

Lost Natural Networks of the Cities: Storm Water Drainage Network – Mavisehir Housing District, Izmir / Turkey

1. Introduction

In the course of their evolution and development, cities go through major changes and transformations, which in turn result in changing and transforming the natural environment as well. This evolutionary process of urban development in fact involves a compelling interaction between the city and the nature where they mutually keep testing their limits. Despite the difference in structure of their networks separately, the city needs nature for its existence, which means that it has to adapt to natural frameworks to a specific extent. At this point, the extent to which the emerging artificial structure of the built environment and urban network systems duly address to natural networks plays a crucial role.

The surface water and rainwater networks (blue networks) among all natural networks bear considerable importance for the existence of water cycle and green networks and sustainability of the natural ecosystem. The interventions by the urbanization process and urban growth and agglomeration upon these networks exert such pressure that menaces sustainability of not only the natural environment, but also the urban ecosystems and this adversely leads to depiction of these networks as the source of problems and risks threatening urban life. In recent years, the flooding and overflows put on the agenda of many cities as a frequently-occurring problem manifest that the ecologically-insensitive development of cities take no regard of surface water and rainwater networks at all, opening the debate on the issue. Therefore, considerations of surface water and rainwater networks are of pivotal importance during phases of urban policy formulation and planning.

This paper dwells upon relations between urban built environments and the natural networks they take place within, the extent to which cities can adapt to and cause changes in these natural networks, and how they construct the urban network systems. Within this framework, the discussion focuses on surface water and rainwater networks among the blue networks that occupy an important place in water cycle and analyses, in a specific case, the mutual changes and transformations emerging between natural and urban settings in response to urbanization processes. The discussions are therefore held for the specific case of Mavişehir Housing District, which encounters the housing demand for middle and upper-income groups in Izmir, pursues a rather rapid pace of development and takes place at a location that intersects with the blue networks. Problems pertaining to the recently increased urban development activities in parallel with the flooding and overflows prove the importance of the need to dwell upon the case in a more comprehensive manner. The paper elaborates the evolution of the developments in the district, the process of changes taking place and the obtained results in detail. The plans, projects and implementations held for solution of the emerging problems are evaluated extensively.

2. The place and importance of natural networks within the urban network system

The city is an integrated whole of systems consisting of many layers intertwined with one another. Each layer interferes with other layers in a broader perspective in the city as well as within itself. While each one of these layers, such as economics, social and cultural spheres, ecological sphere, transportation and infrastructure, constitute a holistic network of its own within the city, it becomes a piece of the whole within the urban network system as well. Depicted as such, natural networks also emerge as the most important network system that make up cities, because they can directly give shape to and have a guiding impact upon urban developments.

The natural networks that take place within the urban network system can be divided into two as blue and green networks. While the system that is composed of bodies within the water cycle such as streams, rivers, lakes, wetlands, sea, rainwater and underground waters etc. constitute the blue network, other bodies like the vegetation or agricultural lands make up the green network. This dual system of networks cannot be independent from one another. Thus, it is only in presence of the two systems that sustainability of the living species, biological diversity, and preservation of the natural balance and ecosystem can possibly be at issue. It is crucial to mind that the decisions concerned with these networks that are shaped by the urban life influence the green networks and urban landscape as much as the impacts upon blue networks. For this reason, examination of these networks should not be confined to urban built environments, but cover a broader sphere as holistically including the boundaries defined by these networks.

2.1. Surface and rainwater networks in cities

The surface water and rainwater networks that make up a substantial part of blue networks are one of the networks within the urban system that is influenced by urbanization the most. Particularly those surface water and rainwater networks affected by urban agglomerations are subject to loss of natural environments or alteration of natural characteristics to a great extent. Under circumstances as such, the leading problems emerge as follows: changes in alterations in stream cross-sections; covering of stream beds or diversion of their routes; construction of bents blocking their flows; permissions given to urban development within boundaries of stream beds or flood plains; pavement of grounds or soil with impervious materials in response to rising density of the built environment, causing problems in natural absorption of water by soil; lack of sufficient green space in the urban fabric; dehydration of wetlands, marshy lands and reed fields; and filling of the sea. These interventions result in mal-functioning of the task by surface water and rainwater networks within the water cycle, further causing serious problems and resulting in climate change. Furthermore, they also increase the threat of natural disasters like floods and overflows over the urban environments.

