

Underground Space and Street Art towards resilient and sustainable infrastructure

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Abstract

Cities are shaped and re-shaped dynamically, through spatial and social interactions that occur and develop among places and people, and the way they inhabit them. Graffiti and street art are urban phenomena that illustrate and reveal these socio-spatial interactions. While they are formed by other cultural, historical, and aesthetic components of a place they become part of that place over time.

At the same time, they can be used as a tool to disseminate ideas, challenges, and memories in cities, whilst being an expression of urban space and its governance. They constitute visual signs of the city and thus challenge the existing urban aesthetics while producing new social narratives and counter-narratives in place. As a practice, they have been primarily associated with the public expression of the marginalized other, one that disrupts the visual landscape of the city. Nowadays, graffiti and street art have become popular and are recognized as expressions of contemporary art, finding their ways in galleries, art fairs and public spaces as acclaimed commissioned artworks, balancing between the mainstream and the marginal [1].

Often graffiti can also be found in pedestrian passageways and tunnels. Underground space is part of the built environment and often as infrastructure (constructed through mining and tunnelling), specifically in urban settings, where a major application is transportation infrastructure. However, there is a growing number of other underground applications such as utilities, geothermal energy, groundwater resource, storage, parking, and even public recreational facilities (such as swimming halls and sports centers) and underground farming. The processes of urbanization ask of a comprehensive understanding, re-thinking and reshaping of the underground spaces that become even more vital and crucial in the urban transformation of our cities, considering overpopulation and extended density figures that urban settings suffer from. The ‘right to the city’ defined from Lefebvre (1996) as the “right to change ourselves by changing the city” in order to achieve urban and social transformation, transcends from the over ground spatiality of our cities to their adjacent underground spaces. There is consequently the need of changing the public perception of the underground space of that being a welcoming and friendly environment, that fosters social interaction and inclusion [2].

This paper examines how street art and underground space can work together and add social value to existing urban environments by contributing to resiliency and sustainable smart cities (by means of specific examples that are further analysed). Conclusions on ways of creatively re-thinking the urban (underground) space and making it more human-friendly by changing the existing public perception are drawn.

Keywords: *urban city; public space, street-art; urban sustainability; resilience; infrastructure, underground space.*

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1. INTRODUCTION

Contemporary cities foster the ecosystem of urbanism. As the world population is growing dramatically the last decades and the need of building effective urban ecosystems in cities is imminent. A huge challenge however, that needs to be overcome are surface space constraints which can prevent the city from expanding horizontally, for instance Hong-Kong or New York City. In addition, the latter solution is not considered as a smart way of expanding the territories of the city nowadays, as this can impact further the well-being of its citizens by making it inevitable to commute for longer periods while contributing to gas emissions, deteriorating the environment. Resource inefficiency is another by-product of this. The more we are spread apart the less efficiently we can use our supporting infrastructure and energy supply. Underground space is also part of the cities we live in. Consequently, in order to overcome that challenge, there is the urgency to consider the underground space within the urban planning and development phases of a city.

When considering critical urbanism, geography and cultural studies, one can understand our cities' and urban regions' complexities by looking at urban transformations through various lenses. [3] tried to implement this by introducing the dynamic structuralism approach. According to his views, the nature of contemporary urbanism is co-produced "with simultaneous forces, movements, agents and politics". More specifically, the dynamic structuralism approach focuses on the value of unpacking other central forces that are dominant at a specific place and time and constitutes structural forces in the shaping of our cities. Hence, the role and significance of forces concerned with the city's economic life, the globalizing economy, and the capitalistic modes of space production are recognized [1].

The main questions that this research work tries to answer are: How can urban underground spaces become an integral part of cities and be holistically considered in their development? How can the multi-layered dimensions in a city include and involve the underground space as part to grow together organically? Can urban underground space contribute to sustainable development? This paper focuses on how street art and underground space can work together while adding social value to existing urban environments by contributing to resiliency and sustainable smart cities.

