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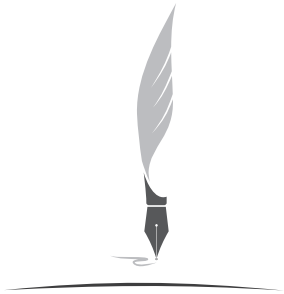

Chapter 1

URBAN DEVELOPMENTS OF SALONICA IN THE 19th CENTURY

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INTRODUCTION

19th century is one of the most interesting eras of the urban history. Social theories and ideas such as socialism and nationalism, various expectations of the city national communities and different interests of European powers like France, England, Germany, Austria, Italy and Russia connected with the future of the city. The characterization of the general situation of the period was implemented by inter communal strife-motivated by the European powers- and the cultural differences of the society. Moreover, many sides of the urban life were affected by European attempts for penetration to the east along Macedonian struggle and the young Turks Revolution as well as the attempts for the modernization of the Empire. Salonica, being second major city and port of Greece and also being an administrative center of north Greece, had been never a capital of a civilization throughout the history. But always existed as a critical settlement. After governed by Byzantine and Venice, the city was dominated by the Ottoman Empire. Like the many other Ottoman and Mediterranean Port Cities, various ethnic and religious groups –Jews, Muslims, Slavs, Rum, Ottoman-Greeks, Franks, Bulgares, Armenians- were settled in Salonica. More than 40% of its population was composed of Jews that highly affected the economic and social life of the city. (Veinstein, 1999) (See Figure 1)

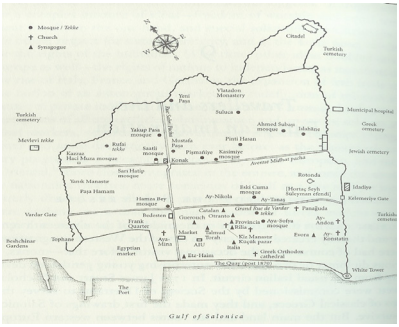

Figure 1. *Salonica in early 19th century (Mazower, 2004)*

In the 19th century, two different Salonica that were totally opposite to each other were existing. There were massive differences between the plan of early 19th century and late 19th century of the city. Anastassiadou (2010) mentions Salonica has experienced the same transformation period like the other East Mediterenean Port Cities -İstanbul, İzmir, Beirut, Trabzon. This transformation manifested itself not only in the physical structure of the city, but also in production, economy, social life and even in the mind of citizens.

As a result of the Tanzimat Edict many new standards and principles were created in the Ottoman urbanization. The main intention of these approaches was to build a modern city. In this term, main efforts fundamentally changed the urban structure. In this study, it is tried to be understood a spectrum of urban dynamics in terms of alterations in urban structure- demolishment of city walls, construction of railway network and city ports- changes in economic and social life of the city, and the architectural style.

THE URBAN STRUCTURE OF SALONICA

In order to comprehend the urban structure of Salonica, it is essential to focus on the meaning of the

city walls, its transformation process as well as the development of transportation network and the ports.

City Walls

Throughout the history, defence was an important determinant in the foundation of early settlements. Sites that have natural advantages in terms of defence became favorite site to settle. In addition to natural protection, man also constructed walls around their settlements to guard themselves from outer dangers. "Location, city wall and gate are the result not of mythic but of military thinking." (Nihenjuis, 1994, p. 15) Nevertheless, wall does not function only as a defensive unit; it is also an important tool for shaping and controlling the urban territory in physical, symbolic, governmental and financial terms. Thus, wall has been always a dominant element, in most case one of main components, of the urban structure. *"*The traditional Chinese words for city and wall are identical. The English word town comes from a Teutonic word that means hedge or enclosure*"*. (Kostof, 1992, p.11) As stated by Ashworth (1991, p.13), *"*the wall becomes in many cultures essential to the definition of a city and the very symbol of urbanism itself*"*.

Today, the condition is very different from the Kostof's and Ashworth's statements. Walled edges have no more such vital and symbolic role in modern cities structure. Especially in the second half of 19th century, in many European cities, walls became technically obsolete and began to function as barriers that caused obstacles in the urban life. Walls, including ditches, water defenses and glacis slopes, are not thin lines as showned in city plans. They cover a large area of land. Therefore, reshaping and reusing these structures became an important issue for urban planning, "from its emergence at the beginning of the 19th century, the discipline of urban planning has been founded on the disappearance of the urban frontier…

urban planning has legitimized its existence with the promising search for the lost form. It is the discipline of the lost frontier which is both its obsession and its motive". (Nihenjuis, 1994, p.13)

One of the most remarkable examples of this process is Vienna. In 1858, to connect the old city with newly developing suburbs, a competition was organized for re-designing the walled edge of the city without walls. The main idea of the winning project was to construct Ring Strasse aligned with theatres, museums, concert hall, law courts, university, parliament building, dwellings and parks in the place of old city walls. As seen in Vienna case, re-using old cities edge offered great potentials for the modernization attempt of most cities. During this process, some new concepts, such as boulevard and esplanade, were introduced in urban life.[2] "The boulevard started as a boundary between city and country. Its structure rests on the defensive wall. ….In 1670, with the destruction of the medieval walls of Paris and filling of the old moats, these sites were transformed into broad elevated promenades, planted with double rows of trees and accessible to carriages and pedestrian. These tree-lined ramparts eventually became a system of connected public promenades, a recreational zone at the edge of the city". (Kostof, 1991, p. 249). Therefore, the change in the use of city walls have the power to transform the urban structure.

Although city wall in most cities demolished, its traces in the urban context always continue to exist as seen in the case of Vienna Ring Strasse, Paris Boulevards, New Orleans Rampart Street or Amsterdam's urban waterways (old ditches). As mentioned by Kostof, there

2 The term boulevard "derived trough a French corruption of the Dutch word bolwerk, or artillery bastion" and esplanade refers to a "military-engineering term for the open space in front of fortification". (Ashworth, 1991, p.170)

is a Wall Street or Linienstrasse almost in every city. As the city wall is not characteristic only in a specific region or part of the world, almost every city experienced this process but in a different way than each other.

Walls were constructed around cities to control, sometimes to block, every kind of circulation such as people, money, goods. Based on this basic explanation, wall can be stated as an urban edge that is defined by Lynch as "edges…are the boundaries between two phases, linear breaks in continuity: shores, railroad cuts, walls. …Such edges may be barriers…which close one region off from another; or they may be seams, lines along which two regions are related and joined together". (Lynch, 2000, p.47) Besides this definition, various terms –border, boundary, territory, interface- can be used to identify city walls. Each of these terms defines a different relation between the city and its surrounding.

In Salonica, one of the basic features of the city silhouette was sea side city walls. They surrounded the city which were built up and reinforced by Ottomans. Nevertheless, in 1869, the Ottoman governmental authorities ordered to tear down the sea-side walls. After the demolishing of the sea side walls and the earthquake that took place for the constitution of the quay, a new avenue was cut by the sea-side. There were fourteen gates around it and buttresses of the walls were the towers. There were six main towers: Kelemer Kulesi (tower), Tabya Kulesi, Zincirli Kule, Yedi Kule, Namazgah Kulesi and Tophane Kulesi (Keyder et. al.,1994) (See Figure 2)

Figure 2. *The sea approach from the south-east (Mazower, 2004)*

Two other parts of the city existed outside the city walls. One was located at the eastern side and the other at the western side. Eastern side was called Kelemeriye (Kalamaria) or Hamidiye suburb. Çayır was the western part of the city and placed outside the city walls. Its development went parallel with the eastern part (See Figure 3)

Figure 3. *Walls at the north site of Salonica. (Veinstein, 1999)*

In 1876, National garden (Millet Bahçesi) was designed by Sabri Paşa. The area from the garden to the city year by year became an industrial zone. Central water cistern and pumping station which were canalizing the water to the city were built in that area in 1890. The

liquid gas for civic needs was started to canalize into the city in the same year from its installations at Beş Çınar. Furthermore, leather workshops (*debbağhane*) and timber sellers (*keresteciler*) located into this zone. In the second half of 19th century, the population of the city was doubled. So, the city needed to extend outside the walls. As the north part of the city was enclosed by hills, the east and west sides were suitable for new settlements. After the removal of walls, new neighborhoods were established and lower income groups were settled on these neighborhoods (Veinstein, 1999) (See Figure 4)

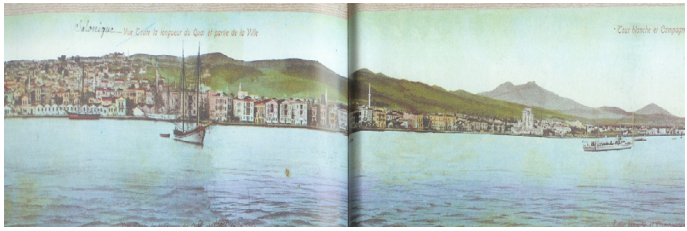

Figure 4. *A view from Salonica's waterfront without walls (Veinstein,1999)*

For the authorities, the primary condition of the modernization was to freeing the city from its hard edges: Walls. According to Nijenhuis (1994, p. 13) "modernity was characterized by the systematic demolition of strongholds and increasing dysfunctionality of fortresses, city walls and city gates". Therefore, in 1864, the first remarkable project done by the municipality was the demolition of walls that exist on the seaside. New lands[3] that became available after the destruction sold by the government to entrepreneurs. In ten years, without walls, the appearance of the city was totally changed. Restricted relation between sea and the city was transformed by

3 A Waterfront land in 23m widths was obtained by filling the sea with the ruins of demolished walls.

the construction of public spaces and some institutions like hotels, restaurants, cafés, banks and insurance companieson the water's edge. Waterfront became the most vivid, popular and cosmopolite part of Salonica. Walled edge of the old city turned into a promenade – *kordon.*[4] At that time, two different and conflicting uses were functioning on the seaside; port and recreational activities. Anastassiadou (2010) states that this model was common in all the Ottoman Port Cities (See Figure 5)

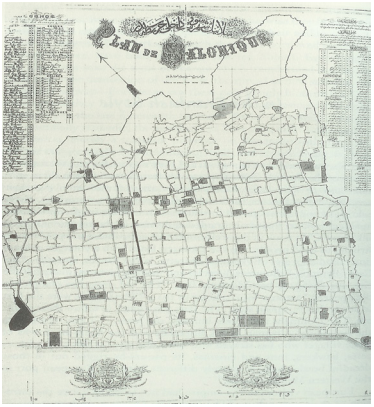

Figure 5.*The first map of Ottoman City, 1882, showing the new sea frontage (Mazower, 2004)*

In 1889, Salonica municipality developed first plan of the city. Based on this plan, Hamidiye Boulevard was constructed in the place of old walls. And also a housing unit called *Sultani* was implemented on the land that was obtained by the demolishment of walls (Veinstein,1999) Ambassadors or higher income group citizens were renting these dwellings. Unlike the west part, the east part of Salonica developed as an elite district.

4 Kordon can be stated as a new term –like boulevard and esplanade- introduced in urban life after the demolition of seaside walls.

In the second half of 19th century, five new boulevards were constructed in the city. Moreover, many public spaces and squares, which were not common in eastern cities, were developed. In spite of all these improvements, some parts of the city were still in a poor condition at the end of the 19th century. Veinstein (1999) states that the city was reflecting many opposing scenes. Modern view of the waterfront and *Kelemeriye* neighborhood on the east side and the narrow streets in the old city center and north part of the city were contrasting with each other.

City ports and railroads

At the beginnings of the 19th century, there was not a developed transportation network (road or railway) coming to the city. The only way to arrive to Salonica was through the sea. Although Salonica was one of the significant East Mediterranean Port cities, the port was in a poor condition lacking many infrastructures that caused difficulties in the carriage of goods. Until 1903, the port was rather in a natural recess, which through the years acquired some functional improvements. During the period of *Abdülhamid* reign ships were loading on three small wooden docks. The working conditions were very hard. After a rough storm in 1887, the docks were almost destroyed. (Mazower, 2004) In the first half of 19th century, the city was in a recession period for its transportation network. In 1901, an agreement between port's company and the company of railroad line Salonica was stipulated. The aim was to link the central railroad with the port to avoid drays, carts or other means. (Mazower, 2004) (See Figure 6)

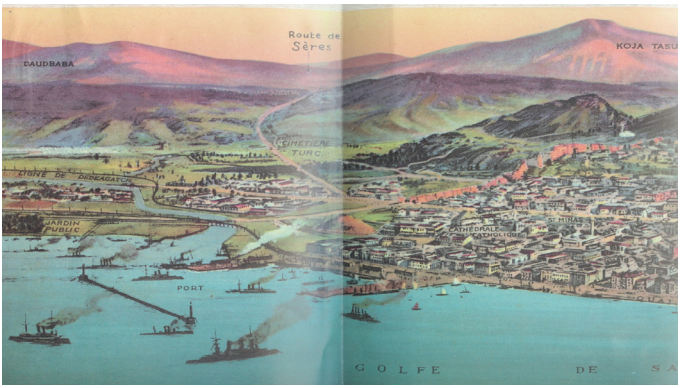

Figure 6. *A view of port and railway station at the west side of Salonica (Veinstein, 1999)*

One of the most remarkable attempts at that period was the construction of a railway network that would support the port. Braudel (1993) argues that virtually all major cities were located on the intersection of routes (sea and land) and this condition is essential for the foundation and also survival of cities. But, generally, geographical obstacles create a barrier between land routes and seaside in Mediterranean cities.

With the construction of railway system in the west side of the city close to the port zone in 1873, Salonica became an important node of the transportation network between the east and the west. Railroads contributed to the improvement of the transports of the city from the hinterland and the development of its production. The city was in a close relation with Paris and other metropolises of Europe. Veinstein (1999) states after the development of railway, many factories were constructed in the city and Salonica was industrialized. (See Figure 7)

Figure 7. *Factories and warehouses at the west side of Salonica's waterfront (Veinstein, 1999)*

In addition to railway system, existing port of the city was also developed. In 1988, the line Salonica-Belgrade inaugurated. Thus, Salonica had been linked with the railroad stations of central Europe. The connection of the port and railway brought a great improvement in the city's economy in international level. Due to this link, great improvements occurred in the Ottoman Port Cities. Braudel (1993) mentions, there was a great network in Mediterranean that created a strict interaction and relation between Mediterranean Settlements. Febvre (in Braudel, 1993) states "Mediterranean means routes". Between 1880-1912, tonnage of the ships that come to Salonica port were doubled and Salonica became the third important port city of the Ottoman Empire. (Veinstein, 1999) (See Figure 8)

Figure 8. *A view from Salonica's waterfront in late 19th century (Mazower, 2004)*

SOCIO-ECONOMIC LIFE OF SALONICA

Salonica consisted of different cultures and nationalities, but all communities of the city have approximately the same rights as citizens in the development of the city. In the 19th century, in Salonica, there were so many banks in the city which had a direct effect on its economy. Thus, socio-economic developments should be demonstrated to understand the urban dynamics of the city.

Economic Development of the City

It is known that during the end of the 19th century, a new era has started in the big urban centers of the Ottoman Empire particularly İstanbul and Salonica. This period is called as Constitutional Period. In 1877, this passé affected the whole economic activity of the Empire. In the last quarter of the 19th century, industrial progress of the city was supported by the parallel development of substructure of the city. By the end of the century, Salonica was linked with its hinterland; Europe and Asia by railroad. (Bugatti, 2013) Although older land transportation was used in some areas, modernization attempts for the city and its communications would drive to the construction of contemporary roads and storehouses. (See Figure 9)

Figure 9. *A view of Hamidiye Boulevard and Beyaz Kule at the east side of Salonica. (Veinstein, 1999)*

The port of Salonica with its quay was reconstructed according to the needs of the century. The city obtained a modern well-structured port between 1897 and 1902. (Anastassiadou, 2010) Finally, trade ways were being combined by the emergence of railroad and cooperate for the industrial development of the city. New imperial laws which allowed the penetration of foreign capitals facilitated the interested investors to get into the city production activity. (See Figure 10)

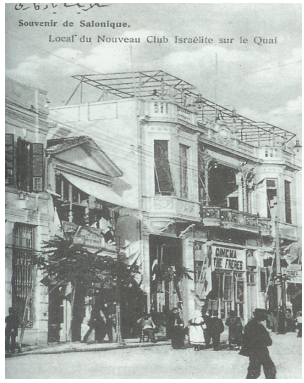

Figure 10. *After the demolition of walls, hotels and clubs were constructed on the waterfront (Mazower, 2004)*

Construction of banks and the foundation of various technical and commercial schools were the other important factors that contributed to the industrial development of the city. Banking in the city emerged from the bourgeois class rather than as a result of commercial activity. Nevertheless, at the end of the 19th century, city banking developed. There were so many banks in the city that they had a direct influence on the economy of the 19th century in Salonica. For instance, the branch of the Imperial Ottoman Bank in 1863 was the first bank established in the city. (Mazower, 2004) (See Figure 11)

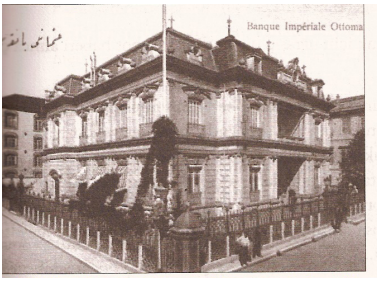

Figure 11. *The branch of Ottoman Bank (Veinstein, 1999)*

The second organized bank was a branch of *Agricultural Bank.* The first city bank of Ottoman and Greek ownership was the Bank of Mitillini. Along with the banks, economic development served for the insurance companies. After the big fire of 1890, the insurance companies and agencies suffered severe economic loses.

Social life of Salonica

In the middle of the 19th century social life of Salonica was in such a terrible atmosphere. Government was not in the slightest degree interested the planning process of the city. The city looked like a labyrinth with its circuitous and clinging streets. Streets belonged to everyone; a place where children could play and a place where someone could dump garbage. Indeed, it was no man's land. Moreover, fires were familiar to people, it was the part of daily life. In 1814, fifteen thousands of people died due to pest. (Veinstein, 1999) It is obvious that early 19th century was a depression period for the city due to war, disease, lacking infrastructure, fire and economic recession. (See Figure 12)

Figure 12. *Street life in the middle of the 19th century (Veinstein, 1999)*

There was a sharp transition after the declaration of Tanzimat Edict in 1839. Opposing to this, at the end of the century, Salonica became the metropolis of the Ottoman Empire in the Rumelia region. At that period, the city, which was located in the intersection of the west and the east, turned into a dynamic, modern and westernized area of the declining Empire. Like the other port cities -İzmir, Beirut, Trabzon, İstanbul- Salonica was offering great potentials. It was the place where all the reforms and renewals of Tanzimat were realized such as the new transportation networks, modern governmental institutions, development of the industry. (Anastassiadou, 2010)

As westernization is a governmental attempt, it was experienced in all the main cities of the Empire almost in the same way. Therefore, Ottoman Cities in 19th century showed a similar model in many ways. For most developments, İstanbul was the pioneer between the other Ottoman Cities. Many new attempts were first implemented in the capital of the Empire. For example, the first modern municipality, similar to Sixth-circle municipality was established in Salonica and İzmir ten years later than the İstanbul. During the Ottoman period, it was an administrative center of the western provinces;

Rumeli state and politically capital of the province; Selanik province. It was a seat of the provincial governor, a county's governor and a district's head official at the same time. On the other hand, it was the place of the Greek/Hellenic Orthodox. (Yerasimos, 1989)

Although Salonica consisted of different cultures and nationalities, all communities of the city participated with more or less equal share in the development of the city. The cultural peculiarity articulated not only in frictions but also in architecture and art. Due to the competition among the communities many architectural works were created. They are still being considered as the jewels of the city; for instance, in 1881, the famous house in which Atatürk was born. (See Figure 13)

Figure 13. *The house which Atatürk was born in Salonica, Aya Dimitriya District (Veinstein, 1999)*

THE ARCHITECTURAL DEVELOPMENTS

Tanzimat Edict introduced a new era to all communities. Between 1840 and 1880 many of the abandoned Ottoman and Jews religious constructions restored, reconstructed or expanded. By the last quarter

of the 18th century, the city became a reception center of foreign engineers and architects. Typology and morphology of the architecture, the introduction of new, western structural methods, new styles such as neoclassicism, eclecticism, the economic prosperity of the city, the increase in city population because of the inflows from the hinterland, the competition between the communities, the series of fires during the last years of 19th century, and the Macedonian struggle (1870-1910) were the main factors which highly affected the buildings construction, particularly the religious ones. Moreover, there had been some alterations in urban planning. After the declaration of Tanzimat Edict, streets became wider and flat, cul-de-sacs were abated, new main roads were opened. (Yerasimos,1989) (See Figure 14)

Figure 14. *The sea approach from the south west showing the minarets and cypresses rising above the walls (Mazower, 2004)*

Main architectural type of the city mosques had big quadrangular prayer lodge which was covered by a big central dome. Later, the type developed and the antechamber became a portico which was covered according to its size. There were also some mosques (mescit*)* that looked like two-floor houses. (Mazower, 2004) Besides, until the first decade of the 20th century, city synagogues did not have significant characteristics. They would remain simple unlike the other communities' religious buildings. Furthermore, the architects were

all foreigners and were chosen by the communities like National States. (See Figure 15)

Figure 15. *Example of a mosque in the 19th century (Veinstein, 1999)*

Another remarkable development which had an influence on the progress of the city in the 19th century was schools. The Ottoman- Turkish community of the city had a considerable number of schools that were founded mainly at the end of 19th century. There were educational foundations of different levels with various educational specialties. (Bugatti, 2013) They did not have an impressive architectural style. It is an interesting phenomenon that during the same period, almost no other city in Europe demonstrated with a such number of schools, variety of languages, specialties in terms of military, commercial, law, etc. It is because of inter communal competition and interactions among the communities. İdadiye (secondary school), Rüştiye (semi high school), Daru'l-muallimin (teacher-training school), Selanik Hamidiye Mektebi (technical school), İnas Rüştiye Mektebi (females' semi-high school) were some of the significant schools which gave different types and levels of the education of the era. (Anastassiadou, 2010, p. 172) As well as Muslims, Jews, Levantines, Slavs, Romanians, Armenians established many new schools. Furthermore, cafes, hotels and banks were the formations that played a significant role in social

life and spatial configuration of the transformation of the city. (Anastassiadou, 2010, p. 172) (See Figure 16)

Figure 16. *A street consists of cafes, hotels and banks (Veinstein, 1999)*

CONCLUSION

In the case of Salonica, one of the main reasons of the demolition of walls was to create a modern city without any restriction and also to facilitate the access between the old city and newly developed suburbs. This process was the most remarkable attempt of 19th century urbanization. Nevertheless, the only reason of destroying walls could not have been created a modern or well organized city. This attempt was also an outcome of reestablishing the central power of Ottoman Empire. As Braudel says, "there were always two runners, the state and the town, -two forms and two speed of deterritorialization- and the state usually won." (Deleuze and Guattari, 1987, p. 480)

Salonica, the second city of the Empire, had an impressive character of its own. It was mingle of two worlds; east and west with many Balkan characteristics and it is the ultimate urban melting pot. Eastern colors were dominant until the third quarter of the 19th century. By the last quarter of the century, when westernization and European diffusion began to be realized European features of the city would be more leading. During that

transitional period the city acquired more cosmopolite structure particularly at its center and western suburb *Harbiye*. Railroad linking with Europe and İstanbul, electrification, water supply network, gas-light network for civic needs and public transport of the city were the innovations that the city was faced with. Moreover, the emergence of banking and development of education and their roles in the city economy as well as the role of other financial organizations and the contribution of the city port and railroads is very significant to comprehend the transformation of the city.

The alteration was also apparent in the architectural forms of particularly public buildings such as churches, mosques, schools and banks. Some architectural styles are more dominant in the period like neo-classicism and eclecticism. Although some parts of the city had been in a poor condition, the construction of the public spaces, square and boulevards was some very important urban developments for the city. Anastassiadou (2010, p. 13) described Salonica as a western city, *"*the waterfront of Salonica constructed by a French Company, cafés on the waterfront were selling German beer, tramway came from Belgium" All these improvements demonstrated that Salonica was transformed into a modern Ottoman city at the end of the 19th century.

