A perspective on the governance of London’s subsurface

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Abstract. The role of the urban subsurface for cities has long been disregarded but is recently getting more attention. To capture it, the city’s geographical and geological setup, its history and the social context it is located within are of particular relevance. As a case study, this paper illustrates the context and governance of London’s subsurface through the lens of a ‘governance arrangement’ looking at these three elements. It is highlighted that feedback loops between the material reality and the societal context – human influences on the subsurface environment – are not sufficiently recognised. The paper demonstrates how the discretionary nature of the UK’s planning system puts local planning authorities on the one hand, and engineers and technical knowledge on the other hand, in central positions to mediate strategic plans and influence specific project applications and decisions. From the empirical analysis presented here, no sense of urgency is assigned to the concept of underground space planning in London at this moment in time. However, the analysis suggests a need for better understanding of the spatial and material effects of specific interventions, as well as of the according policies and strategies. Current discourses around underground data sharing or geothermal energy provision could facilitate the process towards a spatial integration of the various strategies that are in place.

1. Introduction

Sigmund Freud once drew an analogy between the city of Rome and the human mind [1]. This analogy describes how a city evolves around the topography and natural context – the physical form – determined by the various and complex historical processes and the intricacies of the social context. These 3 elements - the physical, historical and social - need to be analysed in parallel in order to fully understand human consciousness. These three elements resemble what has been described as the baseline considerations for any intervention in the subsurface [2]: (a) a city’s geographical, and therewith also geological, location that due to its invisibility often appears to be ‘out of sight, out of mind’ [3]; (b) its history that is often connected to its location, as many cities evolved around either accessibility with regard to trading routes or the availability of resources [4]; and, (c) sometimes as unaccounted for as the subsurface itself, the social context of a city that manifests in the rules and regulations, as well as in the different actors and the discourses between them that might constitute change and influence decisions around a topic at hand.

Based on these elements, the current paper proposes a new way of looking at the governance of underground, using London as a case study. The terms “underground” and “subsurface” will here be used interchangeably. It employs the policy arrangement approach (PAA) [5] to provide a different viewpoint and a theoretical perspective on urban subsurface governance, and as a tool that helps to
describe and understand individual areas of policy, as well as to gain insights into discursive shifts and institutional contexts [6]. This approach is extended to include the description of the local geology and legacy of human interventions, so as to provide a coherent framing for the analysis of urban subsurface governance. The analysis helps to gain a general understanding of the developments, policies, people and organisations that have shaped and are shaping the current governance of underground space in London and provides an approach to furthering the question of whether there is a need for more, or more specific, regulation. This paper provides an overview of this framing, hoping that the approach will inform further analyses providing a basis for more holistic comparative studies in the field.

2. An approach to subsurface governance arrangements

A policy arrangement represents a ‘temporary stabilisation of the content and organisation and substance of a policy domain’ [5, p54], with the latter domain being comprised of four analytical dimensions: (a) actors and coalitions, (b) rules, including policies and formal procedures, (c) resources these actors and coalitions can mobilise, and (d) discourse about the policy domain. All four dimensions are interdependent and a change in any dimension can trigger a change in the overall arrangement. For example, a change in discourse can lead to the engagement of different actors, the allocation of resources and, ultimately, a change in policy. Arts et al. illustrate these interdependencies by depicting the arrangement between the four dimensions as a tetrahedron [5] (Figure 1).

The PAA, as laid out in [5], explicitly aims to analyse a specific moment in time. However, in terms of spatial planning and, in particular, considering the underground, any effort of governance has to be firmly based in and react to the material reality: the geology and legacy of human intervention; the physical and environmental processes these are exposed to, and how they might be captured in a specific moment in time. As such, the PAA is here extended to include a description of this reality. As illustrated in Figure 1, the connection between the social context and the material reality establishes a feedback loop as the material aspects form a determining part of the governance arrangement for the subsurface, which in itself determines how the material reality can be changed. The following paragraphs will describe the material aspects as well as each of the PAA-dimensions, of which the first three refer to organisational aspects of the policy domain and the fourth to the substance of policy making itself [7], in turn. As will be described, currently there is no management strategy specifically addressing the underground in London, and the discourse about the urban subsurface management sits within general interest groups. As such, no resources towards establishment of more holistic underground management have been triggered in the relevant institutions as yet and the two dimensions of discourses and resources will be described jointly.

