The implementation of network governance for sustainable urban underground usage, a comparative analysis of the case studies of the cities of Rio de Janeiro, Brazil and Helsinki, Finland.

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Abstract. This research investigates how cities faced with the intensification of underground space usage to accommodate urban infrastructure are being required to change their traditional method of planning and management of underground space use. The shift is represented by the replacement of an uncoordinated approach to new forms of planning and management that respect the multiple interactions between stakeholders and takes into consideration the multiple relationships that are created with urban underground usage. The study works with the hypothesis that there is a need for a special form of governance of this layer that may contribute to the capacity of continuance of underground space usage for present and future generations, thus contributing for urban sustainability. Two case studies are developed to verify how the concepts are reflected in these cities’ lives and to compare the choices made by cities’ administrations, presenting their similarities or differences in order to assess how different initiatives may behave in different contexts. These case studies are the Helsinki Underground Master Plan-UMP, one of the world’s most comprehensive and advanced urban underground planning instrument and the Rio de Janeiro’s Project Geovias an initiative designed to map and register under one single database all the underground infrastructure existent in the urban area. aimed to make possible a more efficient arrangement of the city’s underground. The research suggests that the implementation of network governance tools centered on coordination and guidance of interactions and relationships according to shared objectives are examples of operational models of urban governance that modify the way cities plan and manage underground space usage more capable to provide the continuance of underground uses into the future what may be considered as a contribution for urban sustainability as most of these uses are vital for the satisfaction of the city’s essential needs.

Keywords: urban underground usage, urban underground planning, network governance.
1. Introduction

Considering that it has already been noted that “rapid and unplanned urban growth threatens sustainable development when the necessary infrastructure is not developed” (UN- DESA, 2014)[1] it is likely that, without appropriate planning and management, cities will struggle to provide the multiple services to satisfy their dwellers’ needs through the intensive use of the most suitable territory for the implementation of a great part of the city’s infrastructure services - the urban underground space. Indeed, some cities such as Stockholm have already acknowledged in their planning instruments the future shortage of space to accommodate their utilities infrastructure (Stockholm City Planning Administration, 2010) [2].

Cities have been exploring their underground territory for multiple infrastructure purposes for a long time, nevertheless, the planning and management of this layer still does not correspond to the same legal, economic and institutional framework applied at the city surface, a gap that may compromise the sustainability of the use of the underground resource in the future due to the intensification of the process of urbanization.

Lack of coordination of underground infrastructure development is a problem that has been frequently observed around the world (National Academy of Science, 2013 for the United States[3]; Chow et al., 2002 for Europe[4]). The uncoordinated piecemeal approach is imputed “to compromise the recognition of the full potential of the underground territory for the city development” (Dobinson, 1997, p.1) [5] and to overlook the social and infrastructure needs of the city in the long term, a pattern that is considered to be inconsistent with urban sustainability (National Academy of Science, 2013)[6].

If the trend for increasing exploration of this space under uncoordinated schemes continues, the feasibility of underground infrastructure might be compromised for future generations’ uses. Urban underground space is considered by some authors to be a scarce resource, limited by several constraints and by how the city’s surface is configured above ground (Bobylev, 2009)[7]. The sustainable provision of urban underground infrastructure depends on the availability of space and thus becomes closely tied to the planning and management of the urban underground space.

Therefore, if the uses of the underground space are growing, suggesting an increase in the complexity of the underground network and, at the same time, the availability of space is decreasing, reflecting scarcity, it is important to look at how better governance might be applied to implement sustainable underground usage for the fulfillment of present infrastructure needs without compromising the capacity of future generations to explore this territory to satisfy their own needs.

2. Research hypothesis and methodology.

2.1. Hypothesis. This research agrees with the conclusions of Adger and Jordan that sustainability might be interpreted, at the same time, as an outcome “the standards of human well being and the ecosystems on which it ultimately depends” and also as a process “through which we engage with our environment and the society is shaped and directed in ways that determine the future of both” (Adger and Jordan, 2009, p.5-6)[8]. In such latter case, governance appears as a fourth dimension of sustainability, as the same authors suggest that the implementation of sustainability depends on
processes of governing, guiding, participating and collective decision making that are typical of governance.