2. UNDERGROUND SPACE

Mass rural to urban migration leads to cities becoming vastly overpopulated while emerging challenging issues emerge that the world will need to address. Estimates suggest that by 2050, 70% of the world's population will be living within urban areas [4]. At the same time, governments are looking to expand cities to accommodate rising populations whilst maintaining open and green spaces, ensuring a good quality of life [5]. The latter plants a major challenge of space availability in urban areas. [6] argued on the value of underground space in urban environments as it is utilised to build the foundations of buildings, harvest the crops, extract ores and minerals which are all non-renewable while providing recommendations on how to consider the subsurface as the foundation of life for any living creature and entity. There is the misconception that underground space is only related to the construction of tunnels, and mainly for utilities and transportation, as well as mining activities [2]. However, underground space has developed over time and utilised in many ways while its limited early uses have evolved into geometrically complex arrangements [7]. A multitude of uses of underground space have been applied over time in different parts of the world. There has been significant growth in underground space use over the last century [2], in parallel to the

invention and innovation of new technologies allowing for complex constructions and developments of the underground.

Currently, there is a plethora of other underground applications (Figure 1) such as: geothermal energy, groundwater resource, storage facilities, parking even underground farming and public recreational facilities (such as swimming halls and sport centres) [2]. However, [7] argued that the growth of underground space, particularly in the last century, has been sporadic and poorly planned, typically implemented as a reactive measure. Poor planning has created issues of overcrowding and misuse of underground space. Early identification of arising issues has allowed some to understand that planning the use of the subsurface is necessary but this is still the small minority as it has not yet sunken into the heads of urban policy makers. A recent goal has been to plan effectively and sustainably, meaning underground space can evolve by implementing innovative ideas and stretching the limits of what the subsurface can provide for future generations. The ITA Committee of Underground Space is in constant contact with major urban policy and planning authorities and agencies to foster this thinking.



Figure 1. Example of user-friendly and sustainable use of underground space: Cliffs of Moher, Ireland, visitors centre (Photos Courtesy: C. Paraskevopoulou).

Underground space however is often considered as a dark and less-welcoming environment, not friendly or even scary for the users. This is a miscomprehension of the general public without realizing that in overpopulated places around the world the most visited public spaces are usually the underground metro lines and their ubiquitous stations reaching great depths down to 100 m. As [2] stated there is consequently the need of changing the public perception of the underground space of that being a welcoming and friendly environment, that fosters social interaction and inclusion.

[8] stated that megacities have a big impact in the economy and politics of urban development at a global scale. [2] highlighted those processes of urbanization require a comprehensive understanding, rethinking and reshaping of the underground spaces that become even more vital and crucial in the urban transformation of our cities, considering overpopulation and extended density figures that urban settings suffer from. The ‘right to the city’ defined from as the “right to change ourselves by changing the city” in order to achieve urban and social transformation, transcends from the aboveground spatiality of our cities to their adjacent underground spaces [2].

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2.1 Underground Space and Sustainability

[2] suggest there is historical evidence that ancient civilisations, including the Greeks, Egyptians and Romans, dealt with environmental challenges such as deforestation, salinisation, and soil fertility. These challenges were identified as environmental degradation, and there is evidence of mitigation techniques designed to extend the earth's lifetime [2]. However, despite early evidence of considering sustainability, it was only much later when sustainable development was first discussed in literature by John Mill in 1843 and since, variations of authors ideas of sustainable development have continued [2]. In modern times the commonly quoted definition of sustainable development was put forward by the World Commission on Environment and Development in 1987: "sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their needs". Thirty years almost later in 2015, all United Nations Member States adopted the 2030 Agenda for Sustainable Development based on which 17 Sustainable Development Goals (SDGs), shown in Figure 2, were introduced and 169 targets were set that are integrated within the three-fold sustainable development of social, economic and environmental pillars. These agendas aim to achieve "a world free of poverty, hunger, disease and want", where living environments are safe, resilient and sustainable with inclusive access to affordable, reliable and sustainable energy [9]. Many of these SDG's can be linked to underground space development and are considered in the work presented herein.



Figure 2. Sustainable Development Goals introduced in the 2030 Agenda for Sustainable Development proposed by the United Nations members in 2015 [9].

2.2 Underground Projects and SDGs

Underground space applications can target various Sustainable Development Goals (SDGs) [2], to investigate this further a database of 30 underground projects were examined and grouped into the following categories based on their application purpose: transport & commuting, energy (geothermal hydropower), storage (waste), recreational, housing and food & beverage (FnB).