Figure 1. Policy arrangement tetrahedron according to Arts et al. [5] and its connection to the material reality of the subsurface
3. Material aspects: geology and legacy

London’s geology and built underground legacy are not independent but have mutually influenced each other [8]. Subsurface levels of up to 100 to 250m are described as ‘shallow’ and relevant for urban planning [9], even if the exploitation of resources, such as drilling for deep geothermal energy or groundwater wells, can reach into deeper levels. For London, these shallow layers comprise the formations within the so called ‘London Basin’, formed around 14 to 24 million years ago [10]. An extensive description of formations and their engineering properties would go beyond the purpose of this paper. However, the following two aspects illustrate how the geology and hydrogeology have significantly influenced, or were themselves influenced by, the development of London’s subsurface use to provide an idea of the depth of connection between the geology present, the structure of underground uses and the city as a whole:

- **As in many other cities around the world, groundwater levels in London were strongly affected by over-exploitation for industrial purposes, which led to a drawdown in the main aquifer of approximately 65m by the mid-1960s** [11]. Today, post-industrial relocation and the reduction of industrial activity have led to the contrary problem of rising groundwater tables. Feared effects of the rising groundwater table on engineering structures included flooding of subsurface infrastructure or basements, shrink-swell movements, increased uplift pressures on foundations and floor slabs, loads on retaining walls, and drainage requirements for excavations [12], as well as risk of corrosion due to the chemical composition of the rising water [13]. As a response to these concerns, abstraction rates were increased and are now managed through licencing by the Environment Agency [14]. This main aquifer is now carefully monitored and maintained between an upper and a lower limit, providing an example of how human interventions can lead to lasting changes of an underground system and to circumstances that have to be managed in the long-term.

- **‘Man-made’ or ‘artificial’ grounds/anthropogenic deposits have gained importance in cities everywhere, and it has been claimed that a systematic assessment of artificial ground is required to ‘inform the planning process and provide the basis for engineering solutions’** [15, p399]. In London, due to the reclamation of land and river bank reinforcement, artificial ground predominately occurs along the river embankment [16] with a thickness of 0-15m [9]. In addition to these physical modifications, as captured by the categorisation of artificial ground by the BGS [17], chemical and biological processes from industrial activities have led to ground contamination [18]. Also, areas of archaeological interest that might be outside of what is categorised as artificial ground [19] cover between 14% and 72% of the ground area of London Councils [20] and the built environment currently in use could be understood as part of the future ‘archaeosphere’.

4. Organisational aspects

Following the above description, the archaeosphere of the future is shaped by the objectives or human intentions for the built environment that is currently in formation [19]. These are captured in plans and developments and are scrutinised through the planning system, giving today’s planning system a central role in that formation of future archaeological layers.

4.1. The underground in urban planning legislation

Urban planning is here understood as the development and implementation of strategies and plans to regulate and balance the various potentials and current uses of land. When urban planning is referred to in the context of the urban subsurface, it is often imagined as a detailed land-use plan setting out fixed locations for specific types of developments or infrastructures. However, whilst this kind of binding planning policy is prevalent in most of the European countries, planning in the UK is discretionary, meaning that formal development plans on local and regional levels set out policies which serve as a framework for decision making. The plan is a document that provides general guidance, but any project or development decision is ‘subject to administrative and political discretion,’ [21, p744] meaning that
decisions are taken in the format of a discretionary judgement by councilors in local authorities, rather
than through following bureaucratic rules [22] and resulting in a ‘notable absence of certainty’ [21, p744]. In the UK, planning legislation, as first established with the Town and Country Planning Act in 1947 [23], is embedded within the tradition of the English common law on the one hand, and in the duality of central government and local authority on the other [24]. For London, whilst the 32 boroughs and the City of London constitute the main planning authorities, the Greater London Authority (GLA) was established in 2000 as an intermediate administrative level.

