RE-INTERPRETING THE IMRAHOR VALLEY (ANKARA-TURKEY) IN TERMS OF GREEN INFRASTRUCTURE DIRECTING URBAN AND RURAL DEVELOPMENT

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The earth is rapidly urbanizing. One of the most effective means of dealing with the emergency caused by rapid urbanization is green infrastructure now. Ankara as a metropolitan capital city is also rapidly losing its urban-rural integrity due to rapid urbanization. Although different spatial plans have been made since the declaration of the Republic, the city continued oil-stain expansion and the green area system could not be protected. The Imrahor Valley, which is of ecologically vital importance in the urban-rural integrity, is one of the valuable areas under threat. The valley is an ecotone between the rural and urban ecosystems, southeast of Ankara city center. The valley has come to the point of losing its natural and rural character, especially with the urban transformation practices on the valley floor, slopes and surrounding areas. In this context, the ecological processes to which the Imrahor Valley is connected and dependent and human interventions in these processes are examined in three layers at different levels initially: the province, the city containing the central districts and the basin containing Lake Mogan-Eymir Lake-Imrahor Valley. Then, we focus on the transformation of the Imrahor Valley, one of the most important ecological components of the metropolitan city of Ankara, between 2003–2020. All transformational interventions in the Imrahor Valley affect all natural processes of the Valley irreversibly. It is necessary to re-read and interpret the Imrahor Valley landscape within the framework of the green infrastructure approach in all spatial planning studies and plan changes to be made regarding the metropolitan city.

Keywords: valley landscapes, urban transformations, rural-urban interaction

Globally, more people live in urban areas than in rural areas, with 55% of the world’s population residing in urban areas in 2018 and by 2050, 68% of the world’s population is projected to be urban (United Nations, 2019). Urban expansion has occurred fast in areas adjacent to biodiversity hotspot on a global scale. This urban expansion will heavily utilize natural resources, including water, and will often consume prime agricultural land, with irreversible damages on biodiversity and ecosystem services elsewhere. On the other hand extensive areas of impermeable surfaces in urban areas result in large volumes of surface-water runoff and increase urban vulnerability to climate-change effects, such as increased frequency and intensity of storm events (Secretariat of the Convention on Biological Diversity, 2012).

As the world continues to urbanize, rethinking of the relationship between urban and rural landscapes radically is needed and the linkages between cities and surrounding rural areas should be strengthened. Global serious problems such as climate change, massive internal and international migrations and Covid-19 pandemic, which we have experienced recently in the global scale, made it necessary to examine the “resilience state” of an urban settlement much more comprehensively. In particular, the Covid-19 pandemic has clearly demonstrated that the rural areas, which feed the city in terms of ecological, economic and socio-cultural dimensions, represent the main factor that keeps safe the fragile urban life.

In this context, Green Infrastructure (GI), which breaks the rigid structure of cities, aims to create multi-functional connections between urban and rural, as well as preserve the existing connections and thus make the city healthier and more resilient, has emerged as a concept of global importance.

According to Benedict and McMahon (2002), GI is a natural life support system that is necessary for the environmental, social and economic sustainability of countries and has an ecological framework.

In the EC Communication, GI is defined as “a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. This definition includes three important aspects: the idea of a network of areas, the component of planning and management, and the concept of ecosystem services. In this sense, GI integrates the notions of ecological connectivity, conservation and multi-functionality of ecosystems” (Liquete et al., 2015).

It is a concept that should be considered at all spatial scales from regional to local-neighbourhood scale, which can be applied to urban sprawl areas connecting with wider rural expansions, as well as large rural areas far beyond the city (Natural England, 2009). They offer regulatory services...
that are highly relevant to cities, such as microclimate regulation, noise reduction or air filtration, while also providing important cultural services such as nature experiences, recreation and promoting social cohesion (Palliwoda, Banzhof and Priess, 2020).

Ankara as a metropolitan capital city is also rapidly losing its urban-urban fringe-rural integrity due to the rapid urbanization. When Ankara was declared as the capital of the young Republic of Turkey in 1923, it was focused on elimination of post-war destruction, shelter, health and security issues and ensuring the usual production and consumption conditions (Cengizkan, 2004). However, while taking steps to meet these conditions on the one hand, Ankara faced a rapid population increase with the effect of rural-urban migration on the other. This increase has continued steadily (Duman and Coşkun, 2015; Doğan and Bostan, 2019) and the migration rate that Ankara received is 32.27% for the 2011-2012 period (AKA 2015). Ankara has become the second largest city in the country (ÇDP, 2017). Having a population of approximately 400,000 in 1927, Ankara reached 5,639,760 people in 2019. While the population of the country reached approximately six times the population of 1927 in 1992, the population of Ankara reached approximately 14 times for the same period (TUİK, 2020).

