamy et al., 2017).

The second approach is the 'risk-based' or 'suitable for use' approach which is more cost-effective through tailoring the extent of removal and remedial actions required to the level of risk suitable for prospective land-use. While the risk-based approach underpins economic management of contaminated land, it does not inherently represent a holistic sustainable approach given the complexity of sustainability assessment (Bardos et al., 2011), especially when it intersects with the social facets of development, e.g. public health, safety, ethics and locality (Capuyns, 2016). In addition, from an environmental perspective, partial cleanups can be shown to face inevitable failure at some future date (Meyer, 2010). Nevertheless, given the economic feasibility of the risk-based approach and increasing development costs especially in inner-city areas, this approach has evolved widely in many developed countries with solid brownfield regulatory framework, particularly in the US. The USEPA has been a proponent of Risk-Based cleanups, such as Risk-Based Corrective Action (RBCA) and Risk-Based Decision Making (RBDM) (USEPA, 2016). Under the Seventh Environment Action Programme (7th EAP), the European Commission has also mandated European member states to establish a proportionate risk-based approach within a binding regulatory framework. However, as the direct legal responsibility for the management of brownfields in Europe is state dependant, several member states have not fully applied the risk-based approach due to the lack of methodological principles, as well as insufficient infrastructural support and experience with techniques for soil and groundwater remediation.

#### 5.3.5. Addressing socio-cultural stigma attached to land contamination

Another important concern that influences brownfield planning policy and practice relates to public attitudes to contaminated land.

Environmental contamination in most cultural and social contexts is viewed as a stigma (Eisen, 2015). Stigma relating to contaminated sites often poses obstacles to identifying the extent of land contamination in many countries. Some of these obstacles include:

- Difficulty in communication risk management to public, particularly amongst developers and new land purchasers.
- Landowners' reluctance to register their contaminated lands.
- Governments' reluctance to publicly reveal their records that results in inaccurate data and information on the history of contaminated land in many regimes.
- Depressed demand for brownfields from developers and real estate markets.

In Japan, the stigma associated with brownfield is extremely noticeable, given ingrained public attitudes towards environmental problems (Otsuka and Abe, 2008). Results from interviews suggest that under pressure from landowners, the Japanese government was forced to remove contamination records for fully decontaminated sites, causing difficulties in public accessibility for data on previously contaminated sites. In the late 1990s, the UK government abandoned the national registration of contaminated land for the same reason. However, public registration has subsequently been resumed in England and Wales through a comprehensive contaminated land register.

The US government has taken an effective approach to address stigma and negative images of brownfields. Over the past two decades or so, the transparent environmentally driven system for brownfield remediation has raised public awareness of contamination issues in the US. Widespread fiscal incentives offered by the federal and state governments have increased the market demand for brownfield sites. Because of the supportive policy for contaminated land, brownfield sites have become valuable assets in the US and, thus, potential developers and investors tend to be attracted to them.

## 6. Discussion

Based upon three inter-related dimensions, the paper has framed PIB for analyzing brownfield-related decisions and actions across five international cases (see Fig. 4). Under the first dimension set out in the tool, it is clear that policy and legislative drivers of brownfield regeneration vary between the five regimes. In the US and to some extent in Japan, although spatial and economic motives are evident through anti-sprawl and land reuse policies, environmental protection, health, and public safety are the major policy drivers to brownfield regeneration. By contrast in Europe, brownfield policies and legislative actions have been predominantly driven by land use planning regulations and the necessity of spatial reorganization of cities. In the case of China, the marketability of brownfields and economic drivers for urban development appear to be paramount.

The second dimension of PIB focuses on the cross-sectoral relationships across multiple levels of governance with particular attention to horizontal and vertical jurisdictional structures. In Japan and China, local and municipal governments often deal with brownfield-related issues in both strategic planning and project actions, with limited degree of intervention from higher levels of government. However, the US experience represents a conventional top-down approach, with federal and state governments as the main actors providing the overarching policy framework and funding mechanisms for site clean-up. In such a conventional case, the management and action take place locally, but within a strategic framework developed nationally. Compared to the Chinese and Japanese experiences, this collaborative governance network along a continuum of top-down approach appears to be more effective in remediation and redevelopment of contaminated sites in practice.