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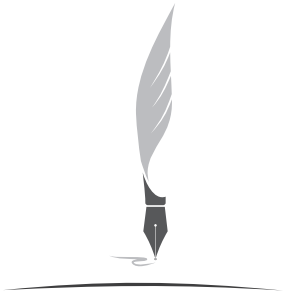

Chapter 2

WOMEN IN THE AXIS OF THE ENCLOSURE OF RURAL-ECOLOGICAL COMMONS

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1. INTRODUCTION

In various field studies in the literature, it is stated that indigenous knowledge, food production and agriculture are becoming more female as a result of the rural-urban migration of the (young) rural men in search of new jobs. As a result, the responsibility of women in rural areas increases. Rural women often simultaneously engage in social reproduction, food safety, crop harvesting, home horticulture, plant breeding, herding, seed keeping, farming and husbandry. Women manage many wild plant resources and ensure in-situ conservation, especially as a user and administrator of natural resources in tropical rural areas. However, participation of women in policies and decision-making processes that affect biodiversity are still severely limited, which results various conflicts (Howard, 2003).

In societies where women are marginalized, it is inevitable that indigenous knowledge they produce and possess that is essential for the continuity of the rural livelihoods would be destroyed. Especially the wild plant varieties are often seen as secondary sources in agriculture, parallel to the fact that women are seen as secondary actors in decision making processes. Even, most of the studies on local sustainable development produce erroneous results as a result of not taking into account the perspective of women in the field studies (Howard, 2003).

The local and cultural value of the plant genetic resources and seeds (rural-ecological commons) are often underestimated by decision-makers. In many communities around the world, natural resources that provide food, medicine, clothing, shelter, tools and income are the main wealth of rural women, and the continuity of their access to these resources is important for their position and well-being in their society. Another aspect is the need for women

to be involved in the sustainable development strategies and decision-making processes because biodiversity can only be preserved as long as the fair and equal sharing of benefits derived from the use of natural resources and the sustainability of the indigenous knowledge (Hazar and Velibeyoğlu, 2018; Hazar, 2018). In addition, it is remarkable that the reflex of women when their access is restricted to the necessary natural resources for their livelihood are usually similar in the world.

In this contex, the study aims to open a debate on the women within the axis of the enclosure of the rural-ecological commons in order to propose gender-sensitive planning parameters by the literature review on the political ecology and ecofeminism perspectives, commons and enclosure movements, in addition with the media search on the women in the environmental struggles in Turkey (Figure 1).

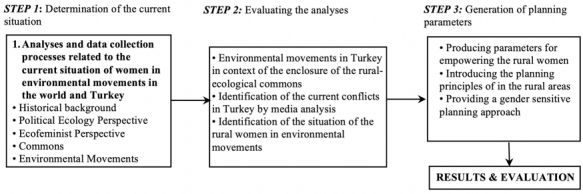

Figure 1. *Methodological Diagram*

2. Political Ecology Perspective

The word 'ecology' was first described by the German biologist Haeckel (1866) as a science that works for the interdependence of the species. Political ecology, on the other hand, is defined as a science that examines the social structures and social organizations that interact with the environment. The concept of political ecology *(écologie politique),* which was first used in French by Jouvenel in

1957, was translated into English by anthropologist Wolf in 1972. The political ecology approach leads a discussion of the history of the environment and/or nature, public responses to the ecological crises, and main political trends proposed by the ecology movements (Dobson, 1995; Heynen et al., 2006).

The conflict between 'anthropocentric' views and 'biocentric' views have been going on for many years. The 'deep ecologists' within the political ecology approach follow a clear biocentric route; while 'social ecologists' stand in the middle of the two (Dobson, 1995). Political ecologists argue that nature has an intrinsic value and directs the principles and approaches of behavior to understanding the intrinsic value of the non-human world. In this context, what provides integrity, stability and beauty for the biotic community must be true and the individual beings can be sacrificed for the good of the whole (Leopold, 1949). However, this idea is also criticized as being 'environmental fascism'. The main practical problem of the environmental movements is whether or not ecologically sensitive actions are truly appropriate to the environmental ethics. Eventually, a fundamental social change is required in order to move to a life practice that places ecological awareness on the basis of environmental ethics and biocentrism on the basis of the ecological perspective (Regan, 1988).

Political ecologists, who have a common idea to create a community with ecological awareness, are divided into various branches: *'Eco-Social Democrats'* perspective argues that the environmental problems of social democrats cannot be solved by election. *'Eco-Marxism'* perspective tries to create a synthesis between Marxism and ecology and argues that ecological and economic problems cannot be solved locally. *'European Libertarian Eco-Socialists'* perspective proposes decentralized, feminist and autonomous regions and advocates fighting against any

attempt that makes politics a profession. *'Social Ecology'* perspective, which has been philosophically founded by Bookchin since the 1950s, is the most striking approach in terms of suggesting a radical and feasible program among the political ecological approaches (Roussopoulos, 2015).

According to Bookchin, local government is the most direct political sphere of the individuals, who can be transformed from private individuals to a legal entity as being active citizens. In this context, political ecologists who want a comprehensive form of government that challenges the central state, and the social ecologists who put the Green Movement theory into practice place 'local government' at the center of public life and prefer to limit the electoral activities within the local elections. Of all political ecology perspectives, the 'dual power' proposal of the social ecologists is the most realistic strategy of dealing with a subjective social form called 'the community' (Roussopoulos, 2015).

Ecofeminist, feminist environmentalist and feminist political ecologists have pointed out to a direct link between the gender, environment / nature and sustainable development processes and to discuss the global role of women for the local sustainable development (Rocheleau, 1995).

2.1. Feminist Political Ecology Perspective on Commons

In recent years, Turkey's urban and rural areas have witnessed several small scale and locally oriented struggles against the enclosure attempts such as 'Do Not Touch Kültürpark' in İzmir, 'North Forest Defense' and 'Yedikule Urban Gardens Protests' in İstanbul, all of which aim to prevent the historical landscape turning into a commodity (Figure 2). These struggles are often seen as reactions to the restrictions on the access to the commons,

which can be categorized as rural / urban; natural / artificial, and tangible / intangible (Table 1) (Ostrom, 1990; Adaman et al., 2017).

Table 1. *Common Types (Ostrom, 1990)*

	Rural Commons		**Urban Commons**	
	Tangible	**Intangible**	**Tangible**	**Intangible**
Natural / Ecological Commons	Seed, pasture, river, forest etc. natural resources	Air, climate, time etc.	Waterfront, river, urban park, market gardens etc.	Air, climate, time etc.
Artificial / Human-made Commons	Village square, village fountain, cemetery etc. public goods	Tradition, apparel, dance, music, accent, tales etc.	Street, public library, square, public transport, cemetery etc. public goods	Tradition, etiquette, information technologies, music, fashion, etc.

The ongoing enclosure pressure on the commons is based on the 'primitive accumulation', the enclosure movements that began at England countryside in the 17th century as a detention through the conversion of the public lands into private property on behalf of the landlords. Marx (1867) described this process as 'the attack of the capital on the rural commons' (Marx, 1867). Especially since the 1980s, it is frequently referred that the 'second enclosure movements' continue by neoliberal policies enclosing the agricultural lands, forests, pastures and coasts on behalf of the construction, tourism, mining and energy sectors, and patenting the seeds and genes (Benlisoy, 2014).

The work of the feminists in the commons literature has been continuing for more than thirty years (Mies and Shiva, 1993; Agarwal, 1995; Rocheleau et al., 1996). In addition, in recent years, studies that have positioned the commons as an alternative to neoliberal capitalism (De Angelis, 2007; Bollier and Helfrich, 2015; Gibson-

Graham et al., 2016) and several studies have been made that focus on the 'commonization practices' (Linebaugh, 2008; Bollier and Helfrich, 2015). Commonization can be described as the process of re-creating the commons. The studies approaching the commonization practices from a feminist perspective pay a special attention to the daily life practices, social relations, designed spaces and social reproduction areas (Clement et al., 2019). Feminist political ecology research is particularly concerned with the community / society and collectively reconstructed commons (Sultana, 2009; Federici, 2011; Nightingale, 2011; Elmirst, 2015). The common approach and practices from a feminist political ecology perspective has an important position against the risk of re-commodification of the commons.

Figure 2. *Yedikule Urban Gardens (Personal Archive, 2016)*

In the historical process, the political ecologists have been focusing on the pressure created by neoliberal environmental management, while the feminist political ecologists have been focusing on the gender roles in the community and the power relations on the common debates on the natural resource management (Rocheleau, 2008; Ahlers and Zwarteveen, 2009; Harris, 2009). Feminist political ecology does not only focus

on to gender; it is enriched by 'intersections' related to race, age, class, talents and castes. Feminist political ecology studies focus on the 'intersectionality' on how gender-based power relations are shaped by everyday life practices, and how everyday living spaces, such as households and communities, affect social relationships, access to resources, identities and knowledge. Feminist political ecology also distinguishes the commons as biophysical, knowledge, cultural and social commons, and demonstrates the coexistence potential within the transformative practices (Clement et al., 2019).

Sato and Alarcon (2019), draw a post-capitalist feminist political ecology approach, that aims to broaden the limited vision of the class-blind and capital-centered commons discussions. Feminist political ecology studies approach to commons in a variety of forms, including non-human beings, and property independence. Marxist feminists also argue that commons should not be reduced to commodifiable resources and unmanaged natural resources as the commons are the products of the community's actions and awareness of the responsibility. Therefore, it is not possible to talk about commons without talking about a community (Sato and Alarcon, 2019).

Feminist political ecologist Nightingale (2019) describes the commonization practices as 'socio-natural processes'. The socio-natural systems can be defined as the 'anti-anthropocentric socio-ecological systems' (Castree and Braun, 1998) as the term socio-ecological tends to ontologically separate the communities and ecologies. On the other hand, the term socio-natural describes the communities within the ecology and does not classify them as separate entities. Nightingale (2019) states that there are intersectional relations such as gender, race, ethnicity, caste, age and disability; which are not exempt from the contradictions between the power relations. Common relations are also the subjects to the

conflicts including the socio-natural inclusions and/or exclusions. Thus, common practices should be seen as the act of power, including human and other living beings (Nightingale, 2019).

There are several collective management examples of the commons, such as forests, water and other livelihoods, urban gardens, vacant parcel reclamations, open sources and internet based production efforts, alternative currencies (e.g. block-chain, bitcoin) and so on (Bollier and Helfrich, 2015). Commons are fragmentary and temporal states that are constantly depend on the commonization practices. The subjectivities of socio-natural relationships lead to the emotional attachment to customers and daily life practices (e.g. emotional connection of the farmers with olive trees). But loving a common, for example a forest, cannot prevent the contradictory practices on it. In this context, environmental actions, resistance and uprising socio-natural communities may not overcome the conflicts on the commons, yet, they become the part of these conflicts (Nightingale, 2019).

2.2. Ecofeminist Perspective on Women and Biodiversity

Gender approach has started to be discussed in the axis of sustainable development since the 1990s. In the 20th statement of the Rio Declaration published in 1992 it is stated that *"Women have a very important role in the management and development of the environment and thus, the full participation of women is necessary for the sustainable development".* However, in most biodiversity studies, there are serious data deficiencies on the criteria set by gender. Particularly in conservation and development projects in Africa and Asia, there are serious male-dominated environments.

The indigenous knowledge of women is the basis for ensuring the food safety, and if women get more control over the natural resources, it can be predicted that they can protect biodiversity more. In this context, strengthening women's participation in the decision-making processes is essential for an effective management of the natural resources. Women should be involved in decision-making process, economic opportunities, land ownership, credit, education and health services with equal access and full participation (Deda and Rubian, 2004; Howard, 2003).

Biodiversity can be defined as a whole of genetic resources, species, ecosystems and the foundation of life on earth. Biodiversity has a significant economic value for plant growing and related industrial uses. However, beyond its economic value, it is primarily important for the nutrient supply and adaptation to climate change (resilience). Especially, the food safety of the local and global communities depends on the biodiversity in the fields and forests. However, after modernization in agriculture, the seeds have turned into feasible agricultural raw materials and a serious genetic erosion has occurred. The Earth Summit in Rio in 1992 addressed the importance of in-situ conservation to prevent this genetic erosion. However, most conservation approaches have given false results due to a sexist vision that envisions women at home and men at work, away from a direct intervention on nature (Rocheleau, 1995; Zweifel, 1997).

The importance of the indigenous knowledge of women is becoming more visible in the recent studies. The United Nations Conference on Environment and Development in Rio in 1992 and the United Nations Women's Conference in Beijing in 1995 had significant impacts on gender issues in the context of biodiversity management and conservation. The United Nations Environment Program (UNEP, 1992) highlighted the vital role of the women in the conservation and sustainable use

of biodiversity. Since the 1970s, while the environmental movements have increased, researchers have noticed the importance of women in the rural areas. The gender approach, which was discovered in the 1980s, demanded direct socio-economic and political changes by revealing the ongoing gender-power relations in the society. This approach has analyzed the gender differences in the agricultural labor, the different relationships between genders with the natural resources and the impact of the rural-urban migration on rural women's work and responsibilities (Zweifel, 1997).

There are a large number of studies on the relationship between women and the plant biodiversity (seed) protection in the world; however this issue has not been adequately discussed in Turkey yet. Shiva (1992) reveales her implications on women's labor in the traditional agriculture, husbandry and forestry practices and ancient indigenous knowledge, based on the examples of the female farmers in India. In the capitalist system, women's labor (which usually does not enter the cycle of wage) is consciously rendered as 'invisible' within the category of 'unproductive labor'. This an indispensable part of the exploitation of labor. The labor-time that women spend in the production and social reproduction processes without harming the nature and biodiversity is considered as the part of the 'spontaneous productivity of nature'. However, the diversity and continuity of seeds, food cycle, animal feed, forestry and products that are sold and/or consumed daily are the processes that occur within the wisdom and hard work of the indigenous women. Rural women produce, reproduce, consume and preserve biodiversity while becoming a part of the cycle of nature as the watcher of the seeds (Shiva, 1992).

The fact that the seed is considered sacred in some cultures is another factor that protects biodiversity. Traditional festivals (e.g. seed exchange, shearing) help

to ensure the sustainability of the biodiversity. Unlike monocultures, maintaining the diversity of local products is necessary for the soil fertility and prevention of the plant diseases. Especially in the underdeveloped and/or developing countries, the only way of self-sustaining is to provide diversity. However, farmers, particularly female farmers (watchers of the seeds) lose their decision-making status in the production process and reduced to status of unskilled labor and/or consumer when seeds are purchased from outside (Shiva, 1992).

Most of the rural women are not legally landowners or part of the labor force; therefore, their labor is not included in the GNP, GDP and other productivity measures. However, the rural women continue to work with an increasing responsibility as farmers, shepherds, foresters, water tractors, food processors, market sellers, construction workers, soil protectors and watchers of the natural and rural built environment (Rocheleau, 1995).

Several ecofeminists argue that there is a direct relationship between women and the nature through the biological characteristics of women; yet, others criticize this view as being reductionist and risky and prefer to examine the relationship through the socio-economic structures. However, both groups evaluate the nature / environmental protection from a gender-sensitive perspective that strives for the biodiversity protection. Surely, this concern is primarily applied to the rural women of underdeveloped and/or developing countries engaged in the agricultural production, whose livelihood frequently depend on the natural resources. In this context, ecofeminist approaches has a capacity to define the (1) multiple uses and values, (2) multiple actors, relationships, different organizations that mediate people and environmental ecosystems; and (3) the relationship between physical and spatial relationship to landscape and daily living practices (Rocheleau, 1995).

The information that is described as the 'unaware ecological wisdom', 'local ecological science', 'implicit/ tacit knowledge' and/or 'indigenous knowledge' in the literature is often reserved for the women in the rural areas. Among these women, vast information on forage crop collection, stockbreeding and weeds is transmitted from generation to generation (e.g. Kenya). In countries such as Bolivia, Colombia, Peru, Vietnam, Indonesia and India, women are responsible for the selection, development and storage of the seeds and the management of the small farms. In sub-Saharan Africa, women produce more than 120 varieties of plants. According to the FAO (2004) report, as a result of the decrease in the male population in rural areas due to war, diseases and migration from rural to urban areas for new job opportunities, the responsibility of women for food production in the rural areas increased, which is described as 'feminization of agriculture' (Deda and Rubian, 2004). However, especially in less developed countries, the land ownership of men creates increasingly difficult situation for women to access the natural resources. In this context, it is not possible to say that biodiversity can be truly preserved unless the gender imbalance between the rights and responsibilities and the inequality in the access to resources are eliminated (Rocheleau, 1995).

The private ownership of women in the world is less than 2%. In addition, 70% of the women in the world live on a strict poverty line as they find it difficult to get a loan to start a business or maintain an activity. The limited access of women to education restricts their technical knowledge and competitiveness on the biodiversity conservation and sustainable production practices (Deda and Rubian, 2004).

'The Green Revolution', emerged by the mechanization of agriculture, also had an impact on the gender roles in rural areas. Traditional methods of

substitute mechanized agriculture create jobs, increase workload and reduce opportunities so that women have to work more labor-intensive, low-wage and precarious. The formation of the gender roles according to the socio-cultural norms is reflected in class differences, and race and ethnicity are often used against the women. The major presence of men in the bureaucratic institutions usually makes women's voices less heard. For this reason, environmental actions in which women organize have usually occured spontaneously and informally throughout the history (e.g. Kenya Green Belt Movement, Narmada) (Deda and Rubian, 2004).

The ecofeminist approaches advocate the increasing local power of women and argue that the social and ecological crisis have founded long before the capitalism by patriarchy. They aim to create a non-dualist perspective between the society and environment / nature. However, several ecofeminists are labelled as 'irrational thinking' by their claim that men cannot develop an accurate policy to protect nature. Thus, Bookchin often states that they cannot cope with real social struggles within an emotional pantheist eco-spirituality. The real confrontation with domination can only be possible through the collective action and social movements that can challenge the social power relations and economic systems on a large scale (Biehl, 1991; Roussopoulos, 2015; Shiva, 1993).

3. Environmental Movements

The environmental movements in history have started with the resistance of the local people (e.g. Indians, Aborigines) whose natural resources and rural-ecological customers are enclosed by mining, tourism and commercial capital in the 19th and 20th centuries (Garner, 1996). The environmental movements in history is summarized in Table 2.

Table 2. *Environmental Movements*

Years	Period	Events
1950-1960	The Effects of War	• DDT poison and pesticides after the WW2 • Test of nuclear weapons and nuclear power plants • Environmental united peace activists in USA, western Europe and Japan
1960-1970	The Birth of Environmentalism	• 1962 ⇨ Silent Spring, a book about the toxic chemicals and pesticides • 1968 ⇨ The Population Boom, a book by Paul Ehrlich on the negative effects of the population growth on ecology • Environmentalist groups against industry in Japan • Green Parties in Europe
1970-1980	1973 Oil Crisis, (OPEC), Energy Supply	• End of Vietnam War, student and environmental movements in Europe • Green Parties in Europe and Australia • 1971 ⇨ Greenpeace establishment • 1972 ⇨ Stockholm Conference: United Nations Environmental Program • 1972⇨ Roma Club: Limits to Growth, resource pessimists • 1973 ⇨ Schumacher's book: Small is Beautiful, shrinking in economy by clever use of nature • 1979 ⇨ Antinuclear movements
1980-1990	Ozone Hole, Health Issues, Sustainable Design	• 1982 ⇨ IUCN world nature restriction document • 1985 ⇨ Ozon hole • 1986 ⇨ Chernobyl nuclear disaster felaketi (Ukraine) • 1987 ⇨ Brundtland Commission, Our Common Future Report: Sustainable development concept • Acts against racism in USA

1990-2000	Sustainable Development	• 1992 ⇨ Rio De Janeiro, World Summit: climate change, biodiversityy, rain forests, Agenda 21 • 1996 ⇨ UNCHS Habitat II Conference in İstanbul: sustainability concept, liveability, survival, equity • 1997 ⇨ Kyoto Protocol on climate change • Acts against NIMBY policies to the rural people, industrial workers, indians and blacks in the 3rd world
2000-2010	Climate Change, Loss of Biodiversity	• 2002 ⇨ Johannesburg Summit • Global environmental issues: water, energy, health, agricultural productivity, biodiversity protection and ecosystem management
2010-Today	Information Technologies, Climate Change, Biodiversity, Resilience, Commons	• Triple bottom line of sustainability: economical, social, ecological • Resilience concept • Commons concept • Climate protests • Truantry protests of students (e.g. environmental activist Greta Thunberg)

In 1970, a group of Indian rural women shielded themselves against the trees that were planned to be cut down. This action called ‘Chipko Movement’ and spread to all of India within a few years leading to several reforms in the field of forestry (Figure 3). Although it has spread to a wider audience afterwards, it is still accepted as one of the landmarks of ecofeminism (Shiva, 1993; Url-2).

Figure 3. *Chipko Movement, India, 1970 (Url-1)*

Since the 2000s, global warming, climate change, loss of biodiversity and sustainable development are among the primary issues discussed in the environmental debates. The main environmental issues addressed at the Johannesburg Summit in 2002 included water, energy, health, agricultural productivity, biodiversity conservation and ecosystem management. The triple bottom line of sustainability and resilience concepts have also been discussed in recent years. In addition, recent studies on biodiversity conservation and the common concepts of gender have attracted attention. In particular, the actions of young activists against global climate change (e.g. Swedish climate activist Greta Thunberg) and active use of the communication technologies and social media stand out in the context of the organization and dissemination of the current environmental movements.

4. Environmental Movements in Turkey

There are several attempts to address women and gender issues in the context of the space and environmental movements in the Turkish literature. The examples of these initiatives are the 'United Nations Women Friendly Cities

Program' and the local administrations implementing, TMMOB (Union of Chambers of Turkish Engineers and Architects) Women's Congresses, Symposiums and Panels organized by professional chambers, and various theses and articles. However, despite being a significal increase in the study of women and urban issues since the 2000s, its contribution to the studies on gender and space and studies on gender and environment are still relatively fewer in number in Turkey (Karaburun Akıncı et al., 2018).

'Women in Ecological Transformation' (2010) is a book containing reviewed articles by the editorship of Emet Değirmenci can be labelled as the first book about ecofeminism published in Turkey. It consists remarkable examples of the rural women and their indigenous knowledge. It describes women as the 'memory of agriculture', especially in terms of seeds, medicinal aromatic plants and food safety, and focuses on local seed production and rural development re-encouraged through the locally-oriented organizations, associations, groups and cooperatives (Değirmenci, 2010).

Following that, Sinek Sekiz Press translated the book 'Ecofeminisim' in Turkish in 2018 (Shiva and Mies, 1993). In addition, a small number of theses have been identified in the Departments of Public Administration, Sociology, Philosophy and International Relations, which examine the environmental movements and sustainable development from the perspective of gender and ecofeminism since 2003. However, it can be said that the issue has not been studied in the Department of City and Regional Planning yet. Eventually, Turkish resources on the relations of the rural women with seeds and biodiversity and ecofeminism are very limited.

The previous studies have mainly focused on the gender inequalities in terms of ownership especially

after the mechanization in agriculture; increased sexist use of private and public spaces by commercialization; and alienation of the rural women in the decision-making processes. As a result, women cannot acquire property, cannot get credits and are unable to participate in the decision-making processes in Turkey. Neoliberalization projects such as Marshall Project, Green Revolution and GAP have worsen this situation (Yüksekkaya, 2018).

The motivation of the women participating the environmental movements in Turkey vary in rural and urban areas. While women living in urban areas try to protect their lifestyles against the environmental destructions, women living in rural areas struggle for their livelihood. As in many other societies in the world there is a close relationship with the nature and women in Turkey. Female activists express their concerns about the environmental problems, green consumption and sustainability and emphasize the relationship between women and nature; although, there has not been an ecofeminist awareness yet in Turkey (Seçkin, 2016).

5. Findings and Evaluation

In the study, feminist political ecology and ecofeminism perspectives in the context of commons, enclosure of the rural-ecological commons and the place of women in the environmental movements have been investigated in Turkey. The data obtained through literature review and media analysis has been evaluated by the content analysis. The place of women in the environmental struggles within the last five years (2014-2019) has been examined by the media analysis. Accordingly, it is determined that rural women, who act with the motivation to protect their natural resources are often at the forefront of environmental actions, frequently keep their livelihoods (Figures 4).