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The results of this analysis showed that most of the SDGs can be targeted in underground projects. More specifically in Figure 3 it is shown that 66.6% of the under-investigation projects targeted SDG 3, 7 and 11: good health and well-being, affordable clean energy, sustainable cities, and communities. Furthermore, 50% of the projects (15) targeted SDG 13 on climate action. Illustrative examples of such underground space are illustrated in Figure 4. More specifically when considering the benefits of transitioning towards the underground space even in the case of semi-underground housing (Figure 4.c) the energy demand can be a key driver. [10] compared the total energy demand of typical aboveground house and an earth-sheltered building located in Kea Island in Greece (close to the mainland with similar climate and temperature of Attika region). The results indicate that the surface building has an overall of 42% bigger total energy demand than the underground building.

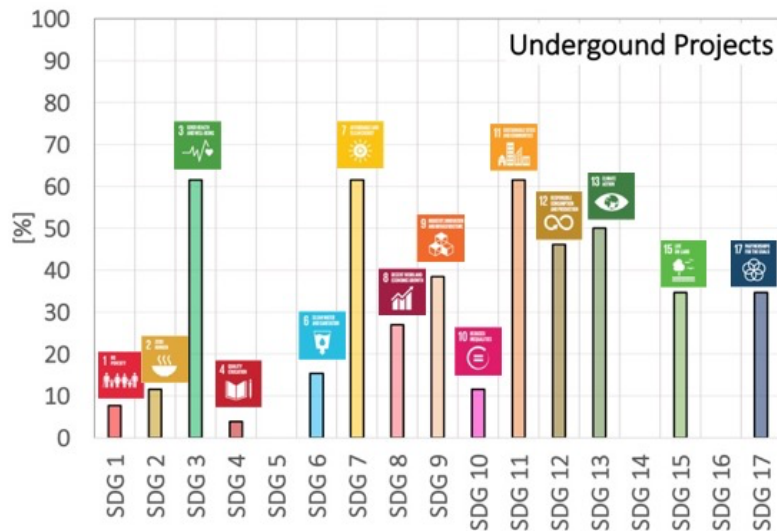


Figure 3. SDGs and Underground Projects.



Figure 4. Sustainable Underground Projects: a. Underground boat parking/storage, b. Underground Green Farming and c. Underground Housing.

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3. STREET ART

On the one hand, interactions between the space and the people are responsible for how cities are formed, developed and eventually re-formed to meet these interactions' requirements. On the other hand, graffiti and street art as urban phenomena illustrate and reveal these socio-spatial interactions. At the same time, they get integrated with the cultural, historical and aesthetic characteristics of a place [1]. They express new social narratives (and counter-narratives), challenging the existing, known and widely accepted urban aesthetics being exposed to the public sight. Nowadays, graffiti and street art have shifted to become popular and are recognized as expressions of contemporary art, shown in art galleries and public spaces as acclaimed commissioned artworks, balancing between the mainstream and the marginal [1].

Many researchers from various scientific fields, mainly social sciences, have tried to develop an understanding of the cultural dimensions of both graffiti and street art. [11] in 1982 in an attempt to analyse the subway graffiti thriving during that period in New York City, concluded that this initiative was targeting the spatial politics of the city at that time. According to [12] graffiti as we see it in urban areas is an attempt to interrupt the established order of the everyday life. [13] defied that graffiti and street-art have “taken-for-granted everyday normative landscapes”. Others explored the relationship of street art and ‘urban creativity’ with the city’s economic growth [14] in terms of ethics and space. According to [1] “sterile urban environments with ‘clean’ and sanctioned urban aesthetic are produced through commissioned street-art pieces, popularizing the ‘hip’, ‘mainstream’ and ‘upmarket’ neighbourhoods within the urban fabric. In this regard, the relation of the ‘criminalized’ graffiti practice and the ‘commissioned’ urban street art to the practices of spatial governance is underpinned.”

According to [15] the organization of space must be performed in the street, both materially and symbolically, as the street is a *“place for talk, given over as much to the exchange of words and signs as it is to the exchange of things. A place where speech becomes writing, A place where speech can become ‘savage’ and by escaping rules and institutions, inscribe itself on walls”* ([16]:19). Illustrative example “Fight for Street-art” shown in Figure 5.

Considering the afore-mentioned this research work focuses on identifying street art as a structural force that can co-shape the urban environments with emphasis on underground spaces. At the same time, street art as an artistic and cultural expression is placed and produced in public space so as to be viewed and encountered by the city’s inhabitants and/or passer-byes. In this respect, this practice represents an urban expression and intervention contributing and/or challenging the existing social realities of the city [1].