In the third dimension, the PIB tool underlines a series of critical development elements. The comparison of the five international cases,

highlights the critical performance factors in their different brownfield policies and practices (see Fig. 4). Public understanding of the brownfield phenomenon and the resulting legal responses to it differ significantly in different jurisdictions. As largely reflected in the case of Japan, cultural disquiet over contamination issues has imposed restrictions on government policy approaches to regeneration of contaminated sites. The Japanese experience essentially shows that a stigma resulting from environmental contamination is often attached to brownfields and this can hinder land registration, environmental assessment, and remediation processes. Stigma represented a problem in the UK in the 1990s since labelling a site as contaminated could impact on its market valuation. This stigmatization problem has been largely rectified in the UK, the US and many European countries given the decades-long public awareness and government policy development in respect of soil and groundwater contamination.

As Fig. 4 shows, PIB assists us in identifying a suite of policies that together can contribute to the overarching aims of SDG 11 and helps identify where policy weaknesses exist as a result of siloed responsibilities or ineffective governance structures. It suggests the need for balance between often conflicting environmental and non-environmental objectives. PIB also demonstrates that the location of power and accountability in environmental and spatial agencies in both vertical and horizontal dimensions is critical to successful regeneration of brownfield sites. Further application of PIB could investigate brownfield policy integration in different countries with different governance models.

The explanatory analysis provided by PIB suggests that there are a number of key considerations which need to be addressed in any successful brownfield regeneration regime. Whilst these may be tempered by political, cultural and economic factors, any attempt to reform a nation's approach to brownfield regeneration would need to include the following:

- Recognition of the importance of environmental sustainability in the context of future strategic urban planning.
- A clear definition of brownfield land.
- Comprehensive data on contaminated sites.
- Clear policy frameworks to identify trigger points in recognizing contaminated sites.
- Clear lines of communication and share of responsibilities between levels and departments of government within both top-down and bottom-up regimes.
- Clear lines of communication and share of responsibilities between governments, industry stakeholders and public communities.
- Comprehensive tools, programs and funding mechanisms.
- Clear policy on a range of site-specific redevelopment aspects, such as risk management or total cleanup.
- Clear policy directions, technical knowledge and expertise in respect of soil and groundwater remediation.
- Application of the PPP through legislation along with liability protection for subsequent land-owners.
- Clear policy frameworks which address potential stigma risks associated with land contamination and registration.

## 7. Conclusion

This paper examines policy integration in respect of brownfield land recycling. Building on EPI, it develops PIB as an analytical tool. The key steps are review of literature to provide a systematic analysis of the context and policy in different locations followed by construction of a horizontal and vertical framework for analysis. This is then used to identify the key components of successful policy driven by the overarching aim of SDG 11. Application of PIB has identified policy differences and gaps in specific nations' brownfield policies. The outcome of the PIB analysis is an overview of how a comprehensive policy agenda might be framed and critically, how it needs to be situated within

government structures and hierarchies. We consider that the approach outlined here advances the rationale and application of EPI and using Brownfields, as a case example, provides a practical method which could be used by governments to address policy formulation across multiple domains. We propose that this approach could potentially be adapted to other policy arenas, for example energy, minerals or natural resources conservation, building on relevant literature review. Further research is also required to examine how the policy integration approach might be applicable across other problems and issues for governments, especially in arenas where there is fragmentation of policy due to multiple goals and governance structures.

## CRedit authorship contribution statement

**Armin Mehdipour:** Conceptualization, Methodology, Data curation, Investigation, Formal analysis, Visualization, Project administration, Resources, Writing – original draft, Writing – review & editing. **Jon Kellett:** Conceptualization, Methodology, Formal analysis, Supervision, Validation, Writing – review & editing. **Elisa Palazzo:** Conceptualization, Methodology, Formal analysis, Supervision, Validation, Writing – review & editing. **Martin Larbi:** Conceptualization, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## References