In 2014-2019, 28% of the environmental acts in Turkey are about Hydroelectric Power Plants (HES), 17% are about the pasture occupations and gold mines, 17% are about the Thermal Power Plants and the rest (equally 6%) are the Quarries, Green Road, Wind Power Plants (RES) and Geothermal Power Plants (JES) (Figure 5). Several examples of the environmental movements leading by women according to the media analysis can be seen in Figure 6-9. These conflicts, lawsuit processes and environmental acts continue as reactions to the enclosure attempts.

Figure 4. *Media Analysis, 2014-2019*

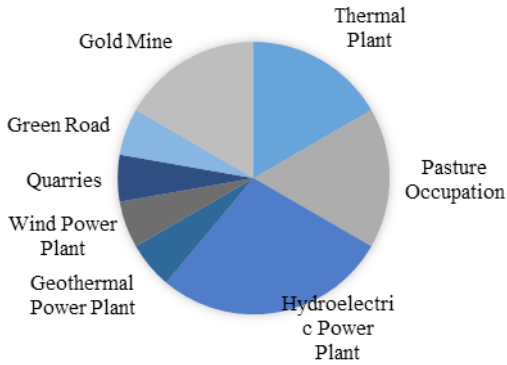

Figure 5. *Environmental Acts in Turkey, 2014-2019*

Figure 6. *Çamlıhemşin 'Green Road' act, 2015 (Url-2); Göllüce village, Torbalı-İzmir, pasture-meadow act, 2016 (Url-3)*

Figure 7. *Fındıklı-Rize, HES act, 2015 (Url-4); Pınarça village, Çerkezköy-Tekirdağ, thermal power plant act, 2019 (Url-5)*

Figure 8. *Rize, pasture occupation act, 2018 (Url-6)*

Figure 9. *Kızılcaköy, İncirliova-Aydın, JES act, 2018 (Url-7)*

Proposed Planning Parameters

The study aims to propose several planning parameters in order to sustain the livelihood of the rural women, local sustainable development, indigenous knowledge and to provide the gender equality in the rural areas:

- Encouraging the participation of rural women in decision making and investment processes
- Empowering the rural women by education (agrotourism, gender equality seminars etc.) and by subsidies and loans for their economic independence
- Promoting gender-sensitive, interactive and participatory planning activities and interactive, participatory and multi-disciplinary decision-making processes (commonization practices, forums, community councils etc.)
- Promoting in-situ preservation (natural resources, local seeds etc.)
- Promoting alternative job opportunities, which do not conflict but supplement with the agricultural sector in the rural areas (agrotourism etc.)
- Encouraging international networks and public disclosure on the environmental issues (social media, web sites, hashtags etc.)
- Promoting agricultural land use planning and management, pasture reclamation, holistic farming, forage crop production and organic and regenerative farming methods
- Preserving and spreading the indigenous knowledge by knowledge sharing activities (forums, panels, projects, academic studies and publishing etc.)

- Promoting gender equality and co-presidency in community councils and local governance
- Promoting marketing and logistic distribution of the local products by encouraging rural cooperatives and unions; international and national funds, subsidies and loans

6. Conclusion

In Turkey, it is observed that the women are at the forefront of the local resistances and environmental acts against the enclosure of the rural-ecological commons. One of the reasons for this situation can be the prediction that law enforcement officers may perform lesser violence against to the women and children at the front lines. However, from an ecofeminist perspective it can be said that women have a stronger desire to defend their rural livelihoods for the future generations.

It is necessary to support the commonization practices against the enclosure movements, to gather different and diverse groups with a common purpose. There is a potential to ensure the protection of the rural-ecological commons by making gender-sensitive budgeting and incentives in the rural areas with the coordination of Municipalities and Provincial and District Agriculture Directorates. However, in order to achieve this goal, there is a need to build new institutions, such as city councils, together with the benevolent local governments that will participate in proactive commonization practices. These participations can be actualize through various field studies and/or theoretical discussions. Therefore, a further research on the rural-ecological commons should be undertaken, the importance of ecological commons for biodiversity should be emphasized and the commons should be represented by the right tools in participatory planning and decision-making processes.

The promoting commonization practices against the enclosure movements in rural areas may help to prevent the rural-urban migration by improving the quality of life and sense of belonging and are thought to be important for the conservation of the biodiversity. The more detailed analyses are required for the accurate representation of the rural-ecological commons in terms of their ecological and global importance and their participation in the decision-making processes. Agricultural land use planning and management processes should be holistically considered. The rural-ecological commons should be evaluated within an ecologically-sensitive planning approach and protected by the improved rural policies, which require gender-sensitive incentives and the displaying of the rural women's labor and indigenous knowledge.

In this context, there is a need to increase the 'ecofeminist awareness' to prevent the destruction of the ecosystem and biodiversity and a social movement that can challenge the current system through collective actions and strong objections against the environmental threats caused by the neoliberal policies. Reactive and locally oriented environmental movements may have a potential to transform into proactive and collective political subjects as the 'opposing hegemonic movements' that can be effective at regional and national scales, which have the power to mobilize various social groups outside the rural locality. Thus, women should be involved in the policies and decision-making processes on all issues affecting their well-being (Howard, 2003).

The study is important in terms of being a theoretical priori to the studies on ecofeminism, feminist political ecology and commons in Turkey. At this stage of the study, it is observed that there is not a nationwide common aim or identity as a political subject of the environmental acts by the locally oriented heterogeneous groups in Turkey. However, the literature of the feminist political

ecology, social ecology and commons has the potential to provide a theoretical background to form these struggles. In addition, gender-sensitive planning has a potential to empower the rural women. In this context, the literature review on the feminist political ecology and commons, the field studies on the rural women's labor and indigenous knowledge, the media analysis on the place of women in the environmental acts in Turkey should be widened for the future studies.

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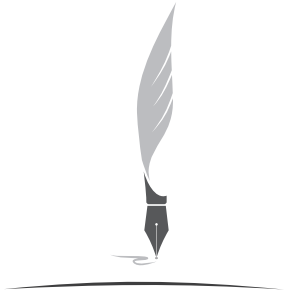

Chapter 3

EXPLORING THE AESTHETIC ASPECTS OF THE BUILT ENVIRONMENT

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1. INTRODUCTION

In our interaction with the built environment, the appearance of the built environment plays a significant role in our social and psychological well-being. In everyday experiences, people perceive and respond to visual attributes in the environment. Various visual attributes in the built environment affect the participation and engagement of people in their daily activities. The aesthetic quality of the built environment may influence their immediate experience; it may evoke emotions or feelings such as pleasure, relaxation, fear and excitement that affect environmental preferences and spatial behaviors (De Sousa Vianna, 2002; Nasar, 1992). The perceived aesthetic quality depends on the evaluations of people who regularly experience the environment (Nasar, 1998; Sanoff, 1991). Averill, Stanat and More (1998) claimed that "objects are experienced aesthetically if they activate cognitive representations of response patterns that do or did contribute to the survival or enhancement of the species, society, or the self" (p. 153).

People prefer and spend time in favorable places and avoid unfavorable ones based on experience with and emotions about the aesthetics of the environment (Nasar, 1992). The aesthetic quality deals with objects as they are perceived directly with the senses and it disregards the origin of purpose of an object (Porteous, 1996). People are able to identify visual attributes in the environment that create pleasant feelings and negative emotions. The field of environmental aesthetics focuses on how people react to the visual quality of the built environment. This paper focuses on the issue of environmental aesthetics and explores the aesthetic aspects of the built environment. Aesthetic responses and experience, formal and symbolic aesthetics as aesthetic models and aesthetic evaluation with respect to assessment and appraisal are highlighted in relation to the visual quality of the built environment.

2. ENVIRONMENTAL AESTHETICS

Environmental aesthetics is one of the major new areas of aesthetics that has emerged in the last part of the 20th century (Berleant, 1997). Understanding the principles of aesthetics is not a new concern. It has a long past in philosophy, design and research (Nasar, 1992). The term aesthetics is derived from the Greek word 'aisthanesthai' meaning 'to perceive' and 'aistheta' meaning 'things perceptible' (Porteous, 1996). The Merriam-Webster Dictionary (2020) defines aesthetics as an approach to what is pleasing to the senses and especially sight. The term was first used in the work of 'Aesthetica' written by Baumgarten (1750), known as the father of modern aesthetics. According to Baumgarten (1750), aesthetics is a science involving the senses and cognition (cited in Nia & Atun, 2016). Aesthetics is concerned with sensory perception, judgment, affect and feeling in the appreciation of how and what we perceive through our senses (Carlson, 2000, 2002). However, with Kant's influential work 'Critique of Judgment', the term aesthetics became the dominant position in modern aesthetics (Townsend, 2001).

Environmental aesthetics is a philosophical research field that studies the ways in which people experience the world through their senses and discusses the aesthetic value of environments (Carlson, 2002; Makino, 2018). Environmental aesthetics is concerned with the mutual relationship between the objective, physical attributes of the built environment and the subjective responses of people to environmental attributes. The response arises from the observer and the environment and the interaction between them (Berleant, 1997; Carlson, 2000, 2002; Kaplan & Kaplan, 1989; Lang, 1987; Nasar, 1992, 1998; Wohlwill, 1976). In other words, it focuses on the aesthetic appreciation of the environment and how it influences the senses in a pleasurable way (Carlson, 2000,

2002, 2006). As a complex phenomenon, the aesthetics of the built environment appears as a dimension of the entire complex of objects, people and associated activities (Berleant, 1997).

Nasar (1992) proposed that environmental aesthetics is a unique and interdisciplinary field that represents the merging of two study areas namely, empirical aesthetics and environmental psychology. Empirical aesthetics is involved with the art (painting, music, literature and dance) and environmental psychology, which is an applied field, is involved with improving the quality of the human life. The main concern in environmental aesthetics consists of understanding environmental influences on affect and translating this understanding into environmental design (Nasar, 1992). With the inclusion of aesthetics in the environmental studies in the 1960's, environmental aesthetics was considered with the unification of art with political social and ecological issues, development of environmental awareness and activism, and development of new information about the human and environment relationship (De Sousa Vianna, 2002). In the last few decades, the aesthetic aspect of the environment has attracted great attention. Psychologists, planners, geographers, philosophers, environmentalists and the general public have recognized the aesthetic dimension of the environment (Berleant, 1997; Carlson, 2008). The aesthetic matters of the environment mainly depend on the world of design and the decisions of design professionals.

Carlson (2008) argued that environmental aesthetics has become necessary in various fields because it indicates the aesthetic values of the environment. According to Berleant (1997), the aesthetic value of built environments is not restricted to the value of beauty. Thus, there is a distinction between beauty and aesthetics; beauty refers to the attribute of an object or place that offers an

experience of pleasure, satisfaction and meaning, whereas aesthetics refers to the philosophical study of beauty and its appreciation (Nia & Atun, 2016). Berleant (1997) argued that the aesthetic value of built environments "encompasses the perceptual experience of meanings, traditions, familiarity and contrast as well" (p. 34). Thus, the built environment is considered to consist of various kinds of aesthetic values that relate to aesthetic qualities (Makino, 2018).

3. AESTHETIC RESPONSE

Environmental aesthetics considers visual attributes in the built environment as inputs that affect an individual's evaluation of a specific environment. Aesthetics can be searched within the questions of: how physical features influence the evaluative quality of the built environment and what features evoke favorable evaluative responses (Nasar, 1994). As a result of the active interaction between the people and the environment (aesthetic experience), aesthetic responses are induced. This evaluative or aesthetic response can be defined as favorable emotional appraisal or evaluation that refers to the aesthetic experience in relation to the environment (Nasar, 1994; Wohlwill, 1976). Onaran (1995) claimed that people's aesthetic experience of their environments cannot be independent from the meaning they attribute to and the attachments they form with the environment. People respond to the visual attributes of the environment by assessing feelings and behavior that derive from previous experience with the environment, by gaining inferences from environmental cues or by recalling similar places (Ataöv, 1998).

Rapoport (1977) stated that there are three steps in the process of environmental interaction: perception, cognition and evaluation. The environment is sensed through perception, which is influenced by the visual

attributes, and then it is encoded by the process of cognition. Evaluative responses occur through perception and cognition of the environment. The amount of cognition can differ during the evaluation process (Isaacs, 2000; Nasar, 1992, 1994). Aesthetic response can be viewed as having probabilistic relationships to environmental attributes (see Figure 1). The probabilities result from the ongoing interaction between people and their environments. Perception of the visual attributes has probabilistic relationships to the actual visual attributes present and cognition has probabilistic relationships to perception (Nasar, 1994).

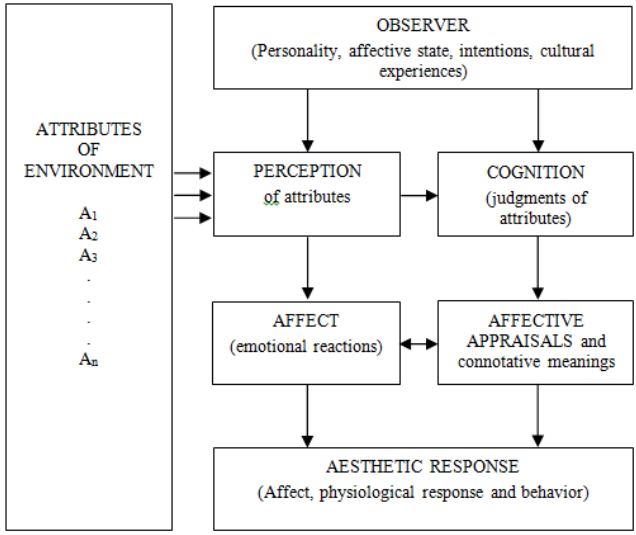

Figure 1. *A probabilistic model of aesthetic responses (adapted from Nasar, 1994)*

People respond to what they see, which requires little or no cognition, or respond to the content meaning of an environmental attribute, which requires cognition in order to recognize the attribute and draw inferences about it

(Nasar, 1992; Rapoport, 1990). Individual characteristics such as cultural, physical and physiological differences and environmental attributes influence environmental aesthetic responses.

Research related to environmental experience can be classified as perceptual and cognitive processes, and emotional and affective appraisals (Ataöv, 1998; Hanyu, 1997). Perceptual and cognitive processes aim to identify and understand the factors that contribute to the perception and cognition of visual attributes in the environment. The process focuses on the acquisition, organization and memory of these visual attributes (Ataöv, 1998). Studies in this category have examined people's cognitive or mental maps of places as representations of the environment and focus on naturalness, openness, distinctiveness, upkeep, mystery, legibility, complexity, coherence (Appleyard, 1970; Downs & Stea, 1973; Kaplan & Kaplan, 1989; Lynch, 1960; Moore, 1979; Nasar, 1994, 1998; Wohlwill, 1976). Perceptual and cognitive processes deal with the visual attributes while emotional and affective appraisals focus on the human reactions to the visual attributes.

Emotional and affective appraisals investigate how individuals respond to and evaluate environments. It attempts to understand the nature of human reaction to environmental attributes (Ataöv, 1998; Hanyu, 1997). Studies in this category have adopted certain measures such as preference, likability, pleasantness, arousal, excitement, relaxation, interest, safety and fear (Hanyu, 1997, 2000; Kaplan & Kaplan, 1989; Nasar, 1998; Ulrich, 1983; Wohlwill, 1976; Zhang & Lin, 2011)

Although there are two main categories of research in environmental experience, some researchers mention a third category as relational research (Ataöv, 1998). Relational research investigates the relationship between perception and cognition, and emotional and affective

appraisal. Researchers treat the visual attributes of an environment as perceptual and cognitive factors and then investigate how these factors influence emotional and affective appraisal.

4. AESTHETIC MODELS

Although in environmental aesthetics, various types of theories and models related to visual attributes exist, Lang (1987) and Moore (1979) divided the models as formal and symbolic. According to Lang (1987), formal aesthetics is concerned with the structure of forms and symbolic aesthetics is the study of people's responses to the form content and the individual's internal representation of the building's meaning (Lang, 1992; Nasar, 1992, 1994, 1998).

4.1. Formal Aesthetics

Formal aesthetics focuses on the visual structure of an object or an environment as they contribute to the aesthetic response (Carlson, 2002; Isaacs, 2000; Lang, 1987, 1992; Nasar, 1992). Each object in the environment has a set of sensory elements that are common in other objects, but distinctive in their unique form. Objects can occur in distinctive ways by the arrangement of line, shape, color, texture, light and dark, space; the combinations of sounds, rhythm, motion; the patterned sequence of bodily movements; the choice and order of word patterns and verbal image (Berleant, 1997). The way the sensory elements is repeated, overlapped and arranged creates the formal qualities of an object. They are not isolated but are combined to compose the formal compositions of a building that create pattern, rhythm, symmetry, balance, contrast, proportion, theme and unity.

Formal aesthetics can be subdivided into collative-arousal models and ecological models (Ataöv, 1998;

Hanyu, 1997). Collative-arousal models concentrate on how environmental attributes affect emotional appraisals (Berlyne, 1971; Wohlwill, 1976). Berlyne (1971) proposed the collative-arousal model explaining the relationship between perceptual and cognitive processes and emotional and affective appraisal. The collative variables include incongruity, novelty, surprise and complexity that are seen as the most relevant factors to human responses. Ecological models focus on the relationship between the physical attributes of an environment, the information afforded by those attributes and people's emotional reactions to them (Kaplan & Kaplan, 1989; Ulrich 1983). According to Kaplan and Kaplan (1989), clarity (Making sense) and involvement play a significant role in a person's preference for an environment. They suggest that both immediate and inferred or predicted information have important roles. The environmental preference model, proposed by Kaplan and Kaplan (1989), indicates that preference is an outcome of the process of perceiving the environment and its attributes and reacting to the environment and its attributes. The environmental preference model components consist of complexity, coherence, legibility and mystery (see Table 1). People prefer environments that make sense and provide an opportunity for either immediate or future involvement.

Table 1. *Environmental preference model (Kaplan & Kaplan, 1998).*

Level of interpretation	Making sense	Involvement
Visual array	Coherence	Complexity
Three-dimensional space	Legibility	Mystery

Attributes of formal aesthetics include rhythm, scale, color, shape, proportion, illumination, shadow, hierarchy, spatial relations, complexity, incongruity, ambiguity, surprise, novelty and order (Erman, 2004; Isaacs, 2000;

Kaplan 1992; Nasar, 1992, 1994; Lang, 1992; Sanoff 1991, 2000; Wohlwill, 1976). Apart from the elements of the buildings, the components of the built environment are important in the formal aspect of aesthetics. These can be stated as landmarks, paths, districts, edges and nodes, which were identified by Lynch (Lynch, 1960).

4.2. Symbolic Aesthetics

The environment is not only composed of physical attributes, perception of a setting, environmental ideas or activities, nor an order given by society or culture, but all of these (Berleant, 1997). As a result, the symbolic content of an environment is as important as its physical surroundings (Lang, 1992; Nasar, 1998). Symbolic aesthetics is concerned with the associative meanings of the environment and attributes (Gifford 2002; Kaplan, 1992; Lang, 1992; Nasar, 1992, 1998). Nia and Atun (2016) concluded that in order to increase the aesthetic quality of a built environment, the combination of formal and symbolic attributes within the configuration of the environment is necessary.

People's experiences, values, lifestyles and cultures may influence affective responses to an environment. Through experience people learn the associative meanings of environments. According to Nasar (1992, 1994), an environment can present both denotative and connotative meanings to the people who experience them. Denotative meaning refers to what an environment is, without evaluating it, and connotative meaning refers to "inferences about the quality and character of an environment and its user" (p. 31). "[…] Symbolic aesthetics refer to the latter set of meanings. In particular it refers to favorable connotative meanings associated with the content of the formal organization" (Lang, 1992, p. 20). Therefore symbolic aesthetics depends on cognitive process in which the individual recognizes a denotative meaning and

infers connotative meaning about it. Evaluative responses to the symbolic property of an environment depend on the interaction of denotative and connotative meanings. These meanings also have an effect on design decisions, which are important in terms of both users and design professionals (Lang, 1987). The connotative meaning of aesthetic response to a style depends on the viewer, seeing a style. In other words, characteristic formal organization and the fit of style to the viewer's expectations in relation to the building type define the role of style as a generator of connotative meaning (Lang, 1992).

Some researchers suggest that an environment's symbolic meaning can influence affective and cognitive appraisals (Lang, 1987; Nasar, 1994; Ulrich, 1983). Lang (1992) indentified two variables of symbolic aesthetics: physical variables and non-physical variables. Physical variables consist of building configuration, spatial configurations, materials, illumination and pigmentation, and non-physical variables consist of names of places, people and events that communicate and manipulate the symbolic meaning of an environment. In this case, the form of the building becomes a symbol and this symbolic meaning is not under the control of the designer (Lang, 1992). Other symbolic attributes include the naturalness of the environment, the type of land use and the presence of certain features (Erman, 2004; Hanyu, 1997, 2000; Lang, 1992; Kaplan & Kaplan, 1989; Nasar, 1998; Sanoff 1991; 2000; Wohlwill, 1976).

5. AESTHETIC EVALUATION

Aesthetic evaluation has two dimensions that are related with the knowledge of 'living in' and 'looking at' (Berleant, 1997). Berleant (1997) described the term 'looking at' as a part of experiencing the environment. An environment is approached both from inside and outside. It means that users are also part of it while being

affected by it as well as affecting it. In this respect, the associational meanings of environments, the meanings conveyed by visual elements and ideals are important elements affecting the built environment significantly (Rapoport 1977, 1982).

An aesthetic experience is related to the human interaction with an environment (Isaacs, 2000). The attitudes of both design professionals and users toward the environment and its associated meanings become significant, thus it can provide feedback to clients and design professionals (Galindo & Rodriguez, 2000). Environmental evaluation includes two points of views: appraisals and assessments. The environment can be evaluated from the design professionals' point of view and users' point of view that are called assessment and appraisal, respectively (Kaplan, 1992).

Assessments are place centered and they focus on the quality of a setting. Researchers in environmental aesthetics define the built environment as the relationship between perceiver and perceived (Fenton & Reser, 1992). Assessments are done by experts, who have professional training relevant to the setting or have a special interest in the setting. These experts make critical analyses of the built environment and make correlations between the individual's perception and the present environment (Gifford, 2002; Fenton & Reser, 1992; Isaacs, 2000). In assessment, design professionals become important and they assess the effectiveness of the designed environments for their users (Sanoff, 1992; Carslon, 2002). While lay people tend to focus on isolated elements of the environments, design professionals are able to grasp the relationship between these elements.

Previous studies have shown that individual differences related to biological, personal, social and cultural characteristics, and differences between design

professionals and lay people exist in the aesthetic evaluation of the built environment (Akalın, Yıldırım, Wilson & Kılıçoğlu, 2009; Akalın, Yıldırım, Wilson & Saylan, 2010; Çubukçu & Diktaş, 2013; Devlin & Nasar, 1989; Ekşioğlu Çetintahra & Çubukçu, 2015; Gifford, 1980; Gifford, Hine, Muller-Clemm, Reynolds & Shaw, 2000; Ghomeshi & Jusan, 2012; Ibrahim, Abu-Obeid & Al-Simadi, 2002; Montanana, Llinares & Navarro, 2013; Nasar, 1992; Purcell & Nasar, 1992; Safarova, Pirko, Jurik, Pavlica & Nemeth, 2019). Some studies found that design professionals and lay people sharer some meanings about the physical environment; however, most studies argue that design professionals think and evaluate the built environment differently. The difference between design professionals and lay people becomes an important consideration in the design of projects in which the client and the user differ in their preferences (Ghomeshi & Jusan, 2012).

Although there are design professionals' impact on the assessment of the aesthetic quality of the built environments, it is stated that the full range of users' responses influence the design process. In this context, it is essential to analyze how the users interpret the built environment. The users' response to the built environment is the most critical factor in the assessment of environmental aesthetics (Mehrabian & Russell, 1974). Appraisal, as the other component of environmental evaluation, is related with how users interpret an environment (Russell, 1992). Appraisals are person centered and focus on the individuals' feelings and thoughts about places. Appraisal measures the interactions between observer and physical environment (Sanoff, 1992). Therefore, appraisal of a built environment is influenced by emotional and aesthetic considerations that basically depend on individuals' selective perception (Galindo & Rodriguez, 2000).

