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The Invisible Morphology of the Loss: Convergence of urban forms and divergence of ecology

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Abstract

Streets are the fixation lines of the fringe belts, borders of the morphological regions, frameworks of urban design practices in the city, veins of the mobility and tools for accessibility in the cities. As the accessibility and connections between cities increase, changing land use patterns cause ecological fragmentation as well as morphological transformations. This situation is incompatible with the sustainable cities approach that is laid out especially within the SDG11. The aim of this study is to reveal the pattern of morphological and ecological fragmentations in Marmara Region, Turkey, following the traces of changing land use patterns. Connecting the cities around the Marmara Sea with transportation roads and bridges not only provides sustainability in transportation and logistics by increasing the connectivity and through-movement potential between cities and rural areas, but also causes the deterioration of urban and natural forms in the locations they pass through. In the study, the morphological loss caused by the transportation network connecting the cities of Marmara Region including Istanbul has been identified. The morphological changes in land use -especially forest areas, natural resources, and urban texture- created by the transportation lines passing through the cities are elaborated. Data obtained from satellite images, land use, tree cover and climate maps, transportation projects of the region were analyzed in terms of morphological regions, fringe belts and space syntax methodology. The results of the study indicate that the dilemma that policymakers and city planners need to solve, should be managed through working on targets and indicators in all SDGs, primarily SGD11. This paper also queries the instrumentalism of the morphology discipline to make visible and articulate the invisible morphology of the ecological loss that is more than a "fine" linear morphological trace.

Keyword: *SDG11, ecological sustainability, space syntax, fixation lines, Marmara Region*

Introduction

In recent years, many policy makers at different levels of governance across the world have turned their faces to SDGs adopted in 2015 at the UN General Assembly. They embrace the framework since, among other reasons, it provides a ready roadmap which has a potential to guide their actions while tackling the problems of development. That orientation towards SDGs is promising in establishing a more sustainable world, yet it may not create the expected level of impact. According to one branch of literature, there is a complex and sometimes contradictory relationship between SDG targets (e.g., Machingura and Lally 2017, Valencia et al., 2019). In other words, progress on one SDG target may come at the expense of others.

Therefore, policy makers need to be aware of the possible trade-offs between the targets before adopting policies to decrease the level of negative impact that may arise due to their actions. Several studies have revealed trade-offs between some SDG targets (e.g., Machingura and Lally 2017). Yet, more research is needed to be done for us to see the whole picture as we do not know the exact nature of the relationship between all targets yet. In this study, we aim to contribute to the existing scholarship on trade-offs between the targets by specifically focusing on SDG 9.1 and SDG 11.4. In other words, we will try to illustrate the possible tension between investing in infrastructure for economic development and protection of the natural environment. In order to do that we will examine the connectivity of road networks versus the segregation of natural ecosystems by using the British school of urban morphology and space syntax methodology.

Literature & Methodology

Transport and ecology have a mutual and multidimensional relationship that is not fully understood yet. The impacts of transportation on the environment can be examined in three levels: direct, indirect, and cumulative impacts (Rodrigue, 2020). The direct impacts are observable or measurable, such as noise and carbon monoxide emissions; in other words, they are the most visible and predictable impacts among the others. The indirect impacts are the secondary effects that often have a higher consequence than direct impacts; however, they are more challenging to establish since they involve multidimensional relationships. Cumulative impacts are multiplicative consequences that can be considered as the varied effects of direct and indirect impacts on an ecosystem, and they are often unpredictable. Climate change—in which transportation plays a significant role—can be an example of this (ibid.). Although several control systems such as Environmental Impact Reports are compulsory for the mega transportation projects in the Turkish case, there are still insufficiencies in terms of how much it covers the impacts in different scales mentioned above.

However, in the context of sustainability, transportation developments require a deep understanding of these impacts and the mutual influence between the physical environment—in terms of geographical location, topography, geological structure, climate, hydrology, soil, natural vegetation, and last but not least animal life—and transportation infrastructures, and this kind of understanding is still very insufficient (ibid.). In these respects, some methodologies used widely within the architecture and planning literature can help us visualize and examine some impacts of transportation projects in the urban-natural context. Within this study, we are offering to use the methodologies of morphology and space syntax.