- Adams, D., De Sousa, C., Tiesdell, S., 2010. Brownfield development: a comparison of North American and British approaches. *Urban Stud.* 47, 75–104.
- Alberini, A., Longo, A., Tonin, S., Trombetta, F., Turvani, M., 2005. The role of liability, regulation and economic incentives in brownfield remediation and redevelopment: evidence from surveys of developers. *Reg. Sci. Urban Econ.* 35, 327–351.
- Alexandrescu, F.M., Rizzo, E., Pizzol, L., Critto, A., Marcomini, A., 2016. The social embeddedness of brownfield regeneration actors: insights from social network analysis. *J. Clean. Prod.* 139, 1539–1550.
- Bardos, P., Bone, B., Boyle, R., Ellis, D., Evans, F., Harries, N.D., Smith, J.W.N., 2011. Applying sustainable development principles to contaminated land management using the SuRF-UK framework. *Remediation* 21, 77–100 (New York, N.Y.).
- Bardos, R.P., Jones, S., Stephenson, I., Menger, P., Beumer, V., Neonato, F., Maring, L., Ferber, U., Track, T., Wendler, K., 2016. Optimising value from the soft re-use of brownfield sites. *Sci. Total Environ.* 563, 769–782.
- Bell, D., Oakley, K., 2014. *Cultural Policy*. Routledge.
- Berke, P.R., 2002. Does sustainable development offer a new direction for planning? Challenges for the twenty-first century. *J. Plan. Lit.* 17, 21–36.
- Brandon, E., 2012. *National Site Contamination Law*. Dordrecht: Springer. Netherlands.
- Cao, K., Guan, H., 2007. Brownfield redevelopment toward sustainable urban land use in China. *Chin. Geogr. Sci.* 17, 127–134.
- Cappuyns, V., 2016. Inclusion of social indicators in decision support tools for the selection of sustainable site remediation options. *J. Environ. Manag.* 184, 45–56.
- Collins, F.P. 2003. The small business liability relief and brownfields revitalization act: a critique. *Duke environmental law & policy forum*, 13, 303.
- Couch, C., Petschel-Held, G., Leontidou, L., 2008. *Urban Sprawl in Europe: Landscape, Land-Use Change and Policy*. John Wiley & Sons.
- Cox, L., Rodway-Dyer, S., 2023. The underappreciated value of brownfield sites: motivations and challenges associated with maintaining biodiversity. *J. Environ. Plan. Manag.* 66, 2009–2027.
- Davis, T.S., 2002. *Brownfields: A Comprehensive Guide to Redeveloping Contaminated Property*. American Bar Association.
- De Sousa, C., 2005. Policy performance and brownfield redevelopment in Milwaukee, Wisconsin. *Prof. Geogr.* 57, 312–327.
- De Sousa, C., 2021. *Sustainable Brownfield development: Building a Sustainable Future on Sites of Our Polluting Past*. Routledge.
- De Sousa, C.A., 2003. Turning brownfields into green space in the city of Toronto. *Landsc. Urban Plan.* 62, 181–198.
- De Sousa, C.A., 2006. Urban brownfields redevelopment in Canada: the role of local government. *Can. Geogr./Le Géographe canadien* 50, 392–407.