In the course of urbanization, those policies which target at producing urban land without taking regard of surface water and rainwater networks cause partial loss of blue networks. Consequently, with the intention to substitute these lost networks, cities are obliged to construct rainwater channels, pumping stations, artificial ponds, collection ponds, bents, all of which make up the artificial blue networks to replace the same function required. Such artificial means of solving these urban problems dispose surface water and rainwater away from urban fabric, but hinder soil and underground waters from their natural nutrition. Unfortunately, these water bodies become polluted and the natural water cycle of the region is broken in the end.

3. Development of Mavişehir housing district in time

Located on the western coast of Turkey within its history of 5000 years, Izmir has developed as an important port city in history. Owing to its port characteristics and its ability to host national and international fairs, on the one hand, and its economic structuring based on industrial development, on the other, it occupies a crucial place for not only the Aegean region, but also the entire country. With regard to its population, it is ranked as the third greatest city of Turkey with its urban population of 3.606.326 persons.

In metropolitan city of Izmir, Mavişehir district takes place on the western end of Karşıyaka sub-province on the northern axis that shelters about 310 thousand inhabitants. The spatial layout consists mainly of housing areas and commercial uses where the majority is composed of large scale shopping centers and hyper-markets. The area is surrounded by the Bypass Road, the Suburban Line and triage areas on the north, organized industrial zone

and wetlands on the west, Şemikler residential district on the east, Atakent residential district on the southern east and the sea on the south. Particularly after 2008, this district appears to outstand as one of the most important residential development areas of the city. Those factors which leave significant impacts upon recent urban development trends of the district are as follows:

- Operations of Izmir Ataturk Organized Industrial Zone initiated in 1990
- Completion of the first phase of Mavişehir in 1995
- Completion of the bypass road in 2008
- Opening of the Izmir suburban line in 2010

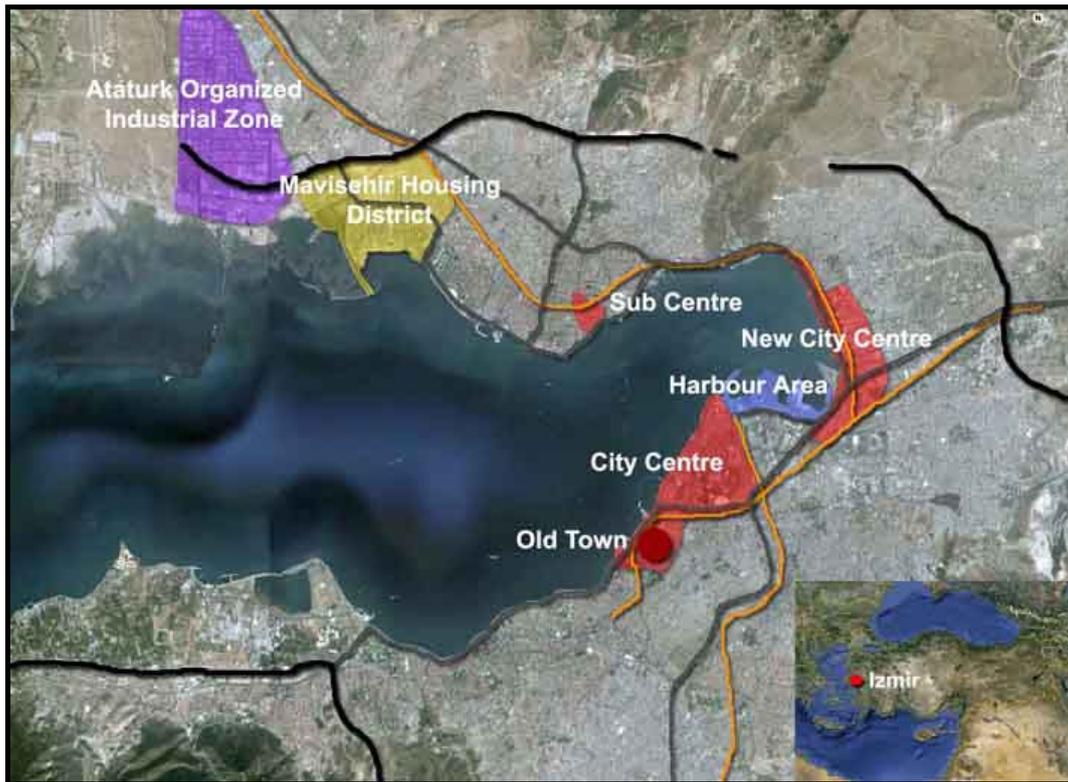


Figure 1. Location of Mavişehir housing district in the city.