Urban morphology analyses are crucial to understand the divergence between transportation and ecological urban policy practices. Scheer (2016) states that the classification of the building, parcel and street, which are the main components of the building block in urban morphology studies, is based on the need to differentiate one type of element from another. While the “build form” -such as objects, buildings and infrastructure- explained as man made one and the “land” is the natural area on which buildings are settled, the lines or areas that form the borders of plots or the paths that provide access between the plots are the “boundary matrix” (Scheer, 2016). In British school of urban morphology, morphological regions represent the hierarchical plan units which are homogeneous within. They are the keys to define the characteristics of urban and natural and heritage conservation areas. Whitehand (2009) claims that “Conzen reaffirms in the first paragraph of the first chapter of the Alnwick study that the plan, or two-dimensional layout, of an urban area is but one of three components (or ‘form complexes’) of its morphological character, the other two being building form and pattern of land and building utilization” (Whitehand, 2009, 3). He (2009) exemplifies from historical cores of cities or specific fringe belt areas but he especially emphasises the World Heritage Site areas to reveal the failure in sustainable urban planning practices.

The second method that we will utilize in this study is space syntax. Hillier and Hanson (1984) stated that space syntax is a theory of space and a set of analytical, quantitative and descriptive tools for analysing the layout of space in different scales from building to regional. It is possible to gain insights into the consequences of spatial form in the physical environment by learning to control the spatial variable at the level of the complex patterns of space that create the city. Spatial configuration in space syntax terms means the relations taking into account of other relations, or a set of relationships among parts such as urban streets, all of which are interdependent in an entire structure (Hillier, B., Hanson, J., and Graham, H. 1987; Hillier, 2007). This notion defines the whole of a complex rather than its parts. Connectivity measures the number of spaces immediately connecting a space of origin (Hillier et. al., 1984, p.103). Segment angular choice measures how many least angular paths lie between every pair of segments within a given distance. Angular distance is defined as the cumulative amount of angular change between all adjacent segments along the path (Hillier, B. & Iida, S. 2005). According to Turner (2007), angular segment analysis generates relatively accurate correlation with the vehicular movement.

Marmara Region and Three Bridges

Marmara Region has one-third of the population with three of the most competitive cities in the country, including one of the megacities of the world, namely Istanbul. In the study, along with the city of Istanbul which has approximately 15 million inhabitants, the city of Kocaeli, Yalova at the east side of Marmara Region and Canakkale at the west side of Marmara Region are considered as being some of the important cities bordering the Marmara Sea (which is an inland sea connecting the Black and Aegean seas). The region generates more than 45% of Turkey's GDP. Therefore various mega-sized projects, including real estate, infrastructure and transportation areas, have been implemented in the region, increasingly in the last decades. The present research focuses on the bridges and the following highways built on the Marmara Sea in different parts of the region. The first of all is the third Bosphorus bridge, called Yavuz Sultan Selim, in Istanbul which connects the European and Anatolian sides of the city of Istanbul. The second one is the Osmangazi Bridge which cuts the transportation duration between the city of Kocaeli and Yalova. And the last one is an incomplete bridge project in Canakkale which is planned for providing access from European and Anatolian sides of Canakkale.

Data

In this research, existing biodiversity maps (biodiversity areas and hot spots), data of forest change (tree cover, tree cover loss and tree cover gain) and data of climate (forest greenhouse gas emissions and forest landscape integrity index) from 2000 to 2020 are considered. Besides, land use data gained from CORINE Land Cover and satellite maps from Google Earth are used. Road centerline data obtained from Geofabrik and space syntax analysis is generated by depthmapX software. Before analyzing the road network in depthmap programme, the road centerline data should be simplified and invalid geometries such as inconsistent points and overlapping lines should be eliminated (Dhanani et. Al. 2012). A tool based Douglas-Peucker algorithm in the GIS programme was suggested to be used by Kolovaou et. Al (2017). By this tool, the number of vertices and segments as well as the polylines between the intersections are reduced and topological errors are corrected in order to provide a cartographic generalization.