Figure 2 provides an overview of the current relevant plans and associated documents for London. The National Planning Policy Framework (NPPF) and the National Planning Policy Guidance (NPPG) set out the major guidelines for the local authorities to prepare their local plans [25]. For London authorities, these plans also have to comply with the London Plan that is prepared by the GLA. The NPPF and NPPG, alongside regulation stemming from European directives, also serve as ‘material consideration’ when decisions about planning applications are taken [26]. In addition to local plans, local authorities prepare supplementary planning documents (SPDs) and evidence documents reacting to specific local topics of concern. Apart from regular planning applications at council level, planning approval for major infrastructure projects can be achieved through project specific acts of parliament, such as the Crossrail Act [27], or through the National Significant Infrastructure scheme [28]. In addition, specific underground developments, in particular for utility infrastructure, are permitted without making a planning application [29].

![Figure 2. Schematic of London Boroughs Local Plan Documents](image-url)

In the UK, a range of subsurface functions are regulated through environmental and planning policy and legislation at different levels (national – regional – local) [4]. Consequently, separate from the main planning strategies, the London Plan and Local Plans, a range of strategies and plans exist in different underground related sectors. For example, water companies issue water resources management plans that aim at ensuring continuous water supply. Other plans that are integrated across councils include waste management plans, the London Sustainable Drainage Action Plan [30] or the London Infrastructure Plan [31]. These plans are currently coordinated by mutual consultation on draft versions or earlier stages of plan development between the leading institutions. The existence of these plans shows that while joining forces across councils proves necessary for specific topics like waste or flood management, at the same time specific strategies are considered to be required, possibly because the corresponding issues are seen as too complex to integrate into an overarching plan, or more detailed plans are considered necessary to capturing local specifics.
4.2. Who has a stake?
The multitude of topics connected to the subsurface and covered in the planning guidance is necessarily reflected in the amount of institutions, organisations and individuals who are, in one way or another, involved with the subsurface. As no subsurface specific planning strategy or regulation exists for London, the current paper presents a hypothetical account of developing such strategy and a stakeholder analysis as such would not have been expedient. However, who is assigned as having a ‘stake’ in a particular project or plan determines who will be involved in or able to influence decisions [32] and two observations shall be made that will be relevant for the following discussion:

- There is a limited number of consultees who are prescribed for both, local plans [33] as well as specific projects [28] (Table 1). Ultimately, many more consultees will overlap between consultations for Local Plans and those for major infrastructure projects. However, owing to their prescription in both sets of regulation, consultees listed here appear to have an overarching role that operates on various scales, whereas other consultees need to be identified in a manner that is specific to the authority or project location. It stands out that all listed consultees have a direct connection to one or more subsurface related themes with the Coal Authority having been established exclusively to manage the legacy of an underground activity. This indicates that (a) subsurface topics are assigned relevance, and (b) they constitute overarching, multi-scale topics.

- Stakeholders are usually clustered according to their affiliation rather than their discipline. In contrast, groups active in the field of subsurface planning, like for example Think Deep UK (TDUK) [34] usually list who needs to be involved in the process towards integrated underground management according to the necessary expertise rather than regarding the specific institutions or organisations. This focus on interdisciplinarity rather than representation shows that in order to realise a meaningful process of working towards a new policy or strategy, expertise from various disciplines is required in addition to the representation of relevant institutions and organisations. For a specific local solution to be found, it has to be understood how this expertise is embedded in the local institutions and organisations involved in planning as previously illustrated.