Ankara is located on a natural threshold zone between the mountain ranges that separates Central Anatolia from the sea and other regions, and located in a “topographic bowl” with an average of 840 m (Buğra, 2006). This bowl also determined the initial development of the city, guiding the potentials or constraints where the urban macroform could expand outwards.

Although different spatial plans have been made for Ankara since the declaration of the Republic, the city has continued oil-stain expansion due to uncontrolled urbanization. This situation is strengthened with the economic model change. As stated in Şahin (2015), Turkey has focused on ‘construction-oriented capital accumulation model based on urban rent’ recently, thus, its economic growth has become completely urban transformation oriented. In addition to being a metropolitan city under intense urbanization pressure, Ankara is a city that is becoming increasingly fragile due to the challenging conditions of the steppe climate. These conditions bring fundamental changes in landscapes and their ecological conditions, especially for rural areas connected strongly with the city economically and politically.

The İmrahor Valley, an ecotone between the rural and urban ecosystems, southeast of Ankara city center, is of ecologically vital importance in the urban-rural integrity, and is one of the valuable areas under threat. Although the İmrahor Valley is located within the Ankara metropolitan area, it is still an area that keeps distinctly its rural-natural character that makes the valley unique. On the other hand, the geomorphological structure of the valley, consisting of hundreds of small valleys, reinforces this uniqueness. Sınacı Özfindik (2019) stated that the plan revisions, market forces and speculative pressures implemented since the mid-2000s are the main reasons increasing tensions in the valley and pave the way for intense construction.

This study deals with the İmrahor Valley at three-tier spatial approach at the 2003-2020 time interval: the province; the city with the central districts; and the basin containing Lake Mogan-Eymir Lake-İmrahor Valley. Thus, it is revealing the need to rethink and reinterpret the quality and functions of the Valley landscape and propose necessary changes in spatial plans in terms of green infrastructure approach.

Material and method

The focus of the study is the İmrahor Valley located in the southeast of Ankara city center, within the boundaries of the Gölbaşi, Çankaya and Mamak districts. Since the valley, which is approximately 3,500 hectares in size, is hydrologically connected (Karadeniz et al., 2016) with Mogan and Eymir lakes, this study was carried out in the sub-basin that includes Mogan Lake-Eymir Lake-İmrahor Valley (Fig. 1).

These two shallow lakes interconnected hydrologically with a flow from South (Mogan Lake) to North (Eymir Lake) in the close vicinity of Ankara cover a total of 245 km² of the total 971.4 km² watershed (Karakoç, Ünlü and Katırcıoğlu, 2003). Gölbaşı Watershed is a river basin that has been subjected to rupture at a depth of 200–250 m in the Quaternary under the effect of the stream processes provided by the İmrahor Stream and its tributaries. Mogan and Eymir Lakes, and the reedfields and mud flats around them; were formed by the accumulation of colluvial materials carried by the side streams on the main valley floor (Kalkan et al., 1992).

The area covering Mogan and Eymir lakes was declared as “Specially Environmental Protection Area” in 1990 (ÇŞB, 2020a). Mogan Lake Key Biodiversity Area (KBA) consists of Mogan and Eymir Lakes and is an important breeding, nesting and wintering areas for herons, predators and duck species. There is a lesser kestrel (Falco naumanni) overnight area of approximately 200–300 individuals. The number of white-headed duck (Oxyura leucocephala) – classified as ‘endangered’ in the IUCN Red List of Threatened Species (Gürsoy Ergen, 2019) – has decreased due to reed harvesting and construction activities around Mogan Lake (Kiliç and Kiraç, 2006). Mogan Lake is one of 122 Important Plant Areas (IPA) in Turkey. Centaurea tchihatcheffi Fisch.
resources (Şenöz Orsan and Karadeniz, 2019). However, with two major plan revisions approved in 2013 based on the 2023 Ankara Master Plan, the Imrahor Valley has become a “new development focus” (Sınacı Özfındık, 2019).