As part of the urban development process of Izmir, Mavişehir housing district has been planned as a residential development area with its target group as the middle and upper-high income groups. The holistic approach in planning and design of these ongoing or completed housing projects involves consideration of many aspects of urban environment ranging from infrastructure to landscape design or high housing standards to social and cultural facilities as well as commercial areas etc. and these features are deemed as the added value of this district in comparison to other districts sheltering recently-constructed housing estates.

While the district was partially wetland and marsh area prior to its development, the construction activities have taken start in 1969 and nine phases of the development process have continued until today with completion of Bostanlı Housing, Atakent Housing and Mavişehir Housing estates (Sayar & Süer, 2006). The first residential development pertains to construction of Emlak Bank Housing estate between 1969-1984, which was followed by Atakent mass housing project that began in 1986 and was completed in 1989. Mavişehir housing district has emerged and implemented as continuation of this project.



Figure 2. High-density residential development throughout the district.



Figure 3. Residential developments as viewed from the wetland on the eastern direction.



Figure 4. Developments on the southern and northern parts of Cahar Dudayev Boulevard.



Figure 5. View from northern parts of Cahar Dudayev Boulevard witnessing rapid development after 2008.

Construction of the first phase of Mavişehir housing estate has taken start in 1992 and been handed to its owners in 1995. The entire mass housing district of Mavişehir covers an area of about 270 hectares sheltering 17.000 dwellings. Following completion of the first phase of 2872 dwellings (2784 apartment flats, 88 triplex villas) in 1995, the second phase consisting of 2448 dwellings were completed in 1997. The third phase with 71 triplex villas on the waterfront was then finished in 2002. Subsequently, the first of the two phases of Soyak Mavişehir consisting of 880 dwellings was accomplished in 2007, while its second phase of 688 dwellings was completed and handed to its owners in 2008. Among the 2250 dwellings planned for the housing estate of Soyak Siesta, the 1st and 2nd phases consisting of 761 dwellings were completed in 2011 and the 3rd and 4th phases of 663 dwellings are still under construction. The construction of the remaining 826 dwellings has yet not been initiated. The construction of Soyak Optimus housing estate consisting of 1200 dwellings has not taken start as well. Albayrak Mavişehir housing estate with its 536 dwellings was over in 2008, while the 316 dwellings of Mavişehir Modern were handed to their owners in 2011. Karya Housing consisting of 300 dwellings was completed in 2009 and the 126 dwellings of Mavişehir Modern 2 are still under construction. Apart from these projects, the same district is home to ongoing or completed residential developments for comparatively smaller scale projects targeted at middle and upper-income groups as well. In conclusive words, it is possible to state that about 12.000 dwellings have been constructed and are home to their owners today. Subsequent to completion of the transportation network, construction activities

throughout the district have gained pace, leading to rapid urban development and rise in density.