| Table 1. Prescribed consultees for Local Plans as well as infrastructure projects |
|---------------------------------------------------------------|
| **Consultee** | **Description** |
| Affected planning authorities | Responsible for developing and enacting local strategies and local planning decisions. Act as Lead Local Flood Authorities, responsible for managing flood risk from surface water and groundwater. |
| Statutory undertakers | Utility companies (mostly regional) and nationalised companies such as Network Rail that provide infrastructure services. Water companies are Flood Risk Management Authorities managing risk from water and sewers. |
| Environment Agency | Non-departmental public body responsible for regulating waste, treatment of contaminated land, water quality and resources, flood risk management. |
| Historic England | Non-departmental public body acting as statutory adviser to the UK government on all aspects of the historic environment, including archaeology. |
| Natural England | Non-departmental public body, responsible for protection and improvement of the natural environment, including its land, freshwater, and geology and soils. |
| Highways England | Government-owned company responsible for operating, maintaining and improving the strategic road network. |
| The Coal Authority | Non-departmental public body managing the mining legacy, including subsidence damage claims and mine water pollution. |
4.3. Connections between actors, institutions and planning policies

Following the brief overview over current planning policies and actors, any concept for an underground plan or strategy would, arguably, have to help the integration of the various plans and policies already present, or be integrated in the landscape of plans, strategies and regulations already present, and be based on the local context. To further this thought and better understand how the different agencies and actors are positioned, Figure 3 maps the connections between main stakeholders and policy documents as listed in section 4.1, using the examples of flood risk and waste management (see [35] for flood risk) as two underground related topics. The main findings illustrated here are:

- Local planning authorities (LPAs) are a linkage point between strategic planning and project decisions in that they have the dual role of preparing and adopting the Local Plan (in accordance with the NFFP and the London Plan) on the one hand and being responsible for the evaluation of planning applications on the other hand. In doing so, they are required to ensure that an application is in accordance with the plans and policies set out. Key stakeholders responsible for the subsurface related plans and strategies, as for example the Environment Agency, are often involved in plan-making, but also act as consultees for specific planning applications. However, it is the responsibility of the local planning authorities (LPAs) to consult the relevant stakeholders for a specific application.

- To be able to plan and take decisions about subsurface interventions – or to capture the interaction between spatial planning and subsurface functions – a comprehensive knowledge of the material substance and processes taking place is required, placing technical and engineering knowledge in a key position for mediating this space. Engineers not only design the temporary support and final structures, but also compile supporting documents, such as transport assessments, and serve as consultants to those commenting on local plans and specific planning applications. This is particularly prevalent in the context of the underground, where even small projects require an intervention in a geological material present previously. All stakeholders require technical explanations to be able to form an informed opinion on suggested plans or
projects. The role of engineers is to learn from existing projects, capture the newly produced knowledge when new projects are implemented, and develop and convey an understanding of the complexity of the urban subsurface as well as the embedded infrastructure systems [36]. Engineers thus serve as intermediaries between specific projects and the various stakeholders, and occupy a position of high responsibility and power.

5. Substantive aspects
The identification of knowledge as a powerful resource for interventions into the subsurface offers an explanation for the observation that a lot of the literature about underground planning stems from the engineering discipline [20]. However, an integration of various areas of expertise is required in order to provide a strategy going forward. In light of the previously described observations, it becomes apparent that whilst the planning system sets out a framework to balance different interests and topics, particular aspects are still addressed separately and only come together regarding specific planning applications or projects. Targeted resources – here referring to the assets that actors can mobilise, including funding, knowledge or technology [6] – are mobilised only in these specific contexts, and no resources are allocated at authority level to a more holistic underground planning approach. The discussion for the need of the latter sits within special interest groups like TDUK. The following paragraphs shed a light on some general aspects that would need to be established as a starting point towards a subsurface planning strategy in London but also elsewhere.