- Dixon, T., 2006. Integrating sustainability into brownfield regeneration: rhetoric or reality?—An analysis of the UK development industry. *J. Proper. Res.* 23, 237–267.
- Dixon, T., 2007a. The property development industry and sustainable urban brownfield regeneration in England: an analysis of case studies in Thames Gateway and Greater Manchester. *Urban Stud.* 44, 2379–2400.
- Dixon, T., Otsuka, N., Abe, H., 2011. Critical success factors in urban brownfield regeneration: an analysis of 'hardcore' sites in Manchester and Osaka during the economic recession (2009–10). *Environ. Plan. A* 43, 961–980.
- Dixon, T.J., 2007b. Sustainable Brownfield Regeneration: Liveable Places from Problem Spaces. Blackwell, Oxford, England.
- Downey, D.C., Myers, W.M., 2020. Federalism, intergovernmental relationships, and emergency response: a comparison of Australia and the United States. *Am. Rev. Public Adm.* 50, 526–535.
- EC, 2006. Soil protection—the story behind the strategy [Online]. European Commission. Available: [https://ec.europa.eu/environment/soil/making\\_en.htm](https://ec.europa.eu/environment/soil/making_en.htm) [Accessed 15 March 2021].
- EC, 2023. Proposal for a directive on soil monitoring and resilience. European Commission. Brussels.
- EEA, 2005a. Environmental policy integration in Europe: state of play and an evaluation framework. European Environment Agency Copenhagen. EEA Technical report No 2/2005.
- EEA, 2005b. Environmental policy integration in Europe; administrative culture and practices. European Environment Agency Copenhagen. EEA Technical report No 5/2005.
- Eisen, J.B., 1996. Brownfields of Dreams': Challenges and Limits of Voluntary Cleanup Programs and Incentives. University of Illinois law review, p. 883, 1996.
- Eisen, J.B., Duke, J.M., Wu, J., 2015. Stigmatized sites and urban brownfield redevelopment (ed.). The Oxford Handbook of Land Economics. Oxford University Press.
- Geltman, E.G., 2000. Recycling Land Understanding the Legal Landscape of Brownfield Development. University of Michigan Press. Ann Arbor.
- Hammond, E.B., Coulon, F., Hallett, S.H., Thomas, R., Hardy, D., Kingdon, A., Beriro, D. J., 2021. A critical review of decision support systems for brownfield redevelopment. *Sci. Total Environ.* 785, 147132.
- Heberle, L., Wernstedt, K., 2006. Understanding brownfields regeneration in the US. *Local Environ.* 11, 479–497.
- Hollander, J., Kirkwood, N., Gold, J., 2010. Principles of Brownfield Regeneration: Cleanup, Design, and Reuse of Derelict Land. Island Press.
- Jacek, G., Rozan, A., Desrousseaux, M., Combroux, I., 2022. Brownfields over the years: from definition to sustainable reuse. *Environ. Rev.* 30, 50–60.
- Jones, R.A., Welsh, W.F., Hula, R.C., Jackson-Elmoore, C., 2010. Michigan Brownfield Redevelopment innovation: two decades of success. Reclaiming Brownfields: A Comparative Analysis of Adaptive Reuse of Contaminated Property, Eastern. Michigan University, pp. 341–370.
- Jordan, A., Lenschow, A., 2010. Environmental policy integration: a state of the art review. *Environ. Policy Govern.* 20, 147–158.
- Kellett, J., Ashkam, P., Blake, L., 1999. Explaining contamination issues (ed.). The Best of Mainly for Students: Volume Two. Estates Gazette.
- Kuppusamy, S., Venkateswarlu, K., Megharaj, M., Mayilswami, S., Lee, Y.B., 2017. Risk-based remediation of polluted sites: a critical perspective. *Chemosphere* 186, 607–615.
- Lægred, P. & Rykkja, L.H. 2014. Governance for complexity—how to organize for the handling of «wicked issues»?
- Lafferty, W., Hovden, E., 2003. Environmental policy integration: towards an analytical framework. *Environ. Polit.* 12, 1–22.
- Lee, S., Mohai, P., 2012. Environmental justice implications of brownfield redevelopment in the United States. *Soc. Nat. Resour.* 25, 602–609.
- Leiren, M.D., Jacobsen, J.K.S., 2018. Silos as barriers to public sector climate adaptation and preparedness: insights from road closures in Norway. *Local Gov. Stud.* 44, 492–511.
- Lenschow, A., 2002. Environmental Policy Integration: Greening Sectoral Policies in Europe. Routledge.
- Li, X., Jiao, W., Xiao, R., Chen, W., Liu, W., 2017. Contaminated sites in China: countermeasures of provincial governments. *J. Clean. Prod.* 147, 485–496.
- Limasset, E., Pizzol, L., Merly, C., Gatchett, A.M., Le Guern, C., Martinát, S., Klusáček, P., Bartke, S., 2018. Points of attention in designing tools for regional brownfield prioritization. *Sci. Total Environ.* 622–623, 997–1008.
- Liu, G., Li, Z., Han, Q., Zhang, H., 2023. The redevelopment mode selection framework for third front brownfields in China. *Environ. Sci. Pollut. Res.* 30, 33061–33074.
- Liu, Y., Van Oort, F., Geertman, S., Lin, Y., 2014. Institutional determinants of brownfield formation in Chinese cities and urban villages. *Habitat Int.* 44, 72–78.
- Loures, L., Vaz, E., 2018. Exploring expert perception towards brownfield redevelopment benefits according to their typology. *Habitat Int.* 72, 66–76.
- Mccarthy, L., 2009. Off the mark? Efficiency in targeting the most marketable sites rather than equity in public assistance for brownfield redevelopment. *Econ. Dev. Q.* 23, 211–228.
- Mcmorrow, A., 2004. CERCLA liability redefined: an analysis of the small business liability relief and brownfields revitalization act and its impact on state voluntary cleanup programs. *GA State Univ. Law Rev.* 20, 1.
- Mehdipour, A., 2020. Understanding brownfield regeneration in iran through the lens of international experience. Unpublished PhD thesis. University of Adelaide.
- Mehdipour, A., Rashidi Nia, H., 2013. The role of brownfield development in sustainable urban regeneration. *J. Sustain. Dev. Stud.* 4, 78–87.
- Meyer, P.B., 2010. Brownfields, risk-based corrective action, and local communities. *Cityscape* 12, 55–69.