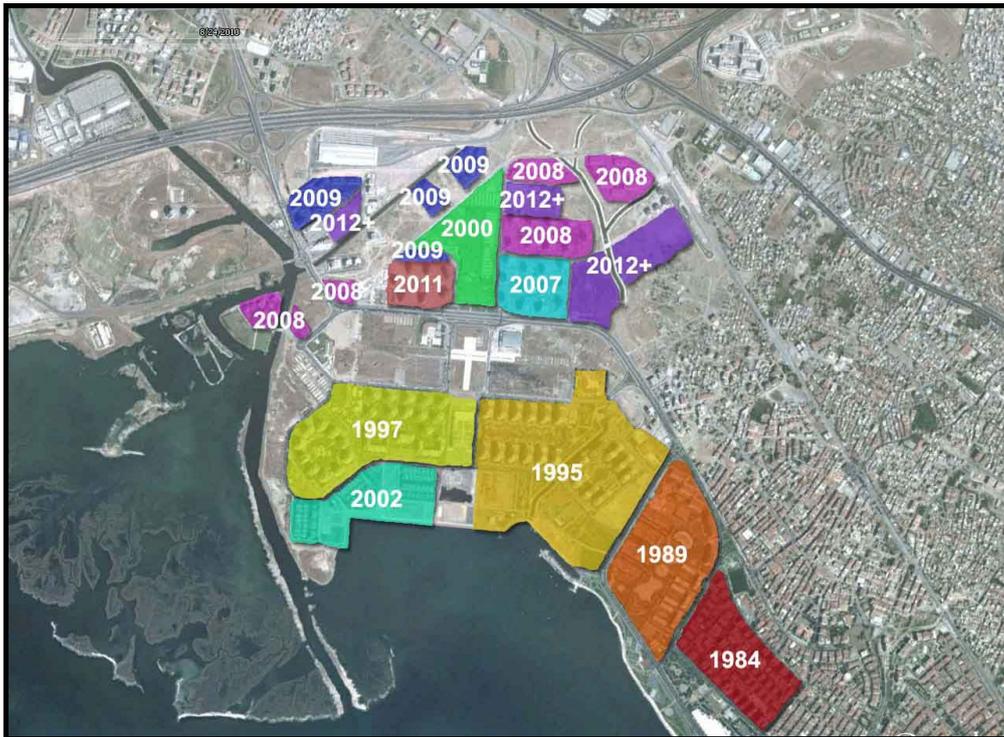


Figure 6. Development of Mavişehir housing district and the dates of completion of housing estates.

Consideration of the spatial development throughout the district in terms of the planning process reveals that the first plan made has been for the area comprising northern and southern parts of Cahar Dudayev Boulevard. Since 1989, this plan was subject to ten revisions for a variety of reasons such as changes in plan boundaries, alterations of building codes and increases in social facility areas etc.. According to the Master Plan prepared in 2007 by the Metropolitan Municipality of Izmir (MMI) on scale 1:25.000, the area circumscribing the western and northern parts of Mavişehir housing district extending until the Cahar Dudayev Boulevard appears to be allocated to residential developments as well as schools, sports facilities and green areas. On northern parts of the boulevard where the current density of development is rather high, there take place residential areas of medium density and mixed-use areas of an urban sub-center of 2nd and 3rd in ranking. Furthermore, tourism facility areas and the organized industrial zone occupy the western parts of the district. The lands neighbouring the western parts of the AOSB Stream are to be preserved as wetlands and ecologically-sensitive zone. The building codes of the implementation plan on scale 1:000 determine that the total area ratio may range between 1 and 2,5. Concerning the building densities, while urban development trends demand rather high density along the Cahar Dudayev Boulevard, the backsides of building blocks appear to be less dense in building terms. The functional layout along this Boulevard and the northern building blocks are to be composed of optional land uses (housing, offices, bazaar, office blocks, retail, public institutions, entertainment activities, tourism facility areas etc.). While construction details have to a great extent been left free in most cases, some building blocks appear to be limited in terms of their building heights.

4. Surface water and rainwater networks in Mavişehir housing district.

Mavişehir housing district sits on a natural network (blue network) of considerable importance in terms of surface water and rainwater. Prior to its development, the majority of

the surrounding urban geography used to bear characteristics of a wetland, marshy area and reed field, and even of the sea, but due to filling and dehydration of these lands for urban development, its natural characteristics have been lost. Under circumstances as such, the surface water and rainwater networks of the district have gone through major changes in parallel to spatial development trends of the district. Today, one can speak of surface water bodies as consisting of three main streams within the district, namely, the AOSB stream on the far west, Maltepe Stream on the north and Peynircioğlu Stream collecting water from slopes on the northeast direction. In the waterfront area starting with the AOSB stream located to the west of Mavişehir housing estate, the wetland and reed field character of the district remains to some extent, resembling the geographical characteristics of the period prior to planned spatial development. These areas are to be preserved as wetlands for their ecologically-sensitive features to be minded. This area additionally acts as a buffer zone decreasing the impacts from the industrial zone on the north and the pressure for residential developments from the neighbouring Mavişehir housing district, because according to the Ramsar convention, the western part of this area is to be preserved as wetland.