5.1. Purpose
The purpose of a system defines its boundaries and determines how it will be analysed, or what it will be measured against [2]. As such, understanding and agreeing the purpose of a specific intervention or the establishment of a new policy, strategy, or framework, is crucial for their respective acceptance and evaluability, as well as for definition of the necessary next steps. Most strategies proposed towards more holistic underground management or governance focus on the spatial allocation of different functions, either through the establishment of a masterplan, or through the efficient weighing of different potential functions for the same volume [2]. Given the multitude of topics and actors involved in subsurface related topic areas, as described above, it appears that the common denominator between the different disciplines is not the ambition to establish an independent strategy. Rather, the purpose of engagement in the field for cities like London might be to seek a better explanation of the (three-dimensional) spatial and material dimensions of various policies and strategies on all levels in such a way that the long-term impact on the subsurface, and the functions that it embraces, come to be recognised.

5.2. Urgency
Considering the origins of planning more broadly, the reason for establishing an urban planning regime in the first place can usually be traced back to the time of industrialisation and issues of public health and housing – urgent problems that affected individuals at all levels of society, as well as the society as a whole, and ultimately led the government to take action. A similar urgency is described for the recently established area of Marine Spatial Planning (MSP), into which the traditional realm of spatial planning has been extended owing to increasing concerns about the conditions of marine ecosystems [37]. In the context of the current argument, it is noteworthy that internationally the urgency of introducing underground specific planning strategies is much less articulated. The purposes of establishing an underground planning strategy usually concerns the economic development of a region [38], and even if a shift towards economic drivers has also been observed for urban planning strategies in general, the question can be raised whether the establishment of an underground planning strategy in London shares the same notion of urgency.

5.3. Location and local need
Following the above argument and independently of the form that an underground strategy could take, the establishment of a planning strategy for the underground or the integration of the underground into
Urban planning does not appear to constitute an area of urgent action where the problem is already at hand but, rather, could provide an opportunity to pre-empt specific problems that are predicted to occur. For instance, in the City of Glasgow it was found that the poorer part of the population was exposed to pollution originating from brownfield sites, leading to a lower life-expectancy in these specific areas [39]. These kinds of examples indicate that whilst specific problems like urban sanitation systems or general concepts such as those relating to MSP allow for the development of transferrable technological solutions and the definition of drivers, the urgency of establishing a planning strategy for the subsurface can only arise and be answered locally in response to the specific physical, historical and social settings.

5.4. Enabling mechanisms

Despite the lack of discourse about the integration of the subsurface into planning in London, related discourses have gained awareness and mobilised significant resources. These can serve as enabling or ‘bridging mechanisms’ [35] that facilitate the cooperation between stakeholders or related policy arrangements, and thus help to overcome the described sectoral fragmentation:

- The increase in the number of basement developments triggered a public discourse in the media, mainly with negative connotation assigned to these developments, reflected in terms such as ‘millionaire basements’ [40]. This discourse has led to increased awareness of the topic and the development of specific policies in a growing number of London Boroughs, as well as an acknowledgement of the issue in the London Plan [41].

- The discourses around data management and sharing, in particular of utility data, is gaining momentum (see [4]). The efforts aim to improve the situation by providing spatially referenced data. In particular, at shallow levels of the subsurface, insufficient spatial coordination appears to persist [42], and efforts such as the one by the Geospatial Commission to create a National Underground Asset Register [43], can serve as bridging mechanisms that not only facilitate better coordination between stakeholders, but also initiate spatial integration between the different subsurface topics that are aligned with the overarching purpose of a strategy, as previously outlined.

- Overarching themes, such as urban resilience or responses to climate change, can constitute a discourse that bridges various disciplines and may thus enable integration processes. As mentioned above, the City of Glasgow provides an example where discourses about energy provision (The city is looking into extracting heat from waters in abandoned mine workings, see [44]), or inequality (see section 5.1.3) have led to a recognition of the subsurface and integration of the respective considerations into planning.

- The variety of stakeholders bridge different categories of subsurface usage and would thus have an opportunity to foster improved coordination within their particular organisation. The central position of the LPAs in the current arrangement, and the powerful position of technical knowledge highlighted beg the question of how the necessary knowledge is provided to or within the authorities. The fact that planning permission needs to be granted and requires means of judgement means that well informed and independent ‘judges’ are needed.