Consequently, this practice contributes not only to the spatial transformation of specific urban areas but results in the transformation of our social world. According to [1] “this intertwined relationship of the public presence of street art, and its private ‘social’ understandings is at the core of unpacking not only the production and/or transformation of the urban environment, but also the construction and perception of our urban realities, and thus of the diverse forces that assemble our cities”. [1] argues that this two-fold process leads to the construction and re-construction of urban space, and while at the same time reinforcing and/or transforming perceptions of the urban.

“the street becomes a place for talk, given over as much to the exchange of words and signs as it is to the exchange of things. A place where speech becomes writing. A place speech can become ‘savage’ and. By escaping rules and institutions, inscribe itself on walls’
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Figure 5. Street-art example in New York City “Fight for Street-art” piece by Artist Kobra.

3.1 Street art as critique

[17]: 62) stated that intermural art, which is art between the walls [18], ‘through the visible presence of the material artefact suggests the representation of diverse voices within the urban, exercising their right to appear regardless of the absence of the performing action. Critique is generated then not only through the channelled message of the image, but also in the way the message is created, where, by whom and towards who. The latter implies that thought this act of critique ‘intermural art’ may result in constructing ‘new ways of being in the city’ and of ‘understanding of our urban realities’.

[1] suggests that cities are spaces of concentration which in turn requires to find balance within the social life to achieve social order. She continues by suggesting that street art is often associated with ‘illegal practice’ and often challenges the techniques of controlling the public space. The latter has driven its integration into commissioned and municipal led programmes to eliminate the anti-graffiti activities.

3.2 Street art as the art in between

[19] argues that graffiti and street-art have a transitional and non-permanent nature sitting at thresholds, in which the pass-byer is sitting between the former way a structured and known identity and the new unknown open to question course of action. This so-called concept of liminality is adopted in intermural art and it creates passages and not confined spaces to the pass-byer.

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[20] argues that this liminality found in intermural art serves as interruption of the ‘authorised’ use of public space’ and they build upon this by suggesting another dimension of space based on the social interaction and social exchange of memories and images creating a symbolic meaning ([21]: 24). [22] states that this kind of art becomes a ‘turning point’ of an urban threshold “belonging to everybody and nobody at the same time, in which different groups and individuals could negotiate their presence, their acts and their suggestions”.

4. INTEGRATION

The means of implementation for sustainable development are closely associated with models of economy (i.e., circular model of economy) [2] otherwise it would remain an utopian idea. This approach holistically considers how underground space as part of the ecosystem can contribute to achieving global sustainability. This holistic appraisal method for determining (planning and designing) was initially introduced by [6] and considers 4 factors investigating the geological, ecological, planning and the environmental aspects while considering the past, present and the future as shown in Figure 6. This underground space development model examines not only the subsurface independently from the aboveground system but also as an integral part of the overall system focusing on its long-term impact in this eco-system [2].

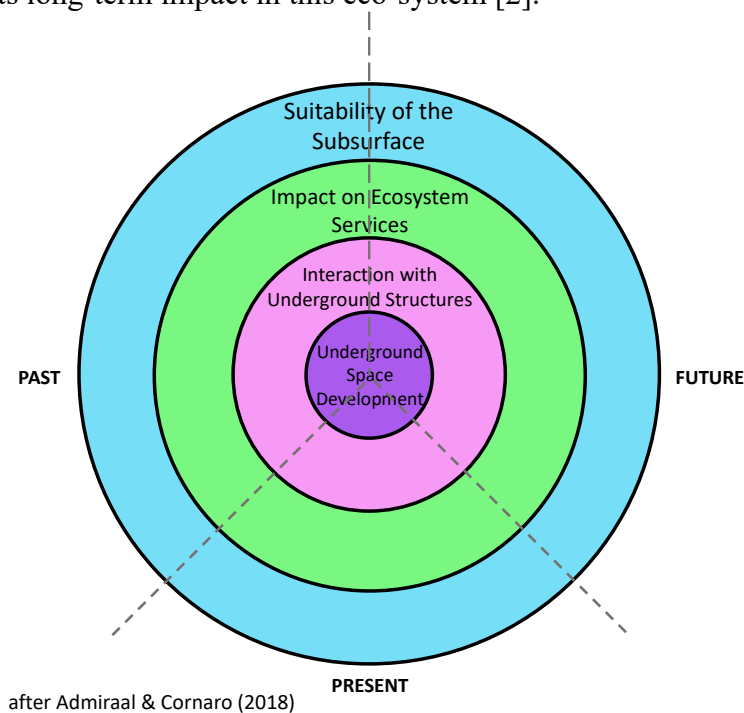


Figure 6. Underground Space Development Model (modified after: [6]).

