AN APPROACH TO URBAN RIVER REHABILITATION FOR COEXISTENCE OF RIVER AND ITS RESPECTIVE CITY: PORSUK RIVER CASE AND CITY OF ESKİŞEHİR

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submitted by **GÜL ŞİMŞEK** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in the Department of City and Regional Planning, Middle East Technical University** by,

Prof. Dr. Canan ÖZGEN ______________________
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Melih ERSOY ______________________
Head of Department, **City and Regional Planning**

Prof. Dr. Tansı ŞENYAPILI ______________________
Supervisor, **City and Regional Planning Dept., METU**

Examining Committee Members

Assoc. Prof. Dr. Serap KAYASÜ ______________________
City and Regional Planning Dept., METU

Prof. Dr. Tansı ŞENYAPILI ______________________
City and Regional Planning Dept., METU

Assoc. Prof. Dr. Ela BABALIK SUTCLIFFE ______________________
City and Regional Planning Dept., METU

Assoc. Prof. Dr. Özlem GÜZEY ______________________
City and Regional Planning Dept., Gazi University

Assist. Prof. Dr. Aydan SAT ______________________
City and Regional Planning Dept., Gazi University

Date: May 20, 2011

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct. I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Gül ŞİMŞEK

Signature:

ABSTRACT

AN APPROACH TO URBAN RIVER REHABILITATION FOR COEXISTENCE OF RIVER AND ITS RESPECTIVE CITY: PORSUK RIVER CASE AND CITY OF ESKİŞEHİR

Şimşek, Gül

Ph.D., Department of City and Regional Planning
Supervisor: Prof. Dr. Tansı Şenyapılı
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All living things mostly the humans, as builders of civilizations, have always been in intrinsic bonds with water. This interaction between *water* (oceans, seas, lakes, rivers etc.) and settlements has existed since ancient civilizations. Among water resources, 'flowing waters' such as *rivers*, streams, creeks, etc. have a prominent role as they are the lifeblood of most cities in terms of providing transportation, security, energy, irrigation, commerce, and recreation. By the late 19th century, developments of terrestrial transportation modes diminished the magnetism of rivers and riverfronts, and growing industries led to the deterioration of rivers. Owing to these reasons, along with many others, they turned into sewage channels, were covered up, and became water scopes detached from the urban life. Particularly since the 1970s, with more attention given to sustainability of resources, a greater awareness has grown of the vital role of urban rivers as a resource for humans and a lifeline for cities. After being neglected for decades, urban rivers have started to be *rehabilitated* to solve the related problems. The new approach to urban river rehabilitation beyond classical practices that aim at recovering the physical conditions of rivers has come to the fore to address the problems comprehensively. Instead of independent and one-dimensional practices, the urban rivers have become to be seen as a vital part of urban water system and of the city itself.

While rehabilitating urban rivers, recovering river health can be ensured provided that the entire urban water ecosystem is taken into consideration. The *ecocity* approach is one of the major new approaches that geared toward achieving a healthy city, and sustainability of water system is the significant goal within this approach. In this regard, the thesis first asserts that the ecocity criteria are likely to give way to a more sustainable future for urban rivers. Besides being a part of the ecosystem, urban rivers have transformed together with the surrounding built environment throughout the history of cities. Significant focal elements of the urban pattern, urban rivers should be dealt with other urban focal points, with the introduced concept of *river-city integration*, which is proposed as the second assertion of the thesis. In this respect, the study attempts to investigate urban rivers and their rehabilitation in relation with both the *ecocity* approach, and the *river-city integration* concept. The research methodology in the present study involves comparative anaysis of best practices and case study analysis. *Porsuk River* and the *city of Eskişehir*, which the river passes through, were selected as a case for empirical study. Criteria sets that determined within the frames of ecocity and river-city integration, and the testing of the criteria in the case area offers an opportunity to contribute to literature of *river and city coexistence*.

Keywords: Urban rivers, urban river rehabilitation, urban water system, ecocity, river-city integration, criteria checklist, Porsuk River, city of Eskişehir

ÖZ

AKARSU VE KENTİN BİRLİKTE VAROLUŞU ÜZERİNE KENTSEL AKARSU REHABİLİTASYONA BİR YAKLAŞIM: PORSUK ÇAYI VE ESKİŞEHİR KENTİ ÖRNEĞİ

Şimşek, Gül

Doktora, Şehir ve Bölge Planlama Bölümü
Tez Yöneticisi: Prof. Dr. Tansı Şenyapılı
Mayıs 2011, 354 sayfa

Tüm canlılar, en çok da uygarlıkları inşa eden insanlar, daima su ile içsel bir bağ içerisinde olmuşlardır. *Su* (okyanuslar, denizler, göller, akarsular) ile yerleşimler arasındaki bu ilişki antik uygarlıklardan beri sürmektedir. Su kaynakları arasında *akarsular*, çaylar gibi 'akan sular' ulaşım, güvenlik, enerji, tarım, ticaret ve rekreasyon gibi yönlerden pek çok kentin yaşam kaynağı olmaları nedeni ile ayırıcı bir yere sahiptir. 19. yüzyıl sonları ile karasal ulaşımdaki gelişmeler nehir kıyılarının cazibesini azaltmış ve büyüyen sanayiler akarsuların zarar görmesine yol açmıştır. Bu ve bağlı nedenlerle kentsel akarsular, atıksu kanallarına dönüşmüş, çoğu kez üzerleri örtülmüş ve kent yaşamının marjinal elemanları haline gelmişlerdir. Özellikle 1970'li yıllarla birlikte, kaynakların sürdürülebilirliğine artan ilgi ile kentsel akarsuların hem insanlar için, hem kentler için yaşam kaynağı olma niteliği yeniden önem kazanmıştır. Onyıllarca ihmal edildikten sonra kentsel akarsular, oluşan problemleri çözmeye yönelik olarak *rehabilite* edilmeye başlamıştır. Yeni kentsel akarsu rehabilitasyonu yaklaşımında, akarsuyun fiziksel koşullarını düzeltmeyi hedefleyen klasik rehabilitasyon pratiklerinin ötesinde, kentte su sisteminin bir bütün olarak ele alınması ön plana çıkmıştır. Birbirinden bağımsız, tek yönlü uygulamalar yerine, kentsel akarsular sürdürülebilir kentsel su sisteminin ve kentin kendisinin önemli bir parçası olarak görülmeye başlamıştır.

Akarsu sağlığının iyileştirilmesi, kentsel akarsuları rehabilite ederken tüm kentsel su sisteminin dikkate alınması ile sağlanabilir. *Ekokent* yaklaşımı, sağlıklı bir kente ulaşma yolunda kentleri bir sistem yaklaşımı içinde ele alan önde gelen yeni yaklaşımlardan biridir ve bu yaklaşım içinde su sistemlerinin sürdürülebilirliği belirgin bir öneme sahiptir. Bu bağlamda, tezin birinci savı olarak, ekokent ölçütlerinin, kentsel akarsular için daha sürdürülebilir bir geleceğin oluşturulmasında yol gösterici olacağı ileri sürülmektedir. Kentsel akarsular, ekosistemin bir parçası olmalarının ötesinde, tarih boyunca yapılı çevre ile birlikte yaşamışlar ve dönüşmüşlerdir. Bu nedenle, kent dokusunun önemli bir odaksal ögesi olarak kentsel akarsular, kentteki diğer odak noktaları ile birlikte değerlendirilmelidir. *Akarsu ve kentin bütünleşmesi* kavramı ile ortaya konan bu kısım, tezin ikinci savını oluşturmaktadır. Bu bağlamda tezde, kentsel akarsular ve kentsel akarsuların rehabilitasyonu, *ekokent* yaklaşımı ışığında ve *akarsu-kent bütünleşmesi* kapsamında irdelenmektedir. Çalışma, *karşılaştırmalı analiz* ve *alan çalışması* analizi araştırma yöntemleri ile yürütülmektedir. Ampirik ele alış için seçilen alan, *Porsuk Çayı* ve içinden geçtiği *Eskişehir kenti*dir. Ekokent ve akarsu-kent bütünleşmesi çerçevesinde geliştirilen ölçüt setleri ve bu ölçütlerin alanda test edilmesi, *akarsu ve kentin birlikte varoluşuna* katkıda bulunmak için fırsat sunmaktadır.

Anahtar Kelimeler: Kentsel akarsular, kentsel akarsu rehabilitasyonu, kentsel su sistemi, ekokent, akarsu-kent entegrasyonu, ölçüt listesi, Porsuk Çayı, Eskişehir kenti

To my Dear Brother…

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LIST OF ABBREVIATIONS

BMPs: Best Management Practices

SHW (DSİ): General Directorate of State Hydraulic Works (Devlet Su İşleri Genel Müdürlüğü)

EGM (EBB): Eskişehir Greater Municipality (Eskişehir Büyükşehir Belediyesi)

ESTRAM: The Tramway System of Eskişehir

EWSA (ESKİ): Eskişehir Water and Sewage Administration (Eskişehir Su ve Kanalizasyon İdaresi)

EU: European Union

GHG: Greenhouse Gases

IWA: International Water Association

LEED-ND: Leadership in Energy and Environmental Design for Neighborhood Development

LID: Low Impact Development

UN: United Nations

UNEP: United Nations Environmental Programme

UNESCO: United Nations Educational Scientific and Cultural Organization

US: United States

USGBC: United States Green Buildings Council

CHAPTER 1

INTRODUCTION

1.1 Scope and Aim of the Study

The history of human settlements is intertwined with different aspects of *water*. Water has always been on the agenda of human settlements. Since Ancient times, as it was mainly used either for drinking and sanitation or agriculture and stock breeding, water has been one of the main determinants of location of settlements. Water has also provided protected ports for defense, as well as means of transportation and trade. In this respect, terms like hydraulic empire or water monopoly empires, denoting a government structure, maintaining power through exclusive control over access to water, have developed. Most of the early *civilizations* in history, such as Ancient Egypt, Sri Lanka, Mesopotamia, China and pre-Columbian Mexico and Peru, are assumed to be hydraulic empires.

Rivers provide drinking water, sanitation facilities, transportation routes, economic vitality, social interactions, navigation, aesthetic expression, sense of identity, etc. One of the most important determinants of why the city exists at a certain location is *accessibility to water*. Settlements located on navigable rivers serving as main transport routes, find the opportunity to develop into centers of commerce. One well-known example is the city of Lyon in France, which was very conveniently located where two navigable rivers. This *locational advantage* led Lyon to become an important trade center in the Middle Ages. The city was so powerful that it competed with Paris as a trade center until the industrial revolution. Similarly, in same period, many cities such as St. Petersburg, Paris, London, and Hamburg built on the banks of rivers became centers of trade.

Meanwhile, water especially *urban rivers* were exposed to and suffered from human activities. The issue of urban rivers reflects an overview of the effects of urbanization on the aquatic environment, need potential solutions to the resulting problems, and new opportunities for rehabilitation along their corridors and in the adjacent urban areas. It is essential enabling the *reintegration of rivers* into their city in order to foster their role in the history of the city celebrated (Giardet, 2004).

Urbanization and concentration of population in cities brought forth problems; for instance urban rivers suffered from different types of pollution from sewage and stormwater discharge, chemical wastes, careless exploitation of water supply. This mishandling of river treatment resulted in the decrease and contamination of urban water ecosystems including aquatic organisms, creating floods and public health risks. Since especially flowing water was used for drinking, sanitation and irrigation, it was an easy ground of contamination and epidemics. This contamination usually occurs due to discharges of, for example, sewage and/or industrial wastes into flowing *waters*[1] and through contaminated stormwater washed off from roads, fields, and environment. Therefore, in the 19th and 20th centuries, serious degradation of urban water ecosystems posed important public health hazards. Flooding also was a very acute urban settlement problem; the Middle Age settlement history is full of incidents of floods causing major depopulations and destruction of agricultural land.

As degradation of urban water ecosystems have become an important source of problems mentioned above, *rehabilitation* efforts for those areas have been initiated. As it is discussed later on in the thesis, through the implementations, rehabilitation tends to focus on the river itself and its immediate margins. These projects include sanitary measures, improvement of the ecological and chemical quality of water, and upgrading of environmental quality of the immediate surroundings. Thus, the term rehabilitation in general includes *technical and physical interventions to the rivers* flowing through cities. These interventions include prevention of flooding, elimination of danger zones, increasing the level of sanitation, and cleaning the river. There is also concern for aesthetics, yet this concept is evaluated based on the particulars of the water body, like its visual aspects, its accessibility and infrastructure.

So, as technology and civilization has improved point and piecemeal measures were taken, intervening with problems wherever they appeared. These measures, detailed further on in the study, were mostly *singular measures designed to solve the problem at its very location*. Remedies were brought through indirect developments like sewage systems, waste

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[1] This study deals with all type of flowing (or running) surface waters such as rivers, streams, creeks, brooks etc., by the way while refering those, the 'river' concept is selected for general expressions owing to its wider usage area.

management, building of dams but still the urban concentration rose to such levels that in order to cope up with the problems brought by flowing urban waters radical measures had to be taken e.g. by *filling them in or taking them underground*. However, in the meantime, a far more acute problem rose, threatening the human civilization namely the *scarcity of water*.

The water in rivers, soil and lakes is only about 0,014% of the total global water (Harris, 2007). Availability, quantity, quality and sharing of the global supply of water is closely related to urban planning, as urbanization alongside industrialization may be cited as the major pressure over the above mentioned aspects of global supply of water. The world has become highly urbanized particularly in the last century. As Devuyst (2001) stated, in 1900, only 160 million people, one tenth of the world's population were living in the cities. By the 2000s, more than half of the global population started living in urban areas. Hence, between 1950 and 2010, the global urban population more than tripled to reach 3.15 billion; while natural resources remained the same, the best hypotheses (See Appendix A). Besides population growth, industrialization, urbanization, and climate change are the major pressures that affect resources in particular quantity and quality of water.

Rivers are among the most sensitive of all ecosystems to *climate change* because the increasing temperature and altered rainfall affect them directly, for they will also be interacting with other pressures such as water pollution, abstraction and intensifying land use and freshwater organisms are vulnerable to all these things. It is needed to consider the processes between climate and stressors and how rehabilitation can adapt rivers to climatic effects (Ormerod, 2009).

With impending issues looming in front, several global meetings have been held to reduce the threats over global water supply. Starting with the 1990's, sustainability of water has been a subject emphasized in most global meetings related to water, resources, and environment. The milestones of water-related global events since 1972 are as follows:

- 2009 - 5th World Water Forum
- 2006 - 4th World Water Forum, Mexico
- 2003 (International Year of Freshwater) - 3rd World Water Forum, Japan
- 2002 - World Summit on Sustainable Development, Rio+10, Johannesburg
- 2001 - International Conference on Freshwater, Bonn

- 2000 - 2nd World Water Forum, the Hague; Ministerial Declaration on Water Security in the 21st Century; UN Millennium Declaration
- 1997 - 1st World Water Forum, Marrakech
- 1996 - UN Conference on Human Settlements (Habitat II), Istanbul; World Food Summit, Rome
- 1995 - World Summit for Social Development, Copenhagen; UN Fourth World Conference on Women, Beijing
- 1994 - Ministerial Conference on Drinking Water Supply and Environmental Sanitation, Noordwijk; UN International Conference on Population and Development, Cairo
- 1992 - International Conference on Water and the Environment, Dublin; UN Conference on environment and Development (UNCED Earth Summit), Rio de Janeiro
- 1990 - Global Consultation on Safe Water and Sanitation for the 1990's, New Delhi; World Summit for Children, New York
- 1981 – 1990: International Drinking Water and Sanitation Decade
- 1977 - UN Conference on Water, Mar del Plata
- 1972 - UN Conference on the Human Environment, Stockholm (Adapted from UNESCO, n.d.; “Timeline of International Conferences” and “World Water Day”, 2010) (See Appendix B for a more detailed list).

The problems associated with urban rivers cannot be isolated from the water system. As a result, a new approach was developed, one that is comprehensive, combined and integrative, taking the problem of running waters within the ecosystem in the beginning of 1980’s. In such a comprehensive *ecosystem approach,* the aim is to cope with environmental problems assuming that there are close links between living organisms and their environments; in other words, the approach is *based on the relationships between all living organisms including the human society and their physical environments*.

> “Past industrial practices have often made the urban waterway a blight in otherwise vibrant cities, or, at best, an engineered system to be maintained. But advances in management of stormwater and urban water quality have caused dramatic improvements in the quality and function of our rivers. As this recovery continues, the opportunity exists to move beyond mere management of our waterways, working instead to restore the river to its place at the heart of the city, by blending the functional aspects of a working aquatic ecosystem with the

> urban needs for recreation, parklands, transportation, and urban ecology." ("Urban River Restoration 2010", n.d.).

Therefore, in fact urban river rehabilitation is an important issue for both *the urban water system and the city itself*. Nevertheless, rehabilitation of urban rivers has, in general, been implemented within the context of the river itself; in this study the proposal is to rehabilitate a river in a comprehensive and- combined approach within the broader context of the city. Urban rivers are both *natural and built entities* of the cities. Within this backdrop, a twofold approach is proposed linking these two aspects of urban rivers: wider aspects; to their rehabilitation for the sustainability of these natural entities, and to the planning process covering spatial integrity of rivers to the city.

The first one is to include the physical rehabilitation process of the river considered within the urban ecosystem; *the context of the ecocity principles*. It is a concept developed for attaining and sustaining a high level of urban ecosystem quality and thus the sophisticated physical rehabilitation of the river is defined and applied according to the future vision of the city.

The second approach proposes to link the river and the process of its rehabilitation, to the city itself. It is assumed that the interrelation with the city may be developed by establishing a close connection of the river with basic nodes and landscapes of the city, such as its main socio-cultural values, its basic public transport system which would not only provide enhanced accessibility, but also place the urban river at the base of the urban planning, making it the *basic reference* from which the plan would develop. To identify this connectedness that involves *legibility, walkability, accessibility, orientation* etc., the term *integration* is coined here.

Besides growing consciousness about water resources, urban water ecosystem, and their urban integrity, rehabilitating urban rivers gets attention as they are significative elements of cities, within the global agenda as well. A global change in the role and status of cities has brought forth the competitive capacity of the cities so much so that most projects made and applied in cities aim to increase this capacity. Aiming to create viable cities, urban administrators concentrate on the development and application of many transformation projects, which are as varied as upgrading of the urban infrastructure system to the regeneration of old abandoned industrial properties. The urban image that would develop might increase the competition potential of the city in national and global urban networks and help attract investments and create an identity for the city and the citizens. It is then hoped that this would increase their sensitivity to the urban environment and motivation to protect the city.

At this point, it should be noted that the scope of the study is not on how to enhance the competitive capacity of cities via handling urban river rehabilitation. It is a fact that attracting local, national, and global investments will sustain and develop the economic base of the city, yet this does not considered within the problem formulation of the thesis. The thesis was formulated with a particular focus on how to contribute to the *evaluation of urban rivers and their co-existence with their respective cities*. That is, an increased capacity of cities in a global manner is seen only a potential gain of these projects within the scope of the thesis.

> "Urban rivers and waterways are at the center of two major trends: an increased focus on sustainable practices to benefit the environment, and a population shift back to cities tied to a renewed emphasis on a livable urban environment. Both trends link naturally to the river at the heart of so many cities, where these waterways function as a conduit for stormwater flows and sediment movement, provide opportunities for human interaction with the environment, serve as a focal point for urban parks and pathways, and define neighborhoods and districts." (Water Environment Federation [WEF], 2010).

To sum up, this study centers on urban rivers, namely rivers that run through cities and proposes to analyze their rehabilitation from the point of view of two aspects: the more advanced technical aspect of rehabilitation, and spatially connected presence of river and city. The technical aspect is extended into *the context of ecocity principles*, and *the connectedness is extended to spatial imtegration, which constitutes the frame of the coexistence of the river and the city.* This is discussed from the viewpoint of urban planning. Both, actually, require a system approach that sees city as a system.

In this context, this study attempts to ascribe a more comprehensive and selective context to the concept of rehabilitation. With this respect, urban river rehabilitation will be discussed under two headings:

- The *ecocity* concept plans the city in a united approach. Therefore, rehabilitation in the form of direct intervention to the urban river to upgrade its quality within its system will be discussed in the context of ecocity concept.

- *Integration* of the urban river focuses on the integration of the urban river with the city in conjunction with nodal points of the city. Such a comprehensive approach is far beyond the connectivity concept mentioned above and will presumably add to the achievements of the plans and projects.

1.2 Assumptions of the Study

The study is based on the following *assumptions*:

- Urban rivers are major sizeable, visual and functional urban planning elements, which may have multi-dimensional positive or negative impacts on the lives of the urban environment and population and if not planned, may lower the quality of urban water and create life-threatening hazards for the urban population. Therefore, cities in the past century have predominantly engaged in the rehabilitation of urban rivers.

- Traditional urban river rehabilitation involved technical measures in general, which were limited to the problem zones. All these measures should be combined by other considerations, which are related to the city as an urban ecosystem. The theory of ecocity might help show a way to proceed and realize a more environmentally sustainable future for our water resources and rivers in urban areas.

- The rehabilitation process may involve connecting urban population to the river by arranging the banks of the river for bicycle riding, for pedestrian walkways, for public performance locations, for viewpoints, by providing preferably non-motorized boating on the river, by arranging vegetation and creating public parks, and by controlling building standards particularly along the riverbanks.

- Yet a more comprehensive urban planning approach is needed in order to integrate the urban river with the city itself, one that would go beyond mere accessibility and connectivity on and right around the river itself. Such a planning approach would make a viable basis for the integration of urban river and city. Cities have cultural and historical heritages along with contemporary urban works that are usually preserved and planned as individual focal points of the city. The urban river, if planned in conjunction with these focal points, would become a part of the urban identity and image. In this sense, it would not only be a nice and spectacular element that extends along the city but it would also be such as a *spine* planned together with the cultural, historical and contemporary works of the city.

1.3 Research Questions of the Study

It is asserted that urban rivers are important and *integral functional components of cities*, because they constitute the main elements of *urban water ecology*. Thus, if planned well, they contribute to the achievement of sustainability of urban water ecosystem. On the other hand, neglected urban rivers may develop external negativities that may even threaten the lives of the urban population.

Awareness of *the vital role that urban rivers play in the lives of urban population and urban environment* has led planners to take rehabilitation measures to control the external negativities of urban rivers. These rehabilitation measures like canalization and culverting to underground applied wherever the problem appears and has a singular goal. It is true that aesthetics may a source of concern, yet again this concept is up to the particulars of the water body, limited to the river itself and to its immediate surroundings.

This study proposes that the concept of urban river rehabilitation is to be enriched by the introduction of two sub-concepts, ecocity and integration. The *ecocity* concept is an integrative and comprehensive approach, aiming not only to the rehabilitation of the urban river according to ecologic principles but also according to be as an integrative part of the city itself. Therefore, the urban river is not treated as an *urban river* but *as an urban river in harmony with the principles of an ecocity. Integration*, on the other hand, involves planning of the upgrading and beautification of the urban river and its surroundings together with the planning of the other *focal urban landscape elements* like *major centers, major museums, major historical sites* and the like. That is, in this sense, *the context of integration is also enriched as it now includes accessibility, connection and going beyond them includes the planning of all image makers of the city in an integrated whole*.

In this scope, *the main research questions* of the thesis are as follows:

- What are the problems with rivers and urban river rehabilitation?
- What elements should urban rivers and cities include if they are to comprise ecocity principles?
- What elements should urban rivers and cities include if they are transformed to include integration with other focal points?
- (Based on the best-practices evaluated) Can a planning framework with checklists to include the principles of ecocity and integration be developed as a guidance to planners?
- Can this checklist be applied to the existing/planned projects and cities in order to analyze the performance of the projects and cities in terms of ecocity and integration?
- How do Porsuk River Rehabilitation Project and the city of Eskişehir perform when tested against this checklists/framework?

The very nature of the research questions of the thesis lends itself to a research design which is overall qualitative. In the following section, research methodology of the study is considered broadly.

1.4 Research Methodology of the Study

The previous sections of this chapter were concerned with question of '*what'* the research aims to comprehend. In this part, the answer to the question of '*how it'* does so. That is, the main purpose of the methodological section is to explain how the research was accomplished, what the data consists of, and how it was collected, organized, and analyzed (Berg, 2000). Hereby, methodology of the study consists of three intertwined phases: Research design overview, methods of data collection and data analysis, and evaluation phases are discussed in this section.

1.4.1 Research Design

The research design phase involves three intertwined parts. *The first part* is the establishment of the theoretical framework of the thesis. Considering the main problems and the assumptions of the thesis, it consists of a literature review on urban river, interaction between river and city, its rehabilitation, ecocity, and integration of river and city, which lays the basis for the the thesis. The concepts have been renewed in time with the changing functions and attitudes related to city. In *the second part*, best practices from the world are discussed, and *the final part* probes the the case study.

1.4.1.1 Review of Technical Literature

The first part of design phase contains a literature review, and it basically observes the followings:

- The link between the urban river and the city should be established, and the vital role that urban river assumes in the city should be clarified.
- Since the role, function and positive and negative impact of the urban river in the city have changed radically throughout advancement of civilization and urbanization, this functional transformation should be itemized.
- The concepts of urban river, rehabilitation, ecocity, and integration, which constitute the main theoretical framework components of the study, should be discussed, clarified and interrelated within the defined limits of the study.
- The scope of urban river rehabilitation, which contains technical and bounded operations, could be held broader with internalization of the concepts of ecocity and integration.

1.4.1.2 Selecting Best Practices around the World

This *second part* of design phase contains a collection and interpretation of best practices. Reviewing and analyzing the experiences on urban rivers around the world has three dimensions: Evaluating certain best practices on urban river rehabilitation, considering well-known ecocity examples for their eco-principles, and and considering significant cities that are associated with their rivers through themselves for river and city integration. By comparative analysis of these experiences, the aim is to reach criteria groups that both for ecocity and river-city integration as leading frameworks.

Best Practices on Urban River Rehabilitation

Examples from all over the world are selected to analyze urban river rehabilitation. It is noticeable to see after the 1990s, particularly by the 2000s, new approaches to the rehabilitation have emerged. Selected practices are London Rivers Action Plan (London, UK), the Banks of the Rhone River (Lyon, France), Emscherumbau Plan (Emscher, Germany), Isar Plan (Munich, Germany), the Zurich Stream Daylighting Program (Zurich, Switzerland), Restoration of Besòs River (Barcelona, Spain), Porsuk River Rehabilitation (Eskişehir, Turkey), Cheonggye River Restoration Project (Seoul, South Korea), Funan River's Comprehensive Revitalization Project (Chengdu, China), Singapore River Planning (Singapore, Singapore), Muddy River Restoration Project (Boston, MA US), San Antonio River Improvements Project (San Antonio, TX US), Los Angeles River Revitalization Master Plan (Los Angeles, CA US).

Ecocity Examples

Ecocities and their addressing ways of urban waters are evaluated. Selected ecocities are Hammarby Sjöstad (Sweden), Sino-Singapore Tianjin (China), Qingdao (China), Dongtan (China), Masdar (United Arab Emirates), Treasure Island (CA US), Sonoma Mountain Village (CA US), Curitiba (Brazil), Malmö (Sweden), Vancouver (BC Canada), and Portland (OR US).

River-City Integration Examples

Twenty cities selected for evaluating river-city integration are as follows: Belgrade (Serbia), Budapest (Hungary), Florence (Italy), Geneve (Switzerland), London (United Kingdom), Lyon (France), Munich (Germany), Paris (France), Rome (Italy), Salzburg (Austria), St Petersburg (Russia), Strasbourg (France), Vienna (Austria), and Zurich (Switzerland) from the cities on the banks of major rivers in Europe. In addition to those, Chengdu (China), Seoul (South Korea), Singapore (Singapore), and Shanghai (China) from Asia; and Boston (Massachusetts, US), and San Antonio (Texas, US) from North America are evaluated.

The third group of examples referred to as *'portfolio'* is taken into consideration broader than the first two ones, it comprises *schemes* and *texts* belonging to selected 20 cities that are associated with their rivers. Via *schemes* produced, graphical representation of central part of cities including rivers is set. It is attempted to understand how functions of city come together in a context and in spatial organization, spatial distribution of functions, linkages binding and patterns of streets and transportation within city system. Covered spatial distribution of main functions are commercial, leisure, cultural, historical, religious places, parks, public squares, health, education, and main public transportation networks. Within the *texts*, regarding each city scheme, a city and its respective river are described in general, and its scheme are expounded. Moreover, the rehabilitation projects on these urban rivers are detailed.

Through the results obtained in the first part of the study will be compared and therefore evaluated with an existing case, namely the rehabilitation of the Porsuk River Case in Eskişehir.

1.4.1.3 Case Study

The main aim of investigating the groups mentioned above is setting of criteria lists to form guidance while testing cases. *The third part* of the study is based on an area study through which results reached in the first two parts of the study will be compared and therefore evaluated with an existing case. In this study, *Porsuk River and city of Eskişehir*, as a case study is suggested for further empirical handling.

The main reason for choosing Porsuk River as a case has two main reasons. Firstly, a comprehensive river rehabilitation implementation has already operated on the river passing through the city. Secondly, it brings a new image and identity to the former industrial city of Central Anatolia as a new center of recreation, culture and transformation. These aspects of the case provide opportunity to study on urban river rehabilitation deeply, and to test the frameworks developed within the context defined above.

Eskişehir is the biggest settlement in Porsuk River Basin. More importantly, the city of Eskişehir is one of the Turkish cities settled and grown on two banks of an urban river. Several transformation projects have been implemented in the city during recent years creating popular recreation spots. Improving the river’s health was a major challenge for the local government. In recent years, after 1999, the river has been subject to a series of serious rehabilitation projects, today it has been transformed from *‘an open garbage and sewage canal’* into *‘a clean river’* which banks reinforced, and on which non-motorized boats sail. Accessibility between both banks has been provided by about 24 bridges copies of well-known bridges of the world. Today the rehabilitated river provides the basic image of the city, and the city is associated with its river.

The city of Eskişehir, because of the attraction of the rehabilitated river, is now one of the most visited cities for its attractions originating from the existence of the 'new' river and its 'attachments', and the visitors now come not to see the city but to see the river and its recreative activities as well.

In the thesis, Eskişehir study has been conducted through two channels. The first channel comprising a literature survey, involved written and visual documents on history of evolution of the function and role of the river in the city and the story of its rehabilitation. In this channel; books, research reports, articles, local presses, city plans and projects, and relevant theses were reviewed. The second channel consists of local study, observation, and interviews conducted in the city of Eskişehir.

Three field trips were made; the first one was conducted in mid-2010 to observe (both field observations and citizen behavior observations), to photograph and to get to know the atmosphere of the entire city, the city center, the river, and the *Porsuk River Rehabilitation Project* area covering 12 km in length that includes the city center as well. The second one was a four-day trip conducted in late 2010, covered interviews, data collection, and further observation, that had the aim of gaining information via getting official documents (written and drawn documentation, and verbal information) related to Porsuk River and city of Eskişehir in general, and Porsuk River rehabilitation project in particular. The third trip as final one was a follow-up of second trip in order to complete the remaining gaps of information obtained from previous trips.

In the trips, within the scope of the case study, written and visual data (official plans and report, maps, photos etc.) were collected, observations were made, and interviews were done with the experts in the field on Porsuk River and the city of Eskişehir.

In the second and third trips, interviews were conducted with officials of the Eskişehir Greater Municipality, Tepebaşı Municipality, Odunpazarı Municipality, State Hydraulic Works 3rd Regional Directorate, Eskişehir Chamber of Industry and Commerce, Bank of Province Eskişehir Regional Directorate, Eskişehir Water and Sewage Administration (EWSA), EWSA Clean Water Treatment Plant, Ministry of Public Works and Housing, an

Urban Planning Firm, and METU Department of City and Regional Planning. The in-depth interviews with the local authorities have been organized to obtain the information on the city, the river, and the story of river rehabilitation.

Through a set of questions prepared according to the expertise of the interviewees, expert opinions were obtained and the interviewee was encouraged to express his own personal opinion, feelings and impression as a resident of the city. Further documentation was collected through these interviews. Random interviews with few local citizens were also conducted to obtain the impressions and thoughts of the unofficial residents. The experts and institutions interviewed are listed in Appendix O.

1.4.2 Data Collection and Data Analysis

Data gathering techniques include document analysis (of written and visual documents such as official documents, newspapers, books etc.), observations and semi-structured interviews with experts. Expert opinions are significant alongside the other data in detemining criteria coming from the outputs of international examples' analysis. The interviewees are from local authorities mostly. Interview questions framed as semi-structured that allowed the interviewee to express his isead freely. Most of the experts interviewed are citizens of Eskişehir. That is, in addition to the professional information and opinions, values, needs, and feelings of citizens are also considered.

Data collection for case study is based on literature survey through a variety of books, articles, newspapers, periodicals, official reports and plans, and videos from printed publications or electronic media. Paper documents such as reports and notes of city plans, and visual material such as city plans itselves, photographs and films about the city of Eskişehir have been collected, studied, and discussed.

During interviews, detailed notes obtained from the interviews were kept. Interviewees were selected by *purposive sampling,* which means specific predefined groups of people were approached. In particular, it is *expert sampling* as these people are professional agents. Most of the interviewees were selected from among experts (planners, engineers, architects etc.) who hold positions of local institutions (pointed out at the Chapter 1.4.1) and live in Eskişehir who had taken part in the Porsuk River project or were informed about the project, and the remaining interwiewees were selected from planners who lived in Eskişehir or at least visited the city. The questions derive from the experience of experts. All experts were interviewed to obtain data on both the river rehabilitation project in specific, the river, and the city. The content of the interview items was designed to get answers to the *criteria frameworks* determined in the previous chapters of the thesis (See Appendix N for interview questions). The questions were asked to interviewees with respect to their expertise areas and field of knowledge. Totally 34 respondents were interviewed.

As *data analysis* procedures in the framework of qualitative research, *comperative analysis* and *case study analysis* are used. By *comparative analysis*, the most common principles coming from the outputs of best practices and portfolio are listed, and they are used to form the sets of *criteria checklists*. A comprehensive list of all issues of concern regarding rivers was not actually within the scope of the study, but rather as a set of essential principles that can help communities to achieve more sustainable cities with their efforts related to urban rivers.

In this respect, the expected result of this study is to develop two sets of criteria that help evaluating the co-existence of rivers and cities in general and rehabilitation of urban rivers in particular, so that the rivers as urban spines could be developed as integral parts of sustainable cities. In addition, the framework of criteria can be adapted depending on the local historical, cultural and socio-economic features of a particular place. The case study of Porsuk River and city of Eskişehir is studied to test the criteria lists, and to suggest an opportunity to evaluate the case.

1.4.3 Evaluation Phase

The essential aim of comparative analysis is to develop a set of general criteria checklist that should be a guide for implementations. The sets of criteria are derived from mostly best practices around the world and from the discussion in the conceptual framework. Then it is compared with and evaluated in relation with the experience gained from Porsuk River rehabilitation process. This provides both the opportunity to test the criteria developed in the first part of the study with *the case of Porsuk River and city of Eskişehir*, and the opportunity to discuss deeply the rehabilitation experience on the case.

Case study was preferred to form a framework to analyze the urban river rehabilitation with reference to eco-principles and river-city integration principles. The method can be characterized by the followings:

- *Descriptive*, for it provides rich data through observation, interview, literature review
- *Comparative*, for it brings together foreign experiences
- *Supportive*, for it develops testable criteria.

The assertion is that the concept of urban river rehabilitation, which contains technical data and operations, has changed with internalization of the concepts of ecocity and integration. Both the ecocity concept and the integration concept aim at realization of the river rehabilitation within the context of the city. Therefore, at first the definitions, concept and classifications related to rivers are discussed to clarify the object of the study and then the interrelation of the urban river and the city is taken up and discussed from the point of view of evolution and transformation of this relationship and the nature of their interdependency in time. Emphasis is given to the existence of duality in the contribution of the urban river to its respective city with rising urbanization. Chapter 2 covers this discussion along with relevant examples.

Urban river rehabilitation, in essence, involves elimination of the existing problems and upgrading of the quality of the running water. Therefore, Chapter 3 starts with the discussion of major problems and different concepts related to similar approaches to solve the problems, and the chapter explains why the concept of rehabilitation has been chosen for this study. What is more, paradigm shifts of river rehabilitation are reviewed to clarify the definition adopted. In addition, discussing recent best practices on urban river rehabilitation constitutes an important part of the study, to be able to see the *recent tendencies*.

The discussion of the general implementation of urban river rehabilitation displays two basic characteristics: First, they are technical in essence and the implementation is limited to the problem area. Therefore, it is assumed that with importance of cities rising, where all administrative, management and control functions are located, administrators, managers and planners aim to improve cities. Kinds of transformation projects in effect in most cities today have this vision. Rehabilitation of urban rivers which are inherently the natural, continuous, image creating, recreative and therefore one of the most important urban elements cannot be restricted to a limited vision offering only technical solutions but must be planned within the vision of the city entailing its structure and policies. It is asserted that the urban river rehabilitation concept has been renewed in time with the changing concepts and attitudes related to the city, to the function of the city, to the understanding of the city and to the planning of the city.

Today the general aim for future cities is to mitigate and eliminate their multidimensional negative impact on the present and future welfare of earth and to provide for this, and the concept of *ecocity* has been developed thereof. The discussion then centers on the clarification of this concept *firstly*, and a key list is derived from the projects and implementations carried out by the ecocity principles. This list will be used as the first step of a check to be applied on the rehabilitation of the Porsuk River in Eskişehir to see if this process has been realized according to the criteria.

The *second* attempt to internalize the issue of urban river rehabilitation by the city and by urban planning is through the concept of *integration*. This concept includes connectivity, which is devoid of human interrelations and involves only connecting two points. It includes provision of accessibility of a point from another one, and thus is a wider concept which involves establishing of reciprocal, mutual, functional relationship of the citizens with certain focal points of their physical environment. Being one of these focal points, urban river bears attractive, image and identity creating elements along with accommodating historical and cultural sites, buildings, monuments and prominent architectural works. Now cities are planning these nodal landmarks in an integrated whole. Specific lookout points are structured in the city from where one can see especially the river and other focal points around or near it; one can orient himself or herself using them. This *legibility* is fortified by the availability of transport lines and stops. The urban river with its refurnished banks and attractive bridges becomes major elements for the integration. Commercial, cultural, and recreative facilities accessible from the river, located on the riverbanks, next to, or sometimes even on the bridges constitute junction of this *integrative spine.*

The essential aim is to develop a set of general criteria that should be evaluated in accordance with the examples in Turkey so that they would be developed as integral parts of cities. It should also be noted that a rich source of best practices of urban river rehabilitation around the world exists in the relevant literature. This, actually, creates a voluminous matrix

(See Appendix J) that forms a varied source, and it is hoped that it might further enlighten the subjects discussed in the main body of the study.

This assertion of the thesis is supported by ecocity examples around the world as indicated above. Then the assertion is supported by selected cities throughout the world presented in a sample *portfolio*, showing the integration of the urban river with the nodal points and landmarks of the city to fortify its legibility, walkability, accessibility, and connectivity. Twenty sample cities have been chosen for portfolio, which are also known through by their urban rivers, and which have created an integrated cultural, historical, recreative, educational, religious identifiable corridors that seem to have taken *the urban river as the main urban planning reference*. A similar sketch is prepared for Porsuk River and city of Eskişehir to determine the integration status achieved in the city.

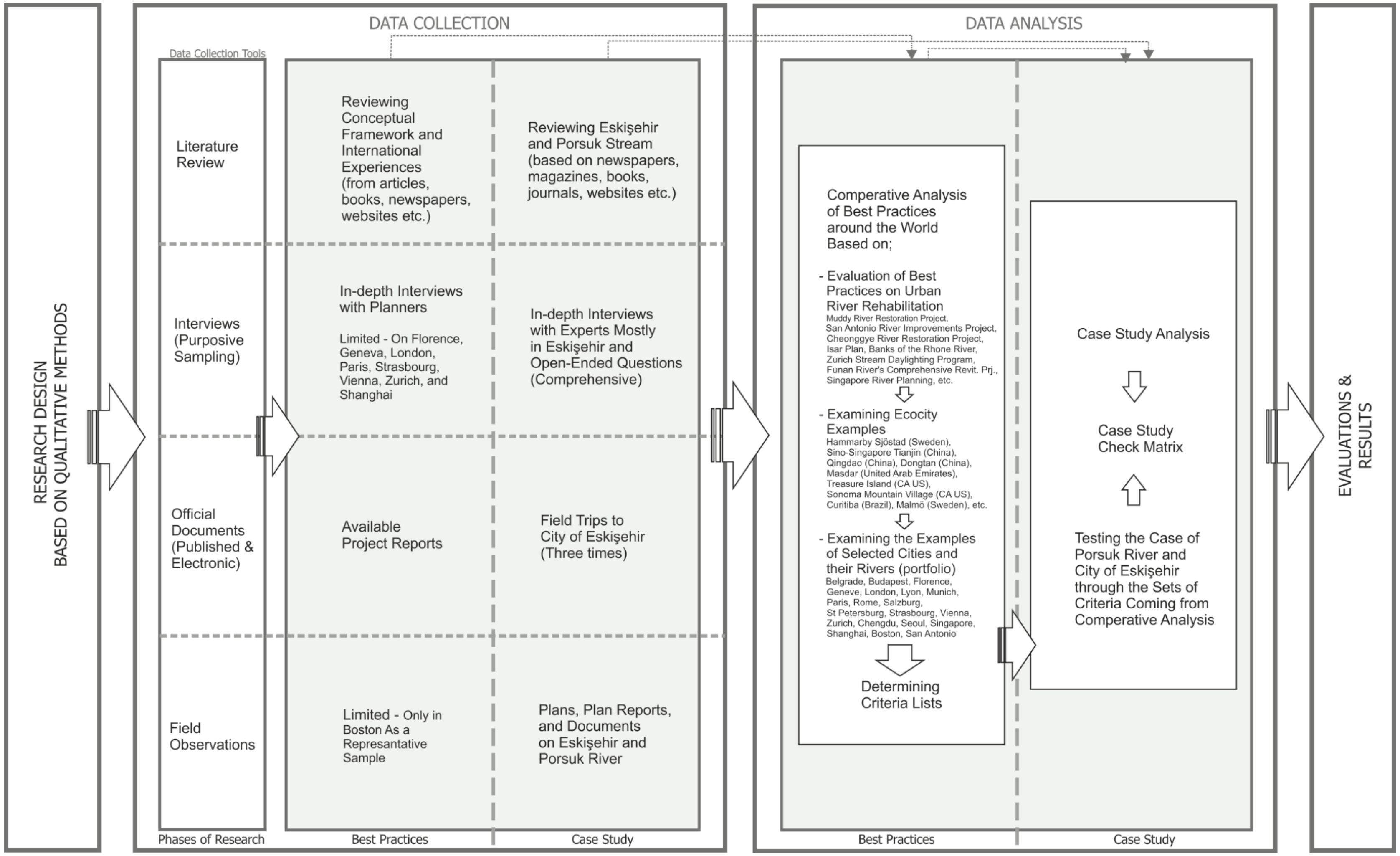

Figure 1.1 A Diagram for Methodological Framework of the Research

1.5 Outline of the Thesis

The thesis has eight chapters: *Chapter 1* determines the scope of the research, laying down an introductory conceptual framework of the study. This chapter also describes the main aims, assumptions and research questions, as well as the methodological framework of the research.

Chapter 2 starts with the definitions of relevant terms such as river and stream. Classification of natural rivers and characteristic features of urban rivers are considered. As the entire study emphasizes urban rivers, this chapter concentrates more on the role and importance of urban rivers' evolution through civilizations, interrelation between rivers and cities, and functions of rivers in different periods of time.

Chapter 3 involves major isues and problems related to urban rivers that lead to their rehabilitation at the beginning. The Chapter then includes relevant concepts and definitions of *urban river rehabilitation*. At the end of this chapter, solution ways of problems within the context of urban river rehabilitation and changing aspects of this context are examined; and correspondingly various urban river rehabilitation examples around the world are introduced. These best practices are analyzed to determine the changing aspects of treatments on urban rivers.

Chapter 4 evaluates urban river rehabilitation through reflections of new approaches. The chapter starts with the evaluation of eco-approaches; later it mainly discusses the perspective of *ecocity*, mainly through its concern of water. Within this discussion, definition of the ecocity concept, the state of urban water system and river in the ecocity concept, and related criteria are brought up. Well-known ecocities are taken into consideration before analyzing them and determining the set of ecocity criteria.

A new conceptual content for urban river rehabilitation was formed by introducing two sub-concepts: one is ecocity as indicated in Chapter 4 above and the other is *integration*. Thereby, *Chapter 5* covers urban spatial integration between rivers and cities. It is propounded that urban rivers are the most integrated part of the built environment as well as the natural environment. The chapter illustrates the river-city integration with schemes and supporting texts. It is determined that urban river and riverfronts have great influence on urban pattern, functions and urban focal points. The portfolio includes twenty cities mostly from Europe and around the world. After all, this chapter also introduces a set of criteria coming from the analysis of the portfolio. The criteria sets form a framework to be considered in related practices.

Chapter 6, which focuses on *the case of Porsuk River and the city of Eskişehir*, first introduces the city of Eskişehir, its historical development and planning works. An overview of Porsuk River including its streams and catchments, and its place throughout the history of Eskişehir are explained. Review of Eskişehir urban water system and problems and solutions related to Porsuk River are also included under the section on overview of the river. As the main issue of the case, the rehabilitation of Porsuk River is clearly described. This is followed by discussion of the analysis of river within the urban pattern.

Chapter 7 evaluates the process of Porsuk River rehabilitation and the city of Eskişehir based on two sets of criteria determined. As an example to way of testing the criteria lists, the implemented, partially implemented and non-implemented ones for both ecocity criteria and integration criteria are indicated in the chapter. At the end of the chapter, a checklist matrix is formed that facilitate overview.

Finally, *Chapter 8* defines the key concepts of dissertation and highlights the main findings of the research. It discusses the directions for addressing urban rivers as an integral entity for both the natural and built environment that contributes to *coexistence of river and city*. The research's potential contributions to the field of urban planning, further implications and limitations of the study and suggestions for future research are incorporated in this chapter.

CHAPTER 2

THE CONCEPT OF RIVER: DEFINITIONS AND CLASSIFICATIONS OF RIVERS AND EVOLUTION OF URBAN RIVERS

2.1 Definitions

In this section, which is allotted to definitions, two of the largest and most common flowing waters are defined namely the *river* and the *stream*. "A *river* is a natural, flowing stream of water that provides an avenue for drainage of water from higher elevations to a standing body of water at lower elevations, which is typically a lake or ocean." (Lerner & Lerner, 2009). Ross (2005, p.4) defines a river as a large stream of fresh flowing water. He adds the following: "High in mountains, small streams gather together to form a river rushing down through hills and valleys. Lower down most rivers flow more slowly through flatter land until they reach the sea".

Stream is a general term for a body of flowing water, natural water course containing water at least part of the year (Kemp, 2009). *Stream* involves a body of water flowing in a channel or watercourse, as a river, or *brook*[2]. A stream is a flow that may be as small as a brook or as large as a river ("Stream", 2011). The word stream has many different meanings as well, and has a larger context involving several types of flowing waters (See Appendix C and Appendix D for detailed definitions of river, stream and related terminology). Another concept used instead of rivers or streams sometimes is a *waterway*. However, a waterway is defined "as a body of water that is navigable by boat" (Lerner & Lerner, 2009, p. 714). Also, "waterway can be a river, but this concept also includes lakes, oceans, and human-made canals" (Lerner & Lerner, 2009, p. 714).

[2] Brook means a natural freshwater stream smaller than a river ("Brook", 2011). Creek is an another generic term for a smaller stream an originated in New England (Riley, 1998).

"We can probably find some relative correlation between greater flows and drainages named rivers, but there are also *creeks* on topographic maps that contain greater flows than so-called rivers. [….] What this definition problem tells us really is that creeks, brooks, streams, rivers, and the rest are important components of our landscape history" (Riley, 1998, p.2). Varied terms used to define flowing waters represent cultural and regional customs more than they define or standardize a geographic feature (Riley, 1998).

The term of stream seems to be appropriate to use within the context of this thesis, as the thesis considers *flowing water bodies* whatever they are called. However, the term river has a wide range of usage areas in literature, and unlike the term river, the term stream can be used for anything that flows different from water. So in formulation of the thesis structure, the term of *river* is used to simply describe flowing waters.

Urban river, or urban stream, is a formerly natural waterway that flows through a heavily populated area. Urban rivers are often significantly polluted due to urban runoff[3] and combined sewer[4] outflows (Riley, 1998). They are also highly modified by means of their structure as well. Therefore, before urban rivers are discussed, it makes sense to go over *rivers in general* and *classification types* of them.

2.2 Classification of Rivers

There are common classification scales as to rivers. *Classification of rivers* can be based on their drainage area, relief, length, number of tributaries, regimes (slow, mixing, mass flow) etc. Different scientists (Strahler, Leopold, Brookes, Brierley, Schumm, Brice, Montgomery, Schueler etc.) have formulated different classifications. The milestones of the river classification systems of various researchers can be marked as:

- Strahler Stream Order (by Strahler in 1957)
- Straight, meandering, braided (by Leopold and Wolman in 1957)

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[3] "Runoff is the water that flows over and through the soils, eventually making its way to surface water systems" (Ward et al, 2004, p.6). Urban runoff is a stormwater from city streets and adjacent domestic or commercial properties that may carry pollutants of various kinds into the sewer systems and from there to rivers, lakes or oceans (The United Nations Environment Programme [UNEP], 1996).

[4] Sewer is a system of underground pipes that collect and deliver wastewater to treatment facilities or streams (Kemp, 2009).

- Fluvial Audit (by Sear et al. in 2003)
- IFIM/PHABIM (by Bovee in 1982)
- Stream Pattern (by Schumm in 1985)
- Montgomery and Buffington Mountain Channel Classification (by Montgomery and Buffington in 1997)
- River Channel Typology (by Newson, Clark, Sear and Brookes in 1998)
- River Habitat Survey (by Raven et al. in 1997)
- River Styles (by Brierley and Fryirs in 2000)
- Rosgen Classification of Natural Rivers System (by Rosgen in 1996) (adapted from Wheaton, 2010).

These various categories of river classifications depend on such criteria as rivers' *ordering, sinuosity, sediment*[5] *load, channel width, channel depth* (and variance in width/depth ratio), *straightness, meandering, braiding, stability of banks, slope, velocity, nature of materials, existence of bars and islands* etc. in river. Between the late 1800s and 2000, many scholars formed their own classifications based on types. The types can be process-based, form-based, watershed[6] scale form-based, habitat-based, and urban development-based. Earlier classification types are mostly form-based such as Leopold's and Wolman's ones (1957); since end of 1970s, process-based classifications have notably increased. Appendix E shows a more detailed list of various stream classification systems, descriptions, and classification types.

Below are four basic classification systems which are commonly used. They are based on (1) stream ordering, (2) stream pattern, (3) water quality, and (4) inland waterways. Once they are explained, classifications of urban rivers are specified.

[5] Sediment is naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity acting on the particle itself.

[6] Watershed is "the land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified bt tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Mississipi River Basin contain thousands of smaller watersheds." (Kemp, 2009, p.218).

2.2.1 Classification Based on Ordering

Streams can reach another stream, lake or wetland or the sea. According to stream flowing hierarchy and based on size, a classification system was developed. A method for hierarchy of natural channels namely *stream ordering* was originally developed by Horton in 1945. Several modifications were produced on this original scheme. Stream ordering scheme by Strahler (in 1957) (the Figure below) is the most frequently used one today. The uppermost channels are designated as first order-streams. The confluence of two first-order channels forms a second-order stream. A third-order stream is formed when two second order channels join, and so on. According to this system, the intersection of a stream with another channel of lower order does not raise the order of the stream after intersection (Federal Interagency Stream Restoration Working Group [FISRWG], 2001).

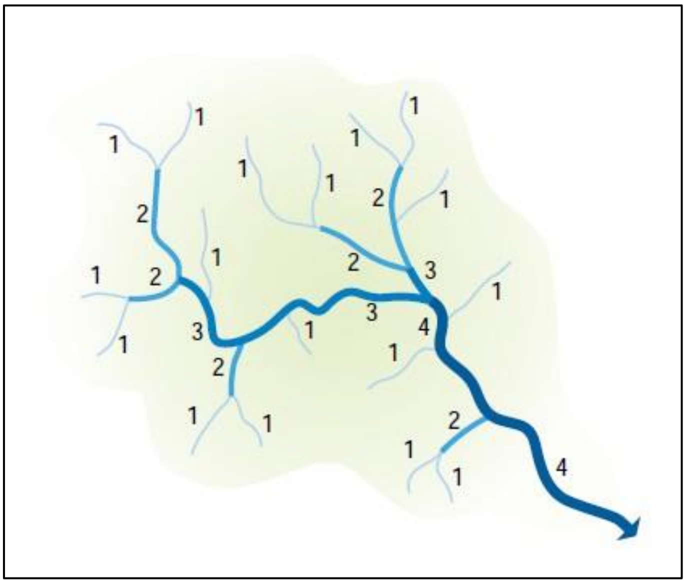

Figure 2.1 Stream Ordering in a Drainage Network
Source: FISRWG, 2001, p.1-26.

When using stream order to classify a stream, the sizes range from a first order to the largest 12th order stream. First through third order streams are headwater streams and about 80% of the world’s waterways fall in this category. Streams that are classified as fourth through sixth order are medium streams while seventh through twelfth are considered a river. For instance, Ohio River is on eighth order, Mississipi River is a tenth order, and Amazon River is a twelfth order stream. Medium and large rivers are usually less steep and flow more slowly, unlike the smaller order streams. However, they tend to have larger volumes of water (Briney, n.d.).

The stream order classification is an effective way to understand the differences between streams of different sizes. It gives an idea of the size and strength of specific waterways within stream networks which is an important component of water management. In addition, this classification allows scientists to carry out more feasible studies on the amount of sediment and effective use of streams as natural resources (Briney, n.d). "Within a given drainage basin[7], stream order correlates well with other basin parameters, such as drainage area or channel length. Consequently, knowing the order of a stream can provide clues concerning other characteristics such as which longitudinal zone it resides in and relative channel size and depth" (FISRWG, 2001, p.1-26).

2.2.2 Classification Based on Pattern

Schumm's *stream pattern* is another major stream classification system. Pattern change occurs by natural reasons, as well as a result of man's activities. The drainage pattern is one distinctive aspect of a watershed in planform (FISRWG, 2001). As a stream pattern shows the physical form and position of a stream, it is considered here. Schumm (1985) stated that, the pattern of a river is considered at different scales related to its size, flow etc. River pattern, which provides information on river characteristics and behavior of the river, is a field depending upon the interaction of hydrology, hydraulics, geology and geomorphology. Civil engineering and planning as well are involved in river patterns because of the bridges and other sites of construction and decisions.

There is a great variability and dynamic behavior of river patterns. Understanding patterns is essential for water reclamation[8], channel modification, flood control, and navigation (Schumm, 1985). Another major classification was made by Brice. Brice has illustrated types

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[7] Drainage basin is a land area where precipitation runs of into streams, rivers, lakes, and rezervoirs (Kemp, 2009).

[8] Water reclamation is a process by which wastewater from homes and businesses is cleaned using biological and chemical treatment so that the water can be returned to the environment safely to augment the natural systems from which it came. Water reclamation and reuse have two ways; from rainwater, and from wastewater ("Water Reclamation", 2010). (See Chapter 3.1 for details).

of channels characterized by the degree of sinuosity, braiding, and anabranching (See Figure 2.2 Types of Channel Patterns). As Schumm (1985) stated, *sinuosity* is the ratio of channel length to valley length or channel slope to valley slope, *braiding* means dividing channel by islands and bars, and *anabranching* is the division of a river by wider islands.

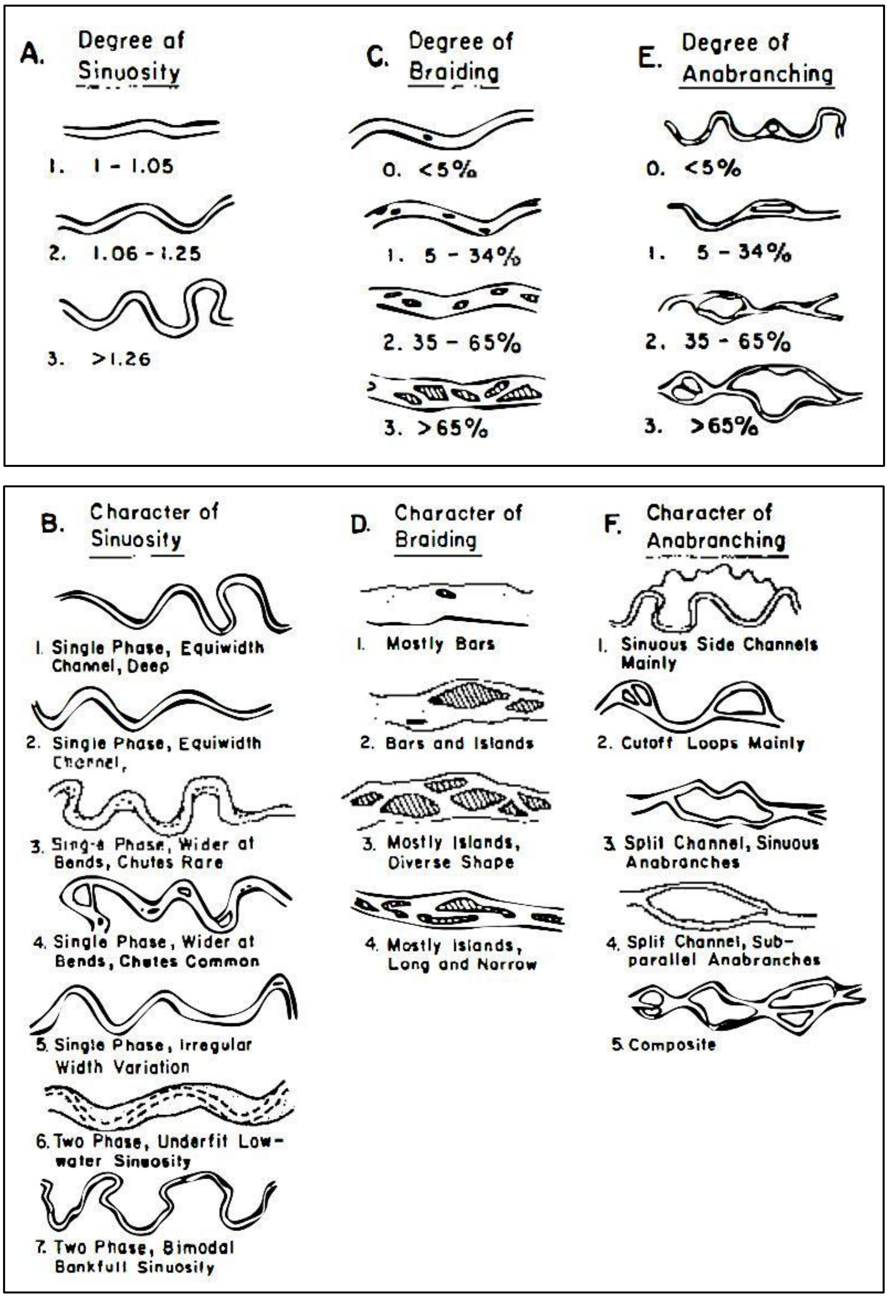

Figure 2.2 Types of Channel Patterns

Source: Schumm, 1985, p.8

Schumm (1985) grouped the range of common channel patterns into five basic patterns. Figure 2.3 shows channel classification based on pattern and type of sediment load, types of channels, their relative stability, and some associated variables. This figure is reveals a causal relation, and it illustrates the differences to be expected according to the type of *sediment, velocity,* and *stream power differentiation*. While the channel pattern moves through 1 and 5, channel pattern, channel type, and stability change. For example, as the pattern changes from 1 to 5, sediment load increases, flow velocity increases, and stability decreases.

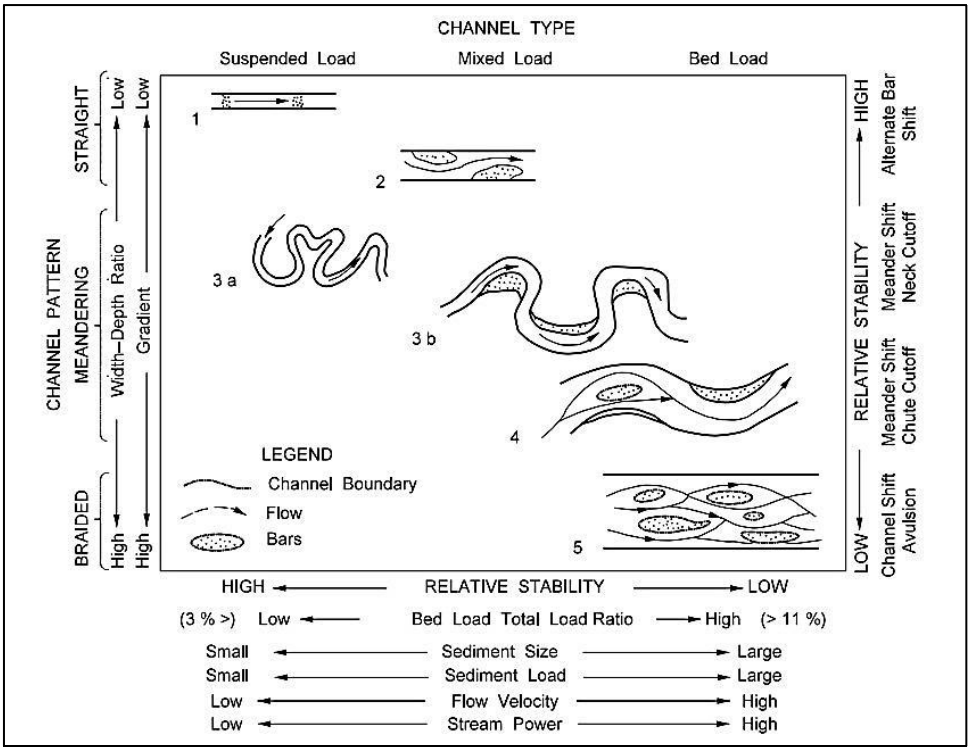

Figure 2.3 Channel Classification and Relative Stability As Hydraulic Factors Are Varied
Source: Indiana Department of Transportation, 2011 (based on Schumm, 1985, p. 10)

2.2.3 Classification Based on Water Quality

Another classification system is based on the *surface water quality*. US Clean Water Act requires that surface waters be classified according to these designated uses; Class I (potable water[9] supplies), Class II (shellfish propagation or harvesting), Class III (recreation,

[9] Potable water is water of a quality suitable for drinking (Kemp, 2009).

propagation and maintenance of a healthy, well-balanced population of fish and wildlife), Class IV (agricultural water supplies), and class V (navigation, utility, and industrial use) (Florida Department of Environmental Protection [FDEP], 2009).

The Turkish Regulation of Water Pollution Control (published in the Official Gazette No. 25687 dated 31/12/2004), classified inland surface waters according their quality. In Regulation, the current water quality parameters were determined according to 4 classes: *Class I*- High-quality water; *Class II*- Less contaminated water; *Class III*- Contaminated water and *Class IV*- Very contaminated water (Ministry of Environment and Forestry, 2004).

Corresponding to the specified water quality classes, the following water uses are considered to be suitable for the following. Class I: Potable water with a high potential for surface waters, recreational purposes (including those requiring physical contact such as swimming), trout production, animal production and farm needs, other purposes; Class II: Less contaminated water, drinking water with the potential of surface waters, recreational purposes, the production of fish other than trout, Technical Methods Bulletin issued on condition that provide irrigation water quality criteria as irrigation water, Class I all use non-digger; Class III: contaminated water, food and textile industries, such as requiring high quality water, except after a proper treatment and industrial water supply available; Class IV: Multi-contaminated water. The quality parameters for the lower and upper quality class, improving the quality of surface waters can be used (Ministry of Environment and Forestry, 2004).

2.2.4 Classification Based on Navigability of Inland Waterways

There is also a *classification system on inland waterways*, as determined by European Conference of Ministers of Transport (ECMT). The ECMT classification document sets the characteristics based on transportation such as minimum height under bridges. The capacity (such as vessel lengths, tonnages etc.) of navigable waterways shows the I-VII classes of a waterway (ECMT, 1992). In other words, this classification is based on the eligibility of waterways for the usage of vessels rather than the stream’s morphological, physical or biological characteristics.

After reviewing the common classification types of flowing waters above, classification based on those in urban areas is held in the following section.

2.3 Classification of Urban Rivers

No matter whether inland or adjacent to sea, rivers *are affected by the existence of cities* and in turn, they *affect the city*. General classification systems including all types of rivers have been reviewed so far. Now classification of certain specific types of rivers, namely urban rivers will be discussed.

2.3.1 Classification Based on Impervious Cover

In literature, there is a limited number of classifications of urban streams. Schueler (see Appendix E) classifies urban streams according to the *imperviousness* of the relevant watershed area which three types may be covered: (1) *sensitive* (<10%), (2) *impacted* (11%-25%), and (3) *non-supporting* (>25%) (Niezgoda et al, 2005). (See Figure 2.4). That is, the *percentage of impervious cover* is the determinant of this urban stream classification system, and stream quality has an inverse ratio. *Sensitive streams* are typified by stabled channels, good to water quality and have diverse aquatic habitat. When impervious cover is low, streams do not experience hydrological changes such as frequent flooding that accompanies urbanization. *Impacted streams* show clear signs of degradation, and storm flows alter the stream geometry. Erosion occurs, channel is widened; stream banks become unstable, and habitat of the stream declines drastically. In *non-supporting category*, streams become conduits for *stormwater*[10] flows; the stream channel becomes highly unstable, streambank erosion occurs, water quality is rated as fair to poor, and habitat diminishes ("The Impervious Cover Model", n.d.).