Analyses

First of all, several mappings of environmental features are examined. The analyses of morphological regions and fringe belts are applied. Space syntax analysis is used to demonstrate the new bridges and roads' effectiveness in the road network system of the Marmara Region. The following map (Figure 1) demonstrates the landscape integrity[1] of the Marmara Region. It is relevant to say that the value of integration decreases as we approach urbanized areas. The biodiversity map of the region also emphasises the natural significance of both bosphorus in Istanbul and in Canakkale (Figure 2).

[1] "To produce the Forest Landscape Integrity Index (FLII), four data sets were combined representing: (i) forest extent; (ii) 'observed' pressure from high impact, localized human activities for which spatial datasets exist, specifically: infrastructure, agriculture, and recent deforestation; (iii) 'inferred' pressure associated with edge effects, and other diffuse processes, (e.g. activities such as hunting and selective logging) modelled using proximity to observed pressures; and iv) anthropogenic changes in forest connectivity due to forest loss" (Global Forest Watch, 2021).

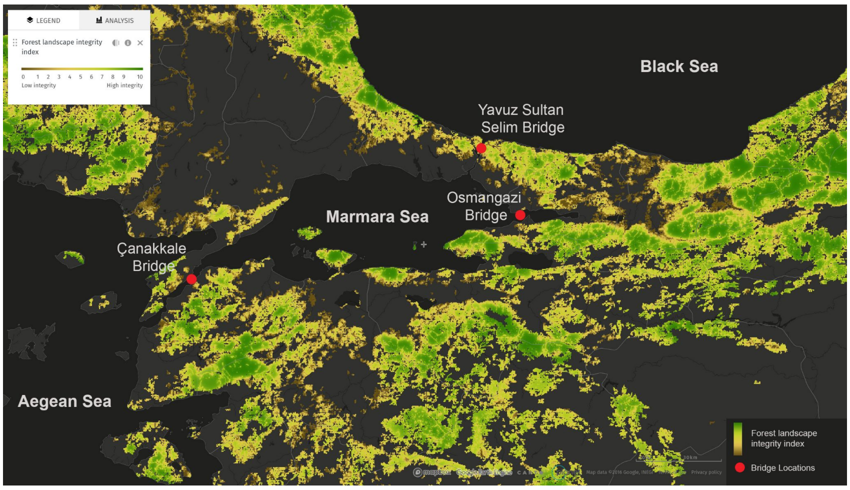


Figure 1. *Forest landscape integrity index for Marmara Region (Global Forest Watch, 2021).*

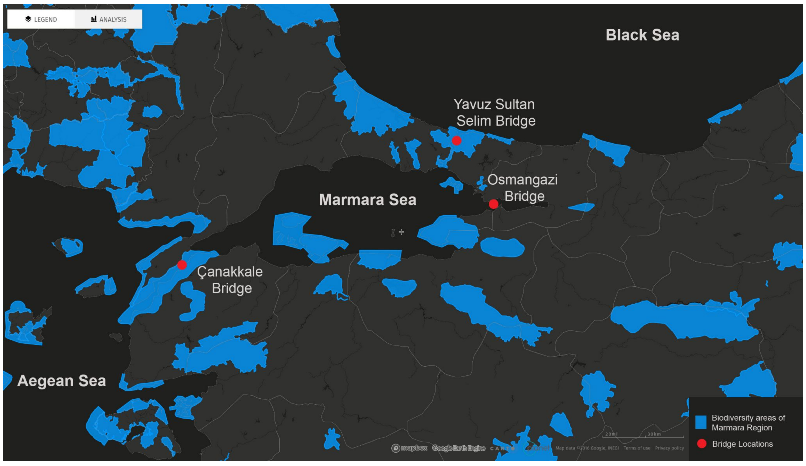


Figure 2. *Biodiversity areas of the Marmara Region (Global Forest Watch, 2021).*

A striking fact is that the tree cover loss seen in Istanbul between 2001 and 2020 is due to the Yavuz Sultan Selim Bridge and highway project located on the Istanbul Northern Forests, as well as the airport and other projects at the north of the city. In other words, 14% of the tree cover of Istanbul has disappeared since 2000, relatedly with these mega projects (Figure 3, Graph 1). In the case of Osmangazi Bridge, no evidence of tree loss is observed around coastal areas that are already urbanized or even formed as industrial fringe belt areas (Figure 4). It has been observed that there is no loss of trees around the ongoing Canakkale Bosphorus Bridge (Figure 4).