4.1. Evolution of the network of surface water and rainwater in Mavişehir district

This part of the paper focuses on the surface and rainwater drainage networks based on analysis of periodically taken aerial photographs (1952, 1963, 1996, 2005, 2010) and dwells upon the changes in surface water in response to urban development and building trends in time. Considered as such, the elaborate analysis is made on surface waters such as streams, rainwater drainage network, sea line, waterfront line or wetlands etc..

Within this framework, the 1950s and 1960s, during which there yet were no urban development at all, can be depicted as a period of no serious intervention upon natural characteristics of the district and the blue network. This period outstands for its two noteworthy aspects. One of these is that one of the reaches of the Gediz Stream flows into the sea in this district. Secondly, the sea line appears to pass through more inward areas and there were broad areas of marshy land and reed fields during this period. With the beginning of 1960s however, in the area through which the Bostanlı Stream passes, the first piecemeal filling of the sea was observed to be led by the surrounding building activities in the eastern part.

Considering that the Bostanlı, Atakent and Mavişehir 1st Phase Housing estates were all completed by the year 1996, the sea appears to have been filled to a serious extent. With the additional impact of the location of the Organized Industrial District, the Gediz Stream divides into two reaches and the route of one reach is diverted to flow into the sea at the western boundary of the Organized Industrial Zone. In brief, the connection between the Gediz Stream and the surface waters throughout the district has consequently been broken down. The AOSB Stream has emerged as result of these changes taking place. The routes of Peynircioğlu and Maltepe Streams, which were previously flowing into the sea at the eastern part of the district, were also diverted to merge firstly with the AOSB Stream and then flow into the sea at the western side of the district afterwards. Within boundaries of the 1st phase of Mavişehir Housing estate, while some parts of the stream bed were kept at where these streams were to flow into the sea, a small pond was created there as well. With the impact of the significant rise in rate of building activities between 1963-1996, some parts of the surface and rainwater networks appear to have inevitably been lost within the emergent urban pattern. Because of the problems caused by the fact that the waterfront developments began to act as a bend blocking the surface waters on their way to the sea on the one hand, and that Maltepe and Peynircioğlu Streams merged with the AOSB Stream on the other, the northern parts of the residential areas have become subject to occasional floods and overflows.