Although this classification grounded in research, its assumptions are limited. As a matter of fact, it is difficult to apply in larger urban streams; the regional adaptability may vary significantly; it does not taken into account stream riparian cover and continuity, which most

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[10] "Stormwater is defined as storm water runoff, snowmelt runoff, and surface runoff and drainage" (Environmental Engineers Handbook, 1999).

likely affects model; the influence of urban *Best Management Practices*[11] (BMPs) on impervious cover thresholds is not covered. "While there are some limitations to the application of the urban stream impervious cover model, impervious cover still provides us with one of the best means of evaluating the health of a subwatershed. Impervious cover serves not only as an indicator of urban stream quality but also as a valuable management tool in reducing the cumulative impacts of development within subwatersheds" ("The Impervious Cover Model", n.d.).

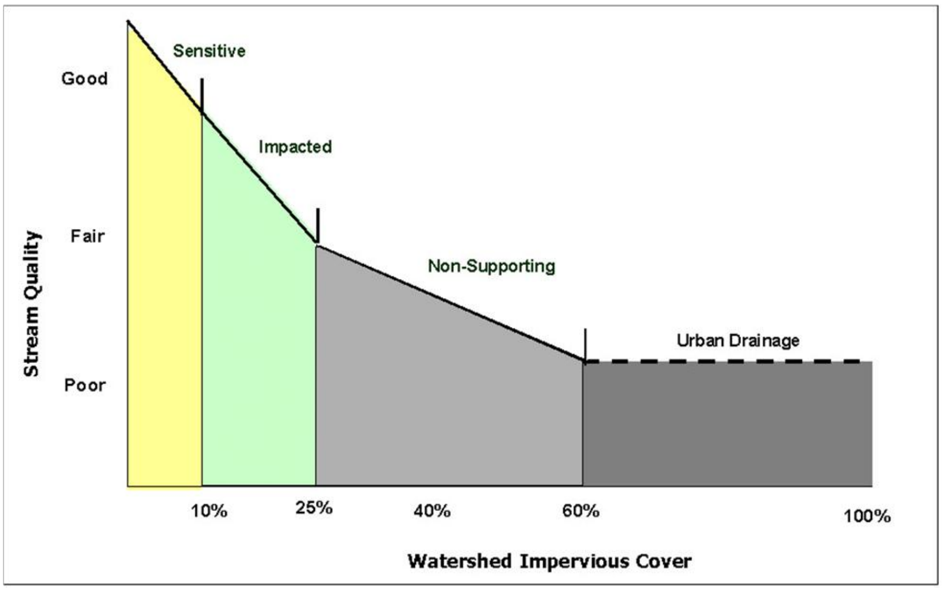

Figure 2.4 Urban Stream Classification System: The Impervious Cover Model
Source: "The Impervious Cover Model", n.d.

2.3.2 Classification Based on the Location within Urban Pattern

Besides the classification considering impervious cover, *the location of a river in an urban pattern* could be another base for classification. According to Silva et al (2006), the position of the river relative to the city was divided into three main types:

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[11] Best Management Practices (BMP) is methods that prevent or reduce water pollution from nonpoint sources (Onondaga Environmental Institute [OEI], 2009). BMPs is a term in US to describe structural and nonstructural stormwater management control measures taken to mitigate changes to both quantity and quality of runoff caused through changes to land use. Generally BMPs focus on increased impervious surfaces from development; and designed to reduce volume, peak flows, and/or non-point source pollution through evapotranspiration, infiltration, detention, and filtration or biological and chemical actions. In UK, the term of Sustainable Urban Drainage Systems (SUDS) is used to refer the same meaning ("Best Management Practice", 2011).

I. *Diametral;* means the ratio between built areas on both banks varies between 0,5 (two identically sized banks, that is, the river dissects the city) and 0,7 (the biggest bank is slightly bigger than the smaller one).

II. *Eccentric;* is used to describe those cities that have clearly a more developed bank, but still cross the river to created smaller nuclei on the opposite bank. This is characterized by ratios between 0,7 and 0,95.

III. *Tangential;* means the river passes right outside the city, bordering it on one or more sides. There is no urban settlement on the opposite bank of the river, or that these urban areas are minute in proportion to the total area of the city.

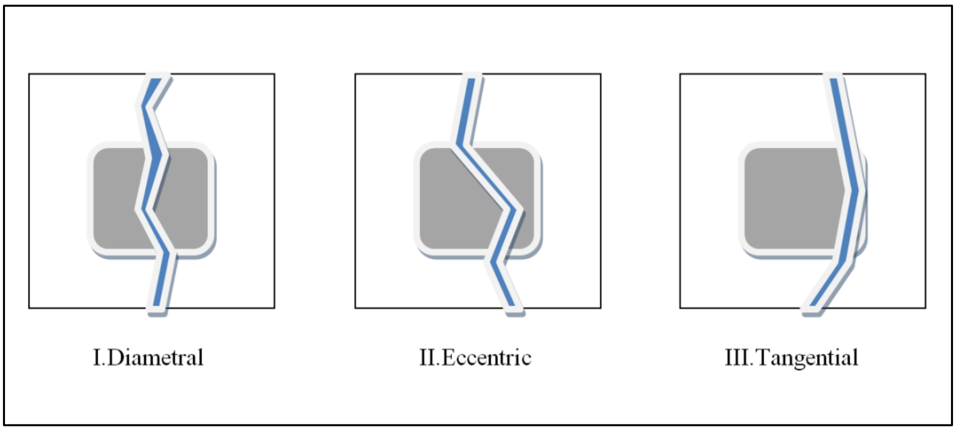

Figure 2.5 Types Based on the Location of a Stream in the City

Source: Reproduced based on Silva et al., 2006, p.8

This research is based on practices on urban rivers flowing through cities, and particularly through city centers (See Chapter 5.3). Therefore, most of them are positionally diametral or eccentric. Their rehabilitation in respect of urban ecosystem and their spatial integrity with the relevant city establish reference basis for the discussion on the case of the thesis.

Besides those classifications on urban rivers above, *morphology* and *modification level of streams* are also distinctive features. *Morphology of urban streams* is mostly straight because of concrete channel engineering practices. The *modification level of urban stream*, from *highly modified to unmodified*, is a common case. “The worst physical modification of urban watersheds is the relegation of stream channels and tributaries to underground culverts.” (Riley, 1998, p.129). In addition to that, some other types of urban streams are *public* *accessible streams and banks, culverted stream, canalized stream, park stream* (the stream passing through a public park) etc.

2.4 The Evolution of Interdependence between Urban Rivers and Civilizations

The positive impact of running waters on the establishment and growth of human culture in the world is an undisputable and universally accepted fact. The assertion at this point is that water does have imbedded duality and in case of maltreatment and careless use, the negative impact will surpass the positive impact of water on human culture and communities.

From the beginning of known history, settlements have been located at *water's edge* and it is in these locations that, the greatest cultures and empires of history developed. The availability of sufficient clean and abundant water determines whether land can be used for different purposes. As Adler (2007) states, waterfront areas have been among the first lands to be developed because proximity to water was useful for navigation, irrigation, industry, defense etc. Girardet (2004) stated, as well, that being close to these areas, people could obtain water easily. What is more, *urban waterfronts* stimulate economic and recreational activity and provide public access.

Most historians agree that *civilization flourish in river valleys*. There are five main urban hearts in the world, from which urbanization sprang: *Mesopotamia* (developed in the flood plains of the *Tigris and the Euphrates*), Egypt (developed along the narrow flood zone of the ***Nile***), *China* (developed in the valleys and alluvial fans of the *Huang or Yellow River*), *Pakistan* (developed along *the Indus River Valley*), and *Mesoamerica* (Boone, 2006; Madeiras, 2009). "Proximity to fertile soils, delivered annually by river floods, made these places ideal for the *birth of cities*." (Boone, 2006, p.3).

In Mesopotamia, *Tigris and Euphrates* rivers had been used for navigation, so they provided trade, irrigation, drinking, fishing, and water for use. In Ancient Egypt, fertile soil and predictable flow and flooding of *River Nile* were the main factors for the development of Nile Valley civilizations (Madeiras, 2009). Agriculture had been invented along the *Huang River* 4800 years ago (Riley, 1998, p.129). Lastly, *Indus River* civilizations had invented grid-pattern cities, plumbing and sewer systems; they constructed public baths, drinking water infrastructure, water storage facilities; and intricate sewage network systems

("Civilization Water", 2010). The Table below summarizes the interaction between ancient civilizations and their rivers.

Table 2.1 Interaction between Ancient Civilizations and Their Rivers

Rivers	Ancient Civilizations
Nile River (Ancient Egypt, today's Egypt, Sudan, Ethiopia) Egyptian Civilization (3000 BC)	Nile was Egypt's major source of water. Irrigation and navigation were the most significant functions in ancient times. The river and its predictable flooding periods have had a huge positive impact on economy, culture, and social life. Farming and fishing were the source of wealth and economy. A dam (in 1960) and hydrologic power generation increased the amount of arable land, but 60.000 people had to be resettled. Erosion and salinization of land was a serious problem. The river is navigable now throughout the year.
Tigris and Euphrates Rivers (in Mesopotamia, present day Iraq) Sumerian Civilization (5000 BC)	Mesopotamia is known as '*the cradle of world civilization'*. Irrigation is aided by a high water table and by melting snows from the source of the Tigris and Euphrates rivers. The efficiency of irrigation depends upon the ability to mobilize sufficient labor for the construction and maintenance of canals, and this, from the earliest period, has assisted the development of urban settlements and centralized systems of political authority. In the marshlands of the river, a complex water-borne fishing culture has existed since prehistoric times, and has added to the cultural mix. Early cities had developed sewage systems.
Yellow River (present day China) Shang Civilization (3000 BC)	The Yellow River is called *'the cradle of Chinese civilization'*.The river contributed to irrigation of agriculture and to rice cultivation as the main staple of the nation. Devastating floods occurred frequently largely due to the elevated riverbed in its lower course. Centuries of silt deposition has caused the river to flow above the surrounding farmland. The low volume was due to increased agricultural irrigation. In order to capture excess water for use when needed, and for flood control and electricity generation, several dams have been built. However, due to the high silt load, their life is expected to be limited. One-third of China's Yellow River is unusable even for agricultural or industrial use, due to factory discharges and sewage from fast-expanding cities.

Table 2.1 Interaction between Ancient Civilizations and Their Rivers continued

Indus and Ganges River (in Indus Valley, present day Pakistan, India, and Afghanistan Indus Valley Civilization (3300 BC)	The river is fed by monsoonal summer rains and winter runoff. There were massive walls of Indus cities most likely to protect them from floods. A sophisticated urban culture is evident in the Indus Valley Civilization. Cities, which were built around the banks of river, were laid out on a grid pattern. The quality of municipal town planning suggests the knowledge of urban planning and well-organized governments. Cities had developed plumbing systems, drains, and wastewater systems. The urban plan of Harappa, an old Indus Valley settlement, had the world's first known urban sanitation system. Within the settlement, individual homes or groups of homes obtained water from wells. The river was used for agriculture, fishing and fish farming in canals, and as the main supply of potable water in some part of the valley.

Sources: Boone, 2006; Riley, A., 1998; UNESCO Finland, 2011; “History of Mesopotamia”, 2011; “Yellow River”, 2007; “Indus Valley Civilization”, 2011

Following these early civilizations through time, the Hellenic, Roman, Byzantine, Asia Minor, and Islamic cultures developed relatively advanced urban water technologies and urban water systems. Yet in time, the interrelation between rivers and their respective cities, and their functions have changed as discussed below.

2.5 Changing Functions of Rivers and Changes in Their Respective Cities

2.5.1 Changing Functions of Rivers

We need rivers, “not only to enrich our lives, but also to solve pressing modern, urban problems. We need their natural features to help control flooding, improve and manage water quality, and provide for a greater diversity and abundance of wildlife, as well as for a more attractive environment in which to live, work, and play” (Hey, 1994, p.84).

The most important role that rivers played in the development of human culture is the opportunity they provided for transformation from migratory to sedentary mode of life. The discussion starts with the role of the river as one of the most important *location factors.* As a location factor, river has provided clean water for drinking, for domestic use, for elimination of wastes, for irrigation and animal husbandry, thus providing an opportunity for settling down and, and fishing as an important source for food . Rivers also provided easy protection against hostile threats from outside, and navigation boosted any simple economic venture of the time. These contributions of the river to the development of human culture constitute the *positive face* of the duality embedded in urban rivers.

Interrelation of rivers with human settlements has not displayed a linear course. In time, as human communities flourished, developed and expanded in space with rising population, the *negative impact* of rivers became more apparent. Flooding of the unregulated rivers was the most important natural hazard and at times inundations resulted in tremendous damage to human lives and communities. As population intensified parallel to insufficient technical infrastructure, increasing manufacture, although mostly manual and of small scale, so were the farms polluting running waters, turning them into garbage and sewage channels. Deforestation in the mountainous areas caused landslides that filled up rivers, elevating riverbeds, causing more floods and impairing navigation. Reclamation of land from wetland for housing, industrial sites, and agriculture worsened the ecosystem of the habitats.

The advent of the industrial age aggravated the condition of the urban rivers. Technical infrastructure was still not well developed therefore the new industries could not afford to move away from the transport and energy systems, from water sources, and waste collections, so they were located near urban areas and water sources increasing pollution and damaging the ecosystem of the rivers and of the settlements. The condition of rivers became so acute that many of them were given names that expressed the bad smell, wastes accumulated on their banks, flood hazard, and other such negativities, which they have now come to be identified with.

The pollution and accompanying adverse effects now originating from running waters changed the relationship between urban rivers and cities. In the Table 2.2 below, the major functions of rivers are shown overall along with functions that continue, i.e. functions that are added or diversified and functions that have been abandoned.

Table 2.2 Changing Functions of Rivers in Time Perspective

Function	**In Ancient Times**	**Until 1850s**	**Between 1850s and 1950s**	**Between 1950s and 1990s**	**Since 1990s**
Potable Freshwater	√	√			
Water for Domestic Use	√	√		√	√
Water for Industrial Use			√	√	√
Sewage Disposal Area			√	√	
Converted to Concrete Channels			√	√	
Covered up			√	√	
Source of Irrigation	√	√	√	√	√
Object of Rehabilitation				√	√
Transportation	√	√	√	√	√
Navigation	√	√	√	√	√
Boating, Canoeing etc.		√	√	√	√
Fishing	√	√			√
Recreation	√	√		√	√
Washing up along the River	√	√			
New Approaches for Urban Rivers					√
Waterfront Design Innovations					√
Environmental Concern					√
Considering with Green Infrastructure					√

Source: Produced by the Author

The second table below demonstrates the recent functions of some selected main urban rivers and some descriptions of these functions. The table aims to add an actual dimension to the listed functions above through these selected rivers.

Table 2.3 Recent Functions of Some of Main Urban Rivers

Function	Danube River	Rhine River	Rhone River	Seine River	Description
Potable Freshwater	√ Some parts	√ Some parts	√ Some parts	√ Some parts	Some parts of their basins have revealed
Water for Domestic Use	√	√	√	√	It continues in most of the cities
Water for Industrial Use	√	√	√	√	Yes
Sewage Disposal Area	√ Partial	√ Partial	√ Partial	√ Partial	It decreased owing to lack of resiliency to extreme events and environmental awareness
Source of Irrigation	√	√	√	√	Yes
Transportation	√	√	√	√	Yes
Navigation	√	√	√	√	Yes, but not as much as in industrializated era
Boating, Canoing etc.	√	√	√	√	Yes, there is growing interest
Fishing	√ Partial	√ Partial	√ Partial	√ Partial	Yes but decreased
Recreation	√	√	√	√	Yes and increased
Washing up along the River					Not any longer, along with technological improvements
Object of Rehabilitation	√	√	√	√	Yes, incsreasingly continues since 1960s
New Approaches for Urban Rivers	√	√	√	√	Yes, mostly with 1990s
Waterfront Design Innovations	√	√	√	√	Yes, mostly with 1990s
Tourism (River cruises)	√		√	√	It continues increasingly
Artificial Beach				√	Yes
World Heritage Site	√ Budapest			√ Paris	Defined by UNESCO around 1990s

Source: Produced by the Author

Besides transforming functions, rivers have fairly influenced and are influenced by urban development. It has already been mentioned that rivers, due to their vital role in human lives and in the sustainability of human settlements, have always attracted settlements to themselves. In all continents of the world, there is a string of settlements along major rivers such as Nile River, Mississippi River, Yellow River, Yarra River, Volga River, and Danube River. As for functions and uses of rivers, the history and patterns of cities is significant in understanding the whole concept of urban rivers. In the next section, for a clearer evaluation of rivers as they have evolved over time only some rivers and cities are focused. These are *Danube River and Vienna, Rhine River (Ill River* as Rhine's tributary) *and Strasbourg, Rhone River and Lyon, and Seine River and Paris*.

2.5.2 Changes in Some Major Urban Rivers and Their Respective Cities

There is a huge network of rivers and lakes in Europe owing to the fact that most regions of Europe receive a heavy rainfall, which accounts for the large amount of inland waters. Therefore, the rivers and their respective cities are selected from Europe in this section. The major rivers drain across vast areas and are very long. Especially in the north and in the central sections of the continent, they originate from the mountains, mostly the Alps and branch off in different directions. Rivers of Europe have drawn a string of settlements to them in history and have been crucial in the development of important cultures, empires, cities and several capital cities. Empires have been administered from cities on them; agriculture and industry have developed around and along the banks of rivers like Danube, Rhine, Rhone, Seine, Thames, Elbe, Vistula, and Volga in Europe.

The settlements drawn to riverside locations in time grew into major trade centers and then into industrial and cultural centers, so today most of these settlements are identified also with their urban rivers. These rivers have been important elements of the urban economic bases and later on, as civilization and technology developed, they became the cultural and historical entities rendering identity and image to city in the modern era. Since some of these cities are studied in more detail later on in the thesis, a review of the major rivers is taken at this point (See Figure 2.14 for a map of main rivers and their respective cities in Europe).

Danube River is the longest and most important waterway in the region that includes European Union (EU) countries. Along Danube's route of 2850 kilometers, it passes through the countries of Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Moldova, Ukraine, and Romania. Some major cities through which the river passes are Vienna, Bratislava, Budapest, and Belgrade ("Danube", 2008). *Rhine River*, which is 1232 kilometers long, passes through Germany, Italy, Austria, Liechtenstein, Switzerland, France, Netherlands, Luxembourg, and Belgium (Frijters and Leentvaar, n.d.). *Rhone River* as well has been regarded as a significant waterway and trade route since the Romans like other major rivers of Europe. Its length is 813 kms, its basin spans over Switzerland and France, and the major cities it passes through are Geneve and Lyon ("Rhone", 2010). *Seine River,* which is a river associtaed with Paris, passes through France and Belgium within its route of 776 kms ("Seine", 2011).

2.5.2.1 Danube River & Vienna

Danube River, originating in Germany and emptying into the Black Sea, is the second longest river of Europe after the Volga and is known as the site of some of the earliest human settlements and as one of the long-standing frontiers of the Roman Empire. Danube flows through ten countries: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Moldova, Ukraine and Romania, and it flows through four capital cities: *Belgrade, Vienna*, *Bratislava* and *Budapest*. It has 29 tributaries that are important running waters as well. The Danube Delta has been declared as a World Heritage Site by UNESCO since 1991 with wetlands and flocks of migratory birds. A historically navigable river, its potential has been increased by the opening of the Rhine-Main-Danube Canal in 1992 opening the trans-European waterway from Rotterdam to the Black Sea ("Danube", 2008).

Below, after each section, visual material belonging to the former plans and recent photos of respective cities selected on those rivers are displayed. The former plans and recent photos from the Danube River & Vienna, Ill River & Strasbourg, Rhone River & Lyon, and Seine River & Paris are presented later on.

Figure 2.6 Vienna Historical City Plan, 1858

Source: “Vienna Plan 1858”, 2010

Figure 2.7 A View from Danube River, Vienna, Austria

Source: “Danube Canal”, 2010

2.5.2.2 Rhine River & Strasbourg

The ***Rhine,*** the nineteenth longest river of Europe, is born in the Swiss Alps and empties into the North Sea in Netherlands. It flows through Switzerland, Italy, Austria, Liechtenstein, Germany, France, Netherlands, Luxembourg, and Belgium. Like the Danube, the Rhine formed most of the northern inland frontier of the Roman Empire. It has been a vital and navigable waterway since those days. Rhine River passes through many major European cities such as *Basel*, ***Strasbourg***, *Mannheim, Bonn, Düsseldorf, Duisburg, Arnhem, Nijmegen*, *Utrecht,* and *Rotterdam* in the countries of Switzerland, Liechtenstein, Austria, Germany, France, and Netherlands ("Rhine", 2010; Frijters and Leentvaar, n.d.).

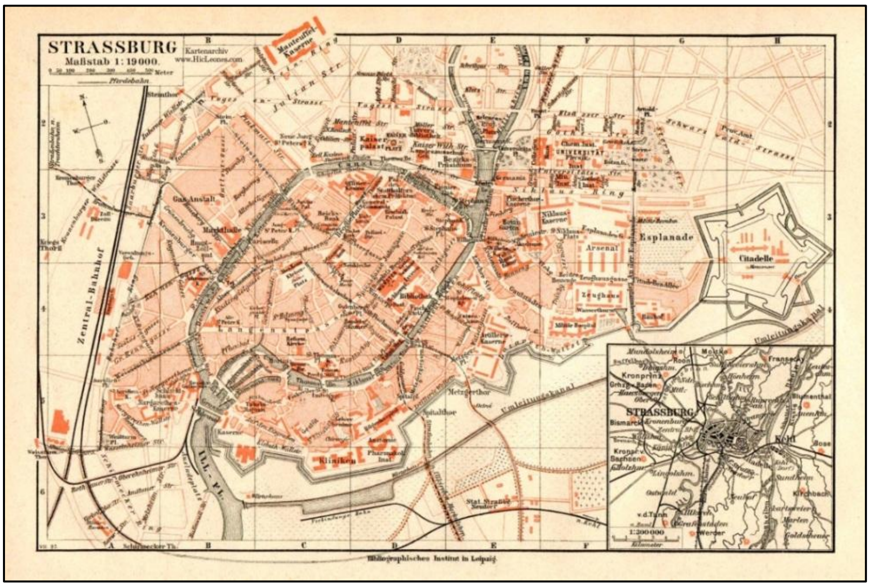

Figure 2.8 Strasbourg Historical City Plan, 1880s

Source: "Plan Orte Strassburg", 2010

Figure 2.9 A View from Ill River (A Tributary of Rhine), 2010.
Source: Arad, 2010

2.5.2.3 Rhone River & Lyon

The *Rhone*, the 25th longest river of Europe, is also one of the major rivers of the continent. It is born in Switzerland and empties into the Mediterranean Sea from France. Before railroads and highways were built, the Rhone had been an important inland trade and transportation route since the times of Greeks and Romans, connecting the cities such as *Geneva*, *Lyon* and *Valence* to the Mediterranean ports. *Lyon* is the biggest city along the course of Rhone, and it meets its biggest tributary Saone in this city. The Rhone is classified as a class V waterway according to the classification on navigable waterways ("Rhone", 2010).

Figure 2.10 Lyon Historical City Plan, 1914

Source: “Lyons Plan 1914”, 2010

Figure 2.11 A View from Rhone River, Lyon, France

Source: “Best Value in River Cruising”, 2009

2.5.2.4 Seine River & Paris

Another great historic river of Europe’s is the ***Seine***, the 26th longest river of the continent. It is born in central France and empties to the English Channel. In the days of the Roman Empire, the Seine became a great commercial artery, which was linked by canals to the River Rhine, the River Rhone, and River Loire. The Seine is a major river of North Western France. River Seine flowing through ***Paris*** gives the city its distinct, geographic division (“River Seine”, 2010).

Figure 2.12 Paris Historical City Plan, 1871

Source: “Paris Plan 1871”, 2010.


Figure 2.13 A View from Seine River, Paris, France

Source: “Seine River, Paris, France”, 2010

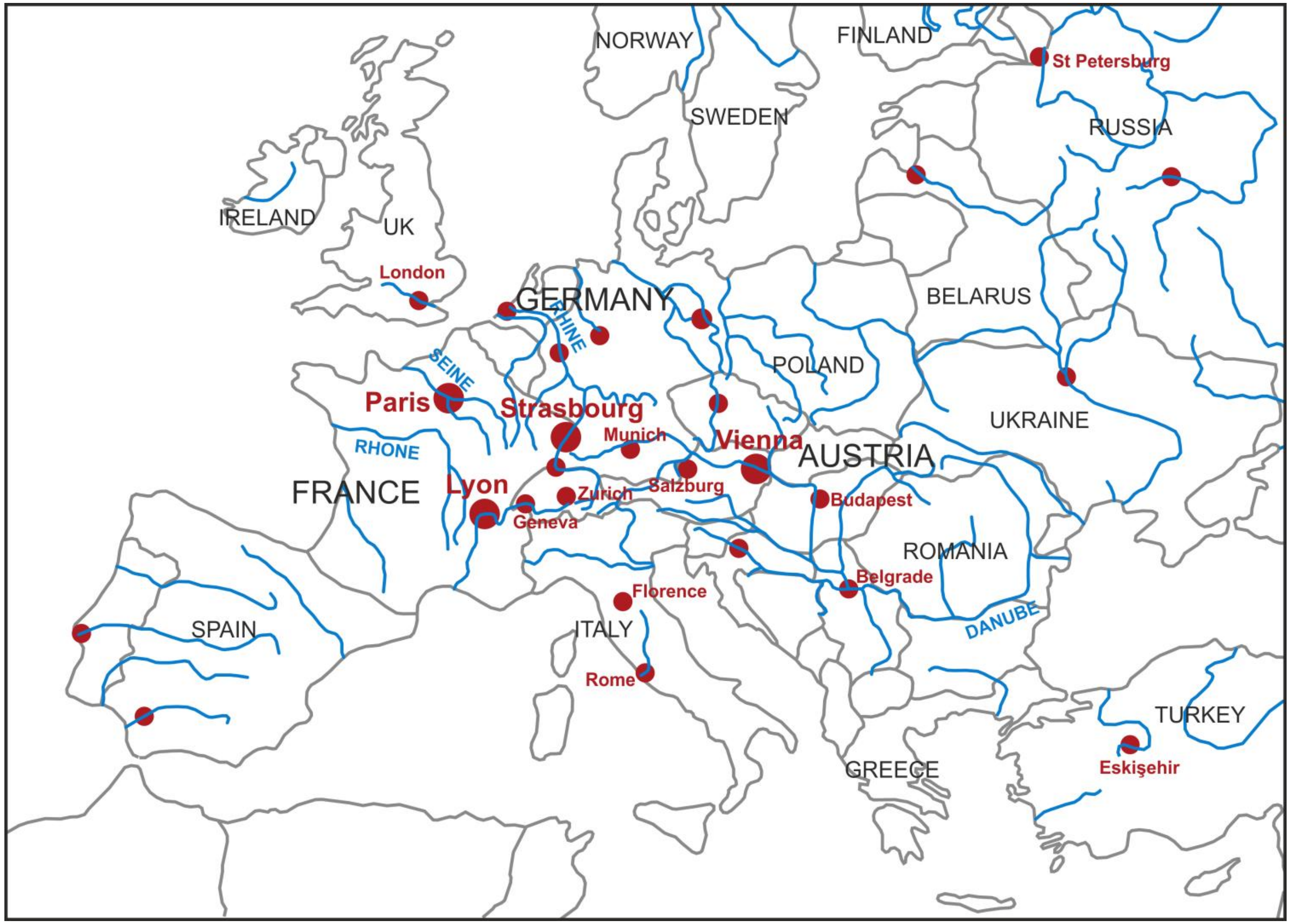

Figure 2.14 Main Rivers and their Respective Cities in Europe

Sources: Produced by the Author Based on "Blank Map on the European Continent", n.d.; Google Earth; and various European and country maps

The Figure 2.14 above shows these rivers, and the cities that have flourished on them. These rivers have drawn the earliest historical settlements, which the developed into important trade centers due to the favorable conditions along the rivers. The emphasized rivers and cities here are shown with bigger marks in the figure. Table 2.4 below summarizes the functions of these major rivers of Europe.

Table 2.4 Major Rivers in Europe and Evolution of Their Functions throughout History

Major Rivers of Europe	**Evolution of their Functions**
The Danube	*Danube River*, the longest river in the European Union (2850 km), is an essential transport route. People used to drink its water and use it for cooking. To purify the water, they used filtering. Danube is already a source of drinking water for about ten million people today. In the Middle Ages, fishing was very important on the Danube. Recently fishing has declined dramatically due to the development of fishing technology and due to dykes built on the river, which cause high waters preventing fishing with fishnets; nevertheless it is still practiced at certain points on the river. Nowadays Europe is being unified further – culturally and economically, transport is the most important contemporary contribution of the Danube and measures are continually searched for and taken to reduce the negative effects of transport on the environment. As many major rivers, Danube has inspired artists, the German tradition of landscape painting, of the 16th century. There are many national parks which are significant touristic and natural spots along the Danube.
The Rhine	*The Rhine* is a classic example of a 'multipurpose' river, which is used for transportation, industry and agriculture, drinking, sanitation, hydroelectric production and recreation. Canals link the river with the Rhone-Saone, Marne, and Danube via the main valleys. The Rhine is connected to the Mediterranean Sea by the Rhine-Rhone canal, and it is joined to the Black Sea by the Rhine-Danube canals. This makes it possible for commercial ships and passenger boats to travel from the North Sea to the Black Sea. The Rhine is the busiest waterway in the world and cargo is transported all over the continent through two canals. Rhine carries more commercial traffic than any other European river. Almost 50 million people live in its watershed. It flows from the Swiss Alps to the Netherlands along 1232 km; the basin is densely populated and highly industrialized. Since Roman Empire the river has also functioned as defense agent. There are many historic castles located along the Rhine. The river flows through Germany, Italy, Austria, Liechtenstein, Switzerland, France, Netherlands, Luxembourg, and Belgium. Duisburg, the outlet for the Ruhr industrial region on Rhine, is the world's largest river port.

Table 2.4 Major Rivers in Europe and Evolution of Their Functions throughout History continued

The Rhone	Since the times of the Greeks and Romans, *Rhone* has been an important waterway. Before railroads and highways were developed, the Rhone had been an important inland trade and transportation route in its region. It also helped to convey Greek cultural influences to the Western cultures. Until the 19th century, passengers travelled in water coaches or under sail. By the mid 1900s, construction on locked barrages and canal cuts improved navigation and generated electricity. Today The Rhone is an important resource for agriculture, industry, tourism, transportation and the generation of energy. Its delta is used for extraction of salt, agriculture, recreation and industry today.
The Seine	*Seine River* is another major river and commercial waterway (776 km) in Europe. It is navigable by ocean-going vessels in about ten percent of its length; over sixty percent of its length is navigable by commercial riverboats, and nearly its whole length is available for recreational boating. The Seine accounts for 50% of national river traffic. Numerous dams have been built on the Seine and its main tributaries. It is connected by canals to some of the main rivers including the Saone, the Meuse and the Rhine. Seine hosted rowing, swimming and water polo events in 1900 Summer Olympics. In 1991, the banks of Seine in Paris were added to UNESCO's list of World Heritage Sites in Europe. The basin countries of the River are France and Belgium. The Seine's run-off is relatively regular, in part due to dams and flood protection infrastructure. These have reduced flooding which historically was a serious problem.

Sources: Produced by the Author based on "Danube" 2008; Frijters and Leentvaar, n.d.; Gibb, 2010; "Rhine", 2010; "Rhone", 2010; "Seine", 2011; Washington University, 2010

The table above shows that in time, with the development of technology and urban technical infrastructure, many of the functions of provided by urban rivers disappeared. Today these long rivers flowing through production areas of several countries and of cities maintain one of the basic historical functions, namely navigation. This function has been improved through the development of especially navigation engineering and since long distance freight is cheapest by boat. These rivers provide excellent inland channels joining main seas and the ocean around Europe and inland production and consumption areas. The closeness of major navigable rivers to each other at certain locations and the flatness of the land have made it easy to connect these rivers by means of canals which enable them to reach more distant ports through shortest routes. Provided that rivers did not suffer from seasonal catastrophes such as floods, most of the rivers of Europe were navigable. Major rivers from Europe, the

Danube, Rhine, Rhône, Seine, Saône, Elbe and Main are linked to each other by canals, establishing an unbroken line of waterways.

This being discussed, the section below is considered some major issues such as problems and actions taken against them. This is a preliminary discussion prior to the next chapter.

2.6 Evaluation & Conclusion

This chapter starts with definitions of flowing waters. Several definitions that exist in literature are shown in Appendix C and Appendix D. At this point, the two most common definitions related to the largest of flowing waters; the *river* and the *stream* are discussed. Both definitions, often used interchangeably, differ in that stream is a wider concept representing running waters of different sizes. Therefore, the concept of river is adopted to refer the moving bodies in urban settlements in this study.

After the definitions, *classification of rivers*, changing functions of rivers in time, transformation of rivers together with their recpective cities are explained. It is observed that several different classifications of flowing waters have been developed mostly based on their physical and hydrological characteristics, and these classifications used in most relevant studies are reviewed. Put differently, in general rivers are classified according to the following: their ordering (determining the main body of the flowing water and the hierarchy of its tributaries and confluences), the pattern (defining the physical form), the water quality and finally the navigability of the water. These classifications and the related terminology are used later on in specific sections of the study.

This thesis, which is about urban rivers, denotes flowing waters in the urban areas, so the discussion centers on the classification of *urban rivers*. Two significant classification systems have been developed for urban rivers; the first one is according to imperviousness that is measured by the impercentage of perviousness of the land cover, and the second is according to the morphology of the river, which is the position of the river in the city. The second classification has been used in this study while classifying urban rivers are included in the Sample Portfolio. In the case of Porsuk River, both of the classifications are considered.

As seen in the following section, the *historical evolution and interrelationship of urban rivers and urban settlements* have not displayed a linear development through history. This matter was then discussed through the cases of some of the major rivers of the world and well known cities on them to add a tangible dimension to the discussion.

In the section concerning *functions*, it is expressed that providing a safe and sanitary location for development of human settlements and an opportunity to transform from migratory to sedentary mode of life, urban rivers have assumed a vital role in the development of civilization. However, their functions have changed in time as some of their contributions were taken over by developing technology and science.

The discussion in this chapter presents definitions and classification criteria to be used in the following discussion and in the case study. The discussion on the changing aspects of evolution of interrelationship between rivers and urban settlements throughout history will also be used especially on the samples included in the sample portfolio. The following chapter dwells on major issues related to urban rivers along with the negativities, the concepts related to urban river rehabilitation and the *best practices* of it.

CHAPTER 3

MAJOR ISSUES RELATED TO URBAN RIVERS AND THE CONCEPT OF URBAN RIVER REHABILITATION

> "As urban areas continue to grow, we will need to better utilize amenities in the local environment by protecting and enhancing steam systems, developing what Leopold (1977) referred to as '*a reverence for rivers*'" (Kondolf et al, 1991, p.39).

3.1 Major Issues Related to Urban Rivers

It was already mentioned that running waters have an embedded dual nature. Although they have allowed civilizations to grow, in time due to natural or mostly man-made reasons such as careless exploitation, the negative impact of water started to take its toll on human settlements, the location and growth of which they once had supported. The main reason for the negative impact of running waters overshadowing the positive one was urbanization that developed as increasing population concentrated on areas without proper infrastructure. Changes observed on rivers are based on two main causes; natural causes, and human impact. *Natural causes* are floods, drought, etc. *Human-induced causes* are the changes in rivers' flow and sediment load, dam construction, land use changes, pollution etc. (Kondolf et al, 1991).

Cities have been obtaining their water from either or both of two basic sources: (1) surface supplies, water running off the surface of the land as streams or temporarily stored as lakes and ponds; and (2) ground-water, water stored or slowly flowing within the ground (Detwyler et al, 1972). A 1984 report by United Nations itemizes the characteristics of pollution of these sources through *expanding urbanization*:

- "Declining environmental quality in urban areas because of air, water and soil pollution, noise modifications to microclimate and loss of natural areas
- Severe degradation of the surrounding environment and ecological systems of hinterlands because of urban demand for resources

- Demographic degeneration of rural and urban areas because of migration with severe social, economic, and environmental consequences
- Inadequate housing, transportation, public services (water, sanitation, education, health, etc.) resulting in threats to human health and quality of life
- Deprivation of the urban poor as to such basic goods and services as food, good water and fuel
- The threat of environmental non-sustainability (Platt, 1994).

Urbanization in the modernist era began to develop in the 19th century. While the population of cities was increasing, watershed areas have been urbanized in this process. Concentrations of populations which grew in face of insufficient technical infrastructure and increasing manufacture, although it was mostly manual and small scale, settled next to waters and so were the farms polluting running waters, turning them into garbage and sewage channels. Deforestation in the mountainous areas caused landslides that filled up rivers, elevating riverbeds, causing more floods and impairing navigation. Reclamation of land from wetland for housing, industrial sites and agriculture worsened the ecosystem of the habitats.

The advent of the *industrial age* aggravated the condition of the urban rivers. Technical infrastructure was still not sophisticated; therefore, the new industries could not afford to move away from the transport and energy systems, labor pools, water sources and waste collections, so they inhabited near urban areas and water sources increasing ***pollution*** and damaging the ecosystem of the rivers and of the settlements. The condition of rivers became so critical that many of them were given names that expressed the bad smell, accumulation of wastes on their banks, *flood* hazard and other adversities, which they have now, came to be identified with.

The scenes of water quality deterioration of rivers and awful smell pervading the area surrounding rivers have been seen in developed cities such as *London* and *Boston* after the industrial revolution for about a hundred years ago. Between 1860 and 1960, London's River Thames assumed the status of sewer. As the city's main sewage-treatment facilities were improved, the tideway was cleaned up thoroughly (Owen, 2010). Then, about fifty years ago, *River Thames* was so polluted that it was declared biologically dead. Now, the river that flows through the hearth of London is awash with wildlife. Indeed, "with 120 fish species, hundreds of thousands of birds, and a thriving fishing industry, the river now ranks among the cleanest metropolitan tideways in the world" (Owen, 2005). However, the Senne River, which flows through the Brussels (Belgium) is still one of the most polluted rivers in Europe (Owen, 2010).

River pollution may occur because of *point-sources* or *non-point sources*. *Point sources* come from pollution caused by discharges[12] from industry or pollution caused by discharges from sewerage systems. *Non-point source pollution* is more complicated. It can involve diffusing of pollution from rural areas (caused by sewage, farming etc.) or diffuse pollution from urban areas through *urban runoff*. The linkage between land and water management has become most evident in the control of nonpoint sources of water pollution. The traditional emphasis on water pollution control programs has been to regulate the discharge of wastes from point sources such as sewage treatment plants and industrial facilities. Water quality goals, however, cannot be achieved with such a limited approach because much of the pollutant load comes from nonpoint sources such as runoff from construction sites, agricultural operations, and urban streets. Land use control is necessary if the nonpoint sources are can be controlled (Goodman, 1984).

Controlling point-source pollution is easier than non-point one. However, point-source pollution is still a severe case of the pollution. As Novotny (1999) states, point source discharges are regulated and limited by permits. In contrast, urban and agricultural runoff enters and diffuses to surface waters and is randomly related to the meteorological occurrences.

Xiao et al (2006), Aucharova (2006), Novotny (1999), and Semenova et al (2006) state this runoff issue as urban runoff is one of the important sources of water contamination in urban areas. With urbanization, the conversion of landscapes from *pervious* to *impervious surfaces* (buildings, roads, and parking lots) reduced the infiltration[13] rates and increased the runoff rates. In addition to this, surface runoff generated in an urban landscape leads to non-point-source pollution. Urban runoff picks up a variety of pollutants such as atmospheric dust,

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[12] Discharge is the volume of water that passes a given location within a given period of time (Kemp, 2009).

[13] Infiltration means the entry of water into the soil. The amount of water that infiltrates into the ground depends on soil properties, vegetation, topography and human activities (Ward et al, 2004).

asphalt automotive discharges, metals, bird/animal fasces etc.) (Xiao et al, 2006) and discharges it to urban rivers.

As a result, pollution sources, point and non-point, are part of the water impairment, and they are difficult to control. Still in developed countries, in general, the urban control of water is not about pollutants, but it is about what the runoff carries. The rain events associated with the climate change is part of the overall flow. This is because of the fact that the precipitation[14] is becoming more variable and it will be affected by the rainfall and the drought. According to Aucharova (2006, p.192), "Loads and concentrations of pollutants in urban runoff depend on rainfall characteristics, local atmospheric precipitation, drainage design, type of functional zone, traffic density, etc.", and "The urban areas with high traffic and pedestrian density produce severe contamination of urban runoff" (Aucharova, 2006, p.200).

There is a connection between human society, land use change and ecosystem function, at the core of which lies the water quantity and quality (Harris, 2007). "Urbanization of the upstream watershed itself produces fundamental changes in watershed hydrology. Infiltration is reduced by the creation of extensive roof area and pavement, and runoff moves more quickly from upland to stream through storm sewers[15]" (Kondolf et al, 1991, p.29). Downstream treatment facilities are more costly than the source controls. Therefore, much emphasis is currently placed on controlling storm water pollution by addressing the problem at source. The existing developed and redeveloping areas are directly subject to efforts for reducing nonpoint source pollution.

Xiao (2006) measured and stated that; Best Management Practices (BMPs) are effective management strategies resorted to reduce storm runoff and landscape irrigation demand. The measurements of various BMPs (cistern, swale, rain gutter, lawn retention basin, driveway interceptor, and drywell) in the study site shows this. Reducing surface runoff not only decreased the storm runoff, but it also increased deep percolation to groundwater. The changes observed in the hydrologic regime, would benefit the urban ecosystem. A water-

[14] Precipitation is water that falls to earth from the atmosphere in the form of rain, snow, hail, or sleet.

[15] Storm sewer is a sewer that carries only surface runoff, street wash, and snow melt from the land. In a separate sewer system, stormsewers are completely separate from those that carry wastewater (Kemp, 2009).

wise landscape can add to rainfall interception, increase soil permeability, and decrease ambient temperatures.

Certain planning measures are also being developed in this context. For example, one of the land use implications or urban streams is low-residential density. Two-acre lot and one-acre lot residential development tends 50% impervious cover. Traditional practice of *large-lots zoning* may not be sufficient to protect stream reservoirs. In addition to this, as Richards (2009) states, the *lower density scenario* creates more runoff and consumes more land than the higher density scenario. Placing a hypothetical low-density development on the urban fringe would produce 10 times more runoff than a mixed-use development in the urban core. Liu (1999) states that imperviousness of storm pollutants from low to high are; rural pollutants, large lot family houses, medium density houses, townhouses, apartment buildings, light commercial/industrial uses, and heavy industries.

It was already mentioned in the discussion on classification of rivers that imperviousness of the water surface was a relevant *criterion* and it is also used to indicate the degree of pollution. Impervious cover causes urban runoff, degrades the river habitat, increases rain discharge and raises the flood risk. In soft engineering practices, runoff is stored and treated as storing and treating runoff removes pollution from stormwater. Removing pollution from stormwater means that removing non-point source pollution from streams.

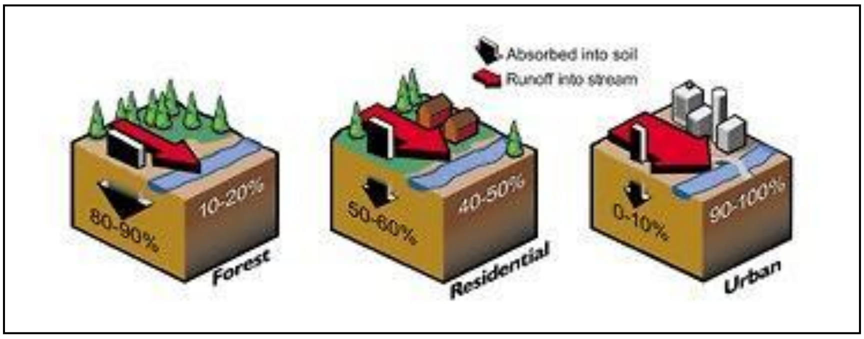

Figure 3.1 Relation between Urban Runoff and Imperviousness
Source: “Stormwater Management”, 2009

As it is seen at the figure above, decreasing the ratio of impervious surface minimizes runoff in streams, and increases the water absorbtion into soil. This is an efficient tool to be able to provide sustainable conditions in urban streams.

> "In an undeveloped watershed, most of the rain is absorbed into the soil and taken up by vegetation, with only a small amount of runoff occurring. As a watershed is developed, impervious surfaces such as buildings, parking lots and roadways prevent rainfall from infiltrating the ground. This results in increased stormwater runoff which can cause flooding and stream bank erosion" ("Stormwater Management", 2009).

The other important factor of degradation is *climate change*. Climate change means *less water* for everyone. The climate change will certainly affect the availability of water. Therefore, that is going to really affect the water management locally. Water-related impacts of climate change are (1) increasing air and water temperatures (as air temperature rises, water level rises), (2) decreasing water supply, floods, increasing pollution, sedimentation, soil erosion, water temperature and sea level. The forecast is that climate change will bring with it a greater volume of water. Most frequently it will be changing where the rainfall patterns will occur. Typically, more of the rainfall is delivered in the intense storms, which is a problem the *stormwater systems* have to address.

If hydrologic patterns change as predicted, producing less frequent but more intense rains, already struggling to manage combined sewer systems will cause increased flooding and pollution problems associated with infrastructure (Steffen et al, 2008). As Vairavamoorthy (2008, p.3) states, "the current model of urban water systems, and their corresponding infrastructure, originating from the 19th century and are questionable from the perspective of cost effectiveness, performance and sustainability". As a remedy used for about one hundred fifty years, many urban streams were converted to concrete channels, or were covered (Novotny, 2009).

> "But, underground culverted or sewered streams generally do not provide resiliency to extreme events. The capacity of buried streams is generally limited because the early designers could not anticipate demands on the systems or the extremely high level of imperviousness associated with today's millennium, the 'green movement' began to change adapt BMPs from a relatively unappealing appearance with no ecological value, to attractive and desirable assets of the urban landscape; grass ditches, swales and dry detention ponds were converted to raingardens and bioretention facilities" (Novotny, 2009, p.24-25).

The '*green infrastructure'* provides a resilient approach to the stormwater. It means managing stormwater to mimic natural processes to percolate or reuse on-site runoff (OEI, 2009) instead of gray or concrete-based infrastructure. Green infrastructure does the following: (1) preserves (protects and enhances natural features, such as undisturbed forests, meadows, wetlands, and other natural areas), (2) recycles (recycles land by directing development to already degraded land, e.g. parking lots, vacant buildings, abandoned malls), (3) reduces (reduces land consumption and development footprint by using land efficiently), and (4) reuses (captures and reuses stormwater by directing it back into the ground through infiltration or evapotranspiration) (Richards, 2009).

As part of actions taken against major river related problems, many intervention types were developed called with such terms as urban river rehabilitation, restoration, reclaiming, revitalization, improvement, and regeneration. As it can be seen in this section, everything related to water has a direct or indirect impact on rivers. Some recent methods of treating urban river health are enumerated above. Some include the *prefix 're'* in their names. This naming concept will be discussed in detailed way in Chapter 3.2.

3.2 Relevant Concepts and Definitions

In connection with the discussion mentioned in the previous section, urban rivers have been subject to rehabilitation. Rehabilitation projects on urban rivers can aim at reduction of negative conditions, reduction of their harmful effects on the environment, increase of sanitation[16], improvement of their use in provision of clean water to the residential areas, building of an efficient waste water system, and creation of reserve water areas etc. At this point, it is wise to clarify definitions and concepts relevant to the treatment types of *urban rivers*.

Some of the most commonly used concepts in literature in the subject area of upgrading treatment types of running waters are *rehabilitation, restoration, revitalization, regeneration, reclamation etc*. The literal meaning of *restoration* is bringing back to life, of something that has faded with age or been damaged, and the process of putting something, such as a piece of art or a building, back into its original condition ("Restoration (1)", 2010). At this point, definition is turning into a former position, rank; restitution for loss, damage; a putting or bringing back into a former, normal, or unimpaired state or condition ("Restoration (2)",

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[16] Sanitation means in general, "the process of keeping places clean and hygienic, especially by providing a sewage system and clean water supply" (Vliet et al, 2010, p.1).

2010). *Rehabilitation* means to restore to a former state (as of efficiency, good management, or solvency) or to restore or bring to a condition of health or useful and constructive activity (“Rehabilitation”, n.d.).

The main difference between restoration and rehabilitation is that the aim is to return the object to its original condition in restoration while this is not the case for rehabilitation. Still, it is interesting to note that in environmental and ecological literature, these concepts are used interchangeably. In architecture and art, restoration is more often used in case of singular buildings while rehabilitation encompasses an aerial scale.

In case of *river restoration,* the process aims to return the water to its original condition including all aspects like water quality, morphology, organic life, riverbed, and the like. It also entails improving the degraded points, and this is a near impossible achievement. River restoration activities may range from a simple removal of an unpleasant condition, which constrains natural stream function (e.g. repairing a damaged culvert), to stabilization of stream banks and to installation of *stormwater management*[17] facilities, such as riparian[18] zone restoration and constructed wetlands (“Stream Restoration”, 2010). There are many types of practices such as dam removal, levee breaching, modified flow control, vegetative methods for riverbank erosion control, channel reconstruction (Shields et al, 2003).

“*River rehabilitation* is the return of a degraded stream ecosystem to a close approximation of its remaining natural potential” (Shields et al, 2003, p.575). That is, by alterations, additions or deductions, implementation of new technology and engineering practices, the main characteristic features of the river including its historical, cultural, and functional values and features may be returned to its natural state in rehabilitation. Most of the literature on *river rehabilitation* involves straightening and deepening of rivers. For example, over the 90% of streams in lowland countries of Europe has been channelized. Rehabilitation works appear to take place at two scales: small and huge projects. The largest planned rehabilitation projects in Europe have taken place on the Rhine River, the Danube River. The major

[17] Stormwater management is mainly based on conveying water by pipe or channel to a discharge point. It aims to moderate runoff flows, energy use and transportation requirements and natural aesthetics (Clume et al, 2007). Storm water management is gaining importance in urban water systems with increasing residential, commercial, and industrial development (Liu, 1999).

[18] Riparian is relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater (“Riparian”, 2011).

evidence of success of these massive projects, which cost many billions of dollars, has been the return of salmonid fish to the streams (Rutherfurd et al, 1998).

The term *stream restoration* is used in US commonly; in UK the term *river reclamation* is used instead of stream restoration. This term describes a set of activities that help to improve the environmental health of a river or stream. Improving health is indicated by expanded habitat and reduced stream bank erosion. Enhancements also include improved water quality via techniques such as reduction of pollutant levels, and achieving a self-sustaining flow regime in the stream system that does not require periodic human intervention, such construction of flood control structures ("Stream Restoration", 2010).

Kondolf et al (1991, p.39) state that "the success of *stream restoration* will depend upon development of a multifaceted management plan to include floodplain[19] regulation, stormwater management from urban areas, and control of sediment input from urbanizing areas. Lacking such a plan, channel restoration[20] efforts are likely to fail". At this point, a review of some terms is needed. "*Stream restoration* differs from 'river engineering', a term which typically refers to alteration of a water body for a non-environmental benefit such as navigation, flood control or water supply diversion; and 'waterway restoration', a term used in the United Kingdom describing alterations to a canal or river to improve navigability and related recreational amenities." ("Stream Restoration", 2010).

Another term, *revitalization,* is a more recent term and has fewer frequency of use now. It is the process of making something that is failing or weak become strong and successful again ("Revitalize", 2010). *River revitalization* is used more often compared to stream revitalization. It is used in a limited number of cases such as Los Angeles and Milwaukee

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[19] Floodplain is a strip of relatively flat and normally dry land alongside a stream, river, or lake that is covered by water during a flood (Kemp, 2009).

[20] "Channel restoration may be defined as the process of altering urban stream channels (commonly neglected, channelized, and filled with trash) so they are similar to natural streams, while providing some measure of flood protection, erosion control, and a positive aesthetic experience" (Kondolf et al, 1991, p.36). "In practice, channel restoration involves removal of trash, removal of brush and trees encroached within the active channel, and selective emplacement of erosion control structures where needed to retard bank erosion" (Kondolf et al, 1991, p.36).

rivers. River revitalization refers to wider areas of city besides the river and riverfronts[21] and generally used in the context of downtown areas and surrounding neighborhoods.

Cities are playing a vital role in our societies. In difficult economic times, more than ever before, it is essential to re-invest in our cities' infrastructure and environmental improvement, which means *revitalizing*. Revitalizing is not only ecocomically but also socially beneficial. "International experience shows that revitalizing streams can leverage urban quality of life and provide a central artery to the city, an asset that has the potential of changing the image of the city and carrying immense economic value." (Carmon et al, 2009, p.3).

River restoration and river rehabilitation (and stream as well) are the concepts that are not sharply separated from each other in practice. In the literature, even in the same article, these two concepts may be used instead of each other. These two concepts have one thing in common; both are geared toward improving the ecosystem of the damaged river or stream. Shields (2003) expresses the parallel view; according to him, stream rehabilitation and stream restoration express the same thing. By the way, while considering their origins, some differences are noticed:

> "Restoration is directed towards recreating the pristine physical, chemical and biological state of rivers. In its purest sense, it means a full structural and functional return to a pre-disturbance state. Renaturalisation or naturalisation describes the naturalistic way of bringing (river-) ecosystem back to a natural state but without targeting the really pristine, pre-disturbance state. Rehabilitation indicates a process, which can be defined as the partial functional and/or structural return to a former or pre-degradation condition of rivers, or putting them back to good working order. It is dedicated to the ecologic state (biological, hydromorphological and physico-chemical) by structural and partly non-structural measures" (Schanze et al., 2004 cited as Saraiva et al, 2008, p.931).

In cities, according to pattern and density of the urban part, the rehabilitation techniques should be implemented in different ways. "In less densely developed locations where riverbanks are not lined by buildings, the river might be restored to a more attractive meandering geometry through the application of fluvial geomorphology principles"

[21] "A riverfront is a region along a river; often in larger cities that border a river, the riverfront will be lined with marinas, docks, parks, trees, or minor attractions. Today many riverfronts are a staple of modernism and city beautification." ("Riverfront", 2010).

(Fleming, 2009, p.191). This approach results in a more stable river whose waters move more slowly, and it also creates a more attractive environment for people and its habitat (Fleming, 2009).

It may be asserted that rehabilitation is a more contemporary approach to creation of a new, healthy ecosystem sustaining the basic riparian characteristics of the river through 'repair'. By the statements above, the prefix 're' for repairing rivers are seen in the frame of cleaning the water and decreasing the impairments around a river in general. The success of traditional rehabilitation is generally measured by whether or not the river is able to sustain its achieved health level, by its own natural activities without necessitating interference by humans. In this thesis, the term *river rehabilitation* has been adopted to address the kind of efforts mentioned above as it more conveniently expresses upgrading currently implemented. Yet, the recent implementations have tended to broaden their treatments. Below, the changing aspects of *urban river rehabilitation* are discussed.

3.3 Urban River Rehabilitation, Changing Aspects and the Best Practices

With the rapid urbanization of 1950s and 1960s particularly in developing countries, the first intervention to rivers in cities was to *prevent floods*. Floods have taken place since ancient times, so preventing techniques such as planting of vegetation, terracing to slow down landslides, building of channels to divert the river have been used ever since. With the development of engineering levees (An embankment raised to prevent a river from overflowing) and dikes (embankment, natural or artificial slope or wall to regulate water levels were introduced.

The traditional approach emphasized *enlargement and straightening of the river* and building of high banks. Straightened concrete channels have been used to achieve flood control. However, this approach did not prove very effective in controlling floods as certain failures were experienced, such as in San Lorenzo River. In some cases, designers of channelization projects have overestimated or underestimated roughness by ignoring the effects of sediment. Consequently, the traditional implementations thereby have appeared to control flood, but they may fail to perform properly (Kondolf et al, 1991).

Increasing pollution with increasing population especially in developing countries in face of inadequate infrastructure raised public awareness of water borne epidemics. One artificial remedy was *isolation of rivers from public* as water quality of urban rivers became poorer in time owing to ineffective environmental measures. “A foul, stinking stream is hardly an amenity, so isolating such waters in underground conduits was no doubt seen as a positive step” (Kondolf et al, 1991, p.36) within traditional approach. However, as with the deficiencies of traditional implications and through increased environmental awareness, improving the water quality and *daylighting*[22] of these buried channels have become a focal point for efforts to restore districts (Kondolf et al, 1991).

Through mid-20th century, most rivers were in natural condition with a few artificial structures. Rivers and streams were seen as sources of floods and sewer paths. Rehabilitation of urban rivers was taken up almost universally after the second half of the 20th century in particular. In 1970s, river management mainly focused on flood control (channelization) and water use. Thus, they lost environmental functions, ecological habitat, self-purification and riparian scenery. At those times, the approach was technical in nature and concentrated on the river itself, including measures like the widening and structuring of riverbed, structuring of banks, creating and/or connecting side channels, reconnecting backwaters, restructuring of longitudinal connectivity by removing barriers that cause habitat fragmentation for organic life and the like. The basic aim was to transform the river back into its natural state.

In early 1980s, floodplains of streams were occupied by parking lots, roads, farmlands and recreation areas etc. In the late 1980s, social needs emerged for *improvement of river environment* (water quality and aesthetics). To this end, walkways, cycling roads and green parks were created along certain sections of the river and rehabilitation was confined to the river and its immediate environment. Since 1990s, *ecological river improvement* techniques have been used (Kim, 2006). Main targets of river restoration changed from water quality of 1950s and 1960s, to enforcement of 1970s, to landscape and amenities of 1980s, to nature and ecosystem of 1990s, and finally to improvement of relationship between river and

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[22] “*Daylighting* restores the natural drainage system using surface waterways by removing them from the pipes in which they were entombed. Daylighting still addresses flood control, and stormwater management objectives but also adds value by maximizing ecological and water quality benefits. It also begins to regognize stream corridors as potential amenities in site an urban design. The goal is to physically connect people to the natural systems in which they live.” (Hitzhusen at al., 2007, p.183).

human of 2000s (Wada, 2010). Table 3.1 below summerizes this transition of river rehabilitation practices in time.

Table 3.1 Transition of River Rehabilitation Practice in Time

Period	**Transition of River Rehabilitation Practice**
Before 1850s	*Natural Stream* Most rivers were in natural condition.
1860s-1960s	*Sewer status stream* A few artificial structures existed.
1970s	*Flood Prevention Stream* River management mainly focused on the flood control (channelization). Rivers lost environmental functions, such as providing an ecological habitat, self-purification, and riparian scenery.
1980s	*Park Stream* Parks along urban streams were constructed. Most parks were constructed on the floodplains.
1990s	*Ecological river improvement* techniques have been employed to enhance the environmental function of the stream.
2000s	*The relationship between river and human*, nature and community improved.

Source: Adapted from Kim, 2006; and Wada, 2010

Now, rivers and streams in cities are not seen as urban infrastructure elements; they are now becoming important themes for the restoration of nature ("Urban Fishing", 2010). There are lots of urban river rehabilitation programs and projects around the world like the Cheonggyecheon River (South Korea), the Singapore River (Singapore), Boston Bay (USA), the River Rhine (Netherlands), the Itachi River (Japan) ("Urban Fishing", 2010). Table 3.2 demonstrates further examples.

Table 3.2 Some Major Urban Rivers and Rehabilitation Efforts on Them

Project Name, City, and Year	Descriptions of Rehabilitation Projects
London Rivers Action Plan - London, UK-Since 2002 (target year: 2015)	The plan aims to restore *Thames* tributaries of 15 kilometers of to their natural state, creating a more sustainable city, as well as reducing the flood risk and improving the environment for all. River Thames itself is already considered today one of the world’s cleanest metropolitan tideways. Once a biologically dead river, in 2010 it won the world's biggest environmental prize.
The Banks of the Rhone River - Lyon, France - 2006	Until 2006, large portions of the riverbanks of *the Rhone River* had been planned to be rehabilitated by the *Lyon* agglomeration authority Le Grand Lyon. The rehabilitation program embraces an area of about 60.000 m² where new functions are brought.
Emscherumbau Plan - Emscher, Germany- Since 1990	The mining history of the Emscher region shapes the urban character of the Emscher basin in the Ruhr valley. The ‘*Emscherumbau Plan’* has been in force since 1990 and advocates the rehabilitation of all water bodies within the Emscher catchment basin, aiming at a sustainable use of water and providing for the future needs of the region.
Isar Plan - Munich, Germany- 1995 (project implementation: 2000-2006)	The *‘Isar-Plan’* was initiated in 1995. It is a joint programme of the State of Bavaria and *City of Munich*, designed to improve flood defense, ecology and recreational value on the Isar River in Munich by 2006. The project deals with the restructure of an 8 kilometer-strip of the river beginning on the southern borderline of the City of Munich up to the Deutsches Museum, located on a river island nearby the city center. The target was to change the artificial, unattractive riverside into a natural, attractive area with high ecologic value and a large-scale recreation area.
The Zurich Stream Daylighting Program, Zurich, Switzerland - 1988	A clean-water concept for separating of uncontaminated water from sewage channels was extended into a stream restoration concept. The goal was to ‘daylight’ as many streams as possible, realigning them on the surface so as to increase ecological and recreational values within the urban area of the *city of Zurich*.
Restoration of Besòs River - Barcelona, Spain - 1999	*Besòs River* is a torrential river flowing through the urban area of *Barcelona*. It has been named the most contaminated river in Europe during the 1970s and 1980s. Since the mid-1990s, however, the river has been in the process of recovery. The design of a meandering low flow channel within the floodway is dealt with. Constructed wetlands to improve water quality were planned for the floodplain on both sides of this channel.

Table 3.2 Some Major Urban Rivers and Rehabilitation Efforts on Them continued

Porsuk River Rehabilitation - Eskişehir, Turkey - 2001	*Eskişehir's Porsuk River*, which passes through downtown area, was restored in 2001 by the Eskişehir Greater Municipality (EGM) under a package project. *Eskişehir Urban Development Project* has 3 phases: preventing flooding damage with restructuring riverbed, renewing canals and urban water system infrastructure, improving a tramway system. These main objectives were reinforced by creating parks and walking ways nearby the river, renewing old bridges and building new bridges on the river, setting up designs for boats etc.
Cheonggye River Restoration Project - Seoul, South Korea - 2005	*Cheonggye River, Seoul* (South Korea) was covered by a road (1967-1976). The road became old and despite reinforcement, it became dangerous for use due to aging. Solutions drawn with *Cheonggye River Restoration Project* are mainly removing the road, and daylighting a buried stream that was under highway. This is the world's first case of urban re-development project carried out by removing the road and restoring the river. The Project includes developing a linear park, open watercourses handling flooding rains and global warming, increasing fish and bird species, transportation changes like expanded bus services, etc.
Funan River's Comprehensive Revitalization Project - Chengdu, China - 1996	The biggest venture of the project is *The Living Water Garden*, a 2,4 ha park on the river. The river passes through the center of *Chengdu*, a city of nine million. In the park, there are pumps, settling ponds, reconstructed wetlands, natural water purification system, various plant species, steps going down to the river to provide public access, and various sculptures as public arts to raise awareness of the pollution in the *Funan River*.
Singapore River Planning, Singapore, Singapore - Beginning of 1990s	The river forms a central artery in *Singapore*'s densely packed Central Business District. A long promenade was constructed to offer shady walkways, art venues, restaurants for alfresco dining, entertainment and retail establishments in conserved shop houses for rest and recreation. Key points of restoration are water purification, and river development unified with the city. After purification, land value was raised, fish returned to *Singapore River*, some catchments are opened to public for boating and swimming.
Muddy River Restoration Project - Boston, MA US - End of 1990s	The objectives of the *Muddy River Restoration Project*: Improvement of flood control, improvement of water quality, enhancement of aquatic & riparian habitat, rehabilitation of landscape and historic resources, and implementation of Best Management Practices (BMPs). Riverfront already provides a range of public space such as promenades, walking ways, bike paths, parks, boating, river clean-up days.

Table 3.2 Some Major Urban Rivers and Rehabilitation Efforts on Them continued

San Antonio River Improvements Project - San Antonio, TX US - Since 2002	The *San Antonio River* runs through downtown *San Antonio*. The *'river-walk'* is already the major attraction in the city and location of many shops and restaurants, and high-class hotels. The benefits of this four-phased project: ecosystem restoration, flood damage reduction, improving quality of life, developing cultural connections and promoting economic development along and adjacent to the river.
Los Angeles River Revitalization Master Plan - Los Angeles, CA - 2002	In 2007, the city adopted a master plan for the revitalization of the 32-mile long river with visions to 'reconnect, re-imagine, and re-claim' the forgotten watershed. The plan details strategies to realize the city's goals of revitalizing the river, greening neighborhoods, capturing community opportunities, and creating value. The plan is intended to guide the construction of a series of parks along 48 kilometers of the river from Canoga Park to downtown *Los Angeles* over 25 to 50 years. It consists of over 200 projects, most of which are small-scaled. Revitalizing the *Los Angeles River* would address not only the need to rehabilitate the ecological functions of the watershed, but would also target the city's deficiency of neighborhood parks.