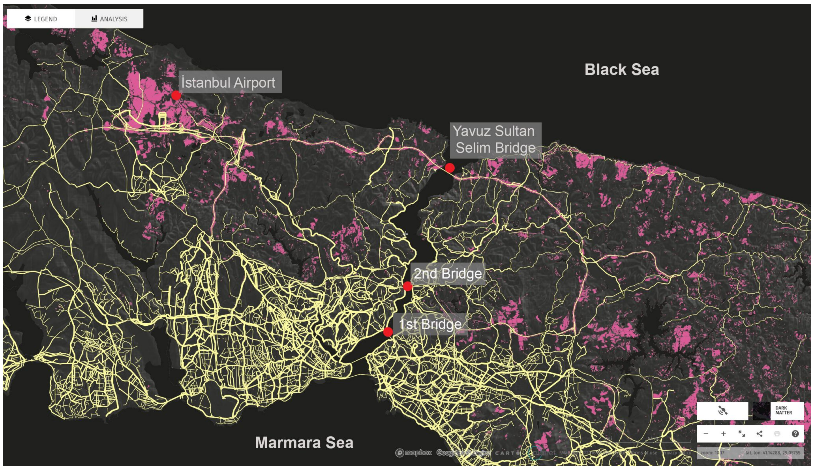
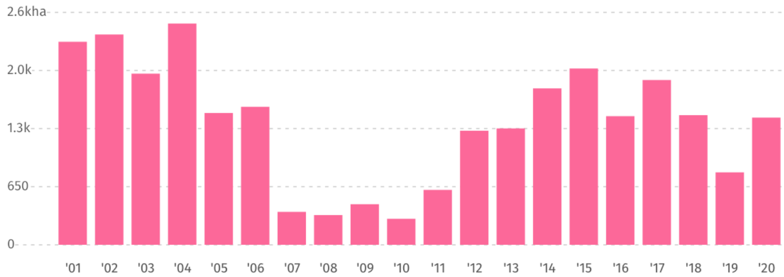


Figure 3. *Tree cover loss (pink) and road network (yellow) in Istanbul from 2001 to 2020 (Global Forest Watch, 2021).*



Graph 1. *Tree cover loss in Istanbul between 2001 and 2020 (Global Forest Watch, 2021).*

Figure 4. *Tree cover loss in Istanbul (Yavuz Sultan Selim Bridge), Kocaeli (Osmangazi Bridge), and Çanakkale (Bosphorus Bridge) between 2001 and 2020, respectively (Global Forest Watch, 2021).*

Spatial analysis shows that the new bridge in Istanbul is not highly integrated with the city centre on the contrary of Kocaeli and Canakkale cases. The bridge of Istanbul and the roads around it are significantly connected and it has apparently high values in the system like Osmangazi Bridge, Kocaeli. Canakkale bridge has not completed yet but according to analysis anticipates that the system will more robust after implementation.

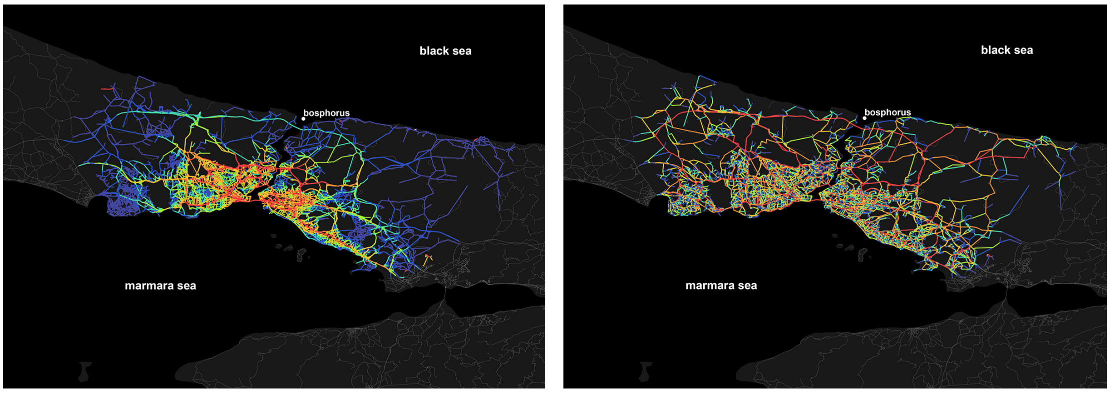


Figure 5. *Spatial integration (on left) and choice (on right) analysis of Istanbul (produced by authors).*