- Miller, R.L., Brewer, J.D., 2003. Sampling, Snowball: Accessing Hidden and Hard-To-Reach Populations. SAGE Publications, Limited. United Kingdom.
- Miyagawa, T., Nakayama, T., 2001. Comparison of national acts on treating land contamination in Japan, the Netherlands, Germany, and the United Kingdom. Study on approaches to treat land contamination and redevelopment of brownfields. I. *J. Archit. Plan. Environ.* 66, 177–183.
- Miyagawa, T., Nakayama, T., 2003. An examination on integrated planning of treatment and reuse/redevelopment of contaminated land. Study on approaches to treat land contamination and redevelopment of brownfields. II. *J. Archit. Plan. Environ. Eng.* 565, 209–216.
- Morar, C., Berman, L., Unkart, S., Erdal, S., 2021. Sustainable brownfields redevelopment in the European Union: an overview of policy and funding frameworks. *J. Environ. Health* 84, 24.
- Nathanail, C.P., Bardos, P., 2004. Reclamation of Contaminated Land. Wiley, Chichester, West Sussex, England.
- Nathanail, C.P., Bardos, R.P., 2005. Reclamation of Contaminated Land. John Wiley & Sons.
- Nathanail, P., Millar, K., Grimski, D., Ferber, U., 2007. 1.7 Key findings from CABERNET—Europe's sus-tainable brownfield regeneration network. 2nd International Conference on Managing Urban Land. 59–64.
- Newton, P.W., 2010. Beyond greenfield and brownfield: the challenge of regenerating Australia's Greyfield suburbs. *Built. Environ.* 36, 81–104.
- Nilsson, M.N., Persson, A.S., 2003. Framework for analysing environmental policy integration. *J. Environ. Policy Plan.* 5, 333–359.
- Orderud, G.L., Skogheim, R., Nordahl, B.I., 2020. Review of brownfield redevelopment in China and a comparison with that in OECD countries. *Chin. J. Urban Environ. Stud.* 8, 2050022.
- Otsuka, N., Abe, H., 2008. Challenges for brownfield regeneration: a comparison of English and Japanese approaches. *Trans. Ecol. Environ.* 107, 33–42.
- Panagos, P., Van Liedekerke, M., Yigini, Y., Montanarella, L., 2013. Contaminated sites in Europe: review of the current situation based on data collected through a European network. *J. Environ. Public Health*, 2013, 1–11.
- Persson, A., 2004. Environmental policy integration: an introduction. PINTS—Policy Integration for Sustainability Background Paper. Stockholm Environment Institute: Stockholm.
- Pizzol, L., Zabeo, A., Klusáček, P., Giubilato, E., Critto, A., Frantál, B., Martinát, S., Kunc, J., Osman, R., Bartke, S., 2016. Timbre brownfield prioritization tool to support effective brownfield regeneration. *J. Environ. Manag.* 166, 178–192.
- Raco, M., Henderson, S., 2006. Sustainable urban planning and the brownfield development process in the United Kingdom: lessons from the Thames Gateway. *Local Environ.* 11, 499–513.
- Rey, E., Laprise, M., Lufkin, S., 2021. The Multiple Potentials of Urban Brownfields. Springer International Publishing AG. Switzerland.
- Rey, E., Laprise, M., Lufkin, S., Rey, E., Laprise, M., Lufkin, S., 2022. Urban brownfield regeneration projects: complexities and issues. Neighbourhoods in Transition: Brownfield Regeneration in European Metropolitan Areas. The Urban Book Series. Springer, Cham, pp. 65–76.
- Rizzo, E., Pesce, M., Pizzol, L., Alexandrescu, F.M., Giubilato, E., Critto, A., Marcomini, A., Bartke, S., 2015. Brownfield regeneration in Europe: identifying stakeholder perceptions, concerns, attitudes and information needs. *Land Use Policy* 48, 437–453.
- Runhaar, H., Driessen, P., Uittenbroek, C., 2014. Towards a systematic framework for the analysis of environmental policy integration. *Environ. Policy Gov.* 24, 233–246.
- Sarni, W., 2009. Greening Brownfields. McGraw-Hill Professional Publishing. New York, USA.
- Seawright, J., Gerring, J., 2008. Case Selection techniques in case study research: a menu of qualitative and quantitative options. *Polit. Res. Q.* 61, 294–308.
- Sessa, M.R., Russo, A., Sica, F., 2022. Opinion paper on green deal for the urban regeneration of industrial brownfield land in Europe. *Land Use Policy* 119, 106198.
- Simeonova, V., Van Der Valk, A., 2009. The need for a communicative approach to improve environmental policy integration in urban land use planning. *J. Plan. Lit.* 23, 241–261.
- Simons, R.A., Pendergrass, J., Winson-Geideman, K., 2003. Quantifying long-term environmental regulatory risk for brownfields: are reopeners really an issue? *J. Environ. Plan. Manag.* 46, 257–269.
- Song, Y., Hou, D., Zhang, J., O'connor, D., Li, G., Gu, Q., Li, S., Liu, P., 2018. Environmental and socio-economic sustainability appraisal of contaminated land remediation strategies: a case study at a mega-site in China. *Sci. Total Environ.* 610–611, 391–401.
- Syms, P., 1999. Redeveloping brownfield land the decision-making process. *J. Proper. Invest. Financ.* 17, 481–500.
- Tallon, A., 2010. Urban Regeneration in the UK. Routledge. London.
- Thornton, G., Franz, M., Edwards, D., Pahlen, G., Nathanail, P., 2007. The challenge of sustainability: incentives for brownfield regeneration in Europe. *Environ. Sci. Policy* 10, 116–134.
- Tiesdell, S., Adams, D., 2004. Design matters: major house builders and the design challenge of brownfield development contexts. *J. Urban Des.* 9, 23–45.
- UN 2015. Resolution adopted by the General Assembly on 11 September 2015. New York: United Nations.
- USEPA 1997. Brownfields national partnership action agenda. In: (NSCEP), N. S. C. F. E. P. (ed.). United States Environmental Protection Agency.
- USEPA 2010. Partnership for sustainable communities: a year of progress for American communities. In: (1807T), O. O. S. C. (ed.). Environmental Protection Agency.
- USEPA 2016. Risk-based cleanups at brownfield sites. United States environmental protection agency, Office of Land and Emergency Management.