6. Feedback loops between material reality and social context

Based on the social context, humans plan structural interventions that, once completed, become part of the material reality and, as such, constitute boundaries for any future intervention. The above description shows that to gain planning approval and ultimately to change the material reality of the subsurface, financial and knowledge resources play a central role. This puts developers of buildings and infrastructure who have or are able to raise the required financial resources as well as engineers who hold the necessary knowledge to alter the material reality through their interventions in a powerful position. The continuous management of the Chalk aquifer shows how human interventions can lead to lasting changes in an underground system and to circumstances that have to be managed over the long-term. The resulting expenses have been termed ‘eternal cost’, for example in the context of the discontinuation of coal mining in the Rhein-Ruhr area in Germany, where the groundwater needs to be
maintained at a certain level to prevent local flooding and groundwater contamination and is continually pumped [45]. The London example differs in that the extracted groundwater here is being utilised and, as such, currently provides a benefit. However, in both cases the original intervention was focused on the needs and forces of the present and the consequence for the future were not foreseen. Hence, the irreversible change of material reality led to the formation of a new policy arrangement. The continuous management of the water regimes will be necessary for the foreseeable future. It is these kinds of ‘eternal cost’ that an underground planning strategy would seek to pre-empt – either though preventing the intervention in the first place or by incorporating the effects of discontinuation into the design of the structures that might be affected.

Such feedback loops between the material reality and human activity confirm that the use of the underground is ‘very much situational’ [46, p5], but also demonstrate that the picture of a ‘chaotic’ space is somewhat misleading. Rather, some specific elements – in this case, the groundwater table – are highly managed in order to avoid effects on the built and social environment. The notion of ‘incidental interventions’ [47, p215] is also deceptive, considering the amount of functions, institutions, people and regulations that govern the space. However, the examples discussed here illustrate that the spatial dependency of different functions, planning guidelines and decisions are not, or probably not, sufficiently understood or integrated. This is reflected, for example, in the various categorisation systems used for the subsurface as listed in [48]. Nearly all of these systems are one-directional in presenting the possible utilizations of the ground by humans and do not mention the influence that humans exert on the ground. The description of anthropogenic layers and man-made ground presented in Section 3 contradict this one-directionality. Human alterations of geology and the replacement of subsurface functions by man-made materials show that the dynamic is reciprocal. This recognition not only strengthens the proposition to define the current geological time period as ‘Anthropocene’ – that is, as human-influenced, as first declared in [49] – but also reinforces the notion that the concept of the Anthropocene is fundamentally linked to the underground [50].

7. Conclusions

This paper has illustrated the context and governance of London’s subsurface showing that the subsurface, the materials within it, and the functions it serves have had a profound effect on how London developed, and vice versa. The management of the deep aquifer and the prevalence of artificially modified ground or areas of archaeological interest were presented as examples of this co-evolution between London and its subsurface. The current governance arrangement around London’s subsurface was summarised and discussed, employing a modified version of the policy arrangement approach developed by [5]. For a specific moment in time, the original approach distinguishes between the organisational aspects (actors, rules, and resources) and substantive aspects (discourses) of a policy arrangement. In this discussion, material aspects were added, as these are understood as an essential basis for the study of subsurface governance.

The paper demonstrated how the discretionary essence of the UK planning system puts LPAs, on the one hand, and engineers and technical knowledge on the other hand, in powerful positions to mediate strategic plans and influence specific project applications and decisions. By way of comparison, purpose, location and urgency were looked at as defining elements for a potential underground specific planning strategy. The paper revealed that, for London, whilst no sense of urgency could be assigned to the concept of underground space planning in London at this moment in time, there appears to be a need for recognition and better understanding of the spatial and material effects of specific interventions, as well as of the according policies and strategies. Discourses around data management or energy provision as well as institutions bridging different subsurface topics have to happen anew for each location, responding to the specific physical, institutional, and social settings. Facilitating the process towards a spatial integration of the various strategies that are in place, the role these discourses and the resulting exchange and cooperation between stakeholders play goes beyond their specific topic-area.

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