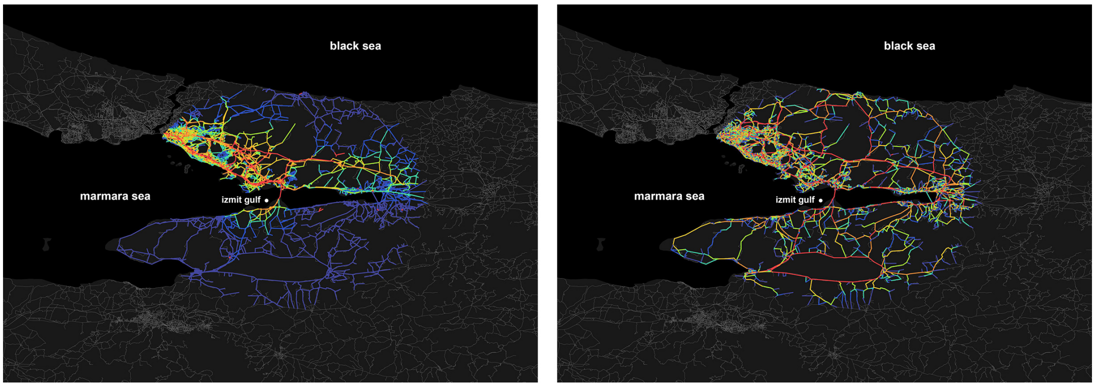


Figure 6. *Spatial integration (on left) and choice (on right) analysis of Kocaeli (produced by authors).*

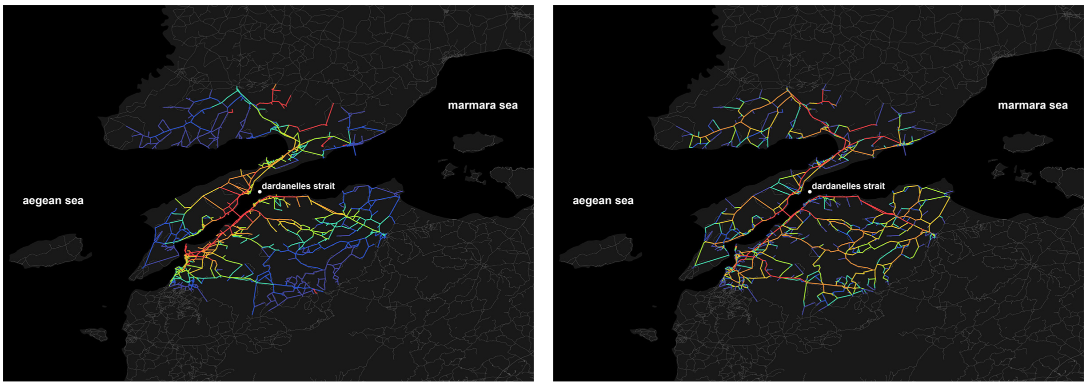


Figure 7. *Spatial integration (on left) and choice (on right) analysis of Canakkale with the bridge (produced by authors).*

Discussion & Conclusions

This study reveals that the bridges and the highways constitute the fixation lines which are the signs of potential fringe belt areas or new morphological regions in terms of natural ecosystem or physical structure (Figure 8-9).