Sources: Conradin, 2004; "London Rivers Action Plan", n.d.; "London Rivers Are to Be Restored", 2009; Martín-Vide, 2001; "Muddy River Restoration Overview", n.d.; "Munich Isar Plan", n.d.; Park, n.d.; "Restoration of Singapore River", n.d.; "San Antonio River F.", 2011; Schanze et al., 2004; Stein, 2009; Yuen, n.d.

3.4 Conclusion

This Chapter started with the major issues related to urban rivers. This section is important because, as it will be mentioned at several relevant points later on, rivers and streams have developed a dual nature of impact on human settlements in time with increasing population, diversifying economy and careless use of water. The impact of the duality is defined, the reasons behind and the consequences are underlined.

The next section in the chapter is the discussion on definitions and concepts related to river upgrading. It was underlined that, in general, two concepts are used interchangeably to describe this process: rehabilitation and restoration. In this study, the term rehabilitation has been adopted as it more effectively expresses the kind of upgrading currently implemented. The discussion is centered on the changing aspects of urban river rehabilitation through time.

Most common measures in history were taken to control floods, and several technical applications were realized like planting of vegetation, building channels, dikes, dams and ponds etc. The transition is shown via review of literature, and via the tendencies in recent practices.

The discussion is supported by best practices of some major urban rivers and rehabilitation efforts on them conducted in the context of new understanding of rehabilitation. Involved within the lights of this discussion are theoretical and practical dimensions. In view of the complexity and close interrelation of the problems, it was obvious that they could not be handled singularly and merely with structural upgrading techniques. It is no longer sufficient to attempt to preserve natural and manmade environmental element degradations and problems in the traditional manner. The next chapter focuses on the reflections of new approaches to cities.

CHAPTER 4

EVALUATING URBAN RIVER REHABILITATION THROUGH REFLECTIONS OF A LEADING NEW APPROACH: ECOCITY

4.1 Evolution of Eco-Approaches

In the last 20 years, several paradigms or movements have been developed related to sustainable living in urban areas, such as *New Urbanism*, *Smart Growth*[23], *Ecological Urbanism*, *Landscape Urbanism*, *Urban Ecology*, and *Ecocity*. New Urbanism is an urban design movement, and promotes pre-automobile, traditional neighborhood design with prominent pedestrian walkways. It arose in the United States in the early 1980s basically to be applied in urban sprawl. It is closely related to the broader concept of smart growth ("New Urbanism", 2010). *Smart growth*, an urban planning theory dating from 1970s, is about concentrating growth in compact, walkable urban centers, it is against urban sprawl and advocates compact cities with walkable, bicycle-friendly neighborhoods and mixed land use ("Smart Growth", 2010). Another discourse *Landscape Urbanism* establishes the significance of infrastructure and its associated landscape in the development of contemporary urbanism, and in the generation of public space" (Mossop, 2006, p.165). Moreover, design movements such as the City Beautiful Movement[24] and Garden City were the efforts creating an alternative urban ideal rooted in aesthetics, environmentalism and moral order (Boone, 2006).

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[23] Smart growth covers a range of development and conservation strategies that help protect our natural environment and make our communities more attractive, economically stronger, and more socially diverse ("Smart Growth, Basic Information", 2010). "Smart growth strategies have been used by communities for years to protect open space, use infrastructure more efficiently, reduce air pollution, improve water quality, and enhance quality of life." (Steffen, 2008, p.72).

[24] "The development of city planning in advanced nations during the 1920s and 1930s was largely governed by mechanistic considerations of building design, site planning, physical infrastructure, and density. Such functionalism represented a major improvement over the purely aesthetic neoclassicism of the 'City Beautiful' designs of the turn of the century, but the relationship of human settlements to the natural world was largely neglected" (Platt, 1994, p.7).

> "The science that informs our management of natural resources and the environment is called ecology. […] The science of ecology attempts to understand the interactions between the organisms and processes that form the basis of what has been called the 'economy of nature'. [...] The science of ecology, such as it is, has a strong observational base in natural history and a theoretical basis in mathematics. The science of ecology is an attempt to understand the great complexity of the natural world and to provide humans with some predictive tools. In the past thirty years or so the science of ecology has become more socially involved." (Harris, 2007, p.39).

Lewis Mumford addressed broad issues of the ecological sustainability of cities. "In 'The Natural History of Urbanization', Mumford identified three stages in the evolution of cities in relation to their natural environments: (1) ancient cities such as Babylon that were dependent upon and limited by the resources of their immediate hinterland; (2) imperial cities such as Rome that expanded artificially by preempting food, water, energy and other resources from external sources; and (3) the postindustrial conurbations of Europe and North America." (Platt, 1994, p.8). According to Mumford, covering the natural site with an artificial environment enhances the dominance of man and encourages an allusion of complete independence from nature (Platt, 1994). Therefore, there is need to go back to establish the balance between nature and human communities through *ecosystems*.

By *urban ecology*, first ecologists tried to understand the interactions between people and the natural environment, in which their cities exist. However, this term was studied by sociologists who sought to use the ecological theory to describe human behavior in the urban setting. Today's attempts are to integrate human-dominated ecosystems into ecology itself (Collins et al, 2000). One of the principles of urban ecology is to restore damaged urban environments, especially creeks, shorelines, ridgelines, and wetlands (Roseland, 2001). The new approach for urban waters is based on the ground that urban waters are the lifeline of cities and the focus of the movement is towards greater sustainability.

As urban ecologists state, "urban ecology has not focused on the traditional environmental priorities of preserving land, air and water. Neither have we had a traditional community development focus aimed at, for example, generating affordable housing. Rather, our work has integrated elements of these disciplines and others, with *healthy 'human habitats'* as the common denominator." ("Urban Ecology", n.d.). Another parallel approach *'ecological urbanism'* explores alternative approaches between ecology and architecture, landscape architecture, planning, and urbanism (Graduate School of Design, Harvard University, 2010).

> "The disciplines of planning and urban design will need to consider new models of development. Ecological urbanism provides one possible mode of thinking and designing the future city. […] The modernist paradigm of planning still in many respects of dominant mode of practice today needs to be supplanted by alternative strategies of thinking about the city. But we should also be very of a nostalgic return to some pre-modern ideal. Clearly we need to be respectful of the past to learn from it and to think how the contemporary and possible future circumstances of our cities provide the basis for alternative forms of spatial design that recognize the conflictual, dynamic and diverse qualities of urbanism." (Mostafavi, 2009).

4.2 The Ecocity: Concept and Evolution

Urban growth, which developed especially in the second half of the 20th century in form of somewhat unplanned sprawl, resulted in the deterioration of historical centers, poor infrastructure and transportation, increased pollution, reduction in green and public areas, pollution, congestion and finally degradation of urban environment and quality of life. To clarify the concept further, Collins et al (2000, p.416) stated,

> "In cities, people mobilize some nutrients and deplete others, create habitats that never before existed, divert water, increase temperatures and, by intent or by accident, manipulate the communities of other species found within city boundaries and beyond. Cities are some of the most profoundly altered ecosystems on the planet; within their boundaries are also found some of the most diverse ecological conditions. If there is a laboratory where ecological change can be viewed at close hand, it is the city".

In view of the complexity and close interrelation of the problems, it was obvious that they could not be handled separately, individually and even locally. It was no longer sufficient to attempt to preserve the natural and manmade environmental element degradations and problems traditionally and individually. A new method had to be introduced, one which would unite them on a common denominator. The answer came from the field of biology, which was born out of concern for creation and maintenance of a healthy relationship between the environment and the human society, the *ecology*.

Ecology involves the environment as it relates to living organisms within an *ecosystem*; it is formed by the interaction of a community of organisms with their physical environment. The concept of *ecocity* that was born with reference to ecosystems is a city designed with consideration of environmental impact, inhabited by people dedicated to minimization of required inputs of energy, water, air, food, and wastes. The ecocity approach means the city planning and design is strongly informed by knowledge of ecology and its principles.

Human health, human well-being obviously surpasses all other aims put forth for human societies, as degradation of environment and of quality of life do not only lead to decreased pleasure to be derived from urban life but also to loss of human lives and destruction of environment. Therefore, this new approach, in essence, not only aims to preserve and upgrade the environmental elements, as has been the case so far, but the relationship between the living organisms and their environment. This brings the difference and the superiority of the ecological approach in upgrading human societies, and both natural and built-up environments.

Richard Register first coined the term *ecocity* in his 1987 book, *Ecocity Berkeley: Building Cities for a Healthy Future*. Other leading figures who have written extensively on the subject are architect Paul F. Downtown, and authors Timothy Beatley and Steffen Lehmann. The basic and unique principle of the ecocity is its *integrative*, is to be *comprehensive* and *unifying* (Gaffron et al., 2005). The vision of and ecocity is depicted in the figure below, which is an outcome of the Ecocity Workshop II in Vienna 2002.

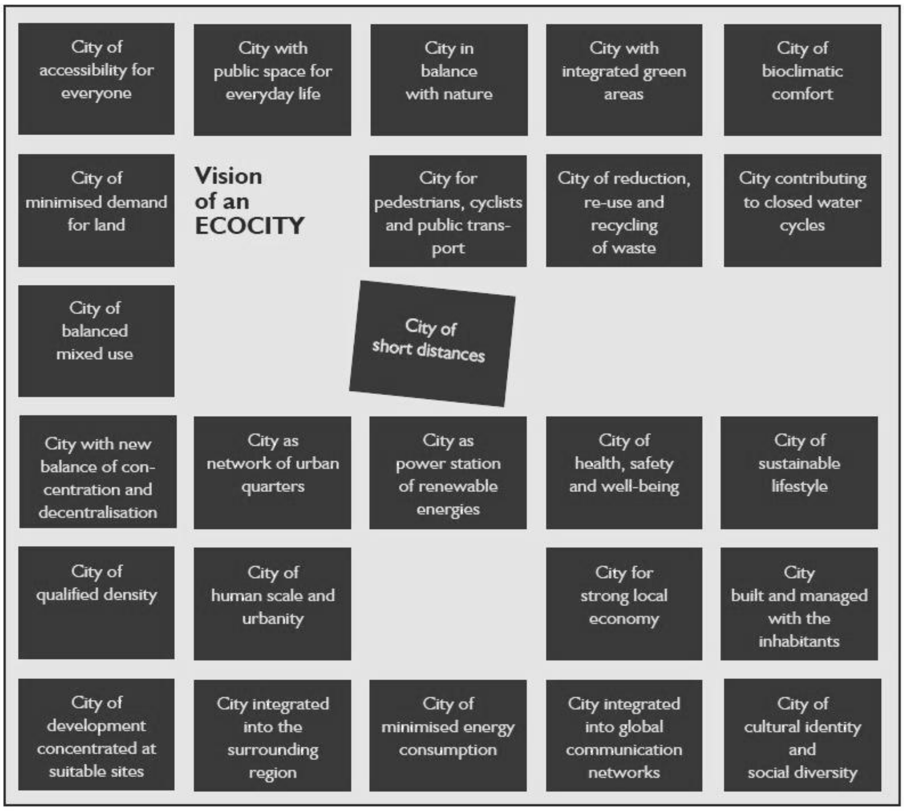

Figure 4.1 Vision of an Ecocity
Source: Gaffron at al, 2005, p.17

An ecocity is a city, or a part thereof, that balances social, economic and environmental factors (triple bottom line) to achieve sustainable development. Ideally, a sustainable city powers itself with renewable sources of energy, creates the smallest possible *ecological footprint*[25] and produces the lowest quantity of pollution possible. It also uses land efficiently, composts used materials, recycles or converts waste-to-energy. If such practices are adopted, the overall contribution of the city to climate change will be none or minimal, i.e. below the resiliency threshold. Urban green infrastructure, resilient, hydrological and ecologically functioning landscape, and water resources will constitute one system (Novotny, 2010).

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[25] Ecological footprint is the area that would be required to support a defined human population and material standard. The ecological footprint is a measure of how much nature we have and how much nature we use. In other words, the ecological footprint measures how fast we consume resources and generate waste compared to how fast nature can absorb our waste and generate new resources. Towards end of 1990s, global ecological footprint has gone beyond world biocapacity and that trend is keeping on (Register, 1987). This indicator was propounded by William Rees.

Ecocity is a city designed with consideration of environmental impact, inhabited by people dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution, and water pollution (Novotny, 2010). The basic and unique principle of the ecocity is its *balance with nature*. In theory, ecocity is a logically compact settlement, saving space, energy and infrastructure; the emphasis is on pedestrians, bicycle traffic and mass public transportation. The city image is based on attractive public spaces, lush green areas and well preserved historical and touristic sites. Creating an ecocity involves an integrated approach.

The system concept helps us recognize that there are connections between functions in a coherent structure (Lein, 2003). A river itself is a dynamic system, which has its own homeostasis, a city itself is a dynamic system as well, and beyond that, they both are parts of an interrelated dynamic system as well. Moreover, river and city can be interrelated because both of them are open systems.

By imitating nature, built or artificial environment will produce no waste. Every output would be recycled and reused within the system. While Yeang and Powell (2007) call the process of imitating ecosystems as *'ecomimesis'*, Novotny (2010) calls it *'mimicking the nature'*, while others such as Benyus (1997) prefer *'biomimicry'* to refer to the same process. Yeang and Powell (2007) state that, nature without humans exists in stasis, therefore, to achieve a similar *state of stasis in our human built environment*, our built forms and systems need to imitate nature. It brings the discussion to how human can design his buit systems so that they would be like ecosystems. As a matter of fact, ecosystems produce nowaste, everything is recycled within the system.

Below, goals and objectives of eco-cities are summarized in Table 4.1. After that, the goals of ecocity expressed in the table above are evaluated with the criteria and indicators summarized in Table 4.2.

Table 4.1 Ecocity Goals and Objectives

Overall Ecocity Goals for Urban Structure	
• Minimize demand for land (particularly for greenfield sites); avoid urban sprawl • Minimize primary material and primary energy consumption; achieve energy-saving and material-saving settlement structure • Minimize transport demand: by optimizing mix of use • Minimize impairment of the natural environment and human health • Maximize mental well-being and community feeling; enhancing urban comfort, livability, mix of use, communication and opportunities for social contact, safe and barrier-free access, aesthetics, diversity, short distances, gradual development, sufficient space forworking and living	
Objectives for	
Demand for Land	• Increase re-use of land and built structures to reduce demand for land and new buildings • Develop structures of qualified high density
Land use	• Organize a balance of residential, employment and educational uses as well as distribution, supply and recreational facilities • Strive for fine-meshed, mixed-use structures at building, block or neighborhood level
Public Space	• Provide attractive and livable public spaces for everyday life • Consider livability, legibility and connectivity of public space patterns
Landscape / Green spaces	• Integrate natural elements and cycles into the urban tissue • Create landscape patterns for high social usability
Urban Comfort	• Strive for daily, seasonal and annual outdoor comfort • Minimize noise and air pollution
Buildings	• Maximize indoor comfort and resource conservation throughout the lifecycle of buildings • Plan for flexible, communicative and accessible buildings

Source: Gaffron et al, 2005, p.21

Table 4.2 Core Criteria and Indicators for the Ecocity Evaluation Scheme

Criteria and Indicators	
Urban Structure	**Energy/Material Flows**
Building density Location of settlement Mix of uses Public spaces Landscaped area Urban comfort Integrated planning	Energy efficiency Energy demand Greenhouse gas (GHG) emissions Building materials Soil movement Water management
Transport	**Socio-economy**
Infrastructure provision Modal split and CO2 Accessibility User friendliness Quietness Provision of parking spaces	Community involvement Social infrastructure and mix Economic infrastructure Labour-related issues (employment) Profitability (costs)

Source: Gaffron at al, 2005, p.89

According to Register (1987, 2006), main principles of ecocities are;

- Compactness
- Lively settlements
- Waste less land
- Low energy consumption
- Reduced water demand and loss
- Fewer ecological and water footprint
- Partly closed (hybrid) or closed water system loops
- Higher levels of stream, wetland or lake protection
- Stream restoration
- Renewable energy such as solar and wind
- Recycling technologies
- Foot, bike, and public moods of transportation
- Healthy environment
- Mixed-use planning
- Decentralized management of water system

- Reduced carbon emissions
- Rainwater harvesting
- Maximum permeability of surfaces
- Created wetlands
- Separation of grey water[26]and stormwater infrastructures
- Integration of ecoblocks

Novotny (2009) as well, listed the main challenges of ecocities:

- A complete change of the paradigm
    - Closed urban hydrologic cycle (reuse, recycle), surface drainage
- Non or minimal carbon imprint supports ('One Planet Living Criteria')
    - Energy recovery from wastewater
    - Distributed resource recovery, minimum sewers
    - Alternate energy sources
    - Carbon sequestering
- Terrific public transportation, walking and biking paths
- Alternate energy sources
- Stream restoration and protection of ecosystems
- Leisure and recreation
- Huge infrastructure business potential

As it can be seen, water related innovations in ecocities constitute a significant place from closed-loop water system to stream restoration. In this section, after elaborating on the concept, emergence, vision, and principles of ecocities, next section will be on how ecocities handle water resources and streams. Before it, ecocity best practices around the world are listed in the Table 4.3 below.

[26] Grey water is a wastewater from washing machines, showers, bathtubs, hand washing, lavatories and sinks (Kemp, 2009).

Table 4.3 Ecocity Best Practices around the World

Country	**City**
Australia	Sydney
Brazil	Curitiba
Canada	Dockside Green
Canada	Toronto
China	Caofeidian
China	Dongtan
China	Huangbaiyu
China	Qingdao
China	Shanghai
China	Shenyang
China	Tianjin (Sino-Singapore Tianjin)
China	Cluster of cities in the Pearl River Delta
Equador	Loja, Equador
Germany	Freiburg
Iceland	Reykjavik
Ireland	Clonburris
Kenya	Hacienda, Mombasa
New Zealand	Waitakere, Auckland
Philippines	Puerto Princesa
Sweden	Hammarby Sjöstad, Stockholm
Sweden	Waxjo
Sweden	Malmö
United Arab Emirates	Masdar, Abu Dhabi
Uganda	Campala
UK	2010 Olympic Sites
USA	Alexandria
USA	Arcosanti, Arizona
USA	Sonoma Valley
USA	Treasure Island, San Francisco

Source: Produced by the Author

Ecocities have been turning into reality from theoretical and experimental dimension in some countries for the last few decades. The table above shows the most familiar ecocities in the world such as Dongtan, Tianjin, Freiburg, Malmö and Masdar. As an example, projected ecocity Dongtan will be built near Shanghai. Designers hope to meet the goals of zerocarbon emissions by alternative energy technologies, such as wind turbines, and through urban design that encourages walking, biking, and playing. Dongtan city will be built on the island of Chiongmin in the Yangtze River near Shanghai. The population of this new metropolis determined is half a million people. The megaproject of ecocity is being developed in partnership with the international corporations (Wagner, 2008).

Register (2006, p.7) states also makes mention of these cities besides those in his book: “Cities such as Vancouver, British Columbia; Portland, Oregon; Curitiba, Brazil; and Waitakere, New Zealand, are making ecological progress on a number of fronts, and the international ecovillage movement is steadily growing”. The interventions, mostly the water-related ones, of these cities are detailed in the following section.

4.3 Water within the Context of Ecocity

The evaluation of water-centric operation within the context of ecocity concept is significant for the basic assumptions of this thesis. The particular assumption states that the theory of ecocity might help show a way to proceed and realize a more environmentally sustainable future for our water resources and streams in urban areas. The present urban plans, which are no longer of comprehensive nature of the 1970’s, can be prepared as the plans which have the ecocity principles in their visions. These are also reflected in the accompanying strategies and policies. Within this study’s context, urban river rehabilitation can be incorporated into sustainable urban water resources *through the lens of ecocities*.

It has already been argued earlier in the study that traditional urban river rehabilitation involved technical measures in general. These measures were not only technical but also were limited to the problem zones, and some of them even can have negative impacts on the river habitat. The assertion at this point is that all these measures should be combined by other considerations, which are related to the city as an urban ecosystem. While the new approach has come into prominence with the late 1990s and the 2000s, it was indicated in the former section that the paradigms have been transformed. The table below expresses the transition urban water system has gone through.

Table 4.4 Characteristics of 'Old' and 'Emerging' Paradigms of Urban Water Systems

The Old Paradigm	**The Emerging Paradigm**
Wastewater is a nuisance. It should be disposed of after treatment	*Wastewater is a resource*. It should be captured and processed effectively. It should be used to nourish land and crops.
Stormwater is useless. Stormwater should be conveyed away from urban area as rapidly as possible.	*Stormwater is a resource*. It should be utilized as a water supply. It should be infiltrated or retained to support aquifers, waterways and vegetation.
Demand is a matter of quantity. Amount of water required or produced by different end-users is the only parameter relevant to infrastructure choices. Treat all supply side water potable quality, and collect all wastewater for treatment.	*Demand is multi-faceted*. Infrastructure choice should match the varying characteristics of water required or produced for different end-users in terms of quantity, quality, level of reliability, etc.
One use (throughput). Water follows one-way path from supply, to a single use, to treatment and disposal to the environment.	***Reuse and reclamation***. Water can be used many times, by cascading from higher to lower quality needs. It should be subjected to reclamation treatment for return to the supply side of infrastructure.
Drainage oriented. Rapid conveyance of stormwater from premises by underground concrete pipes or culverts, curb and gutter street drainage	***Storage oriented***. Keep, store, reuse and infiltrate rainwater on site or locally, extensive use of rain gardens, drainage mostly on surface
Gray infrastructure. Infrastructure is made of concrete, metal or plastic.	***Green infrastructure***. Infrastructure includes not only pipes and treatment plants, made of concrete, metal and plastic, but also soils and vegetation, such as greenroofs.
Bigger / centralized is better for collection system and treatment plants.	***Small / decentralized is possible***, often desirable for collection system and treatment plants.
Limit complexity and employ ***standard solutions***. Small number of technologies by urban water professionals defines water infrastructure.	Allow ***diverse solutions***. Decision makers are multidisciplinary. Allow new management strategies and techniques.
Integration by accident. Water supply, wastewater and stormwater may be managed by the same agency as a matter of historical happenstance. Physically, however, three systems are separated.	***Physical and institutional integration by design***. Linkages must be made between water supply, wastewater and stormwater, which requires highly coordinated management.

Table 4.4 Characteristics of 'Old' and 'Emerging' Paradigms of Urban Water Systems continued

Collaboration means public relations. Approach other agencies and public when approval or pre-chosen solution is required.	***Collaboration means engagement***. Enlist other agencies and public in search for effective solutions.
Community expectation of water quality. Distorted by hard infrastructure and past abuses such as buried urban streams, fenced off streams converted to flood conveyance and/or effluent dominated	***Daylighting and/or renaturalization*** of water bodies with ecotones (parks) connecting them with the built areas enhances the value of surrounding neighborhoods and brings enjoyment
Low resilience to extreme events. Underground stormwater conveyance can handle only smaller storms, infiltration is low or nil, fast conveyance results in large peak flows	***Surface drainage with bioswales[27] or bioretention.*** In addition to storage and infiltration, increases dramatically resilience of the watersheds to handle extreme flows and provide water during the times of shortages.

Source: Adapted from Mitchell, 2006; and Novotny, 2010

The chart above compares traditional cities and *cities of the future*[28] with respect to water management. It point out directly related concepts of urban waters as well as the indirectly related as well as important concepts as public transportation and energy. Novotny states that by using less polluting fuel, improving public transportation, making bike paths and adopting the BMPs on roads would reduce water pollution caused by traffic. Energy recovery, and reduction of use as a part of the heat in wastewater, will be recovered and used locally without carbon emissions (Novotny, 2010).

4.4 Ecocity Best Practices and Water

Within the *emerging paradigm*, technical measures have finally taken the city as a healthy system. The new paradigm sees wastewater, stormwater and rainwater as a resource as they exist in the cycles of nature, and it seeks to discover ways of efficiency by recycling and reusing. It embraces a transformation to a green infrastructure from grey infrastructure; it

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[27] Bioswale (or vegetated swale) is a wide, shallow channel with a dense stand of vegetation. They are designed to promote infiltration, reduce the flow velocity of stormwater runoff and maximize time water spends in the swale, which aids in capturing pollutants ("Bioswale", n.d.).

[28] Novotny calls new cities managing water in a sustainable way as Cities of the Future (COTF). (Novotny and Brown, 2007). COTFs have many challenges those the traditional ones have not.

allows decentralized system designs, tries to daylight the flowing water bodies and connects them with neighborhoods, pursued coordinated management and public engagement. The table below shows basic data (population, population density, energy saving, green area, and cost) and some water-related data (water use, water recycle, water system type) of known ecocities:

Table 4.5 Basic Data Related to Water of Ecocities

City	Population	Population Density (per ha)	Water Use (L/cap-day)	Water Recycle (%)	Water System	Energy Savings Renewable (%)	Green Area (m²/cap)	Cost (US$/unit)
Hammarby Sjöstad	30,000	133	100	0	Linear	50	40	200,000
Dongtan	500,000 (80,000)+	160	200	43	Linear	100	100	~40,000
Qingdao	1500+	430 - 515	160	85	Closed Loop	100	~15	
Tianjin	350,000 (50,000)+	117	160	60	Partially Closed	15	15	60,000 – 70,000
Masdar	50,000	135	160	80	Closed Loop	100	<10	1 million
Treasure Island	13,500	170	264	25	Mostly Linear	60	75	550,000
Sonoma Valley	5,000	62	185	22	Linear	100	20	525,000

Source: Novotny, 2009

The ecocities included in Table 4.5 reveals the fact that the major water related objectives of ecocities are minimizing water consumption, avoiding waste, minimizing potential damage of natural waterways, collection and recycling of used water, increasing permeability of hard urban surfaces, inducing healthy storm water management, protection of all water system from pollutants, and restoration of all water bodies.

In addition to the cities above, Malmö (Sweden) is also a good example to water-centric ecocities. One of the greenest cities in Europe, Malmö, is highly related to tackling with high-level water and stormwater management. Stormwater management was great problem in Malmö. In addition to anticipating climate change, the sewage system was old and had no enough capacity for growing population. Canals are part of the rainwater collection system in neighborhoods. Almost all buildings have renewable energy (Fitzgerald, lecture notes, 2009). In Malmö, “The trend […] is to replace traditional planning procedures with a more integrated structure to city planning with water, green structure, and waste plans, developed alongside the masterplan” (Eran, 2001, p.163).

Table 4.6 Changes Realized Through Contributions of World-Known Ecocities

Ecocity	**Challenges**
Hammarby Sjöstad, Sweden	Heat extracted by wastewater, Carbon-neutral-oriented neighborhood, Green infrastructure
Sino-Singapore Tianjin, China	Water recycling in awater scarce region, Partially closed urban water cycle 50% of water supply from non-traditional sources, At least 20% of energy usage from renewable sources, At least 90% traveling to be green trips Integrated masterplan
Qingdao, China	Ecocluster composed of ecoblocks, Constructed wetlands for treatment within, 85% waste water recycling on site, Closed water system
Dongtan, China	Venice-type water-centric ecocity on Yangzee River, 60% smaller ecological footprint, Requiring 66% less energy, will produce 40% of its energy from bio-energy, Cycling, walking, great green area portion, hydrogen fuel-cell buses and solar-powered water taxis. The boats will use a network of canals and lakes
Masdar, Abu Dhabi, United Arab Emirates	Carbon neutral city, Renewable energy, Closed water loop, it reuses and recycles water several times
Treasure Island, CA US	Skyscrapers and ferry services to the mainland, small, pedestrian-friendly blocks, Constructed wetlands to purify storm water runoff Large proportion of green areas

Table 4.6 Changes Realized Through Contributions of World-Known Ecocities continued

Sonoma Mountain Village, CA US	Mixed-use, solar-powered, zero-waste community, Included in the pilot program of the USGBC's LEED-ND[29] program
Curitiba, Brazil	High level of public transportation Creation of pedestrian streets
Malmö, Sweden	Canals as part of the rainwater collection system, Aim to replace traditional planning procedures with a more integrated structure to planning with water, green structure, and waste plans, and developed alongside the masterplan
Vancouver, BC Canada	'Eco-density[30]', Reducing ecological footprint
Portland, OR US	'Green streets' are developed for innovative solutions for stormwater and stream crossings, Re-establish natural wetland in a dense urban area, Green roofs, Promoting walking and cycling

Sources: "Hammarby Sjöstad, Stockholm", n.d; Leng, n.d.; Novotny, 2009; Eran, 2001; Novotny, 2010; "Celebrating Eco", 2010; "Green Streets", 2011; Das, 2006; Hoyer et al., 2011; Heap, 2010; Fox, 2008; "SOMO Living", n.d.; Goodman et al., 2005/2006; Hancock, n.d.; "Urban Design - EcoDensity", 2008

Ecocities are subject to many challenges varying from green infrastructure implementations to closed water loops, to constructed wetlands, and to high level of public transportation. In the Table 4.6 above, the changes realized through contributions of more than ten well-known ecocities are displayed. Considering those outcomes and previous section's outcomes, the next section determines the key criteria to identify the link.

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[29] The LEED-ND (Leadership in Energy and Environmental Design for Neighborhood Development) rating system integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design (USGBC, 2011).

[30] 'EcoDensity' is the City of Vancouver's recent initiative which aims to map a course for future development that encourages increased density, while at the same time reducing the city's ecological footprint ("Urban Design - EcoDensity", 2008).

4.5 Evaluation

The following is a key criteria list collected based on discussions and best practices realized within the ecocity issue. This key list will also be used to evaluate the Porsuk River Case to learn about its rehabilitation, and the city in general concord with the criteria especially in terms of water and river related ones.

- Cleaning of Waterway from Pollutants
- Control of Erosion and of Sediment Deposition
- Building of Buffer Zones in Problematic Areas Next to the River
- Rehabilitation of the Rivers and River Corridors
- Rehabilitation of Wetlands
- Improvement of Domestic Water Quality
- Restoring of the Infrastructure of Urban Water System
- Building of Wastewater Treatment Plant
- Separation of Sewage and Stormwater Systems
- Obtaining Energy from Used Water / Water-Energy Nexus
- Development of Hybrid or Closed-loop Water System
- Ecological Recycling of Water: Reuse of Stormwater for Garden Watering and Irrigation
- Increase in Area of Pervious Surfaces and Decrease in Area of Impervious Surfaces
- Developing Measures to Decrease Impervious Surfaces in New Urban Plans and Designs
- Increase in Urban Green Spaces and Open Public Spaces along the River and Through the City
- Transformation of Stream Catchments to Green Parks and Open Areas
- Daylighting of Waterways Those Had Taken Underground, Integration them with Green Spaces
- Implementation of Mixed Use Planning Design
- Improvement of Mass Transport System, Accessibility of Transport Nodes, and Connection of Various Mass Transport Modes
- Development of Environmental Sensitive Mass Transport Systems
- Development of Pedestrian Roads
- Development of Bicycle Roads

- Reduction of Ecological Footprint
- Reduction of Carbon Expansion
- Green Infrastructure Substituted for Concrete Piped (Grey) Infrastructure System
- Rehabilitating Inefficient Building Stock in order to Decrease the Carbon Footprint of the City
- Decentralization of the Water System to Neighborhoods
- Improvement of Rainwater Collection Systems
- Building of Stormwater Detention Parks
- Implementing Planning Practices like Smart Growth to Obtain Compact and Dense Urban Tissues to Achieve Less Consumption of Land, Water and Other Resources
- Increasing of Importance for Protection of Hydrophilic Habitats like Rivers, Lakes, Wetlands and Groundwater
- Projects on Development of Neighborhood Units / Eco-blocks / Eco-buildings That Can Recycle Their Waters and Produce Their Own Energy
- Coordination of the Stakeholders and of the Responsible Institutions at Project and Catchment Level

4.6 Conclusion

Ecology in essence deals with the environment as it relates to living organisms. Ecology reflects on cities as a healthy relationship between the urban environment and human society, namely human ecology. Human well-being obviously surpasses all other aims put forth for human societies, especially after observing that degradation of environment and of quality of life do not only lead to a decrease in pleasure to be derived from urban life but could and at times even result in loss of human lives and in destruction of built environment. The discussion then covers the adoption of ecology by the urban planning. This is the difference and the superiority of the *urban ecology* in upgrading human societies and of natural and built-up environment.

Urban ecology born *ecocity* is a sustainable city; it is a city designed with consideration of environmental impact, inhabited by people dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution. The assertion at this point is that until the introduction of the ecological considerations, urban river rehabilitation involved technical and narrow-purpose interferences in general. The concept of ecocity now has an incentive for transformation and rehabilitation projects in the city to be planned and practiced within the urban context. Thus, ecocity principles and the concept in general are expressed clearly in visions of structure and/or policy plans now prepared for the cities and the pragmatic issues of the concept are itemized in the relevant city projects.

Then the discussion extends into the old and emerging paradigms of urban water system. A review of ecocities of the world and their achievements are also included to add further clarification to the subject. The discussion terminates with the issue of a key criteria list collected mostly from the ecocity projects, compiled from recent (since end of 1990s) urban river rehabilitation practices (from the previous chapter). It is mentioned that this key list will also be used to evaluate Porsuk River case in accordance with the contemporary ecocity context within water system upgrading principles.

It is expressed at the Introduction Chapter that this thesis proposes to discuss the urban river rehabilitation in two different dimensions. One is taking up urban waters as a system within the context of ecocity, discussed above. The next channel involves the rehabilitation of the urban river in integration with the basic urban nodes and so with the city itself. This channel is discussed in the coming chapter along with a sample portfolio of 20 cities.

Therefore, the new approach in essence, aims to preserve and upgrade not only the environmental elements, as has been the case so far, but the relationship between the living organisms and their environment.

CHAPTER 5

BEYOND THE RIVER ITSELF: INTEGRATION OF RIVER AND CITY

> "The presence and crossing of rivers in cities bring additional concerns to the urban environment. Besides the historical, geographical and morphological features, several specific aspects should be considered, such as water quality, flood vulnerability, accessibility, increased aesthetic and landscape value and contribution to urban attractiveness and identity, among many others." (Saraiva et al., 2008, p.930).

It is crucial that a city point at the goal of a better balance between natural components and the built environment. Rivers in many respects play a key role in attaining this target. As Fleming (2009) stated, an urban river can be a healthy, unifying and multipurpose; which is a source of pride for the city. Rivers bring benefits to urban areas, such as *amenity, aesthetics, recreation, heritage, spatiality, identity and image*. They influence the urban pattern and offer their restorative capacity. There is an increasing interest in the rehabilitation of rivers and watercourses all around the world. In order to achieve a successful project, which takes into account the several domains involved, physical and ecological processes, as well as social processes, need to be both identified and studied (Saraiva, 2008).

"Interventions ranged from a very localized creation of green urban areas in the river corridor that did not address rivers at all, to intervention on the whole river corridor that crosses the city, to intervention on reaches of rivers, mostly located in degraded or neglected urban areas" as Saraiva (2008, p.933) indicated. But not much has been done to make provision for a better integration of the city (by means of certain urban focal points such as cultural, historical and contemporary significant assets) and river. Below, the integration term and its area of usage were introduced within the context of this thesis.

5.1 On Integration

The term, *integration* has different meanings in several disciplines. It may mean an act or instance of combining into an integral whole; an act or instance of integrating a racial, religious, or ethnic group; an act or instance of integrating an organization, place of business, school, etc.; in mathematics the operation of finding the integral of a function or equation, esp. solving a differential equation; as of an individual, that is in harmony with the environment; in psychology the organization of the constituent elements of the personality into a coordinated, harmonious whole; and in genetics coadaptation ("Integration (1)", 2011).

Owing to the fact that itbears many meanings, it is usually referred with the predecessors of the relevant context such as *social integration*, *economic integration* etc. The most common type, social integration, means bringing of people of different racial or ethnic groups into unrestricted and equal association, as in society or an organization; desegregation ("Integration (2)", 2011). Within the scope of this study, integration does not refer to social integration; it is specified as '*spatial integration',* the extent of which is urban space. The concept of spatial integration is used for territorial and political considerations as well from a regional perspective (De Boe, 1999). Therefore, in the context of this study it may be more accurate to mean *urban spatial integration*.

Costa (2002) stated two levels of integration: 'town integration' and 'site integration'. The town integration would be, the higher or lower integration of a renewal operation in a harbor area in the planning of a city, e.g., being part of its strategic and physical planning, being articulated with the urban management of the city, meeting some specific urban goals for the city. The site integration would be the higher or lower integration of renewal in a harbor area in the confining urban tissues, e.g., having continuity in the main public spaces with the same quality of design, suppressing urban barriers, articulating urban functions and offering some new equipment to the existing confining urban areas (Costa, 2002).

He added that some common phenomena could occur in both scales of analysis and at both levels. By use of comparative analysis, some factors might be identified as key factors for both levels of integration, which he denominates as factors of integration. He attempts to identify the common relevant factors of integration from the selected cases (Costa, 2002).

As it was indicated above, from a regional perspective, integration is used for territorial and political considerations. The concept of spatial integration is an important criterion to assess the situation of the various parts of the European territory (De Boe et al., 1999). As cited in

Noordwijk, 1997) they add “spatial integration expresses the opportunities for and level of (economic, cultural) interaction within and between areas and may reflect the willingness to co-operate. It also indicates, for example, levels of connectivity between transport systems of different geographical scales.” (De Boe et al., 1999).

In this thesis, the second approach to the discussion of rehabilitation of urban rivers is their *integration with city*. Integration is a term used in varied academic contexts as economics, sociology, mathematics, biology, engineering and planning. More broadly, by definition, integration involves the combination of variables into an integrated whole. In this sense, it includes *accessibility,* which is the capacity of easy access, capability of being reached and includes *connectivity,* which is the ability to make a connection between two or more points in a network. The term integration refers to a wider context than the previous two terms, accessibility and connection, do. Indeed, it involves *relationships*, *changing relationships, interaction, reciprocity* etc. In short, it involves individuals within a system, and may be used to enlighten the relationship between urban environment and people’s spatial behavior.

Consideration of the river in this context would bring forth the following aspects of the relationship between the river and the city:

- River is considered as an element incorporating the nodes of the city and an element incorporating the mental maps of the citizens and visitors.
- River as a path unifies the linking elements of the city itself, physically, culturally, socio-economically. It displays viable characteristic and is conductive to change over time.
- It is a central axis and linkage for a network among activities as nodes and combines them to form the image and identity of the city.
- It creates a sense of solidarity and unification.
- It brings together local recreation areas, local leisure, and other recreative activities.
- Wayfinding via gateways, signage, street furniture, and greenery serve as guidelines combining nodes and river edge.
- It provides for coherent public transportation systems (Eran, 2001).

What follows is a brief discussion of how peope relate to environment. As mentioned before, it is assumed in behavioral approach to sociology and urban geography that people may sometimes be satisfied with less than optimum solutions and, with less than optimum profit levels, decisions may be made in context of incomplete knowledge and uncertainty. In this context, a person’s behavior is based on his perception of his environment, not on the environment as it actually exists. That is, people’s behavior in urban environment depends upon their perception of it. People operate in the well-defined world, amid awareness of space and of their cognitive maps. The actions they take in these individual maps do not have to be rational. They may not necessarily choose the shortest path between an origin and a destination.

Integration in the field of urban planning is often discussed along with the term *readability (or intelligibility), wayfinding, focal points*, and *spatial cognition.* The structures with different functions open to the public in the city increase the possibility of people coming together. According to Hillier, where these structures are located and which spatial relationships they are is very important. Hillier used the term of integration, as well as the terms of readability, visibility, wayfinding, axial lines, etc. (Çil, 2006).

Nenci et al. (2006) maintain that “other environmental elements should be taken into account, in order to enrich our design with more variables, as the presence of landmarks in selected routes (intended both as territorial markers and as significant places for the residents), capable of influencing the mental routes representation of the inhabitants”, thus mentioning elements which would enrich the mental map. Nenci et al. (2006) emphasizes the concepts of *spatial cognition, integrity and legibility*.

According to Arquati (2008), “For navigating-as-they-go, pedestrians use a wide variety of urban characteristics, including landmarks, lighting schemes, urban landscaping, public art and more”. And, an effective wayfinding system will relieve the streets of visual pollution as it reduces marks of reference into a single one, which helps the residents orient themselves in the city. Such a system gives reliable and effective way information, so it gives the pedestrians the belief that they will not gey lost, or even if they do, they will easily find their way easily. He clarifies his point by standing that a successful wayfinding system contributes to a better feeling amongst its users. Both of the environment they are in, and of the transport system enabling them to get around it.” (Arquati, 2008). All these discussions contribute to the establishment of integration of the river with focal points of the city, on foot or by vehicle, including accessibility and connectivity along with creation of a sense of unity among the urban elements including the river.

One of the basic functions of the cognitive map is development of the feeling of belonging to the urban environment that comes with participation in and acceptance of this environment. This aspect is important as it may lead residents of a city to feel actively interested in decisions, in plans and developments related to the city. This aspect is the basis of becoming a 'good citizen'. From the point of view of the urban planning, the residents should be pleased with and proud of their city, they should be presented with unique national, historical, touristic, global assets of the city that are underlined by the plan.

"Streets connect the water edge to the rest of the city in a series of corridors, or fingers. As the streets come within a certain distance from the water, the pavement changes to a rough, water-permeable texture. Permeable hard surfaces - interlocking pavers, for example - support a variety of uses while allowing water to filter slowly into the soil." (Bennett et al, 2001, p.55). Pedestrian and moped bridges built across a river help the opposite shores of the river to act as one park. Increasing access in this way also provides additional commuter routes across the river, and creates a unified seam between. Daily use of these places raises public awareness and animates the city (Bennett et al, 2001).

Urban river rehabilitation not only contributes to improvement of the ecology of the river but, through provision of a sanitary, pleasant and attractive environment, it can contribute to city itself. One of the aims of the contemporary urban plans is therefore to create an urban environment where sustainability is raised with inclusion of new and current technical and planning issues, along with the emphasis on the unique and attractive historical and contemporary assets of the city. Present administrators concentrate on transformation projects involving eradication of low-income neighborhoods, renewal of certain urban neighborhoods, creation of gentrification areas, returning old abandoned industrial properties to productive use (brownfields), creation of spectacular, specialized centers etc. In this process, all urban elements are revalued according to the criteria of increasing provision of a favorable image of the city. Raising in the spatial integration of the city through planning of focal points together would contribute to creation of a pleasant and feasible image of the city.

In post-industrial cities, the trend was urban renewal and urban regeneration of waterfronts such as harbor areas, of riverfronts and of brownfields. This is one of the dominant factors of post-industrial landscape that aim at providing efficiency and sustainability to the cities. Regeneration of urban spaces from local to global has usually interventions with special finance and intellectual investments (Costa, 2002).

In this process of creating sustainable and vibrant places, *urban river rehabilitation* has been 'rediscovered'. In the discussions, it was emphasized that in history, rivers flowing through cities had vital functional importance for cities in terms of choice of location, provision of infrastructure, protection, sanitation, transportation and socio-economic facilities. Nevertheless, urban rivers have suffered considerably from human activities. They have been contaminated by sewage, chemical wastes, storm water discharge and careless exploitation of water supply. To cope up with these problems, which caused environmental negativities and threatened lives through epidemics, measures were taken like culverting, canalization, fragmentation and even taking rivers to underground. This inconsiderate treatment of urban rivers has resulted in contamination of urban water eco-systems and it has resulted in impairing the sense of belonging of the residents as well.

> "A river can help provide linkages through the city and enhance the physical environment as well. It can serve as the foundation for an urban greenway – a linear park that connects neighborhoods within the city. This can help establish the river as the social heart of the community, making it a more interesting place for people to live and work, and providing an open space corridor that connects neighborhoods" (Fleming, 2009, p.191).

While integrating parts of the city, the river rehabilitation project itself is standing as an element that helps to provide integration. Development of adjacent sites is also elements for integration. Connectivity between the primary level routes and larger level routes in the city should also be considered. Rebuilt bridges including pedestrian bridges offer the key linkages between the two sides of the river (Eran, 2001).

The elements for incorporating the natural world into the lives of city-dwellers and visitors are as follows:

- The adaptive re-use of industrial landscapes, riversides and specific buildings
- The incorporation of the built environment, cultural heritage, and natural and native systems

- Mixed-use developments that reinforce relationships with commercial and industrial uses providing them with direct access to natural elements, services, and infrastructure
- Diverse programs made up of various intensities (i.e. a mixture of programmed and unprogrammed spaces), available for day and nighttime use, and oriented to all ages
- Public support generated through annual events, active community participation, and regional governance that involves individuals from a variety of backgrounds
- Creative financing that can be achieved through phased development, charging membership fees, allowing individuals to own specific elements, and fundraising at festivals and events
- Incorporate wayfinding, access points that attract people, and public amenities that dot the riverside
- Improve the channel network and natural riverbanks
- Green corridor stretching throughout the city, while relating to urban developments along the river
- Building development guidelines, orientation and massing of the buildings, treatment of parking, setback restrictions, and commercial buildings' direct relationship to river's edge should be considered (Eran, 2001).

5.2 Forming the Portfolio of Sample Urban Rivers and Their Respective Cities

From the point of view of the urban planning, the residents should be pleased with and proud of their city, especially with the unique global, national, local, historical, contemporary touristic assets of the city, which provide an image and identity to the city. Urban focal points are by themselves image and identity sources. They, for example, provide accessibility and, by clearing their immediate surroundings, a panoramic view of the city from afar for the citizens and visitors. This was the attitude of urban plans in the early 20th century. With the oncoming of globalization and the accompanying changes in attitudes towards urban visions and strategies, this singular treatment of cultural urban assets has been abandoned and the new approach is to enhance, emphasize and underline their impact on the city and on the attraction of the city conveyed through its image and identity, by a comprehensive approach to these assets. It is interesting to note in the samples of the following *portfolio* that this comprehensive handling of many urban assets is arranged around, maybe the most natural, the most different, the most recreative of urban element, the *urban river*.

The assertion at this point is the relationship between river and city should exceed mere provision of accessibility and connectivity. This relationship should, for example,involve a *continuity, orientation, and legibility.* This overall handling and combination of the elements of the city is expressed by the term *integration* in the study and is expressed in a portfolio that includes 20 cities. Portfolio carries a preamble-like feature to spatial integration analysis. In these cities, rivers are perceived as important constituent of *urban reference element*. In selected examples, it is seen that all of the urban rivers can use its potential in order to be a focus.

The following 20 samples have been chosen mostly from the capital cities or important global cities located on one of the main rivers or their tributaries. These cities, among several other cities included in the portfolio, are the sample *cities known with their rivers*. For example *Danube*, the second longest river in Europe after Volga, originates in Germany and flows southeastward passing through four capital cities *Vienna, Bratislava, Budapest* and *Belgrade*. Vienna, Budapest and Belgrade are included in the following sample portfolio. *Munich,* through which Isar, one of the main tributaries of the Danube, is also included in the portfolio.

One of the major rivers of Europe is the *Rhone,* which rises in Switzerland. It flows through the city of Geneva and crosses Lake Geneva. Then flowing southward, the Rhone enters into France converging in Lyon with the Saone and empties into the Mediterranean. The cities *Geneva* and *Lyon* are included in the following portfolio. The ninth longest river of Europe, the *Rhine,* flows from the Swiss Alps to the North Sea coast in Netherlands. The portfolio are included two cities located on one of the main tributaries of the Rhine: *Salzburg* and *Strasbourg*. The tributaries of Rhine, *Ill River* flows through Strasbourg, and *Salzach River* flows through Salzburg. The other cities included in the portfolio are *Paris* on *Seine, Rome* on *Tiber, Florence* on *Arno*, and *Zurich* on *Limat* (the tributary of Aare that tributary of Rhine) rivers from Europe.

Four samples from Asia, and two samples from North America have been included in the portfolio to underline the universality of the analysis. The sample cities from Asia are

Chengdu on Funan River in China, Seoul on Hangang River and Cheonggye Stream in South Korea, Shanghai on Huangpu River and Suzhou Creek in China and Singapore on Singapore River. Lastly, from North America, Boston on Charles River in MA, US and San Antonio on San Antonio River in TX, US are selected for the portfolio.

The evolution of interrelation between the urban river and the respective city in the portfolio reflects the discussion covered in Chapter 2 under the same heading. All these cities have grown from ancient settlements and were sites of some of the earliest sedentary human cultures. It was obvious that it was the river and the river basin that attracted these settlements and caused them to develop on and along the rivers. These rivers defense borders for the settlements; the castles and fortifications were located along these rivers. Besides, these large rivers were navigable and extended to distant places so trade could be conducted between coastal and central European areas.

So up till the first half of the Middle Ages, the rivers contributed positively to the economy, defense and therefore the flourishment of the cities where they pass across. Especially long and wide rivers with wide wetlands including tributaries allowed trade and traffic reaching farthest corners of the continent. As a result, the sample cities are old towns that flourished on these rivers with their majestic cathedrals, castles, palaces and old houses which are today preserved as historical sites and some of which, as to be mentioned further on, have been designated as World Heritage Sites by UNESCO.

In all the samples in the portfolio almost all main urban elements are located around and along the river and even if they are not, they are connected to the river by roads and/or by the new transport system. The urban rivers are surrounded by important urban focal points, which at certain points show themselves at bridgeheads or even on the bridges as well.

Mostly, historical landmarks have already been located along or near the river, yet new buildings as well like shopping centers, parks, recreative centers are also located near the river or are connected to the river through direct routes. As already mentioned, some new buildings are also located next to bridges or even on the bridges themselves. The bridges, themselves are often well designed spectacular, worth viewing and unique.

The distribution of the nodes and landmarks of the city around, along and on the river in the sample portfolio surpasses simple connection and accessibility among them but expresses the existence of a new, spectacular, impressive complex of the cultural, artistic, recreative assets of the city forcefully so as to create a new and contemporary image and identity for the city.

Integration elements are within the sketches, and the related texts include the following:

- The place of river in city history
- Accessibility via expanded public transportation such as light rails and tramways
- Connections between different transport systems
- Proximity to main terminals
- Continuous green systems
- Orientation
- Centrality by the river / running through downtown
- Varied functions such as restaurants and cafes on the riverfront
- Regenerated brownfields (old docks / industries turned into museums)
- Recreation areas
- Parks and green spaces (both riverfront parks and other big parks)
- Public buildings accessible to riverfront
- Historical buildings accessible to riverfront
- Cultural buildings such as museums and art galleries accessible to riverfront
- Squares accessible to riverfront
- Stunning buildings that help to improve urban image
- Mixed-use urban pattern
- Experimentation on the compact city
- Multi-purpose rehabilitation

In addition to those above; integration elements some are evaluated in texts but not included in the sketches are as follow:

- Utilized to architectural language of bridges / bridges as public art elements
- On-river facilities such as rowing, canoeing, sailing
- Realization of special local / regional / international events such as riverfront festivals
- River boats / taxis as a form of public transportation

- Public art installations / Art objects such as bridges
- Adjoining residential areas
- Pedestrian & bicycle paths
- Seating along river
- Unique aesthetic characteristics (such as civic buildings, street furnishings, transit hubs, parks, lighting etc)
- Good lightning at night
- Clean streets
- Wayfindng boards
- Bridges for only bike and foot
- Legibility
- Visual accessibility
- Daylighting
- Citizens' awareness of the river (collective activities such as riverbanks cleaning, education of children)
- Existing or created accountable institution / agency / corporation for urban river
- Neighborhood associations included in the project setup
- Existence of public and private partnerships within the project design

5.3 Portfolio of Sketches and Data on Sample Urban Rivers and Their Cities

Cities from among well-known cities and their rivers were selected for the *portfolio*. The idea of creating a portfolio as seen in the examples, is based on these objects: (1) to examine the historical development of the relationship between the river and the city, (2) to remark urban river rehabilitation projects and eco-approaches, and above all (3) to introduce and evaluate the integration issue. The main target is to improve a comprehensive criteria list for the integration. Below, these three purposes are elaborated before each city sketch[31] is covered.

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[31] All the sketches were produced by the Author based on the city maps provided from http://www.hot-map.com/, http://mappery.com/, and http://maps.google.com/, and the personal archieve of Şenyapılı.

5.3.1 City of Belgrade & Sava River & Danube River

Belgrade, capital of Serbia, lies at the confluence of the *Danube and Sava rivers* ("Belgrade", 2011). According to the 2002 census, there were about 1,3 million citizens in the inner-city area ("Population", 2004). Belgrade has an extensive public transport system based on buses, trams, and trolleybuses, but the metro/subway system is still in the planning stage ("Public Transport", 2011). The basin of Sava River, about 95.000 km², covers much of Slovenia, Croatia, Bosnia, and northern Serbia. It flows just north of Ljubljana, touching Zagreb, and joining the Danube River at Belgrade after a course of 940 km ("Sava River", 2011). Sava River flows through the city in a *diametric* position. The city has a famous historical centre located on the right bank of the river, and after the second World War, the new city was developed on the left bank of Sava. The west bank of the river is called as *New Belgrade;* the older pattern takes place on the east banks of Sava and around *Kalemegdan Park* between Sava and Danube. There is a lively nightlife on both riversides with many parks, monuments, squares, museums, cafes, and restaurants. The bridges over Sava River carry railroads, tramlines or motorways, and some of them combined, many of them create an artistic impression.

The River Sava entails *a river island* called *'Ada Ciganglija'* (colloquially shortened to Ada), which has been artificially elongated and attached to the mainland to form a peninsula. The peninsula, which is 4 kilometers far from the city center, has been rehabilitated into a centrally attractive recreation area popular among residents and visitors. The aim was to create a microclimate by the river with the artificial lake, the islands, the dams and the woods. This microclimate heightens air humidity in the city, helping to nullify Belgrade's high temperatures during summer. This type of rehabilitation improves not only the river ecology and whole ecosystem nearby, but also improves city itself. Ada Ciganlija is a natural resort, a favorite beach and an outstanding sporting venue for the city ("Ada Ciganlija Island", 2010; "Belgrade Outdoors", n.d.). The sketch shows the integration of the river and the Ada with the important landmarks and nodes of the city as the latter are mostly concentrated on the peninsular elongation of the mainland towards the river and the Ada.

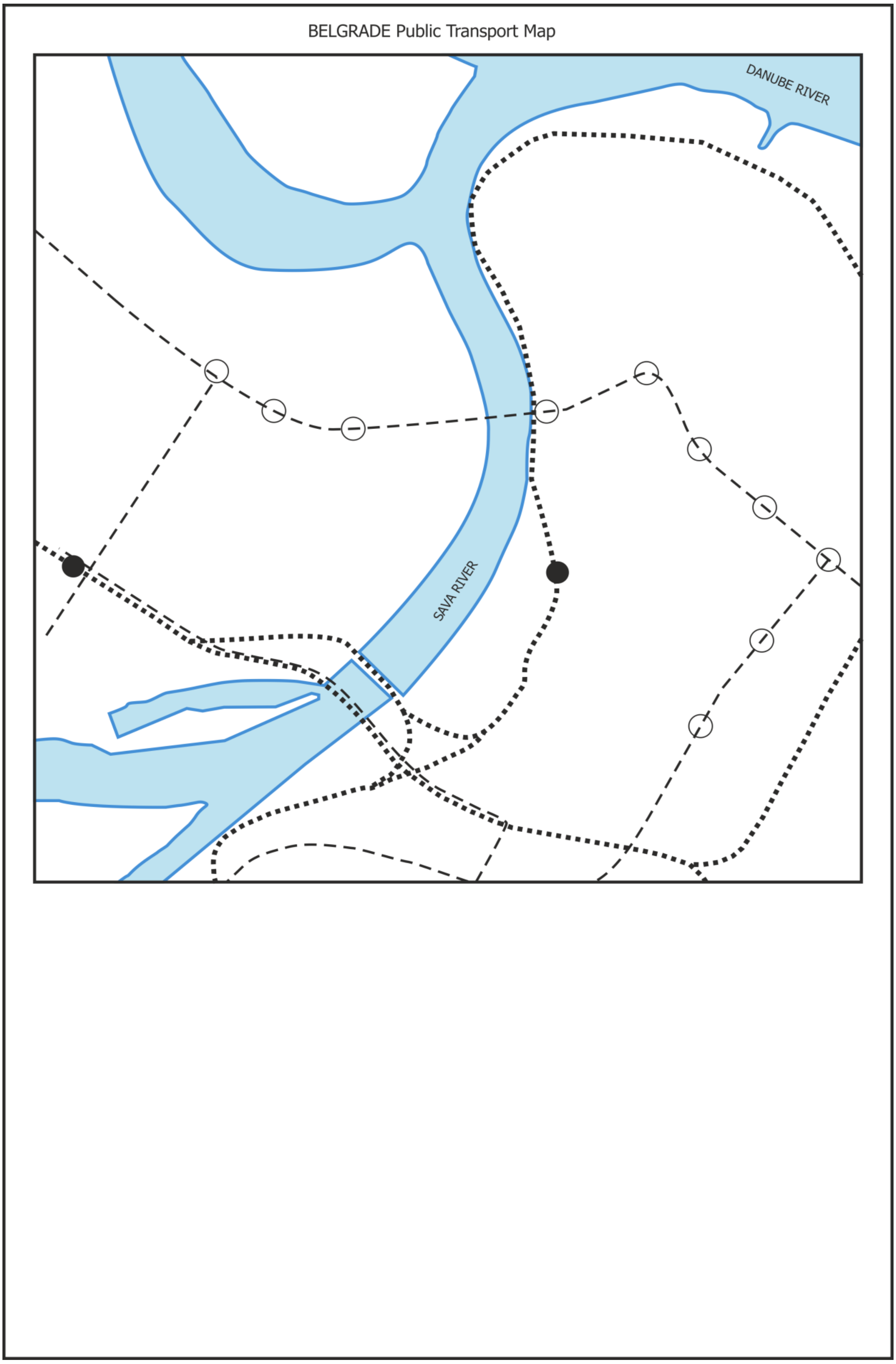

Figure 5.1 Public Transport Lines in City of Belgrade & Sava River & Danube River

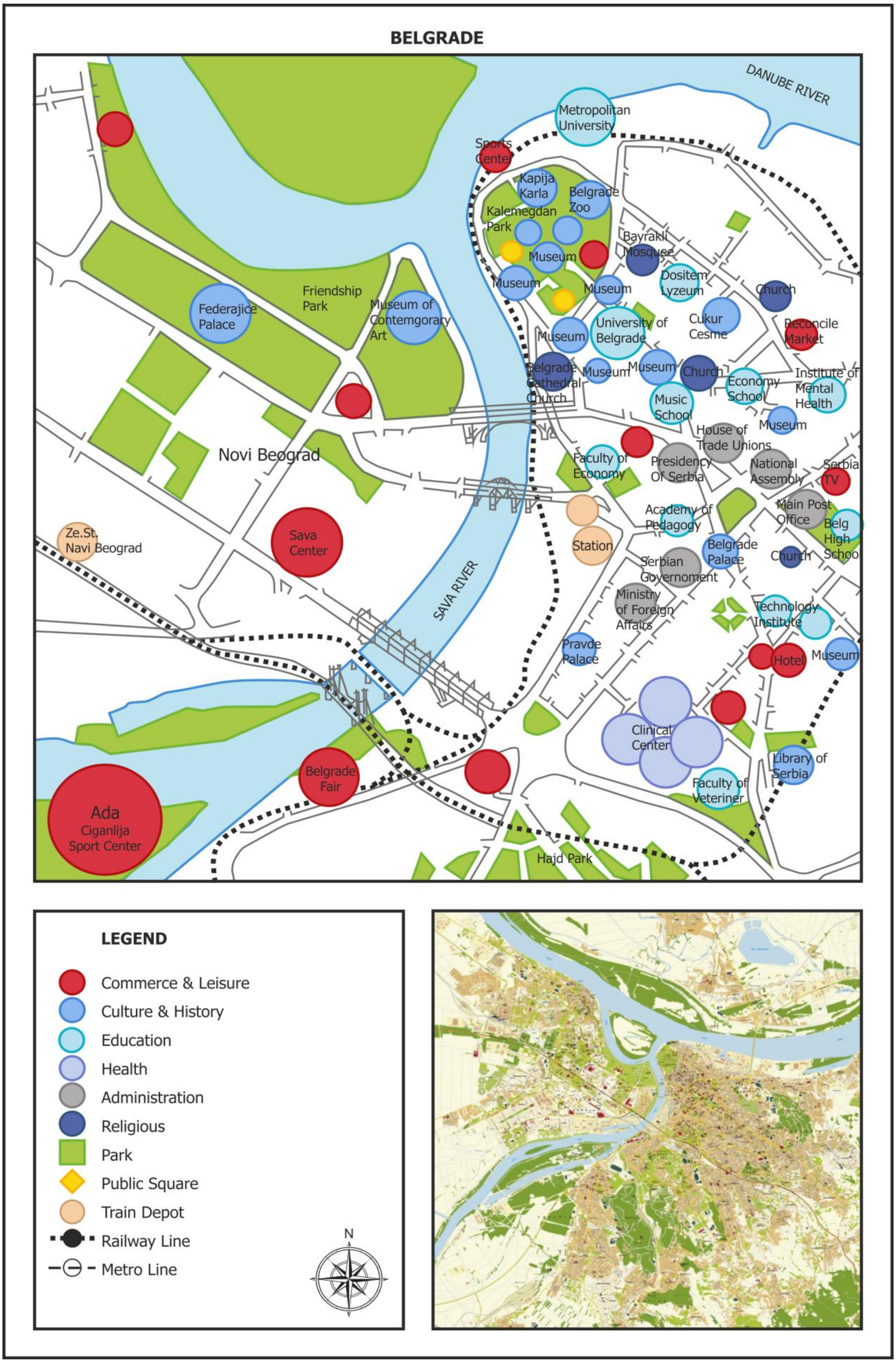

Figure 5.2 A Sketch on City of Belgrade & Sava River & Danube River

5.3.2 City of Budapest & Danube River

Budapest is the Hungary's capital and largest city holding a central-northern position in the country. *Danube River* divides Budapest into two halves of *Buda* and *Peste.* Green and hilly Buda is on the western bank of the river, and the flat and more built-up Peste is on the eastern part. Danube runs for 28 km and is covered by many bridges through the city. The center of Pest that involves shops, businesses, wide boulevards, and squares is defined by two ring roads that provide easy navigation. Buda is characterized more by its historical features among narrow streets or green hills. There are three metro lines in the city, one of which crosses the river and a suburban railway with three main stations in the city (Philips, 2005).

The first permanent bridge, which played a major role in the unification of Buda and Pest, was built on Danube in 1849. Today there are seven bridges on Danube used by cars and pedestrians, and two more bridges have railroads on them ("Bridges in Budapest", 2008). The wide Danube enters the city from the north and flows through the city to the Black Sea. Since the river is navigable, the city has always been an important trading port ("Danube River", 2011). The city center and the densest neighborhoods are located on the plains east of the river.

Budapest was included in World Heritage Sites of UNESCO in 1987 ("Budapest, including the Banks of the Danube", 2011). Each year the Danube International Festival is celebrated in Budapest ("Danube Carnival", 2010). Today cruises on the river provide opportunity for sightseeing tours. Consequently, the river is an inseparable element of the city; and it is indeed one of the most important image creators of the city. This aspect of the river is enhanced by the integration of other cultural and historical assets of the city with the river. The city has various public transportation modes as well (See Figure 5.3 and Figure 5.4).