The working hypothesis drawn from this theory is that there exists a need for governance of underground territory for the sake of a sustainable provision of urban infrastructure and this hypothesis sets the boundaries and guides the aims of this study. Thus, it investigates the role of governance in the establishment of sustainable underground usage and how cities dealing with the governance of their urban underground may improve their capability to implement urban sustainability.

2.2. Methology and limitations. This research adopts a mixed method approach - a “class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (Johnson & Onwuegbuzie, 2004 cited in Yin, 2014, p.65)[9]. This work uses the variation defended by Yin (2014) where the research does not need to combine a variety of quantitative and qualitative methods but a mix of only one type of them, in this case, all qualitative methods (desk based research, case studies, interviews and comparative analysis). The research explores the case studies of two cities: Rio de Janeiro, Brazil and Helsinki, Finland. In this work the case studies are analyzed in order to verify the likelihood of a need for governance of underground usage to assure the sustainable provision of urban infrastructure as, according to Bouma and Atkinson, the case study may be done “in order to provide an initial test of a hypothesis” (Bouma and Atkinson, 1987)[10].

The choice was motivated by their different development backgrounds where the former lies has still unattended demand for infrastructure that may be placed underground while the latter has already a vast network of underground infrastructure and expertise in underground development. We also considered the different levels of maturity in their agendas of action where Rio de Janeiro has recently started a process to review the governance of its underground territory whereas Helsinki is the global benchmark for urban underground planning and development. The comparison of two different realities is intended to confront how the issues of urban underground governance may behave in different contexts and investigate the existence of similarities and differences between them.

However, the small sample of only two cities studied does not permit the construction of a global perspective on the subject considering that several others variables such as differences in governance regimes, economic and technological levels of development that exist in other cities around the world may also influence the results. Thus, the generalizability of this research should be taken with precaution until other researchers confirm the interpretation of the data collected for this work.

3. Literature Review.

3.1. Opportunities brought about by underground space usage for sustainable urban development. According to Sahely et al. (2005) “at the heart of urban sustainability issues lies urban infrastructure systems” (Sahely et al., 2005, p. 72)[11]. This is related to the fact that urban infrastructure is a critical asset that permits city life as citizens and economic activities heavily rely on the uninterrupted operation of infrastructure systems to perform their own activities. The same authors (Ibid, 2005) comment that the main obstacle for sustainable development is the transformation of its principles into
operational models. Thus, we might consider that a sustainable underground usage for infrastructure that may contribute for urban sustainability will also require an operational model to be in place.

The construction of this model, albeit not an aim in itself, is a fundamental process of assessments (of the underground territory, the infrastructure network and the built environment on both the subsurface and surface) and decision making (about the uses of urban infrastructure and its relationship with present and future users) by which the model will be configured, agreed and implemented. This process configures what we call the urban governance of the underground space and what, according to Adger and Jordan (2009) is one of the aspects of sustainability “through which we engage with our [urban underground] environment” (Adger and Jordan, 2009, p.6)[12].

3.2. The concept of urban governance and its relationship with infrastructure networks. Bobylev and Jefferson (2014) remark that considering physical assets of urban infrastructure through the governance concept is still a new approach as this component of the city’s life has been under evaluated by the governance research (Bobylev and Jefferson, 2014)[13].

The main features of urban governance are its multilateralism where it is recognized that power exists inside and outside the formal authority and institutions of government and its aspect of a decision making process where decisions are made based on complex relationships between many actors with different priorities (UN-HABITAT, 2002)[14].

When planning and managing for infrastructure networks the interactions are high because it exists in a multilateral arena that requires involvement, negotiation, information and decision making among different levels and departments of government each one with its own legal competences and rights, different players, private and public explorers of services and different expectations of the multiple stakeholders: licensors, dealers and users. Klijn et al. (2010) highlight that is often impossible to achieve satisfactory outcomes in complex interaction processes without adequate network management (Klijn et al., 2010)[15].

In this respect, urban infrastructure might be considered as one of the fields of city management that needs most the implementation of a scheme capable to organize and guide its natural tendency for dispersion among different uses. Koppenjan and Klijn (2004) call this initiative, network governance-a public policy and implementation that observes the interdependencies through a web of relationships between government, business and civil society actors (Koppenjan and Klijn, 2004 cited in Klijn et al., 2010)[16] a concept that we argue is valid to be applied to planning and management of physical infrastructure assets. According to Griffioen et al. (2014) “sustainable use of the subsurface has to do with being able to continue using the subsurface for existing uses and with accommodating new uses” (Griffioen et al. 2014, p.811)[17]. It seems therefore reasonable to accept that some sort of governance scheme that looks at these complex interactions will be required if the sustainable use of the subsurface is envisaged.