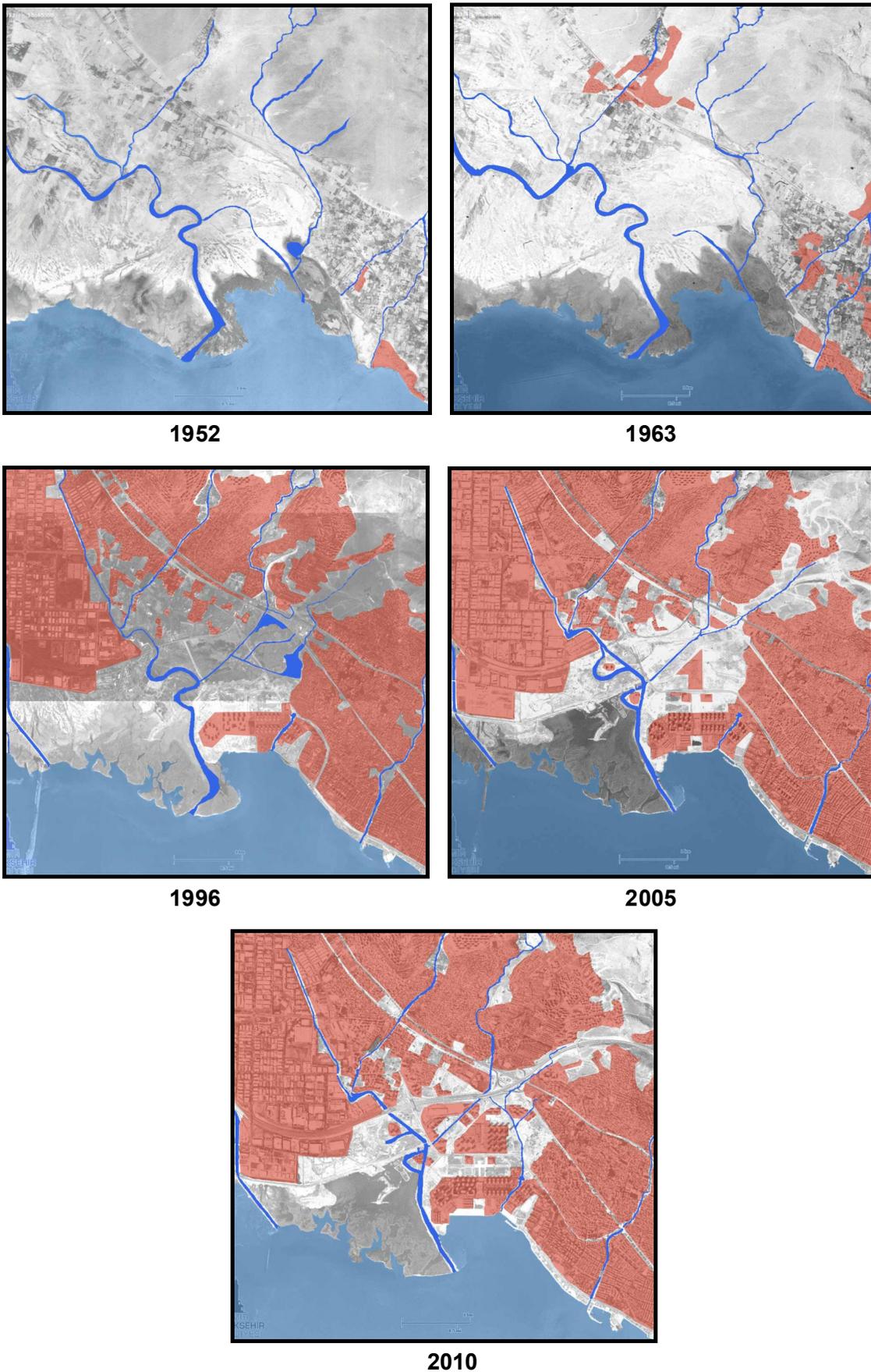


Figure 7. Changes in surface water and rainwater network and urban development areas in Mavişehir Housing district between 1952 – 2010.

In 2005, the meandering route of the stream and the point where the stream meets the sea have been diverted for rehabilitation of its route with the intention to provide for easier flow of waters carried by the AOSB Stream into the sea. With additional changes in its route, the Peynircioğlu Stream has been connected to Maltepe Stream at northern parts, causing an utmost change in route of the old stream bed.

In 2010, the bends of the AOSB Stream bed appear to have been filled partly. Furthermore, the merging point of Peynircioğlu and Maltepe Streams has been re-aligned in such a way that availed for connection of Maltepe Stream to Peynircioğlu Stream. By this way, Maltepe Stream could be connected to both the AOSB Stream and the Peynircioğlu Stream, which meant that water could flow into the sea through both routes. The previous route of Peynircioğlu Stream during the 1950s has been reopened and connected to the sea through the small pond and stream bed that take place at Mavişehir housing estate.

Such an evaluative analysis of the past six decades provides for observation of the critical changes taking place for surface and rainwater networks in response to the rapid urban development in particular. This process may also be depicted as a picture of how the city has been constructed over the natural network –blue network. Furthermore, this evaluation may as well provide for significant hints regarding the reasons that create the problems with surface water and rainwater and finding the answers to how to solve these problems in specific.

4.2. Problems with surface water and rainwater in Mavişehir housing district

Despite the generation of a luxurious urban environment where trillions of money has been invested in expensive dwellings, Mavişehir housing district confronts the serious problem of flooding especially in case of extreme showers. The facts that surface waters cannot be disposed out from this district and the sea level rises substantially, both play a crucial role in these problems. Even though there have been various measures (such as stream improvement, construction of rainwater drainage channels, construction of a water supply station, construction of levees/seawalls etc.) taken to overcome these problems, the recent years witness that the flooding problem has still not been entirely prevented yet. In addition, the past overflows at Maltepe and Bostanlı Streams in varying dates have triggered the floods to affect this district dramatically. The problem is so critically serious that there even have been 61 persons killed in floods and overflows at Karşıyaka and Çiğli sub-provinces in 1995.