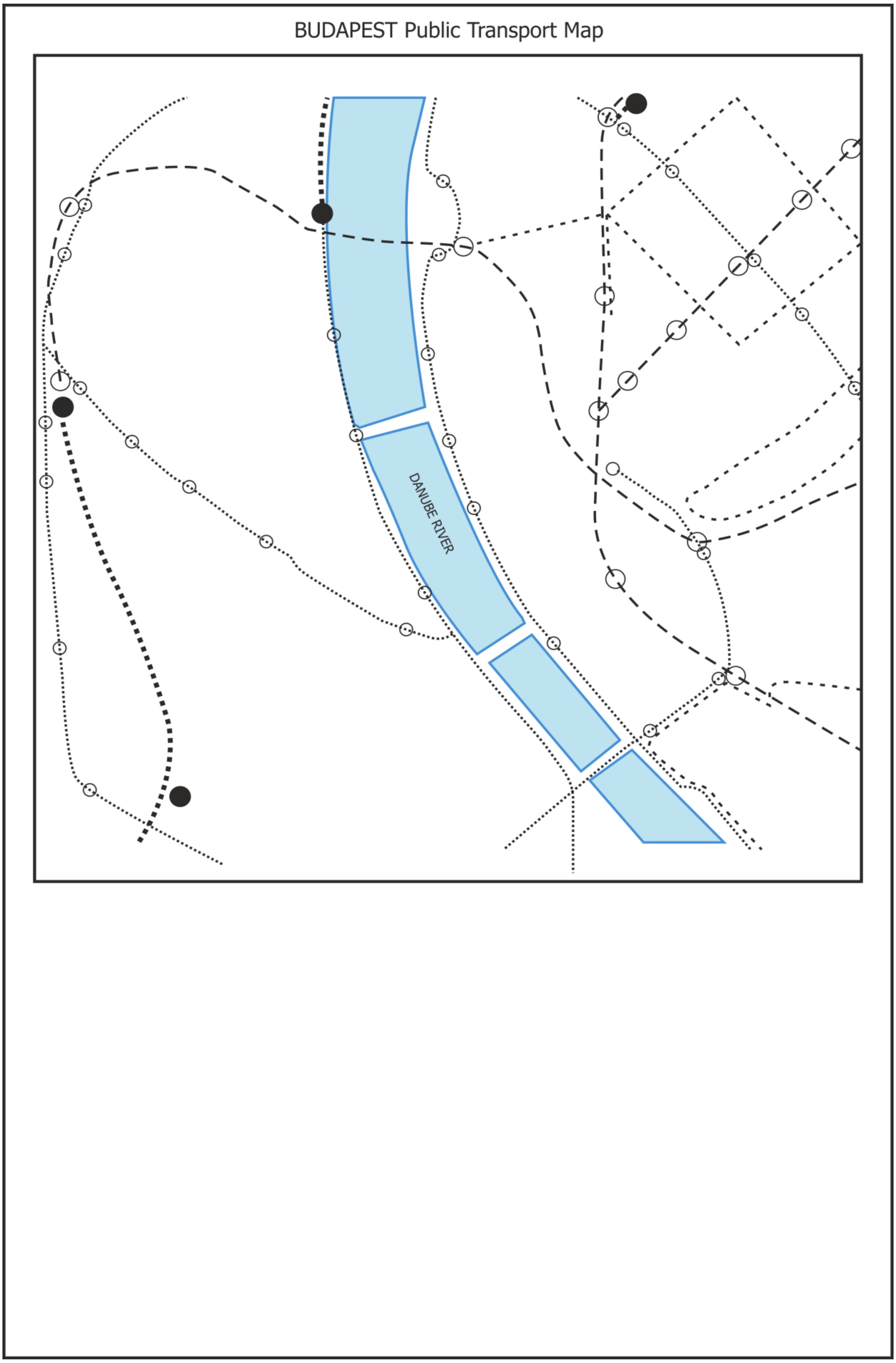

Figure 5.3 Public Transport Lines in City of Budapest & Danube River

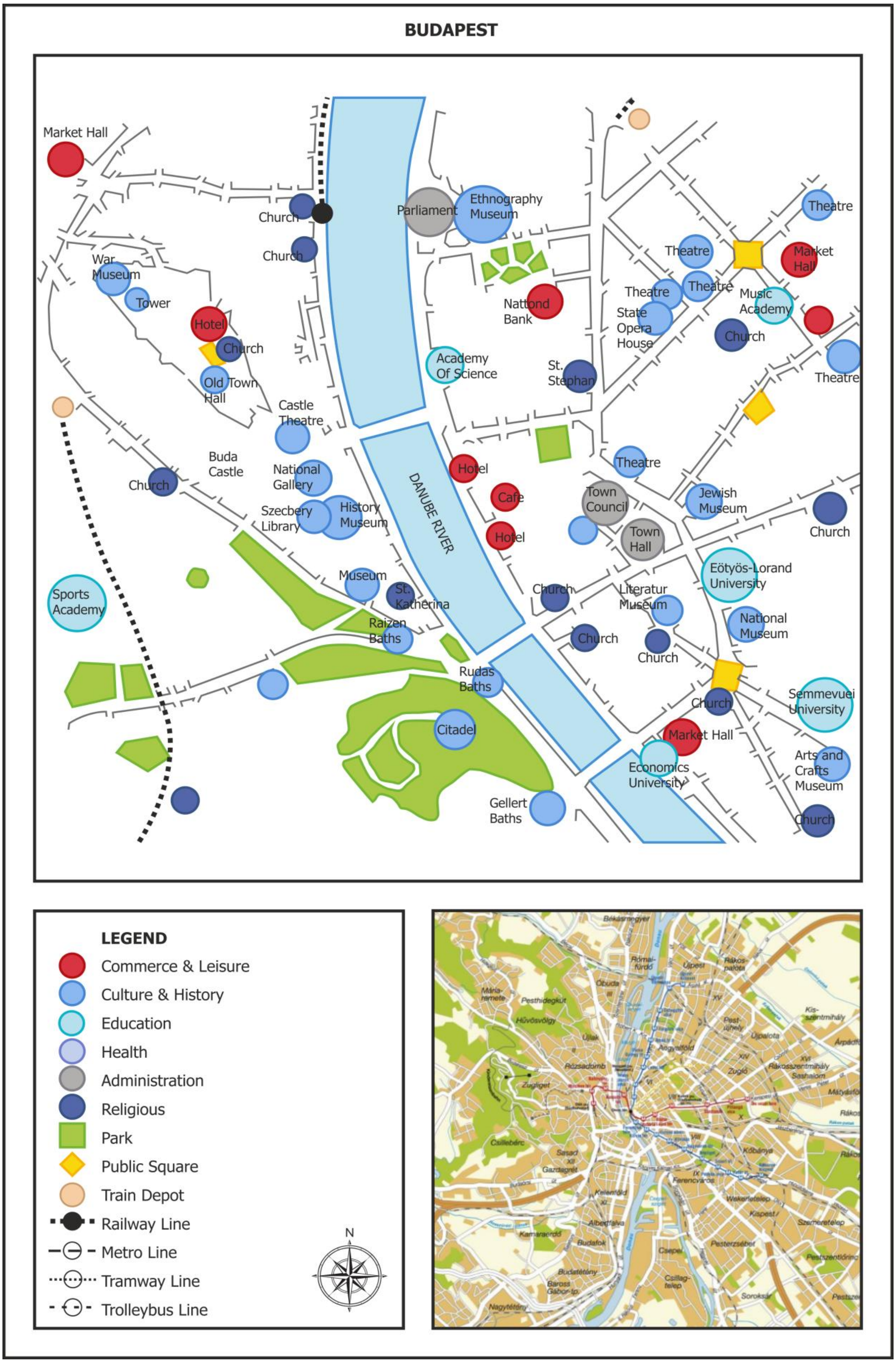

Figure 5.4 A Sketch on City of Budapest & Danube River

5.3.3 City of Florence & Arno River

Florence is an Italian city famous for its historical artistic assets with about 350.000 inhabitants. During the 14th to 16th centuries, Florence became a major centre of commerce, learning and art, in particular. Today, the city has remained to be an important cultural and artistic entity into the modern era. As a reflection of this to the space, its historic centre was inscribed on UNESCO's World Heritage List in 1982 ("Florence", 2011). The city was established on *Arno River* as a small walled city during Roman period (Levey, 1998). In Florence, the streets are perpendicular to the river; they are like corridors leading the pedestrians to the river. Also, there is a strong connection between both sides of the river (Çalışkan Önder, interview, 2011). In the city center, walking has been the best mode of transportation, especially since the cars were banned from the historic section. Buses, tramways, and bicycles for hire are also available. In addition to that, the city is situated on the country's one of the main train routes ("Florence", 2011).

River Arno flows through the city in an *eccentric* position. The river is 240 km long and also flows through the cities of Pisa and Empoli ("Arno River", 2011). It is about 30 m wide in city area and between 5-10 m deep (Bonomi and Bellini, 2003); the basin area covers more than 8200 km^2 ("Arno River", 2011). The connected cultural assets reach a master node on one of the bridges called *Ponte Vecchio*, which is the closest bridge to the world famous *Ufizzi Gallery and Museum*. The bridge is covered by souvenir shops. Another node is reached in *Piazzola Michelangelo* Square on the south bank of the river, which has a panaromic scenery from where most of the river and its bridges can be seen (Şenyapılı, interview, 2011). Figure 5.6 shows that the historical, cultural, educational and religious buildings of the city, which give the city its cultural, artistic identity, are connected with roads that eventually lead to the river. The sketch reflects the integrated cultural and historical identity of the city that is enhanced by the existence of the river.

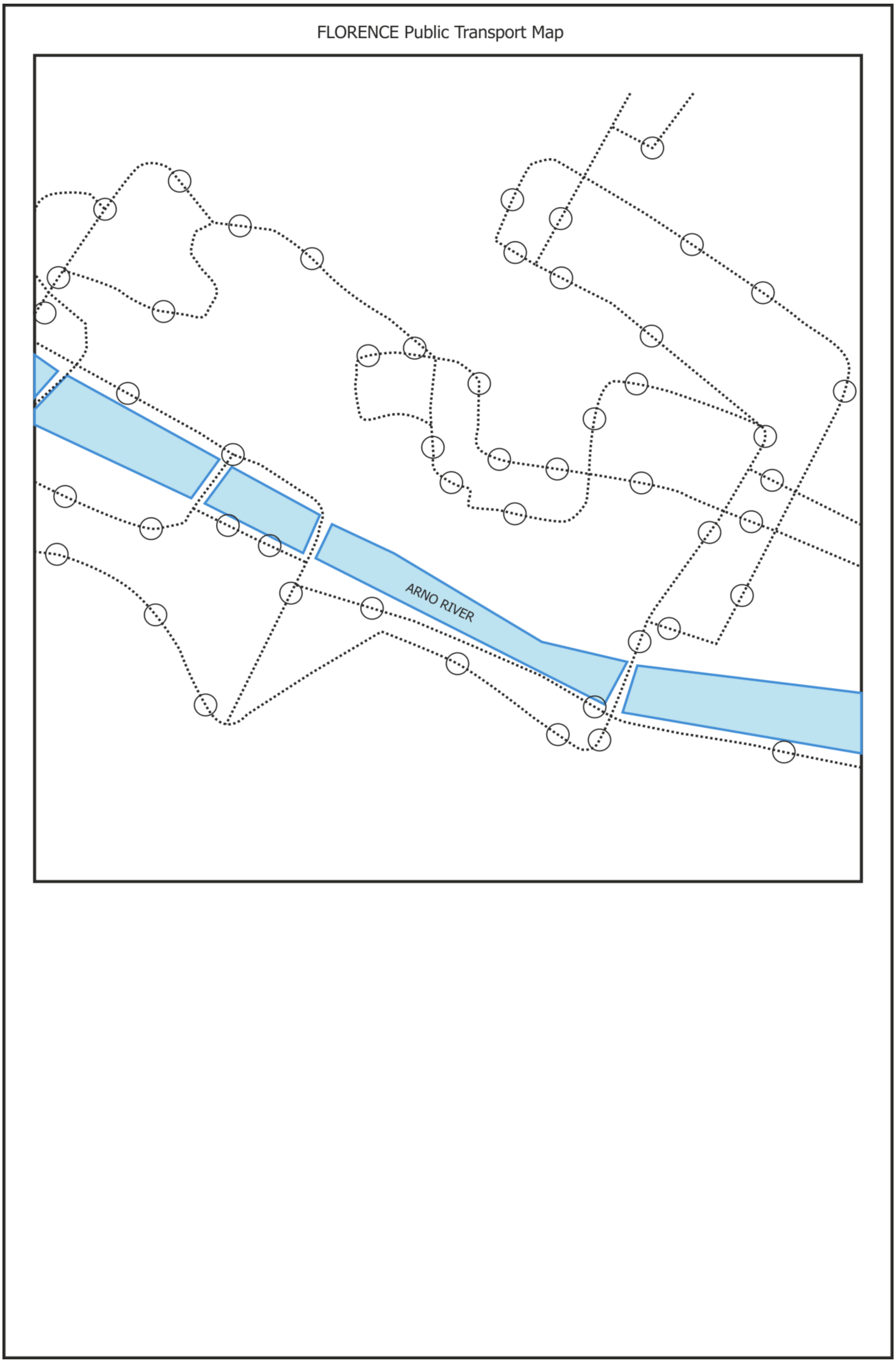

Figure 5.5 Public Transport Lines in City of Florence and Arno River

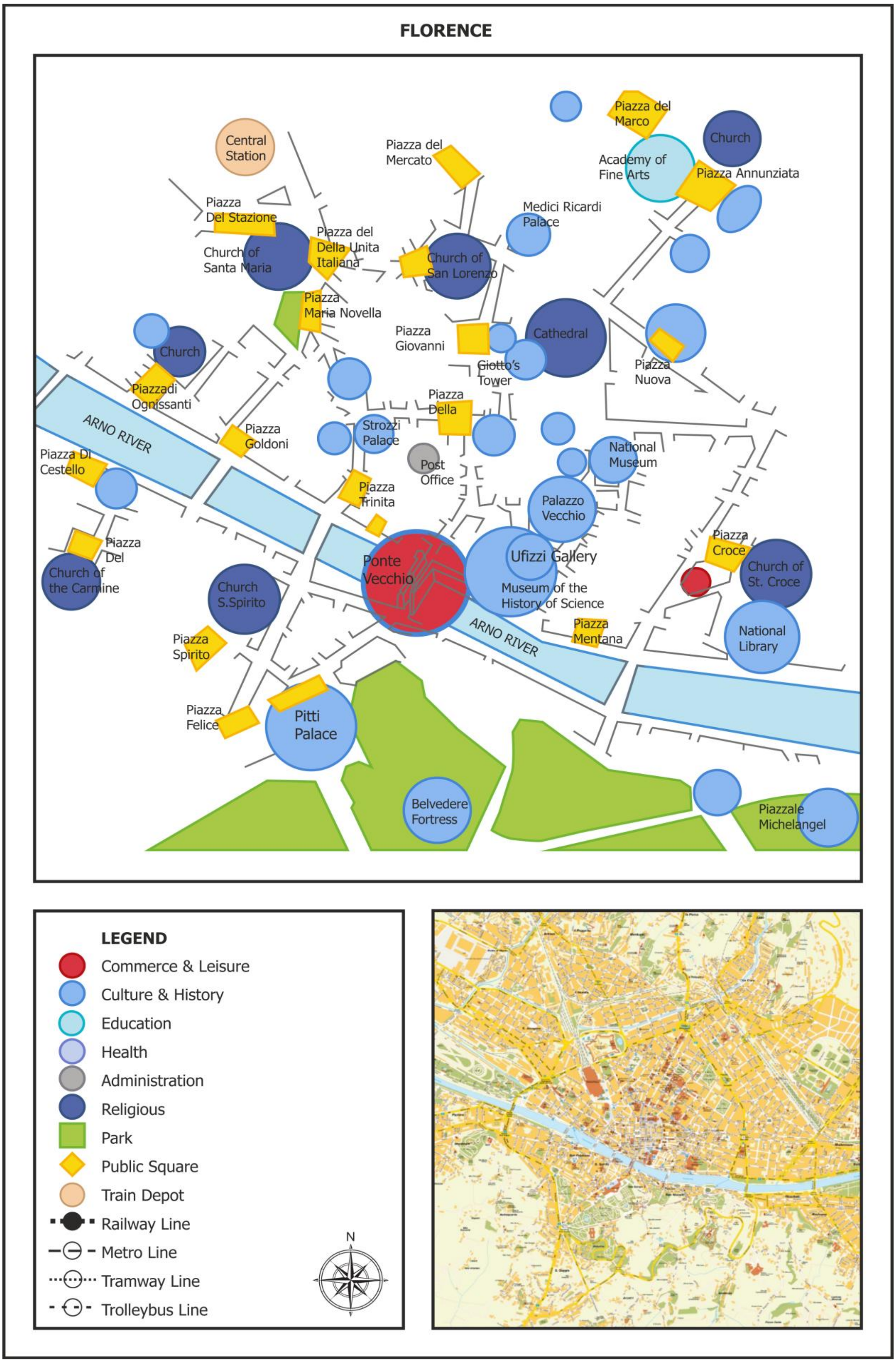

Figure 5.6 A Sketch on City of Florence and Arno River

5.3.4 City of Geneva & Rhone River

Geneva maintains the classic pattern of old European cities, with neighborhoods lying in belts around the core of the city. The *Haute-ville* is centered on the city's original hill site and overlooks the *Cathedral of St. Peter*. It is the historic heart of Geneva ("Geneva", 2011). By year 2000, the population of city of Geneva was about 178.000 ("Switzerland: Geneve", 2010). Geneva is located at the southwestern end of *Lake Geneva* at its junction with the Rhone River. On the southern part of the city, *Arve River* meets the Rhone River. *Rhone River* flows through the city *eccentrically*, and is connected to lake on the north. The lakefront is the centerpiece of the city and offers opportunities for recreation along the banks ("Geneva Sights", 2007). Over 800 km long Rhone River flows into *Lake Geneva*, crosses into France, continues south through Lyon, and enters Marseille ("Rhone River", 2011).

The lake has a crude moon shape and by 1960, it was so polluted that swimming was forbidden and by 1980, all fish life was demolished. After the 1980s, the river and the lake were taken into rehabilitation, today the river ecology is highly improved and the water are opened to leisure activities, to swimming, non-motorized boating and other sports. The city is well known for several international organizations' headquarters, which are located in the city, along with important cultural assets (Şenyapılı, interview, 2011).

The pattern of distribution of cultural, educational and other important facilities shows the importance given to the river as the main reference point. Most of the focal points are concentrated around the river and even on the bridges crossing the river, displays a close degree of integration with the element of water enhancing the attraction of both individual buildings and the area itself (See Figure 5.8).

In 2000, the *Decennial Rhone Hydraulics and Ecological Rehabilitation Plan* was prepared for Rhone. The plan illustrated an adaptive approach to river rehabilitation supported by environmental considerations. The plan covers whole basin including urban areas such as Geneva in the upper basin. The aim of the ten-year plan is to return the heavily modified system to a healthy river with its ecological status restored (Souchon, n.d.).

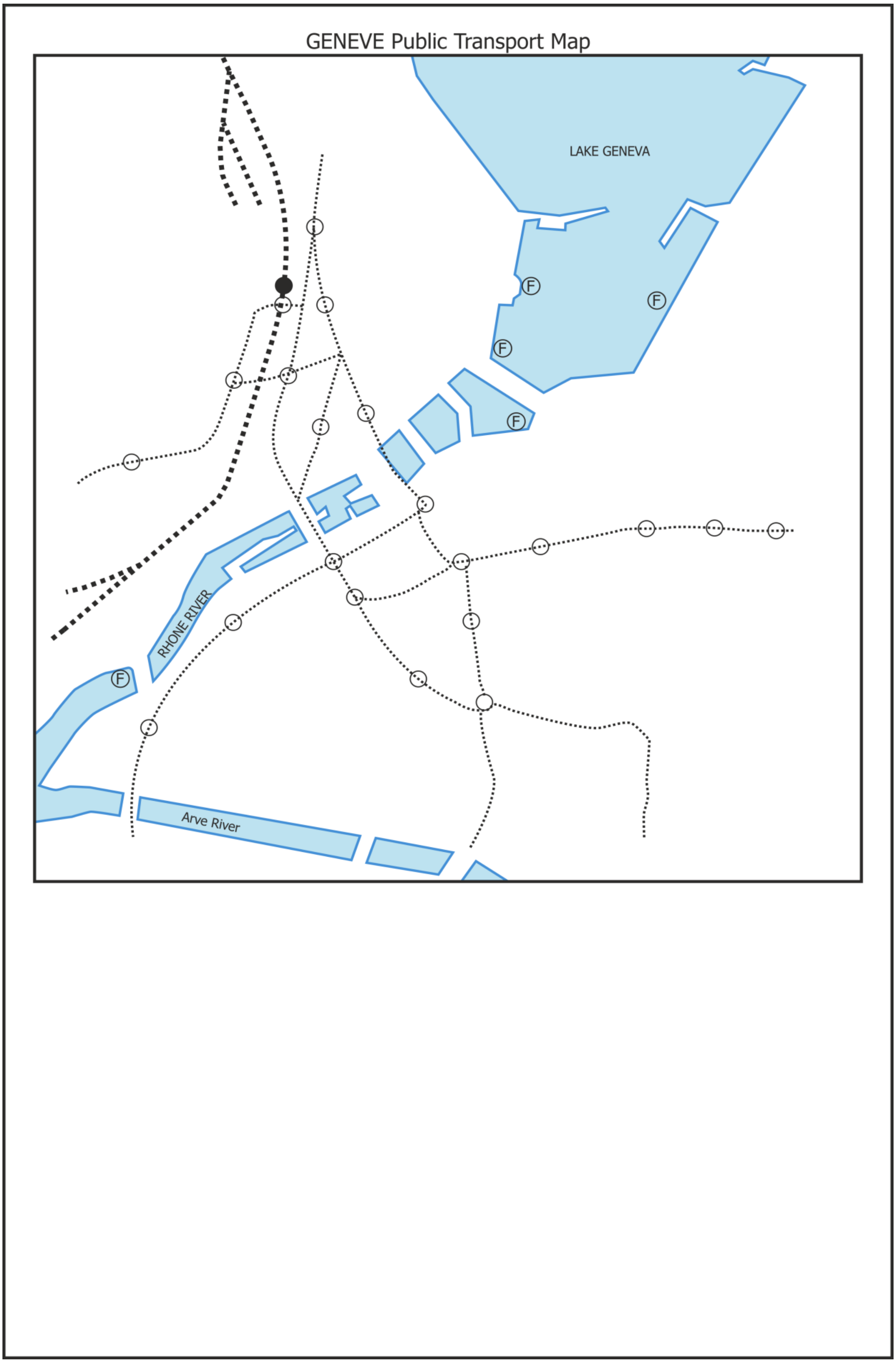

Figure 5.7 Public Transport Lines in City of Geneva & Rhone River

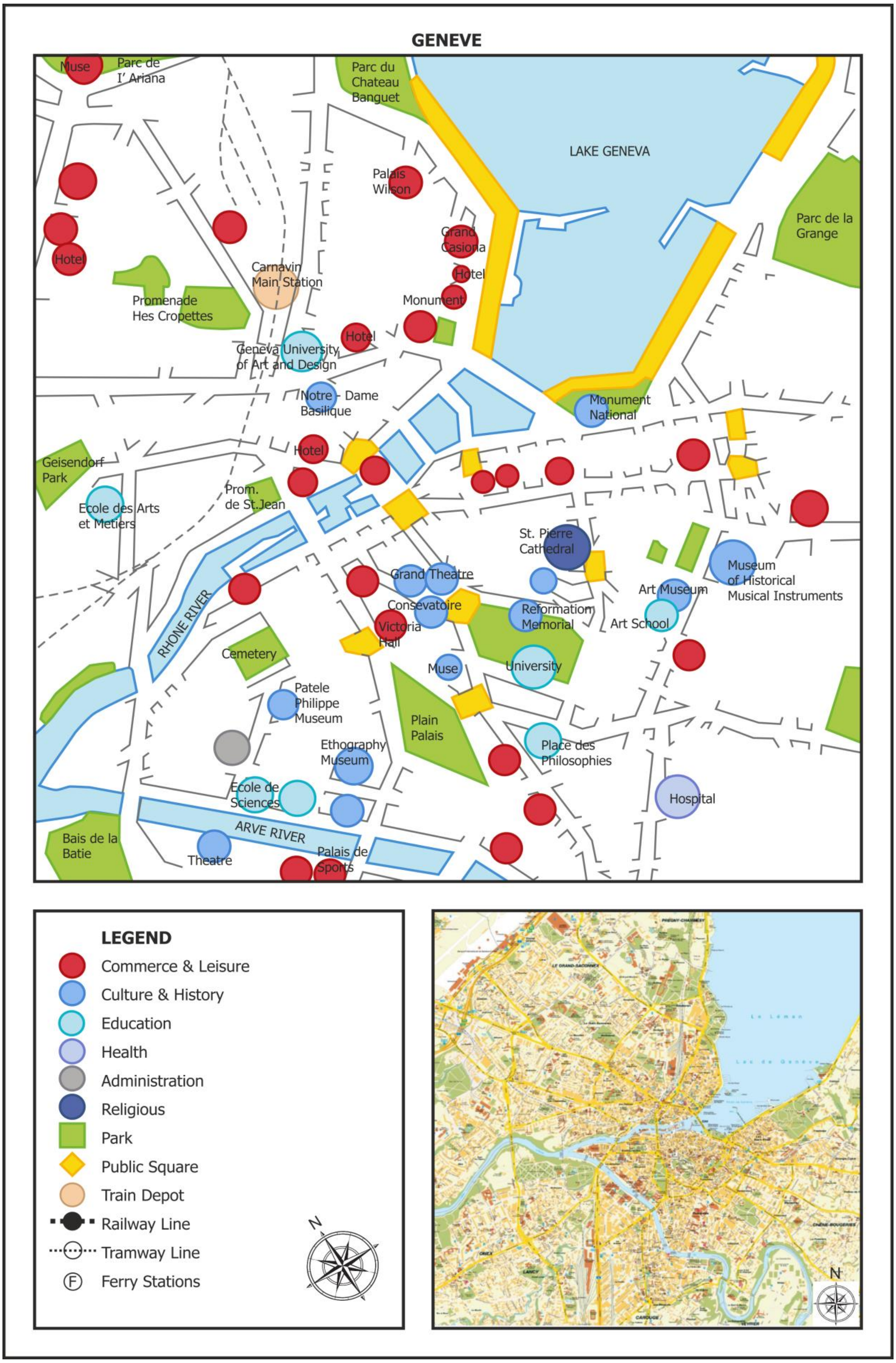

Figure 5.8 A Sketch on City of Geneva& Rhone River

5.3.5 City of London & Thames River

London is the capital and largest city with over 7,5 million people of the UK. Among the oldest great cities that is spans nearly two millennia, this cosmopolitan is situated on the *River Thames*. London has a compact form as the most urbanized area in UK and the most populous city in EU ("London", 2011). The Thames in London is lined with constructed walls however appropriate adjacent landuse and careful design of the public realm along the river yield an attractive urban amenity (Fleming, 2009, p.191). Thames River is still used for navigation. The river does not have a clear view and its water is turbid (Acar Özler, interview, 2010). In fact, the river is clean and hosts more than one hundred species thanks to the large-scale clean-up effort (Masters et al, 2010). River Thames is considered today as one of the world's cleanest metropolitan tideways. Environmental efforts are not limited to the river itself. By 2000s, entering city center by car requires a fee to reduce the pollution caused by heavy traffic. Moreover, buses running on hydrogen fuel cells were begun to be used to lower carbon emissions (Masters et al, 2010).

City Hall, Big Ben, Hays Gallery, HMS Belfast Museum, Tate Modern (a world famous fine arts museum*), London Eye* (a gigantic Ferris wheel), *Tower Bridge, the Parliament* building all are on the riverbanks of the Thames. In London, roads orient pedestrians towards to the river (See Figure 5.10). A good visual accessibility is realized along the river, as many vistas can be seen from the river. The southern part of the river is more intensively used. *Soho* is a district here very near to Thames, where theaters are concentrated and a bright nightlife exists. *Shad Thames* is an area where old wharehouses were gentrified along the Thames. Most of the buildings on both riverfronts were restored; the remaining ones have postmodern features. However, they are not incompatible to each other. Only Tower Bridge stands out as distinct as a landmark, among others (Acar Özler, interview, 2010).

Once-neglected *South Bank* is one of the the city's most vibrant promenades since the last decade (Masters at al, 2010). Entering the 2000s, *London South Bank Riverfront Regeneration* was implemented on the north side of the city. With the project, new usages such as museums, concert halls, cafes, recreation areas were introduced. Famous Modern Art Museum and a giant Ferris wheel (the London Eye) are among them. South Bank Project was realized in the city center; by this project a social and cultural focal point was created in the city (Babalık Sutcliffe, interview, 2011).

Another project on riverfront called *London Dockland Project* was in Docklands located away from the city center. There were large residential areas near the shipyards, in the 1980s the central government created an institution to cover Docklands, Urban Development Corporation (UDC). In favor of UDC, a new financial center, new residential areas were produced. A highly prestigious region was created in Docklands with international investment. London-wide planning constraints such as floor height etc. were overruled by means of declaring the region as enterprise zone. Today the highest building in London is right here, but, according to the older city plans, a church was the highest building. Owing of the fact that social structure was not taken into account in the project, social unrest occurred and a large amount of luxury apartment was left empty. With the second half of the 1990s, the social dimension of the project, employment, etc. were started to incorporate into the process (Babalık Sutcliffe, interview, 2011).

The Thames is a great popular playground, with thousands of acres of public parkland along its banks. The river itself supplies the metropolis with the greater part of its water supply (“River Thames”, 2011). London's greatest natural asset the River Thames is celebrated in September with a cosmopolitan festival (Masters et al., 2010). South Bank and riverway is popular among pedestrians; there is a variety of open public spaces around the city. *The Millennium Bridge*, which was retrofitted at the beginning of 2000s, is a pedestrian bridge across the Thames (“River Thames”, 2011). Besides the opportunities for pedestrians, there is a high-image light rail system in London (Babalık Sutcliffe, interview, 2011). (See Figure 5.9 and Figure 5.10 for details on the integration).

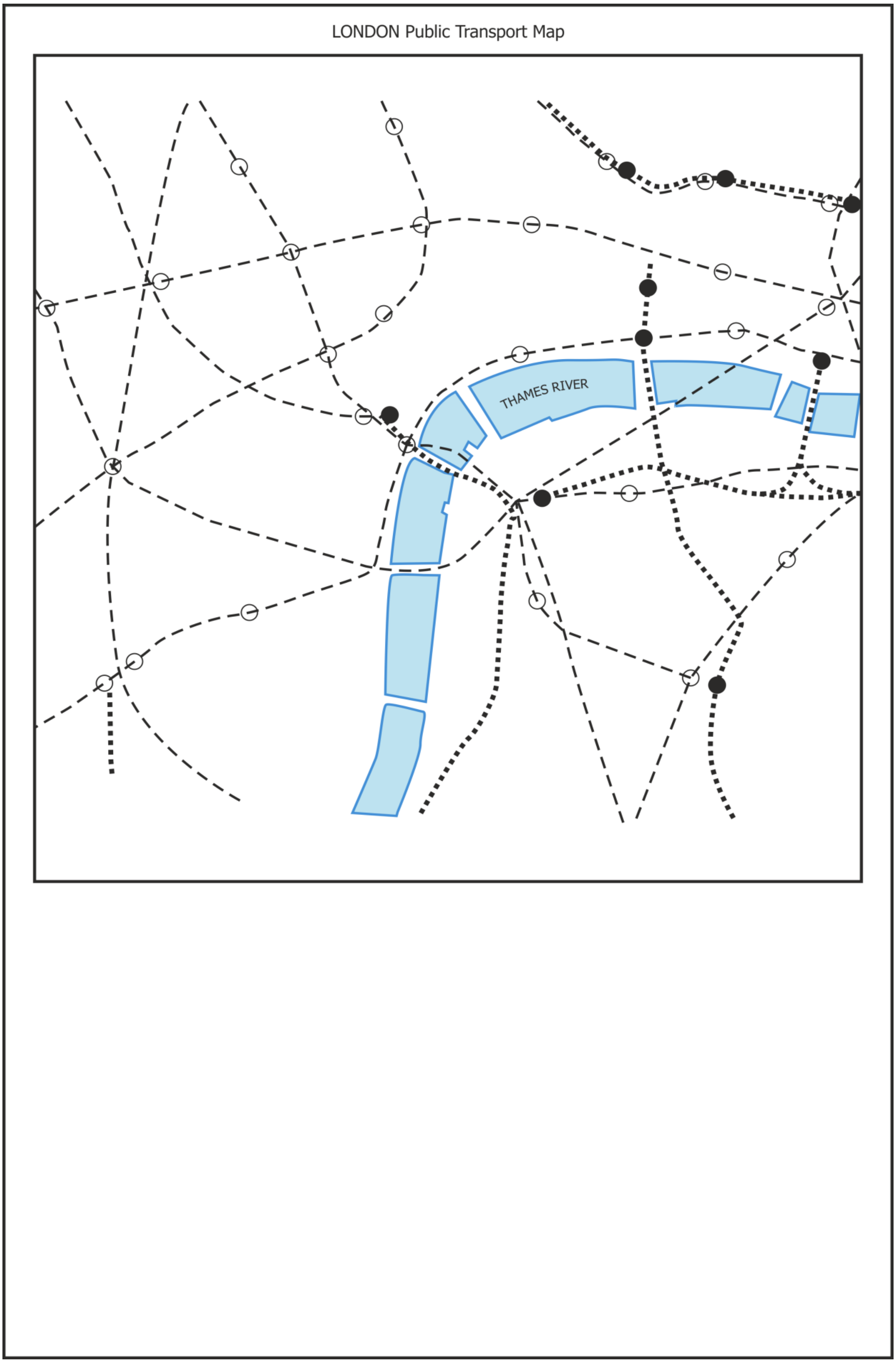

Figure 5.9 Public Transport Lines in City of London & Thames River

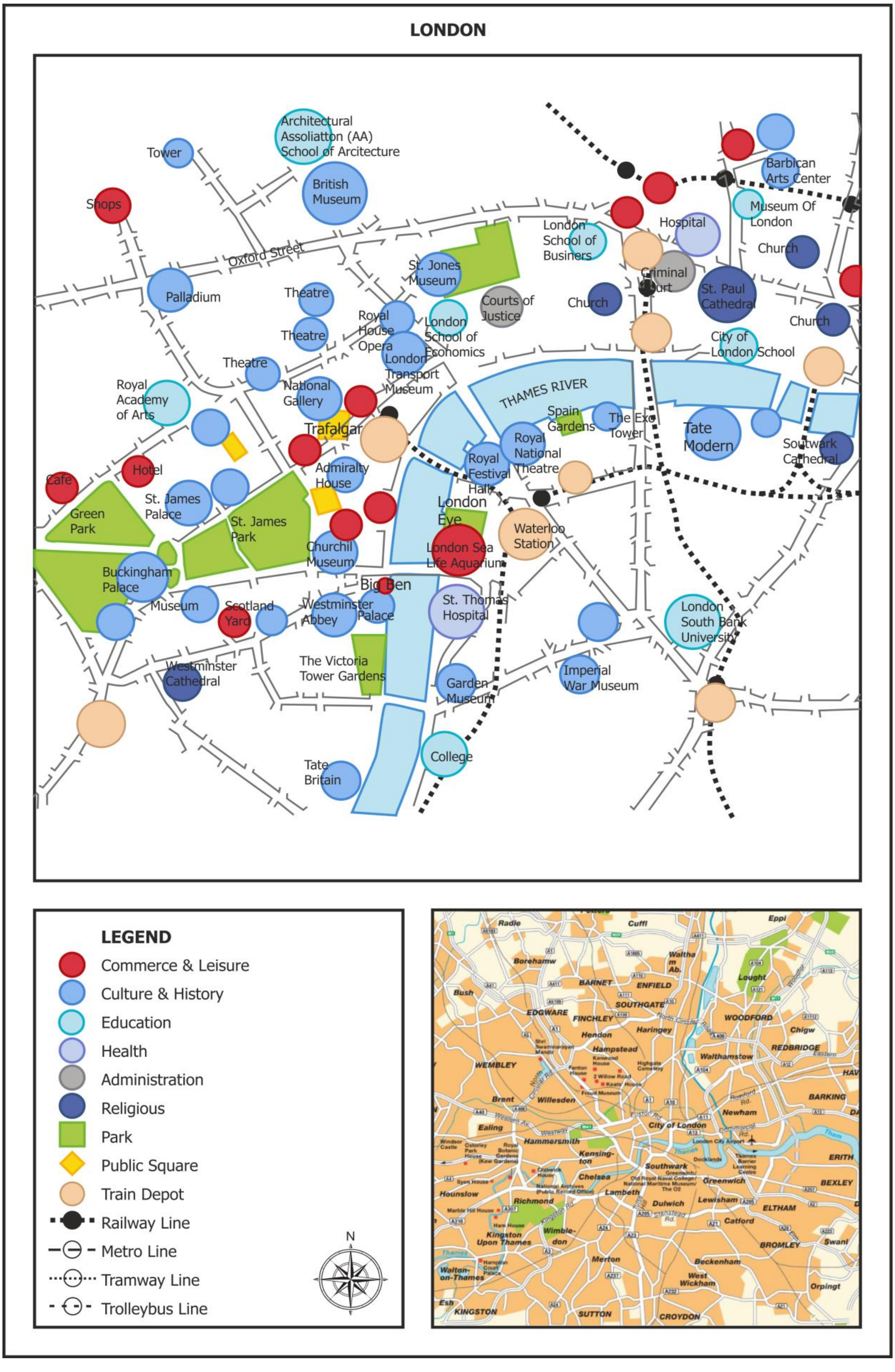

Figure 5.10 A Sketch on City of London & Thames River

5.3.6 City of Lyon & Rhone River & Saone River

An original Roman city *Lyon* was built north of the convergence of two rivers the *Rhone and Saone.* The population of the city is about 450.000 ("Population: Lyon", 2011). It was already mentioned in the Chapter 2 that his favorable location of the city on navigable rivers was connecting the city to central Europe, and this contributed greatly to the development of the city as a major trade center. Due to its locational advantage, silk weavers of Italy moved to Lyon to develop the city into the silk trade center of Europe competing with Paris as a trade center ("Lyon: An Economic and Scientific Metropolis", n.d.). The historical city center located north of the convergence of the rivers was been designated as World Heritage Site by UNESCO in 1998 ("Historic Site of Lyons, France", n.d.). Since the rivers have been the cause of existence and wealth of the city, they have always been important urban elements.

In 2003, a new project called *Lyon Confluence*, also termed as one of the largest city center projects of construction in Europe, was initiated. The project covers about 150 hectares on a former industrial site and stretches from the train station to the convergence point of the rivers. The first phase was completed in 2009, and it is expected that the remaining sections will be completed in 2015. The project will double the size of the historic center including a massive public center with an inner harbor with several new bridges across the river, a big museum and other cultural and recreational areas ("Lyon Confluence", n.d.).

The aim of the plan is to optimize the strategic location of this neglected zone by restoring abandoned industrial structures and enhancing the riverbanks with leisure, recreation, cultural facilities and residential units. The location is strategic because it is located very close to the city center and has a perfect setting for high-quality landscaping along the banks of the Rhone and Saone. A pedestrian and cycle path along the river has been laid out by the municipality ("The Confluence", n.d.). The attached sketch shows how the major focal points of the city have been located between the two rivers integrating them also as image building focal elements of the city.

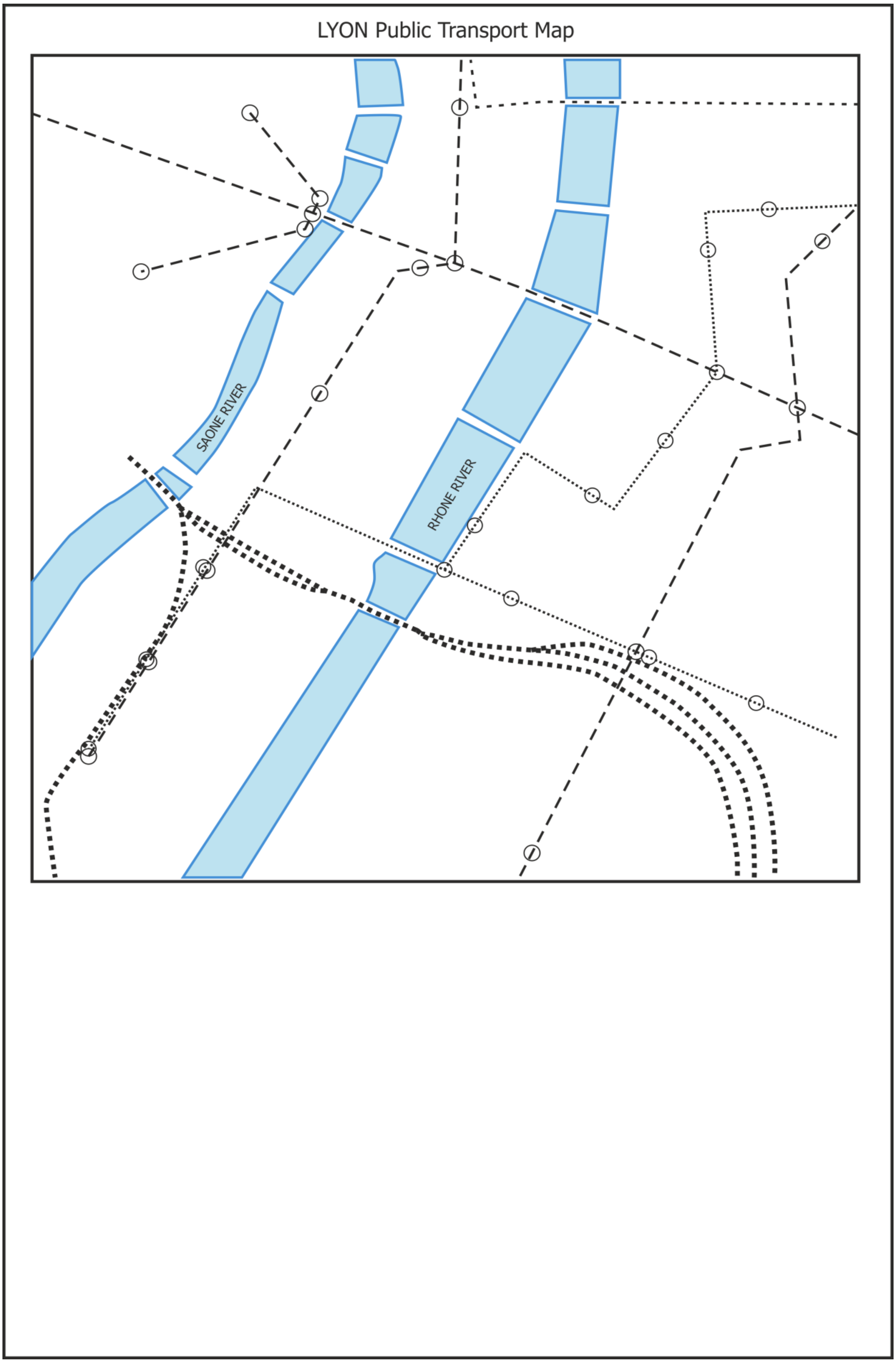

Figure 5.11 Public Transport Lines in City of Lyon & Rhone River & Saone River

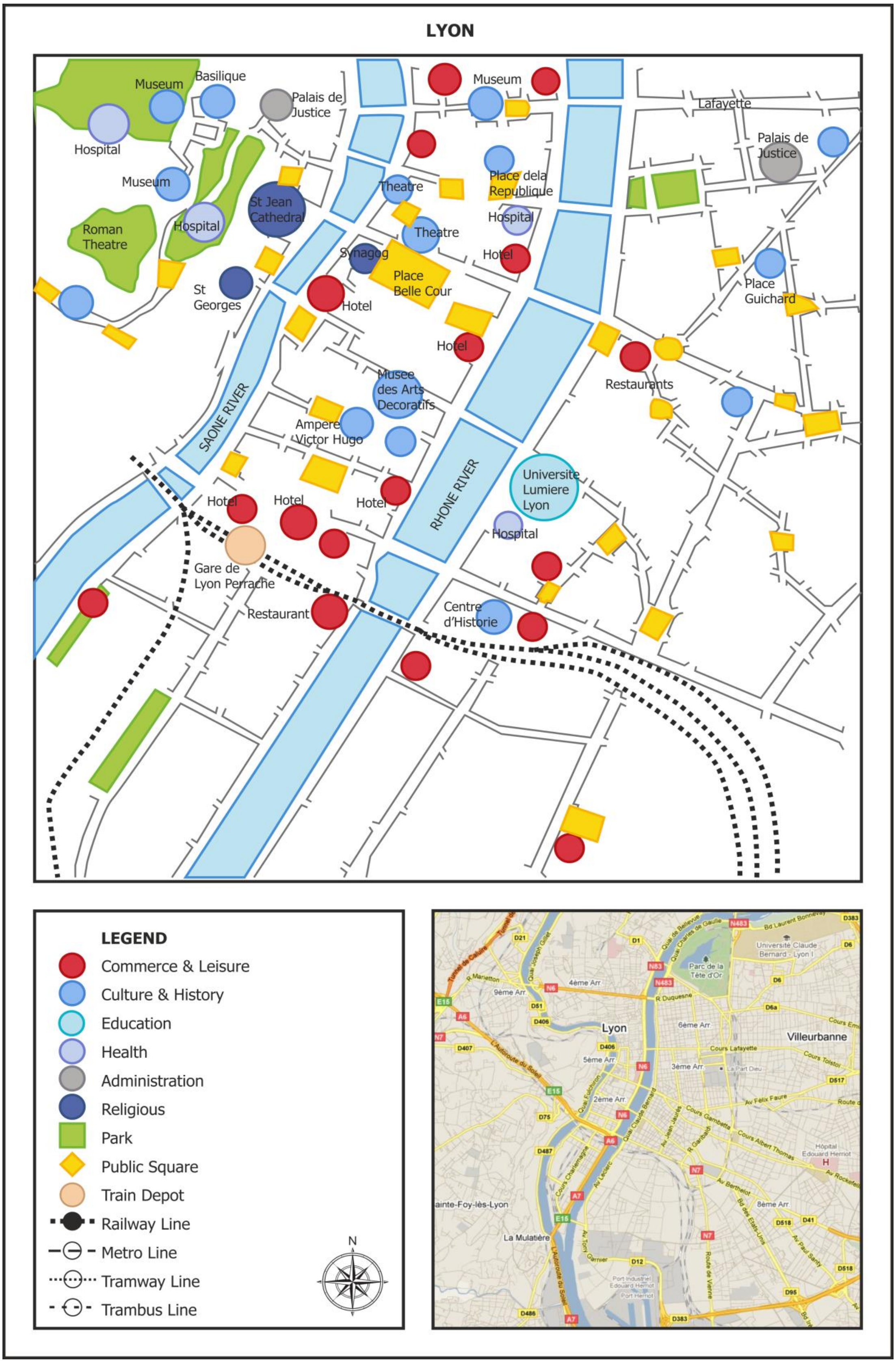

Figure 5.12 A Sketch on City of Lyon & Rhone River & Saone River

5.3.7 City of Munich & Isar River

Munich was founded about a millennium ago, and the city developed as a centre of music and theatre through the 19th century. Being the largest city in southern Germany, the population of the city is more than 1,2 million ("Munich", 2011). *River Isar,* a tributary of the Danube, flows through the city of Munich. Isar has been used as an important trade route, linking central Europe to the Mediterranean. In the medieval times, several small canals were built on Isar providing fresh water to the residents, also filling up the protection ditches out of the town wall. Still, Isar used to cause floods each year resulting in great damage. As a result, starting with the 19th century the banks were fixed and the river was canalized. In the first part of the 20th century, hydroelectric power plants were built using the river for generation of electricity which resulted in further damage to the ecology of the river and its environment ("Travel Munich", 2010).

Finally in the 2000s, attempts were made to rehabilitate the river and return it to its natural state, which is one of the main principles and goals of ecological rehabilitation. The riverbed has been widened, banks are flattened, small islands are built to slow down the flow and dams on it are enlarged. These implementations have improved the ecological environment of the river and of the city. The process still continues and the expressed goal is to alleviate Munich to the level of the few big cities of Europe which own urban rivers the quality of which is good enough for swimming (Schanze, 2004).

Significant streets and squares in the city are *Karlsplatz* in the hearth of the city, *Isartorplats, Lenbachplatz, Leopoldstrasse, Marienplatz, Maximillianstrasse* etc. (Forster, 2005). The old town gates and other medieval buildings such as cathedral the *Frauenkirche, Peterskirche* and the *Old Town Hallare* are important landmarks of Munich. The city has also some outstanding museums and art galleries as *Alte Pinakothek*. The huge *Deutsches Museum* is on an island in the Isar River ("Munich", 2011). The Isar flows through a very green place; it includes the enormous *Englischer Garten* with a boating lake ("About Munich", 2010). The city is connected by rail to all the main cities, and it has a modern subway system built ("Munich", 2011). The attached sketch (Figure 5.14) shows the pattern of integration of focal points of the city clustered together, leading to the river with other located on the bridges underlining the continuity of the urban elements.

An urban river restoration project has been in progress on the Isar since the beginning 2000s. The scope of the *'Isar Plan'* that extends over 8 km in the city covers local flood protection and improvement of ecologically valuable habitats for fauna and flora. At the same time, providing natural landscapes in central urban areas for leisure and recreational use is considered. “This urban river concept combines the nature-oriented redesign of a river with an urban lifestyle.” (Arzet and Joven, n.d.). Schanze (2004) states that it is a “comprehensive approach to rehabilitation covering ecological and social, as well as security aspects, utilisation of a reference and testing section”.

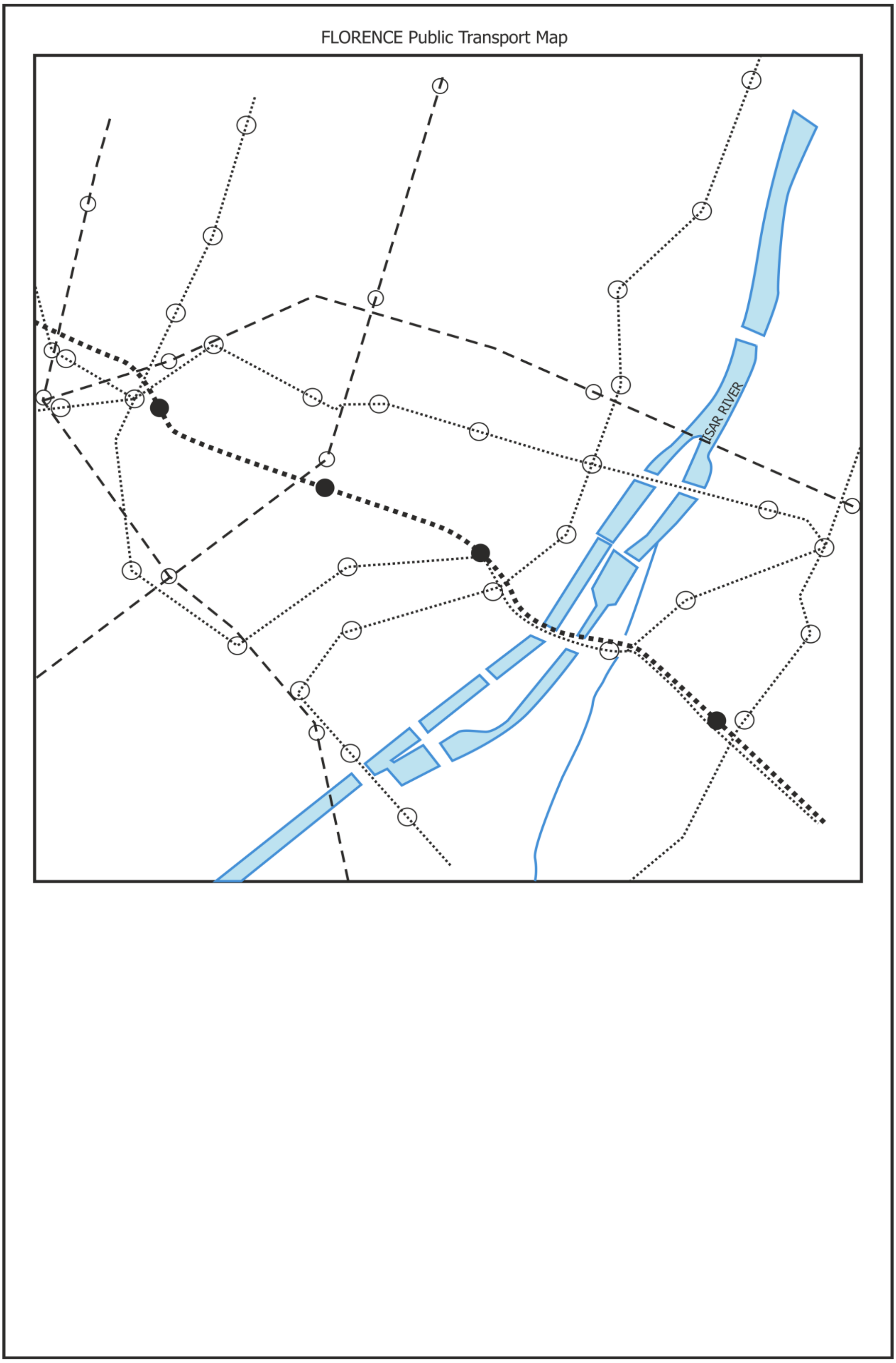

Figure 5.13 Public Transport Lines in City of Munich & Isar River

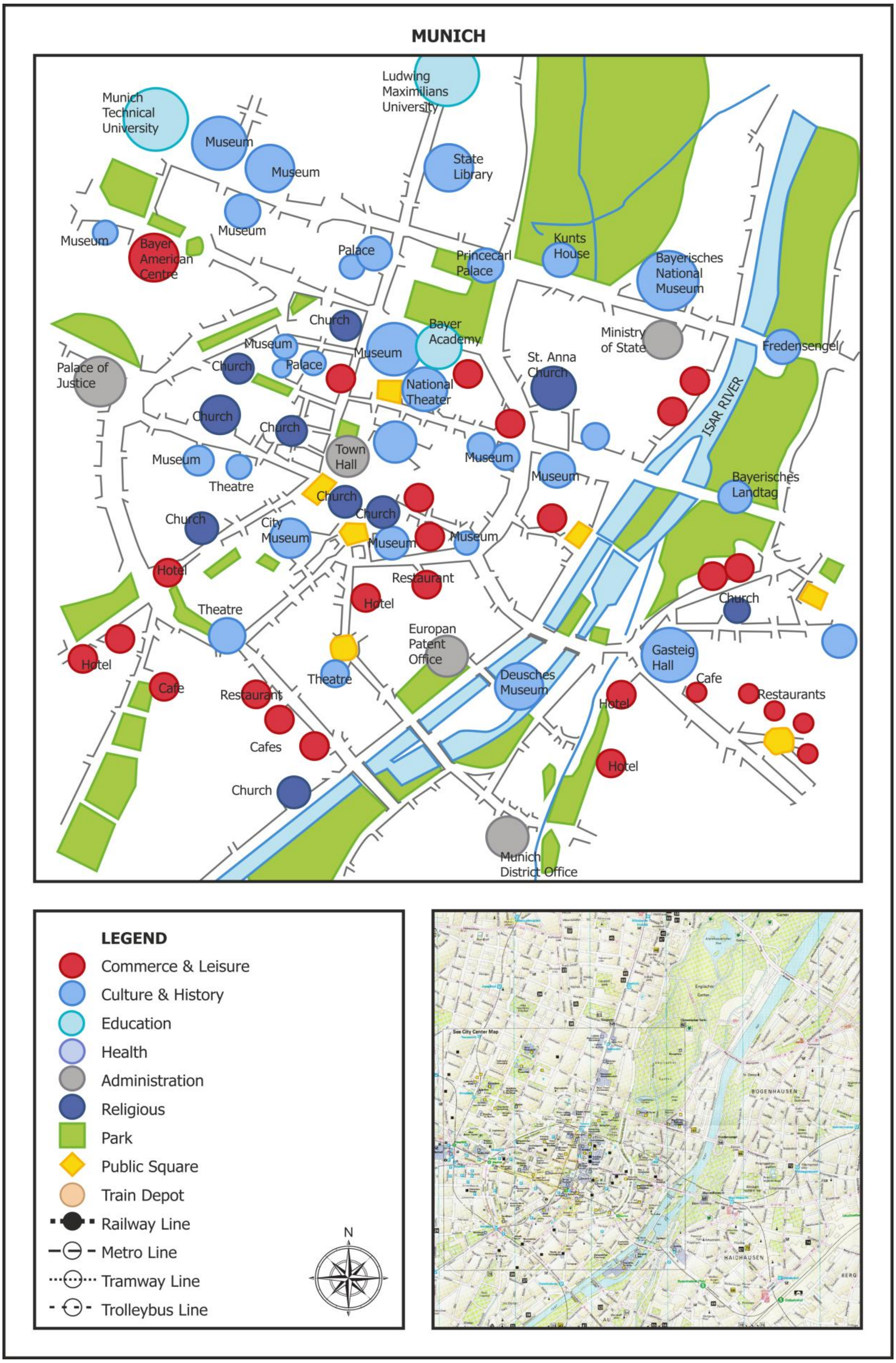

Figure 5.14 A Sketch on City of Munich & Isar River

5.3.8 City of Paris & Seine River

Paris, the capital of France and one of the best-known cultural and artistic cities of the world, is located on the river *Seine*. The settlement dates from about 7600 BC. One of the two islands on the river houses the oldest section of the city. All through its history, the river has always been an important part of the city. Along with provision of water to the city, the economy prospered through trading on the navigable river that was linked with canals to other rivers. The level of the river was not regular and subject to wavering until locks[32] were installed and banks were built in the beginning of the 19th century ("Paris", 2011).

The river divides the city into two halves, but smartly planned city in relation and in integration with the river hosts monuments and nodes of the city. *The Eiffel Tower, Orsay Museum* along with other monumental buildings, is on the south bank and the *Louvre Museum* and others are on the north bank while *Notre Dame* and other landmarks are on the river island. In 1991, the left and right banks were designated as World Heritage Sites by UNESCO ("Paris", 2011). A city sightseeing is possible by a cruise on the river as it is the sight of most famous historic structures ("Seine River Cruise", n.d.). Paris has one of the most attractive cityscapes along the river, with massive stone blocks at the banks decorated by statues and great iron rings and trees, gardens and old buildings (Şenyapılı, interview, 2011).

In recent years, the Seine River has been the subject of major conservation efforts called *'Operation Clean Seine'*. New water purification plants and separating sewers from storm drains within the context of the Clean Seine have removed pollutants and brought the salmon back to the river ("Atlantic Salmon", 2009). The Seine in Paris is lined with constructed walls; however, appropriate adjacent land use and careful design of the public life along the river yield an attractive urban amenity just like in London (Fleming, 2009). Along the north side of the Seine, there is dense traffic; this limits pedestrian accessibility to the river to some extent (Acar Özler, interview, 2010). "Where open space is very limited, still the urban character of the river can be celebrated" (Fleming, 2009, p.191). The Figure 5.16 shows how the focal points oriented towards the river, and the Figure 5.15 displays the heavy metro network that the city has.

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[32] Lock is an enclosure (as in a canal) with gates at each end used in raising or lowering boats as they pass from level to level ("Lock", 2011).

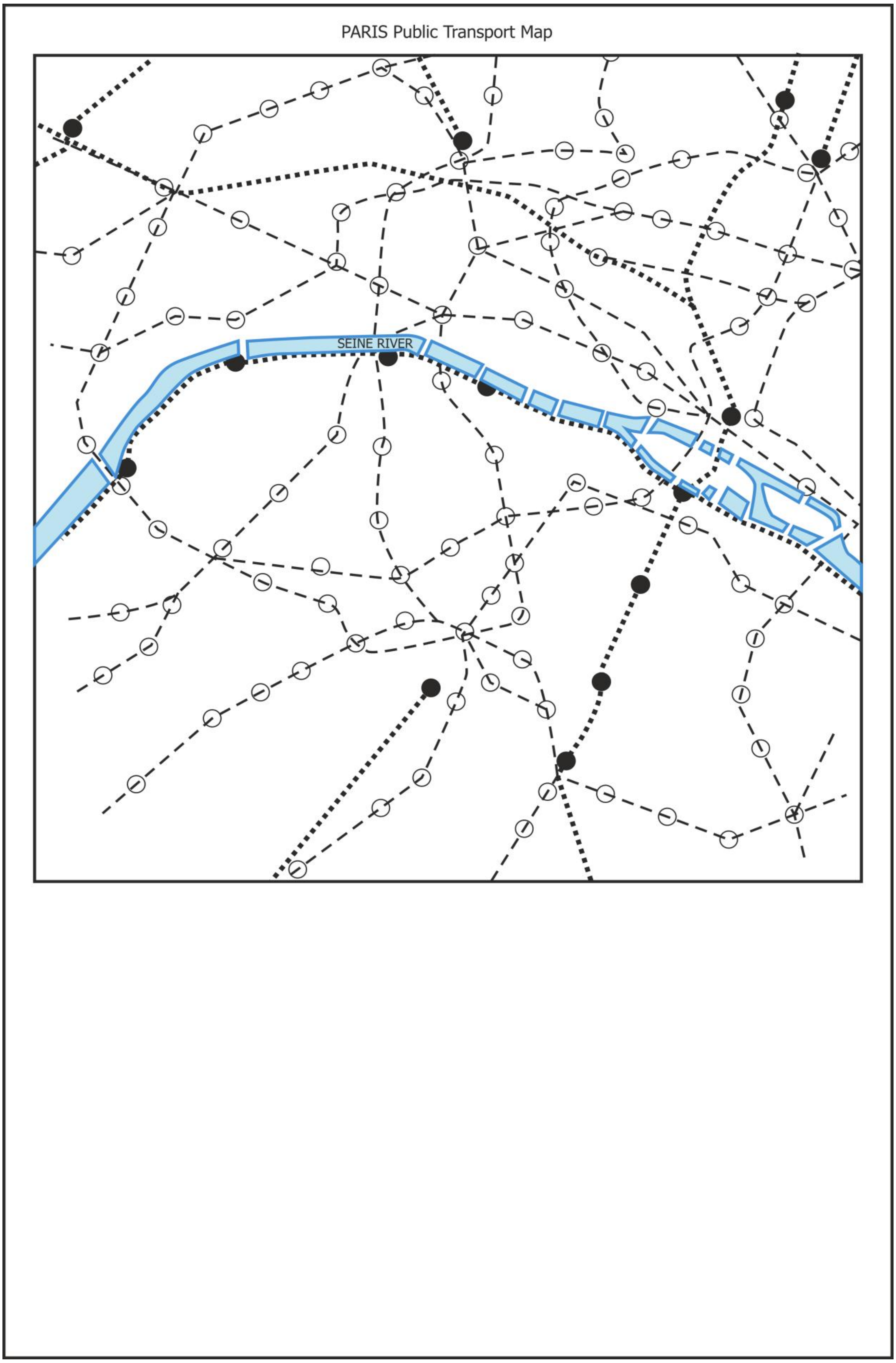

Figure 5.15 Public Transport Lines in Sketch on City of Paris & Seine River

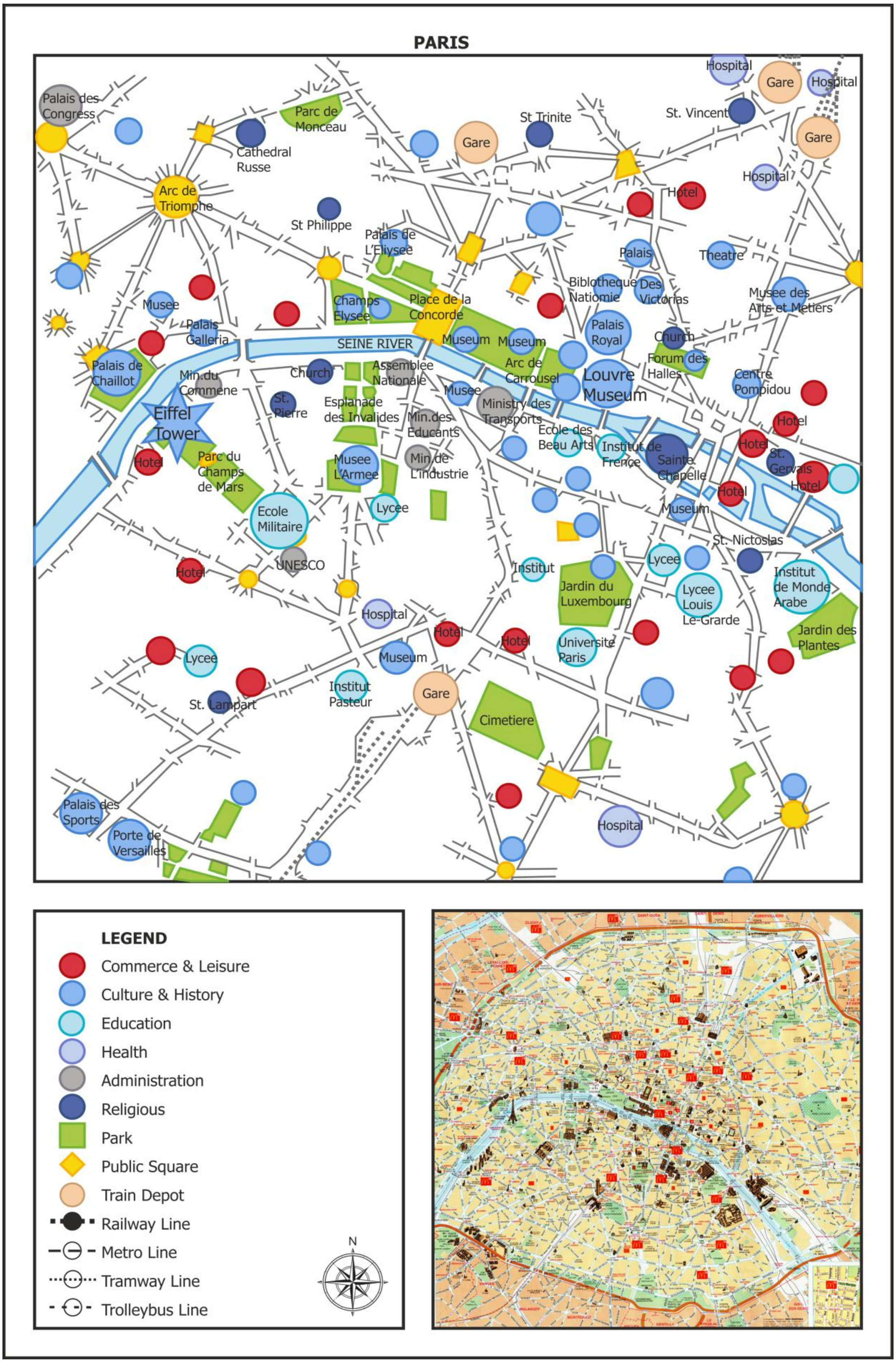

Figure 5.16 A Sketch on City of Paris & Seine River

5.3.9 City of Rome & Tiber River

Rome was the capital of the Roman Empirefor about 700 years. The river *Tiber*, one of the longest rivers in Italy, runs through the city. Throughout history, the river has been an important source of trade as it was navigable. The harbor Ostia was an important port for naval protection, and food was brought from colonies in the Mediterranean making the the settlement grow into an empire ("Ostia", 2003). Then, several wharves were built along the river, and channels were built to serve water to the central parts of the city.