3.3. Urban underground infrastructure network and the governance of the underground space. The most important driving force for underground development suggested is the ever increasing process of urbanization coupled with the demand for better quality of urban environments (Kaliampakos and Benardos, 2008)[18].
It seems unquestionable that the rapid process of urbanization and the consequent intensification of uses of underground is a root cause for the unsustainable use of urban underground spaces as mentioned. Nevertheless, this may be not the sole cause. We might also need to recall the statement of Rode and Burdett (2011) that “urban sustainability problems are not necessary characteristics of urbanization but can rather be considered as results of poor governance and planning” (Rode and Burdett, 2011 cited in McCormick et al. 2013, p.3)[19].

Indeed, some public authorities already recognized their deficiencies on planning, management or coordination of projects in underground development and implemented some sort of policy or regulatory scheme to foster a more structured and efficient development. This was the case for example in Helsinki, where the lack of clear guidelines motivated the review of the planning system for underground construction (Ronka, Ritola, and Rauhala, 1998)[20] and Rio de Janeiro, where the need to enhance the safety of the city’s underground network and prevent accidents boosted the development of a project to map the city’s underground utilities network (Município do Rio de Janeiro, 2012)[21]. We assume that the process of planning and management of urban underground development is more likely to be successful with the implementation of a governance scheme that respects the multilateralism between actors and takes into consideration the multiple relationships that are created with the implementation or expansion of the underground infrastructure network. The ways these two cities are implementing such schemes are analyzed in the following sections.

4. Case Studies.

4.1. Case Study Helsinki. The intensity of use of the underground territory and the close relationship of the underground planning activity with the above ground land use has led the City Planning department to draw up, at the beginning of the 1980's, the city's first overall plan for underground space use for the densely built-up central business area and to set out, in 1986, a space allocation plan for underground activities for the entire city (Narvi et al., 1994)[22]. Notwithstanding the control and planning measures already in place, the extensive volume and variety of uses of underground construction has shown the administrative and legal shortcomings related to underground construction in Finland. In the early 2000’s, the scale of use of the subsurface, the need for coordination of different projects and the growing demand to connect underground premises to each other to form coherent and interrelated complexes (Vähäaho, 2011[23], Vähäaho, 2014[24]) mandated the creation of an underground master plan for the entire city.

The Helsinki- UMP, administrated by the City Planning Department is a legally binding general plan that “controls the locations, space allocations and mutual compatibilities of the newest, largest and most important underground rock caves, facilities and traffic tunnels of the city while also safeguards the permanency and functionality of facilities already constructed” (City of Helsinki, 2009) [25].

The plan has a strong relationship with above ground planning as it serves as a guide when preparing surface zoning plans (City of Helsinki, 2009)[26]. Further, the selection of underground resources is made by taking into consideration issues of accessibility from the surface- an important feasibility factor in underground development according to Ronka, Ritola, and Rauhala (1998)[27] –
and other features of the surface such as zoning, traffic connections, land ownership and possible recreational, landscape and environmental protection values (Vähäaho, 2011)[28].

The Plan also considers the reservation of unnamed rock resources for unclassified future use. The aim of the reservation is to assess resources that are adequate for urban functions suitable for locating underground, and to reduce the pressures on the most demanded sites at the city centre (Vähäaho, 2011)[29]. The approach is relevant because the selection of unclassified resources shows that the Plan is purpose driven and rock-resource driven instead of being solely guided by the most common paradigm of being demand-driven that still rules underground development elsewhere.

4.2. Case Study Rio de Janeiro. The city of Rio de Janeiro started to specifically regulate the usage of the urban space to address the implantation of infrastructure (including underground) with the promulgation of the Decree no. 18.627/00 that brought, for the first time: an analysis of infrastructure networks projects, a permission of use that stipulates the conditions for the beginning of any infrastructure work, a charge for the public space use, a presentation of plans of implantation or expansion of infrastructure network[30]. Nonetheless, the legislation was not sufficient to avoid problems with underground infrastructure. In 2010/2011, a sequence of explosions of manholes in the streets of Rio caused injuries and fatalities showing the fragility and insufficiency of the management system that was in place. The accidents served to boost the implementation of a new initiative that was being managed by a working group established by the city government in 2010: Project Geovias.