$\text{and } Mey. - \text{critically endangered plant species – grows only on limited scale in the vicinity of Ankara-Gölbaşı-Mogan-Eymir Lakes, at a distance of 20 km from Ankara (Okay and Demir, 2010). }$

Tankahya Hacıoğlu, Erik and Mutlu (2011) studied Ankara urban flora and indicated a total of 2,389 taxa and endemism rate of 15%. The city, located in the Irano-Turanian phytogeographical region, is greatly influenced naturally by the steppe flora surrounding it. 48% of the total number of taxa, that is a half, are also found in the urban area. The rate of plant taxa specific to the city is 6% and this indicates the existence of untouched microclimate areas in the city. A research conducted by Altınözü and Vural (2000), shows that 30 of the 387 taxa detected in the Imrahor Valley are endemic and the endemism rate is 8.8%. Besides its floristic richness, the valley has exceptional other assets such as habitat for species, migration corridor and has unique features in terms of geomorphological properties.

The prevailing wind direction is northeast and north in Ankara. The circulation channels of the winds into and from the city are formed by the valley systems (ABB, 2017). In this context, of the Imrahor Valley, its location and the direction of its slopes support the air flow inside and outside the city. Thus, the valley has the feature of being an air corridor which is of great importance for Ankara in terms of air pollution and climate stabilization (Buğra, 2006).

The carbon sequestration amount of the Imrahor Valley is higher than the city center due to the still untouched steppe cover and it has a very high value in terms of habitat provision ecosystem service (ES). Besides these ESs, the Imrahor valley has very high values in terms of local climate regulation, air cleaning, flood prevention, carbon capture and habitat provision ecosystem services to make the city resilient (Çağlayan Demirbaş et al., 2020).

In the spatial plans for Ankara until 2013, the dominant approach has been to preserve the natural character of all valleys in the city and its periphery, perceive the valleys as a part of the green belt and wind corridors as well as to create new green areas by protecting the stream beds and water...
For the first two scales, green-blue-gray infrastructure components were determined by using CORINE 2018 data and Google Earth Pro© image (Fig. 5 and Fig. 6).

In order to better understand the distinctive aspects of the Imrahor Valley and its dense transformation in a short...
time vertically and horizontally, GI components were determined in the Imrahor Valley as the last scale using Google Earth Pro© (2020) image (Fig. 7).

In order to read the different aspects of the relationship between the Imrahor Valley and Ankara city in terms of green infrastructure, a watershed boundary covering Mogan-Eymir Lakes and Imrador Valley, hydrologically dependent on each other, was determined by using the 1 : 25,000 scale geomorphology map (Erol et al., 1980), ArcScene 3D topography map and DEM data (Fig. 8).

Change analyses were made within this watershed boundary using presence of surface waters, geomorphologic structure and land cover parameters. A score scale between 2 and -2 was used when looking at the change in each analysis (0 – excluded).

Permeability, permanent streams and seasonal streams feeding them were used for analysing the surface water change. Zoning was carried out by examining the expansion, shrinkage, deviation, untraceability and transformation of surface waters into impermeable surfaces between 2003 and 2020.

Using the 2006–2018 CORINE land cover data, the change in green infrastructure components was discussed in terms of the transformation of permeable surfaces into impermeable surfaces. The analysis of the geomorphological structure change was made using the geomorphological units, CORINE data and the land sections taken on Google Earth Pro 2004–2020 showing the location of the urban transformation project areas initiated since 2005.

These three layers are overlapped to understand the change in green infrastructure. As a result, they are characterized as areas where green infrastructure maintains its current status, green infrastructure is supported, green infrastructure is weakened and green infrastructure has transformed into gray infrastructure.

Results and discussion

The urban transformation-oriented economic development model that affects the whole country (Şahin, 2015) is the main driving force that causes the transformation of the Imrahor Valley landscape (Fig. 9). Consequently, the area is under dense construction pressure. On the other hand, constructing a concrete canal by taking the Imrahor Stream underground is another important source of pressure. Ignoring the fact that the Imrahor stream and its tributaries are the main ‘landscape-pattern-maker’ of today’s Gölbaşı.
Figure 9  Drivers-Pressures-State-Impacts-Responses (DPSIR)
Source: authors. Illustrator: Inci Saray

Figure 10  Transformation in surface waters

Figure 11  Land cover change in Mogan Lake-Eymir Lake-Imrahor Valley watershed
basin (MTA, 1992) creates irreversible effects on hydrological system and breaks the landscape continuity.

The effects created by the main driving force have been tried to be understood with the observed changes in surface waters, land cover and geomorphological structure.

The main reasons of surface water change within the watershed (Fig. 10) were identified as road fragmentation, loss of surface water due to urban transformation and canal projects. The eastern part of the watershed generally preserves its hydrological structure. Gölbaşı settlement between Mogan and Eymir Lakes has expanded further over the years. However, the biggest change in vertical and horizontal perspective has occurred in the Imrahor Valley. The construction projects initiated at the base of the valley and towards the slopes completely changed the land morphology. The surface runoff collection areas on the east facing slopes of the valley have been replaced by high density settlements and impermeable surfaces. The degradation of the hydrological network within the basin boundaries will also disrupt the flood prevention function of the Imrahor Valley. However, considering the research results of EEA (2019), which reveal that floods will increase due to local precipitation in small basins and one of the critical problems of the city of Ankara, it is once again revealed that the Imrahor Valley should be handled in hydrological integrity.