In time, silting up of the river with sedimentation led to closing up of the harbour Ostia. New ports were built, but they also were silted up. Extensive dredging was applied to the riverbed in the 19th century, but continuous silting kept on slowing down navigation. Tiber also had flooding problem and beginning from the last years of the 19th century, high embankments were built on which boulevards run ("Mediterranean Cruise", 1977).

It is interesting to note that, in 2003, a new city plan was prepared for the city following the 1962 *Piccinato Plan*. In the new plan a section was allocated to a *project for Tiber*. It is mentioned in the plan that the emphasis of this project would not only be on reclamation and development of the river but also on its relation with the city as asserted in this thesis study. The main objective of this Tiber project is to *'bring the city to the river again'***.** For this aim the project proposes that inner city navigability be restored, mooring near focal points should be provided, the banks of the river should be modernized with easy access points to the river, and landscape perception of the city from the river should be provided. The project also mentions that an 'integrated' program is vital for this rehabilitation project in which the river is perceived, evaluated and interpreted within the context of integration with the city ("RiverLinks", n.d.).

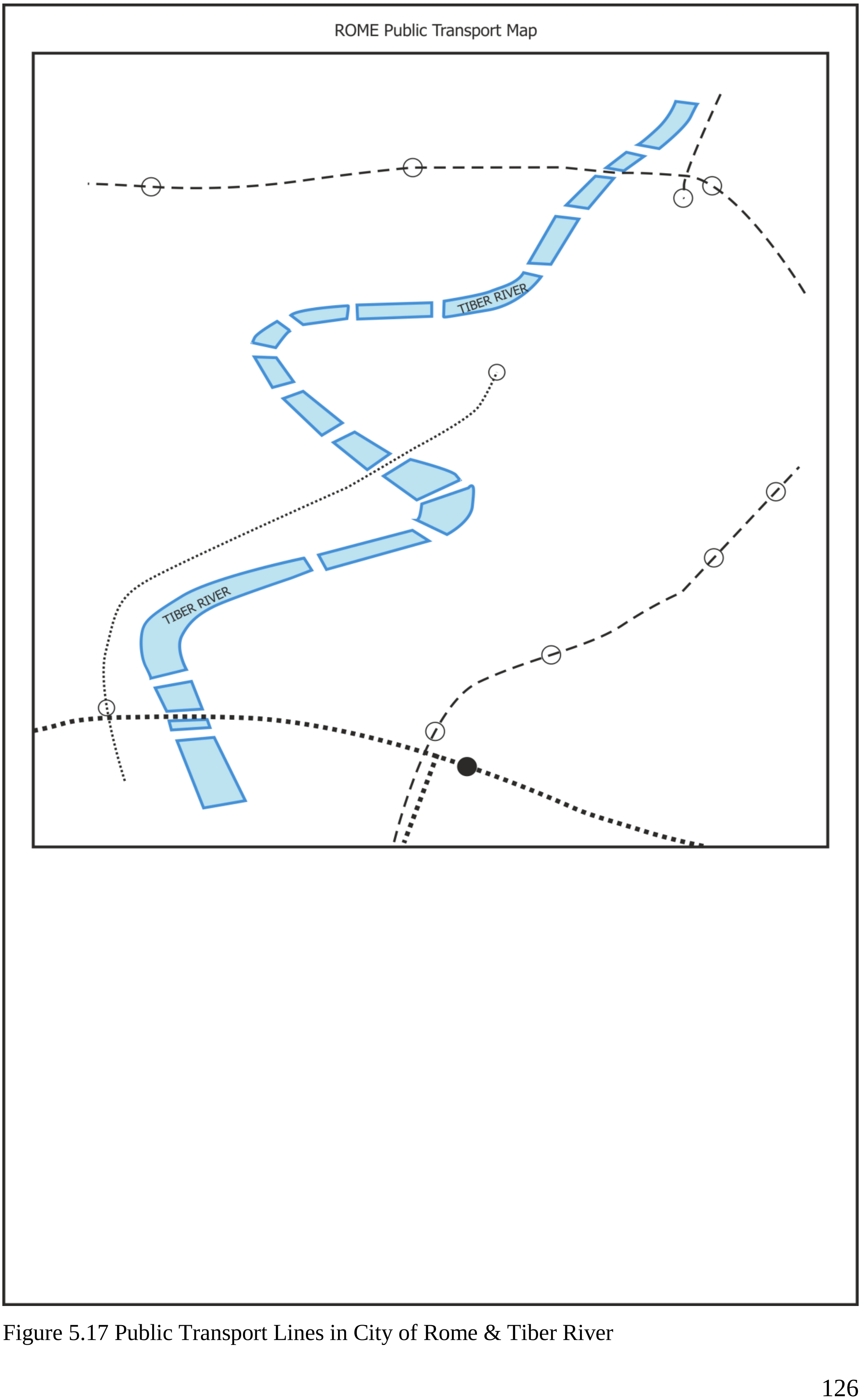

Figure 5.17 Public Transport Lines in City of Rome & Tiber River

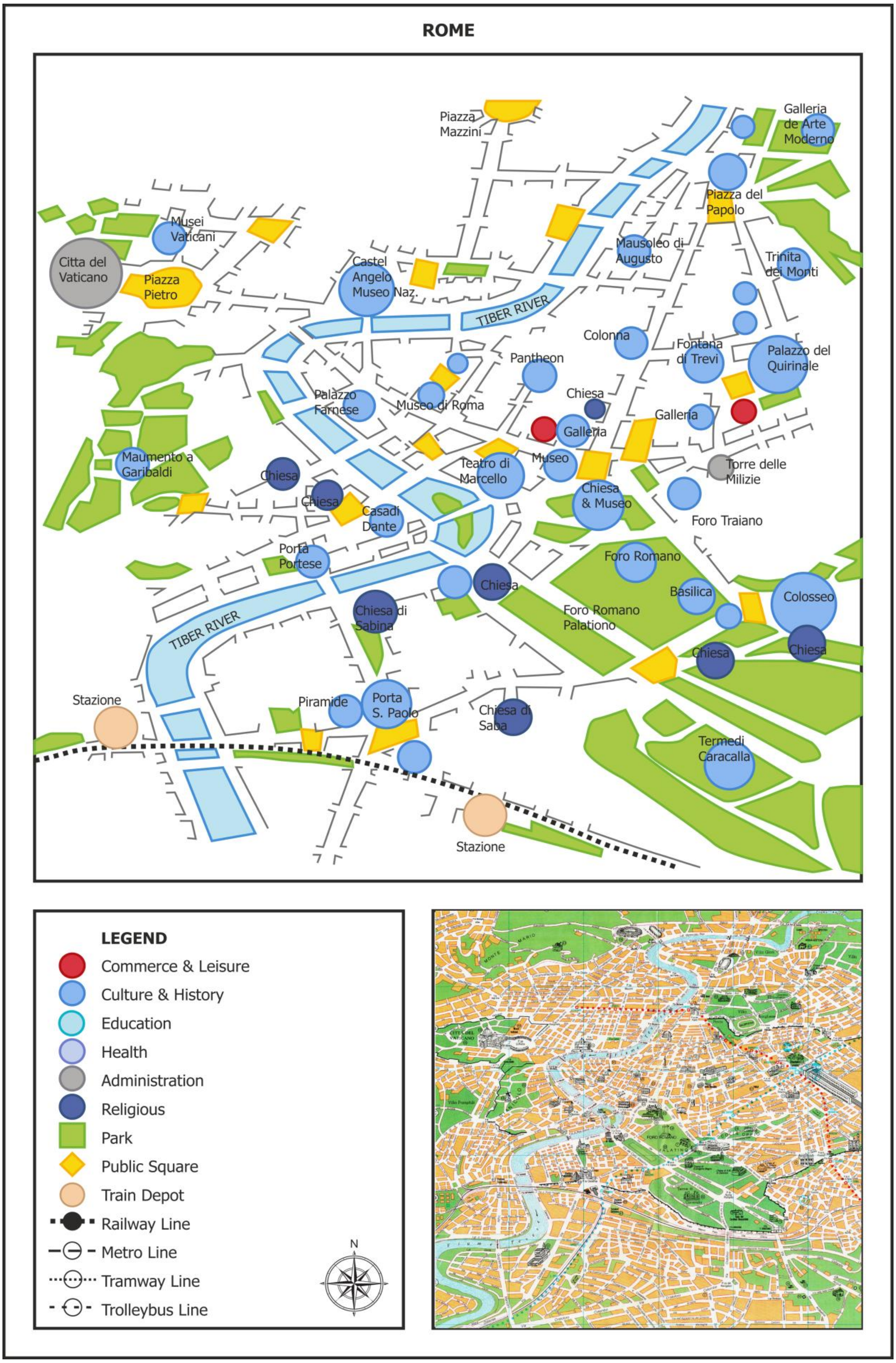

Figure 5.18 A Sketch on City of Rome & Tiber River

5.3.10 City of Saint Petersburg & Neva River

St. Petersburg was built on several islands on the *Neva River* next to the Baltic Sea in 1705 and has served as the capital of the Russian Empire for about 200 years. The Neva River is only 74 km long and flows from Lake Ladoga to the Gulf of Finland, in the eastern part of the Baltic Sea. Before joining the Baltic, the Neva splits into several branches forming a delta, where downtown St. Petersburg is located. Because of its location on the river, Neva has always been a major urban element for the city, its banks include granite laden walkways and with its architecturally famous bridges, gardens, the fortress, impressive palaces and other cultural buildings located in relation to the river, like the famous Hermitage museum, former palace of the Tzar, facing directly the river, it is the most important backbone of the city. The city is also called *'Venice of the North'* ("Woodworth et al, 2005).

Because the river has always been one of the reasons of existence and one of the main attractions of the city, a new image building joint project has been taken up by public-private partnership in the 2000's. The project was called the *Okhta Center* and included allocation of a public and business area with an *eco-skyscraper*, which aimed at creating *a unique landmark* for the city. The designers also expressed that the inspiration for the project, which focuses on the right bank of the Neva, came from energy in the water and the building form was derived from the changing nature of water, and changing light on water ("Gazprom Tower", 2011). However, the project has two opposing sides: though eco-conscious features are highlighted in the project, the height is the biggest source of severe opposition by many residents who believe that the tower will degrade the historic integrity and ambience of the city (Pham, 2009).

The attached sketch shows the integration of many famous buildings and locations in the city in consistency with the original aim of location and design of the city as the 'Venice of the North'. The project Okhta Center shows how urban administrations today attempt to rehabilitate the urban setup through enrichment of the image.

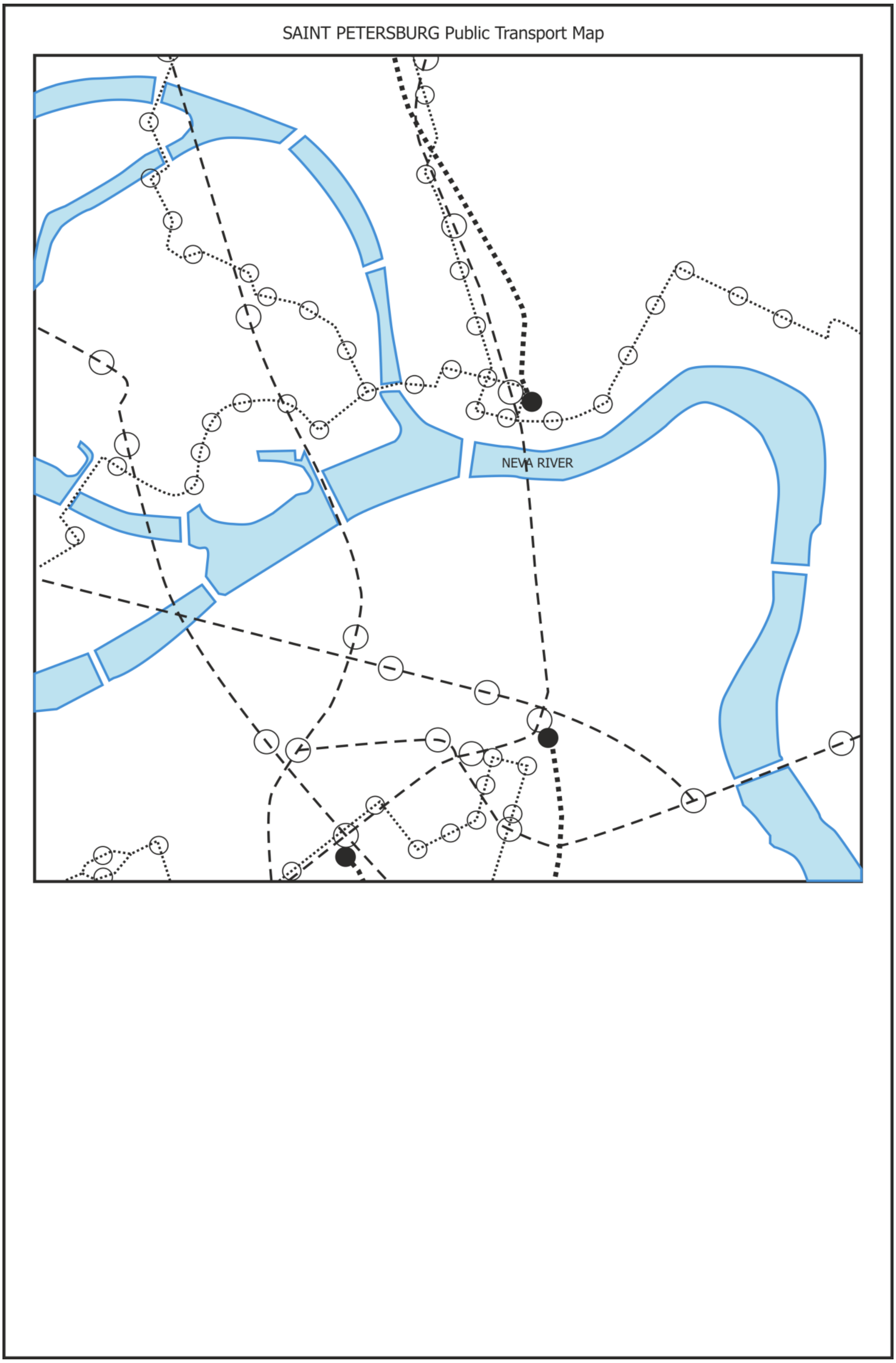

Figure 5.19 Public Transport Lines in City of Saint Petersburg & Neva River

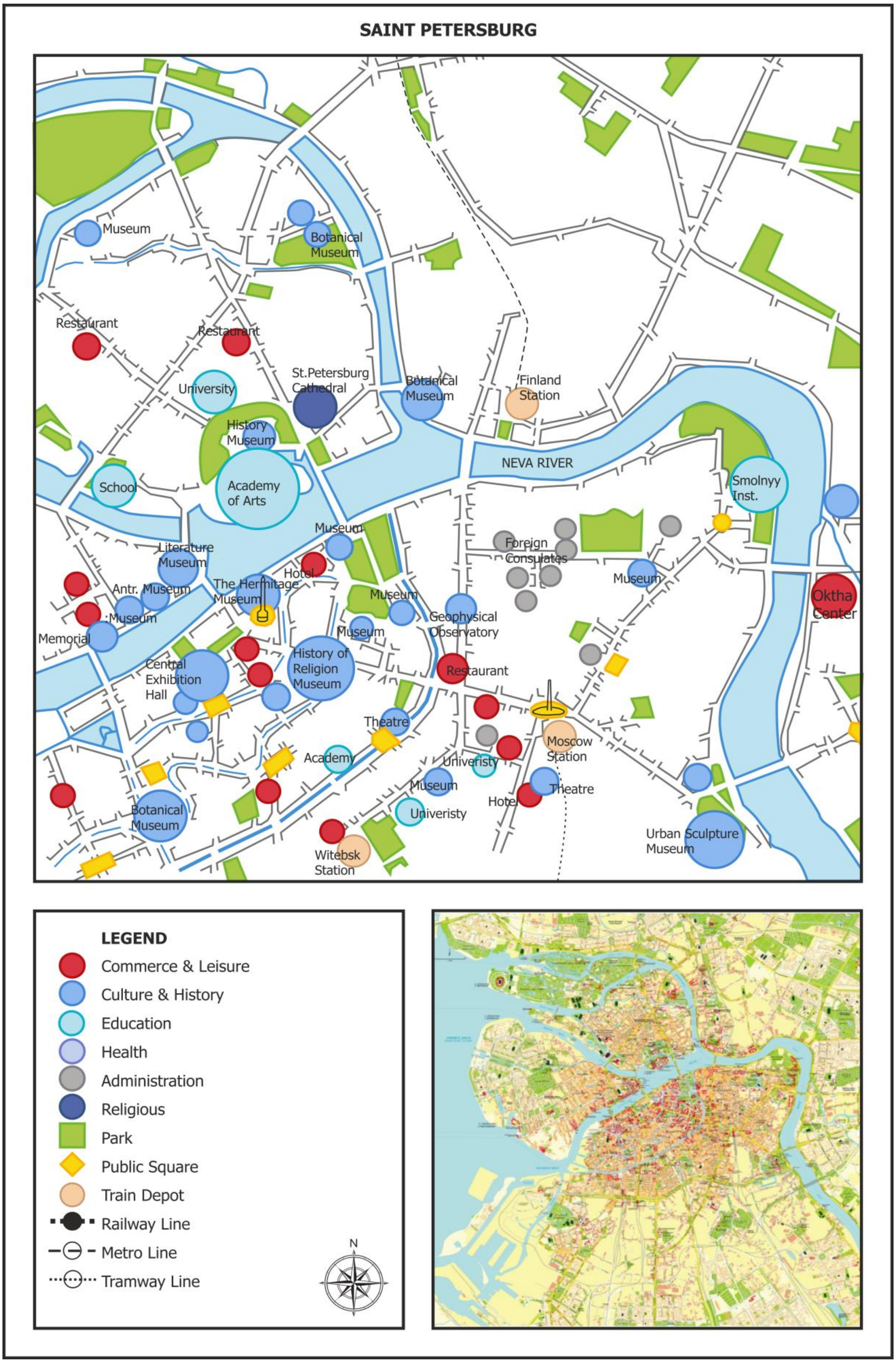

Figure 5.20 A Sketch on City of Saint Petersburg & Neva River

5.3.11 City of Salzburg & Salzach River

Population of city of *Salzburg* is 144.000. Within the borders of the city is flowing the *Salzach River* along a route of 226 km ("Land Salzburg", 2001). Salzburg was first resided by Celts around 5 BC on Salzach River. The Salzach, flowing through in a diametral position through the city, is a tributary of the Inn River. The river was named after the shipments of salt carried on barges down the river. Thence the river also contributed to the economic base of the city until the introduction of the rail system. The old city was designated as UNESCO World Heritage Site in 1997 ("Salzburg", 2011).

Like most of the Alpine rivers, since land is not easily available, Salzach also has suffered from human activities which notoriously aimed at gaining land for agriculture and settlement, active mining, building of hydropower plants. These all resulted in changes in the river morphology. Throughout history, Salzach has also been an important cause of floods resulting in severe settlement damages. Consequently, the river has been regulated since the beginning of the 19th century through agreements between Austria and Germany to build walls for flood protection. Before 1970, Salzach was also severely polluted from the wastes of the paper industries on it, and since then, through technological measures, this problem has also been alleviated ("Salzburg River: The Salzach", n.d.).

A well-developed and well used cycling path runs along its banks accompanied by a popular running track ("Salzburg River: The Salzach", n.d.). The *Salzburg Cathedral* and many other churches in the centre of the Mozart City have given Salzburg the name *'Rome of the North'*. "The many art galleries and museums Salzburg has to offer should also not be forgotten. They include the *Haus der Natur* (Nature Museum), the *Museum Carolino Augusteum*, the internationally renowned *Rupertinum*, the *Residenz Gallery* and the unique open-air museum near Großgmain." ("Arts and Culture in Salzburg", n.d.). (See Figure 5.22). The main attraction integrating the city and the river is the cruising service, which provides a comprehensive view of the city and its focal points from the river.

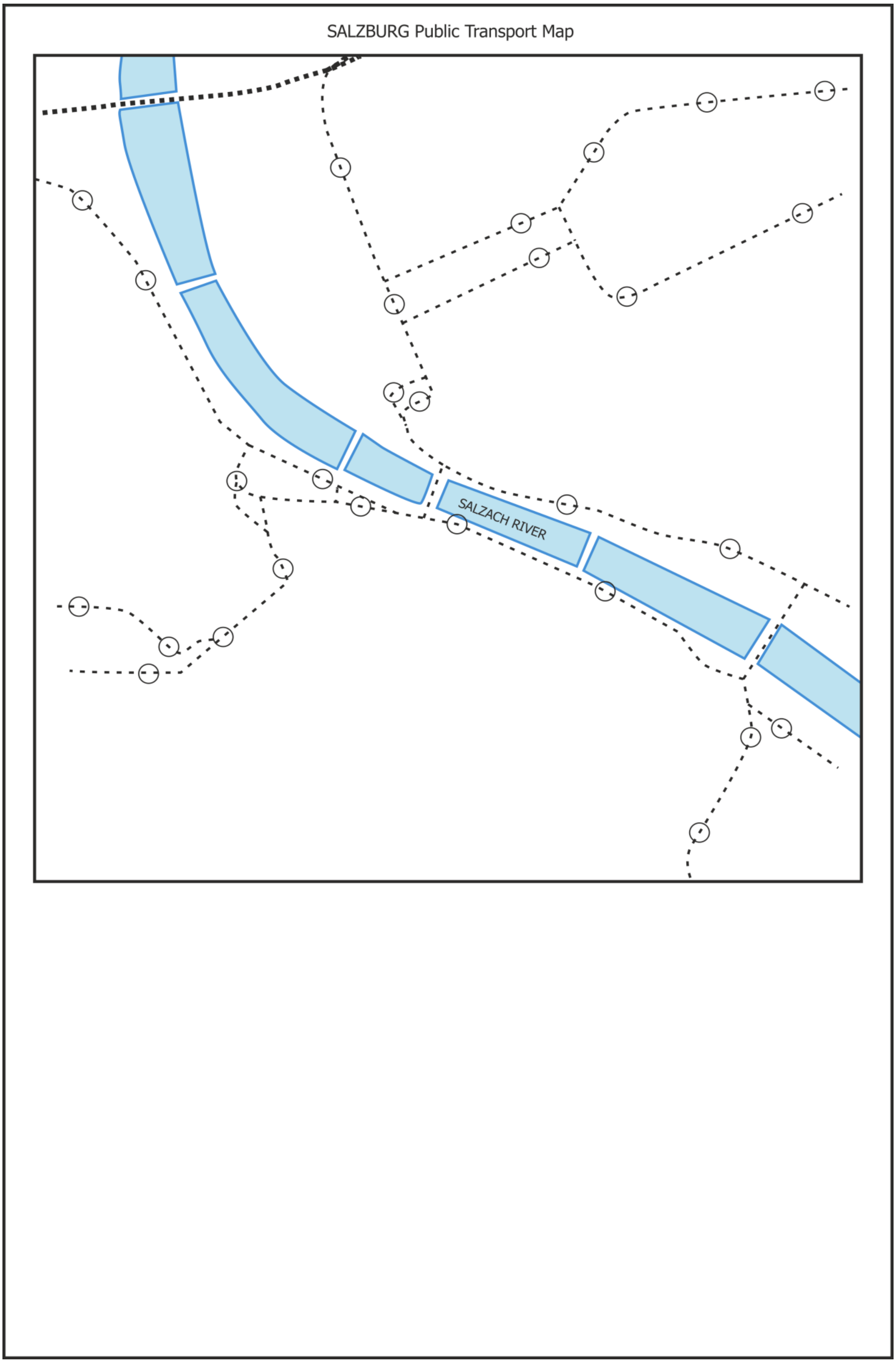

Figure 5.21 Public Transport Lines in City of Salzburg & Salzach River

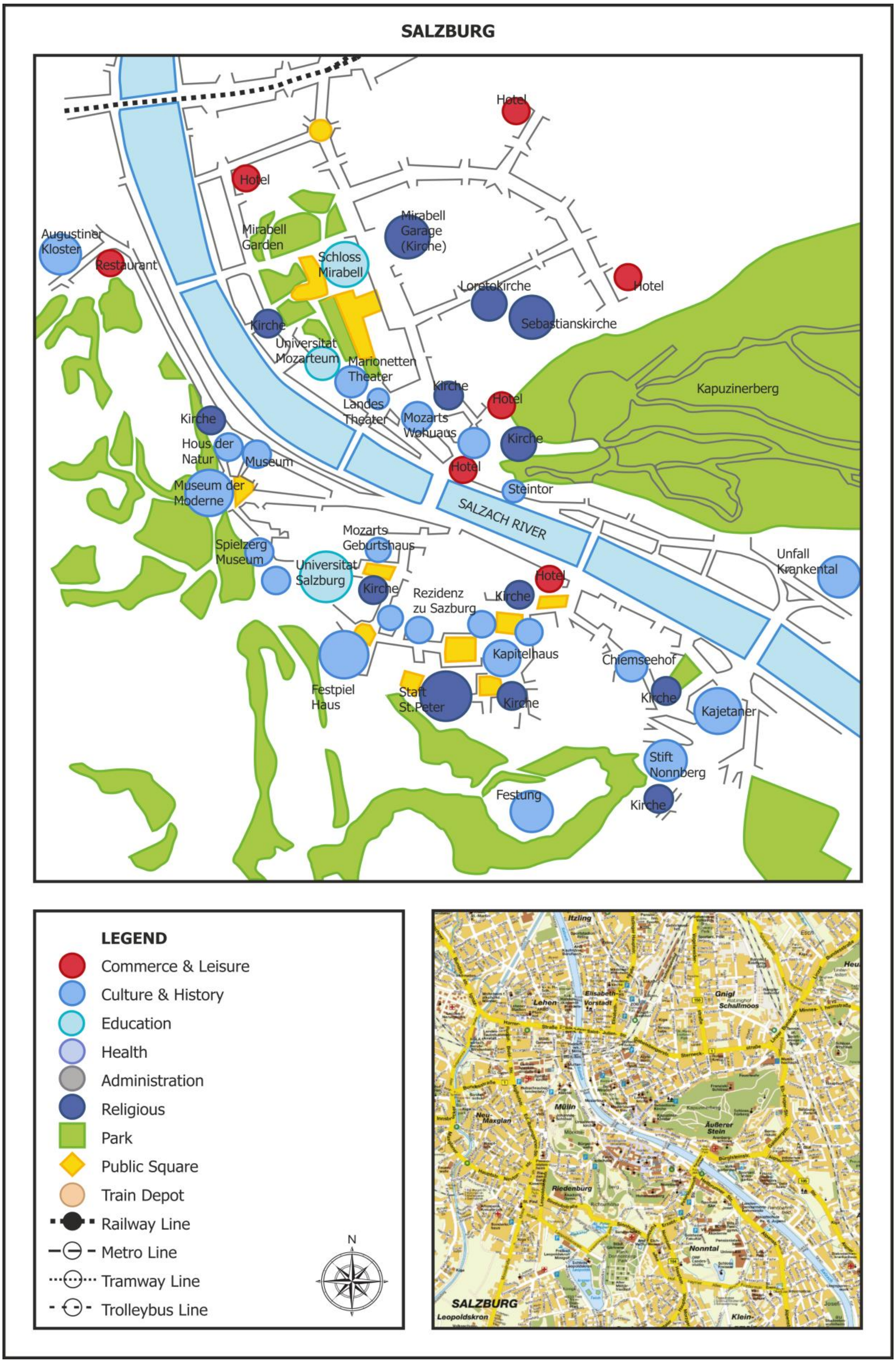

Figure 5.22 A Sketch on City of Salzburg & Salzach River

5.3.12 City of Strasbourg & Ill River

Strasbourg is an old city, about 2000 years old, and was first built by the Romans as a military camp to protect the northern border of the empire against invasions. The city of about 270.000 people is located on the *Ill River*, a tributary of the *Rhine*. The river flows through the city through a series of locks and channels. Once there were tanneries and mills on the river. The city flourished in the past due to its favorable location on both the waterways and land roads allowing trade. Both the river Rhine on the outskirts of the city and the Ill opened the way to trade from the Netherlands to the Mediterranean. The port on the Rhine contributed to the prosperity of the city until the development of the railway. The historical city center is located on the *Grand Island*, encircled by two arms of the Ill and it was declared a World Cultural Heritage site in 1988. Today the city is the seat of several major European institutions including the European Parliament ("Strasbourg", 2011).

The city centre, with walking paths and trams is a popular tourist destination ("Strasbourg", 2011). One of the major touristic attractions of the city today is taking a boat trip that circles the old city on the Ill River (Galvin, 2006). This cruise through locks and channels, allows people to see the old gothic buildings and timber houses of the old city along the two arms of the Ill. The trip also takes the visitors to the contemporary city which houses the official European buildings and other modern cultural entities (Şenyapılı, interview, 2011).

The banks of the rivers have been arranged for pedestrian traffic from where important touristic locations can be reached. Some of the monuments and contemporary buildings of the city are located in scenic locations on the riverfront (Şenyapılı, interview, 2011). The sketch under the figure 5.24 shows the bending of the river and of the canals and nesting of significant nodes of the city in these bends creating sights integrating the river and the manmade architecture.

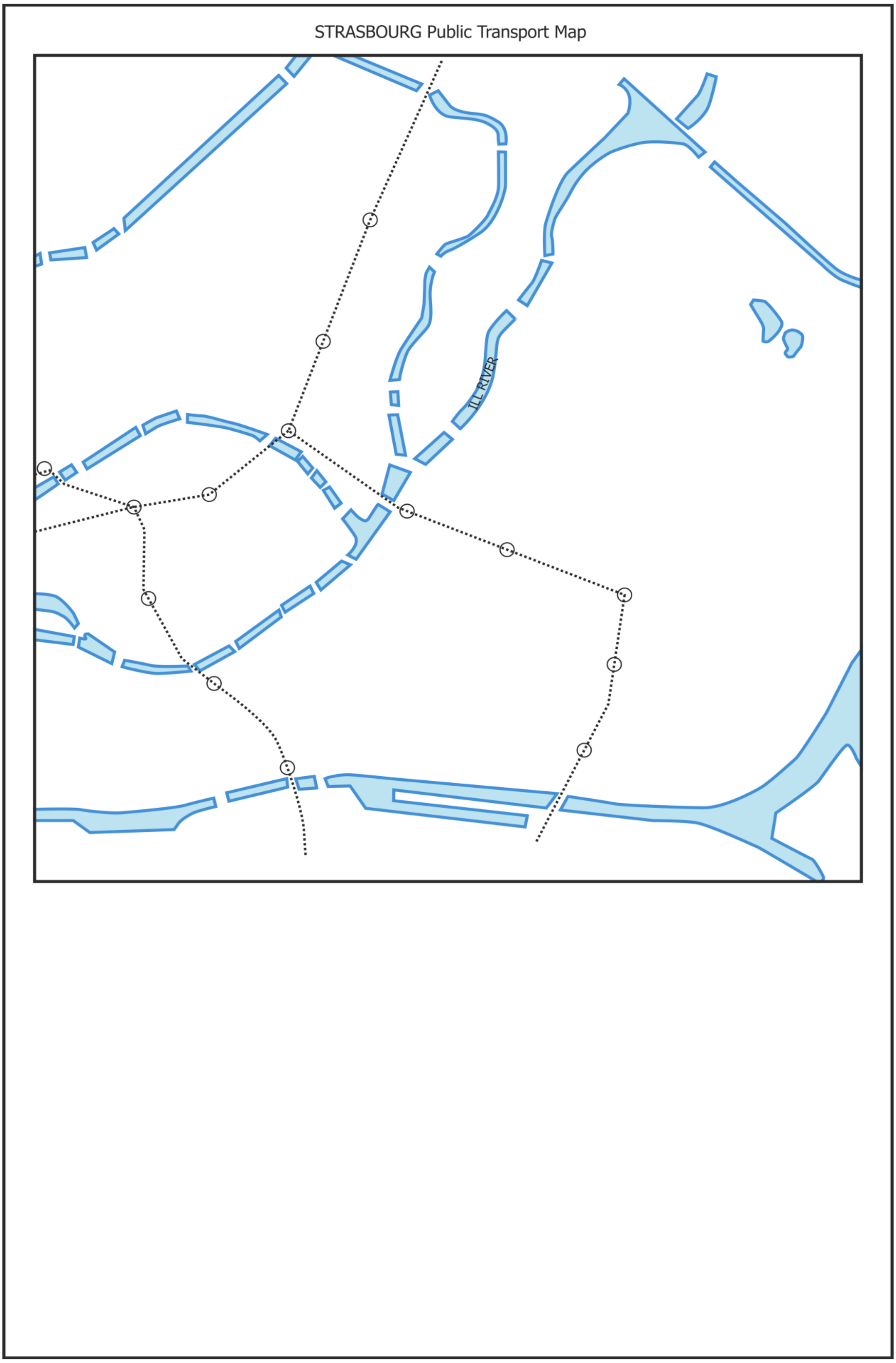

Figure 5.23 Public Transport Lines in City of Strasbourg & Ill River

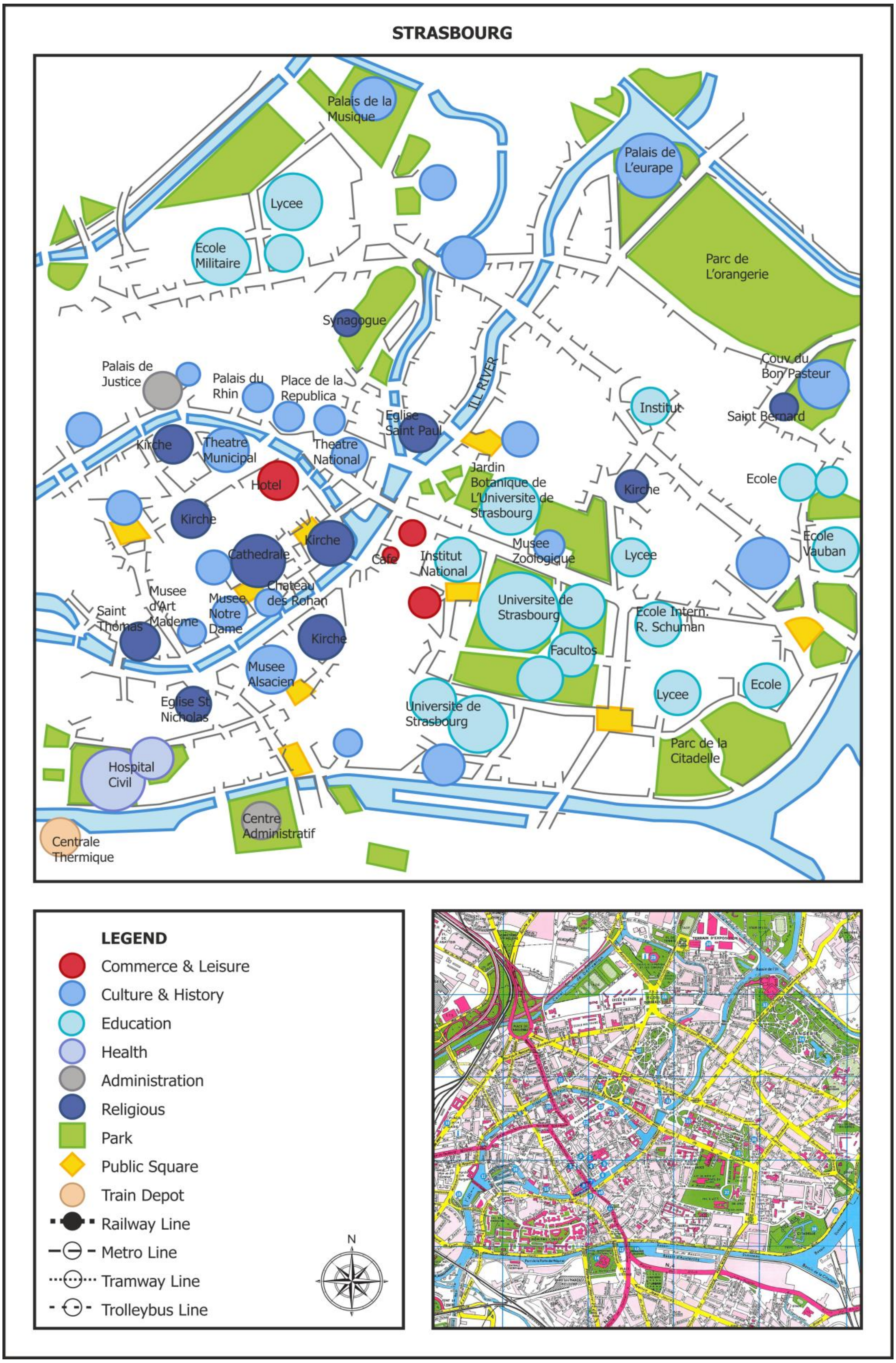

Figure 5.24 A Sketch on City of Strasbourg & Ill River

5.3.13 City of Vienna & Danube River

Capital city of Austria, *Vienna*, was founded by the Celts, and it was also used as a frontier protecting the empire from invasion from the north. The river *Danube* flows through the city and the earliest settlement was on the southbank of the river. Owing to floods repeatedly damaging the settlements nearby, regulation measures started towards the end of the 19th century (“Vienna”, 2011). At first a flood free area about 450 m. wide was created on the left bank along with a dam. Yet, more floods this time on the right bank of the river necessitated new measures. So in 1970, a new plan was developed to build a new canal in the former inundation area. The debris excavated from this canal was used to build a long and artificial island between the main river and the new canal. The island called *New Danube* is fortified against floods and there are locks on both ends of the island along with a groundwater level control system. Along with the island, a long swimming lake is created between the island and the left bank of the river (“Flood Control on the Danube in Vienna”, 2007).

Finished in 1988 when the new urban planning ideas were in effect, it was decided to develop this island as an important recreational center along with sports centers, a beach, an international annual festival area, one of the biggest European festivals, and concert areas. Today, among the other attractions along Danube this artificial island tops them all (Şenyapılı, interview, 2011).

In Vienna, there are many pedestrianized roads, which are perpendicular to the river (Acar, interview, 2010). (See the Figure 5.26). The core of the city contains most of the city’s famous urban structures. The heart of the city is surrounded by a circular road lined with grand buildings, monuments, and parks (“Vienna”, 2011). The island is 21 km long and 70-210 m wide was created from former floodlands and was outfitted by an all-sports park, adding to the city’s already generous recreational space (“Flood Control on the Danube in Vienna”, 2007; “Vienna”, 2011).

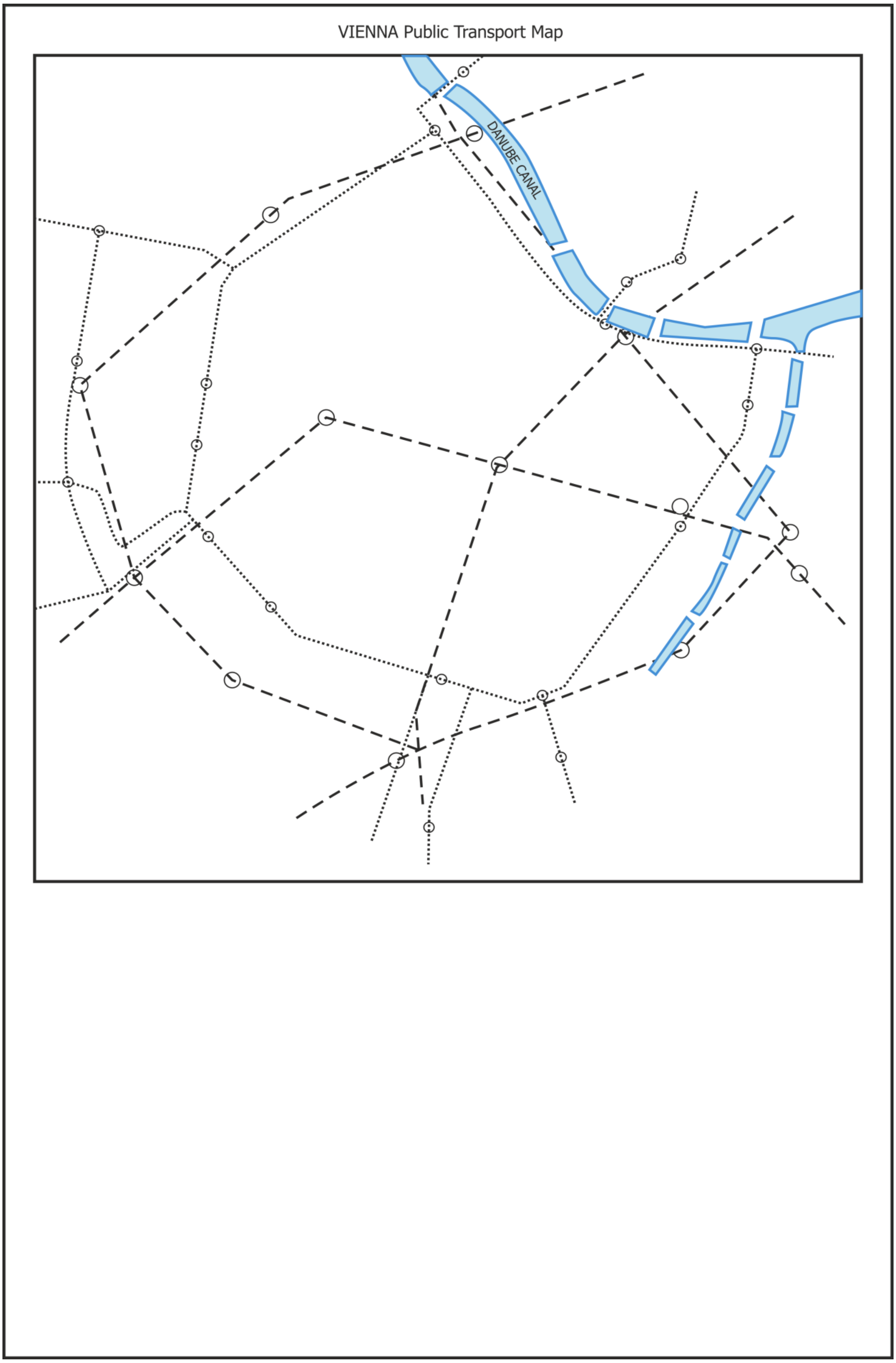

Figure 5.25 Public Transport Lines in City of Vienna & Danube River

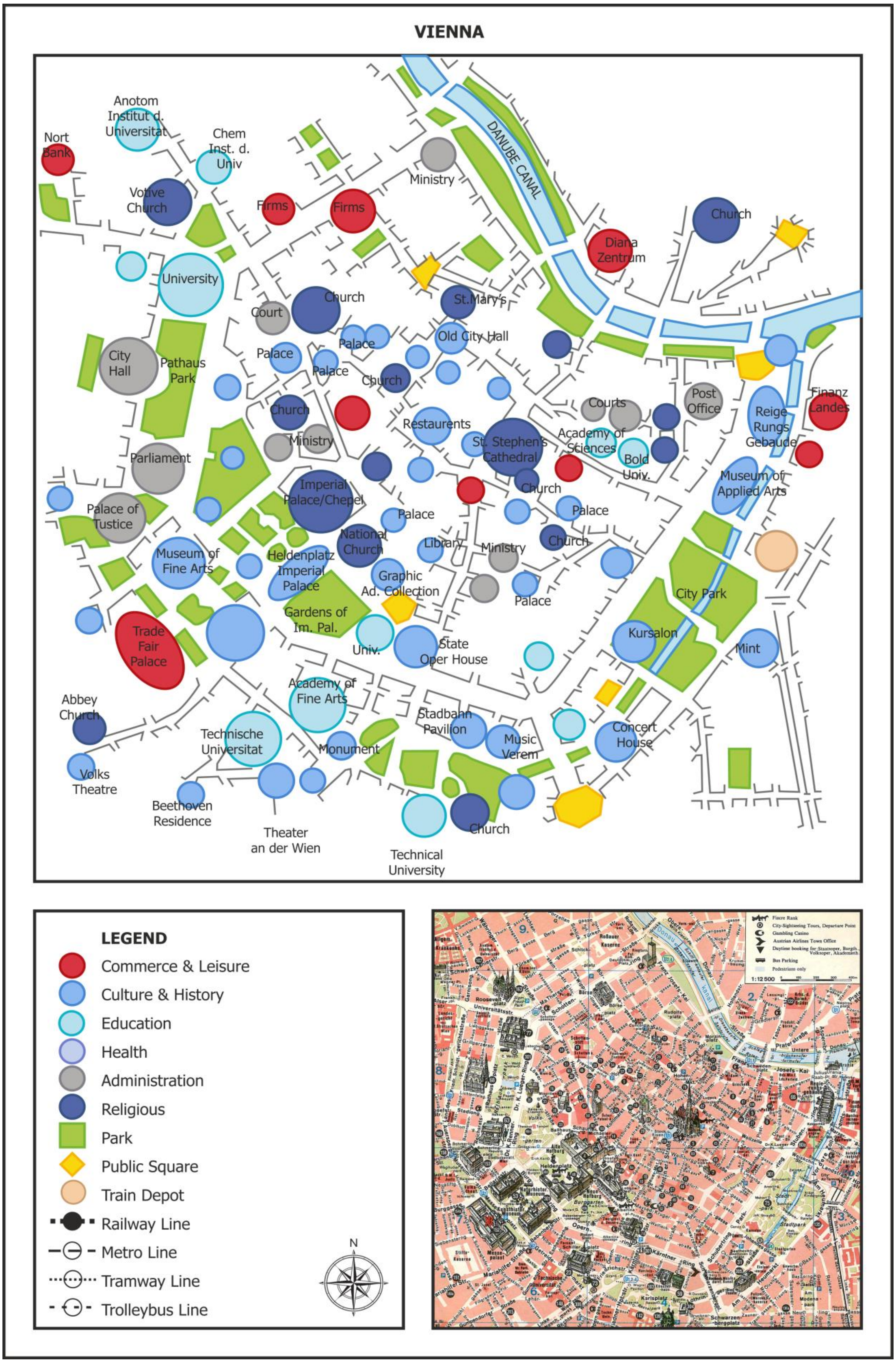

Figure 5.26 A Sketch on City of Vienna & Danube River

5.3.14 City of Zurich & Limmat River

Zurich, a global financial city with almost 350.000 inhabitants, was founded by the Romans in 15 BC and is located on the northwest of *Lake Zurich*. *Limmat River* flows diametrically through the densest part of the city ("Zurich", 2011). The water quality of the river and lake is very good, and most of Zurich's drinking water comes from the lake (Dunford et al, 2009). The river has been partially channeled and straightened. In the city, the riverbanks are lined with residential and commercial zones. The old town called *Altstadt* is located on both sides of the river, and a *Roman castle*, the later imperial palace, an old and famous *cathedral, churches, and houses* of the old town are in this area along with the most expensive and *fashionable shops* of Europe ("Zurich", 2011).

The city is on a junction of railways, roads and air traffic and most of its sights are located on either side of the river between the main station and the lake. The riverbanks have been planned with several quays and there are sailboats and motorboats for cruising on the river and the lake (Şenyapılı, interview, 2011). Like most Swiss cities, Zurich is *compact and easy to navigate*. The city has a dense public transport system. There are paved pedestrian streets in the *Old Town* lining both sides of the river (Dunford et al, 2009). The attached Figure 5.28 shows how both sides of the city have been integrated through planned distribution of focal points converging towards and on the river.

Zurich has reopened covered watercourses and restored ecology of many streams for the past 20 years (Bauer, 2007). With the *Zurich Stream Daylighting Program,* a clean-water concept for separating uncontaminated water from sewage channels was extended into a stream restoration concept. The goal is to 'daylight' as many streams as possible, realigning them on the surface, to increase ecological and recreational values within the urban area of the city Zurich (Conradin, n.d.). The city started to modify its combined water system to a partially separate system that serves the diversion of rainwater runoff (Conradin and Buchli, 2004). Zurich demonstrates that it discovered the value of streams from *an ecological and urban planning perspective with a stream concept*. Each new stream daylighting project made people more aware of a stream and willing to participate in the planning process. Through this program, the streams in Zurich have also become essential elements that are taken into consideration in the spatial planning (Bauer, 2007).

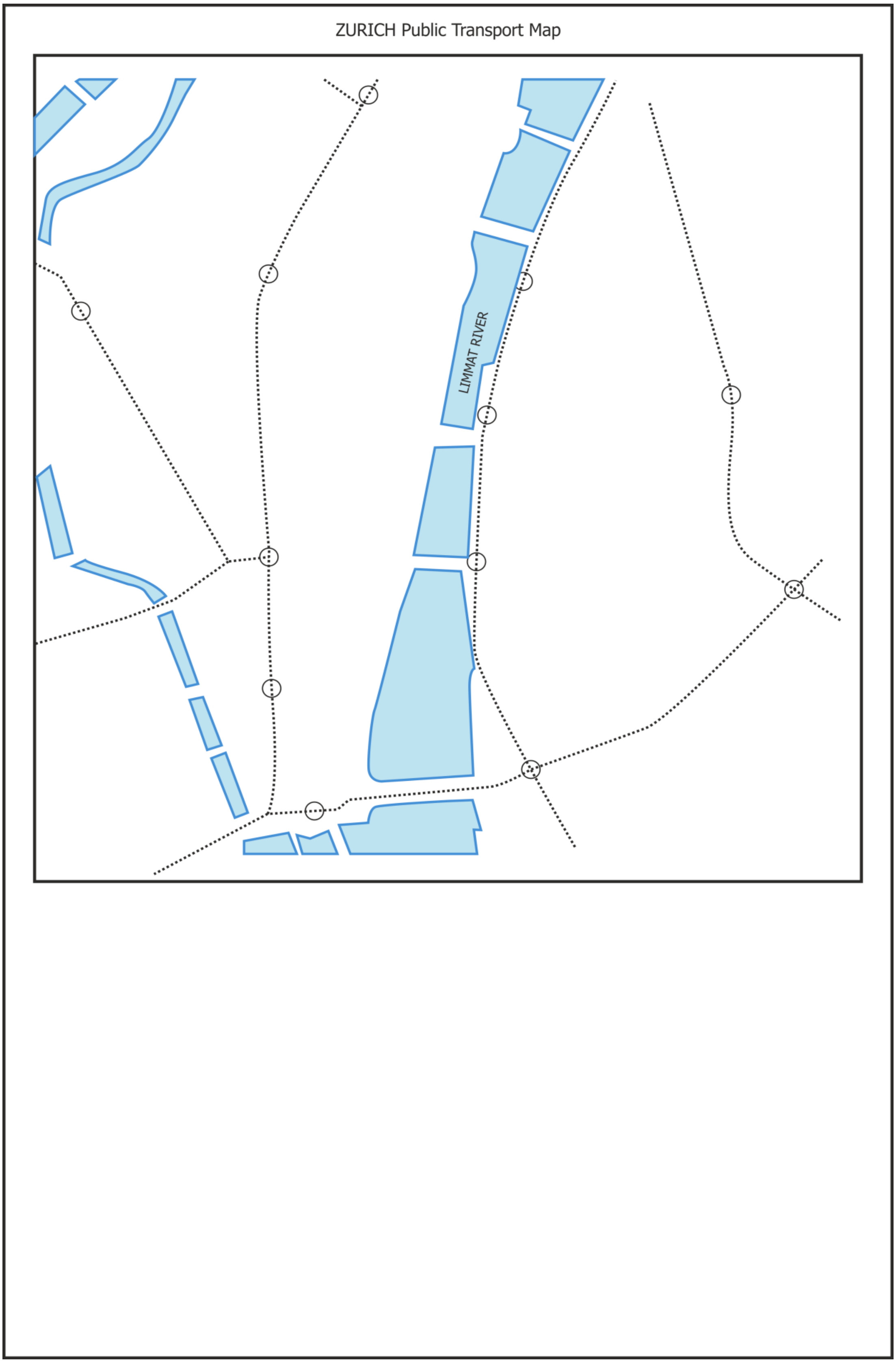

Figure 5.27 Public Transport Lines in City of Zurich & Limmat River

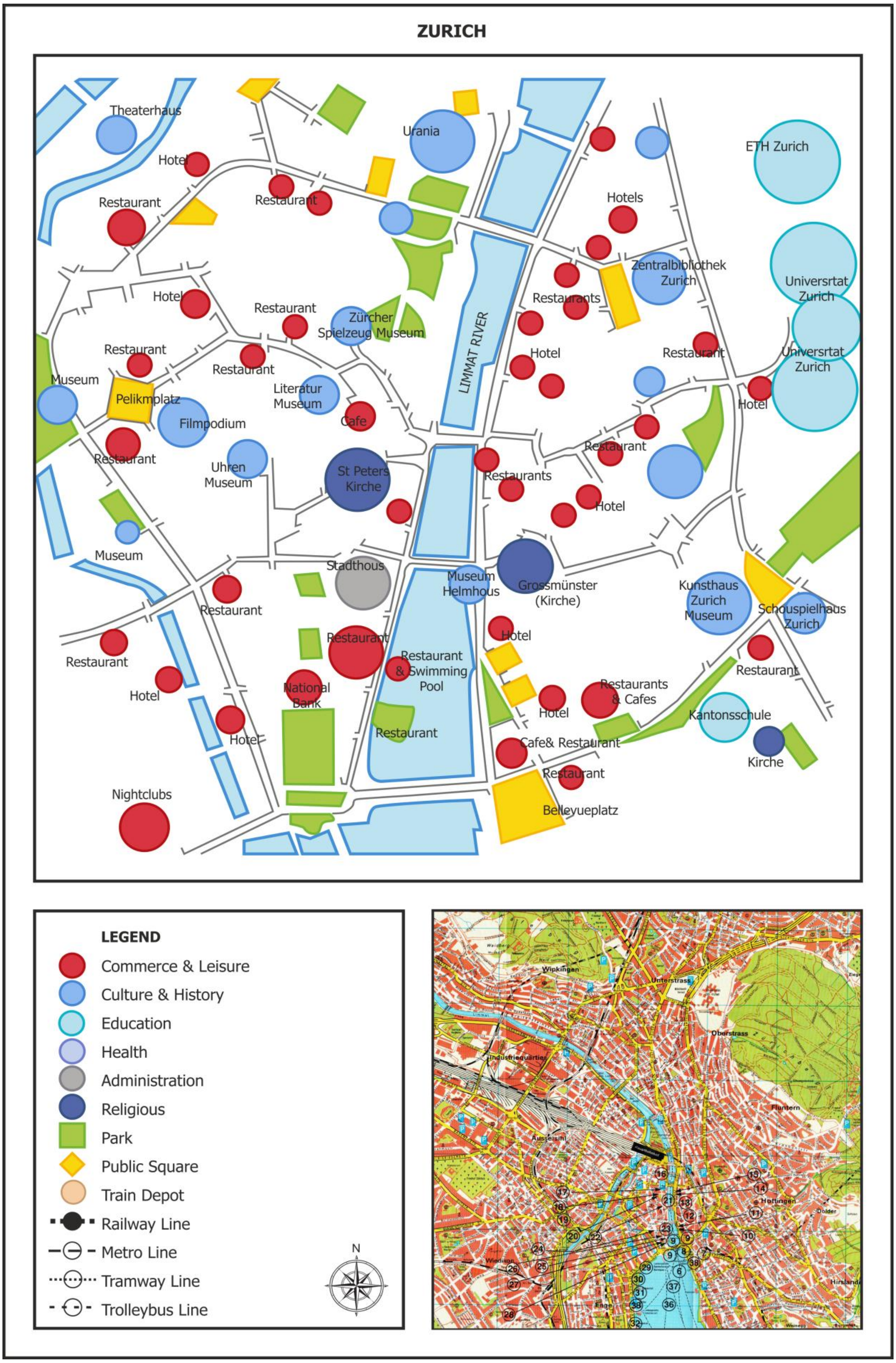

Figure 5.28 A Sketch on City of Zurich & Limmat River

5.3.15 City of Chengdu & Fu-Nan River

Chengdu, where 12 million people live, has a rich culture with its history, religious places, cuisine, and traditional teahouses. With its long history of over 2,300 years, Chengdu was declared one of the 24 cultural and historical cities by the State Council ("History of Chengdu", 2003). *Fu-Nan River*, which is the tributary of Min River (a tributary of the Yangtze), encircles the inner city of Chengdu. These two rivers, Fu and Nan, which play an important role in the history of Chengdu, flow 46 km through the urban area ("Funan He River", n.d.).

According to Quian (2006, p.104), "Fu-nan River seems to be the soul of Chengdu; without it, Chengdu could not be Chengdu and it would lose its energy and vitality entirely, and as a soulless city, its richness, populousness, beauty, prosperity, and everything else seem to be forced and unnatural." Through history, Chengdu was a city *densely covered by rivers and dotted with bridges*. The city was one on the important route of silk trade known as *the Silk Road* ("History of Chengdu", 2003). Moreover, Chengdu, the capital of Sichuan province of China, is situated on the fertile Chengdu Plain, the site of *Dujiangyan*. Dujiangyan has one of China's most ancient and successful irrigation systems, watered by the Min River. *Dujiangyan irrigation and flood prevention system* has been in service for about 18 centuries in Chengdu. The irrigation system and its surroundings were designated as a UNESCO World Heritage site in 2000 ("Chengdu", 2011).

Chengdu began a 5-year plan called the *Fu-Nan Rivers Revitalization Project* in 1992. Central to the plan was the removal and relocation of the factories responsible for the pollution, replacing the derelict shanties along the riverside, and restoring the banks with public spaces. Forty-two kilometers of the riverbank were reconstructed as the city added 25 hectares of green public spaces ("The Long March", n.d.). The project involved moving 100.000 citizens who were living in shacks along the river, building the infrastructure for wastewater treatment, cleaning the river, rebuilding the floodwalls, and creating nineteen kilometers of parks along the riverfront (Damon and Mavor, 2000).

Within the scope of the project, the *Living Water Garden Wetlands* was built along the river. As an innovative public space, it is a recreational park, a water treatment facility and a classroom that teaches everyone the way nature cleans water within an eco-based approach ("The Long March", n.d.). *The Living Water Garden* is the biggest venture of *Funan River's*

Comprehensive Revitalization Project, a 2,4 ha park on the river. The Park construction activities started in 1996 and finished in 1998. Since the park opened, it has become the most popular park in the whole city. In the park, there are pumps, settling ponds, reconstructed wetlands, a natural water purification system, various plant species, steps going down to the river to provide public access, and various sculptures as public arts to raise awareness of the pollution in the Funan River. It received 20 million US dollars funding from European Community in 1996 (Mavor, 1999).

The Living Water Garden is the first Chinese inner-city ecological park, with water as its theme. The park contains a natural water purification system, an environmental education center, and recreation facilities. In the garden, the various sculptures, which are an integral part of the system, articulate the function of water as a creator of life. “This combination of art, science, and education awakens a reverence for water.” (Damon and Mavor, 2000).

The *Chun Xi Lu shopping district* is the most popular shopping district that has a pedestrian street in Chengdu (“What to See in Chengdu”, n.d.). Along the north side of *Jin River*, there are many teahouses, musical street shows and walkways in front of them; and on the south side of the Jin River, traditional *Wangjianglou Park* is one of the major relaxation places in the city (Bernstein, 2008). Tea cooking and tea culture originated in Sichuan in which Chengdu is located. So, *many traditional teahouses* that gradually developed their own unique style can be found today in Chengdu and on the riverfronts of the city (“History of Chengdu”, 2003). Moreover, Chengdu has *many ancient temples* around the city (“What to See in Chengdu”, n.d.). Chengdu is shaped like a circle and utilizes a ring road system, as can be seen in Figure 5.30.

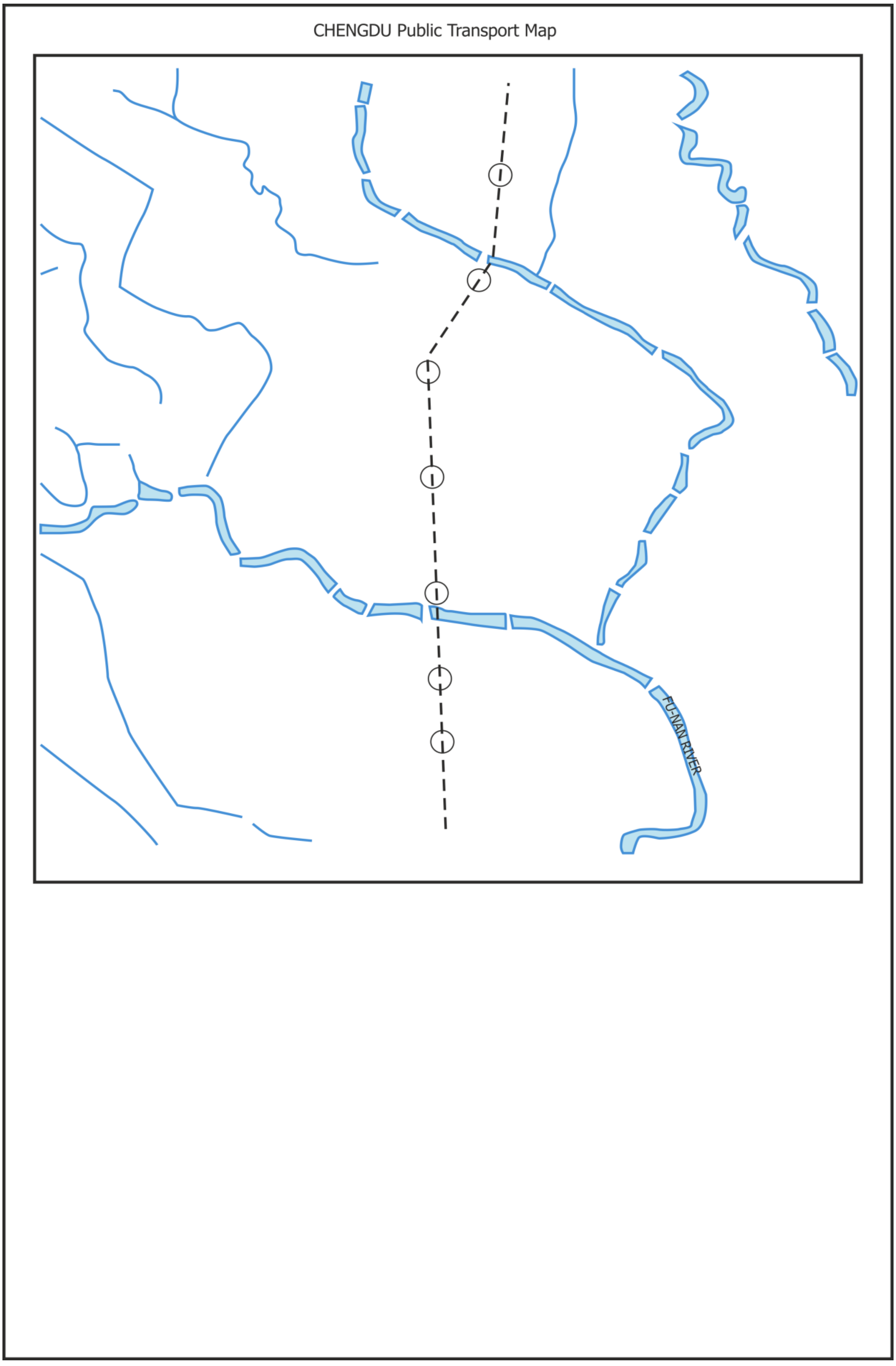

Figure 5.29 Public Transport Lines in City of Chengdu & Fu-Nan River

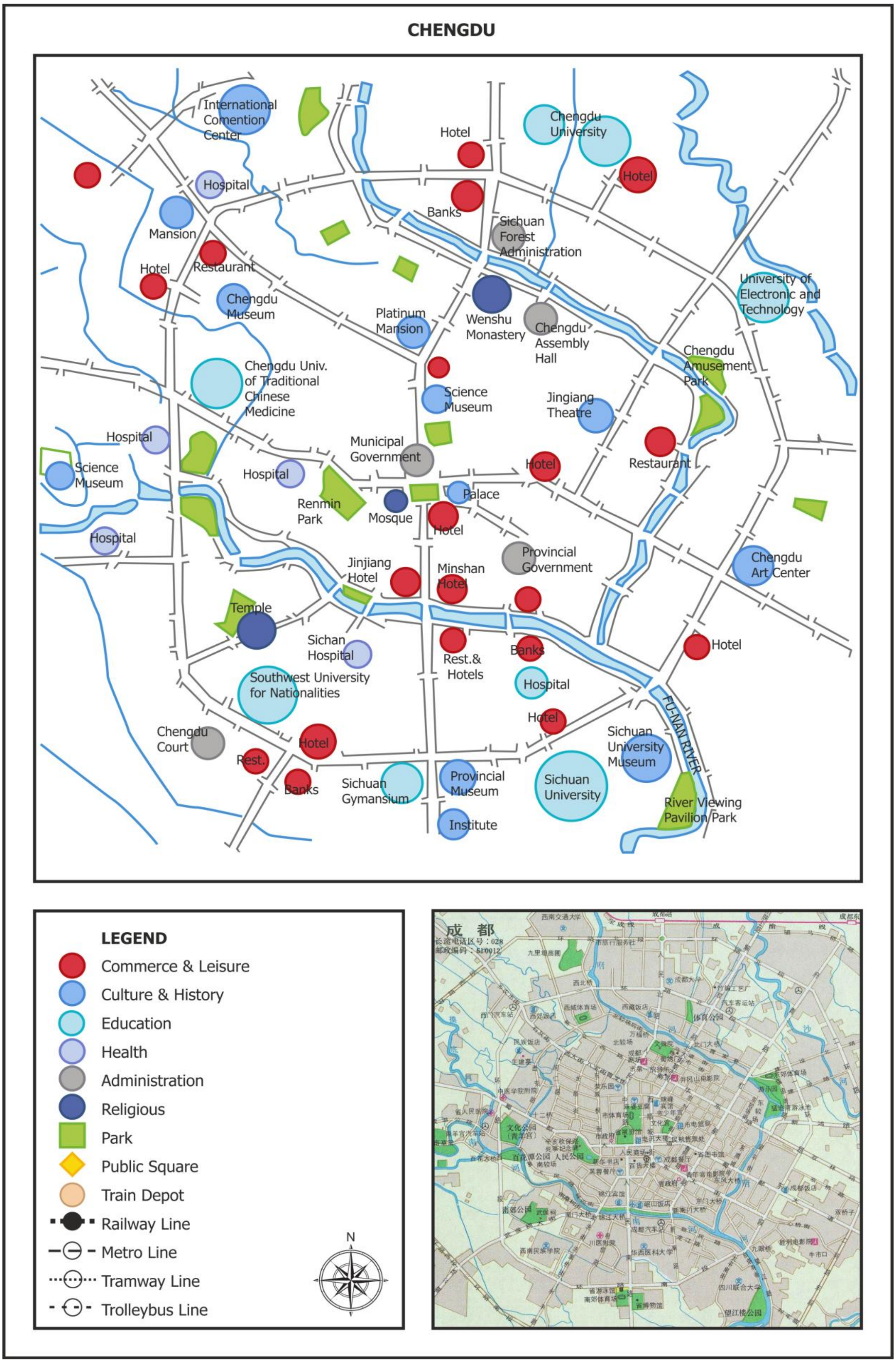

Figure 5.30 A Sketch on City of Chengdu & Fu-Nan River

5.3.16 City of Seoul & Hangang River & Cheonggyecheon Stream

The city of *Seoul*, with over 10 million inhabitants, is the commercial, cultural, educational, and industrial heart of South Korea ("Seoul", 2011). Seoul has two major rivers: One is the *Hangang River*, and the other is the *Cheonggyecheon Stream* (*Cheonggye* as shortened form of the name), both flowing through the center of the city ("Destinations: Cheonggyecheon", 2009). The area on the Hangang River that is occupied by Seoul has been inhabited for thousands of years, and it acquired strategic importance since early historical periods ("Seoul", 2011). Cheonggye Stream is a natural and artificial stream of approximately 11 km ("Cheonggye Stream", n.d.). The stream, which runs through the downtown area, where dirty water and sewage once flowed, was recently reborn with new cultural and recreational areas for citizens and visitors ("Destinations: Cheonggyecheon", 2009).