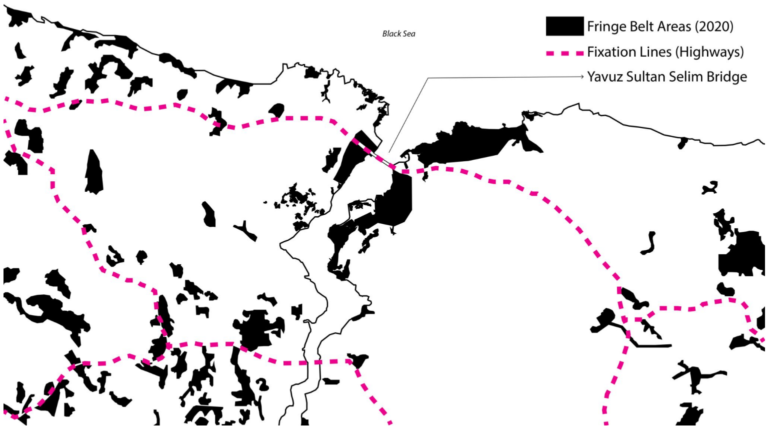


Figure 8 . *Fringe belt analysis of the north part of Istanbul (produced by authors).*

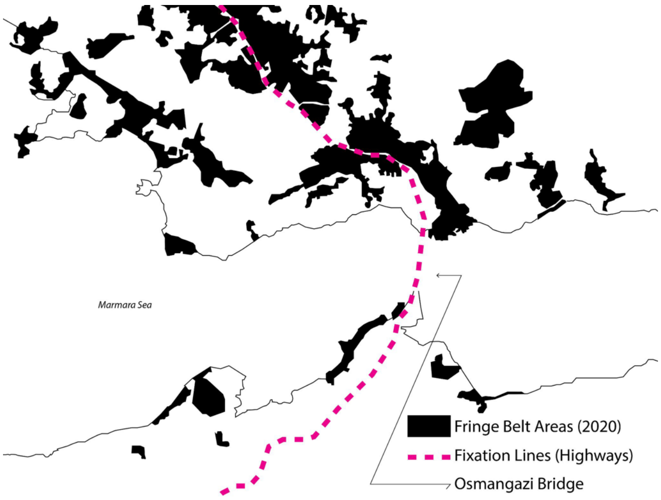


Figure 9. *Fringe belt analysis of Kocaeli and Yalova (around the Osmangazi Bridge) (produced by authors).*

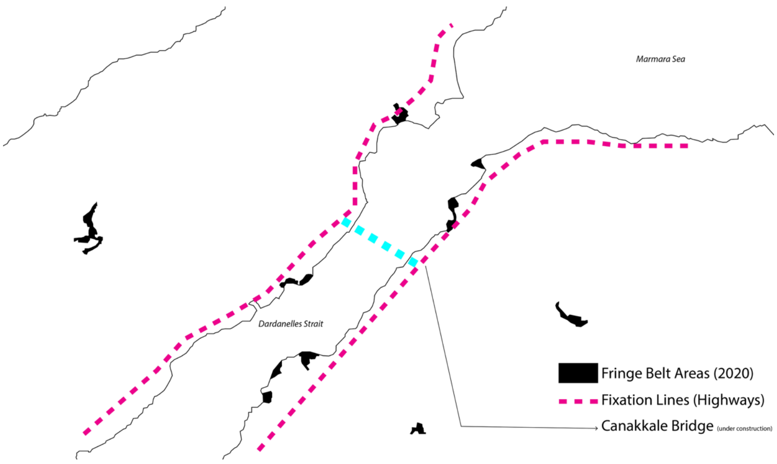


Figure 10. *Fringe belt analysis of Dardanelles (Canakkale) (around the Dardanelles Bridge) (produced by authors).*

Scheer (2016) indicates that "The boundary matrix of path and plots is also a useful mapping key to many other kinds of data, including land use, taxation, ownership, land value, construction data, soil conditions, and demographics" (Scheer, 2016: 14). This study also demonstrates new morphological regions created by linear urban morphology elements of building blocks such as roads or bridges. It reveals the potential effects of these elements on the formation of fringe belts as a fixation line, and above all, the destruction they caused in the natural fabric on which they were built.

This study shows that in the case of the Marmara Region, major transportation infrastructure projects that form a circle that connects the region increase the connectivity of the road network while breaking down the natural network of the region. These fragmented pieces of natural ecosystems, then, have turned into a fringe belt and face the danger of becoming an urbanised development area. Turning back to our remarks on SDGs in the introduction, this result suggests that endeavours that feed one SDG target - carrying out transportation infrastructure projects in our case - may lead to deterioration of another - protection of the natural environment. Therefore, policy makers should be careful while implementing policies aiming at certain SDGs and consider other dimensions that may be affected by their actions.

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