The project was designed to integrate the databases of a consortium of different utilities companies (water, gas, electricity and communications) operating in the city of Rio de Janeiro. This would make possible to map and register under one single database all the underground infrastructure existent in the urban area. The motivation for the Geovias was the recognition by the city government of the needs of: “an arrangement for the city’s underground to be more efficient and effective” and of “raising the level of safety and reduce the risk of accidents by detecting and preventing possible interference between existing underground networks, whether gas, electric power, water, telephone, and other communications that may come to coexist underground” (Município do Rio de Janeiro, 2012, Municipal Decree nº 35.127, preamble)[31].

The second phase of Geovias also envisages optimizing the licensing procedures for infrastructure works. The digital system workflow for analysis of projects derived from the initiative is expected to coordinate the information and evaluation dispersed among different city government departments involved in the licensing process as well as to inform different utilities companies that might be affected in a given intervention. The procedure could bring reductions in the licensing terms and permit the coordination of interventions by different utilities companies within the same site, which would minimize the nuisance of building or maintenance works (Silva, 2011)[32].

It is likely that, once in place, Geovias will help to accomplish one essential condition for a good urban underground development, the mapping and registering of the several underground infrastructure networks, and fill one important gap mentioned by Parrieux et al. (2006)[33] - the dispersion of data, enhancing the city’s institutional capability to deal with the subject.
5. Discussion.

5.1. Differences and Similarities between the two cities. Although the two cities have different levels of maturity in their underground development agendas, perhaps due to the longer history of work on the theme performed by Helsinki (29 years, almost double that of Rio), it was perceived from the desk based research that both were strongly motivated by the need to coordinate the interactions between different uses and infrastructures. The studied cities had overcome the limitations brought about by a site-specific approach that could hinder integrated management through the development of city-wide initiatives.

The enforcement of objectives were safeguarded by the adoption of legally binding instruments - Municipal Decrees nº18.627 and nº35.127 for Rio and City Council Decision number 16 (Khs 2009-237) for Helsinki (Helsinki City Council, 2010)[34] which clearly demonstrates the institutionalization of the operational models adopted by them. Both cities have their instruments tied to other planning or regulatory instruments that are specific to the field of underground development or also related to general land use planning and, in Helsinki, related to environmental planning. However, the relationship between dedicated instruments for underground use with general ones is much higher in the case of Helsinki. The Helsinki Underground Master Plan is considered to serve as a guide when proposing aboveground zoning plans whereas in Rio, the rapport is not as significant as in Helsinki.

The need to order the occupation, operation and deployment of operating systems in technical galleries and ducts underground is mentioned as an objective of the sanitation and public services policy (Plano Diretor do Município do Rio de Janeiro 2011, article 219, IV)[35] but the city’s Master Plan ignores any possible contributions of underground development for the city’s overall development, thus, confirming the dominance of the “flat model” reported by Zhanga; Chena and Yang (2011)[36].

In addition, any further consideration about the harmonization of laying out underground infrastructures according to the environmental features of the city’s underground is strikingly absent despite the fact that Rio has developed a pioneering work of geotechnical mapping since 1965 (Franco et al., 2010)[37].

The main drivers for the two cities’ strategies differ in their nature. Rio de Janeiro seems to follow a top-down approach where a management tool – the Geovias register- is used to understand the reality in order to and accommodate the demand appropriately following the common demand driven development approach mentioned by Bobylev (2009)[38]. In contrast, the city of Helsinki built its urban underground development strategy by combining bottom-up and top-down approaches under purpose and resource drivers. The main difference is that purposes are balanced against what exists and is planned on the surface, thus making the underground territory an integral part of city life influenced by the land use at the surface but also capable of influencing the configuration of the city’s surface.

The approach also takes into consideration the physical nature of the underground space itself and the natural processes that are in place in order to assess the feasibility of current and future uses. In this manner the Helsinki-UMP can be interpreted to be a planning tool that has advantage of looking after the environmental dimension of sustainable underground development.
5.2. Differences and Similarities according to governance processes. The assessments made by the city of Helsinki cover not only mapping the infrastructure network itself but also the environmental conditions of the underground urban area, an option that enriches the level of information given to different stakeholders and makes possible to cover an eclectic range of interests that goes beyond the infrastructure operation. Geovias, instead, had its scope of assessment restricted to mapping the existent infrastructure of utilities. The result is that in practice the project had little involvement of other stakeholders besides the government, as legal grantor and licensor of the services, and the companies that operate the services because of their direct interest in the configuration and operation of the infrastructure network.