Hangang River meanders through the heart of the city on an east-west axis, and it is nearly a kilometer wide. As the city developed rapidly, roads and high-rise apartments sprung up along the riverside, the river's connections with the city were severed, and its banks covered in concrete. The *Hangang* and its major tributaries have served as a major transportation and trade route linking most of central Korea. Korea's industrialization turned a previously meandering river into a deep, stable river lined by concrete embankments. Riverside neighborhoods were transformed into affluent districts of upscale apartments, gleaming skyscrapers and modern sports complexes. In this process, however, much of the river's natural ecology was destroyed and its connection with the city was cut, so the river found itself hidden behind a wall of high-rises and concrete. For these reasons, the *Hangang River Renaissance* project was developed in 2006 ("Hangang", 2011).

The *Hangang River Renaissance* project aims "*to revive the river's ecology and reconnect it with the city by approving its accessibility*. It is a multifaceted program that ties together environmental engineering, architecture, design and city planning to recreate the Hangang River area". That is, the project seeks to bring the river back into the bosom of the city by designing it as an eco-friendly space of culture and leisure ("Hangang", 2011).

Cheonggye Stream was covered by a road (1967-1976), which became dangerous for use due to aging despite reinforcement. Solutions drawn with the *Cheonggye River Restoration Project* are mainly, removing the road, and bringing to daylight a buried stream that was under the highway. The project was shaped in 2005 on the 5,5 km² restoration area. This is the world's first urban re-development project that involved the removal of a road while restoring a river. The project includes the development of a linear park, open watercourses to handle flooding rains and global warming, increasing fish and bird species, transportation changes like expanded bus service, restrictions on cars and higher parking fees, keeping ancient pillars that were left as remnants of the former highway that occupied the space, art installations, and cultural signature bridges (Kee-Yeon, n.d.). Figure 5.32 shows the focal elements and linkages around the Cheonggye Stream and its neighborhood.

Currently ringed by urban beltways, it is not easy to access the *Hangang* riverside, despite the existence of several riverside parks. To improve accessibility, the municipality of Seoul has undertaken projects. The projects include the creation of *ecological walking paths along the river,* improving the pedestrian environment along the Hangang River bridges, creating a river access information system and operating shuttle bus service ("Hangang", 2011).

The major roads in the city areas were designed according to the Cheonggye Stream ("Cheonggye Stream", n.d.). *Street pattern in the city center are mostly rectangular*, streets and buildings stretch out from the sites of *the old city* ("Seoul", 2011). High-rises stand in great number, and roads and other facilities also claim the traditional and modern style of the city ("Destinations: Cheonggyecheon", 2009). The city has *a broad subway system* that has lessened traffic congestion and with buses and railways it has become one of the main forms of public transport. Seoul is also the hub of railway lines connecting most provincial cities and ports ("Seoul", n.d.). With nature living in the heart of the metropolis, the streams of Seoul bring a clean and clear image to the city ("Destinations: Cheonggyecheon", 2009).

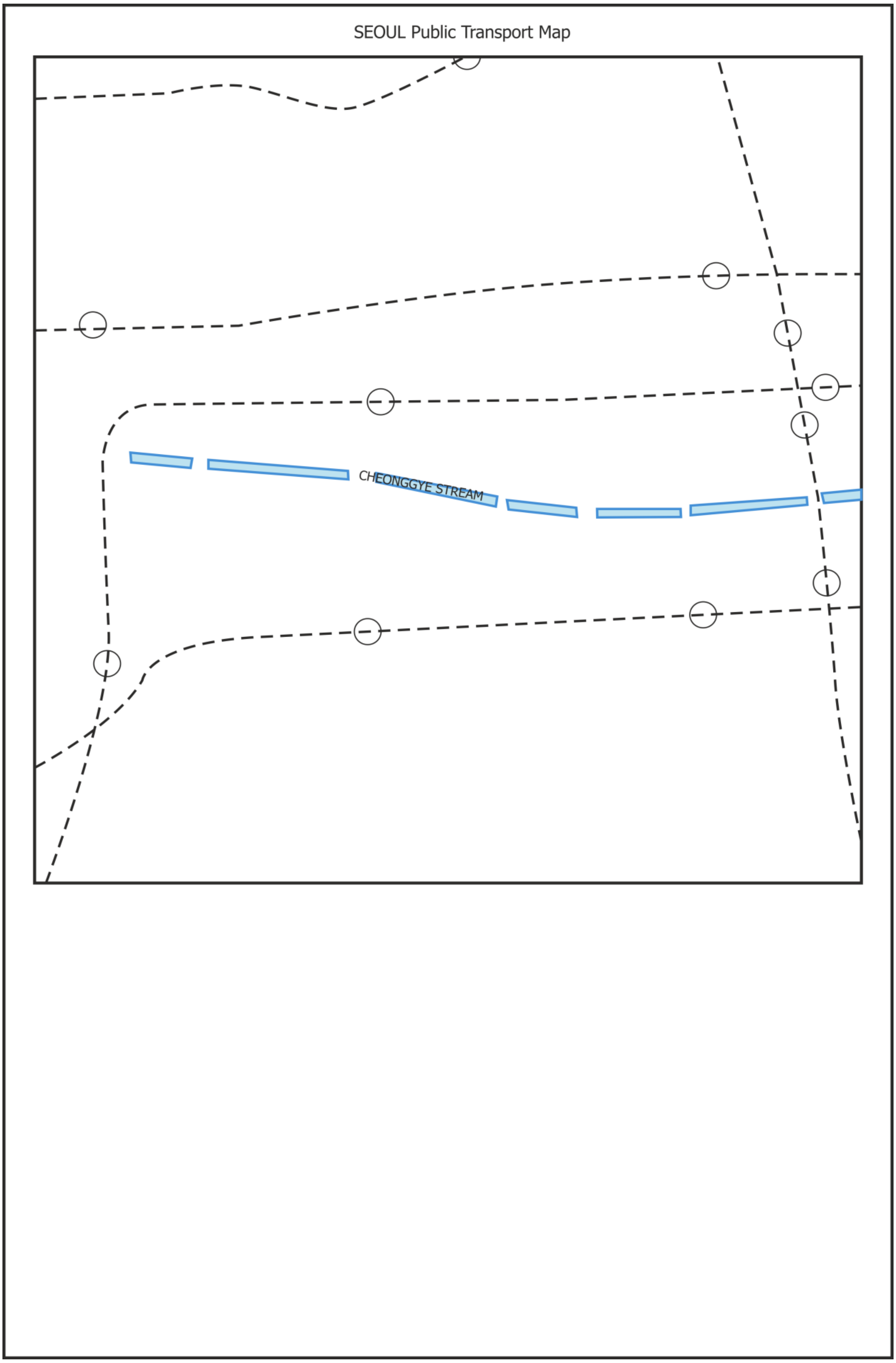

Figure 5.31 Public Transport Lines in City of Seoul & Hangang River & Cheonggyecheon S.

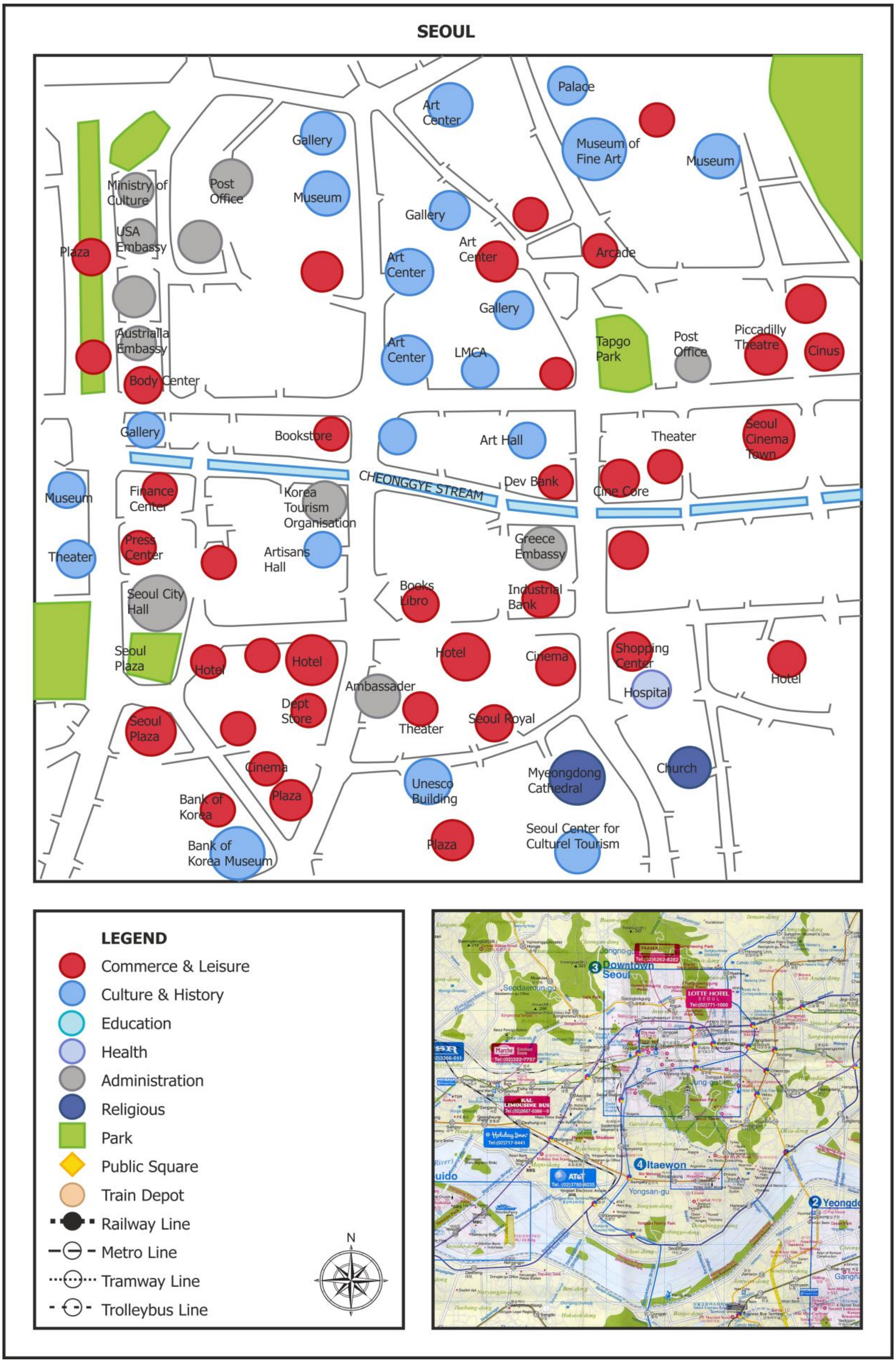

Figure 5.32 A Sketch on City of Seoul & Hangang River & Cheonggyecheon Stream

5.3.17 City of Shanghai & Huangpu River & Suzhou Creek

Shanghai as chief industrial and commercial centre and one of the leading centres of higher education and scientific research in China. The city has a population over 11 million ("Shanghai" (1), 2011). *Shanghai* located at the mouth of the *Yangtze River*, the third longest river of the world after the Amazon and the Nile, on the east-central China. It is an old settlement as between AD 960-1279, the small village located at the mouth of the river grew into a market town due to developing trade. The town prospered rapidly based on its favorable location as a port, and the Shanghai Port is located on the *Huangpu River*. Today, the city is a global center of finance and trade. The Huangpu River, a tributary of the Yangtze divides the city into east and west sides. The *Suzhou Creek* a branch of the Huangpu also passes through 54 km of the downtown Shanghai. The city gets most of its drinking water from Huangpu, the river also serves for shipping, fishery, flood discharge and tourism ("Sahnghai" (2), 2011).

Sprinkled with many rivers and lakes, Shanghai has rich water resources, with the water area accounting for 11% of the city's total territory ("Water Resources", 2006). The Huangpu, a large river of 400 m. wide, on which it was decided to build the world's second longest steel arch bridge in 2000 (the first one in China) due to increasing traffic between the sides of the city. The main bridge spans 550 m. and the project was finished in 2003. Although cheaper alternative bridge designs like the cable-stayed bridges could have been used, this form was chosen to claim a world record for the city, to create a showpiece, and a new image for the city, with the hope that the investment cost would be recovered through its prestige. This *Lupu Arch Bridge* received the 2008 IABSE (International Association for Bridge and Structural Engineering) Outstanding Structure Award ("Opening of the New Lupu Bridge", n.d.).

The *Suzhou Creek* is also significant for the city as it was a shipping route for transport of goods from the port into interior China. The region of the city neighboring the river was an industrial zone with many warehouses and factories located along the river. As expected, this zone caused severe pollution to the river that was known as the 'smelly river' in the 1920's. So in 1998 the municipality introduced the *Suzhou Creek Rehabilitation* project, a 12 year project to improve water quality, mitigate flood impact and raise living standards in the vicinity of the river. After 2002, in accordance with the approaches discussed in this study, new plans for rehabilitation of the creek were approved. The plans involve construction of entertainment and image generating facilities along with large-scale parks near the confluence of the creek and the Huangpu River ("Suzhou Creek", 2011).

The main objectives of the Suzhou Creek Rehabilitation Project are to improve water quality, strengthen water resources management, and improve flood control. The phase commenced in 2003 aimed to improve water quality of the creek, to remedy water issues of its tributaties, and to develop green spaces along the creek. An innovative design of *Meng Qing Garden* is introduced within the project to serve as a landscaped recreational green space and functional wastewater treatment system, which contains to store excessive rainwater and a base for education on environmental and water resources protection issues. The project has a comprehensive approach to tackle severe pollution issues of Suzhou Creek, and it has realized social, environmental and economic benefits ("Transforming an Urban Waterway", n.d.).

The city radiates toward the north, west, and south from the confluence of Huangpu and Suzou. Central Shanghai has a *gridded street pattern* ("Shanghai" (1), 2011). "The layout of the city appears as a well-arranged square. Its regular river beds that have been fully reshaped from formerly unrestrained rivers to run parallel to the roads by and large." (Tianhua, 2004, p.89). Some part of the touristic and vibrant *Nanjing Avenue* that directed to *Peoples Park* was pedestrianized. There also are some pedestrian roads around *Yu Garden,* one of the most impressive gardens in Shanghai (Nakiboğlu, interview, 2011). (See Figure 5.34 for details). *The Grand Theatr*e, *the Shanghai Museum* and *the Town Hall* are directed towards the *Peoples Park*, which is on the route of the both rivers. *The Bund* extending through the western side of the Huangpu, is a strand hosting many restaurants and shops. Other side of the river, called *Pudong*, has the tallest syscrapers in Asia (Bernstein, 2008).

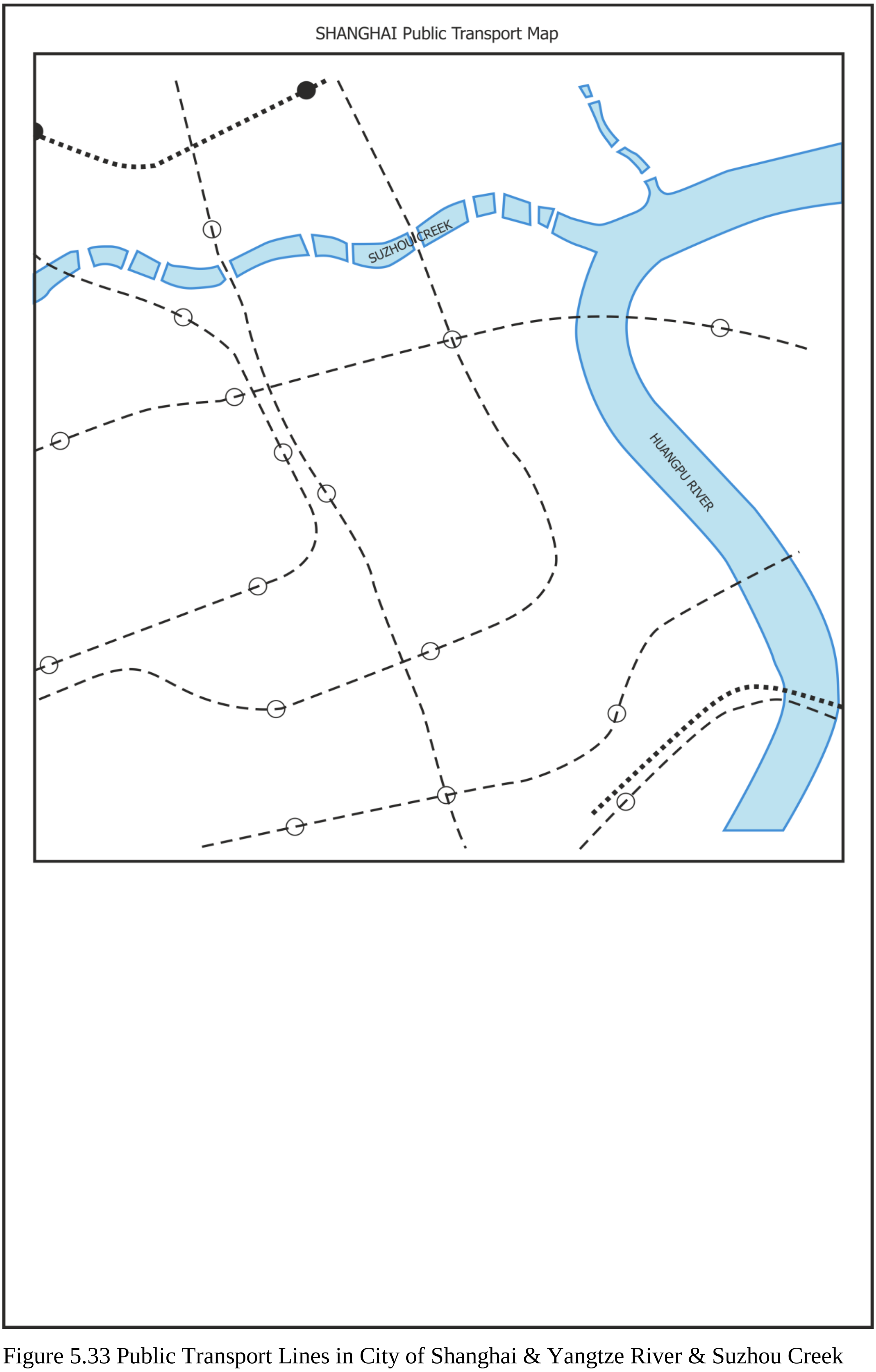

Figure 5.33 Public Transport Lines in City of Shanghai & Yangtze River & Suzhou Creek

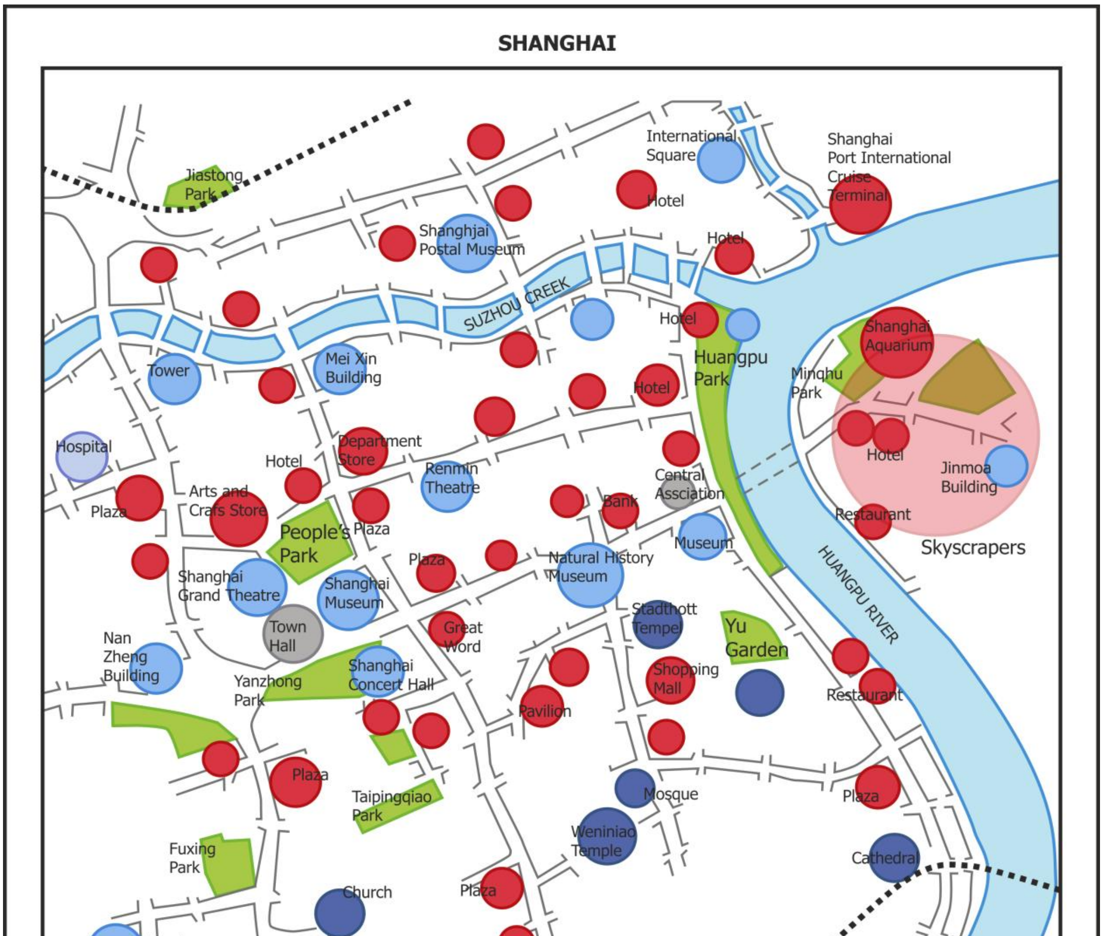

Figure 5.34 A Sketch on City of Shanghai & Yangtze River & Suzhou Creek

5.3.18 City of Singapore & Singapore River

Singapore is different from the previous examples as it is an island located at the south of the Malay Peninsula. The first settlement dates bak to the 2nd Century AD, and today the city is one of the important international trade and finance centers of the world (Oakley and Brown, 2010). The *Singapore River* flows from the central area of the island to the ocean and it is the most important river in Singapore and its islands. Singapore, whose population has reached approximately 3,5 million, is known as a *garden city* because of its many parks and tree-lined streets ("Singapore", 2011).

As trade expanded and population grew, congestion and pollution through garbage, sewage, wastes of industry, pig farms, and boathouses located along the riverbanks, created an acute problem for the city. Bridges were built on the river but as they were too low and the river was too shallow, the river could not be utilized as demanded. In 1977, *an action plan* was prepared and implemented to clean up the river. The plan included the development of infrastructure, and resettlement of squatters, industries, and farms. The riverbed was dredged and the removed debris helped in the revival of marine life ("Singapore River", 2011).

In 1987, the project was completed and today the river is clean. A dam built at the point where the river joins the sea creates a reservoir of freshwater for the city. Other changes were made, such as diverting the mouth of the river where it emptied from its original place to a new bay, the port was relocated ("Singapore River", 2011), and thus the river's economic role has shifted from trade to tourism and aesthetics to give a new image to the city. "For most of its modern history, to speak of Singapore was to speak of the Singapore River, physical centre of the city and site of the greater part of the colony's entrepôt trade. The river has been transformed over the last 25 years from a polluted industrial sewer choked with traffic to a clean, placid waterway that forms the centrepiece of Singapore's financial, civic and entertainment districts. This transformation symbolizes the city-state's efforts *to remake itself for the 21st century*." (Dobbs, 2003, p.202). Today many focal points of the city are located *in the vicinity of the river* and quays have been built along with roads and *walkways directed to the river* (See Figure 5.36). Shops and recreation areas are enriching and integrating the attractions of the city.

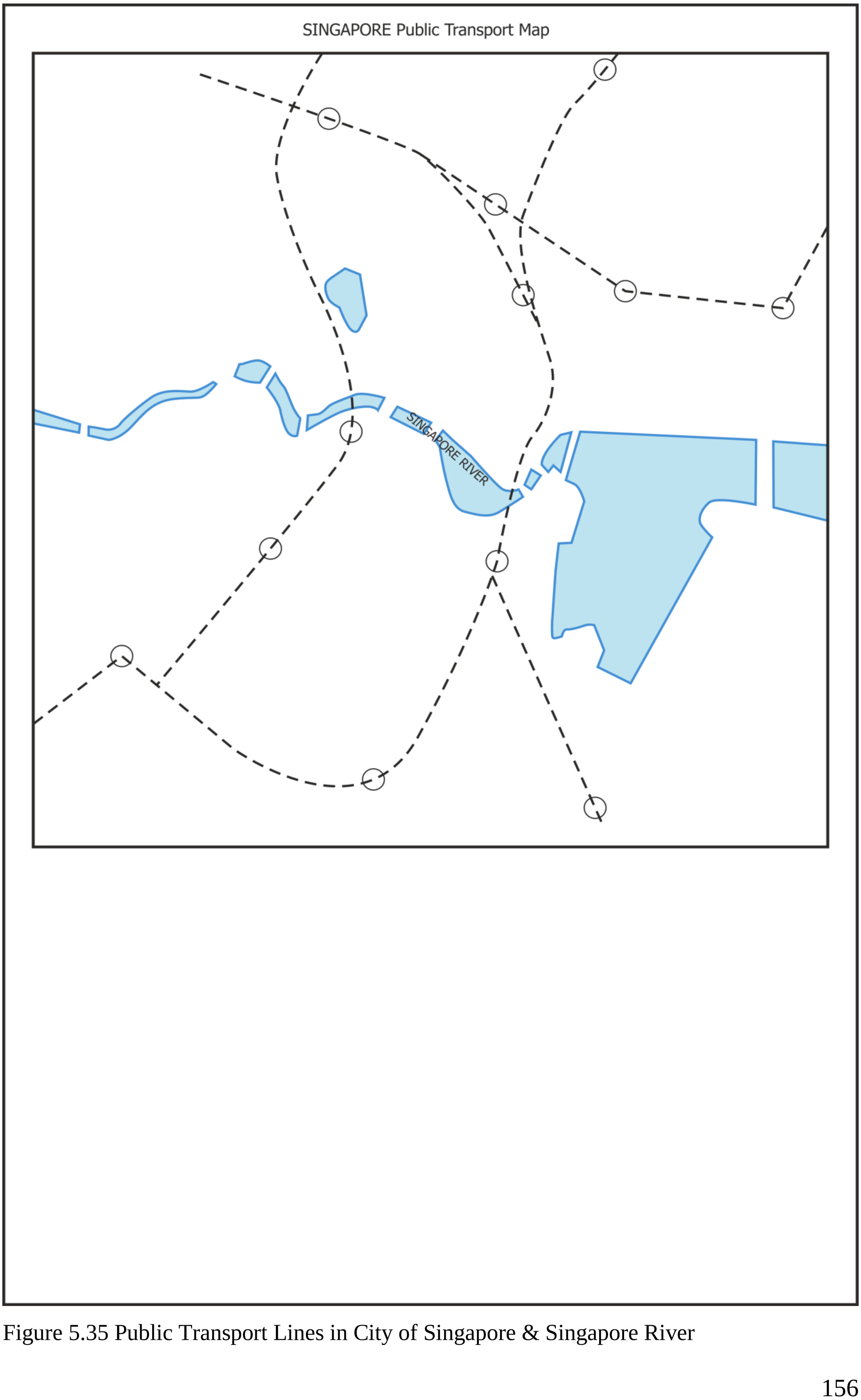

Figure 5.35 Public Transport Lines in City of Singapore & Singapore River

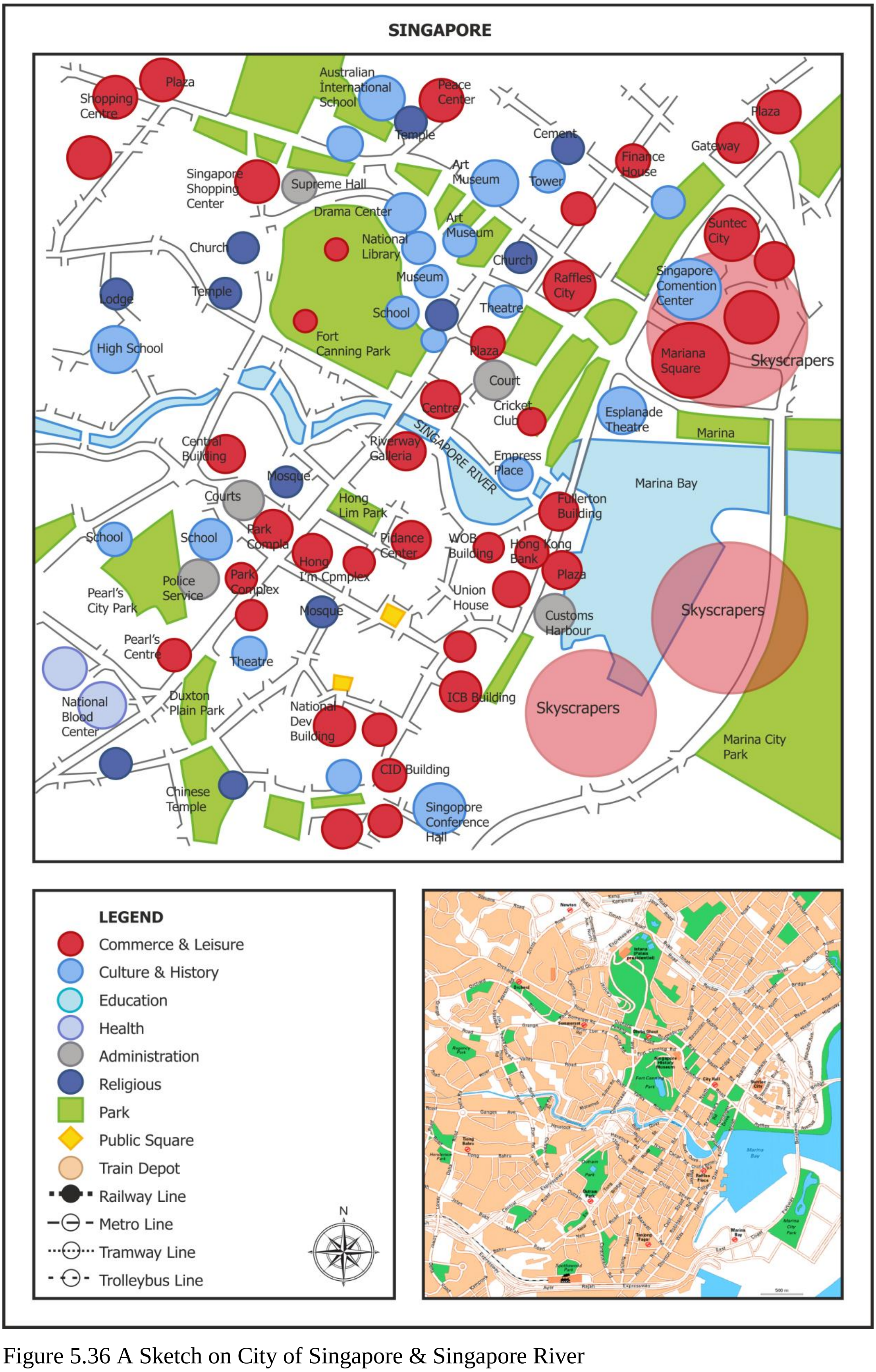

Figure 5.36 A Sketch on City of Singapore & Singapore River

5.3.19 City of Boston & Charles River

The city of *Boston,* which has about 650.000 residents, is one of America's oldest cities with a rich economic and social history. Boston is a hub for many institutions of higher education, health care, commerce, and cultural and sports organizations today ("About Boston", 2011). As the capital of Massachusetts, Boston is lined with the sprawling *Charles River* ("Boston Travel Guide", n.d.). The Charles riverfront provides a range of public spaces, such as promenades, walking ways, bike paths, parks; activities such as rowing, canoeing, sailing races in summer; hosts the Charles River Festival and international events with a large number of participants.

Charles River, the longest river within the state, flows about 130 km through the state and is navigable for about 16 km. ("Charles River", 2011). The Charles River Basin is surrounded by parklands, such as *Emerald Necklace* and *Charles River Reservation*. Emerald Necklace, which is a large-scale design of famous American landscape architect Frederick Law Olmsted, is linked to the *Boston Common*park and *Public Garden* in downtown, *Franklin Park, Back Bay Fens, Muddy River* and *Arnold Arboretum* ("Boston", 2011). Charles River Reservation is a linear park stretching from Boston Harbor 32 kilometers up the river. The Reservation provides many recreational opportunities, such as walking, birdwatching, canoeing, rowing etc. ("Charles River Reservation", n.d.).

The historic Charles River Basin bridges provide critical connections in and out of Boston for a wide range of users, including businesses, universities, hospitals, bicyclists, pedestrians, and drivers. Bridge rehabilitation projects are currently under construction or in design to improve the conditions of structurally deficient bridges in the lower basin area of the Charles River ("Charles River Basin Projects", n.d.). By the mid-19th century, the river had become a sewer for industrial waste and the river was closed to swimmers in 1955. After the cleaning activities of nearly fifty years and $500 million spent, the river is clean again (Ireland, 2010). Since recent, studies have continued to make the water quality of the Charles River appropriate to swim.

Muddy River, which is a tributary of Charles River near downtown, can cause flooding and thus, damage to residents, businesses, institutions and the public transit system. This problem has made restoration of the river more urgent. Implementation of the *Emerald Necklace Master Plan* after years of neglect constitutes a first step and involves landscape and historic resource treatments. The *Muddy River Restoration Project* is phase I of the Emerald Necklace Master Plan. The objectives of the Muddy River Restoration Project include improvement of flood control, improvement of water quality, enhancement of aquatic and riparian habitat, rehabilitation of landscape and historic resources, and implementation of Best Management Practices (BMPs) ("Restoration Overview", n.d.). The riverfront already has a range of public spaces, such as promenades, walking ways, bike paths, parks, boating, river clean-up days.

Many world-known universities in Boston reside along the Charles River. *Boston University* has a campus along the south of the river; *Harvard University* is located across the river, and across the north of the river *MIT (Massachusetts Institute of Techmology)* is located ("Charles River Reservation", n.d.). (See the Figure 5.38 for the focal points including the universities, parks, cultural and touristic attractions etc. and main linkages between them). Owing to factors such as the compactness of the city and large student population, pedestrian commuters play a larger role in Boston than in comparably populated cities ("Charles River Reservation", n.d.). Boston has America's first subway system, which is part of an intricate network of public transportation in the Greater Boston area ("About Boston", n.d.). The local public-transit system offers convenient and safe access to major attractions ("Boston for Visitors", 2008). (See the Figure 5.37 for the public transport network).

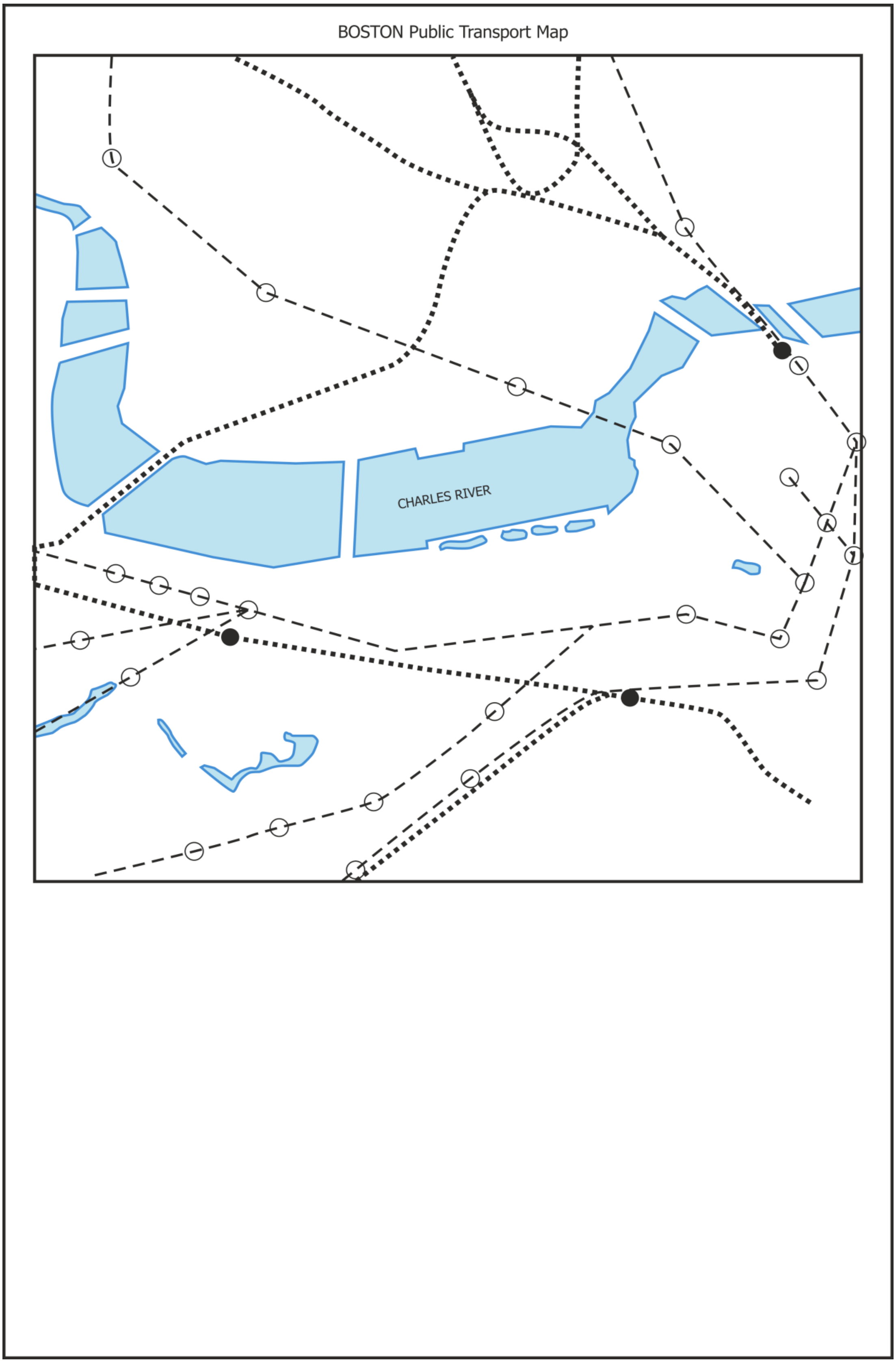

Figure 5.37 A Public Transport Lines in City of Boston & Charles River

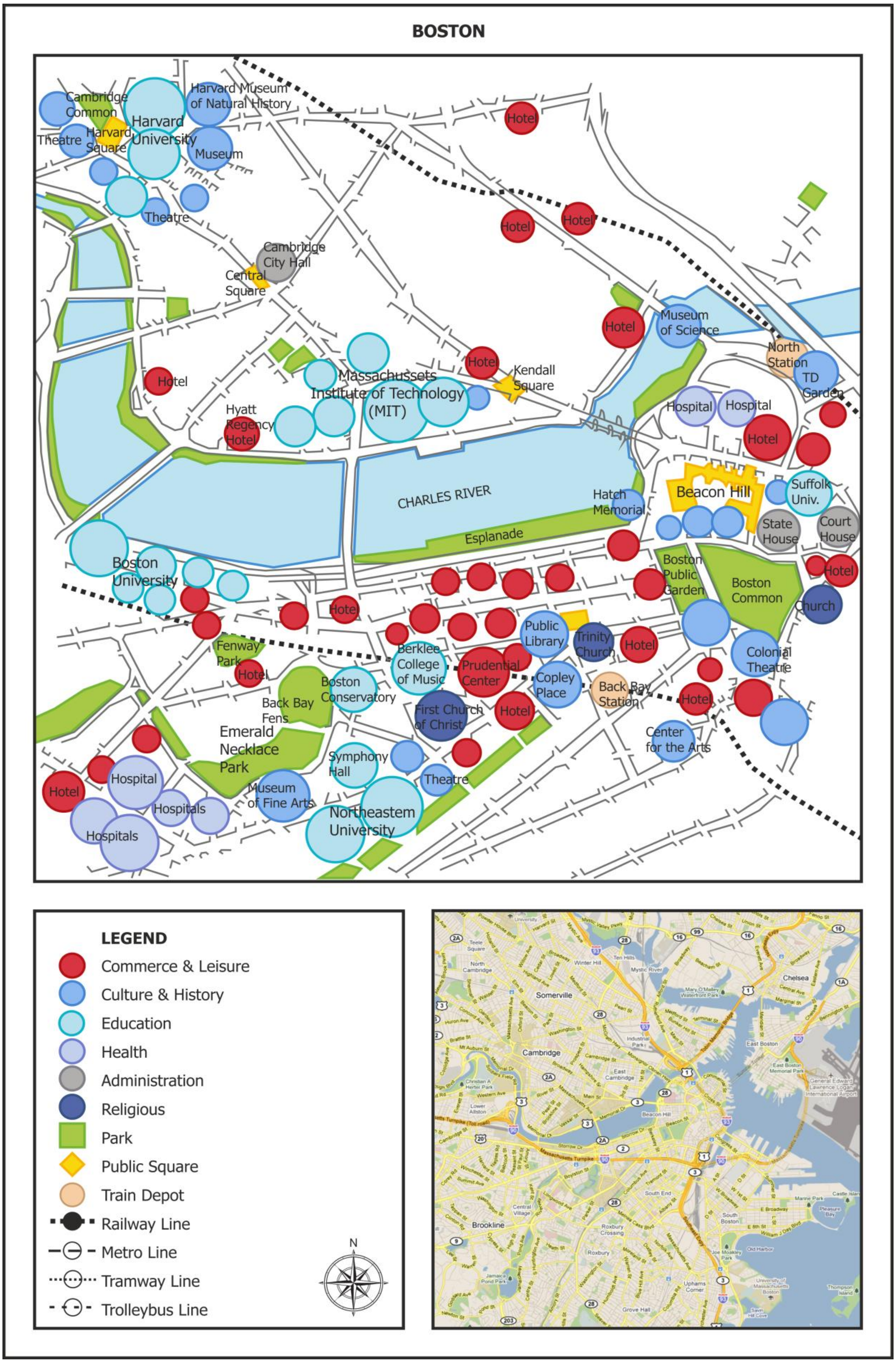

Figure 5.38 A Sketch on City of Boston & Charles River

5.3.20 City of San Antonio & San Antonio River

With a population of over one million, city of *San Antonio* is situated at the headwaters of the springs of San Antonio River (“San Antonio”, 2011). The historic *San Antonio River* has long served as the heart of the city. This urban river with untapped potential lies beyond downtown. A comprehensive, multi-year project is underway to restore and enhance about 20 km of the San Antonio River (“San Antonio River Flows”, 2011). The headwaters of river formed by natural springs are very near downtown (“Explore the River Walk”, 2010).

In the early 20th century, the city experienced flooding along the banks of San Antonio River. Many cities paved over their rivers as a means of flood control. The San Antonio Conservation Society battled to keep the river afloat and supported the design of the *River Walk* in 1929. The project was finished in 1938 and has remained a source of life and a hub of culture for the city (“Explore the River Walk”, 2010). It is interesting to see that the advanced handling compares to that of contemporaries in the 1940s. With this project, the river was not only standing against floods, its ecological health was considered and its landscape taken into account.

In Texas, water has been a lifeline for many generations for centuries (“History of the River Walk”, 2011). Archaeological sites demonstrate evidence that the first human habitation along the San Antonio River occurred as long as 10.000 years ago (“The People's Waterway”, n.d.). *The San Antonio River Walk* in downtown is about to be extended from 3 to 20 km, connecting many of San Antonio’s museums, historic districts, restaurants, hotels, and other attractions (“Explore the River Walk”, 2010). The River Walk (also known as Paseo del Río) is a network of walkways along the banks of the San Antonio River, and an important part of the city's urban fabric.

The River Walk is a successfully built pedestrian street that is one level down from the automobile street. The River Walk rounds under bridges as two parallel sidewalks lined with restaurants, cafes, hotels, and shops. Sidewalks connect the major tourist attractions from the *Alamo* to *Rivercenter* mall, to the *Arneson River Theatre*, to *HemisFair Park*, to the *Tower Life Building*, to the *San Antonio Museum of Art*, and the *Pearl Brewery* (“San Antonio River Walk”, 2011).

Although it was beautified, Novotny (2010) states that San Antonio River is a concrete impounded channel with poor habitat and water quality, so there are no water environment benefits. Consequently, the *San Antonio River Improvements Project* was developed recently. The project involves over $350 million on-going investment in flood control, amenities, ecosystem restoration and recreational improvements. Throughout the project, *San Antonio River Authority* provides project and technical management, as well as overall project coordination between the project partners ("San Antonio River Flows", 2011).

With this project, the river was given pedestrian paths that connected to all principal downtown streets. It was deepened to be made navigable for small vessels. The river is spanned by more than fifty bridges along 24 km. Besides the network of walkways and bridges, the project included landscaping, fountains, and the construction of an outdoor theater equipped with water curtains (Donecker, n.d.).

There are vistas around each bend in the sinuous waterway. There are also public art projects such as tile-mosaic murals ("Explore the River Walk", 2010). *San Antonio Missions National Historical Park*, with a total area of about 3,3 km^2, begins at *the Alamo* and extends 14 km along the San Antonio River. *HemisFair Park*, the site of the world's fair, also is linked to the central city by the River Walk and is used for conventions and exhibitions, and the place for the 229 metres tall landmark the *Tower of the Americas* ("San Antonio", 2011). (See Figure 5.40 for details).

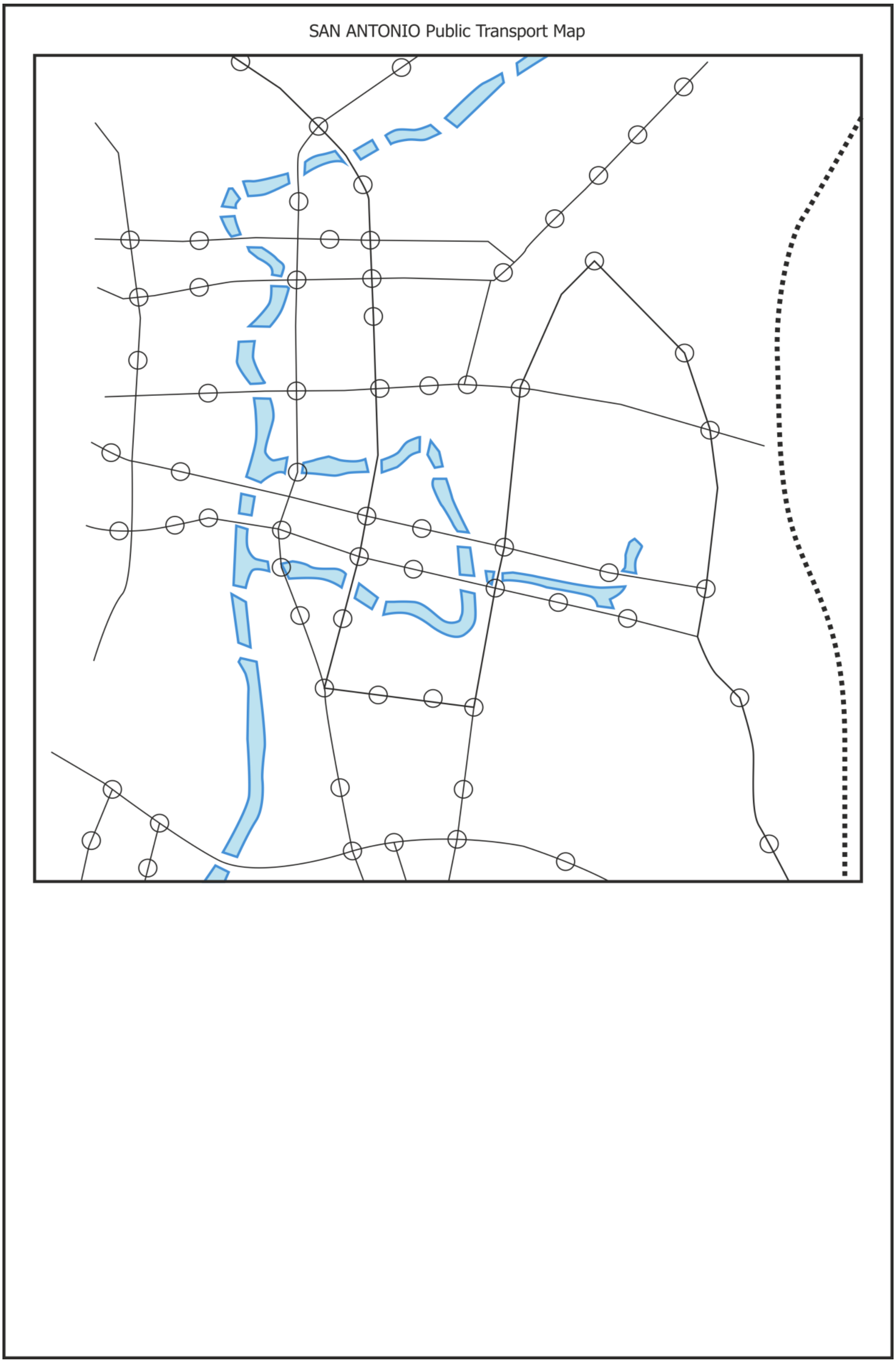

Figure 5.39 Public Transport Lines in City of San Antonio & San Antonio River

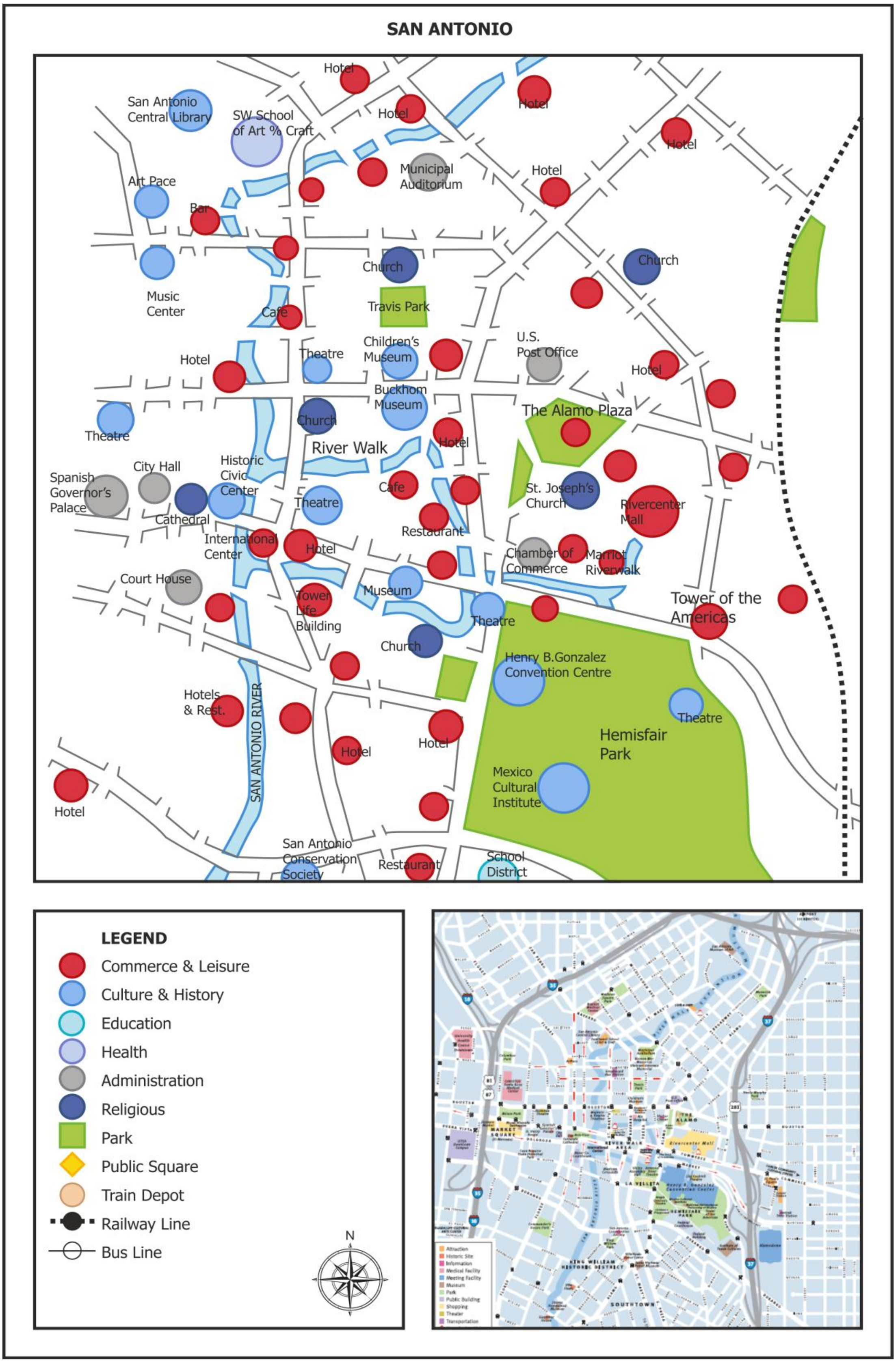

Figure 5.40 A Sketch on City of San Antonio & San Antonio River

5.4 Evaluation

> "The running waters not only bring abundance to their surroundings, but also bring life, culture and serenity." (Atuk, 2002, p.68).

The key point is the interpretation of the integration issue together with the main components of the city, and the features of river integration can be distinguished as follows:

- Main components of the city are connected to the river through roads; they are all concentrated in the surrounding of the river.
- The new components (shopping malls, new administrative buildings, nodal points of transportation system, parks, etc.) have been either constructed near the river or easy access has been provided.
- The old settlement areas, historical and cultural places were not relocated but kept as they were built with a reference to the river. They are situated close to the river and if not, connections are established between the functions, such as trading, recreation, leisure, culture, etc. The connections converging to the river highlight the relation between these places and the river. Bridges, in particular the most eye-catching of them, were built therein.
- Viewing spots overlooking the river and cultural, historical and important components were created in the city (like Michelangelo Square in Florence).
- The river and city relation is highlighted at certain points by the construction of eye-catching bridges from where an overall panorama of city can be seen.
- Unlike previous understandings, the river is no longer a component outside the city that can be watched only from the latter; but it brought a new image to the city following the shift of urban transportation system onto the river by enabling to watch the city from the river.

Cities such as London, Chengdu, San Antonio and many more as shown in this chapter, support the idea of bringing their rivers to the city by adding public spaces such as paths and parks along them, improving accessibility, regenerating downtown areas, and considering urban physical environment in a comprehensive manner. In addition, they have interventions for sustainability of their waters and rivers.

The following elements of good pratices a can be observed from the texts and shetches of portfolio:

- Considering opportunities of sites adjacent to the river
- Mixed-use (involves such as retail, entertainment, leisure, office employment, education, housing, etc.)
- Public transportation (regional train line, subway lines, light rail lines) and development of a multi-modal transportation system
- Unique aesthetic characteristics (such as civic buildings, street furnishings, transit hubs, parks, lighting etc)
- Walkability (sidewalks, crosswalks, building orientation, building facade)
- A rich street life based on pedestrians and public transportation
- Historical places & buildings
- Riverfront parks and park systems extended to rivers
- Realization of special local / regional / international events
- Centralities by the river
- Pedestrian & bicycle roads
- High quality of public realm (such as direct pedestrian routes)
- Stunning buildings which help to improve urban image
- Restaurants and cafes on the riverfront
- Attracting people to visit the city
- Attracting people to work and live in the city
- Cooperative structure of project organization (involves such as neighborhood associations, chambers, NGOs for community involvement etc.)
- An existence or forming of accountable institution / agency / corporation
- Increased accessibility and visibility
- Citizens' awareness of the river (collective activities such as riverbanks cleaning, education of children)
- Considering with other renewal projects (such as old docks or industries being turned into museums via brownfield regeneration)
- Experimentation on the compact city
- Public spaces such as public squares

The following is a key criteria list organized under the headings based on discussions and the portfolio within the integration issue. This key list will also be used to evaluate the Porsuk River Case and the city in general concord with the criteria.

- Taking into Account of the Relation of the River and the City during the River Rehabilitation
- Participation of Stakeholders such as NGOs and Chambers to the Project
- The potential of Eskişehir as A Model
- The Priorities for Entering into a Connection with the City and the Phases were Passed during the Connection Process
- Public Transportation and Accessibility
- Parks and Green Spaces
- Building Intensity in the City
- Public Spaces along the or Accessible to River
- Achievements of the Present Image of the River
- Sufficient Pedestrian Access
- Improvement of Bicycle Access
- Mixed-use Urban Pattern
- Removal of Water Banks and Separations along the River to Establish the Connection of the River to its Immediate Vicinity

5.5 Conclusion

> "Urban riverfronts are being asked to do many things today. Popular waterfront developments in Baltimore, San Antonio, Chicago, and other cities have awakened the public to the value and potential of reclaiming the river's edge. Rejuvenating city centers by developing vibrant riverfronts can be yet another tool in rejuvenating downtowns and counteracting urban sprawl. Residents and tourists want to enjoy and get close to a river, to learn more about its cultural and natural history, and to see wildlife and engage in various kinds of outdoor recreation. But while communities are asking more of their rejuvenated rivers, unchecked development elsewhere in the watershed, increases in stormwater runoff, and inadequately treated sewage discharges have become serious challenges. Protecting and recovering river health must be a co-equal goal with efforts to revitalize riverfronts. Without question, the cities that pay careful attention to both the needs of the river and the economic and social needs of their communities will reap the greatest rewards" (Otto et al, 2004, p. 8).

Urban streams and rivers offer people an easily accessible piece of nature, particularly in downtown areas (Paul and Meyer, 2008). While this is a fact in many river cities, little attention is given to how this is incorporated to river restoration and planning practices. As Paul and Meyer (2008, p.224) state, “urban stream restoration offers challenges not only in integrating physical, chemical, and biological processes to rehabilitate impaired ecosystems, but also requires attention to aesthetics and human attitudes toward a landscape”. In this chapter of the thesis, it is illustrated via the portfolio how urban rivers integrate to the city, and an attempt is made to formulate the integration criteria set.

Showing the pattern of focal points and their main linkages in urban layout is being contented within the formulation of the porftolio. The most common integration elements are within the sketches and the related texts include the following: The place of river in city history, accessibility via expanded public transportation such as light rails and tramways, connections between different transport systems, proximity to main terminals, continuous green systems, orientation, legibility, centrality by the river / running through downtown, varied functions such as restaurants and cafes on the riverfront, regenerated brownfields (old docks / industries turned into museums), recreation areas, parks (both riverfront parks and other big parks), public buildings accessible to riverfront, historical buildings accessible to riverfront, cultural buildings such as museums and art galleries accessible to riverfront, squares accessible to riverfront, stunning buildings that help to improve urban image, mixed-use urban pattern, experimentation on the compact city, and multi-purpose rehabilitating.

These common integration elements are lead to organize and form a key criteria list. This criteria set for integration above on the page 168, are used to evaluate the Porsuk River Case in Chapter 7, together with the determined ecocity criteria formerly in the end of Chapter 4. Before it, a chapter that examines the case study of Porsuk River and city of Eskişehir is got involved in the next chapter.

CHAPTER 6

CASE STUDY OF PORSUK RIVER AND THE CITY OF ESKİŞEHİR

6.1 Introducing the City of Eskişehir

Eskişehir Province is located in the northwest of the Central Anatolia Region, in the Upper Sakarya Zone. Its adjacent provinces are Bolu to the north, Ankara to the east, Konya and Afyon to the south, Kütahya and Bilecik to the west. The surface area of Eskişehir is 13.653 km². Eskişehir, with its surface area, covers 1/8 of Turkey's land mass. The height of Eskişehir from sea level is 792 m. The topographic structure of the province is composed of plains within the basins of *Sakarya and Porsuk rivers*, and mountains surrounding them.

Figure 6.1 The Location of Eskişehir on the Map

Throughout history, Eskişehir has been the gateway of Anatolia to the West by virtue of its location at the intersection of a transportation network, the developments in the agriculture and industry, and the advantages associated to the underground treasures. Certain factors, such as the increase in urbanization rate, the availability of qualified labour force, its proximity to the markets, the suitability of energy and raw material resources and the industrial infrastructure investments, have contributed to the development of the industry in the region (Başar et al., 2008).

Porsuk River runs about 225 km through the province of Eskişehir. While dividing the city, Porsuk establishes the natural boundaries of Tepebaşı Municipality in the north, and Odunpazarı Municipality in the south (Eskişehir Governorship, 1998). Before an overview on Porsuk River, historical development of Eskişehir and planning works in the city are addressed in the following subsections.

6.1.1 Historical Development of the City

"The surface explorations and archaeological excavations revealed that Eskişehir region had been on the stage as from the prehistoric era" (Kılıç, 1997, p. 10). During the 2nd century BC, Eskişehir fell within the Hittite Empire. As of 1200 BC, the Phrygians dominated the Central Anatolia. Following the collapse of the Phrygians in the 7th century BC, Eskişehir came under the rule of the Lydians and Persians, respectively. The royal road that was built during the Persian Period passes through Eskişehir. Beginning from the 4th century BC, the influence of Hellenistic Culture started to be seen upon the arrival of Alexander the Great to Anatolia. During the Byzantine Period, as of the 4th century AD, several towns were established in the vicinity of Eskişehir in parallel to the development of trade centres in Central Anatolia. The Seljuks began to reign the region from the 12th century AD onwards (Kılıç, 1997). The city was first called as 'Eskişehir' (Old City) during the period when the Seljuks dominated Eskişehir and its vicinity.

Eskişehir came under the Ottoman Empire in the aftermath of the Seljuks. Evliya Çelebi in his Book of Travel explains that when he visited Eskişehir in 1648, the city was composed of 17 neighbourhoods and had a market place with 800 shops (Kılıç, 1997). Yunus Emre and Nasreddin Hodja grew up on these lands (Toprak et al., 2009). The 16th century Ottoman historian, mathematician and miniaturist Matrakçı Nasuh also wrote a book about Eskişehir. In the Eskişehir miniature by Matrakçı Nasuh (see Figure 6.2), the illustrations of important historical monuments on a flat plain and the Porsuk running through them can be seen.