Street-art then, as it has been previously implied, can contribute towards underground space development by creating these thresholds challenging the -bye-passers’ perception, thereby creating spaces of indirect communications.

One successful example of utilization of such underground space, are the Stockholm metro stations where passengers and visitors can stroll through and around unsupported granite stations, due to the artistic component and the welcoming environment that the painted unsupported surrounding rock has created.

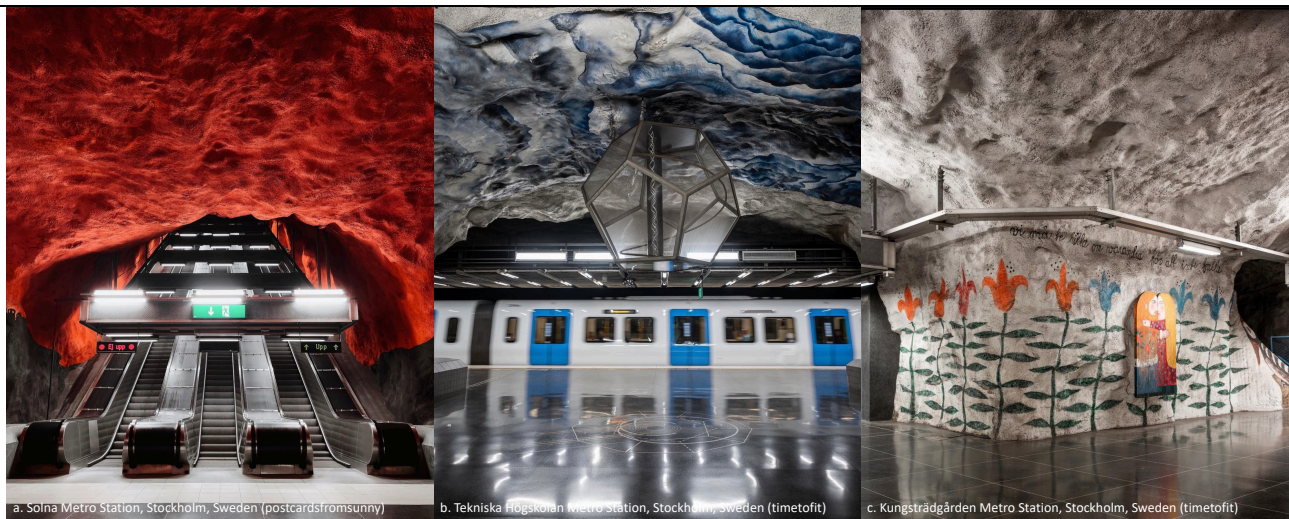


Figure 7. Metro Stations from Stockholm Subway: a. Solna Metro Station, b. Tekniska Högskolan Metro Station and c. Kungsträdgården Metro Station (Sweden).

4. CONCLUSION

Underground space is a major strategic asset of cities worldwide, and when perceived and encountered holistically in the urban eco-system can contribute towards securing long-term sustainability and resilience of cities. As shown a holistic approach needs to be undertaken where underground development is required not only in terms of spatial organization or overcoming the engineering challenges but also regarding the establishments of policies, regulations, and social factors considerations. Another challenge is that the next generation of underground experts will need to address is how the lifetime of existing underground projects can be prolonged in terms of sustainability? Can the abandoned underground structures be re-purposed and re-used? Can street-art contribute towards this re-formation and transition? Well, an attempt to answer these questions was presented in this paper but to achieve the above there is the need to bring together a multi-disciplinary group of people consisting of experts, scientists, engineers, lawyers, planners, architects, ecologists, economists, designers, students, etc. with fresh minds, ideas and intuition to jointly make the world we live in a better, sustainable and resilient environment for the next generations. The ITA Committee of Underground Space, ITACUS, is very much working towards these goals.