The stakeholder involvement in the elaboration of the Helsinki-UMP was higher than in the elaboration of the Geovias. Between 2005 and 2009 a wide consultation process, comprised of: discussions open to anyone interested, discussions with target groups and distribution of draft for comments and objections, was in place for the elaboration of the Helsinki-UMP before its submission to the City Council (Vähäaho, 2014)[39]. In Rio the discussion was restricted to the circles of government departments, regulatory agencies and operators of the infrastructure system. Regardless the restrictive access given during the formulation of the Geovias, the discussion initiated by the Project was a novelty regarding the planning of the underground territory of Rio and assumed to be crucial to the attainment of the objectives of the Project as one interviewee stated that “It is not possible to achieve this level of order [of the urban underground network of utilities] only by imposition. The possibility of legal enforcement is not enough when other variables are present. The agreement leads to success, if we do not seat at the table to find a way it is not possible to move forward” (Regalo, 2015).

While in Rio the process of discussion and negotiation to elaborate the Geovias register was recognized to enhance the quality of the understanding about the theme of underground space usage, in Helsinki it was acknowledged that the long process adopted for the elaboration of the Helsinki-UMP has contributed to bring institutional stability for the implementation of urban underground development.

6. Findings.

It seems that cities are recognizing that stronger knowledge, broader involvement and better coordination are mandatory when planning for the usage of their underground territory and that standard legal provisions alone might not be sufficient to tackle the complexity involved in this endeavour. The rise on ordinances and provisions specifically designed to underground development and management suggests the plausibility of the working hypothesis, that there is a need for the implementation of any sort of scheme to promote governance of the underground territory when the sustainable provision of underground infrastructure is envisaged.

It is likely that the process of elaboration of the studied instruments itself served to raise awareness for the theme, increasing the level of information, coordination and involvement among stakeholders. In the two cities 66% agreed and 33 % strongly agreed with the occurrence of this outcome [41].

Particuraly in Rio, it was pointed out that the unified approach had the benefit to minimize undesirable nuisance resulted from subsurface works that cause interruptions, noise and others
disturbances at the surface. The Geovias register was acknowledged to be responsible not only for an increase on the efficacy of the operation of the different networks and to help to avoid cross damage between them but also as a game changer for the utilities companies that started to consider the underground network as a physical asset with an intrinsic economic value due to its crucial importance for the continuation of their business (Regalo, 2015)[42].

7. Conclusion.

The implementation of both Project Geovias and the Helsinki-UMP constitute examples of a new way of planning and management for the sustainable provision of urban infrastructure where cities adopt dedicated procedures in order to facilitate and coordinate complex interactions that may occur with the rise on the exploitation of their underground territory. Although different in their form, they might be both considered as a component of a new operational model that is institutionalized in order to deal with the urban underground that take into consideration the network governance of urban underground spaces centered on coordination and guidance of interactions and relationships according to shared objectives.

Some characteristics that distinguish this operational model are: the assessment for thorough understanding of the subject, the involvement of stakeholders other than government, the sharing of information and the institutionalization of the model.

It was demonstrated that, between the cities studied, presently only the city of Helsinki has implemented the highest level of network governance. This is due to the ample scope of assessments that, not only include both the present and future demand for infrastructure, but also considers the environmental conditions of the underground resource; the alignment of objectives of the surface and the underground planning agendas and the implementation of a broad involvement of stakeholders, a group of processes that, together, create an enabling environment for sustainable underground usage.

The instrument chosen by the city of Río de Janeiro seems to be, however, insufficient to cover the whole complexity of the subject, as it only looks at the utilities network and not to the whole features of the underground space. Therefore, comparing to the Helsinki-UMP, the Geovias might be more limited in its contribution for enabling urban underground sustainability. Nonetheless, Río’s instrument is definitely a landmark for the city’s organizational culture regarding the governance of its urban underground. Therefore it can be accepted as a starting point for a process capable to contribute to the building of a more sustainable model for urban underground usage in this city.

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