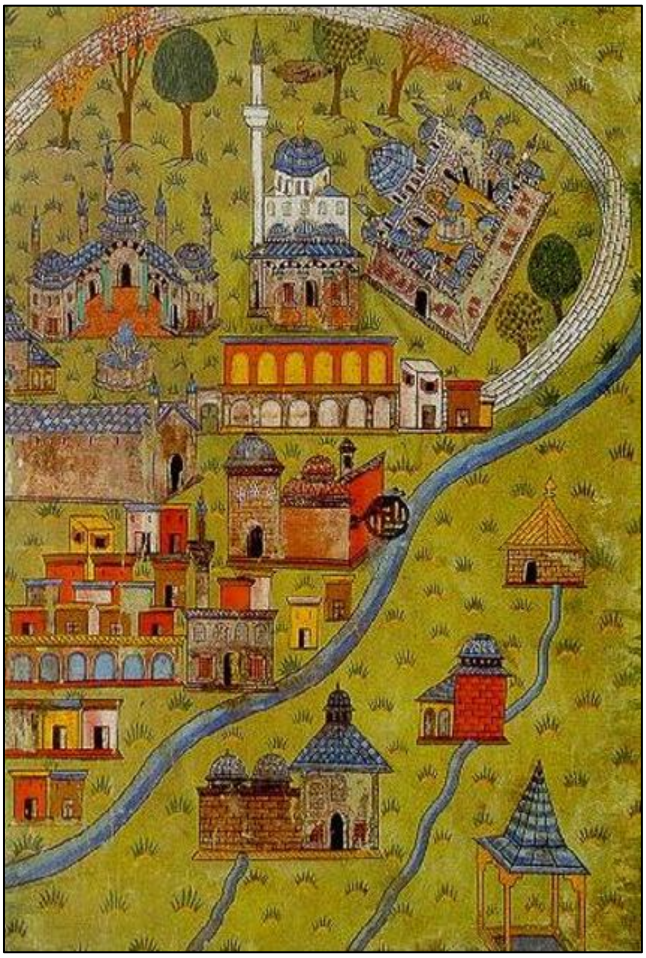

Figure 6.2 Eskişehir Miniature of Matrakçı Nasuh, 1546
Source: “Tarihte Eskişehir”, n.d.

The region underwent considerable changes in terms of its social structure as a result of the incoming migration following the Ottoman-Russian War; however, the fact that the railway passed through the city during 1892 and 1893 led to significant and favourable changes particularly on the economic and spatial structure of the city. The number of Tatar houses on the western coast of Porsuk increased rapidly and numerous Rum shops were opened around the station (Albek cited in Kılıç, 1997, p.6). “The beginning of the 19th century marks a new era in the history of Eskişehir and the city starts to assume a new image. Two important factors affected the development and change in the city: The influx of immigrants following the Ottoman - Russian War 1894, and the establishment of the Baghdad-Berlin railroad.” (Eskişehir Valiliği, 1998, p.15).

Eskişehir is on one of the most important railway intersections. The Railroad Repair Atelier (Cer Atölyesi) was built in 1894 to facilitate the construction of railroad. With it, trade in Eskişehir became active, which had a wide economic effect on the city. In those years, many foreign engineers and technicians worked in the construction. The Cer Atelier became a foundation later on for Eskişehir Locomotive and Motor Industries Company (Eskişehir Lokomotif ve Motor Sanayi AŞ - TÜLOMSAŞ). (Atuk, 2002).

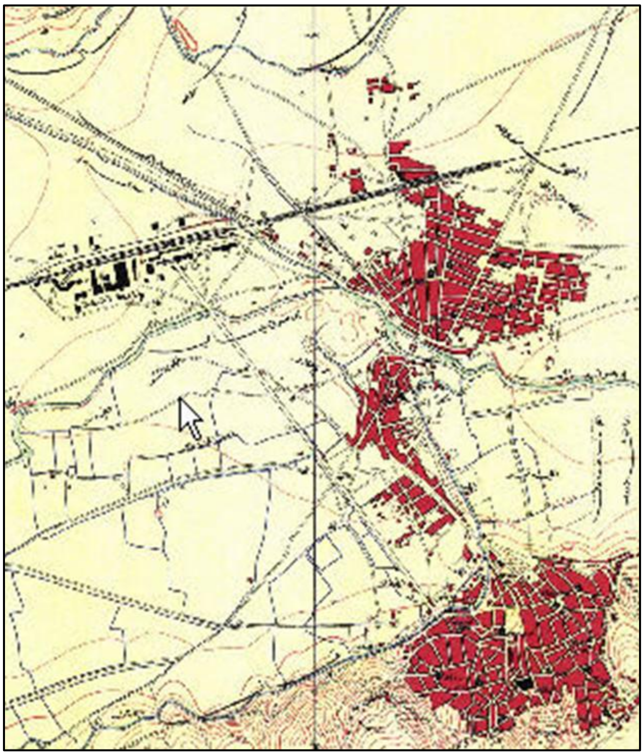

Figure 6.3 First Map Showing Existing Settlements in Eskişehir, 1896
Source: EBB, 2007

The first map showing the existing buildings and the settlements of Eskişehir was made in 1896 (See Figure 6.3). As it did not show urban development areas, the map does not exhibit the features of a plan. Yet, it is important to investigate the situation and development process at those times. Between 1890 and 1920, the city started to grow on the north side of the Porsuk River and around the railway, which accelerated commerce in the city (EBB, 2007). The growth process of the city between 1923 and today is indicated below under the subsections.

6.1.1.1 1923 - 1950 Period

After the end of the Independence War, at the beginning of 1923, the city portrayed a ruined and evacuated town with the effects of war. As a consequence of the fact that the railway passed through the bottomlands during the first years of the Republic, the descending process from the hillsides to the plains gained impetus. Following the orientation of capital and investments towards the Anatolian cities during these first years of Anatolia, Eskişehir became one of the cities in which public investments were concentrated (Ertin, 1994). During this period, the city developed an identity as a city of laborers and civil servants owing to the laborers working in the Sugar Plant, Cer Atelier, and Aircraft Maintenance Atelier, and owing to the civil servants employed in the state institutions and in the military base. The TÜLOMSAŞ Plant, as it is called today, is a public establishment of significant importance which was founded in 1894. The population of Eskişehir increased in parallel to the economic boom and mass housing, and reached 25-30.000 people at the beginning of the 20th century (Ertin, 1994).

Figure 6.4 Eskişehir Odunpazarı District in 1930s
Source: Kılıç, 1997, p.54&55

During the first years of the Republic, the city was made up of a residential area of low density encompassing *Odunpazarı* neighbourhood in the south and two centres around Porsuk in the north and orchards situated in-between these centres. Odunpazarı, where 1 or

2-storey wooden constructions were built, was normally inhabited by the upper class of the city. In the aftermath of 1923, the city experienced revival in the housing field. The old settlement areas ruined during the war started to be repaired and concentrated upon in-between two centres; and towards 1950s, the housing zone started to concentrate around the central business areas and industrial plants. On this ground, a circular and restricted mass housing style is observed (EGM, 1/25000 Master Plan Research Report, 2007). Odunpazarı has been a settlement for more than 700 years. With its typical Anatolian-style houses, narrow streets, mosques, and lodges, it has been a crucial settlement site in Eskişehir (Atuk, 2002).

During these years, the tourism and recreation-oriented uses were concentrated upon particularly around the *Porsuk River*. However, mostly the neighbourhoods in the central and northern parts of the city which were inhabited largely by the migrants were flooded following the overflow of the Porsuk in 1950 and the most of the adobe dwellings were demolished as their basis melted (Tunçdilek; 1950, p.179). In those years, a displacement of large populations were carried out owing to those flood.

Figure 6.5 Eskişehir Porsuk River in 1930s

Source: Kılıç, 1997, p.85

6.1.1.2 1950 - 1980 Period

During the 1950-60 periods, the city of Eskişehir witnessed the highest growth rate. The city continued to receive public investments, and various infrastructure investments were directed to Eskişehir, of which value as a regional centre became clear. The city of Eskişehir received a considerable amount of population from the rural areas, other provinces, and even abroad at certain times. With the 1970s, as a result of both intensifying urbanization and industrial development, the Chamber of Industry of Eskişehir was founded, which established an Organized Industrial Zone at the exit of Ankara in 1973 leading to the concentration of the industry thereabouts (EBB, 2007).

As for the city centre, the mercantile establishments flourished in parallel to the expansion of the centre. In the aftermath of the 1950s, the railway lost its significance due to the investments directed at highways; however, it still maintains its importance as regards persons and goods transportation. Flights were launched from the airdrome affiliated to the Turkish Aviation Association but due to its non-profitability, they were cancelled. The opening of the Bilecik-Ankara ring road between 1960 and 1980 was the driving force behind the development of the settlement area of the city. The coach station with 100-bus capacity was opened during this period (Ertin, 1994).

One of the defining moments in the development of Eskişehir was the opening of the Academy of Economics and Commercial Sciences (AECS) in 1958. The AECS was later transformed into the *Anadolu University* and became one of the pivotal educational institutions of the country. *Yunus Emre Campus* of Anadolu University located in the north created a new development focus for the city (Ertin, 1994). The other historical moment during this period was the fact that the first Turkish car named ‘Devrim’ (meaning ‘Revolution’) was manufactured in one of the ateliers within the city.

6.1.1.3 1980 - 2000 Period

According to the general census in 2007, the population of Eskişehir is 724.849. An examination of the urbanization rate of Eskişehir in light of the census years between 1927 and 2007 (see Table 6.1 below) reveals that 86% of the population (625.453) lives in cities while 14% (99.396) dwells in rural areas. The general census carried out in 2000 revealed that the population of Eskişehir reached a total of 706.009, 79% of which lives in cities. This rate is above the average nation-wide urbanization rate, which is 75%.

Table 6.1 The Urbanization Rate of Eskişehir as Per the Census Years between 1927 and 2007

1927	**1935**	**1940**	**1945**	**1950**	**1955**	**1960**	**1965**
26,80	30,97	34,28	37,09	36,47	42,75	47,82	48,26
1970	**1975**	**1980**	**1985**	**1990**	**2000**	**2007**	
53,53	59,00	63,24	67,67	74,48	78,90	86,28	

Source: Başar et al, 2008, p.5

The city continued to expand in the aftermath of 1980. The three or four-storey buildings were replaced by seven or eight-storey buildings. The 1st degree agricultural areas and the areas within the city centre were opened to settlement. The period between 1980 and 1992 staged the attempts to meet the housing deficits throughout Turkey via cooperatives. Accordingly, the areal expansion of the city continued through cooperatives. Upon the enforcement of the Mass Housing Law, the number of cooperatives within the city increased. The Turkish Aircraft Industry (TUSAŞ) F-16 Plant, of which the foundation was laid and construction started in 1985, commenced production following its inauguration in 1987 (“Eskişehir’in Ekonomik Durumu”, 2005).

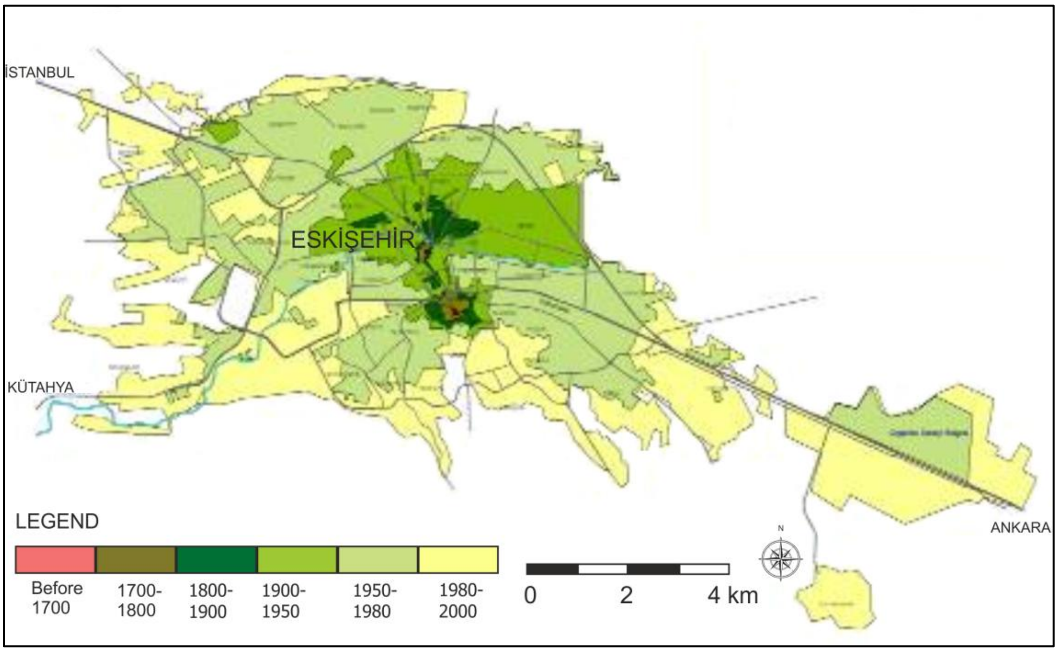

Figure 6.6 Spatial Expansion of Eskişehir Urban Area between 1700 and 2000

Source: Adapted based on the Archive of the Directorate of Public Works and Urbanism of Eskişehir Tepebaşı Municipality

The city of Eskişehir, which expands like an oil stain, has a *single-centred and compact* pattern. This situation causes overpopulation in certain urban areas, security problems, transportation difficulties, infrastructure problems, extreme increases in unearned income and thereby, as a result of increasing reconstruction costs, slumming problems. Due to these reasons, certain works are carried out by the city planners and local administration with the aim of dispersing the mentioned compact structure and creating a healthier urban environment.

The city reached its current size during 1980 and 2000. The Organized Industrial Region (OIR) was extended meanwhile. Today, the OIR ranks among the largest industrial zones in Turkey with its 31 million m2 surface area (The 2nd largest OIR of Turkey after the OIR in İzmir). Currently, the OIR is composed of 259, 39 and 55 establishments, which are in production, under construction and in the project phase, respectively. The Chamber of Industry of Eskişehir has launched investments for the recently designated area to the end of developing the OIR. A total of 35.000 individuals can be employed in 370 facilities when the targeted zone is put into operation (EBB, 2007).

In this period, the *Anadolu University* extended its area as well and was divided into two universities in 1994. The *Osmangazi University* started education in Çamlık, Meşelik and Bademlik (Ulu, 1994). The division into two universities has both influenced the settlement tendency of the city and has rendered it with a student-city characteristic. The rehabilitation and beautification works on the Porsuk River were completed in the centre and arrangements continue along the river.

6.1.1.4 2000 - 2010 Period

The period between 2000 and 2010 was a favorable period by virtue of many important projects carried out in the city. Eskişehir Greater Municipality (EGM) implemented the *'Urban Development Project'* as a package project in 2001. The components of the project are rehabilitation of Porsuk River; the renewal of rainwater, drinking water and sewage lines; and building tramlines. *Rehabilitation of the Porsuk River* includes the cleaning of the riverbed, landscape design, renewal of bridges, and reduction of disaster risks (See Chapter 6.3 for details). The renewal of old water and wastewater works, and building a stormwater network that seperates wastewater from rainwater were realized within the project as another component.

Besides the Urban Development Project, Odunpazarı Municipality also realized many notable projects such as restoration of civil architecture restored and the historic *Rider Inn (Atlı Han)* in this period. Traditional Eskişehir houses were restored and their number reached approximately 200 as of 2008. The municipality conducts various social projects to improve the socio-cultural and socio-economic status of inhabitants as well ("Odunpazarı Tarihi", n.d.).

In this period, new parks, shopping centres, and a youth center were brought to city. Its main parks are *the Sazove Science, Culture and Art Park*, *the Kent Park*, *the Büyük Park* and *the Aydın Arat Park*. *Espark Shopping Centre* was built on the old tile factory land and opened in 2007 ("Eskişehir`in Yükselen Yıldızı", 2006). *Kanatlı Shopping Center* was built on a former flourmill field and opened in 2007 ("Kanatlı Alışveriş Merkezi Özgeçmiş", 2009). Old Wholesale Market on fresh fruit and vegetable was restored and *Haller Youth Centre* was opened in 2000. In the center, there are souvenir shops, kiosks, cafes, bars, a city theatre stage, a bookstore and is home to the cultural and artistic events (Eskişehir Valiliği, 2010).

The Tramway System of Eskişehir (ESTRAM) occupies the central focus of the mass transport system of the city. ESTRAM was rewarded the first prize by the International Rail System (UIC) in an evaluation in 2004 (Bilgili, interview, 2010). ESTRAM functions on two main corridors, one leading from SSK hospital to the bus terminal and the other leading from Osman Gazi University to Muttalip Municipal Concert Hall (1/25000 Master Plan Research Report, 2007). The tramway system, which was completed in 20 months, came into service in December 2004. The network constructed has two lines and 26 stops, with a total length of 15 km ("Eskişehir Light Rail Transportation System", 2008).

ESTRAM has been designed to provide integrated service to the city in connection with the other existing mass transport systems. It is predicted that with the increase of quality of mass transport systems, demand for these systems will also increase. Therefore, it was planned to cancel bus services in the areas where ESTRAM is to give service, and that bus lines would terminate at the light rail stops to provide for exchange between systems. However, interviews conducted with some planners and residents have shown that this integration of ESTRAM with other mass transport systems has not reached the desired level. In section 6.4, the detailed information can be found on the ESTRAM. In the section below, planning works in the city of Eskişehir are considered.

6.1.2 Planning Works

Land use plans were drawn up for Eskişehir in 1956, 1986, 1978 (unapproved), 1980, 1986, and 2002. The 1/25.000-scale plan in 2009 and the approved 1/100.000-scale plan in 2006 were also approved in the referred years. Apart from these, there are rehabilitation plans of 1/1000-scale dating back to 1987, 1988, and 1989 (Mut, interview, 2010).

Table 6.2 The History of Plans

Year	Plan
1952	1/5000 Master Plan[33] (Planners: Berksan and Topaloğlu)
1954	1/2000-scale Implementation Plan[34]
1956	1/1000-scale Implementation Plan
1978	1/5000 Master Plan (Unapproved)
1980	1/25000 Master Plan (Planner: İrem Acar)
1986	1/5000 Master Plan (Planner: Polat Sökmen)
1987	Improvement Plan[35]
1988	1/1000 Implementation Plan, Improvement Plan
1989	1/1000 Implementation Plan 1/1000 (Planner: Polat Sökmen), Urban Centre Master Plan, Improvement Plan
2001	1/5000 Porsuk River and Near Surrounding Master Plan Revision (Planner: Polat Sökmen)
2002	1/5000 Master Plan
2003	EGB Transport Master Plan
2006	1/100.000 Regional Territorial Plan[36]
2009	1/25.000 Master Plan

Sources: EBB, 1986; EBB, 2001; Koca, 2004; Koç, interview, 2010; Mut, interview 2010

The first 1/5000-scale Master Plan of the city came into force in 1952. The 1/2000 scale Implementation Plan went into effect in 1954, and the first 1/1000-scale Implementation Plan took effect in 1956 upon approval. During the enforcement of the latter, which lasted 17 years, the city population rose from 120.000 to 240.000 and as a result, 19 peripheral neighbourhoods were created outside the plan. Thus, the city urgently required a new plan. The new 1/5000-scale Master Plan was approved and went into effect in 1978. The 1/1000-scale Implementation Plan, which was prepared in line with the aforesaid, prioritized the 19 peripheral neighbourhoods that lack a plan, and the first group of plans became effective in 1980. However, due to legal problems, the following phases of the plan focusing on the city centre could not be assigned to the same project owners and thus, were left undone. This

[33] The term of 'Master Plan' is used as equivalent of 'Nazım İmar Planı' in Turkish.
[34]The term of 'Implementation Plan' is used as equivalent of 'Uygulama İmar Planı' in Turkish.
[35] The term of 'Improvement Plan'is used as equivalent of 'Islah İmar Planı' in Turkish.
[36] The term of 'Regional Territorial Plan' is used as equivalent of 'Çevre Düzeni Planı' in Turkish.

situation gave rise to inconsistencies such as the implementation of plans of 1956 in the city centre and of those of 1980 in the peripheral neighbourhoods (Koca, 2004).

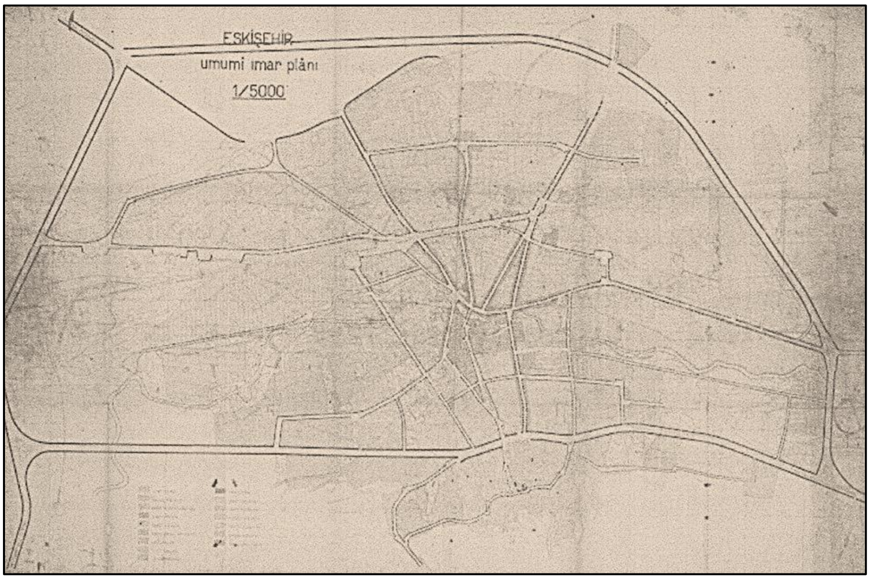

Figure 6.7 Eskişehir Master Plan of 1956

Source: Personal Archieve of Mut, 2008

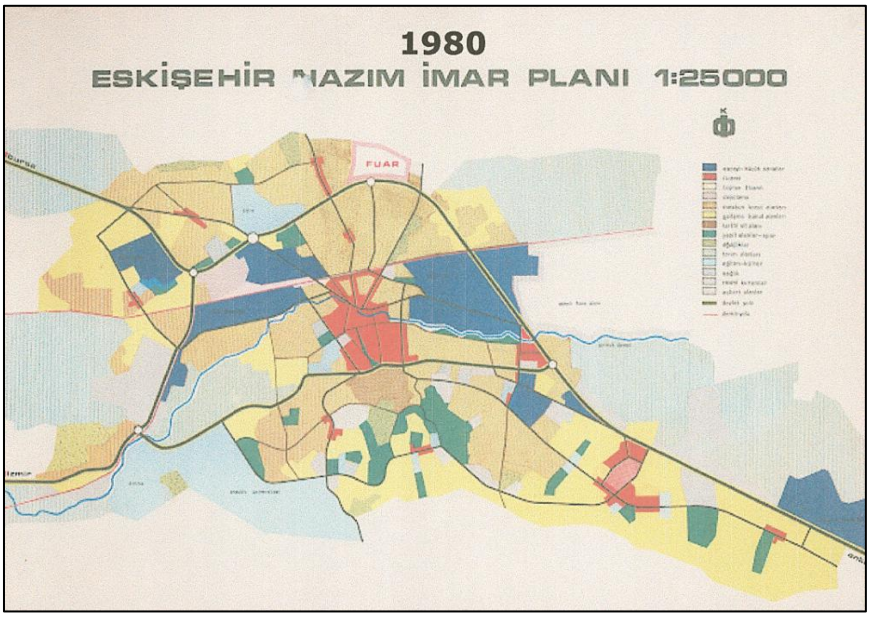

Figure 6.8 Eskişehir Master Plan of 1980

Source: Personal Archieve of Mut, 2008

The Municipality started a new planning work to put an end to this inconsistency prevailing in the city planning and in the first phase, a 1/5000-scale Master Plan was put into force in

1956, which was followed by a 1/1000-scale Implementation Plan introduced in consecutive phases. The Greater Municipality had a revision plan prepared concerning a 1/5000-scale Master Plan, which was put into force in 2000 with an eye to meet the spatial changes and developments taking place in the city (Koca, 2004).

The plans following those in effect are the 1/5000-scale Master Plans approved in 1986 and the 1/1000-scale Implementation Plan approved in 1988. The 1/5000-scale Master Plan covering the city centre of Eskişehir Province was drawn up in 1989. The plan involved a number of decisions including the central business area, organized industrial zone, urban development area and its tendency, transportation solutions and commercial development, and economic, social and cultural development of the city. Afterwards, due to the expansion of the adjacent area, the plan remained incapable and some arrangements needed to be made regarding new areas in the light of position plans (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

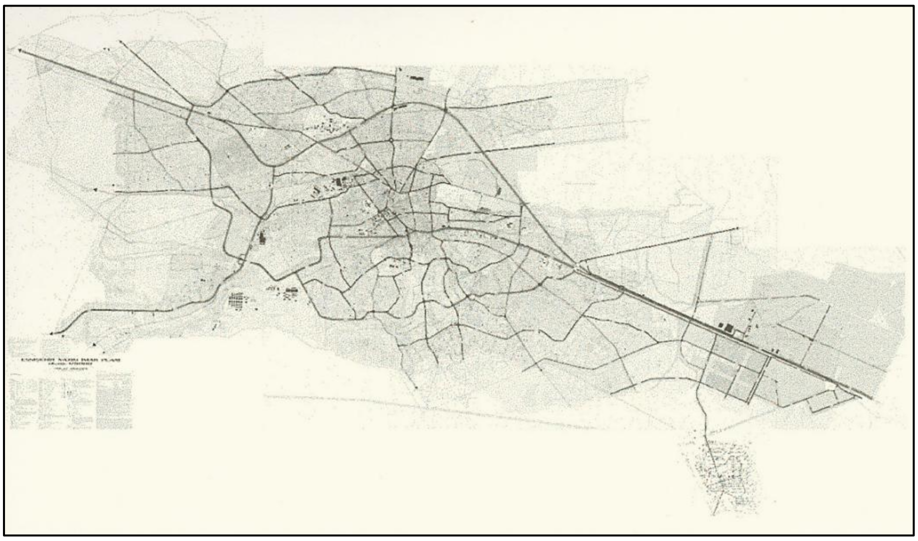

Figure 6.9 Eskişehir Master Plan of 1986

Source: Personal Archieve of Mut, 2008

The 1/100.000 scale Regional Territorial Plan of the province was examined and approved in the framework of the protocol agreed on between the Eskişehir Governorship and Greater Municipality on April 15, 2005. The 1/25.000-scale sub-planning works are carried out by EGM within the municipality borders plans (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

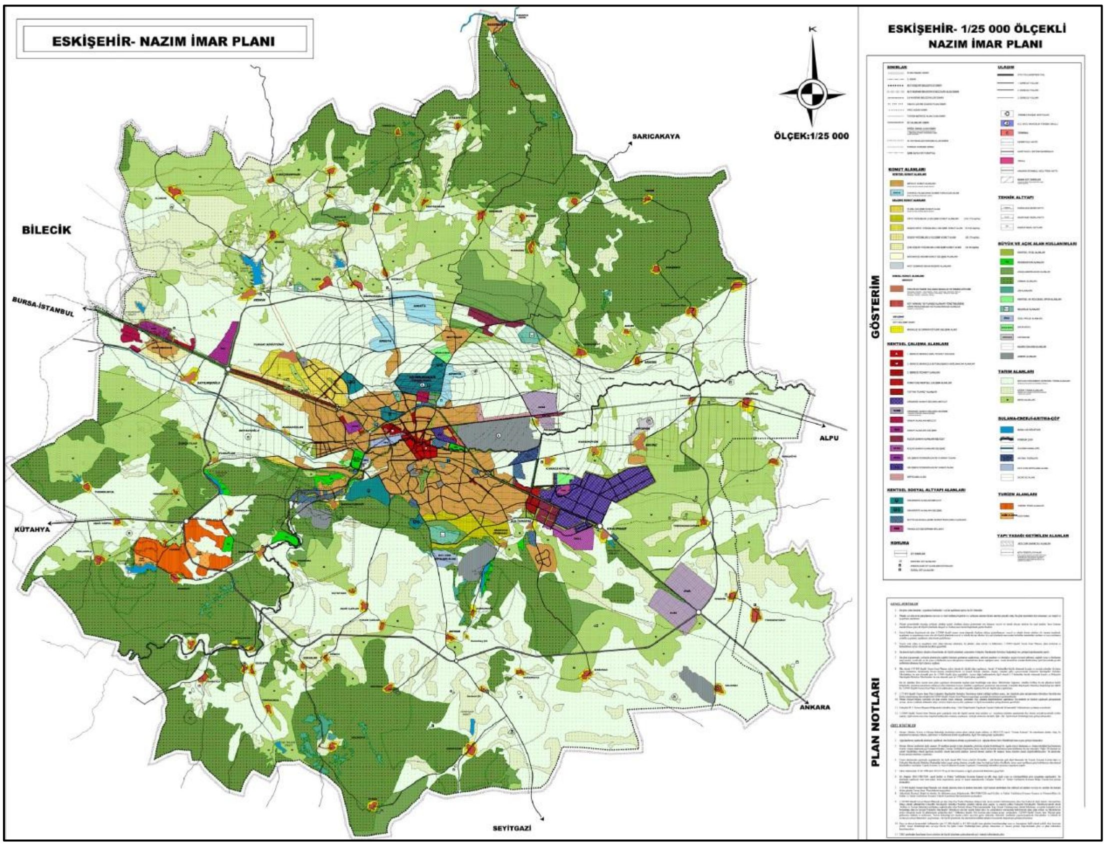

Figure 6.10 Eskişehir Master Plan of 2007

Source: Personal Archieve of Mut, 2008

The total area covered by the 1/5000-scale Master Plan and 1/1000-scale Implementation Plan within EGM borders encompass 17.230 hectares. A total of 60 modification files on 1/5000-scale plans were prepared to be submitted to the due elaborations of the Greater Municipal Council. The final 1/5000-scale plan modifications were registered on the respective map sheets and updated. The approval process and relevant procedures of the 1/100.000-scale Regional Territorial Plan concerning the Province of Eskişehir were completed and approved in May 2006. The necessary works for the 1/25.000-scale Master Plan regarding Eskişehir were commenced and the data forming the basis of the plan were obtained from relevant institutions and agencies. The lacking points were completed in light of the data of the 1/100.000-scale Regional Territorial Plan and satellite images provided by the Geographical Information System (Eskişehir Valiliği, 2011).

6.2 An Overview of Porsuk River

> *The most spectacular cities of the world were established along the riversides and flourished by dint of the advantages offered by these rivers (Bilgili, presentation, 2010).*

Porsuk River is the longest tributary of Sakarya River. Sakarya River is one of the main rivers besides Büyük Menderes, Gediz, Kızılırmak, Yeşilırmak, Dicle, Fırat, etc. of Turkey. As Buyukersen (et al., Porsuk IMO website, 2010) states, Porsuk River Basin's surface water potential is 481 million m³/year, the groundwater potential is 297 million m³/year, and the total water potential is 778 m³ per year.

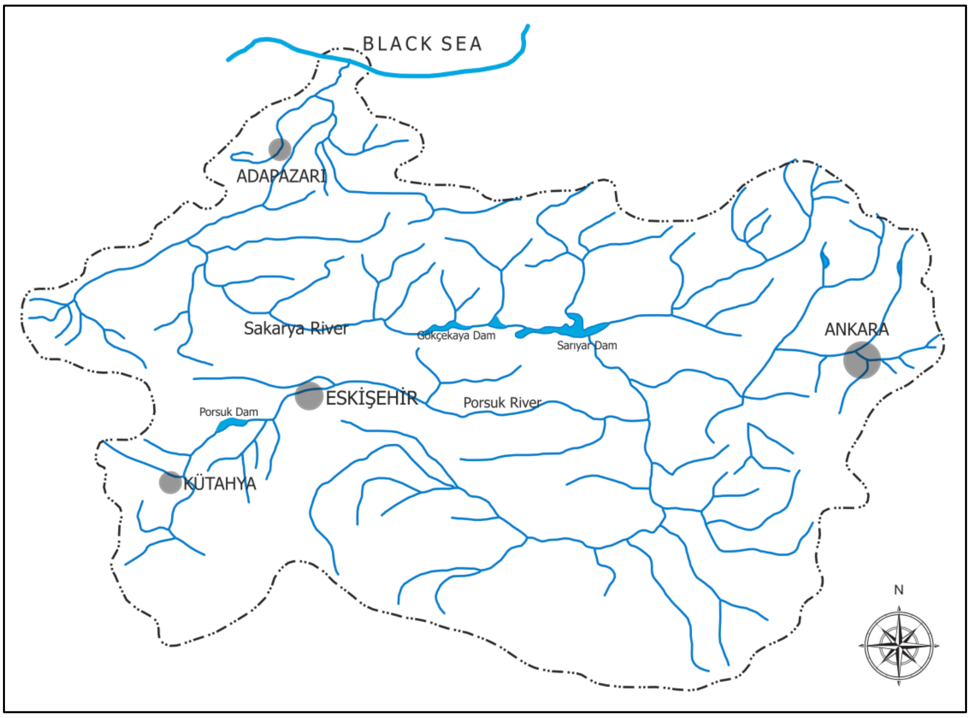

Figure 6.11 A Map of Sakarya River and its Tributaries

Source: Redrawn by the Author based on "Sakarya Havzası", n.d.

Porsuk River catchment area is 11.325 km², approximately 1,4% of Turkey's land area. The stream originates at the Oysu Village in Kütahya on Murat Mountain, and flows 435,8 km eastward before reaching the *Sakarya River*. The two largest cities Kütahya and Eskişehir are situated in the watershed area of the stream (Tanik et al., n.d.). The catchment contributes to the main part of Eskisehir's water.

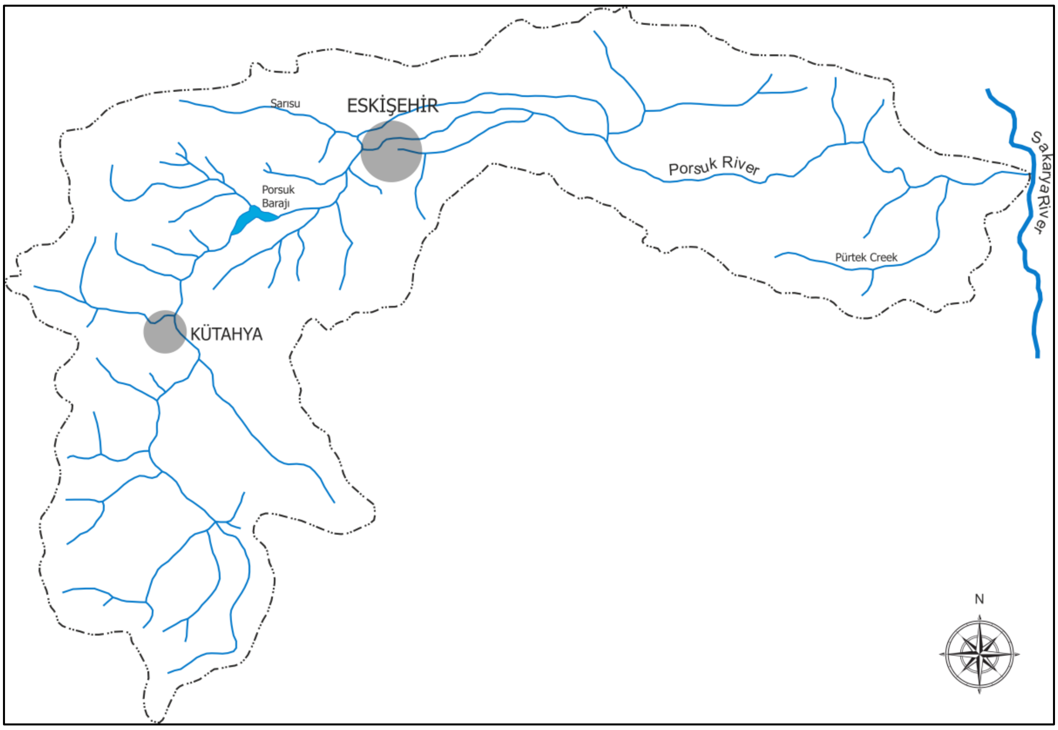

Figure 6.12 Map of Porsuk River Catchment

Source: Redrawn by the Author from Eskişehir Valiliği, 2005

Sakarya River

Sakarya River begins from Sakaryabaşı which is located 4-5 km south-east of Çifteler District. It has five close springs, the temperatures of which range between 19,5°C and 25°C. The length of the Sakarya amounts to 824 km and its total flow rate is 3600 l/sec. The River starts following the rotation of a hydroelectric turbine by these springs collected in an artificial pond. The springs of Sakaryabaşı, after taking in first Bardakçı Stream and then Sarısu a bit to the east, flows southeast into the Deremözü Creek. According to the measurements performed by the General Directorate of State Hydraulic Works (SHW) on the Aktaş Bridge, the annual average flow rate is determined to be 9,7 m^3/sec. After the Aktaş Bridge, turning towards east, it follows the channel collecting the waters of Alikan Springs situated in the vicinity of Sadıroğlu and Köprübaşı villages and then heads back south-east towards the Buzluca Village. After reaching to the Gölpınar Creek on the right-hand side which is a tributary of the Akgöl within Konya Province, it rambles towards the south-east corner of the province taking in a creek on the right side near the Çakmak Village and by forming the border between Eskişehir and Ankara and heads the north. On the right-hand side, it takes in Çıralıözü and Ilıcaözü creeks coming from Ankara Province; and on the left-hand side, it collects the Çardaközü and its waters flowing downwards from the Sivrihisar Mountains and finally, a bit to the north, reaches to the Kavuncu Bridge. According to the measurements of the SHW, its annual average current is 27 m³/sec (EBB, 2006).

Porsuk River

Porsuk River is contains two tributaries, the first of which is called 'Porsuk Runlet'. This tributary flows from the Murat Mountain into the marshy area within the Altıbaş Plain where they gather and form the Gölsuyu. The part thereof streaming north is called the Porsuk Runlet. Just before reaching the Kütahya Plain, it takes in the spring waters at the bottom of the Kocadağ in the vicinity of Porsuk Farm and increases its current. The other tributary, which takes in the excess waters of the Yoncalı thermals coming from the west of the Kütahya Province, is called as the *Porsuk River* of Eskişehir. These two tributaries join 3 km northeast of the Kütahya Centre (Çukurova) and from there ramble towards the Kalburcu Farms located in the north-west of the Su Village (EBB, 2006).

Figure 6.13 A View from Porsuk River outside the Urban Area
Source: "Porsuk", n.d.

The Porsuk River, flowing generally in a narrow and sloped valley, first takes in Kunduzlar Stream on the left side and then Kargın Creek within Eskişehir Province. The slope quite reduces after the Forestry Nursery situated in 8 km south-east of Eskişehir and continues so until joining with Sakarya. The Porsuk River runs towards the centre of Eskişehir Province through the south-west direction and entres from the west. Beforehand, on the left side, it takes in the Sarısuyu near Ertuğrulgazi Neighbourhood in the west of the city, and runs through the city in west-east direction. The tributaries joining the Porsuk, from the provincial centre until it mixes with the Sakarya, are unsubstantial and short watercourses with low flow rate. Except for few, all of them are composed of temporary waters streaming down from the ridges in the north and south of the plain. Once the river leaves the city behind, it takes in the Pürtek Stream flowing in the north of İlören situated to the left of Sugar Plant, and rambles through the Sivrihisar Mountains on the right side (EBB, 2006). In the table below, the physical characteristics of Sakarya River and its tributaries including Porsuk River are indicated.

Table 6.3 The Physical Characteristics of the Sakarya River and its Tributaries

Name of the Stream	**Total Length(km)**	**Length within the Provincial Borders (km)**	**Total Length Ratio(%)**	**Current (m /sec)**	**Starting and Ending Points within the Provincial Borders**	**The Tributary of**
Sakarya River	627	400	64%	98.57	Çifteler Sakarbaşı Alpagut	-
Porsuk River	255	225	88%	5.34	İncesu Kıranharman	Sakarya River
Bardakçı Creek	46	46	100%	2.22	-	Sakarya River
Sarısu Creek	44	44	100%	2.00	-	Sakarya River
Seydi Runlet	70	70	100%	3.38	-	Sakarya River
Çardaközü Creek	18	18	100%	0.25	-	Sakarya River
Sarısu Creek	60	40	67%	1.37	Kandilli	Porsuk River
Pürtek Stream	40	40	100%	0.83	-	Porsuk River

Source: EBB, 2006

6.2.1 Streams and Basins in Eskişehir and in its Immediate Vicinity

There is a developed river system in the Province, which is examined in two separate parts, namely, permanent and temporary tributaries (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

6.2.1.1 Permanent and Temporary Tributaries

Temporary Tributaries

Floods, which play a principal role in shaping the topography, are observed aboundantly in particular on top and on the foothills of ridges, such as mountains and plateaus surrounding the plains. These areas contain water during rains and snowmelts; otherwise, they display completely arid characteristics. As they are rarely fed with springs and fresh waters with very low current, they contain water for a longer time. Especially at the end of spring, during summer months and at the beginning of autumn, the flow ceases due to drought (Eskişehir Governorship Provincial Directorate of Environment and Forestry, 2009).

Permanent Tributaries

The spring of Sakarya, being one of the most essential rivers of Turkey, is situated in Eskişehir. It possesses a number of tributaries, the most important of which is the Porsuk River (EBB, 2006). (See Chapter 6.2 An Overview of Porsuk River in detail).

Sarısu

This stream, begining from the Mahmudiye District, joins the Sakarya in the south-east of the Saidhalimpaşa Village within the Çifteler District (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Seydisu

It is composed of creeks flowing from various directions in the vicinity of Kırka sub-distrtict within Seyitgazi District and joins the Sakarya around Kumarcı Island. Its total length amounts to 107 km, while its flow rate is 38 m^3/sec. Flooding is observed around March, mainly due to snow waters. During summer months, the flow ceases completely as a result of irrigation (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Bardakçı and İhsaniye Runlets

This stream is formed by springs coming from around Keçi Stream in Akdere Village and Bardakçı Village located within Seyitgazi District. Before reaching the Sakarya, it joins the Çifteler and rises to the surface at 1,5 km northeast of Ilıcabaşı İhsaniye Village. The estimated water temperature is 22,5 °C and the flow rate at the spring is 100 l/sec. Its flow rate under the Kınalıtepe Bridge near Sakaryabaşı was measured 15 l/sec. The loss is 85%, which is mainly due to overirrigation. The drainage area collecting Bardakçı and İhsaniye runlets is 1200 km^2 and their total lengths amount to 42 km. The floods are seen in spring during March (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Kargın Creek

It is made up by creeks running from the Sabuncupınar sub-district affiliated to the central township of Kütahya. It is named Kargın just after crossing the Eskişehir Provincial border, and joins the Porsuk on the right between Taydeposu and Gökçekısık stations. With the aim of preventing floods and benefitting from it for irrigation purposes, it was diverted to the Porsuk River lake area through construction (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Ilıca Runlet

The Yayla and Kalabak Creeks flowing downwards from the Mountainside of Türkmen join and form the Ilıca Runlet. The Yayla Creek, on the left, which stream downwards from the Mountainside of Türkmen, is situated in the south of Uluçayır Village; and the Ilıca Runlet, on the right, which is 1,5 km north of this village joins the Porsuk (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Mollaoğlu Creek

It apperars near Nemli Village affiliated to the central district of Eskişehir. It passes through Mollaoğlu Village and joins the Porsuk in the south of Kızılinler Village on the left (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Sarısu

It is formed by hot water springs situated in Dodurga Town of Bilecik Province and in the west of İnönü District located within Eskişehir Province. It runs through Sarısu Plain and on the left side, joins the Porsuk near Ertuğrulgazi Neighbourhood located in the west of Eskişehir city centre. Together with the Kargın Creek, it brings an abundance of water to the Porsuk through floods. The Dodurga Dam was constructed to prevent floods and to establish irrigation facilities. After passing close by Demirci and Ortaklar Villages, it joins the Porsuk in the north of İlören Village (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

Pürtek Creek

Pürtek Creek begins at Karaburhan Creek, which is located in the northeast of the Sivrihisar town centre, flows to the east, and then turns to the north in the east of Mülk Village. After passing by the villages of Demirci and Ortaklar, it joins to the Porsuk River in the north of İlören Village (Eskişehir Valiliği İl Çevre ve Orman Müdürlüğü, 2009).

6.2.1.2 Physical Attributes of Porsuk River

Porsuk River has been used as a source of domestic water supply since 1990 (Oruç, n.d.). The stream, which is unsuitable for fishing due to its polluted state, receives large volumes of water of mostly untreated effluent[37]. These have created water quality problems. In addition, agriculture is one of the main sources of nonpoint source pollution (Tanık et al., 2005).

In Turkey, almost 640 mm/year (1971-2000) of annual average precipitation concentrates in the winter season (Şensoy et al., 2008). It is experienced seasonal and geographic variations in water availability in Turkey. There is lower profile in Eskişehir with 374 mm. of annual precipitation. Eskişehir is in the semi-arid *Mediterranean bioclimatic zone* (Böcük et al., 2009). Porsuk basin population is 900.000, water availability per capita is 865 m^3, which is less than the average of Turkey (1400 m^3/person). Therefore, Porsuk Basin is a water-poor region (Büyükerşen et al., 2008). A variation in seasonal precipitation values is also seen. The river flow varies because of the variation of physical characters of rivers, especially

[37]Effluent is water that flows from a sewage treatment plant after it has been treated (Kemp, 2009).

slope variations. The ratio of urban population in total population is 82% for 2009 ("Eskişehir", 2010).

The observational studies regarding water quality of the Porsuk River are carried out by the 3rd Regional Directorate of the SHW. Though it does not face any quality problems from the Murat Mountain until the entrance of Kütahya, it becomes polluted due to returning waters from irrigation, agricultural pollution, effluent waters of Kütahya and slaughterhouse wastes and due to the wastes of Sugar Plant, TÜGSAŞ, Thermal Power Plants and Ceramic Plants. Water, which holds 1st class quality while entering Kütahya, degrades to 3rd class in terms of dissolved oxygen, BOD[38] and COD[39] and to 4th class as regards ammonia nitrogen. The Porsuk River, flowing from Kütahya, enters Eskişehir by renewing itself after the outlet of Porsuk Dam. Therefore, the river is re-polluted by the wastes of Sarar Textile, TÜLOMSAŞ, Sugar Plant, Air Supply, Organized Industrial Region (OIR), and by urban wastes. Later on, the pollutions originating from the Alpu and Beylikova and leather industry are accrued (Büyükerşen et al., 2008).

It is the responsibility of Eskişehir Greater Municipality to establish and operate wastewater treatment facilities as well as the sewage network and rainwater discharge system. It undertakes this responsibility by preventing leakages, providing scientific and technical infrastructure and creating a management information system. Eskişehir renewed the Eskişehir Water and Sewage Administration (EWSA) master plan and prepared an investment plan in order to solve the wastewater problem of the city (Büyükerşen et al., 2008). The wastewater treatment facilities have already been rehabilitated and expanded so that cleaner water can be discharged into the Porsuk.

The *Porsuk Dam* constitutes the most significant water structure of the Porsuk Basin and thus, its water quality is of paramount importance. The following are the examples of factors that affect the water quality of the dam lake negatively: the partly treated and/or untreated wastewaters of the city of Kütahya, the polluting factors due to the TÜGSAŞ Fertilizer

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[38] BOD (Biological Oxygen Demand) is the standard method for indirect measurement of the amount of organic pollution (that can be oxidized biologically) in a sample of water ("Biological Oxygen Demand (BOD)", n.d.).

[39] COD (Chemical Oxygen Demand) is the standard method for indirect measurement of the amount of pollution (that cannot be oxidized biologically) in a sample of water ("Chemical Oxygen Demand (COD)", n.d.).

Industry, the wastes of Kütahya Sugar Plant and slaughterhouse, and pollutions due to fertilizers and pesticides densely used in agricultural activities. The improvement of the water quality of the Porsuk Dam is highly correlated with the elimination of the polluting factors. According to the Water Pollution Control Regulation, the Porsuk River, just before entering Kütahya, is qualified as 1st class while it drops down to 3rd and 4th class at the exit; as a result of the improvement in the dam lake, the water regains 1st and 2nd levels but at the exit of Eskişehir drops back to 4th class (Büyükerşen et al., 2008).

Based on the classifications indicated in the Chapter 2.3, it should be noted that River Porsuk is a tributary of Sakarya River from which three smaller stream flow out. Therefore, Porsuk River is at the fourth level according to the classification based on stream order. As for pattern-based classification, most of Porsuk River in urban area is modificated with canals. Water quality-based classification shows that water quality of Porsuk River ranges from less contaminated to very contaminated (In Chapter 6.2.3, more detailed information can be found in this matter). The stream is not suitable for navigation. As an urban river, Porsuk River is passing through the city *diametrally*, with the city centre located at the riverfront. Finally, while the imperviousness is reviewed, the ratio is greater than 25% (calculated from the satellite images of Eskişehir accessed from the EGB Directorate of Parks and Gardens), so the stream quality is non-supporting. After being overviewed the the situation of streams in Eskişehir and classification of Porsuk River, the place of the Porsuk River throughout the history of Eskişehir is addressed in the section below.

6.2.2 Place of the Porsuk River throughout the History of Eskişehir

The situation and functions of Porsuk River has been changed or transformed over time, as is the case in cities through which a river passes. In this section, the state of Porsuk and its changing functions throughout the recent history of Eskişehir are addressed.

Figure 6.14 Porsuk River, 1924
Source: Kılıç, 1997, p.39

In the late 1800s, fishing was possible in the Porsuk River and even a traveller visiting the city at the time reported to have caught a catfish of 150 kg. In those years, the Porsuk then had abundant water and served as *a recreation and gathering site* for the city dwellers (Kılıç, 1997). Atuk (2002) cites Evliya Çelebi in his famous book ‘Seyahatname’ (Book of Travel) describing Eskişehir in 1648 like this “all sides of the town are full of rose gardens, vineyards and gardens, and the grains are abundant”. Atuk (2002, p.130) also cites Lucas (in 1705) that “there is a river between the walls of the city. The river is deep but not wide. There are fish weighing 200 kilograms in the river”, referring to Porsuk River.

6.2.2.1 Beginning of 1900s

Figure 6.15 At the Beginning of 1900s, Porsuk River
Source: Kılıç, 1997, p.9

At the beginning of the 1900s, wool-scouring places were founded on certain parts of the Porsuk River falling outside the city (Kılıç, 1997) (See Figure 6.14 and Figure 6.15). At the beginning of the early years of the Republic, extensive constructions such as big parks, roads, and bridges started to be established in Eskişehir. In those years, six new bridges were built and two were restored on Porsuk (Atuk, 2002).

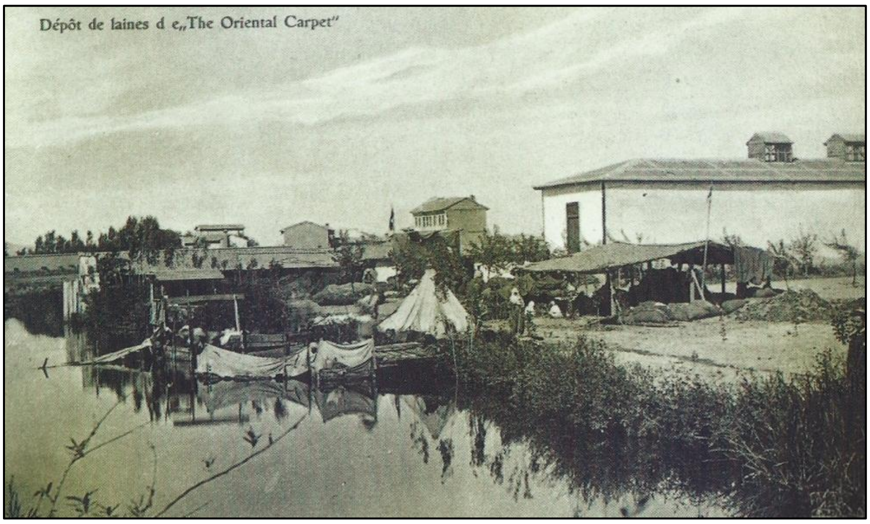

Figure 6.16 Wool Scouring and Stocking Places on Certain Parts of the Porsuk River Falling Outside the City at the Beginning of 1900s
Source: Kılıç, 1997, p.8

Besides the best-known Porsuk, there were also small streams like *Akar, Sarısu, and Muttalip streams* in the city. Before it was polluted, *Akar Stream (or Yediler Creek)* was a place for swimmers. And Sarısu streambanks were formerly used by fishers. Water mills around Akar Stream can be seen in Matrakçı Nasuh’s miniature of Eskişehir (See Figure 6.2) that was drawn in 1546 (Atuk, 2002).

Figure 6.17 Eskişehir Akar Stream Büyük Park Avenue in 1920s

Source: Kılıç, 1997, p.29

Figure 6.18 Eskişehir Akar Stream in 1930s

Source: Atuk, 2002, p.35

Akar Stream mixes with the Porsuk River on the east of Eskişehir. As is seen in Figure 6.17 and 6.18, Akar Stream was an open watercourse until the mid-1900s (Kılıç, 1997). Akar Stream, which gave the name to the section of city called Akarbaşı, does not exist anymore (Atuk, 2002) because the stream was completely covered with concrete later on (Kılıç, 1997). Water-powered flourmills on the stream disappeared as well after the stream was covered (Atuk, 2002).

6.2.2.2 Mid 1900s

In the 1940s, a portion of Akar Stream was covered with concrete. Yet, the part along Hamamyolu Avenue close to thermal water area has remained open for a while (Atuk, 2002). Akar Stream along *Hamamyolu Avenue* was filled by the Municipality in 1990 (Sarıöz, 1997).

Figure 6.19 Eskişehir Bazaar on Hamamyolu Avenue that Adjacent to Akar Stream, 1929
Source: Atuk, 2002, p.67

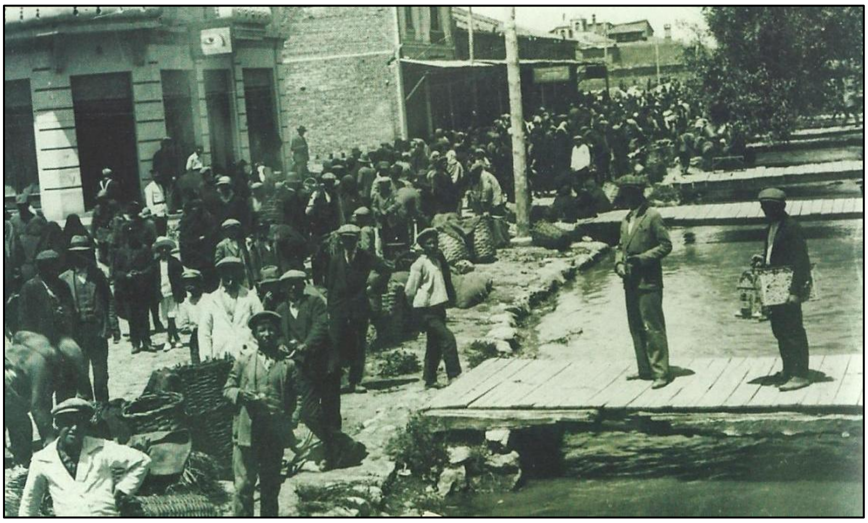

Figure 6.20 Eskişehir Bazaar on Hamamyolu Avenue that Adjacent to Akar Stream, 1935

Source: Kılıç, 1997, p.48

Figure 6.21 The Road Turning to the İstasyon (or İsmet İnönü) Avenue and Kızılcıklı Mahmut Pehlivan Avenue, Porsuk River and beyond, Porsuk Avenue (1930s)

Source: Kılıç, 1997, p.50&51

Figure 6.22 Eskişehir İstasyon Avenue in 1940s
Source: Kılıç, 1997, p.98&99

Above in Figure 6.21 and 6.22, Porsuk River and adjacent neighborhood are seen. Until 1970s, the houses along the river had three floors maximum. Besides houses, there were many amusement places, cultural and health institutions along the river, yet Porsuk always maintained its quiet character (Atuk, 2002).

Figure 6.23 Porsuk River in 1937 (and Kanatlı Flour Mill on the Backround)
Source: Kılıç, 1997, p.55; Atuk, 2002, p.144

Figure 6.24 Eskişehir Porsuk River in 1930s

Source: Kılıç, 1997, p.85

Figure 6.25 Eskişehir Porsuk Hotel on Porsuk Riverfront, 1930s (later on Municipal building)

Source: Atuk, 2002, p.

Figure 6.26 Hamamyolu Avenue, 1934

Source: Atuk, 2002, p.63

Hamamyolu Avenue (see Figure 6.25) has been one of the important shopping places of the city since the early years of the Republic of Turkey. On one side of the avenue, the Akar Stream was flowing, and there were small timber bridges over the creek. Hamamyolu Avenue was called many different names such as *Büyük Park Avenue* (Atuk, 2002). Hamamyolu takes its name from thermal waters and Turkish baths in this area. The area is also called the Sıcaksular District.

Figure 6.27 Recreation Areas around Eskişehir Porsuk River in 1940s
Source: Kılıç, 1997, p.129

In the 1950s, there were summer theatres on both sides of the Porsuk River. Walking up and down Porsuk River, eating corns, and drinking tea were other forms of amusement for Eskişehir people (Atuk, 2002). The bicycle was an indispensable means of transport in Eskişehir until the 1960s. During the 1940s, there were parks, recreation areas and bicycle paths on the riverside of the Porsuk (Kılıç, 1997)

In 1950, a great flood damaged the city and surrounding villages. Hence, canals and reservoirs were built on Porsuk in the following years (Atuk, 2002). Until the 1960s, Porsuk River added beauty to the city, it flowed very clean, and people even caught fish there. However, with the beginning of the 1960s, the density of settlement around the river increased and untreated industrial waste was dumped into the river. Thus, a heavy pollution was caused in the river. After the factories began to install their purification systems, the Porsuk could begin to return to its old days (Atuk, 2002).

6.2.2.3 End of 1900s

Where the Porsuk is divided into two small branches that join again, a small island is created near Köprübaşı. On this island the former building of Tepebaşı Municipality (and the former Eskişehir Municipal Building) is situated. On the backside of the building, there is a tea garden. The building was built as a hotel but soon it was used as Eskişehir Municipal building, and later on Tepebaşı Municipality moved there (See Figure 6.25, 6.28 and 6.29). Since the end of 2010, the building has been empty and it is planned to be used as a museum after its restoration Atuk (2002) states that the district around Köprübaşı has always been a trade centre throughout history. The district has also met the shopping needs for Eskişehir's surroundings for many decades.

Figure 6.28 Eskişehir Municipal Building, 1990s
Source: Sarıöz, 1997, p.51

Figure 6.29 Tepebaşı Municipal Building, 1990s
Source: Eskişehir Valiliği, 1998, p.18

Figure 6.30 Porsuk River in 1990s

Source: Sarıöz, 1997, p.65

The city centre, known as *Çarşı* (downtown) or *Köprübaşı*, is situated on the Porsuk riverfront. Köprübaşı is the paramount assembly point of the city. Owing to its position, it is found at the junction of both the commercial centre and the tramline. The Doktorlar Avenue extending parallel to the Porsuk is one of the most pleasant places of Eskişehir (Mut, interview, 2010).

Figure 6.31 Köprübaşı, 1990s

Source: Eskişehir Valiliği, 1998, p.87

6.2.2.4 2000s

Porsuk riverfront has always retained its distinctive place as a relaxation and entertainment area with its family tea gardens on the banks, summer open-air movie theaters, and restaurants. Today, there are no more summer theaters and family tea gardens anymore; they have been replaced by cafes (Atuk, 2002).

Figure 6.32 Adalar, 2011
Source: Produced by the Author, 2011

The Porsuk River was part of the daily life of the city and served the city until the 1950s and 1960s. Afterwards, its role in city life diminished due to pollution. After Porsuk started to be reutilized following its discovery by students and the establishment of cafes along its coast, the works concerning street and cafe were launched in 1990s along the coast of the Porsuk (Mut, interview, 2010). By the 2000s, Porsuk River started to regain what it lost over the previous decades. The most significant intervention in the Porsuk River is the Urban Development Project of 2001, which is introduced in detail in Chapter 6.2.5. Below a summary of the functions of the river is presented from time perspective.

Table 6.4 Functions of Porsuk River

Function	Porsuk River - City of Eskişehir
Potable/drinking water	Between beginning of the 1900s and 1930s (Until the 1900s, cooled thermal water is used. By1936, Kalabak spring water started to be used as for drinking water).
Domestic/service water	Since the 1960s and after the 2000s' well-water purification
Sewage discharge	Between the 1960s and 1990s (non-treated) and since the 1990s (treated)
Wastewater discharge	Since the 1950s, controlled after the 1990s
Source of irrigation	From Ancient times to present-day
Boating, canoing etc.	Boating until the 1970s and both since 2005
Fishing	Until the 1960s, and since the second part of the 2000s
Swimming	Until the 1960s, and since 2010 (in the part of Kentpark)
Recreation	From Roman civilization until the 1970s and after 2005
Washing up along the river	Until the 1950s
Transportation	No
Navigation	No
Object of rehabilitation	In 1980 (only cleaning sediments), and in 2001 in a comprehensive manner

Source: Produced by the Author

After the functions of Porsuk River and types of its connection with the city are shown above, these functions are grouped according to the periods of time at the table below.

Table 6.5 Functions of Porsuk River in Periods

Year	Function of Porsuk River&Type of its Connection with the City
Pre-1970	Recreation, seating points among the brook, sightseeing on boats over the river, fishing, swimming, watering, potable water, flooding
1970-80s	Recreation, sightseeing on boats over the river, fishing, watering, potable water, flooding, waste water receiving environment
1980-2000	Watering, potable water, flooding, waste water receiving environment
2000-2011	Recreation, sightseeing on boat and gondolas over the river, watering, potable water

Source: Produced by the Author

6.2.3 Urban Water System and Porsuk River

The *Porsuk River* is one of the main tributaries flowing into the Sakarya River. Though maintaining its cleanness until reaching Kütahya, the river is exposed to various polluters therein as was pointed out in the previous section. The sewage waters of Kütahya, the nitrate-containing industrial wastewaters, the pesticides drifting from the surrounding cultivated lands, algae and ammonium nitrate-containing waters originating from the *Porsuk Dam* constitute the main sources of pollution for the Porsuk River (EBB, 2007).

The environmental pollution in the city was first noticed during the 1970s when the colour of the Porsuk River began to change and the stream created an unpleasant smell. The industrial facilities, which had been built up in the immediate vicinity until that period so as to benefit from its water and to discharge the wastewaters into the stream, are the leading actors of this pollution. What is striking here is the fact that the majority of these facilities are composed of public institutions. As a matter of fact, the vinasse and molasses wastes flowing from the affiliated facilities of the Sugar Plant, the chemical dyes from the Sümerbank Plant, the wastes derived from the petroleum products of the TÜLOMSAŞ and the Air Supply Centre were discharged directly into the Porsuk River (EBB, 2007).

Various mercantile establishments and slaughterhouses near the river, though not so much as the industrial facilities, had a direct impact on pollution. Thus, the wastes from the slaughterhouse belonging to the municipality, the chicken slaughterhouses in Çukurpazar, the wastes of the fishermen and the effluent waters from the public baths directly flow into the Porsuk. Furthermore, the impacts of the polluted waters leaking from the cesspools of the houses and drifting to the river cannot be neglected. As a matter of fact, the wastewater flow rate of the stream passing through the city was measured to be 142.000 m^3/day while the domestic BOD, total nitrogen load and total phosphorus load were measured as 35.000 kg/day, 7500 kg/day, 3650 kg/day, respectively. In addition, bearing in mind the fact that during the campaign period of the Sugar Plant of Eskişehir, the effluent water current reaches 25.000 m^3/day while the waste water current and BOD load originating from other industrial facilities attain 13.000 m^3/day and 7500 kg/day, respectively; the extent of the problem can be better understood (EBB, 2007).

Another factor underlying the pollution in the Porsuk River is the mixing of fertilizers and pesticides used in agriculture into the groundwater. The agricultural activity in Eskişehir

Plain has an essential place in the economy of the province. The majority of the plain can be irrigated through irrigation channels. Fertilizers and pesticides are widely used in agriculture, and this results in the pollution of the groundwater (EBB, 2007).

As a consequence of the abovementioned unfavourable factors, the stream does not only pervade unpleasant smell during summer months; but also creates a dark-coloured polluted water view due to factory and domestic wastes. I this respect, during its flow through the city, the aquatic life is considerably affected due to pollution, and the existing ecosystem becomes unbalanced. In addition, as the river becomes populated during its flow through the city, the rural settlements in its vicinity that benefit from the stream for irrigation purposes are affected negatively (EBB, 2007).

In Turkey, the measurement concerning the water quality of the river has been performed since 1933. The flow observational station was first established on the Fırat River. As of 1936, the establishment date of a station in Eskişehir, measurements are performed on the Porsuk River. For the first time in 1972, the Public Hygiene Institution endeavoured to take some measures with an effort to prevent the pollution in the Porsuk; however, due to the fact that most of the said measures were temporary, instead of minimizing the problem, it has reached the present day. Therefore, the first serious steps to succeed were taken in 1988 with the establishment of the organization for the protection of Porsuk by the provincial environment department (EBB, 2007).

The works carried out by the mentioned institution ensured the conclusion to an agreement between the Sugar Plant and the municipality, and the factory wastes were started to be discharged into an old dumpsite nearby the Muttalip Village. Similarly, by dint of the agreement reached with the Sümerbank, it was ensured that the effluent waters were discharged into the Porsuk only after undergoing a colour treatment process with ammonium sulfate and hypochlorite solution in six stilling basins while passing through the treatment facilities (EBB, 2007). However, the pollution in the stream has not been solved entirely yet.