6. CONCLUSION

People perceive and respond to the aesthetic quality of the built environment they live within everyday. The aesthetic quality can evoke emotions or feelings that affect environmental preferences and spatial behaviors. In addition, it can affect the participation, engagement and evaluation of people in their daily activities and environments. People prefer and spend time in favorable places and avoid unfavorable ones based on experience with and emotions about the aesthetics of the environment. Consequently, design professionals play an important role in the design of built environments since the design can facilitate or impede an individual's ability to participate and interact within the built environment. They need to understand the relationship between the visual attributes of the built environment and users' responses, understand the differences in aesthetic perceptions and consider them in the designing process that are suitable to the preferences and activities of the users. The field of environmental aesthetics examines how people react to the visual quality of the built environment. This paper focuses on the issue of environmental aesthetics in the built environment. Aesthetics responses and experiences, aesthetics models with respect to formal and symbolic aesthetics, and aesthetic evaluations are highlighted.

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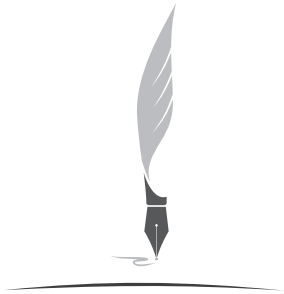

Chapter 4

AN INNOVATIVE APPROACH TO CONTEMPORARY MOSQUE DESIGN: SANCAKLAR MOSQUE

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INTRODUCTION

The mosque is Islamic architecture's most important structure both because it is a place of worship and because of its symbolic and political nature. It is also an important public structure with the quality of being a city-wide meeting and center. Since the Masjid-i Nebawiyah, the mosque, which is the main structure of Islamic architecture, has been focused on symbolic and spatial pursuits (Frishman, 1994). Traditional elements such as mihrab, minbar, minaret, courtyard (atrium), porticco courtyard (narthex) and women gathering-place which are the main plan archetypes of classical mosque architecture, show some differences according to countries and cultures, but these classical elements are not abandoned in the function and symbolic uses of mosque architecture (Akbulut, 2017).

During the Ottoman classical period, the mosque's architecture reached its peak and similar schemes were repeated until the Republican period (Gürsoy, 2013). There was a quest in mosque architecture for self-improvement during the Ottoman period and for constructing larger domes with fewer load-bearing construction. Throughout mosque architecture, the concept of self-development has become today's principle of self-repetition (Antel, 2012). Although in ancient times the arch and dome were used to cross large spaces, other techniques currently exist, but they are still used in ancient forms (Evren, 2013). Kuban (2012) states that, with the exception of the number of examples in our country, most mosques are duplicates. These structures are attempted to compare with the styles of the Ottoman period Sinan the Architect mosques in the 16th century, with planned with domes and minarets.

Within today's mosques, the dome is considered a must-have element as it is agreed that Ottoman architecture lived its highest era (golden age) during

the period of Sinan the Architect and that he brought the dome architecture to the highest level. Sinan the Architect, the chief architect, reached the climax of dome architecture during the heyday of the Ottoman Empire with technological facilities and works creating differences in plan and structural aspects (Antel, 2012; Karaesmen, 2012; Saatçi, 2012). The Ottoman mosques were constructed in masonry, large domed, less pedestal structure and to provide a bright atmosphere inside. The mosques that have been constructed today are built in the form of reinforced concrete, without difficulty from a static point of view, without the purpose of static or aesthetic development of the structure (Özçakı, 2018). Items such as the dome and minaret, which over time have become cultural landmarks, have created an artificial mosque typology that has gained legitimacy, particularly in popular culture.

A number of similar issues have recently been observed in our country's mosques. These can be listed as land selection, inappropriate side functions, architectural and technical inadequacy, the inadequacy of the architectural style. Ultimately, in today's Islamic countries, the trend towards mosque architecture is in the form of reinterpreting the past and past forms (Salimi, 2013).

The Sabancı Central Mosque, the Kocatepe Mosque, Sinan the Architect Ataşehir Mosque and the Çamlıca Mosque constructed by the state in the last half century continued to imitate the Ottoman Classical Period as monumental mosques of the period in addition to the mosques constructed by the people with their own means. These mosques served as examples of mosques that were constructed after them, making it difficult to accept contemporary proposals (Güler, 2016).

Within the 20th century, the mosque architecture, which has different regional characteristics in all Islamic countries, embarked on a quest and various trials were performed by preserving traditional plan elements. Mosque Architecture has become one of the most important issues of contemporary architecture with its changing perspective. Classic elements such as the mihrab, minbar, minaret, atrium (courtyard), porticco courtyard (narthex) and women gathering-place, the archetypes of classical mosque architecture, have been represented with contemporary materials in various forms (Taşdemir & Erarslan, 2018).

Whereas the mosques of today adhere to certain trends, some architects have succeeded in creating examples of mosque structures constructed with a creative attitude that has the characteristics of age. In this context, Etimesgut Mosque (1965) designed by Cengiz Bektaş, Mosque of Grand National Assembly of Turkey (1986-1989) designed by Behruz Çinici and Sancaklar Mosque (2011-2013) designed by Emre Arolat can be shown among the few eligible examples in Turkey.

Designed by Cengiz Bektaş, the Etimesgut mosque is an application that brings innovation to the architecture of the mosque in terms of both plan and form. Cengiz Bektas aimed at bringing the light inside with the slits he used on the facade and establishing a relationship with the outside as a person is praying, sitting or standing inside the structure. Even though the dome existed for structural reasons, this structure did not imitate a dome and the tear between the roof and the walls introduced a different interpretation to the dome. The reinterpreted mosque's minaret also takes on the function of a staircase providing access to the upper floor women's section. The historical essence has been successfully interpreted with the technology developed by the time in the Etimesgut Mosque. As a result, mosques have been proven to be

both contemporary and original while echoing traditional (Figure 1).

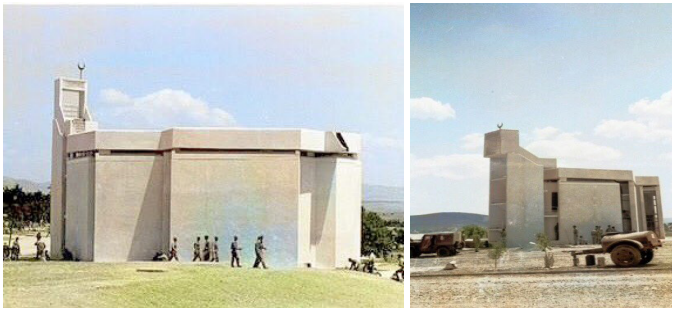

Figure 1. *Etimesgut Mosque*

The Mosque of Grand National Assembly of Turkey (TBMM Mosque), which won the 1995 Aga Khan Architecture Award, has provided our religious structures with a new alternative solution. The mosque designed between 1987-1989 by Behruz Çinici is an example of a mosque with an identity that could relate to the site. By hiding within the topography slope, the structure avoided the monumentality and size that could crush its surroundings. The mosque's design is a stepped pyramid form. Two balconies and a cypress tree symbolize the building's minaret, while the qibla wall is made entirely of glass. Inside, with its transparent wall and play of light, the religious place has a very different concept. Highlighting the linear texture and orientation towards the imam in the worship hall (Figure 2) met the needs of Islamic rituals.

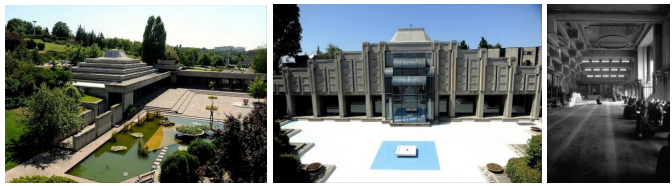

Figure 2. *The Mosque of Grand National Assembly of Turkey (TBMM)*

In contemporary Turkish mosques, innovative attitudes in plan, form, cover and material have gained importance. The dome, which is the classic cover, is presented in a more formalistic way in these structures. The classical system is completely abandoned, preferring mere geometric shapes and angles. Acoustic and air conditioning problems have been addressed in the interior as an age requirement. Light, on the other hand, was used for both symbolic and functional purposes. These structures, where contemporary technologies are used, are aimed at a modern and dynamic image.

One of the contemporary mosques designed in Istanbul, Kınalıada Central Mosque was designed by Turhan Uyaroğlu and Başar Acarlı in 1965 at the request of the Muslim people since the absence of a mosque in Kınalıada, Istanbul, until the 1950s and became the island's first mosque. The mosque, with a capacity of 100 people, is separated by its modern form from the traditional mosque. Its plan is a non-uniform hexagon. The top cover, consisting of the reinforced concrete shell, is made up of two half-pyramids that converge at the apex on two different levels. The vertical space between the pyramids was covered in glass and the interior was illuminated. There are horizontal strip windows at the junction of the main walls and the upper cover. The minaret was handled independently of the main structure. The minaret is of a

similar form to the yard masts on ships and narrows from the bottom up (Eyüpgiller, 2000) (Figure 3).

The Derinkuyu Mosque designed by the sculptor Hakkı Atamulu in Nevşehir is one of the best examples of modern mosques in Turkey (Figure 4). The structure's plan is in a triangular shape. The structure's entrance is in the narrow section. The structure's large section has a qibla wall. In contemporary mosque architecture, the mosque's design as a single mass with a minaret is a different interpretation (Ürey, 2010).

Figure 3. *Kınalıada Mosque*

Figure 4. *Derinkuyu Mosque*

As can be seen, with the development of modern architecture in the 20th century, the mosque architecture, which has maintained its traditional character despite some developments over the centuries has experienced a breakpoint. Contemporary mosque trials, which are beyond traditional typology, have also come to our country's agenda.

With this study, the relationship of form and function, space organization, general architectural features and elements of mosque architecture such as dome, mihrab, minbar, minaret and atrium (courtyard) were analyzed, in the Sancaklar Mosque which is one of the examples of contemporary mosques in Turkey.

SANCAKLAR MOSQUE

The mosque was designed by EAA (Emre Arolat Architecture), which was founded by architects Emre Arolat and Gonca Paşolar in Büyükçekmece, a commuter belt outside Istanbul, between 2011 and 2013 at the request of the Sancaklar Foundation. The design area is set in a prairie landscape separated from the surrounding outward enclosed residential structures by a busy highway (Figure 5).

Designed on a sloping terrain instead of eliminating the slope, the mosque was completely integrated with topography. The long eaves running out of the park stand out as the only externally perceived architectural element. A road in the upper courtyard that runs through the park leads to the structure under these eaves. Through the walls, the mosque is entered through the ground and down the hill (Figure 6). Due to its integration with the topography of the land, the mosque form is not perceived. The interior of the building, which feels like you're underground, evokes the perception of humility, retreat and neutrality of the place.

Figure 5. *Sancaklar Mosque Site Plan (Furuto, 2012)*

Figure 6. *General View of Sancaklar Mosque (Yılmaz, 2017)*

INTERPRETATION OF ELEMENTS IN TRADITIONAL MOSQUE ARCHITECTURE IN SANCAKLAR MOSQUE

1. Interpretation of the Traditional Courtyard

Due to the topography of the land in the Sancaklar Mosque, the courtyard (Yetkin, 1959) was designed in two different ways, due to the need to enable Muslims who cannot find a place in the mosque to participate in prayer. The high walls surrounding the park in the mosque's upper courtyard reflect the clear boundary between the chaotic outside world and the public park's calm atmosphere. The mosque's main entrance is from the lower courtyard (Figure 7). The topography's natural slopes were interpreted as steps, and natural stone stairs led to a descent from the upper courtyard to the lower courtyard (Figure 8). The difference in height between the upper and lower courtyards is about 6 meters. There's

no fountain in the courtyard. Ablutions are within the main structure. The only building element in the upper courtyard that stands out is the vertical mass which serves as a minaret (Figure 9).

Figure 7. *Lower Courtyard (Mayer, 2014)*

Figure 8. *Stairs Leading from The Upper Courtyard To The Lower Courtyard (Mayer, 2014)*

Figure 9. *Upper Courtyard (Mayer, 2014)*

2. Interpretation of the Traditional Plan

The plan used in the traditional architecture of the mosque is square-based. In the Sancaklar Mosque, which was built in 2013, a cross-section spread plan, which was used in the first Islamic mosques, was developed without feet or poles.

The Sancaklar Mosque, which is completely integrated with the topography of the land, is designed in connection with the lower courtyard below the ground. There is the main prayer hall, wc-ablutions, morgue, library and living quarters for the imam in the lower courtyard (Figure 10). The main prayer hall, reminiscent of a simple cave, is very dramatic and awe-inspiring to pray and be alone with God. The mosque, which has two entrances, is directly entered and descends via stairs to the worship area. Construction elements such as windbreakers were not used at the mosque entrance (Figure 11). The Women's Prayer Hall was not designed in any other section as in traditional mosques, separated by panels from the main prayer hall and elevated. The qibla wall extends to the women's prayer hall. There is a section where the shoes are placed in front of the women's prayer hall. The corridor from the northeast corner of the place of worship leads to the living quarters of the Imam. It's also accessible from outside.

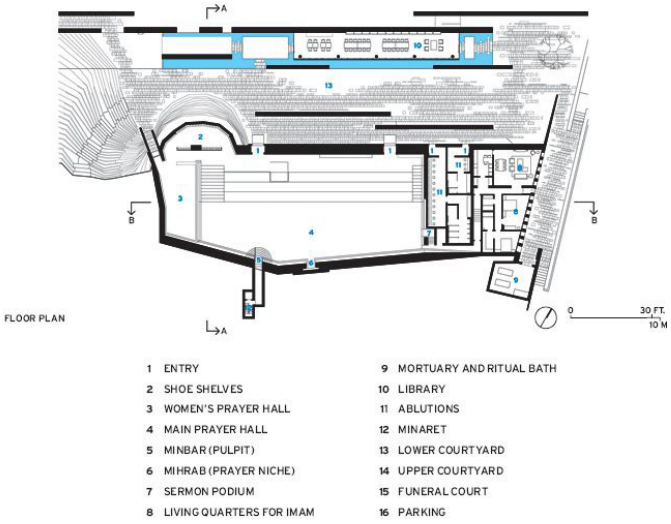

Figure 10. *Lower Courtyard Plan*

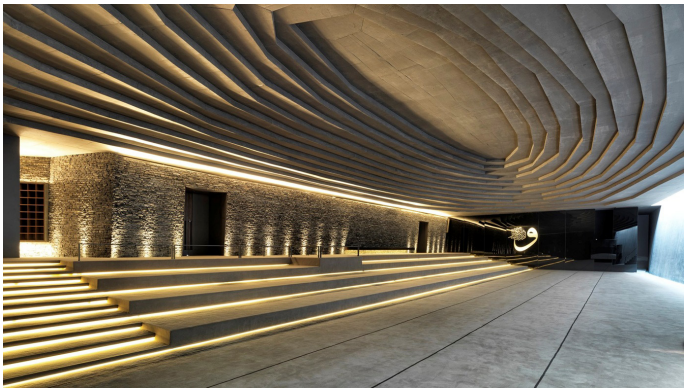

Figure 11. *Main Prayer Hall (Yılmaz, 2017)*

3. Interpretation of the Traditional Cover

The top cover of the traditional mosque architecture is the dome. The dome element is a design that forms the main space. The mosque of Sancaklar was designed with

a plain plaque as its cover. The mosque formed by the slope of the land is similar to the Hira cave. The cover, which was made of gross concrete, was grassed from the outside while the belly section was left wide and a gradual covering was used. The main praying hall of the mosque was designed in a rectangular form in order to replicate its ranks. Within the structure, the slope of the land was used for a good account without being destroyed and the ranks were formed in the shape of steps and a different interpretation was added. Another prominent feature of the mosque is the design of the stepped ceiling system, which differs from the flat, domed appearance (Figure 12). This layered ceiling design enhances this space's cave feel. In the interior, instead of the tile decorations used in traditional mosques, a simple, unadorned, ostentatious design was preferred Likewise, the design of the qibla wall is created of unorthodox, unorthodox and gross concrete. Daylight falling on the gross concrete in the qibla wall is also seen as a sign of purity and inner peace.

Figure 12. *Sancaklar Mosque Layered Ceiling System*

The function of directing worship using light was also used in the Sancaklar Mosque. The slits along the qibla wall reinforce the orientation of the worship area

while allowing the sun's rays to flow into the interior (Figure 13). The light play here is powered not only by sunlight on the qibla wall but by halogen lighting between the space steps. The predominant use of gray and black colors has also made light became apparent in the space. The East and West surfaces are made of black glass. Thus, it was intended to be prayed without distraction.

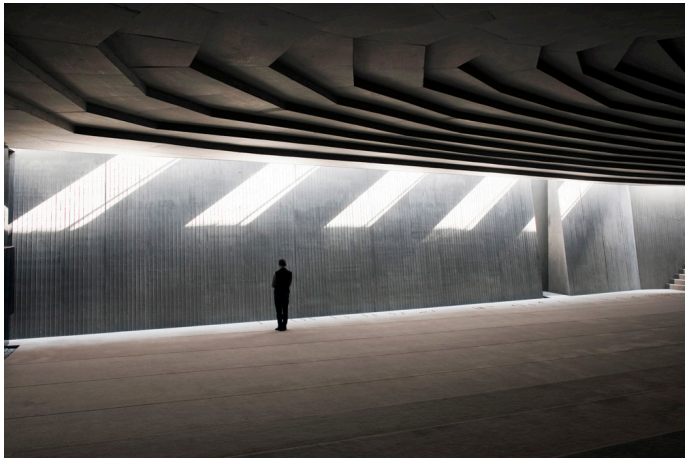

Figure 13. *Natural Light Seeping Through the Qibla Wall (Yılmaz, 2017)*

4. Interpretation of the Mihrab and the Minbar

The Mihrab, derived from the word 'harp' meaning fighting, is the architectural element that shows the Qibla in the mosques, masjid and namazgah, and the place where the Imam will stand while praying (Erzincan, 2005). On the other hand, the minbar appears as a stepped architectural element in mosques where the preacher is held in order to be better seen by the congregation while reading sermons and to make his voice heard better (Bozkurt, 2005). The auxiliary elements, such as mihrab and minbar, were designed in an uncharacteristic manner,

unlike the cultural models in the Sancaklar Mosque. Their function in the structure, rather than their location and decoration, was kept in the foreground. The mihrab is a square niche built on the qibla wall. The hollow of the mihrab continues to the ceiling, increasing the depth felt in space (Figure 14).

As you approach the mihrab wall, the intensity of the light from above increases and the texture of the material becomes quite apparent with the illumination. The minbar is immediate to the right of the mihrab. Also, the steps leading up to the minbar are used to get to the minaret. At first glance, the sermon podium isn't visible. This is because black glass is the material on the wall and the material on the podium (Figure 14).

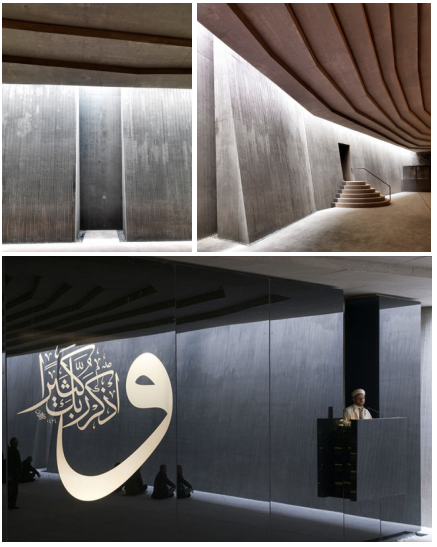

Figure 14. *Interpretation of Mihrab, Minbar and Sermon Podium (Mayer, 2014; Yılmaz, 2017)*

The design of the mosque focuses more on the essence than on the form, and simplicity is prioritized rather than the unnecessary decoration of the main prayer hall. The structure is designed on a human scale that allows prayers to be alone with themselves and the creator and to be isolated from the outside world. The only decoration inside the structure is the qibla wall with cracks and fractures illuminated by daylight that changes according to the times of the Day and the letter "vav" that reflects Infinity as a very special element on the black wall.

5. Interpretation of the Porticco Courtyard

The porticco courtyard in the Sancaklar Mosque is located in the lower courtyard, among the concrete plaques. The rectangular concrete frame, which is the mosque's upper cover, covers the porticco courtyard as the eaves. Natural stone cladding is the material used on the floor, and carpets are laid here during prayer (Figure 15).

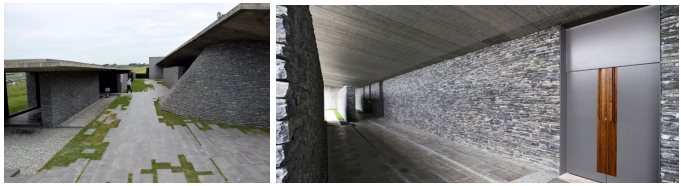

Figure 15. *The porticco courtyard located under the eaves designed in the courtyard*

6. Interpretation of the Minaret

In contemporary mosques, the minaret, another of the most important elements of traditional mosque architecture, was not forgotten. Nearly all Modern minarets have been designed separately from its general structure or associated with a single form (Moustafa, 2013). The minaret originated as a high place created

to call people to prayer, and over time took the form of a tower. In contemporary mosques, the minaret was specifically designed as a special icon. The minaret, an icon, a signature, has gained prominence as a design. The minaret in the Sancaklar Mosque is designed in the form of a plain stone tower located in the upper courtyard, completely separate from the structure (Figure 16). The minaret has no decorations and does not have an end ornament (alem). There are also coffin rests (musalla) next to the minaret.

Figure 16. *Minaret located in the Upper Courtyard*

ASSESSMENT AND CONCLUSION

When the structures of the mosques in Turkey are examined, it can be seen that the mosques of the classical Ottoman period are generally taken as examples and that the types of mosques with domes, decorations and huge sizes are placed in human perception. The dome, minaret and some of the mosque's auxiliary elements have been associated with the religion of Islam, and the design of the mosque has progressed in this respect. However, there are no regulations or rules in Islam regarding mosque architecture.

In many Islamic countries in this century contemporary mosque essays that fall outside of traditional typology have been debated. This study examined the design and plan features of the Sancaklar Mosque, one of Turkey's contemporary mosque examples, and how elements

of traditional mosque architecture are interpreted in the structure. When Sancaklar Mosque compared to traditional mosque typology;

- While traditional mosques imitate the forms of Sinan the Architect, Sancaklar mosque is an original design unique to its location, digressing the order imitating Sinan the Architect.
- In traditional mosques, dominating the surrounding fabric and showing off is in the foreground, while the Sancaklar Mosque is in the foreground of modesty, retreat, seclusion.
- In traditional mosques, land data is not taken into account, but the Sancaklar Mosque has used the mosque topography in design and is almost integrated into the ground.
- In traditional mosques, the minaret with balcony is common. The function of the minaret is preserved in the Sancaklar Mosque and its formal features are interpreted by the architect and it is designed as a stone tower.
- While traditional mosques have a very high height and overwhelming size due to their domed structures, the Sancaklar Mosque is a simple structure that is integrated with the place hidden in the topography and does not overwhelm people.
- Instead of the courtyard and fountain in traditional mosques, Sancaklar Mosque emphasized the relaxing effect of water and provided peace and tranquility with the use of green tissue.
- In traditional mosques, the mosque entrances were divided into as men and women, while in Sancaklar

Mosque, a common entrance was planned without this separation.

- Instead of the dome element, which is the cover system in the traditional mosque, the cover system in the Sancaklar Mosque is designed as a flat concrete plaque according to the slope of the land.

- In traditional mosques, the scale of the interior is overwhelming, and in its interior architecture, the ceiling and the ornamentation of the domes come to the fore. Instead of decorative decorations, a simple, unadorned and simple design was carried out in the interior architecture of the Sancaklar Mosque, which was built in a modest style that did not overwhelm people.

- Due to its domed structure, classical mosques have a bright, spacious interior, while the lighting in the Sancaklar mosque is provided from the opening on the qibla wall, and the interior has a dim atmosphere. Natural light falling from the ceiling of the mosque onto the qibla wall was used for lighting.

- In Sancaklar Mosque, the topography slope is interpreted as cascading ranks, while in classical mosques, the level of the ranks is dominated by planar tendency without any change.