Figure 8. Views from the 2007 flood in Mavişehir housing district. (Source:İZSU, 2011)

Underpinning the floods and overflows taking place in districts of Karşıyaka and Çiğli is the loss of surface and rainwater networks due to ecologically-insensitive urban development trends. For this very reason, lack of any consideration concerned with the surface and rainwater networks in implementation plans and infrastructure projects play a significant role in evaluative analysis and discussions to combat the problem of floods and overflows.

4.3. Surface water and rainwater networks in implementation plans and infrastructure projects

Specific measures taken for problems with surface water and rainwater were mentioned in the large scale implementation plan prepared and approved for Mavişehir housing district in 2007. Concerning the Mavişehir housing district, the AOSB Stream, Maltepe Stream and Peynircioğlu Stream were protected in plan decisions. The connection of the stream flowing from the east of Maltepe Stream to the AOSB Stream was cut, but the Bostanlı Stream at the eastern part of the district was kept as it is. A part of the area has been filled after diversion of the route of AOSB Stream and converted into green space. This spatial alignment does not seem to conform to the plan decisions specific for the area where the stream meets the sea, because the plan designates that the connection of the stream with the sea shall be kept in its natural state. Even though route of the Peynircioğlu Stream is protected until it reaches the suburban line, the plan appears to be devoid of any consideration related with the rest of the stream bed starting from slopes of the hill. The marshy lands and reed fields at western parts of AOSB Stream, on the other hand, are to be preserved by way of being included within boundaries of the wetland protection zone.



Figure 9. Decisions of the 1:25.000 Master Plan for the district.

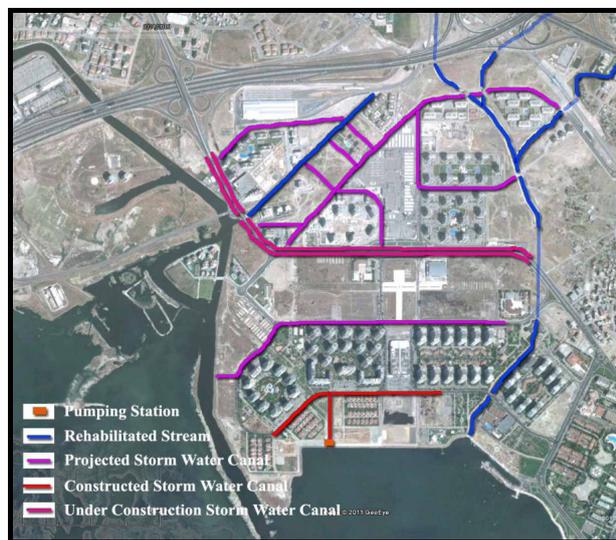


Figure 10. Infrastructure projects for collection of rainwater in the district.

As the elevation of the rainwater drainage channel project made in 1997 was kept lower than the sea level, the floods could not be prevented. Given this, with the intention to evacuate seawater from residential areas, a seawall that was one meter in height has been constructed along the waterfront in 2009. In parallel with these, rainwater channel grate drains were made and a water supply station was constructed to pump the collected water into the sea. Apart from these measures, the rainwater channels to collect surface water in both routes along the Cahar Dudayev Boulevard are still under construction as well. Following completion of this construction task, the collected waters are planned to be transferred into AOSB and Peynircioğlu Streams. It is also planned to direct rainwater collected from mass housing areas built on large parcels into these channels. Implementation of the entire phases of the project involves collection of surface water and rainwater in three stages and their transfer into the streams. Furthermore, rehabilitation of the streams appears to have been accomplished with their connections duly made. Additionally, there also are other routes and districts where the rainwater channel project is completed, but where no construction activity has taken any start yet.

4.4. Overall evaluation

It has become apparent that the network of water bodies in Mavişehir housing district, including the surface water and rainwater, has been subject to severe changes due to rapid urbanization of the last 60 years. Within the course of this period of change, some of the previously existing surface and rainwater bodies are either lost or their routes diverted in response to the density of ongoing spatial developments. The depicted case reveals that as much as the impact of urbanization upon natural networks, the impact of natural networks upon urbanization is quite a remarkable result to be minded, because the floods and overflows of the recent past have caused the previous natural traces of stream beds to be re-activated or become utilized. Within this scope, the relation between flooding and overflows and the fact that Mavişehir housing estate is located upon filled land shall not be disregarded at all.