- USEPA, 1996. The brownfields economic redevelopment initiative: application guidelines for brownfields assessment demonstration pilots. Washington DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.
- Vanheusden, B., 2009. Recent developments in European policy regarding brownfield remediation. *Environ. Pract.* 11, 256–262.
- Wernstedt, K., Blackman, A., Lyon, T.P., NOVAK, K., 2013. Revitalizing underperforming and contaminated land through voluntary action: perspectives from US voluntary cleanup programs. *Land Use Policy* 31, 545–556.
- Wernstedt, K., Meyer, P.B., Alberini, A., 2006a. Attracting private investment to contaminated properties: the value of public interventions. *J. Policy Anal. Manag.* 25, 247–369.
- Wernstedt, K., Meyer, P.B., Alberini, A., Heberle, L., 2006b. Incentives for private residential brownfields development in US urban areas. *J. Environ. Plan. Manag.* 49, 101–119.
- Wu, H., Chen, C., 2012. Urban “brownfields”: an Australian perspective. In: *Proceedings of the 18th Annual Pacific-Rim Real Estate Society Conference*, pp. 1–20.
- Xie, J., Li, F., 2010. Overview of the current situation on brownfield remediation and redevelopment in China. *World Bank. Report 57953* Washington, DC.
- Yamamoto, T., 2017. Reconstruction of marginality: the Tokyo Bay area in the Great East Japan Earthquake. *Planetary Atmospheres and Urban Society after Fukushima*. Springer.
- Zhang, Y., Wang, S., Wang, C., Luo, X., 2023. Risk identification and analysis for the green redevelopment of industrial brownfields: a social network analysis. *Environ. Sci. Pollut. Res.* 30, 30557–30571.



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