- In classical mosques, minbar and mihrab are clearly perceived within the main worship area, where vegetative and geometric ornaments are used. The decoration was not used in the Sancaklar Mosque with the prioritization of the mihrab and minbar functional features, and the mihrab and minbar function was emphasized rather than its appearance.

- In classical mosques, the women's prayer hall was designed as a separate space, while in the Sancaklar

Mosque, the women's prayer hall was raised from the main place of worship and separated by a panel, and the women's and men's worship areas were designed within the same space.

The Sancaklar Mosque, which is one of the most important representatives of contemporary Turkish mosques, was interpreted by the architect in accordance with the functions of traditional architectural elements, unlike the classical mosques, and the architectural changes envisaged by topography and natural environmental conditions can play an active role in the mosques. Sancaklar Mosque, created with an understanding of contemporary technology and contemporary art, has succeeded in breaking the standardized patterns of nowadays mosque architecture. The mosque was able to react against architecture that had no qualification. The mosque interpreted the basic features within the structure of Islamic architecture. Its construction in an unsophisticated style gave those who came to worship the opportunity to be purified from everything, to retreat, to inquire within themselves and to think. Unlike classical mosques of the monumental size that settled in human perception, and designed with domes, minarets, wide spans and decorations, in Sancaklar Mosque's design is inviting and evokes humility to people which does not overwhelm the people.

Today, mosque structures are compressed into some patterns and put in the minds of those who worship as an image. For this purpose, constructions of mosques that were produced with repetitive typology and built with the understanding of imitators have increased. Despite the small number this idea is attempted to break in contemporary mosques today. Unquestionably, as a result of the development of technology, new searches in mosque architecture are inevitable.

Instead of increasing the number of mosques without architects replicating the tradition, mosques that meet the needs of the society should be built with socially functional spaces that can be functionally used, meet the needs of the age and provide equal services to all sections of the society.

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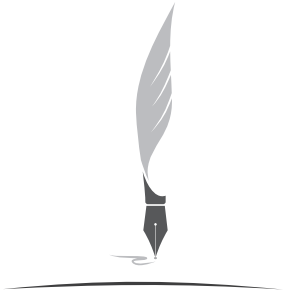

Chapter 5

USER APPROPRIATION ISSUES

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Designers have many intentions and endeavors to meet users' needs and desires. User centered design is already highlighting the centralized position of the user. Addressing users may face difficulties in design processes regarding mass production, where designers do not get acquainted with the people who are supposed to use the designed products. Yet, contemporary practices involving user research and/or involving even users themselves, like in participatory design are providing the the users as active actors. In order to cope with designing for many anonymous users, the practices of user modelling, user research and developing user-scenarios have been improved. Moreover, including the users in the design process, Kristensson et. al. (2002) introduce users as a hidden source for creativity. They evaluated their findings from their experimental study on user involvement regarding improving service design in telephony. Sanders and Stappers (2012) have an extensive study elaborating certain tools and methods for conducting participatory design practices. Within design itself, the emergence of design ethnography, co-design, participatory design, and design probes signals that designers are adopting the tools of social observation. As Hunt (2011) indicates, large corporations hire anthropologists and other social researchers to help them gain insight into user needs and desires, aiming greater market share and more predictable success in the context of new product launches.

As Wasson (2000) indicates, the popularity of ethnography among designers, observations of naturally occurring consumer practices are widely credited with helping manufacturers identify significant new product directions. The scholars of user-based design, participatory design and co-design also involve largely with user habits, opinions and appropriations (Mattelmaki, 2005, Visser et. al. 2005). In this context, inquiries about how users conduct their everyday practices (in their living

rooms) with observations, surveys and interviews are helpful understanding their unmet needs (where any) thus evolving to a stage where designers could rely on for new design ideas.

Many practices including Kristensson et. al. and Sanders and Stappers somehow present the ways how to create a setup or conduct an experiment through which the researchers could provide data unfolding the creativity of users. But it also provides a rich source to observe and analyse the users throughout their own everyday life practices in their ordinary contexts.

1 Everyday Life and its Potential for Spotting Creativity of Users

As Burkitt (2004) indicates, everyday life is a common ground that embraces activities and practices with their many contradictions and differences. Observations and inquiries about everyday life and user appropriations over the designed norms are important as they inform the design research and practice. Everyday studies engage with the critique of established norms by design and manufacturer actors, putting leverage on users' everyday lives, mostly in a deductive way. There are regions of academic research and theory, which improve and elaborate the critique of produced norms of manufacturer and design actors| which hardly consider the users and their actual everyday practices. Adding that, the transformative nature of everyday life practices presents a theorticially parallel lines with everyday studies and critique highly elaborated by sociology scholars as Henri Lefebvre (1991) and Michel de Certau (1984). We see a common focus of critique on the dominant discourse that puts leverage on the everyday practices of people regarding these authors. According to Michel de Certau, everyday is the terrain in which ordinary people often make use of infinite local tactics to constantly manipulate events to turn them into

opportunities (1984). In this sense, then, people (users) are seen as active rather than passive in their appropriation and use of consumer goods. They have the ability to resist the imposed meanings of cultural texts and goods and often ‘re-appropriate’goods into their everyday lives (ibid.). Everyday life studies refer to the critique of the approaches of design practice which do not necessarily include the user and his practices. The critics towards the space designs which ignore users through a top-down viewpoint and the authoritarian approaches which aim to change and control everyday life practices have been elaborated in the agenda of Architecture (Gürel, 2011). Tanyeli (2011) indicates that everyday life in which the dwelling itself (instead of user) is centralized, it is reduced to basic functions of human life, like sleeping, sitting, cooking, bathing, etc. However, Tanyeli (ibid.) overlays that new problems and opportunities could be constructed when contradictions, mismatches and blind points are noticed. In this study, the approaches of design scholars who concentrate on the region of user appropriations in their everyday context are reviewed and evaluated. In this sense, the term , the extensive research of Brandes (2016), ‘non-intentional design’; Suri’s (2005) articulation of ‘thoughtless acts’ and the ‘domestication’ literature are discussed.

2 Non-Intentional Design

Brandes et. al are design scholars who also have an elaborated research focus on user re-appropriations, as well as providing a critique of established design norms (2009), introducing the term, “non-intentional design” (p: 10). While they admit that this term is not found in general language, they use it for describing the everyday re-design of the designed objects, by users. In this context, the emergence of the concept of non-intentional design is tied with the advents in industrialisation and

mass production. It is argued that the concepts of product definition and assignation differed between designers and users (ibid.). Regarding the industrial design process addressing thousands of users, they point out inadequate knowledge of designers about each single user. They (*ibid.*) imply that design decision arrives at users through a hierarchy of actors:

> "(..) hierarchies of decision making at the manufacturer's, the representative of the manufacturer, the procurement manager of the wholesaler, the procurement manager of the retailer, shop windows, brochures, catalogues, advertisements, magazines and finally the salesperson"

Brandes et. al (2009) points out objects that are presented in glossy photographs with elaborate studio lighting in a sterile environment, visually lacking their users. Such a situation can be observed at the sterile environment and flawless configuration without the presence of any users – neither sitting nor having their dishes at dining table – as depicted in Enza Furniture advertisement (Figure 2).

Figure 2: Enza Dining Room

Non-intentional design defying many norms, creates alternative functions for a specific product and break with pre-defined intentions. General focus of non-intentional design can be considered as studying the generation of the function or meaning of things in and through use. Main reasons for this practice are sorted as temporary situations of deficit and convenience (ibid, 2009). Brandes et al (2009) offering re-appropriation practices by users as a great potential for innovation, overlay many examples such: Nutella jar for toothbrush and toothpaste holder, radiator valves as hook, egg boilers as spice containers and many similar cases could be sorted. In the context of domestic life, they also have a specific concern. They (2009) evaluate the private quality of home life as an enhancing element exemplified as chair for representing auxiliary functions. Alongside the main seating function, chairs are used for many other and varied purposes[2]. The backrest lends itself particularly to hanging clothes or drying towels, the seat can be used as a step to reach high places. Having found these instances of repurposing an auxiliary uses, Brandes et al (2009) question how often people use everyday objects in their original design context and the percentage of the repurposing.

The assumption of Brandes et al (2009) of everyday life as a big potential of continuously performed anonymous design is somewhat aligned with Jane Fulton Suri's implications. The use practices, manipulation and re-appropriation of objects and products by people is actually a rich source to inform design research.

3 Thoughtless Acts

Jane Fulton Suri, the director of 'Human Factors' at IDEO, one of the most renowned international design consultancies, IDEO, highlights the importance

2 For an extensive study on how living room units are repurposed in auxiliary uses, see Nasır (2016).

of collaboration of designers with psychologists, anthropologists and other social scientists by means of adapting methods, integrating insights and implementing them. Suri (2011) also suggests ethnographic-style observation could provide inspiration and grounding for innovation and design. Thus, ideas would respond to real needs, having desired social or market impact. Standing out from other trend and futures consultancies because their methodologies for the study of everyday life often comprise unconventional, qualitative-empiricist methods, Suri (2005) indicates that things used in unintended ways usually indicate something about people's needs which often translate into design opportunities. As users make interpretations about the objects and products around them, they develop an awareness of the possibilities and sensory qualities of different materials, forms, and textures in their daily lives. This awareness is evident from their actions, even when they are not conscious of them. Fulton Suri (2005) considers these re-interpretations and repurposing practices as their *'thoughtless acts'*. Observation of people's everyday interactions can help design teams discover what people need in a given context and hence the opportunities for design. It is often observed that people's creativity in reinterpreting and adapting things improvise solutions to improve design process. Suri (2005) argues that dealing with people's behavior provides designers break through limitations imposed by existing solutions and come up with innovations, supporting user activities and experiences. Redefining the design problem this way can lead to new and better ideas. Suri (2005) considers this intuitive personal experience as a very important resource for design. Suri (2011) gives an example of a pen stand designed by the designer Gen Suzuki. Pen Stand design of Suzuki was inspired by a similarly incidental observation of pens held in a stack of tape, whose form and negative internal shape stack to create a container of perfect

dimensions. Therefore, the context, the surroundings and the re-appropriation of the tapes for holding pens have informed design practice in this case.

4 Domestication

The underlying scholarly foundations of domestication literature are obtained from research on the sociology of technology. The term domestication - which in the traditional sense is a reference to a wild animal being tamed - when used in the metaphoric sense, can be understood as the users taming the wild technologies around them by incorporating them into the structures, beliefs, everyday activities of the users and their domestic areas (Berker et. al, 2006). Ingram et al. (2007) argues that the concept of scripting takes us into conceptual territory in which products and objects are accorded a measure of agency. Designers "configure" their users. Designers have a similar role to scriptwriters in scripting the actions and practices of those who use and consume the products they make. Depending upon how they are designed, things permit and prevent certain courses of action. Sorensen (2006) suggests that the study of domestication is considered an area where the views of designers and the needs and interests of users are negotiated. Ingram et. al. (2007) argues that consumption (and use) practices, and their component materials, symbols, and procedures, develop over time, generating new product opportunities. 'Domestication' literature includes extensive studies involving how people use products by integrating and modifying them in their everyday lives (e.g. Berker et.al 2006). As Silverstone (2006) points out, domestication is bringing things home. However, the question is 'What happens after users bring the dining furniture units to their homes?'

Bakardjieva (2006) considers *domestication* as mainly consumption, but interprets it as part of everyday

life from the standpoint of users. Ingram et. al. (2007) argues that consumption (and use) practices, and their component materials, symbols, and procedures, develop over time, generating new product opportunities. By tracking commodities even long after they are purchased, domestication expedites studies relating to consumption and 'use'. Fallan (2010), through an elaborated discussion in regard to integrating domestication studies in the context of design history considers the concept of domestication as "a methodological tool which analyses how users turn *commodities* into functional *things*, meaningful *objects* and expressive symbols" (p.97). The focal point of the concept of domestication is to explain and scrutinize the acceptance, rejection and use of the processes of (media) technology (Berker et al., 2006). The idea of domestication is believed to be uniquely different from models which presumed the adoption of changes to be logical, linear and determined by technology. In contrast to this, the research approach in relation to this concept weighed technologies' place throughout everyday life within its "dynamics, rituals, routines and patterns" (ibid, 2006, p.1). Silverstone et al. (2006) considers the result of a process of domestication as the reciprocal relationship between people and things. In accordance with this view, while using products, correspondingly, people are consumed by the products as they respond to them and engage with their properties, functions and forms.

5 Conclusion

Production, consumption and use are important phases that a designed product undergoes in the courses of its lifespan. While the design discipline is largely engaged in the production process, it is not as involved in the consumption phase and even less involved in the uses developed by the users in their everyday life. However, the phase in which users purchase the products and start

to use them, considered by Attfield (2000) as a post-commodity phase, has potential for also influencing the design discipline.

In the context of visiting such critical views in the discipline of design, we see that such notion of critical design actually belongs to a broader tradition of radical or Anti-Design that emerged as a dialogue with a burgeoning consumer culture and the late 1960s condemnation of Western bourgeois cultural hegemony (Clarke, 2011). Contemporary critical designers combine anthropological –style speculation on emergent social practices. This makes sense for understanding the ways that the studies and approaches involving user appropriations contribute data and insights for industrial design practice. Brandes (2016) conducted a fieldwork and qualitative analysis for depicting "non-intentional design" practices throughout their sample. Suri (2005; 2011) highlights the importance of observing, which is one of the key methods and acts in design anthropology and design anthropology. Likewise, domestication scholars also get involved with in-depth inquiries about the use practices after consumption phase. Everyday life practices, which could be observed and analysed, have a great potential and many opportunities for cases of domestication. Applying ethnographical and anthropological methods for elaborating user appropriation issues define a parallel vein with contemporary critical design practice. As types of design anthropology follow a tradition of Anti-Design that questions the corporate, market-driven relations of object culture, designers engage in social research as well as they do in the conventional steps of industrial design process (Clarke, 2011). Observational techniques, human focus and emphasis on the machinations of the everyday have become prominent subjects regarding contemporary design practice. Finally, user appropriations, re-appropriations and re-interpretations present a rich source

inspiring the creativity of design actors. Further research and fieldwork should be undertaken in order to evaluate the assets that the users contribute for reproduction of the functions of industrial products of mass market.

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Chapter 6

DISASTERS AND EFFECTS ON URBAN MACROFORM: THE EXAMPLE OF DÜZCE

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1. Introduction

Most urban settlements are spontaneously shaped according to the conditions occurring over time. After planning became a necessity, they began to expand and take their forms in line with a set of objectives. However, it is not only the discipline of planning that determines the shape of cities, but natural disasters are also one of the important factors that influence the development of cities and direct their planning. The urban space was previously more local and original, reflecting the cultural, economic and social structure. Now, the planning period has begun to transform this urban space into cities where the influence of administrative will and the socio-political attitude is reflected (Sınmaz and Özdemir, 2016, 82). Conceptually, planning is a forecasting of the future, and the processes of decision making and selection are preparations for achieving a defined goal (Yıldız, 2012, 182).

Historians and sociologists see cities as the greatest achievement of human beings and regard them as the second revolution after the Neolithic Revolution, which is regarded as the beginning of the transition to a settled order. The emergence of cities is considered the birth of civilizations (Keleş, 1993, 20). Cities, as our living spaces, are constantly in motion and changing. Interpreting this change over urban space in the context of urban morphology as a method is based in the last century. As a result of the interactions of many disciplines, urban morphology has emerged as a new field of study which aims to analyze the changes that a city or a part of the city has undergone by examining the existing texture. In particular, this method analyzes the changes that occur due to economic and social conditions or disasters.

The damage and impacts of disasters have increased since people began to densely populate certain areas. It is estimated that at the end of this century, almost half

of the world's population will live in cities. Increasing population and escalating construction due to rapid urbanization also increase seismic risk in certain regions. Over the last 50 years, Turkey has suffered major damage from earthquakes along the North Anatolian fault, including in Erzincan (1992), Dinar (1995), Adana and Ceyhan (1998), and Marmara (1999).

Disasters can occur at any time; it is an inevitable fact of life. Disaster risk comes as an additional consequence. Disaster risk is the possibility of loss or vulnerability of human beings, human settlements, and the natural environment if a certain danger occurs within a certain period (İlgen, 1999, 15).

The United Nations introduced a new approach to disaster policy after the 1990s. The main objective of the new approach was to minimize risks by taking pre-disaster measures and to reduce the severe economic and social devastation that occurs after a disaster. To implement the new strategy, the UN's new body, the ISDR (International Strategy for Disaster Reduction), was created in 2000.

The ISDR 2005-2015, which was introduced at the Kobe Conference in 2005, acknowledges the decade as a new event process and envisages the Hyogo Framework for Action. The general approach at this conference was to prioritize studies on risks and their avoidance. Within the scope of these studies, different approaches were aimed at reducing urban risks (Balamir, 2007, 32). The most important of these approaches featured making decisions on protection or transportation of settlements according to natural data from studies carried out in the settlements after a disaster. In addition, they included making suitable construction and land use suggestions that included preparation of regional zoning plans that were defined according to local geological characteristics.

As an example of these approaches, it was recommended to exclude high-risk areas based on past disaster data, and to allow structures such as recreational, agricultural and storage facilities, public buildings, hospitals, schools, and emergency facilities to be assigned to the safest areas. The areas adjacent to fault lines should be closed to construction, whereas these prohibitions on construction and use could be progressively abolished as the distance away from this region increased (Balamir, 2007, 36).

Cities are the residential areas where the population is concentrated predominantly outside the non-agricultural sector and where the industrial, trade and service sectors constitute the economic base. Cities as economic settlements become centers of attraction for socio-cultural reasons such as job opportunities and education. However, as the population and structural density increase, the risk of disaster increases. Urban planning seems to be the most important tool for controlling risks. Therefore, it is necessary to apply a holistic urban planning approach based on disaster-sensitive micro-zoning studies that minimize risks by taking into account the physical characteristics and socio-economic structure of the place and possible scenarios before and after a disaster (Tam, 2004, 69). In the present study, the urban development of Düzce, a city which lost 90% of its housing stock during the 1999 Marmara earthquakes (Polat, 2009, 33), was examined through the perspective of the city macroform.

2. Aim of the Research

The North Anatolian Fault line in Düzce Province is in an area influenced by two fault zones which can produce severe earthquakes at certain intervals. Before 1999 Düzce was a small town, but after the 1999 earthquakes, Düzce was designated as a separate province with the city of Düzce as its administrative center. This study examined

the spatial development of the city by analyzing both economic and planning decisions through the changing urban macroform after the disaster.

3. Method

In this evaluation study, Düzce's first reconstruction plan along with its amended and revised plans and the revised reconstruction plans made after the 1999 earthquakes were discussed and the change of the urban macroform was examined. The macroform changes of the city prior to the earthquake were obtained by digitizing the photogrammetric maps of 1960, 1981, and 1997 using GIS software.

4. Study Area

In the historical process, archaeological remains reveal that the ancient civilizations in Düzce preferred the northern hills dominating the plain. The ancient city of Prusias ad Hypium was founded on the southern slope of a small hill north of the Düzce plain, surrounded by mountains with the ancient name of Hypios (Zeyrek & Çelik, 2005, 11). Hypios was the first known name of the city, which was situated next to the Melen and Tabak streams, extending from east to west (Zeyrek & Çelik, 2005, 15; Özlü, 2009, 16). Later, during the period of the Eastern Roman Empire, the ancient city of Prusias ad Hypium (Kieros/ Kasaba/ Konuralp) was added to the Ottoman lands by Konuralp Bey, one of the commanders of Orhan Gazi. The ruins of this ancient city are located within the boundaries of the Konuralp / Uskubu District, 8 km north of the city of Duzce.

The information known about the urban settlement in the plain of Düzce starts in the 16th century. During this period, Düzce was the marketplace of the surrounding villages. Düzce in the second half of the 17th century was

described by Evliya Çelebi and foreign travelers in their travel memoirs as a market and place of accommodation, with a mosque and two inns (Anon., 2011, 2). With the opening of the Düzce Plain to agricultural use in the 19th century, the region witnessed migration from the Caucasus, Eastern Black Sea, Eastern Anatolia, and Rumelia. The Düzce Municipality was established in 1881. After the second half of the 19th century, the city, with its neighborhoods, bazaars and markets, became a lively commercial center. Urban development accelerated after 1945, and even more after 1955 (Anon., 2001, 4). Incentive measures, especially for agricultural products and industry, have hastened urban development. The population has increased with the advantages of a fertile plain and proximity to main roads and the important Ankara-Istanbul Highway transportation (Anon., 2001, 6).

5. Research Findings

5.1. Planning process for Düzce City

The settlement, which started as a marketplace in the plain, developed due to transportation, mainly because it is on the transit route. Therefore, the developments up to 1950 were mostly connected to the old Istanbul-Ankara Highway. Between 1950 and 1965, the city continued its "oil stain" form of development. Developments in the city center were achieved through the renovation of the old fabric or by filling in the gaps. The zoning plan of Düzce was first created by the İller Bank in 1963, and then the amendments and revisions of this plan, which could not be implemented in 1985, were realized in 1994. In 2001, according to the new post-earthquake conditions, additional and revised zoning plans had to be made. The first settled area of Düzce was that of the current city central district, where the neighborhoods of Cami Kebir,

Kültür, Şerefiye and Cedidiye are located. The first zoning plan covered these four neighborhoods. The population projection of this plan targeting the year 1990 was 32000 people. Under this plan, building permits were granted to buildings of up to three stories.

Between 1975 and 1985, the city continued to develop linearly along the Ankara-Istanbul Highway. The city, which continued its development along this way after 1985, started to develop to the south with the establishment of an organized industrial zone and also to the north with the planning of the university campus established in Konuralp in 1994. After the 1999 earthquake, development began in the north-northeast, where the new settlement area for disaster housing was built. The housing development of the city has generally been in the form of "oil stains". In addition to this, villages within the boundaries of the municipality, such as Uzun Mustafa, Kiremit Ocağı, Aziziye, and Beyciler have entered into the process of spatial integration with the city. According to the 1963 zoning plan, Dereli Tütüncu, Metek (Koçyazı), and Mergiç (Esen) villages, and according to the 1985 zoning plan, Arab Çiftliği, Akinlar, Çam Köy, Çavuşlar, Karaca Hacımusa, Körpeçler, Sancaklar, and Sarayyeri villages were taken into the urban municipal adjacent area. In 1996, the number of neighborhoods rose to 17 (Anon., 2001, 38).

Between 1963 and 1994, the zoning plan implementations were concentrated south of the existing road, rather than in the area where construction was required. Approximately 2000 plan changes were made up until the last earthquakes. Following the earthquakes, to identify alternative settlement areas, ground surveys covering the Düzce basin were conducted by TÜBİTAK. In the report prepared by TÜBİTAK, it was emphasized that the city central district was not suitable for construction, and when the earthquake damage was examined, it was

revealed that the demolitions were mostly related to the bearing capacity of the soil and therefore, settlement in the plain should be avoided. The northeast of the city was re-proposed for settlement, just as was envisaged in the 1963 zoning plans (TÜBİTAK, 1999, 35).

After the study carried out by TÜBİTAK, the Düzce Municipality initiated a study on the revision of the zoning plan of the existing city central district and its immediate surroundings. Soil surveys were again conducted for this study, which was carried out by the Düzce Municipality after the 12 November 1999 earthquake. Non-residential areas, precautionary areas and residential areas were identified as construction areas. The unsuitable areas covered a total area of 246 ha where the present city center is located(Anon., 2001, 18).

According to the report prepared by TÜBİTAK, 10,500 residences were planned by the Ministry of Public Works and Settlement in a total area of 329 ha between Nalbantoğlu and Sallar villages, 6 km away from the city center, as the new settlement area. A total of 7,622 residences were completed in 2002 in the new residential area, where the necessary social facilities, schools, parks, gardens, green spaces, and shopping centers were located. The number of floors in the new settlement area was limited to three. The new settlement area, which consisted of a total of 14 zones, was included within the service boundaries of the Düzce Municipality in 2002. This area is very close to the city center; however, there is 1st class agricultural land located between the city and this settlement (Fig.1).