According to the analysis of change in land cover (Fig. 11), the recreational potential of Lake Mogan has triggered the development around the lake, the increase in grey infrastructure and the transformation of the rural texture towards the urban fabric. This situation has caused green infrastructure components to transform, change or disappear. Similarly, the green infrastructure components of the Imrahor Valley have also decreased or disappeared.

According to the analysis of the geomorphological structure change (Fig. 12), the most intense change in the basin occurred in the east-facing slopes and valley floor of the Imrahor Valley, then in the mining areas to the north of the basin and around Lake Mogan. Changes in the valley will increase the risk of landslides on the east-facing slopes of the valley, adversely affect the clean air supply function of it, and increase the likelihood of flooding due to changes in surface flow directions.

Overlapping of these three layers shows that while the areas where green infrastructure is not changed are located predominantly at the southeast and east part of the basin; the areas completely disturbed are located at the north of the basin, around Lake Mogan and the north eastern part of the basin (Fig. 13). The areas where green infrastructure is not changed indicate the existence of rural areas around the city.

**Conclusion**

Urban areas are currently facing severe challenges including not only shortages of water, more frequent and severe floods, storms, heat waves, demographic and social changes associated with urbanization and management, but also smart management tools for transition to a more sustainable future (Secretariat of the Convention on Biological Diversity, 2012).
When the Covid-19 pandemic began, scientists stated that the main cause of it was the extermination of barriers between humans and animals that must be protected so that both sides can live in healthy conditions. Similarly, it should be understood that the barriers that exist between urban and rural areas and human beings, which are necessary for the healthy living of all parties, should not be ignored. Only in this way, urban and rural areas become more resilient and safe for all kind of livings.

These indicate the need for comprehensive, integrated, and multi-scale approach which should go beyond imitating nature inside the city. Considering the globally threatening challenges, green infrastructure gains importance as a necessary mechanism in ensuring this kind of approach.

Through a comprehensive green infrastructure approach that understands and describes all components and aspects of natural-rural-urban processes, the challenges that intensive urbanization will bring to the city and the rural can be dealt with.

As stated in EEA (2014), ecosystem multifunctionality and biodiversity conservation and functional connectivity need to be included in all kinds of spatial plans. All plans should illustrate the fragility and be respectful to ecological borders and limits of the ecologic systems of the Valley. Since the Imrahor Valley is connected with two important wetland habitats, GI integrity should be ensured by considering the relationship between core habitats and migration corridors in urban, semi-urban and natural areas. Continuity should be taken as a basis in terms of landscape integrity covering primarily hydrological and geomorphological patterns. In this context, the most urgent step should be to restore the stream starting from the outlet of Mogan Lake to the end of the Imrahor Valley in a way that it will fulfil its multiple functions. Here, it is vital to allow the natural flow of water and remove the concrete surfaces that cover the valley floor. In order to adapt to the natural process, the support of natural wetland plants should be provided at the riparian zone.

Another urgent step is to restore the damaged east facing slopes in order to gain their natural functions. Small rain/runoff collection areas should be created on the eastern slopes of the valley at different heights supporting each other. Thus, the healthy relationship between the stream and runoff waters should be re-established. Astralagus sp., Amygdalus orientalis, Cotoneaster sp, Creatagus sp, Rosa canina, Tamarix sp. (Akaydın and Erik, 2002) found in the flora of Ankara are prominent species of steppe vegetation and can be used primarily to repair damaged areas. The west-facing slopes are the least affected part of the valley and preserve its rural character. The large grasslands in this part should be protected as they are important components of GI, and introducing the scattered woody vegetation including natural species in these areas is needed.

The dramatic effects of urban transformation, which leads the main multiple functions of the natural system into a single function, can be neutralized with the green infrastructure process. Increasing food security and generating income for fragile urban households is possible by protecting agriculture in the urban and surrounding areas, which is one of the main components of GI. The damages caused by urban transformation projects to the distinctive characteristics of the peri-urban areas can be rehabilitated with green infrastructure approaches. The Imrahor Valley should be taken into consideration as ‘avoidance zones’ in the spatial plans for illustrating the fragility and vulnerability of the urban-rural relationships in terms of creating a resilient city.

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