References

1. Paraskevopoulou, A. Managing 'crisis': exploring the role of street art within local municipalities' responses in the governance of crisis. Athens, Greece. The Bartlett Development Planning Unit, University College London, United Kingdom. (in prep.)
2. Paraskevopoulou, C., Cornaro, A., Admiraal, H., Paraskevopoulou, A. 2019. Underground space and urban sustainability: an integrated approach to the city of the future. In: Proceedings of the International Conference on Changing Cities IV: Spatial, Design, Landscape & Socio-economic Dimensions. 4th International Conference on "CHANGING CITIES: Spatial, Design, Landscape & Socio-economic Dimensions, 24-29 Jun 2019, Chania, Greece. University of Thessaly. ISBN 978-960-99226-9-2.

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of the International Conference on Changing Cities V:
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ISBN:

3. Yiftachel, O. 2016. The Aleph—Jerusalem as critical learning, *City*, 20:3, 483-494, DOI: 10.1080/13604813.2016.1166702
4. UNISDR 2013. Global Assessment Report on Disaster Risk Reduction 2013, From United Nations (2007) World Urbanization Prospects. The 2007 Revision. United Nations, Department of Economic and Social Affairs (DESA). See <http://www.un.org/esa/population/unpop.htm>.
5. Admiraal, H., Cornaro, A. 2020. Future cities, resilient cities – The role of underground space in achieving urban resilience, *Underground Space*, Volume 5, Issue 3, 2020, Pages 223-228, <https://doi.org/10.1016/j.undsp.2019.02.001>.
6. Admiraal, H. and Cornaro, A., 2018. *Underground Space Unveiled: Planning and creating the cities of the future*. ICE Press, London, UK.
7. Von der Tann, L., Sterling, R., Zhou, Y. and Metje, N., 2020. Systems approaches to urban underground space planning and management—A review. *Underground Space*, 5(2), pp.144-166.
8. Kaliampakos, D., 2014. Underground Development: A Key to Unlock the Sustainability of Modern Cities, Proceedings of the 14th International ACUUS Conference: “Underground Space: Planning, Administration and Design Challenges”, 24-26 September, Seoul, 2014.
9. United Nations Summit, 2015. 70th Session of the General Assembly: Report on Sustainable Development, New York, USA.
10. Benardos, I. Athanassiadis, N. Katsoulakos, Modern earth sheltered constructions: A paradigm of green engineering, *Tunnelling and Underground Space Technology*. 41 (2014) 46-52.
11. Castleman, C. 1982. *Getting Up: Subway Graffiti in New York*. Cambridge, MA: MIT Press.
12. de Certeau, Michel. 1984. *The Practice of Everyday Life*. Berkeley, CA: University of California Press.
13. Cresswell, Tim. 1996. In *Place/Out of Place: Geography, Ideology, and Transgression*. Minneapolis, MN: University of Minnesota Press.
14. McAuliffe, Cameron. 2012. ‘Graffiti or Street Art? Negotiating the Moral Geographies of the Creative City’. *Journal of Urban Affairs*. 34(2): 189–206.
15. Lefebvre, H. 1991. *The production of space*. Oxford: Blackwell.
16. Lefebvre, H. 2003. *The urban revolution*. University of Minnesota Press, Minneapolis, MN.
17. Gyftopoulou, S., and Paraskevopoulou, A., 2016. “Crisis ridden space, knowledge production and social struggles: The case of Athens,”. In *UniConflicts in spaces of crisis Critical approaches in, against and beyond the University*, edited by ‘Encounters and conflicts in the city’ group, 61 – 74. Greece: Thessaloniki, Greece. url. https://www.academia.edu/30180913/UniConflicts_in_spaces_of_crisis._Critical_approaches_in_against_and_beyond_the_University
18. Schacter, Rafael. 2014. *Ornament and Order: Graffiti, Street Art and the Parergon*. Burlington, VT: Ashgate.
19. Stavrides, S., 2014. “Emerging Common Spaces as a Challenge to the City of Crisis”. Paper presented at the conference *Crisis – Scapes: Athens and Beyond*, 209 – 214. National Technical University of Athens, May 9-10. url. <https://issuu.com/crisis-scape/docs/crisisscapesconferencebookweb>
20. Hénaff, M. and Strong, T., 2001. *Public Space and Democracy*. Minneapolis: University of Minnesota Press.
21. Low, S.M., 2009. “Towards an anthropological theory of space and place”. *Semiotica*, no. 175: 21 – 37. doi. 10.1515/semi.2009.041
22. Stavrides, S., 2013. “Contested urban rhythms: from the industrial city to the post-industrial urban archipelago”. *The Sociological Review*, 61(S1): 34–50. doi: 10.1111/1467-954X.12052