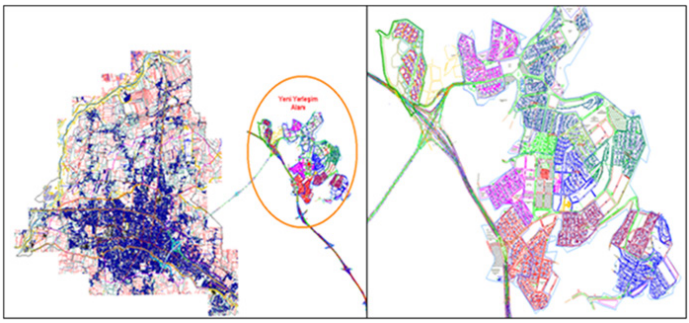

Figure 1. New residential area and existing city connections (Polat 2009, 35)

Since the amended and revised zoning plan approved in 2001 envisages two-storey construction, the existing commercial center was preserved and the new proposal was developed in the vicinity of the city center. However, because the new building conditions limited buildings to two floors, this caused the city to develop in a horizontal manner, thus increasing the urban area. The residential areas were increased by 102 hectares to 1079 ha. and the 463 ha agricultural area within the city boundaries was included in the planning area in order to control the construction. The newly revised development plan encompassed the boundaries of the old plan, but increased it from 2033 ha to 2953.7 ha. In other words, the old plan was expanded and revised (Fig. 2).

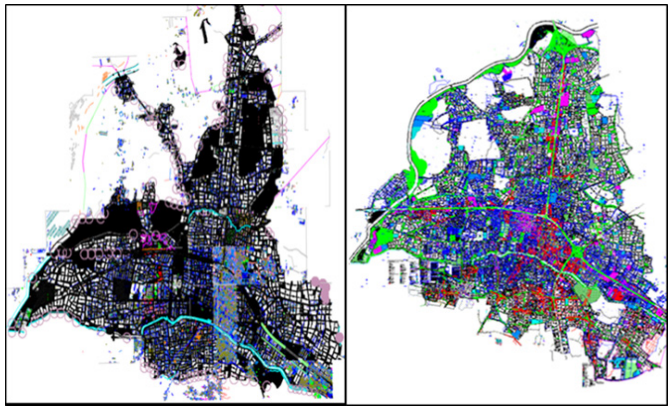

Figure 2. 1987 and 2001 zoning plan boundaries (Anon., 2001).

In the planning, there were 170,000 people within an area of 1080 ha. An average of 157 people / ha were considered for housing areas and 66 people / ha were considered for all of the urban areas. In the aftermath of the zoning plan approved in 2001, a new ground survey was conducted in 2004 and as a result, the floor height limit was increased to three stories (Fig. 3).

According to the results of the 2010 ABPRS (Address-Based Population Registration System), the total population of Düzce Province was 338, 188 and the urban population was 194,128. Despite the general decrease in the population in the Black Sea Region, the population of Düzce increased from 56,649 to 129,118 between 2000 and 2010 as a result of the investments made in an effort to reduce the effects of the 1999 earthquakes. However, the rural population decreased from 103,041 to 68,593. There are 48 neighborhoods within the municipality boundaries of Düzce District.

Figure 3. Residential areas allowed to construct three-storey buildings after 2004 (Anon., 2013).

In the amended development plan of 2013, the spatial development was expected to be in the direction of the Akçakoca road, especially for permanent residences in the north and northeast, where new buildings were located in and around the existing settlement area. Despite the 2008 circular of the General Directorate of Disaster Affairs of the Ministry of Public Works and Settlement, a microzonation ground survey was not carried out during the plan revision, although it is a legal obligation (TMMOB, 2006, 10).

The 2013 revised plan also granted construction permission for an additional storey to some special buildings such as hotels, schools, hospitals, shopping centers, cultural centers, and multi-storey car parks if they had secured the approval from the geotechnical reports (Anon., 2013, 29).

5.2. Thresholds affecting the morphology of the city

The Düzce plain, which was formed under the influence of ground movements in the North Anatolian Fault zone, is a young depression basin (Fig. 4). The surface of the plain, filled in with alluvial deposits from the rivers, is quite flat (Anon., 2005, 11). With the project carried out by the State Hydraulic Works (DSI) in 1971, an area of 22,250 ha in the plain was provided with irrigation opportunities, but as a result of its use for settlement and industry, the irrigated area was reduced to 13,000 ha in 1990 (Anon., 2011, 17).

The natural thresholds limiting the layout of Düzce City central district include the Asar River which divides the city in the middle and the Karaca Creek passing through the development areas in the north. The density of the streams on the plain renders the area a watershed. The Büyük Melen and the streams that feed it are identified as among the water resources within the scope of the Istanbul Drinking Water Project (İSKİ) developed by the DSI to provide water long-term to the city of Istanbul. Conditions related to the economic activities and spatial use of these areas were determined according to the Environmental Law, Water Pollution Control Regulation, Aquaculture Law and the İSKİ Regulation.

The regional transport connections are the most important factors determining the spatial development pattern of the city. Duzce, passing to the south of the TEM Motorway, is located on the D-100 (E-80) Istanbul-Ankara Highway, equidistant between the two cities. The connecting Zonguldak-Karadeniz Ereğli-Akçakoca highway to the north connects to the D-100 highway from the City Center. The city of Duzce developed in the east-west direction around the D-100 highway. For this reason, the city became divided into two macroforms, as the north and the south. In terms of its present function,

the highway seems to be a boulevard used intensively by urban traffic.

The Düzce City central district is located in a first degree earthquake zone, approximately 7 km from the active broken fault line (KAF) to the south (Fig. 5).

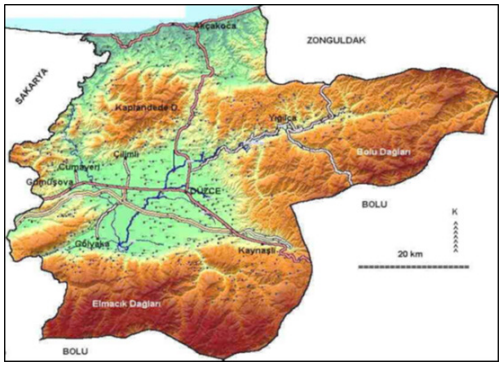

Figure 4. Physical profile of Düzce (Tatar, 2003, 6).

The sedimentary thickness in the Düzce basin is estimated to be 260 m based on geophysical data. According to the results of all drilling and geophysical surveys carried out in and around the city central district, alluvial deposits consisting of clay, silt, sand, and gravel are the basis of the foundation (TÜBİTAK, 1999, 13). Duzce Basin, as a region that has been subjected to natural disasters due to its climatic characteristics and geological structure, experienced four major earthquakes (1943, 1957, 1967, 1999) in the last century and it has been frequently flooded, the last incident having been in May 1998. (TÜBİTAK, 1999, 27).

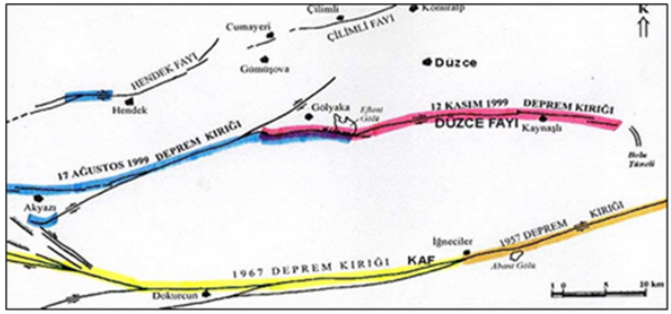

Figure 5. Faults constituting the seismicity of Düzce and the recent earthquakes (Polat, 2009, 31).

Thresholds that limit the Düzce City planning include topography, fertile agricultural land/soil and irrigation areas, geological-geotechnical areas suitable for settlement, the portion of Karaca Creek passing through the city, Asar Suyu and Küçük Melen Streams, highway routes and forest areas. Küçük Melen Stream passes through the north of the city, continues up to the Hasanlar Dam in Yığılca and is a natural threshold that limits the development of the city to the east, northeast and north. The agricultural areas located between the Disaster Housing Settlement and the city center prevent urban development in the eastern direction.

5.3. Change of urban macro form

The planning process of the city of Düzce and the creation of the city form involve many contradictions and tensions. Düzce is a plain that is valuable in terms of agriculture and includes a basin with increasing water potential. Düzce plain, which was formerly a lake bottom, has gained importance as a market place for villages. Düzce has received immigration from all over the country and has gathered all the active cultural features of the immigrants from the Balkans and the Caucasus. The trade axis formed with the opening of the plain to settlement by

the Istanbul-Ankara Highway has been the main driver of the development of the city. Even the earthquakes could not change the residential and commercial centers on this road. Until the 1980s, the settlement, with its *dizeme* and Baghdadi houses, most having gardens, was called "green Düzce". The low-density garden housing texture from the past, which affected the city's macroform, was abandoned over time due to financial considerations, and high-density apartment buildings began to be constructed on the same parcels.

The amended and revised zoning plan made after the earthquake in 2001 directed the city, which grew linearly, toward the north and northeast. It then began to grow radially, with the new settlement area and the new route connecting with the center. The development of trade areas was undertaken within the central business district in the city center. To meet the urban and regional needs, Urban Service areas were planned adjacent to the 50-meter D-100, Akçakoca, and permanent housing (Kalıcı Konutlar) highways that form the development corridors of the city. The housing need for the settlement was provided by the newly developed residential areas in the neighborhoods in the northern and northeastern sections.

The development axis was concentrated in the northeast direction. In order to ensure functional continuity in the city, development areas were proposed in the villages of Çakırlar, Tokuşlar, Kazukoğlu, Kuyumcu Hacıali, and Yahya, which are close to permanent residential areas that are disconnected from the center. Thus, the linearly growing macroform of Düzce turned into a radial structure on the roads connecting to the permanent housing (Kalıcı Konutlar) and Akçakoca (Figs. 6,7,8).

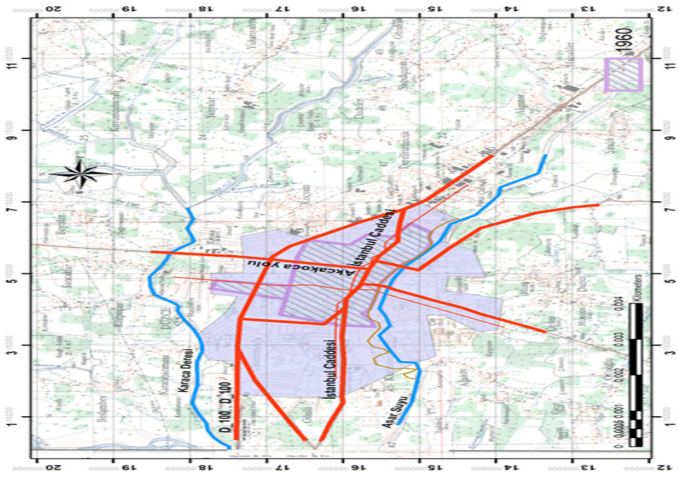

Figure 6. 1960-1981 Düzce City macroform (produced from photogrammetric maps digitized via ArcGIS software)

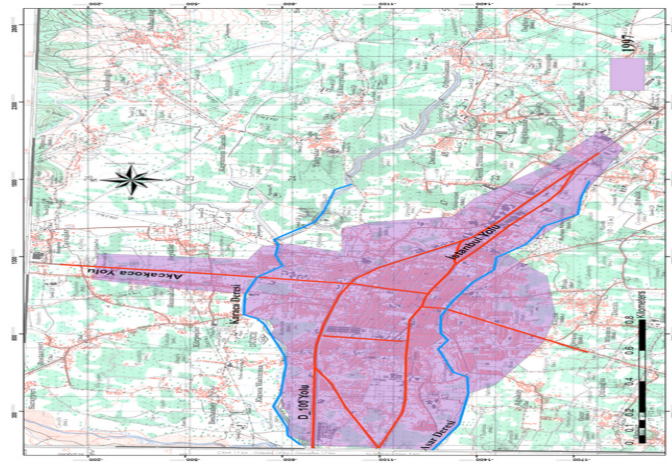

Figure 7. 1997 Duzce city macroform (produced from 1997 photogrammetric map digitized via ArcGIS software)

In 2014, Konuralp, as a district of Düzce, entered into the planning boundaries with seven neighborhoods and also the university campus (Fig. 8). Küçük Melen Stream, which formed the northern border until this time,

had been a border element separating the city center from Konuralp.

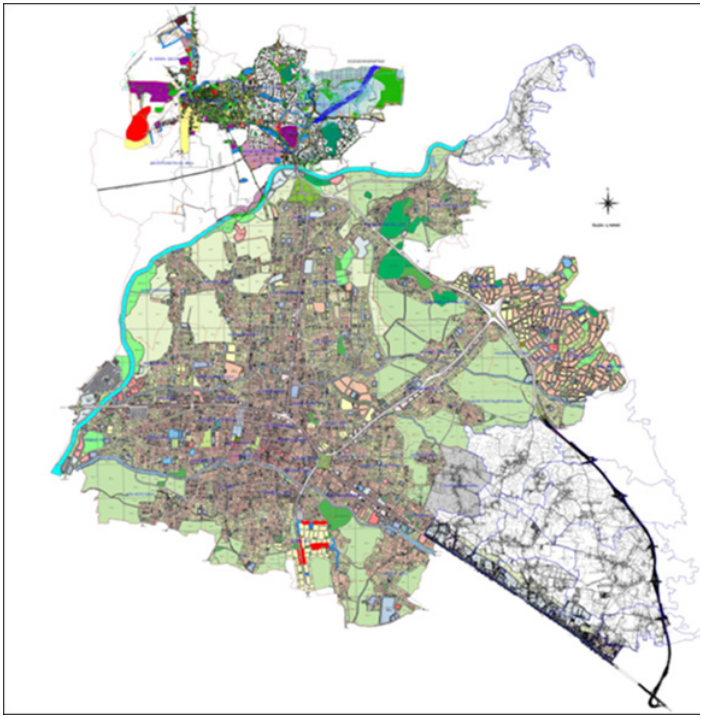

Figure 8. Boundaries of the 2013 Reconstruction Plan (Anon., 2013)

Düzce, which was compelled to develop horizontally after the 2001 zoning plan decisions, gradually spread to the plain by including the nearby villages. This density caused an increase in the problem of air pollution in Düzce because of its bowl-shaped topography. The tectonic depression plain is surrounded by mountains, the climate is humid, the frequency and force of the wind are low, and the amount of precipitation is high at the regional level. All these factors contribute to the escalation of the air pollution in the region. The city of Düzce is one of Turkey's most prominent settlements in air pollution ranking. Its topographical structure, construction activity,

and the formation of a fog layer over the city blocking the sun's rays all year round, especially in the morning hours, which prevents the escape of harmful gases are the causes of the so-called smog (Anon., 2011, 41).

6. Results and Discussion

The macroform or shape of a city, which is defined by the necessary or planned urban growth, describes the general outline of the city separating the settlement from its surroundings. When the macroform of Düzce City is examined according to its geography and physical and socio-economic conditions, it reflects many contradictions and tensions. Features such as the former lake bottom, the collapsed basin, disaster risks, and the watershed are the thresholds that limit the city. In a situation in which the zoning plans approved in 1964 were not implemented and the 2000 plan amendments were up for debate, 90% of the building stock was lost after the occurrence of two major earthquakes. The Ministry of Public Works and Settlement planned the new settlement area and wanted to direct the city toward the safer northern slopes. However, they were not so successful in this regard. While Düzce was a city with a population of 56,000 in 1999, it experienced a surge with the decisions taken after the earthquake, and the population had reached 235,000 people by 2017. The city started to spread like an "oil stain" towards the plain by including Asar and Karaca Creeks. Düzce was declared a province after the earthquakes, followed by the establishment of organized industrial zones. Düzce University was founded by separating from the faculties of Bolu Abant İzzet Baysal University, and the province began attracting more population with the increasing number of students, faculty and civil servants. The new settlement planned and realized by the Ministry of Public Works and Settlement has remained a dormitory city since the old center cannot be abandoned. The workplaces built

in this region were not commercially viable and so were transformed to function as student dormitories and elderly care facilities.

The agricultural land between the permanent housing (Kalıcı Konutlar) area and the old city center was also under the pressure of settlement. The old city central district grew rapidly with the structural renewal and incentive movements initiated for socio-economic recovery after the earthquake, and the rural and urban settlements and the residential and commercial areas became intertwined. Due to the urgent need for shelter after the earthquake and the lack of reserve disaster areas in the Düzce zoning plan, housing applications were rapidly initiated and within 19 years, new towns or urban settlements were established in the pasture and forest areas of the city. In 2014, in accordance with Article 11 of Law No. 5393 on Municipalities, Konuralp was joined as a legal constituent of Düzce Municipality. The city expanded further by including a town in the north. Additional zoning plans after the disaster retained the existing ownership situation and limited the floor height to two stories. This decision did not last long. The floor height was increased to three stories, and then up to four, to be applied under certain conditions. Although it is a requirement in post-disaster planning studies, a micro zoning study has not been performed. None of the measures recommended in post-disaster planning studies have been carried out, including creating fragmented, multi-center residential areas and spatial grading, the planning of sub-centers, leaving green areas and reserve areas to be used in the event of an earthquake, ensuring continuity of green and open areas, preventing the spread of the city, or ensuring a balanced development of the population and its density. With its growing population, the city has spread to the plain in a single-centered, radial macroform and has incorporated villages into its boundaries. The urban macroform reveals

a growth pattern dependent on financial considerations, under the influence of local dynamics, where disaster risk is not taken into account and natural elements such as agricultural land and water resources are ignored.

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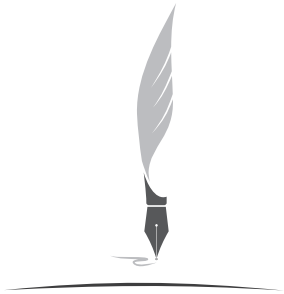

Chapter 7

AN ASSESSMENT OF SUSTAINABLE ENERGY AND GREEN BUILDING CERTIFICATION SYSTEMS IN OFFICE BUILDINGS

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1. INTRODUCTION

From Industrial Revolution to the present, energy acquisition and consumption remained among the most important targets of countries. Energy acquisition and consumption provided the basis of government policies. A system aiming for energy more than anything else and consuming it rapidly now dominates the planet. Energy acquisition and consumption are of crucial importance worldwide as they affect the future of all humankind. As a result, world governments come together regularly in conferences and meetings to discuss the subjects of energy acquisition and consumption (sustainable energy) on an international scale. These conferences and meetings produced regulations and sanctions that are binding for all world governments.

The United Nations Conference on the Human Environment held in Stockholm in 1972, the Rio Earth Summit of 1992, and the Energy Performance of Buildings Directive (EPBD) adopted in 2003 are the milestones in the goals of sustainable energy and green buildings. Green Building Certifications for the inspection of all building systems are a product of the resolutions and regulations formulated in these conventions.

An analysis of energy consumption worldwide shows that office buildings are among the structures with the highest levels of energy consumption. In this study, the aim is to examine the importance of sustainable energy in the office buildings, rapidly increasing worldwide in numbers, and the relevance of energy certification systems within the scope of office buildings.

2. A HISTORY OF THE OFFICE BUILDING

The history of the humankind saw two big transformations. The first of these was the prehistoric

transition from nomadism to sedentary life and the second was from the sedentary agricultural economy to industrial life beginning in the 1760s. Both transformations were marked with radical change in social life and economic circumstances, however, while the first transition was a slowly moving process in the course of centuries, the second one (the age of industry) took place very rapidly and affected the whole world. In this latter period that went down in history as the Industrial Revolution, buildings were constructed in a fast pace and in the economically most feasible ways, without much regard for the environment and human health. All the buildings of this period used solid fuel sources in building heating systems. The air pollution and human health hazards this created over time led world governments to join their forces to seek green buildings and sustainable energy usage.

The concept of office developed in the 19th century as the need for different workplaces emerged with the technological developments in the society. The first offices were the public buildings constructed to meet the requirements of the class of government administrators. Palazzo degli Uffizi in Florence and the Bank of England are examples of the first office buildings. First commercial offices, on the other hand, were built in the 19th century in the industrial Northern cities of the United States. With the invention of telephone, telegraph, and other equipment offices were eventually separated from other buildings and constructed as specialized buildings.

Image 1*: Palazzo degli Uffizi*

2.1 Sustainability and the Sustainable Design Criteria in Office Buildings

Office buildings are used by much more people and sustain a higher level of human activity as compared to other buildings. This means that their energy needs (for lighting, cooling, heating, and ventilation) are higher. In parallel with the amount of energy consumed, the amount of waste they produce is also higher than in other buildings. In a standard office building, 25% of the total electric

energy is used for lighting, 55% for air conditioning, and 20% for other purposes (e.g. equipments, elevators, etc.).

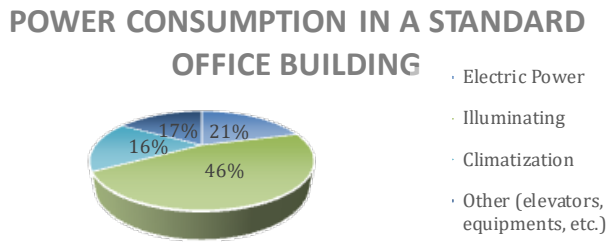

Figure 1. *Table showing power consumption in a standard office building.*

Building office spaces around the concept of sustainability can be achieved on the basis of three main principles: Conservation of Resources, Life Cycle, and Humanitarian Design Principles. In a sustainable office, special attention should be given to the principle of conservation of resources. This principle is of utmost importance in building and maintaining a sustainable office and can be divided into the strategies for the conservation of energy, water, and materials. The main design criteria to be met in office buildings to increase energy performance and conservation are as follows:

- When positioning the building on a land plot, optimum use of daylight and microclimate are among the most important considerations.
- The high level of internal heat generation in office buildings causes the cooling energy load of the building to increase in summer months. In order to reduce the cooling load, the opaque/transparency ratio of the building envelope control elements must be determined correctly and the use of interior passive ventilation systems should be considered.

- While the building is designed to utilize the maximum amount of natural resources, active systems with traditional energy consumption should be kept to a minimum.
- Waste management is crucial: measures should be taken to ensure that energy is recycled and the waste produced eventually affects the environment at a minimal level.

A sustainable office space designed in line with these principles reduces energy consumption, provides a high quality indoors with much better user comfort and energy efficiency, decreases operating costs, and ensures sustainability of resources overall. Above all, sustainable structures help protect the ecosystem.

2.2 Green Building Certification Systems and Office Buildings

Following the United Nations Conference on the Human Environment in 1972 and the 1992 Rio Summit, certification systems were created with the aim that each country would be supervising itself. The established certification systems became international in time and came to be used by all countries of the world. The first of these certification systems was the BREEAM (BRE Environmental Assessment Method) developed in the UK in 1990, followed by SBTOOL in Canada in 1996, LEED (Leadership in Energy and Environmental Design) in the USA in 1998, GREENSTAR (Green Building Council of Australia) in Australia in 2003, CASBEE (Comprehensive Assesment System for Built Environment Efficiency) in Japan in 2004, DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) in Germany in 2008 and BEP-BUY (Energy Performance in Buildings) in Turkey in 2010. The characteristics of each of these certification systems are summarized below:

BREEAM, UK - 1990

- It is the first green building certification system and it was developed in the United Kingdom in 1990. Being the first of its kind, it is the most trusted certification system today.
- Its main purpose is to promote innovative sustainable solutions by establishing criteria beyond regulations.
- It is known as system that is always kept up-to-date according to changes and updates in environmental policies, as well as its capability to adapt to local condition.
- It has 5 different certification classes.

Figure 2. *Breeam Certification Classes and Rating Percentages.*

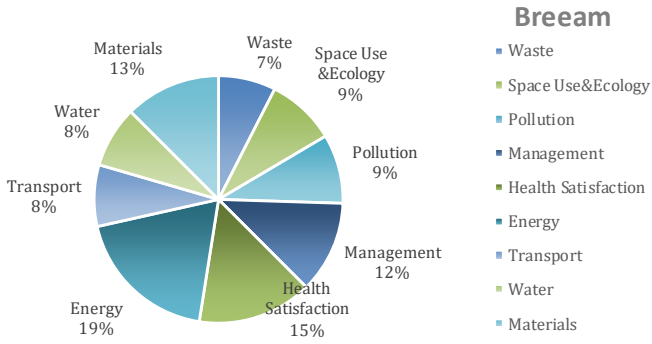

Figure 3. *Breeam Rating Categories and Percentages.*

LEED, USA -1998

- LEED is an internationally recognized building certification system.
- It aims to draw attention to and raise awareness about environmental values in the construction industry to ensure that protecting the natural environment becomes a consideration in the decision making processes of all individuals and organizations in this industry.
- Evaluation criteria can be applied at the design and construction stages. The LEED certification system does not require an authorized expert.
- It has 4 different certification categories.