Underpinning the problems with surface and rainwater is the urban planning approach adopted on the issue and the infrastructure projects made. At this point, the natural network does not seem to be duly addressed particularly in rapidly developing urban districts. Among the issues usually neglected in the planning process take place the facts that stream beds and rainwater collection networks are blocked by building activities or converted into transportation routes; that, in many places, the natural flow of water is cut off by barriers like roads, bridges etc.; that waterfront areas are not allocated to any buffer zones for protection from overflows; that such areas as wetlands, reed fields or marshy areas are opened for urban development; and that the urban spatial layout lacks any sufficient area (like green spaces, artificial ponds etc.) to absorb surface water runoff.

In the upper-scale plan, while it is possible to speak of a general sensitivity over protection of surface and rainwater concerning the Mavişehir housing district, the case manifests neglect of specific issues. Mavişehir housing district takes place within hinterland (delta) of the three water bodies mentioned afore. Therefore, occasional rises in flow rates of these streams emerge as having direct pressure upon this district, which is synonymous to taking great risk. Moreover, the bypass road and suburban line passing through the northern parts of this district not only increase accessibility of the district, but also create a barrier effect on the northern direction. The surface water runoff collected from slopes of the hills at the northern part of the district flow into the sea by passing through such barriers twice. Besides, in order to reduce the barrier effect of these roads, the streams are apparently connected to northern parts of the district at two points. Still however, the ongoing problems manifest the insufficiency of both the existing implementation plans and infrastructure projects in terms of addressing to the problems with surface water and rainwater networks and proposing the required solutions. Depicted as such, rather than technical solutions to combat the problems concerning surface water runoffs and rainwater networks, there is need for debates over upper-scale policies and fostering new strategies. Within this framework, the city should be considered not only within scope of the network system it has created *per se*, but in much holistic means of approach, which involves inclusion of the system of natural networks, i.e., the system of blue and green networks.

5. Conclusion

Examination of the changes and transformations of blue networks with particular reference to Mavişehir housing district entails important conclusive remarks that count for numerous cities going through similarly adverse impacts. In order to overcome these problems brought by ecologically-insensitive urbanization processes, there is need for a much comprehensive undertaking. Deemed as such, natural networks should be regarded as one of the utmost important components shaping the city and its wider region.

Evaluative analysis of natural networks should not be confined merely to central areas of the city, but be more holistic and inclusive of its surrounding regions that are described by these networks. In addition to the implementation plans produced for urban environments, there is also need for blue and green network plans that address to water cycle of the region-basin within which the cities take place, because the blue and green networks cannot be regarded separately from one another. For this reason, in the course of creating urban networks targeted at reduction of environmental problems caused by urbanization and at combating problems of climatic change, natural disasters and risks such as flooding and overflows, the natural networks should inevitably be addressed duly. Creation of sustainable and livable urban environments can be achieved only if the existing policies and strategies in planning and project-making systems approach the issue within such a comprehensive context, because livability can only be reached through protection and sustainability of natural values.

Though varies by different local characteristics of the city or region, the process of urban planning is in need of fostering new methods and various implementation tools related with blue networks. In integration of blue networks with those of the urban fabric, there is need for development of various standards for minimum green spaces, maximum ground area ratio for the built environment, solid-void standards etc., all of which would be of invaluable contribution. Apart from these, in order to collect the surface water and rainwater accumulated in urban space, artificial blue network components such as rainwater channels, pumping stations, artificial ponds, collecting ponds, bends etc. should be produced. The purpose underlying the use of such components shall not be the immediate disposal of surface and rainwater from urban fabric, but its absorption by soil so that the collected water can then become an integrated part of water cycle as well as the ecosystem and the urban life where urban landscape plays a crucial role. In conclusive words, the planner should regard the blue network not as an artificial network system pertaining merely to the city itself, but, within a holistic approach, as part of a broader system of existing natural networks of the wider region.

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