Figure 4. *Leed Certification Classes and Percentages.*

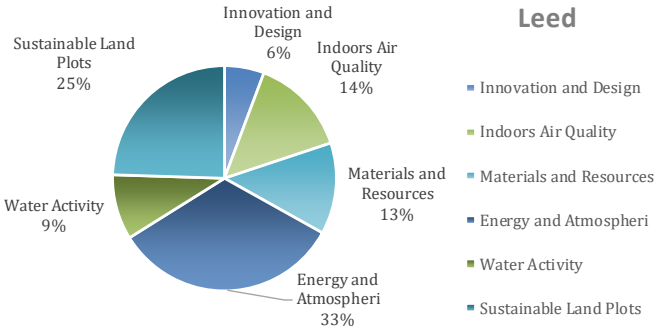

Figure 5. *Leed Rating Categories and Percentages.*

GREENSTAR, AUSTRALIA - 2003

- It is very similar to BREEAM and LEED certification systems.
- It is possible to apply for the Greenstar certification projects only for projects in Australia. Because of the large territory of Australia, it is divided into various regions with their own rating systems.
- Greenstar has 3 different certification classes.

Figure 6. *Greenstar Certification Classes and Percentages.*

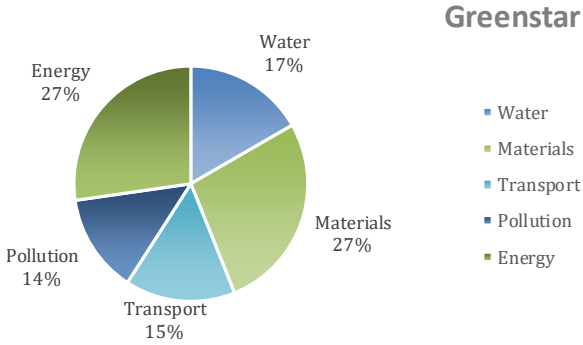

Figure 7. *Greenstar Rating Categories and Percentages.*

CASBEE, JAPAN - 2004

- The CASBEE certification system was prepared taking into consideration the conditions of Japan and Asian countries.
- It is a compatible system that starts inspections in the stages preceding the design work and keeps the post-design stages under control.

- It is divided into 4 target areas: energy efficiency, resource efficiency, artificial environment, and interiors.
- It has 5 different certification classes.

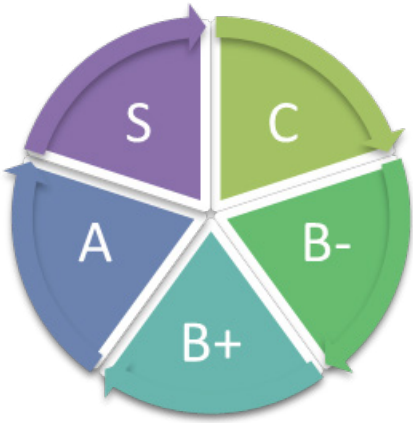

Figure 8. *Casbee Certification Classes and Percentages.*

DGNB, GERMANY - 2008

- It was first released in 2008.
- It is a system established for the planning and evaluation of buildings.
- Actually, its design is based on the LEED and BREEAM systems.
- It has 3 different certification classes.

Figure 9. *DGNB Certification Classes and Percentages.*

SBTOOL, CANADA - 1996

- SBTool is not used for individual buildings, but it is designed as a general evaluation system and it provides a model for use by other countries. It is referred to as the SB Method in the market rather than a certification system.

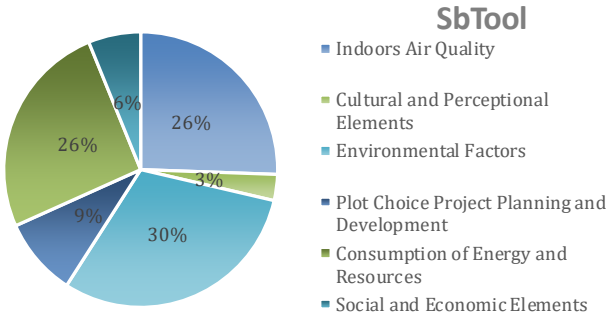

Figure 10. *SbTool Rating Categories and Percentages*

- SBTool (Sustainable Building Tool) Certification system is a green building certification system developed to solve economic and social problems around buildings. It aims to make sure that a building is constructed in a sustainable manner suitable for the region it is located.

BEP-BUY, TURKEY - 2010

- Bep-Buy certification system was established in 2010 under the Ministry of Environment and Urbanization of Turkey.
- It differs from other certification systems in the world in that it categorizes all buildings as either new or an existing structure.
- As a result, even low level buildings can apply to be rated and certified. The purpose of this level of acceptance is to create an inventory of existing structures.
- It has 7 different certification classes.

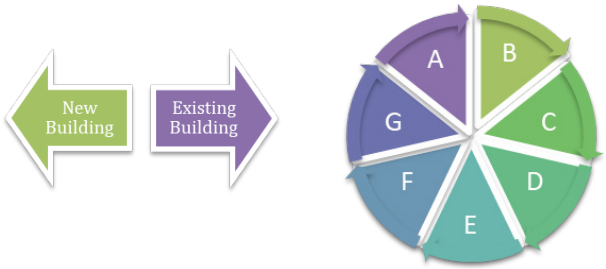

Figure 11. *BEP-BUY Certification Classes and Percentages.*

As each of the green building certification systems is designed according to the geographical and other local characteristics of the issuing country, they differ from the use of the certification system to the calculation of ratings. The year, country, standards, building classification, scores and rating categories, titles and percentages of each system are different. This shows the importance of picking the right certification system to apply to for the building in question.

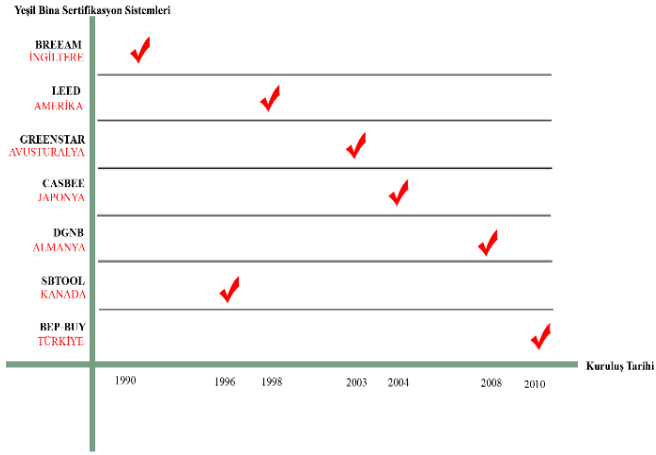

Table 1. *Green Buildings Certification System*

In our study, energy certification systems in the context of office buildings were examined and compared in the category of standard office buildings. As the titles and percentages of ratings are different in each certification system, the total scores in the result section will also be different. For example, in the category of office buildings, the Breeam Certification system makes up a 19% under the title of energy and the share of the Leed Certification system is 33%. Therefore, it is of great importance that the right certification program be chosen for the building to secure a healthy certification process.

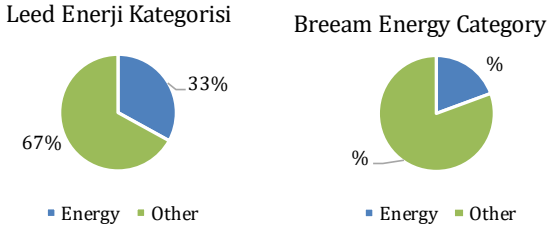

Figure 12. *Energy Percentages in the Breeam and Leed Certification Systems.*

3. Conclusion

Construction of buildings must be controlled if we will have a safe future as the humankind and keep the harm to ecology at a minimum. Each building constructed with renewable energy systems, causes additional energy consumption.

The main reason behind the environmental and health problems worldwide is the consumption of solid fuels. Alternative energy systems and Green Building Certification programs were developed as a result of the awareness of this and with the aim of conserving energy. In time, these were made compulsory to use in the construction processes with international resolutions and agreemenets among governments. As for the office buildings, which are responsible for the greater percentage of all building energy consumption, the purpose of Green Building Certification systems is to control the energy conservation and consumption of the building.

In our study, different energy certification systems were examined in the context of office buildings and it was found that certification systems had different categories and percentage ratings. This difference directly affects the issued certificates. As a result, if the same building applied to more than one certification system, the resulting certificates would very likely have different ratings. Therefore, when applying for a certification, it is advised to choose the program closest to the geographical conditions and standards of the location the building is situated in to secure the highest class certification the building could possibly obtain.

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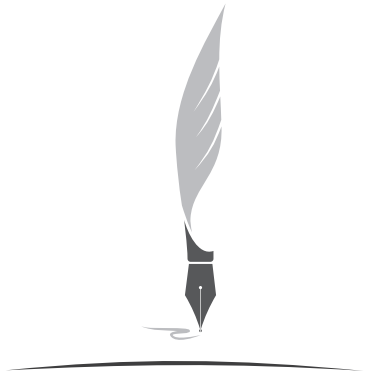

Chapter 8

SIGNAL RECEPTION ALGORITHMS IN GNSS ARCHITECTURE

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INTRODUCTION

The global navigation satellite system (GNSS) is a common term, describing any satellite constellation that delivers services for positioning, navigation and timing (PNT) on a global or regional scale. There are three main segments in GNSS system. They are space segment, control segment and user segment (Fig. 1).

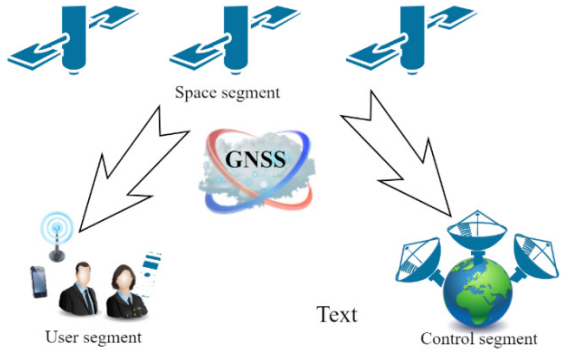

Figure 1. Main segments in GNSS system

Space segment

Space segment is composed of 24 satellites orbiting in 6 different orbit planes inclined at about 55°. The satellites are currently emitting signals propagated on carriers L1, L2, L5, E1, E5, E6 and so on.[14]. The satellites are orbiting Earth in six geocentric orbit planes, evenly distributed at 30° over the length of the equator. Each orbital plane has a 55° inclination towards the equator plane and contains a minimum of four satellites. A single turn around the Earth has a duration of 11:58 hours (half stellar day). At each moment of the day and from each point on the ground there must be radio visibility to at least four satellites. At full constellation (momentary distribution of all satellites on their orbits in the celestial sphere) at each moment of the day there can

be observed limitations of up to 8 satellites, at to 15° over the horizon; at 10° - 10 satellites; at 5° - 12 satellites. The satellites have various identification systems: launch sequence number, assigned pseudorandom noise code (PRN), sequence number of its orbital location, NASA catalog number and international designation.

Control segment

The control segment's purpose is for system control and it is also responsible for satellite orbit parameter estimation and the calculating time skew of the satellite clocks; prediction of orbit parameters, synchronizing of the atomic clocks; providing data for retransmission. The control segment contains a network of master control stations on the surface, data uploading stations and monitoring stations; for GPS there are two master control stations (primary plus backup), four data uploading stations and 16 monitoring stations, ground-based and located throughout the world.

User segment

The user segment contains GPS receivers. Each GPS receiver decodes a time signal, transmitted from the atomic clocks of several satellites and calculates its position with the help of trilateration (a method that differs and yet has similarities to triangulation).

GPS is a satellite navigation system which allows continuous coordinate and velocity estimation of the objects, as well as the accurate time in any point of the globe or in near-earth space. The received coordinates are projected to an earth-centric fixed coordinate system. This system consists of a minimum 24 satellites, distributed at 6 orbits at an altitude of 20 000 kilometers. A surface based command center with monitoring stations, located in different points of the earth, monitors the state of the

satellites and sends data towards them. The approach is based on measuring the distance from the point whose coordinates we are looking for towards a group of satellites whose coordinates are fixed and known. The distance is measured based on the time for propagation of the radio signal of the satellite to the consumer. Since GPS only works in passive mode, the consumer equipment can only operate in receive mode.

Since GPS is the most widely used global navigational system [9, 10], there are other nations which are attempting and have their own systems to supply and maintain additional and independent services on their own for positioning, navigation and synchronization. The most significant ones are Gallileo, GLONASS and Beidou.

Galileo is a global GNSS, owned and controlled by the European Union [16]. The EU has announced the start of the initial Gallileo services in 2016 and plans to complete the whole system of 24+ satellites by 2020.

GLONASS (Globalnaya Navigazionnaya Sputnikovaya Sistema) is another global GNSS, owned and maintained by the Russian federation. It is fully functional and contains 24+ satellites. [8, 17]

The BeiDou (BDS) satellite navigation system [3] is a regional GNSS, owned and controlled by the People's Republic of Chine. China nowadays is expanding its navigational system to ensure global coverage with 35 satellites until 2020. BDS was previously known as Compass.

Table 1 below shows the main features of the various navigational systems.

Table 1. Main characteristic of GNSS

Parameters	**Galileo**	**GPS**	**GLONASS**	**BeiDou**
Orbital planes	3	6	3	3
Satellites + Spare	27(3)	24(3)	24(3)	30(5)

Inclination angle,°	56	55	64.8	55
Altitude, km	23,616	20,200	19,100	21,150
Carrier Frequency, MHz	E5a, E5b, E6, E2-L1-E1	L1, L2, L5	L1, L2	E5a, E5b, E6, E2-L1-E1
Modulation scheme	BOC, BPSK	BPSK, BOC	BPSK, BOC	BPSK

As you see in table 1, there are some obvious differences between the systems. GPS has six orbital planes, Galileo, GLONASS and BeiDou each have three. The number of satellites is different, too. The inclination angle is 55 degrees for GPS; 56 degrees for Galileo, 64.8 degrees for GLONASS and 55 degrees for BeiDou. The altitudes are similar. GPS and BeiDou are in the middle, Galileo is higher and GLONASS - lower. The most stunning technological advances of the last years are the area of Global Navigation Satellite System (GNSS).

Signal characteristics

All satellite time and data signals are synchronized with an atomic clock with frequency 1575.42 MHz. The minimum power received from satellites signals is from -152dBW to -163dBW. It has been established that in order to maintain these levels, the necessary L1 signal transmission power, modulated with C/A code, has to be 21.9W.

Table 2 shows the parameters of the satellites and the consumers for estimating the necessary transmission power level. The following parameters are for the L1 GPS Carrier and C/A code.

Table 2. The parameters for L1 GPS Carrier and C/A code

Transmission power dBW	14.4
Antenna amplifier, dB	+13.4
Broadcast power, EIRP, dBW	26.8

Polarization losses, dB	-3.4
Signal attenuation in space/athmospere, dB	-184.4/-2.0
Amplification of the receiver antenna, dB	+3
Receiver power input, dBW	-160

The spectral density of thermal noise is 174 dBm/Hz (at 20 °C), i.e. the maximum power of the received signal is around 16 dB lower than the thermal noise level.

The navigation message contains information about the time and synchronization satellite signals, the exact coordinates of the satellite, correction data for precise synchronization, ionosphere data and satellite status information. This data has to be transmitted in 12.5 minutes which correspond to transfer rate of 50 bit/s.

Each satellite has a unique code, which consists of a random permutation of 1023 zeros and ones, using pseudo-random-noise code (PRN) (Fig. 2).

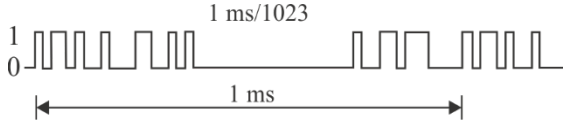

Figure 2. Pseudo-random-noise code

The satellite navigation signals are being generated using Direct Sequence Spread Spectrum (DSSS). The stability of the satellites' onboard clocks has improved from 5 x 10^{-13} to 1 x 10^{-13} over 24 hours with precision thermal stabilization.

The base frequency is a multiple of the resonance frequency of the atomic clock. The carrier frequency, the data signals the time to generate PRN and C/A code are derivatives of the base frequency (Fig. 3). Each bit of the PRN code sequence is called a „chip".

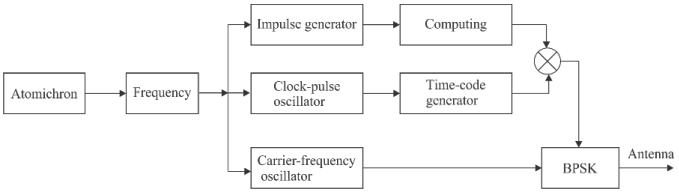

Figure 3: Block diagram of GPS satellite

All satellites transmit at the same frequency of 1575.42 MHz by using Code Division Multiple Access (CDMA), via DSSS modulation. The used C/A code is being generated through recurrent shift register. The code contains information and identification generated by each satellite. The code is composed of random sequence of 1023 bits and is unique to each satellite. It constantly repeat, i.e. each satellite is identified by C/A code. The GPS C/A code is a Gold code [6, 13]. The chipping rate of the C/A code is 1.023MHz, therefore the repetition period PRN sequence is 1ms [17]. This C/A code is modulo -2 added with the navigation data of 50Hz frequency. The resultant signal is BPSK modulated using the L1 carrier frequency (1575.42MHz) to generate the C/A GPS signal.

The structure of the navigational message represents a continuous data stream, transmitted at 50 bit/s. It is necessary for calculating the current satellite position and the transient time signal. Every frame is of 1500 bit length and 30 seconds are necessary for its transmission. Each subframe is of 300 bit length and 6 seconds are necessary for its full transmission. The message has 30-bit words and 10 word subframes, i.e., 300 bits. It also includes time offset information for UTC and other GNSS system clocks. [2]

Every frame is divided into 5 sub-frames which transmit different information. Subframe 1 contains info on UTC, correction parameters, delay of the transit signal and the satellite positioning accuracy. Subframe 2 and 3 contain data on the exact orbital position of the

transmitting satellite. Subframe 4 and 5 contain almanac data for satellites and they also include time offset information for UTC and other GNSS system clocks.

GPS and Galileo signal structures

For reasons of National Security Compatibility, avoidance of unacceptable radio-frequency interference, and suitability of GNSS performance, the international committee has come to an agreement on baseline signal structures. [4, 5]. The GALILEO secured governmental service in the 1559-1610 MHz band using a Binary Offset Carrier (BOC) cosine phased modulation with a 15.345 MHz sub-carrier frequency and a code rate of 2.5575 mega-chips per second (Mcps) centered at 1575.42 MHz (cosine phased BOC (15, 2.5)). The GALILEO signal structures used for any or all other services, including the Open Service (OS), Safety-of-Life service (SoL), and Commercial Service (CS), in the 1559 1610 MHz band using a Binary Offset Carrier (BOC) modulation with a 1.023 MHz sub-carrier frequency and a code rate of 1.023 mega-chips per second (Mcps) (BOC (1,1)) centered at 1575.42 MHz. [11].

The GPS signal structure in the 1559-1610 MHz band, centered at 1575.42 MHz, will be a Binary Phase Shift Key (BPSK) modulation with a code rate of 1.023 Mcps; a BPSK modulation with a code rate of 10.23 Mcps; and a BOC modulation with a 10.23 MHz sub-carrier frequency and a code rate of 5.115 Mcps. [1]

BPSK modulation in GPS

One of the most widely spread systems is the multiple channel per carrier. MCPC). In the satellite communications the widespread application is the pulse code modulation time division multiplexed pulse code modulation time division multiplexed (PCM TDM)

which is used for speech transmission. The signals are digitized by multiplexing according to the hierarchical structure of the plesiochronous digital hierarchy (PDH). The first level contains 30 channels, each with a speed of 64 kbits/s, multiplexed to 2048 Mbit/s bit rate. Then, it is followed by phase modulation - double BPSK modulation or quadruple phase QPSK modulation. The resulting MCPC signal is transmitted to the satellite by way of distributing it into the various frequency bands according to the FDMA access frequency access technique.

Signal modulation is achieved using the operation called exclusive-or (EXOR) (Fig. 4). The result is called Binary Phase Shift Keying (BPSK). The signal at the nominal or base frequency is generated by one of the atomic clocks and all other satellite signals are extracted from it. After that the resulting frequency is modulated with C/A code with a bit rate of 1023 Mbit/s.

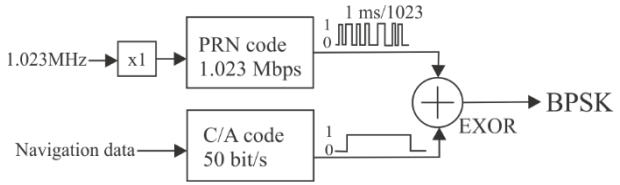

Figure 4. Modulated of the signal with EXOR

The BPSK modulated C/A signal transmitted by each GPS satellite k at an epoch t on $L1$ frequency is represented at:

$$S^k = Ac\big(C(t)\oplus D(t)\big)\cos(2\pi f_1 t + \emptyset), \qquad (1)$$

where S^k is the k^{th} GPS satellite transmitted signal, Ac – the amplitude of the C/A code, $C(t)$ – ± 1 indicates the phase of the C/A code, $D(t)$ – ± 1 indicates the phase of the data signal, f_1 – $L1$ frequency (1575.42 MHz) and $\emptyset$ the initial phase.

GPS carrier signal is a sinusoidal signal with frequency 1575.42 MHz (*L1*) and 1227.60 MHz (*L2*). Each satellite transmits data at these two frequencies. These signals are designated as *L1* and *L2*. They are coherently selected multiples of a 10.23 MHz master clock, derived from an atomic standard.

Binary offset carrier modulation for GNSS signals

Binary Offset Carrier (BOC) spreading modulation is one such technique to accomplish more power at higher frequencies away from center. BOC describes a class of spread-spectrum modulations recently introduced for the next generation of GNSS. Indeed, modernized GPS and the European Galileo system will use BOC (or BOC-based) signals on different carriers and with different parameters, to enable ranging. [12].

A BOC-modulated signal consists of a sinusoidal earner, a sub-carrier, a pseudo|-random noise (PRN) spreading code and a data sequence. The BOC signal is the product in the time domain of these components. [17]. Hence the two independent design parameters of BOC modulation are:

- Subcarrier frequency (f_s)
- Spreading code rate or PRN code (f_c)).

These two components provide freedom to concentrate signal power within specific parts of the allocated band to reduce interference with the reception of other signals.

GNSS satellites have an atomic clock on-board with a nominal reference frequency f_0 i.e. 1.023 MHz, from which all components of the generated navigation signals are derived. In the case of the BOC signal, the carrier

frequency, the sub-carrier frequency fs and the PRN code rate fc are chosen as multiples of f_0.

$$f_s = m.f_0 \quad (2)$$

$$f_c = n.f_0 \quad (3)$$

It is called BOC (*m, n*) modulation and for the sake of simplicity *m* and *n* are always considered as natural integers. As the BOC modulation is a square subcarrier modulation where a signal $s(t)$ is multiplied by a rectangular subcarrier of frequency f_{sc}, the BOC-modulated signal $S_{BOC}(t)$ can be represented as:

$$S_{BOC}(t) = s(t)sign(\sin(2\pi f_s t))$$

$$S_{BOC}(t) = s(t)\text{sign}(\sin(2\pi f_{sc} t)) \quad (4)$$

In BOC modulation the number samples per chip are represented by N_{BOC} factor defined as follow:

$$N_{BOC} = 2\frac{f_s}{f_c} \quad (5)$$

Figure 5 shows the method of generating the BOC (10,5) modulated GPS Signal.

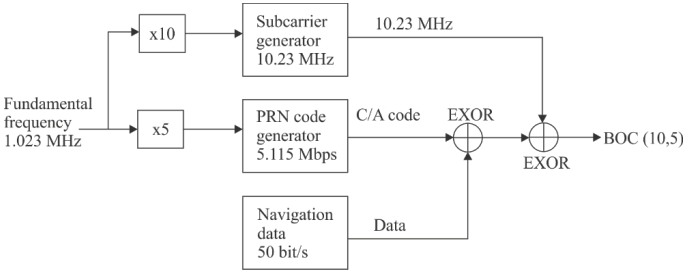

Figure 5. Modulation BOC (10,5)

In the modern satellite systems such as GPS and European Gallileo, the modulation of type BOC is used Binary Offset Code Modulation (BOC). In this way,

the BPSK modulated signal is modulated again. The frequency is always a multiple of the main frequency 1.023 MHz.

Galileo implemented new SAR function, which is comprised of two components: an automatic forward link distress alert and a unique return link alert that informs the sender that their message has been received.

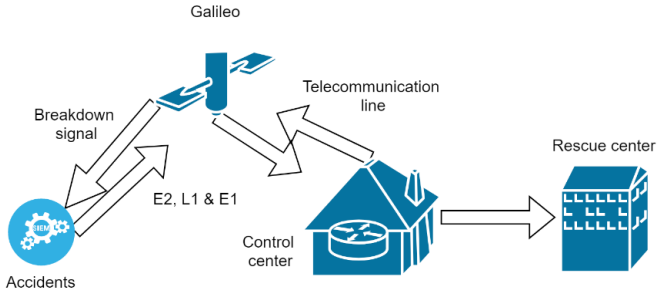

Figure 6. Galileo SAR service overview

The Gallieo GNSS systems provides different level of accuracy, which are shown on Table

Table 3 Level of accuracy.

Service	Receiver type	Horizontal positioning	Vertical positioning
OS	Single frequency	15 m	35 m
	Double frequency	4 m	8 m
CS	Double frequency	<1 m	<1 m
PRS	Single frequency	6.5 m	12 m
SoL	Double frequency	4-6 m	4-6 m

The highest accuracy at horizontal and vertical CS is up to 1 m, and the smallest accuracy is at service OS and single frequency.

Positioning algorithms

In order to calculate the precise position it is necessary to measure the time in transit of the signal between the observation point and four satellites in known positions.

All satellite navigation systems share common principles for coordinate estimation (Fig.7)

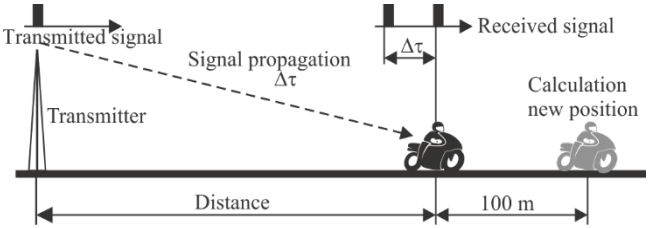

Figure 7. An example for calculation of the time from the transmitter to the vehicle and the exact position

On Fig. 7 is shown calculation of the positions of the vehicle. With calculation of the time from the transmitter to the vehicle we can estimate the exact position of the vehicle on the street.

The distance D is calculated via multiplication of the propagation time with the speed of light Δτ:

$$D = \Delta\tau \bullet c \quad (6)$$

Principles of timekeeping for signal transmission (pseudogap estimation). In order for a given GPS receiver to calculate its position it is required for it to receive time signals from four satellites (Sat1 ... Sat4) for calculating the time signal transmission time $\Delta t_1 \ldots \Delta t_4$ (Fig. 8)

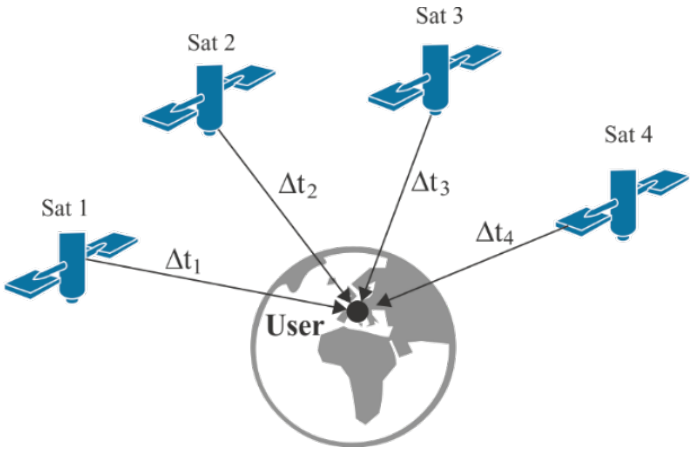

Figura. 8 Determination of the position of GPS receiver

The calculations can be performed in the 3D coordinate system of geocentric originals shown on (Fig.9).

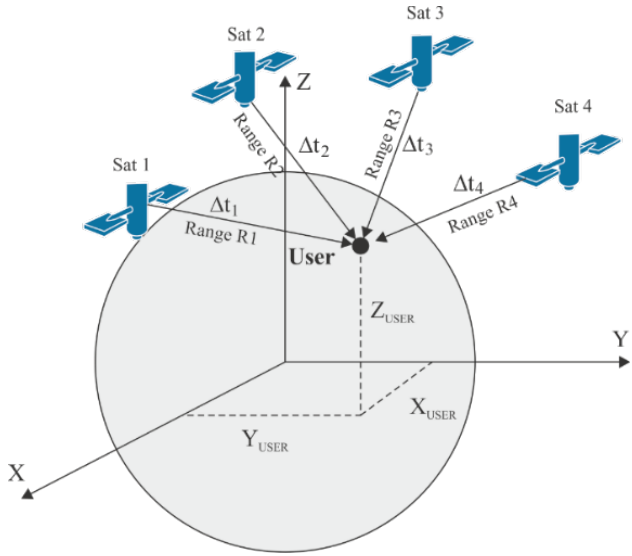

Figure 9. 3D coordinate system

The user range of the four satellites R1, R2, R3 и R4 can be calculated with the time for signal transmission Δt_1, Δt_2, $\Delta t3$ и Δt_4. Since the positions X_{SAT}, Y_{SAT} and Z_{SAT} of the satellites are known, it is possible to determine the exact position of the user.

Due to the availability of an atomic clock oboard the satellite, the time for signal transmission is known with very high precision. All satellite clocks are corrected and synchronized with one another and with the Coordinated Universal Time (UTC). On the other hand, the clock of the user is not synchronized with UTC and therefore it has a certain offset to Δt_0. The sign of Δt_0 is positive when the user clock is fast. The resutling time error Δt_0 is the main reason for errors in calculating the time for signal transmission and the distance *R*. As a result of this, there is an incorrect value for the distance, also known as pseudorange (PSR).

$$t_{measured} = \Delta t + \Delta t_0 \quad (7)$$

$$PSR = t_{measured}.c = (\Delta t + \Delta t_0)c \quad (8)$$

$$PSR = R + \Delta t.c \quad (9)$$

where: R is the real distance between the consumer and the satellite; *c* is the speed of light; Δt_1 is time for signal transmission between satellite and consumer; Δt_0 is delta between the clock of the satellite and the user and PSR is the pseudorange.

The distance *R* from satellite to the consumer in a Cartesian coordinate system can be calculated using the following mathematical expressions:

$$R = \sqrt{(X_{Sat} - X_{User})^2 + (Y_{Sat} - Y_{User})^2 + (Z_{Sat} - Z_{User})^2} \quad (10)$$

We substitute (4a) in (3a) to obtain:

$$PSR = \sqrt{(X_{Sat} - X_{User})^2 + (Y_{Sat} - Y_{User})^2 + (Z_{Sat} - Z_{User})^2} + c.\Delta t_0 \quad (11)$$

In order to estimate the four unknown parameters (Δt_0, X_{Anw}, Y_{Anw}, Z_{Anw}) we would need four independent equations. The expression is the same for the four satellites (i=1…4):

$$PSR_i = \sqrt{(X_{Sat\_i} - X_{User})^2 + (Y_{Sat\_i} - Y_{User})^2 + (Z_{Sat\_i} - Z_{User})^2} + c.\Delta t_0 \quad (12)$$

Equation linearization

The equations (12) represent a non-linear equation set. To solve these equations it is necessary to create a linear root function according to the Taylor model, using only the first part of the equations (Fig. 10)

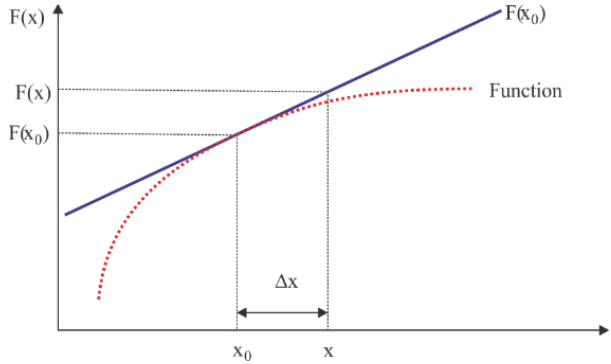

Figure 10. Conversion of the Taylor sequences

The main is substituted by $\Delta x = x - x_0$:

$$f(x) = f(x_0) + \frac{f'}{1!}(x_0).\Delta x + \frac{f''}{2!}(x_0)^2.\Delta x + \frac{f'''}{3!}(x_0)^3.\Delta x + ... \quad (13)$$

And only the first part of the simplified.

$$f(x) = f(x_0) + f'(x_0).\Delta x \quad (14)$$

To linearize the four equations (12) with an arbitrarily estimated value, it is required to substitute x_0 with x. In GPS systems this means that instead of directly calculating X_{User}, Y_{User} and Z_{User} the estimated position is used: X_{Total}, Y_{Total} and Z_{Total} (Fig.43).

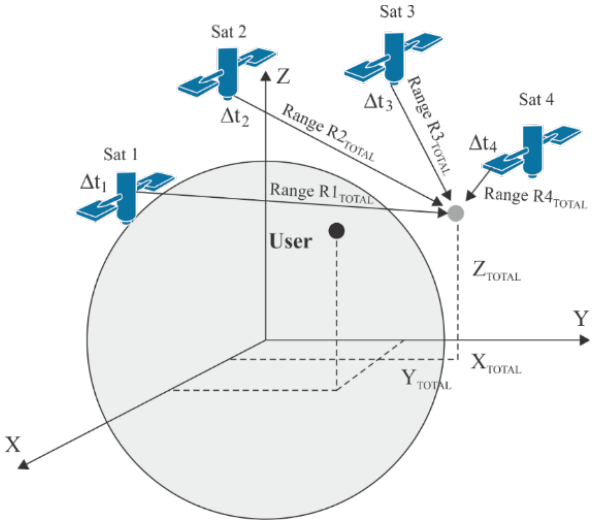

Figure.11 Position calculation

The estimated position contains errors due to the unknown variables Δx, Δy и Δz.

$$X_{User} = X_{Total} + \Delta x$$
$$Y_{User} = Y_{Total} + \Delta y \quad (15)$$
$$Z_{User} = Z_{Total} + \Delta z$$

The distance from the four satellites to the estimated position can be calculated via the following expressions:

$$R_{Total\_i} = \sqrt{\left(X_{Sat\_i} - X_{Total}\right)^2 + \left(Y_{Sat\_i} - Y_{Total}\right)^2 + \left(Z_{Sat\_i} - Z_{Total}\right)^2} \quad (16)$$

By substituting (16) in equations (12) and (14) we get:

$$PSR_i = R_{Total\_i} + \frac{\partial(R_{Total\_i})}{\partial x}.\Delta x + \frac{\partial(R_{Total\_i})}{\partial y}.\Delta y + \frac{\partial(R_{Total\_i})}{\partial z}.\Delta z + c.\Delta t_0 \quad (17)$$

After partial differentiation, the following is obtained:

$$PSR_i = R_{Total\_i} + \frac{X_{Total} - X_{Sat\_i}}{R_{Total\_i}}.\Delta x + \frac{Y_{Total} - Y_{Sat\_i}}{R_{Total\_i}}.\Delta y + \frac{Z_{Total} - Z_{Sat\_i}}{R_{Total\_i}}.\Delta z + c.\Delta t_0 \quad (18)$$

After transposing the four equations (18) for i=1..4 and the four variables (Δx, Δy, Δz and Δt_0) the principles of linear algebra can be used:

$$\begin{bmatrix} PSR_1 - T_{Total\_1} \\ PSR_2 - T_{Total\_2} \\ PSR_3 - T_{Total\_3} \\ PSR_4 - T_{Total\_4} \end{bmatrix} = \begin{bmatrix} \frac{X_{Total} - X_{Sat\_1}}{R_{Total\_1}} & \frac{Y_{Total} - Y_{Sat\_1}}{R_{Total\_1}} & \frac{Z_{Total} - Z_{Sat\_1}}{R_{Total\_1}} & c \\ \frac{X_{Total} - X_{Sat\_2}}{R_{Total\_2}} & \frac{Y_{Total} - Y_{Sat\_2}}{R_{Total\_2}} & \frac{Z_{Total} - Z_{Sat\_2}}{R_{Total\_2}} & c \\ \frac{X_{Total} - X_{Sat\_3}}{R_{Total\_3}} & \frac{Y_{Total} - Y_{Sat\_3}}{R_{Total\_3}} & \frac{Z_{Total} - Z_{Sat\_3}}{R_{Total\_3}} & c \\ \frac{X_{Total} - X_{Sat\_4}}{R_{Total\_4}} & \frac{Y_{Total} - Y_{Sat\_4}}{R_{Total\_4}} & \frac{Z_{Total} - Z_{Sat\_4}}{R_{Total\_4}} & c \end{bmatrix} \cdot \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \\ \Delta t_0 \end{bmatrix} \quad (19)$$

$$\begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \\ \Delta t_0 \end{bmatrix} = \begin{bmatrix} \frac{X_{Total} - X_{Sat\_1}}{R_{Total\_1}} & \frac{Y_{Total} - Y_{Sat\_1}}{R_{Total\_1}} & \frac{Z_{Total} - Z_{Sat\_1}}{R_{Total\_1}} & c \\ \frac{X_{Total} - X_{Sat\_2}}{R_{Total\_2}} & \frac{Y_{Total} - Y_{Sat\_2}}{R_{Total\_2}} & \frac{Z_{Total} - Z_{Sat\_2}}{R_{Total\_2}} & c \\ \frac{X_{Total} - X_{Sat\_3}}{R_{Total\_3}} & \frac{Y_{Total} - Y_{Sat\_3}}{R_{Total\_3}} & \frac{Z_{Total} - Z_{Sat\_3}}{R_{Total\_3}} & c \\ \frac{X_{Total} - X_{Sat\_4}}{R_{Total\_4}} & \frac{Y_{Total} - Y_{Sat\_4}}{R_{Total\_4}} & \frac{Z_{Total} - Z_{Sat\_4}}{R_{Total\_4}} & c \end{bmatrix} \cdot \begin{bmatrix} PSR_1 - T_{Total\_1} \\ PSR_2 - T_{Total\_2} \\ PSR_3 - T_{Total\_3} \\ PSR_4 - T_{Total\_4} \end{bmatrix} \quad (20)$$

The calculated Δx, Δy, Δz are used again for calculating the estimated position X_{Total}, Y_{Total} and Z_{Total} in accordance with equation (15).

$$X_{Total\_New} = X_{Total\_Old} + \Delta x$$
$$Y_{Total\_New} = Y_{Total\_Old} + \Delta y$$
$$Z_{Total\_New} = Z_{Total\_Old} + \Delta z \qquad (21)$$

The estimated values X_{Total_New}, Y_{Total_New} and Z_{Total_New} can be substituted in equation (20), using standard iterative process, until the moment when Δx, Δy and Δz become lower than the desired error (e.g. 0.1 meters). Depending on their initial position it is required to perform three to five iteration so that the error can become less than 1 cm.

To estimate the consumer position (or the position of the device) the last measured value can be used or the estimated new position for which through iterations the desired error can be achieved for Δx, Δy and Δz.

$$X_{User} = X_{Total\_New}$$
$$Y_{User} = Y_{Total\_New} \qquad (22)$$
$$Z_{User} = Z_{Total\_New}$$

The calculated value of Δt_0 corresponds to the error of time of the user and can be used to synchronize their clock.

Error analysis and distribution of precision (DOP)

In GNSS systems the total error is influenced by a few main reasons: the satellite clocks; satellite orbits; speed of light; measuring the time for signal transmission; signal reflection; satellite geometry (Table. 4)

Table 4 Main factors contributing to the occurrence of errors.

Error cause	Error without DGPS	Error with DGPS
Ephemeris data	2.1 m	0.1 m
Satellite clock	2.1 m	0.1 m
The effect of ionospheres	4.0 m	0.2 m
The effect of the troposphere	0.7 m	0.2 m
Signal reflection	1.4 m	1.4 m
Receiver influence	0.5 m	0.5 m
Total RMS value	5.3 m	1.5 m
Total RMS value (filtered)	5.0 m	1.3 m

In some cases there are correctional calculations that can be applied (Differential GPS, DGPS), thanks to which the errors can be reduced or removed.

Comparing performance of GPS and Galileo messages

The navigation message is an essential part of the navigation signals transmitted by GNSS satellites. The various message formats provide user equipment with all the data needed to compute position-velocity-time (PVT) solutions, to aid various receiver tasks, and to improve positioning accuracy.

Four main dimensions have been identified for the characterization of the performance of GNSS data messages: capacity, accuracy, robustness, and timeliness. [10, 12] While accuracy is directly related to the content of the message, the other three factors are related to other properties of the signal carrying the data.

Keeping in mind the definitions of the message performance factors, we now turn to the methodology used for calculating the various figures of merit for capacity, robustness, and timeliness.

This same methodology will then be used to assess the performance of the currently available open service

GPS and Galileo signals as well as the upcoming GPS L1C.

As shown in Table 5, the bits excluded from the computation are the preamble sequences used for frame synchronization purposes, parity bits, CRC bits, and tail bits. The computation takes into account the fact that most of the messages present different structures.

Table 5. Effective bit rates of GPS and Galileo signals

	GPS			Galileo		
	L_1C/A	L_2C	L_5	L_1C	E_1 OS/ E_5b	E_5a
Message ID	*NAV*	*CNAV*	*CNAV*	*CNAV-2*	*I/NAV*	*F/NAV*
Block terminology	Subframe	Message	Message	Frame	Word	Page
Block length [bits]	300	300	300	883	260	256
Preamble [bits]	8	8	8	0	20	12
Parity/CRC/Tail [bits]	60	24	24	48	36	30
Block duration [s]	6	12	6	l8	2	10
Bit rate [bps]	50.0	25.0	50.0	49.1	130.0	25.6
Effective bit rate [bps]	**38.7**	**22.3**	**44-7**	**464**	**102.0**	**214**
Efficiency factor [%]	77%	89%	89%	95%	78%	84%

Parity bits are used in the GPS NAV (6x10 bits) message, while the CRC-24 is used in all other messages. Note that only two out of three subframes of L1C have CRC (total of 48 bits). The GPS L1 C/A, L5 and L1C signals present almost the same bit rate.

Navigation messages are generally broadcast with a more or less fixed repeating pattern, such that the content is provided to users with a certain repetition rate. The robustness of a GNSS data message depends on many factors:

- Minimum received signal power;
- Amount of power dedicated to the data channel;

- Symbol rate of the signal;
- Forward error correction techniques;
- Conditions of the communication channel.

The symbol rate of the signal can be represented with the help of:

$$\frac{E_s}{N_0} = \frac{C}{N_0}\frac{1}{R} \qquad (23)$$

Where E_S/N_0 is the energy per symbol to noise density ratio and represents the SNR of the signal, is given by multiplying the C/N_0 of the signal by the inverse of its symbol rate, i.e., by the symbol duration. The higher this energy is, the lower the probability that the demodulated data will be affected by errors. The signal transmitted at the lower rate will present a lower error probability.

In terms of the data demodulation threshold, this translates into Equation (24):

$$\left(\frac{C}{N_0}\right)_{dBHz} = \left(\frac{E_s}{N_0}\right)_{dB} + (R_s)_{dB} \qquad (24)$$

For signals showing the same E_S/N_0 threshold, the signals transmitted at lower data rates will show a lower C/N_0 threshold.

The results shown on Fig. 12 are a function of the E_s/N_0 and not of the C/N_0. We used the convolutional codes of GPS and Galileo to blocks of length 600 and compared the results with the threshold obtained with the LDPC codes used for the GPS L1C Subframe 2 of the same length.

Figure 12 shows the obtained curves: the benefits of using tail bits and the coding gain brought by the LDPC codes. The both types of FEC have a coding rate of ½,

while the BCH codes applied to the GPS L1C Subframe 1 use a code rate R=9/52.

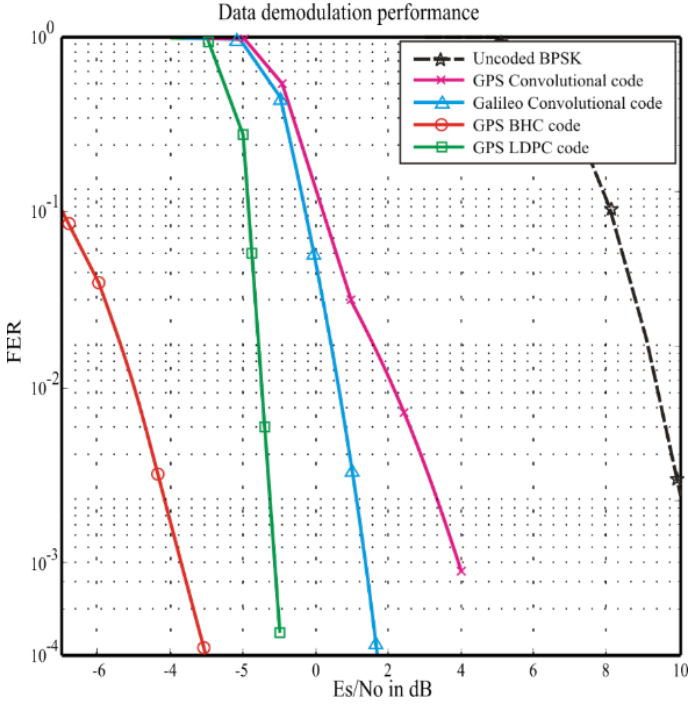

Figure. 12 Data demodulation performance

The error correction capability of the Hamming codes used to protect the GPS NAV message is very limited and the associated error curve, also present in Fig. 12 for reference, is very close to that of the uncoded BPSK modulation.

Conclusions

Starting from the need for a clearer and more extensive methodology for the assessment of GNSS data message performance, this article identified four fundamental dimensions: capacity, accuracy, robustness, and timeliness. The GPS L1C signal almost always gives

the best performance in terms of accuracy, robustness (second only to Galileo E5a), and timeliness. The great potential of the Galileo E1-OS/E5b signals in terms of high capacity cannot be properly exploited due to the presence of a large amount of reserved data and currently only reflects the associated limitation in terms of message robustness. The analysis proved that the key factors for good data-delivery performance cannot be identified separately but should instead be considered through figures of merit that are able to combine the effects of the message robustness and its timeliness. In view of future GNSS signal and message design activities, especially if these efforts are targeting the optimization of the signal performance in terms of robustness and TTFF.

Reducing the influence of the measurement errors would lead to improvement of the positioning accuracy. There can be various options applied separately or in combination:

Measurement at double frequencies: The signals L1/ L2 are used to compensate the effect of the ionosphere. This type of receivers measure the GPS signals at frequencies L1 and L2. On the condition that the signal passes through the ionosphere, it will be slowed down by a ratio to its frequency. Comparing the calculated times using both signals, the delay can be calculated and therefore the effect of the ionization.

Geophysical correction models: Such models are used for initial compensation of the ionosphere and troposphere effects. The correction factors are applied in special and limited regions only.

Differential GPS: When there are one or several ground based stations it is imperative to correct several errors that occur. Estimating the correction data from these stations is possible during post-processing and also in real time. For the real time solution the requirement is

to have data on the connection between the base station and the portable receiver. DGPS applies a number of additional processing measures.

Most of these recommendations clearly reflect the design characteristics of the GPS L1C signal. Proper selection of a location and the time of measurement to improve the direct visibility of the satellite.

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