As for the TÜLOMSAŞ, it partly reduced the amount of effluent water discharged into the Porsuk; however, due to decays and resultant leakage in the pipes of the water treatment facilities, the problem has not been solved completely. The air supply centre has not undertaken any action toward improvement regarding this issue yet. However, the issue of the waste materials from the slaughterhouse of the municipality was solved and by connecting domestic and public bath wastes to the sewage system, the pollution of the Porsuk was attempted to be mitigated. Whether there have been any improvements in the Porsuk resulting from these measures is to be determined by the results of the analysis performed in the laboratories of the 3rd Regional Directorate of the SHW. In case of any improvement, it can be asserted that the pollution of the Porsuk is prevented for today (EBB, 2007).

Clean Water System

Information about the clean water resource supplied to the city:

- Clean water resource: Porsuk River
- Clean water resource capacity: 320000 m^3/day
- Daily operating capacity: 80000 m^3/day
- Water transmission system: Closed Network System
- Type of pipe: Spiral Welded Metal Pipe
- The diameters and length of the Main Supply Lines: Ø1400-Ø400;105.000 m

Wastewater System, Sewage and Treatment System

Information about the wastewater and rainwater of the city:

- Sewage system: Separated system
- Type of pipe: Concrete pipe
- The diameters and length of the Main drainage lines: Ø2400–Ø300 ; 147.600 m
- Wastewater disposal: By the wastewater treatment facility located in the 3rd km of the Alpu Road
- Wastewater Treatment System: Active Sludge System
- Capacity: 75.000 m^3/day
- Rainwater disposal: Drainage into the Porsuk River
- Type of Pipe: Concrete Pipe
- The diameters and length of the rain water transmission lines: Ø 2000 – Ø 300 ; 36.000 m

One out of four of the municipalities in Turkey are deprived of a sewage system and 50% of wastewater is discharged without being treated in treatment facilities (including deep-sea discharge). Eskişehir did not have a sewage system until the 1990s. However, approximately 90% of the city was connected to a sewage system in 2009. The sewage system is connected to treatment facilities covering an area of 450 hectares in the vicinity of Karacahöyük Village on the Alpu Road extending in the north-east of the city. These waters collected in the treatment facility are treated there and then discharged into the Porsuk River (EBB, 2007). Today, almost the whole urban area is linked to the sewage system.

The Wastewater Treatment Plant of EWSA (Eskişehir Water and Sewage Administration) is located at a distance of 3km of the Alpu Road from the city to the east. The designed plant consisted of a four-phased-treatment system based on an active sludge process. The construction of the first phase was completed late in 1998 and at the beginning of 1999 the treated water could be discharged into the Porsuk River. Apart from the sewage, the estimated current of the industrial wastewaters is 20.000 m^3/day. The pre-treated wastewaters are also transferred to this treatment plant (EBB, 2007).

The Wastewater Treatment Plant of EWSA was put into service in 1999 with the aim of reducing the pollution load of the Porsuk River. The wastewaters gathering in the cesspools were disposed by sewage trucks before 1999. With the activation of the treatment plant, the effluent waters started to be discharged into the Porsuk River after being treated in compliance with the existing receiving environment via the biologic treatment system. The plant is a biologic treatment facility operating on the basis of an active sludge system (ESKİ, 2010).

The Rainwater Collecting and Discharge System operate separately from the sewage. The collected rainwater is transferred to the irrigation channels of the SHW. On the other side, ponding areas are formed on the avenues and streets due to heavy rains as the city is situated on a plain or almost plain surface and for this very reason, the cesspools overflow. With an effort to prevent this situation, relevant works gained impetus and rainwater pipelines started to be laid along the avenues with heavy traffic flow. Although the projected total length of the pipeline was 28.200 m, only 12.571 m of the pipeline could be laid by 2007 (EBB, 2007). Today, most of the laying works for stormwater lines have been completed (Yıldırım, interview, 2011).

Review of Eskişehir Urban Water System

Local governments play major role in managing water in Turkey. Local governments maintain and upgrade drainage in towns and suburbs. They manage urban development and local pollution. They supply water and treat sewage. The following are the regulations set by the local administration concerning the water infrastructure and the Porsuk since 1984:

Table 6.5 Works Carried Out Related to Eskişehir Urban Water System and Porsuk River

Years	Works Carried Out
1984-1989	The Drinking and Potable Water Treatment Plants of Eskişehir were established. Eskişehir Sewer System Project was prepared. Eskişehir Sewer System Project composed of three main parts, as Sewage Collecting, Rainwater Collecting and Sewage Treatment Plant, was prepared.
1989-1994	Wastewater Treatment Plant was established. The Drinking and Potable Water Treatment Plant was completed and put into operation. The infrastructure of 930 neighbourhoods was set up. A total of 259.683 sewage and rainwater collecting canals were constructed.
1994-1997	Kalabak Water Carboy and Filling Factory were established. The light rail system project was prepared and ensured that it was approved by the State Planning Agency (SPA). The Porsuk was cleaned and landscape planning was put into practice in Köprübaşı district accordingly. The Sewage Treatment System, of which construction was started during 1984-1989 period, was completed. As a result of the ongoing infrastructure works, additional 33 neighbourhoods were provided with infrastructure.
1997-	Rehabilitation of water canals and wastewater system was conducted.

Source: Adapted from Alpman, 2009

6.2.4 Proposals of Plans for the Porsuk River, and Solutions of Problems

Eskişehir plans envisaged certain issues with respect to the water infrastructure of the city and the Porsuk as follows: In spite of the fact that the reports of the former plans are not available, it is understood that the Porsuk line was not taken into consideration in the plans of 1956 and 1986. It is noticed that the plans of 1980 and the current plans, though protecting the line in question, do not have any influence on the utilization of the surrounding area (See Chapter 6.1.2).

Porsuk River and its near surrounding were treated in a broad manner under the name of *Urban Development Project* of 2001 (Mut, interview, 2010). A plan that involves Porsuk River rehabilitation particularly was producedwithin the framework of this project. The plan named 1/5000 *Porsuk River and Near Surrounding Master Plan Revision* of Polat Sökmen was approved in 2001. According to the Research, Explanation and Justification Report of this plan, this plan was made to allow reorganization of the river and its vicinity in accordance with public interest, minimization of risks due to soil liquefaction, and arrangement of the parts included in the project that were planned to widen the area for recreative reasons. The plan also aimed at ensuring safe movement of pedestrians. To this purpose, the vehicle road between Porsuk River and green spaces was pedestrianized as far as possible. The plan specified that, it would aim at forming a green belt around Porsuk that involves parks, children's play areas and recreation places. It is asserted in the report that the size of present green areas would be increased approximately two-fold with this plan (Sökmen, 2001). The plan involves a number of recreation areas extending from Kentpark towards the west, to Sazova (Mut, interview, 2010).

The plan includes the decisions on construction layout and number of floors for Porsuk River surrounding area. It was indicated that due to liquefaction between the bridge on Ataturk Avenue and the bridge on Yunus Emre Avenue, a decision for the construction of buildings over six floors could not be taken outside the city centre. In partially built-up areas, construction layout would be transformed to detached layout where the subdivision of blocks is appropriate. As for unbuilt areas, the riverfronts of Porsuk would be left for open spaces such as parks and playgrounds. When this was not possible, attached building layout would be adhered to and constructions of more than 3 floors would not be allowed (Sökmen, 2001).

Moreover, the *2006-2010 Strategic Plan* of the Special Provincial Administration of Eskişehir stipulates that the protection of the Porsuk River Basin as one of the biggest tributaries of the Sakarya River and potable water source of the city, shall be handled as the prime environmental objective and accordingly, necessary projects shall be developed (Eskişehir İl Özel İdaresi, 2006). In the following section, the Porsuk River rehabilitation work conducted under the name of Urban Development Project is considered in more detail.

6.3 The Rehabilitation of Porsuk River

Until the end of the 1960s, inhabitants of Eskisehir fished, had fun on the shores, and learned to swim in the Porsuk River. However, later it transformed into an open sewer owing to discharged industrial and household waste. Starting from the late 1960s, the Porsuk River became a veritable open sewage and dumpsite due to industrial and domestic wastes, and connection leaks in urban sewage and rainwater lines. The stream, running through the city, also caused ground liquefaction-related hazards for the basis of surrounding buildings as a result of water leaks. The fact that some parts of its bed were filled by the former municipality administrations for creating parks, posed an overflow risk for the city (EBB, 2010). EGM has played an important role in planning and implementation of the restoration efforts on Porsuk River.

It is possible to define restructuring process of the river by dividing into phases according to the years beginning from pre-1970, in general. In the table below, phases of the treatments on Porsuk River are shown between pre-1970 and today.

Table 7.2 Phases of the Treatments on Porsuk River

Year	**Plan**	**Practices**	**Reason**
Pre-1970	-	-	-
1970-80s	-	-	-
1980-2000	-	-Cleaning of sludge at the bottom of Porsuk River	-Accumulation of dirty base sludge at the bottom of Porsuk
2000-2011	-Project Porsuk within the framework of Urban Development Project (EGM) -Porsuk Basin Improvement Plan (SHW)	-Rehabilitation of Porsuk River and its surrounding in urban area -Plan towards technical improvement of Porsuk Basin	-Flood risk, contamination, expiration of bridges -Renewal of water structures

Source: Produced by the Author based on interviews

For the rehabilitation of the Porsuk River which was reported to be one of the most polluted waters of Europe in 2002 by the Organization for Security and Cooperation in Europe, a large scale project that included the cleaning of the riverbed, landscape planning, renewal of old vehicle and pedestrian bridges, and measurements for reducing disaster risks was prepared and incorporated into the EGM Urban Development Plans of Eskişehir city (EBB, 2010).

EGM (Eskişehir Greater Municipality) concluded a loan agreement by applying to the European Investment Bank in 2001 with a package project titled '*Urban Development Project'*. The components of the project are as follows: Component 1: *Tram project*, Component 2: *A project for reducing the damages of disaster*, and Component 3: *The renewal of rainwater, drinking water and sewage lines* of Eskişehir Water and Sewage Administration (EWSA) and the establishment of domestic waste treatment plants (Bilgili, interview, 2010).

Eskişehir's Porsuk River was restored in 2001 with credit from the European Investment Bank (EIB). In order to prevent flooding damage and pollution, the Eskişehir Metropolitan Municipality spent $50 million of the $250 million credit from the European Investment Bank to restructure the riverbed (Yüzbaşıoğlu, 2009). The EIB has been granting loans for individual projects since its foundation. The Urban Development Project of Eskişehir is a package project. It was first in 2001 that EIB granted a loan for a package project (Bilgili, interview, 2010).

Component 1 and 3 provide monetary returns such as the utilization of tramline and prevention of leakages in the drinking water system. On the other hand, Component 2 does not provide any monetary returns. However, overflow protection is of prior concern for all city-dwellers (Bilgili, interview, 2010).

The objectives of Component 2 are (1) *the establishment of overflow section*, (2) *the construction of 24 vehicle and pedestrian bridges* over the Porsuk, and (3) *The renewal of irrigation channels*. The surveys carried out revealed the fact that the *existed bridges*were not resistant to moderate earthquakes. Before 1999, Eskişehir fell within the 3rd degree earthquake zone; however, parallel to changes in the earthquake map of Turkey in the aftermath of 1999, Eskişehir was placed in the 2nd degree earthquake zone. The reinforcement of bridges is of essential importance in order to avoid interruptions in the transportation flow at the time of an earthquake. The access to emergency response institutions such as hospitals, police, and fire department must remain uninterrupted.

Before the project, *the irrigation channels* had lost their water carrying capacities, the bottom had been loamy and the groundwater liquefaction had caused problems. Also, the urban area had been facing with water leakage induced problems. The irrigation channels gained certain section and underwent landscaping works. In order to prevent post-earthquake landslides, bored piles were erected horizontally on the sides of the Porsuk bed as part of the *establishment of an overflow section*. In the densely inhabited region of the city centre (in-between Ali Fuat Bridges and Tabakhane Bridges), *rectangular piles* were built. In the uninhabited areas, the riverbed was reinforced with *blanket cabion* (blanket cabion refers to a steel case system with which the sides of the river are filled with stones with certain slopes) (Bilgili, interview, 2010).

The Porsuk is also planned to use for boat transportation; however, it is used for touristic trips currently. The water level structures including boat transfer system were built. There are eight water level control structures. By bloating water at these eight points, an appropriate water level is created along a 10 km course. A grit arrester was built in the source (Bilgili, interview, 2010).

Figure 6.33 A View from Porsuk River in the City Centre

Source: Produced by the Author

The discharge points for sewage and rainwater in the city seemed untended, unaesthetic and dirty. Therefore, all the lines within the Porsuk River were closed and sewage and rainwater systems were re-constructed. Rainwater tunnels were built on both the left and right side of the Porsuk River. With respect to bridges, the following work was carried out:

1. Bridges, non-existing though included within the reconstruction plan, were built,
2. New bridges were constructed in the densely populated regions,
3. Non earthquake resistant bridges were demolished and new bridges were built instead.

In materializing these works, full compliance to the regulations concerning elder and disabled people was observed (Bilgili, interview, 2010).

In various parts of Eskişehir, particularly in the city centre, there are slopes conforming to the standards for the disabled. All the pavements belonging to the EGM are *provided with slopes for the disabled*. A particular attention was paid in order to ensure that the slopes, lifters etc. conform to the standards. Tram is a 100% low-based system with level that is suitable for wheelchairs and strollers. In 2004, the International Union of Railways (IUR) awarded the grand prize to the tramway system of Eskişehir (Bilgili, interview, 2010).

Thanks to the project, which is about to be completed, the sludge was extracted from the bed of the Porsuk River and precautions were taken against the risk of liquefaction of ground. Landscaping works were performed on both sides of the completely cleaned riverbed. The bridges over the Porsuk determined to be non-resistant to even 6,5-scale earthquake were renewed, some bridges were reinforced and 24 new bridges were constructed within the scope of the project (EBB, 2010).

Figure 6.34 A View from Porsuk River in the City Centre
Source: Produced by the Author

In the scope of the project, in addition to wide-scale arrangements made with an eye to clean the Porsuk River and to *reduce disaster risk*, there are also certain arrangements and works to benefit from the river in urban transportation, as is the case with the developed cities of the world. A facility was built under the auspices of the Municipality and the production of boats and Venice-like touristic gondolas was commenced. The facility is not only limited to Eskişehir, but also receives orders from across Turkey and abroad (EBB, 2010).

The mayor of the city states that the restoration of the Porsuk has started to pay off and that the river has turned into an alternative mode of transportation for the city's residents. Boats run a distance of 10 kilometers on the Porsuk. The docks on the river by monitoring the water levels were made and the sluices (for the boats) using hydraulic doors, which are water elevators in a sense, were made. The boats enter certain pools and rise to higher water levels to continue on their way. When the pool empties the water, the boat continues on its way at lower water levels (Yüzbaşıoğlu, 2009). Yet, the boats are not being used for transportation; they are being used for touristic trips in the spring and summer.

Additional *flood beds were added* for times of disaster. The areas of the riverbed that had been filled to create space for parks were emptied and old canals were restored. A total of 26 bridges were built over the Porsuk. The river's threat to nearby building foundations was eliminated by the new concrete covering. The river was opened to boats and gondolas. Finally, in order to create Turkey's first artificial beach, 5,000 tons of sand were brought to Eskişehir from Ayvalık (Yüzbaşıoğlu, 2009).

The land of the current beach was previously a sugar beet farm belonging to the Sugar Plant. The *'Kent Park'* project was implemented by transforming an area of 300 thousand m² into a green area. In the framework of Kent Park, like in its European examples, a tributary of the Porsuk was projected to serve as a beach during the summer months. An open Olympic swimming pool with a depth of approximately 1,5 m was built within the Kent Park in the Gökmeydan Neighbourhood of Eskişehir. Afterwards, urban homesteads, restaurants, bridleways, walking paths with tram-like buffets and monuments were built. So the first artificial beach of Turkey rose from the ashes of a beet farm (Tunalıgil, 2009).

According to the mayor, "Just like the Porsuk, a stream runs through Strasbourg where similar islets are formed. It is a long stream with locks. Boats go into certain docks, are lifted to upper water levels, and proceed on their ways. At certain places or turns, the boat goes into docks. Water is discharged and the dock descends to a lower water level and the boat continues its journey. In Turkey, these mechanisms were first used in Eskişehir" (Tunalıgil, 2009). Below, the main problems and solutions developed for the Porsuk River are described.

Table 6.6 Problems and Solutions Related to Porsuk River

Problems	**Solutions**
• With the late 1960s, transforming Porsuk River into an *open sewer* owing to industrial and household waste discharged. • The Stream, running through the city, also caused certain ground liquefaction induced *hazards* for the basis of surrounding buildings because of water leakages.	• A wide-scale project including the cleaning of riverbed, landscape planning, and renewal of old vehicle and pedestrian bridges and measurements aiming at reducing the risk of disaster was prepared and incorporated into the Greater Municipality *Urban Development Plan* of Eskişehir.

Table 6.6 Problems and Solutions Related to Porsuk River continued

	• Thanks to this project, which is about to be completed, the *sludge was extracted* from the bed of the Porsuk River and *precautions weretaken against the risk of liquefaction* of ground. *Landscaping* works were carried out on both sides of the completely cleaned riverbed. The bridges over the Porsuk determined to be nonresistant to even 6,5-scale earthquake were renewed, some bridges were reinforced and 24 new *bridges were constructed* within the scope of the project.
• The Stream posed *overflow risk* for the city due to the fact that some parts of its natural bed were filled by the former municipality administrations to the end of creating parks.	
• Porsuk River was reported to be one of the most ***polluted*** waters of Europe in 2002 by the Organization for Security and Cooperation in Europe (OSCE).	• In the scope of the project, in addition to wide-scale arrangements made with an effort *to clean the Porsuk River* and to *reduce the disaster risk*, there are also certain arrangements and works for river trips. The river was opened to boats and gondolas for recreational purposes.
• Porsuk River was not to be used as a source of domestic water supply. Springs and groundwater were drawn on for this purpose until end of 1990s.	• A facility was built up under the auspices of the Municpality and the *production of boats and Venice-like touristic gondolas* was commenced. The facility is not only limited to Eskişehir; but also, receives orders from across Turkey and abroad. Turkey's first *artificial beach* was created along Porsuk within Kentpark area.
• The river is unsuitable for fishing as well due to its polluted state.	• Additional flood beds were added for times of disaster. The areas of the *riverbed that had been filled to create space for parks were emptied* and old *canals were restored*.
	• The river's threat to nearby building foundations was eliminated by the *new concrete covering*.

Source: Produced by the Author

To sum up, the works performed by the municipality in Eskişehir with respect to the Porsuk River involves the

- renewal of pedestrian and vehicle bridges,
- transportation on the stream,
- overflow protection (Space was created on both sides of the river for flooding),
- establishment of green areas without filling the river,
- pavement of water tunnels,
- open-space planning for the integration of the city and the river,
- construction of Sarısungur Dam for domestic water supply,
- start of the construction of new wastewater treatment plant,
- revision of EWSAdomestic water supply system,
- demolition of some of the production plants around the Porsuk,
- removal of illegal housing from the area surrounding the river,
- clearing of a distance of 9,5 kilometers covered with mud,
- construction of concrete galleries measuring 2 m^2 on both sides of the river, etc.

6.4 Accessibility of Porsuk River, and beyond It Evaluation of the River-City Integration

The Eskişehir Greater Municipality (EGM) focused on an individual-oriented urban transportation and prioritized the pedestrians under the Urban Transportation Plan. The urban transportation plan assigned to the Istanbul Technical University by the EGM was prepared by emphasizing comfortable transportation of people to the forefront. It is underlined that the pedestrians will be given precedence on the grounds that the prioritization of vehicles in the city centre with dense pedestrian traffic reduces the quality of life. Due to the fact that the light rail system, known as the ESTRAM, became the backbone of urban transportation, the two principal avenues within the city centre were closed to the vehicle traffic and pedestrians were prioritized ("Yayalar Kenti Eskişehir", 2009).

The *Light Railway System of Eskişehir (ESTRAM)* occupies an important place in the public transportation network of the city. Entering into service in 2004, the ESTRAM is composed of corridors; such as Social Security Institution (SSK) Hospital - Coach Station, and the University of Osmangazi - Muttalip (The Concert Hall of the EGM), and two principle routes intersecting at the business centre of the city. The light railway system was designed so as to enable its interoperability with the existing mass transportation system. Accordingly, it is envisaged that in parallel to the improvement of the public transportation quality, demands for mass transportation will increase. In this respect, it is projected to cancel the parts of existing bus and minibus routes serving on the same route with the light railway system, and to terminate their routes at the new public transport hubs. The Es-Boat service operating on the Porsuk River (from the blue bridge located on the Atatürk Avenue to the Tepebaşı Municipal building) during summer and spring is another public transport option.

In general, it may be concluded that Greater Municipality has given priority to passenger centered inner city transportation and to pedestrian walkways. The transport plan commissioned by the EGM to İstanbul Technical University has been prepared with priority given to the comfortable journey of the citizens. The light rail tramcar system is a ground level system providing easy in and out access for wheelchairs and baby carriages. It is also underlined in the plan that in the city centre, the existing dense pedestrian traffic is to receive priority as the reverse would degrade the quality of urban life. As ESTRAM became the backbone of the inner city traffic, two main avenues in the city centre were closed to vehicles and were pedestrianized (“Yayalar Kenti Eskişehir”, 2009). Slopes have been added to the sidewalk ends for wheelchairs and baby carriages in all the streets under jurisdiction of the EGM. Attention was paid to build these slopes, elevators and other similar gadgets according to international standards.

The ESTRAM won the ‘World Rail System Award’ granted by the International Association of Public Transportation (UITP) in 2004 (“Eskişehir Tramvay Hattı”, 2011). The factors that pushed the ESTRAM project over the top involve urban sustainable development planning, the rail system solution for a sustainable transportation, system design, the cutting-edge technology and environmental quality management. The ESTRAM was certified to TS-EN ISO 9001: 2000 in 2007 (ESTRAM, 2008).

Figure 6.35 Eskişehir Tramway Routes Map

Source: ESTRAM, 2008

Besides ESTRAM, another significant plan of municipality is *Kent Park*. In Kent Park, an affluent of the Porsuk is separated from its main bed about 100 m, and it forms a beach. The surrounding of the given affluent will be transformed into an artificial park. Thus, adorned with sand, beach chairs and umbrellas, it will give the sense of seacoast for the dwellers of Eskişehir. Middle-aged and elderly people all learnt to swim in the Porsuk, and now this function will be restored. The residents of Eskişehir will have the opportunity to sunbath and relax here as the water of Porsuk is treated before accessing this affluent.

The *Espark* is one of the important focal points in Eskişehir. It is not situated on the side of the Porsuk (Mut, interview, 2010). The Pub Street also falls aside the project area; however, it constitutes the part of tramline and recreation potential of the Porsuk. The cafes and restaurants are parts of the project; despite the fact that the Pub Street is not involved therein, the works commenced concurrently with the Porsuk and developed on their own (Mut, interview, 2010).

Most of the streets are easier to access and pass through over 24 bridges along the 12 km project area. There is no difference between streets situated on both sides of the river and the streets on the river itself. Rebuilt bridges and new bridges including pedestrian bridges, provide key linkages between the two sides of the river. The line adjacent to the river is an important route in the Eskişehir urban area. This way, the settlements along the river are accessible

In an interview, the mayor of Eskişehir says that Eskişehir had to be raised to the level of contemporary European cities. Bridges over Porsuk are to remind the viewers of Paris and the view of boats sailing on the river leads viewers to assume themselves in Strasbourg. When gondolas are built in the city, dockyards will start to sail on Porsuk, which will remind of Venice. The mayor adds that, an urban river that flows about 12 km. through the city should also be used for transportation and they built excursion boats for aesthetic and social purposes after the rehabilitation of Porsuk River and its environment (“Eskişehir Avrupa Kenti Olacak”, 2008).

In Eskişehir, the Chamber of Architects criticizes the mayor and asserts that aesthetics of the rehabilitation of the river should have been allocated to the Chamber of Architects. The president of the Eskişehir Chamber of Architects also emphasizes the contemporary importance of identity of the city and its achievement through building of urban image (Şenyapılı, interview, 2011).

The mayor verbalizes this criticism in an interview as the eternal conflict in this city is related to its identity. Is this city a university-city or an industry-city? Both the administrators and the city itself have not been able to resolve this question. A new identity, namely the European city, was adopted for the city whereas it was possible to develop an original identity. There are now imitated bridges, statues and ornaments like the balustrades on Porsuk, in the center of the city. Actually, these products seem eclectic. To relate all theirrelevant statutes or lighting elements is problematic. The aesthetic issues in this city can and should be resolved by the architects and urban designers (“Eskişehir Avrupa Kenti Olacak”, 2008).

In the schemes produced to evaluate the integration of the Porsuk River, the following are considered:

- The functions on/above/near/adjacent to the river which the city uses in harmony with the nature of stream; such as parks, squares, bridges, public transport stops, restaurants and cafes, shops, and adjacent neighborhood residential sites.
- Special uses on/above/near/adjacent to the river which build the image of the city, such as museums, bazaars, sculptures, historical/artistic bridges, and special architectural buildings and elements.
- The connection between the stream and the main urban elements; such as city's main parks, main squares, main public transport stops, main residential districts, main cultural centres, and main shopping centres.

The existing urban pattern at the Eskişehir city riverfront, connections to links, such as the public transport network, connections between streets, public squares or gathering places, public transport nodes, main cultural and historical sites, leisure activities, recreation areas, and cultural buildings, such as museums, etc., are examined. (See Figure 6.47 and Figure 6.48 for details).

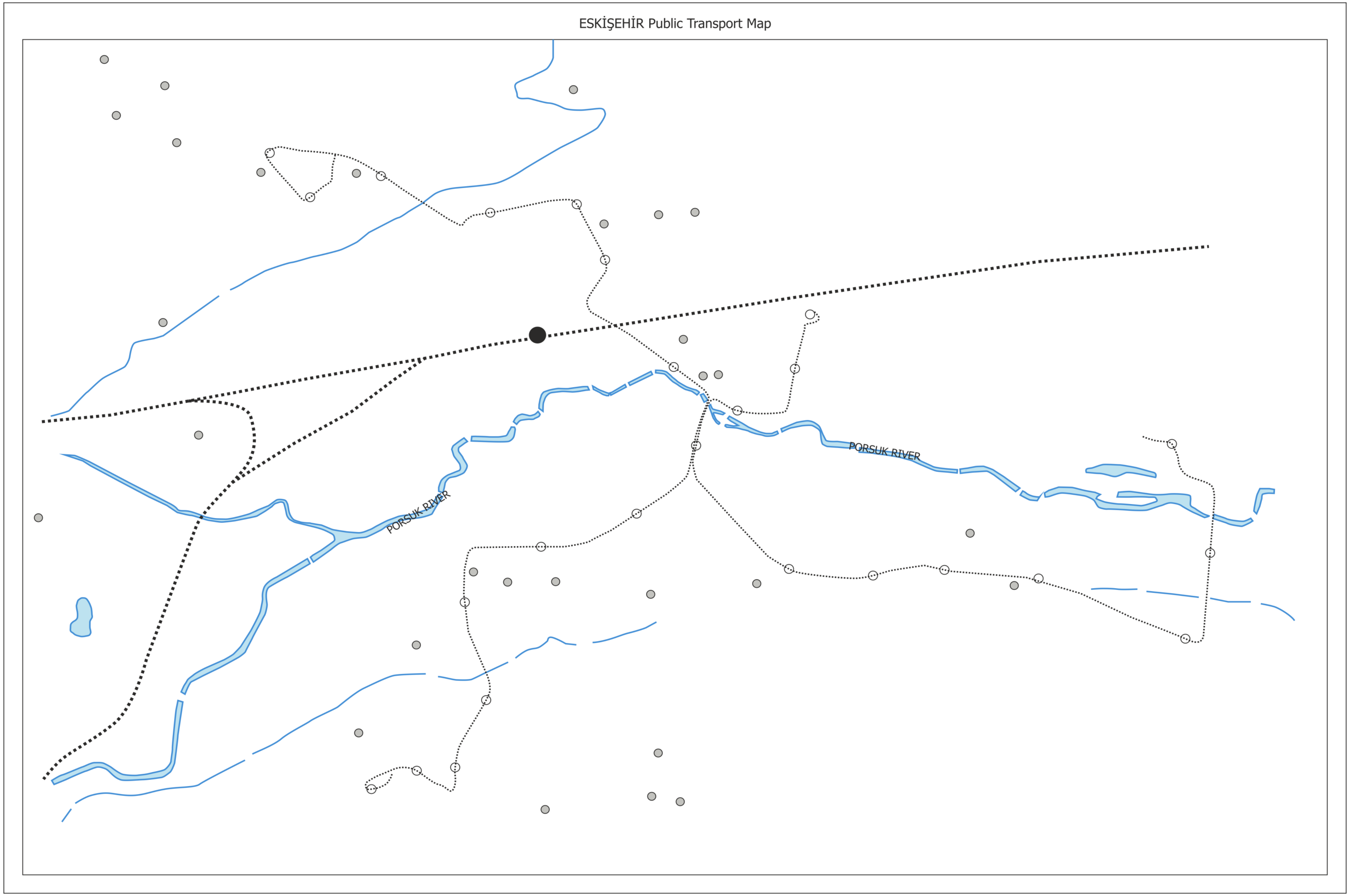

Figure 6.36 Public Transport Lines in City of Eskişehir & Porsuk River

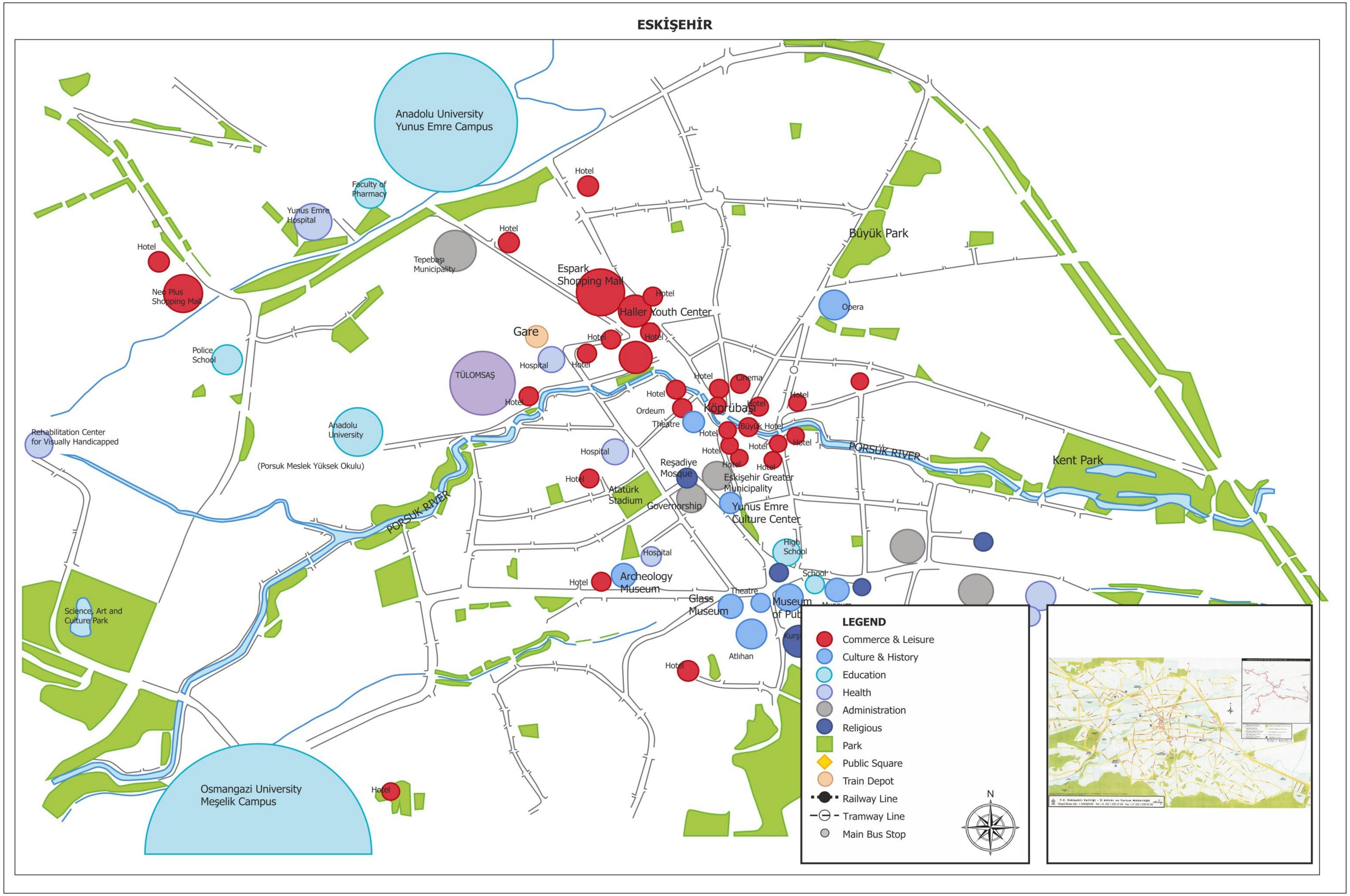

Figure 6.37 A Sketch on City of Eskişehir & Porsuk River

6.5 Conclusion

As discussed in this chapter, the city of Eskişehir has a close relationship with its river throughout its history. The inhabitants Eskişehir have always been intertwined with the Porsuk, and the river has always been an important part of urban life. With the 2000s, the years of the Porsuk River rehabilitation, Eskişehir drew public attention. The river itself and the city with its focal assets are rediscovered now. Within this backdrop, the implementation of the urban development plan depends on the most in particular; before performing restoration works on a stream running through the city, it is necessary to consider whether the given stream has a place in the history of the city (awareness) and has a utilization potential. The pulse of the city needs to be felt and its story needs to be heard. Succeeding in the rehabilitation of a river depends on primarily, the place of the river in city culture, and the people's awareness about the river.

The rehabilitation project on Porsuk River was completed within three and a half years. The mayor of Eskişehir tates that the Porsuk now attracts the attention from some Turkish cities and even from abroad (Yüzbaşıoğlu, 2009). As the arrangements involved the city centre, the mercantile establishments in the vicinity and thus, the economy, were boosted. Further integration was achieved between the Porsuk River and city centre.

Within these viewpoints, Eskişehir Porsuk River Case is evaluated according to the criteria determined in Chapter 4 for *compatibility of ecocity*, and criteria determined for *compatibility of river and city integration* in the next section of the thesis.

CHAPTER 7

EVALUATION OF PORSUK RIVER AND CITY OF ESKİŞEHİR IN THE FRAMEWORK OF THE STUDY

The rehabilitation of Porsuk River and its surroundings in Eskişehir bear similarities with the best practices. Its harmony with the trams and the formation of recovery spots in the surrounding of the stream can be cited as examples. In this Chapter, Eskişehir Porsuk River Case is evaluated according to the criteria determined for *compatibility of ecocity*, and criteria determined for *compatibility of river and city integration*. (See Chapter 1.4.1.3 for the research design of the case study). The experience of city of Eskişehir helps to test the criteria sets accepted as guidelines, and help to improve its performance as a significant case.

7.1 Testing the Ecocity Criteria in the City of Eskişehir

Criteria related to technical measures to rehabilitate and upgrade the river and the urban water system those within the framework of ecocity are evaluated in this section. Through the document reviews, observations, and deep interviews; firstly, fulfilled criteria in Eskişehir are listed and explained, then partially implemented ones are held and finally non-implemented ones are indicated in the following sections.

7.1.1 Implemented Ecocity Criteria

Cleaning of Waterway from Pollutants

Porsuk River, born in the Murat Mountain, flows from the north of the city of Kütahya to the Porsuk dam. From the dam on, Porsuk flows through Alpu and Polatlı borders and converges with Sakarya River. While flowing through the north of the city of Kütahya, Porsuk was polluted by the wastewaters of the nitrogen factory, which were emptied into the river without being treated, along with the household wastes of the city that were also not treated

(Bektöre, interview, 2011). At present, there is a wastewater treatment plant in Kütahya built in 1992 but it still does not work at full capacity (Özyurt et al., 2004).

With the onset of the 1980's, the wastes of industrial plants like Sümerbank, TÜLOMSAŞ, household wastes and street runoffs started to flow into the Porsuk River. The river became so polluted that the popular saying was that the daily color of the river reflected the color of the textile produced in Sümerbank factory that day. The pollution, in time, not only degraded the quality of the water of the river but also caused silting up of the riverbed. The problem became more acute in time and the smell and the slime disturbed the environment. When dam lids remained closed algae increased and as dam, lids were opened, mud mixed with the water (Bektöre, interview, 2011).

During 1980-2000 period, the pollution in the river reached extremely high levels. It was even suggested then that the river be taken to underground. With the election of a new mayor, Y. Büyükerşen a comprehensive cleaning process was started. One of the election promises of the mayor had been the rehabilitation of the river. The process gained velocity with the 1999 earthquake. (Bektöre, interview, 2011) Still, the process is not terminated. For example, the sediment pools for the sedimentation of the river bed silt have not yet been constructed near the dam and this is an important shortcoming (Bektöre, interview, 2011).

The riverbed has not been lined with cement but has been lined with a lattice system, which is preferable from the point of view of ecosystem. Since the bottom of the river has not been covered with cement, the water of the river may not seem as clear as that of a still pond. Yet with this project, the problems of existence of algae, smell and flooding have been terminated. Yet, solid wastes on the water of the river still exist and become worse with the increasing number of visitors and tourists in summer, but it is now possible to periodically clean the solid wastes accumulating at dam lids (Bektöre, interview, 2011).

Control of Erosion and of Sediment Deposition

Construction of retaining walls and planting of vegetation have succeeded in preventing erosion along the river. Greater City Municipality has planted trees and grass on both sides of the river also to provide the river with a green belt. Vegetation has also been planted along other running water canals of the city to stabilize the soil. Another ecological measure to prevent erosion, gabion beds have been laid on both sides of the river (gabion beds are hexagonal boxes made of steel woven wire, filled with rocks and stones, cheap to build, have natural look and they prevent erosion of the soil). As mentioned before, construction of sediment pools near the dam to collect river bed sediment have not yet been completed (Bektöre, interview, 2011).

Building of Buffer Zones on Problematic Areas by the River

In the city center, water level regulation structures were built. Reserve space has been created on both sides of the river to prevent flooding.

Rehabilitation of the Rivers, River Corridors

Rehabilitation of the Porsuk river has been realized within the context of the Urban Development Project, which also included rehabilitation along the river banks (Mut, interview, 2010). In 2001, the Greater City Municipality concluded a loan agreement with the European Investment Bank for a package project called the Urban Development Project. The project consisted of three components, namely, the tram project, a project for mitigating the potential damages of disaster and renewal of rainwater, drinking water and sewage lines of EWSA and the establishment of domestic waste treatment plants (Bilgili, interview, 2010). (See Chapter 6.3 for details on the rehabilitation of Porsuk River).

Improvement of Quality of Domestic Water

The clean water treatment plant of EWSA has been renewed and installed with the latest technological control systems. There now exists chemical and economic sterilization measures which evaluate the level of cloudiness in raw water by an online system, or which use median doze equipment. Water depots of water supply and pumping stations have been upgraded. Kalabak drinking water refilling plants have also been rehabilitated in accordance with current technology (ESKİ, 2010).

Rehabilitation of the Infrastructure of Urban Water System

One of the three components of the Urban Development Projects was the renewal of the infrastructure of the water system of the city, like prevention of leakages, building of separate systems and the like. In this context, the old pipes of clean water and waste water have been renewed. The system has been separated into zones for the control and prevention of leakages and illegal uses. Incoming and outgoing quantities of water has been controlled, valves have been renewed, water quality has been upgraded and a treatment plant has been built. In the about 10 drinking water tanks, all the valves have been changed and connected to the electronic system. So, it is now possible to control the existing level of water and manipulate its pressure. The water tanks have also been insulated to prevent losses and water discharge leakages (Yıldırım, interview, 2011).

Sewage lines have also been upgraded and new ones have been laid, thus, the whole city has been connected to the system. The existing wastewater treatment plant has been renewed and a new one has been built. Better quality water is now supplied to the city. Main collectors of stormwater have been built (Yıldırım, interview, 2011).

Building of Wastewater System

In city of Eskişehir, the sewage and rainwater systems are separate. The city has two wastewater treatment plants. The old plant started to function in 1999 and the new one in 2010. Carbon removal is practiced in the old plant, whereas in the new plant, in addition to carbon removal, nitrogen and phosphate removal are also practiced. From the methane gas of the wastes, energy is obtained and used in meeting part the energy need of the plant itself (Kıyak, interview, 2011). This second plant has been installed with the latest technology and is expected to meet the needs of the city up until year 2030 (“Yeni Atıksu Tesisi”, 2010).

Thus, rainwater is not discharged into the rivers but is emptied into the relevant canals. Industrial plants now have their own treatment plants and wastewater personnel control these plants (Kıyak, interview, 2011).

Separation of Sewage and Stormwater Systems

It was already mentioned that the two systems are separate. Rainwater pipes, which are wider than the wastewater pipes, receive rainwater coming down the gratings, and collect them in the tanks. Collected rainwater is transferred to SHW's irrigation canals. The problem is that in times of heavy rain, puddles form on the flat surfaces of the city and may even cause cesspool overflows. At present, the problem is about to be solved since rainwater pipes have been installed along most of heavy traffic roads and rainwater galleries have been built on both sides of the Porsuk River (EBB, 2007).

Mixed Use Planning

Mixed-use provides more social inclusion, liveliness to the areas and revitalizes the city center. It may be asserted that there is mixed-use pattern in the city center and along the main avenues of the city, like Köprübaşı district, where commercial establishments like cafes, restaurants, offices, markets, stores are located along with official services and green areas.

Urban Green

Natural elements like trees, vegetation and grass are necessary to improve climatic conditions, to maintain ecological stability and to enhance the aesthetic value of the environment. Greater City Municipality has succeeded to plant trees and grass along 13 km., which the river Porsuk covers in the city ("Porsuk Nehri Etrafı Yeşilleniyor", 2008).

Transformation of Stream Catchments to Green Parks and Open Areas

Green zones have been built along the banks of the Porsuk River and these zones are accompanied by cafes and tea houses frequently. On edges of the city, in the east-west axis, two large scale, multi-functional parks, Kentpark and Sazova have been built. Of these, *Kentpark* is adjacent to the river and *Sazova* is near the river. In between the two parks, there are potential green areas, which may be developed as picnic areas and active green parks. These areas, which extend from the city center towards the periphery along the river, are open to development by projects that will contribute to the increase of pervious surfaces and per capita green area.

7.1.2 Partially Implemented Ecocity Criteria

Obtaining Energy from Used Water

It was already mentioned that in the wastewater treatment plant energy is obtained by gas generator through methane gas and that this energy is used to support the plant itself (Kıyak, interview, 2011). Thus, by meeting its need for electricity from the wastes sterilized, the plant achieves a saving of 150-200.000 TL per month ("Yeni Atıksu Tesisi", 2010).

Development of Environmental Sensitive Mass Transport Systems

Bus system works with fuel, not with natural gas yet. However, about one third of all inner city trips are made by tramcar and the plan to expand the tramcar system is a positive factor in reduction of carbon emisson. Pedestrianization of the city center, riverside and many of the streets heading towards the river is also a positive contribution to preservation of clean air (Çeçgel, interview, 2011).

Ecological Recycling of Water: Reuse of Stormwater for Garden Watering and Irrigation

It has already been mentioned that rainwater is collected and transferred to SHW's irrigation canals.

Development of Hybrid or Closed-loop Water System

Existence of a separate infrastructural system for wastewater and obtaining of energy from wastewater are characteristics of hybrid or closed-loop water systems. In order that the system be closed, water should be recycled and reused in the system as it is in nature. In hybrid systems, this recycling and reuse are partially realized. Therefore, it may be concluded that the water infrastructure system in Eskişehir is partially closed and so it is a hybrid system.

Mass Transport System, Accessibility of Transport Nodes, and Connection of Various Mass Transport Modes

Eskişehir has been built on a plain, whose basis is of alluvium soil and water table is high. With the added problem of existing infrastructure under the ground, it has not been possible to build mass transport systems underground. Therefore, there was agreement on construction of a light tramcar system. At present, there are two tramway lines, one in the northwest-southeast axis and the other in the northeast-southwest axis. In the city center, the tramcar system replaced the previous heavy car traffic avenue. With the coming of the tramcar, traffic load on this avenue has been transferred to peripheral roads and the avenue has been reserved for pedestrian traffic. Ongoing problems include the failure of integration of tramcar system with other mass transport mode systems. Passengers who need to go beyond the terminal stop of the tramcar sometimes have to take about three other mass transport vehicles. Besides, the existing distance between the tramcar stops and stops of other mass transport vehicles creates a problem of accessibility. Hence, it is now considered to extend the tramcar system to peripheral neighborhoods by the addition of a third line (Bektöre, interview, 2011).

Development of Pedestrian and Bicycle Roads

It was already mentioned that the city center, *Köprübaşı* has been reserved to pedestrian traffic. This area involves a circle of about one km diameter. Only tramway functions in this area. Other main streets like *Doktorlar, Hamamyolu, İki Eylül avenues* up till *Reşadiye intersection*, and *Adalar* district are also reserved for pedestrians (Çeçgel, interview, 2011) So, pedestrian accessibility is high in the city. On the other hand, bicycle lines are limited and may only be provided in the new development areas as existing road system is not suitable for reserving bicycle tracks on the side (Bektöre, interview, 2011).

Provision of Accessibility to Public Spaces that Include Refreshment and Entertainment Facilities like Parks

Accessibility to big city parks has been provided in general although it still requires taking more than one mass transport vehicle. There are two big parks in the city, namelly Sazova Science, Arts, and Culture Park, located on an approximately 280.000 m² and Kent Park located on approximately 266.000 m² area. At present, green area ratio per person is about 8 m² for the city in total and the Greater City Municipality aim is to achieve 15 m² green area per person in the near future (Bilgili, interview, 2010).

Reduction of Carbon Expansion

The municipal agenda does not include a study about measurement of carbon emission ratios (Çepelen, interview, 2011) Yet, since natural gas is being used in the city now, it may be assumed that carbon emission ratios should be less than they used to be in the past. With the investments launched in 2008, natural gas service is accomplished to bring to all streets of Eskişehir. Today, most parts of the city use the natural gas (ESGAZ, n.d.).

Increase in Area of Pervious Surfaces and Decrease in Area of Impervious Surfaces

The importance of this measure has already been discussed in Chapter 2.3. It is necessary that the ratio of impervious surfaces of the city be less than at least 25% for the maintenance of urban running water quality, sustainability of the riverbed structure, protection of river habitat and prevention of erosion. Calculations based on green area maps obtained from EGM indicate that this ratio is greater than 25% for the total of the urban surface in Eskişehir. The ratio goes even higher in the city center and its vicinity. Both large and small green spaces and grassed riverbanks were created on the riverfront within the project area. The municipalities in the area have constructed urban parks such as Kentpark, Sazova Science, Culture and Arts Park, Büyük Park and Şelale Park since 2000. This increase in green space throughout the city, although not in the city center, supports a positive impact for the lesser pervious cover ratio.

7.1.3. Non-implemented Ecocity Criteria

Daylighting of Waterways Taken Underground and integrating them with Green Spaces

Porsuk River has been in luck for not having been buried underground. However, Akar Stream (Yediler Creek) in the city was covered with concrete in the mid-1900s (Kılıç, 1997; Atuk, 2002). Daylighting of the stream is not on the agenda of the city municipalities right now. It is an obvious fact that daylighting of previously buried waterways will bring ecological and other benefits for the city and its residents.

Green Infrastructure Substituted for Concrete Piped (Grey) Infrastructure System

Urban municipal administrations do not have green infrastructure implementations like street-side bioswale, raingarden, green/eco-roof, community garden, stormwater planter, constructed wetlands, and porous pavements on their programs.

Rehabilitation of Inefficient Building Stock in order to Decrease the Carbon Footprint of the City

Carbon footprint in a place is related to the energy consumption of that place. Energy is needed during every kind of treatment related to city building. Water services require energy, as well. Thus, saving water results directly in reducing our carbon footprint as it means cutting the power needed to pump water around. Urban municipality does not have rehabilitation of inefficient building stock on its current agenda.

Decentralization of the Water System to Neighborhoods

Urban municipality does not have such an implementation plan on its agenda.

Development of Rainwater Collection Systems

With the exception of channelization of rainwater to irrigation the urban municipality does not have such a measure on its agenda.

Measures Developed to Decrease Impervious Surfaces in New Urban Plans and Designs

As mentioned above, neither the EGB Department of Development, nor the existing plans have any measures related to this end.

Building of Stormwater Detention Parks

This measure is not included in the urban municipal agenda.

Implementing Planning Practices like Smart Growth to Obtain Compact and Dense Urban Tissues to Achieve Less Consumption of Land, Water and Other Resources

Municipal Development Office and current urban plans do not include the use of smart growth planning practices. Yet, it may be asserted that the city does have a compact macroform. Due to adjacent building style of the city center and its neighboring zones there has been minimum waste of land. On the other hand, this has caused the decrease of permeability of soil and rainwater now goes to the rain water system along with all the debris it collects on its way. This high and adjacent building system also creates pressure on other resources as well.

Projects on Development of Neighborhood Units / Eco-blocks[40] / Eco-buildings That Can Recycle Their Wastes and Produce Their Own Energy

At present, there are no such plans and projects (Bektöre, 2011).

Increase on Importance of Protecting Hydrophilic Habitats like Rivers, Lakes, Wetlands and Groundwater

Rivers, streams, brooks have their own systems and yet, they are parts of bigger system. For example, a negative impact in the upper basin of a water source will be reflected in the lower basin. Therefore, basin lever approach should be taken towards Porsuk River in order that the rehabilitation measures taken should be more efficient and effective. The Porsuk basin has many smaller convergences, many water canals in and near the city, several small lakes, ponds and irrigation dams. Nevertheless, the rehabilitation projects includes only upgrading the part of the river enclosed in the project, upgrading of irrigation canals and raising of the

[40]Eco-blocks are insulating concrete building blocks and they are being manufactured in the presently fastest growing building industry sector. They are manufactured as panels stacked on top of each other during construction and then they are reinforced by steel and concrete. The resultant form is strong, energy efficient and is a good insulator. Eco-block are also used to prevent erosion and deposition in the streets as they hold sediment and leave water to flow.

bottom of the Porsuk Dam. There are no projects for protection and rehabilitation of hydrophilic habitats.

Reduction of Ecological Footprint

Water footprint designates the total volume of freshwater use, its pollution and location of water use. It consists of three components. Blue water footprint indicates evaporation from the global blue water sources. Green water footprint indicates the volume of water evaporated from the global green water resources like the rainwater stored in the soil. Grey water footprint is the volume of polluted water (Hoekstra and Chapagain, 2008). Eskişehir municipalities are not acquainted with this ecological concept but in general, their implementations indicate sensitivity to the environment and resources.

In the table below, the summary of all criteria can be seen.

Table 7.1 Ecocity Criteria Checklist for Eskişehir

Ecocity Criteria	Implemented (√) / Not-Implemented (X) / Partially Implemented (P)
Cleaning of Waterway From Pollutants	√
Control of Erosion and of Sediment Deposition	√
Building of Buffer Zones on Problematic Areas Next to the River	√
Rehabilitation of the Rivers and River Corridors	√
Rehabilitation of Wetlands	X
Improvement of Quality of Domestic Water	√
Rehabilitation of the Infrastructure of Urban Water System	√
Building of Wastewater System	√
Separation of Sewage and Stormwater Systems	√
Obtaining Energy from Used Water	P
Development of Hybrid or Closed-loop Water System	P
Ecological Recycling of Water: Reuse of Stormwater for Garden Watering and Irrigation	P
Mixed-Use Planning	√
Increase in Area of Pervious Surfaces and Decrease in Area of Impervious Surfaces	P
Daylighting of Waterways Those Had Taken Underground, Integrating them with Green Spaces	X

Table 7.1 Ecocity Criteria Checklist for Eskişehir continued

Implementation of Mixed Use Planning Design	√
Mass Transport System, Accessibility of Transport Nodes, and Connection of Various Mass Transport Modes	P
Development of Environmentally Sensitive Mass Transport Systems	P
Development of Pedestrian and Bicycle Roads	P
Transformation of Stream Catchments to Green Parks and Open Areas	√
Reduction of Ecological Footprint	X
Green Infrastructure Substituted for Concrete Piped (Grey) Infrastructure System	X
Rehabilitation of Inefficient Building Stock in order to Decrease the Carbon Footprint of the City	X
Decentralization of the Water System to Neighborhoods	X
Development of Rainwater Collection Systems	X
Measures Developed to Decrease Impervious Surfaces in New Urban Plans and Designs	X
Building of Stormwater Detention Parks	X
Implementing Planning Practices like Smart Growth to Obtain Compact and Dense Urban Tissues to Achieve Less Consumption of Land, Water and Other Resources	X
Reduction of Carbon Expansion	P
Projects on Development of Neighborhood Units / Eco-blocks / Eco-buildings That Can Recycle Their Wastes and Produce Their Own Energy	X
Increase on Importance of Protecting Hydrophilic Habitats like Rivers, Lakes, Wetlands and Groundwater	X

Source: Produced by the Author

7.2 Testing the Integration Criteria in City of Eskişehir

Findings derived from observations, document reviews and deep interviews those aim to est the integration criteria can be grouped as following:

- Considering the relation of river to the city during rehabilitation process – considered aspects
- Setting cooperation with stakeholders such as NGOs and Chambers
- The present image of the river – Positive (+ in which aspects) / Negative – (+ in which aspects)

- Priorities for entering into a connection with the city
- Considering public transportation (such as light rails, tramways, buses etc.), and accessibility
- Considering the parks, green areas, and recreation areas
- Considering building density
- Sufficiency of pedestrian access (both riverfront parks and other big parks)
- Considering to improve bicycle access
- Existing or created accountable institution / agency / corporation / partnership for urban river
- Rehabilitation projects implemented for the urban river

7.2.1. Opinions on What the Riber-City Integration Is

Besides the questions for criteria checklist, the questions aimed at to understand how the experts see and define the river-city integration issue are asked as well. Before analyzing the ctireria items, the opinions on these are indicated in the section below.

Definition of the Integration of an Urban River and the City

It may be defined as the integration of the river with all aspects of urban life and appreciation of the river by citizens as they live and move in the city. If citizens identify the city with the river and visa versa, if the river has become part of their daily lives, if they enjoy and utilize the river, and protect it while they utilize it, if the citizens consider it as one of their 'shelters' in the city where they find peace and therefore feel the need to protect it and use it with utmost care, then the river may be considered well and closely integrated with urban life. Functional use of the river by the citizens involves a phase of integration. Another consideration is how those who visit the city for short periods of time would approach and evaluate the river is. In short, to achieve integration, the river should not remain as an disfunctional element but should be used actively and become a living organism of the city. In this sense, the river should be perceived not only as a landscape element, but should possess functional processes (Dinç, Çekin, interviews, 2011).

The Image Recalling of Urban River and Its Integration with the City

Concepts and images recalled are harmony, unification, contribution, consciousness of being a citizen, life giver, comforter, a new life, identification of love for the environment with love for the people, global citizenship and desire by the citizens to pass most of their free time near the river. The concept reminds me of river being integrated especially with the social life of the city and attribution of an identity to the city in this sense (Dinç, interview, 2011).

Measures That Should be Taken to Provide This Integration

First of all consistent, effective and sustainable planning strategy is necessary. The canal where the river flows should be opened to public after the necessary protective measures are taken. Citizens should be introduced to different aspects of the urban river by directive visual data, short lectures, examples from other countries and the like, with which they will learn and become familiar with the urban river and its functions. The environs of the river and activities to take place there should be analyzed effectively. It is also important to raise awareness of people. To this end, relevant agents and organizations should work in cooperation, like SHW, municipalities, NGOs, State Agricultural Works, State Forest Administration, volunteers and the like. Through a poll study, opinions of the residents should also be taken. In short, the river should definitely not be left to the nature but all measures to incorporate it to urban life should be taken. So, the river should be designed as an area where several different urban activities are performed including transportation. Urban waters should be an integral part of the open green area system (Dinç, Güngör, interview, 2011).

The Ways of Integration of An Urban River and the City

Feasible structuring of the spatial relation of different urban land uses with the river reguires to provide clean waters, to care for the river, to teach people how important it is to be conscious of existence of this specific body of river right within the dense pattern of the city itself and ways of enjoying and using it in the proper way so as to preserve it for future generations as well. Again, care must be taken for raising the awareness of the public. Different means and ways of accessibility may be provided for different social groups and different urban function through integration of different transport modes. This integration may be achieved when the river takes its place in the economic, social and recreative functions of the city with emphasis. Equilibrium between use and protection should be provided and environmental threats should be eliminated. The user group should be correctly identified and activities proposed should answer social needs of the citizens and should provoke interest. So, in integration the needs of the city should receive priority but care must be taken not to devalue other advantages of the river (Solokoğlu, interview, 2011).

The Components of the City Which Should Receive Priority in Provision of Accessibility to the River

Recreation areas, playgrounds, residential neighborhoods, rehabilitation areas, different areas like industry and commerce and areas where activities are concentrated should be connected. Especially nearby areas and areas along the banks should be integrated. It is also possible to implement extraordinary projects. Actually, the whole city must be integrated with the river.

A Sufficiency Condition of Provision of Accessibility for Achievement of a Feasible Level of Integration

It is not possible to force the integration of an area to the city by just providing accessibility, if it is not adopted and embraced by the citizens. First, the citizens should adopt the areas and demand for accessibility. Besides provision of spatial accessibility, consistent and coherent reasons should be introduced to motivate people to use this environment. It is also vital to provide care and security in these areas (Dinç, interview, 2011).

The Meaning of Provision of Spatial Accessibility to the River

Reaching the river in safety, in an acceptable time period and with ease and not only by private cars but also by mass transportation. Citizens should be able to reach the river when they feel the need for it according to their purposes. Vehicular accessibility should be provided as well as pedestrian accessibility. Use of the river should not be under the monopoly of certain agencies but should be open to benefit of the citizens (Çekin, interview, 2011).

The Feeling about an Approach Involving Integration of the Urban River with Historical, Cultural and Contemporary, Image and Identity Giving Assets of the City in Which Combination the Urban River Becomes a Reference Focal Attraction Point

Such an approach should be adopted when planning the city. Naturally, it is of utmost importance to connect the assets, which give identity to the city with the urban river through modes of accessibility. Such an approach would also stimulate the adoption and use of these areas by the urbanites. Water has always been a source of attraction for the people. Flowing waters were the main recreation and entertainment areas in the Ottoman cities. In this sense, it is important to support the attraction of the city center with the existence of the water body. To this end, the provision of pedestrian and vehicular passage over the water will enhance structuration of internal urban connectivity. The city is a living organism in total, so, urban elements, which may seem very different from each other, do affect and influence each other. Although it may seem that the river has a close connection to its immediate environment, actually it is related to the total of the city. The integration involves a design problem and should be defined, verbalized and solved within the context of special and unique conditions of each city. Therefore, there may not exist a single design solution that would fit all (Dinç, interview, 2011).

Achieving Level of This Integration in the City of Eskişehir

The Eskişehir case has been quite successful. Important urban functions are concentrated around the Porsuk River, gastronomic services in the areas are feasible, the riverbanks are safe, people can comfortably move on these banks, enjoy the environment and fulfill their needs. Visitors to the city also mention the fact that Porsuk River has been actively integrated to the city from the point of view of recreation (Güngör, interview, 2011).

It is interesting to note that all the interviewees expressed the importance and the need for the integration of the urban rivers with cities. Yet, in most cases this integration was limited to (1) limited to the immediate environment and banks of the river and (2) to accessibility, defined as quick and easy access to the river. However, it was also interesting to see that the concept developed in this study enclosing the historical, cultural, contemporary assets of the city with the urban river in such a way that make the river the focal node was accepted with appreciation, which is promising for development and upgrading of the urban ecology and urban assets. After reviewing the opinions on river-city integration, the next section is on the evaluation of the integration criteria under the headings of implemented, partially implemented and non-implemented ones.

7.2.2. Implemented Integration Criteria

Achievements of the Present Image of the River

The present image of Porsuk is mostly positive. When past status of bridges on Porsuk are compered, it mat be said that the project is successful in term of functionality; on the other hand, it receives criticism especially for aesthetic side of the bridges. The reasons for the criticism of architects concerning bridges are that every bridge has a different architecture, colour and they are actually imitations of bridges in specific European countries. In terms of urban planning, it can be seen that there is no design integrity and urban furniture integrity. It would be better to try to maintain the integrity of the bridges and other urban furniture designs with the city itself. Yet, when the successful aspects are considered, Eskişehir Porsuk project can be model for the cities in which rivers flow (Bektöre, interview, 2011).

Building Intensity in the City

With the urban plan of Polat Sökmen in 1986, attached building application has begun. Since then, the centre and its environment have been surrounded by 8-floor attached buildings. In Eskişehir, 60-70% of housing is attached housing. There is 8-floor housing in main roads while it is 4-5 floors in side streets. The building intensity is very high in the city centre due to the share parceling from past to present. For example, while it has about 7 construction area ratio in the city centre, this number is much higher than the average examples (around 2-3) from other city centres (Bektöre, interview, 2011).

Parks and Green Spaces

Until 1970-80s, there were 6-7 open air summer theatres, 2 big parks, 2 big tea gardens on the side of Adalar and along the area from Atatürk Road to bus terminal. Today, the city has few green spaces between barriers and roads. Back then, tea gardens and pastries placed their tables on the green areas and people sat on those areas. The present walking area in Köprübaşı was a tea garden in the past (Bektöre, interview, 2011).

The Municipality of Odunpazarı has accomplished many projects. Şelalepark, which is within the responsibility area of Municipality of Odunpazarı (Yeler, interview, 2011), is the most significant example of these projects for green areas around the Porsuk (Bektöre, interview, 2011).

Other than Porsuk, the irrigation channels are also important water surfaces the in city. EGM tries to integrate these channels with Porsuk by creating green areas around those channels (Bektöre, interview, 2011).

The parks which the EGM is entitled to take care are those of 30 decares and above. The parks around the Municipality ofTepebaşı and Municipality of Odunpazarı are excluded. The bands around Porsuk are under the responsibility of EGM. The area of responsibility covers a region of Sazova Park and around Kent Park because the planning border is between those areas (Yeler, interview, 2011).

Sufficient Pedestrian Access

It has already been discussed within the Chapter 7.1. Some of the integration criteria overlap to the ecocity criteria such as this one.

Mixed-use Urban Pattern

There is a mixed usage in city centre since there are cafes, restaurants, markets, offices, stores, various shops, houses (Bektöre, interview, 2011). This criterion has already been mentioned more detailed in Chapter 7.1.

7.2.3 Partially Implemented Integration Criteria

The Priorities for Entering into a Connection with the City and the Phases Were Passed during the Connection Process

With the rehabilitation project, green bands, barriers were constructed on the sides of Porsuk. While people might sit next to the Porsuk at the water level in the past, now this is not possible. Porsuk can be seen and walked by from a distance. In other words, people can sit at a specific distance toPorsuk although this is something that isolates people from it. Porsuk is separated with green bands from its surrounding close to the road. The mayor explains that this is to prevent littering into the brook. Yet, public wants to have a closer relationship with Porsuk, hence, it would be better to lift the barriers in order to enable public utilisation. Having said that, as people drop litter to Porsuk shores in Adalar region, it is possible to observe that this is an obvious threat with this high visitor number (Bektöre, interview, 2011).

If Köprübaşı is considered as the centre, the inside of a circle with a diameter of 1 m is tried to be non-vehiclized. For example, Doktorlar Avenue (or İsmet İnönü-1 Avenue) is closed to all vehicles, except the tramway. An other example can be Hamamyolu Avenue, which is only open to pedestrians. Vehicles cannot pass beyond Reşadiye intersection. Also, there is no vehicle entry to Adalar district (Çeçgel, interview, 2011). Some of the bridges on Porsuk are for vehicles and some for only pedestrians. Featuring pedestrian bridges in Adalar, where pedestrians pass the most, has relieved the pedestrian traffic.

Restorating of Odunpazarı houses and renovating and providing new functions to historical buildings in Odunpazarı neighborhood belong to the Municipality of Odunpazarı. People can reach Porsuk from Odunpazarı houses easily by following Hamamyolu Avenue (Bektöre, interview, 2011).

Building of Public Spaces along the River

Greater City Municipality is responsible for green parks over 30 acres with the exception green parks in Tepebaşı and Odunpazarı municipalities. The zones on both sides of the river are within the jurisdiction of the Greater City Municipality that extend up to the Sazova and Kentpark vicinity as the planning boundary covers this area (Yeler, interview, 2011).

Riverbanks are closed to traffic. In the past people did not use the banks of the river as they were frequently flooded and there was a disturbing smell coming from the river. In the Adalar district, first floors of buildings were used as depots or as doorkeeper housing only. Today, as the river has been rehabilitated, the banks are used as pedestrian walkways, and restaurants and coffee houses are located along these banks (Bektöre, interview, 2011). At certain locations along the river, small quays provide boat and gondola service. Yet certain parts of the river environment are still to be developed like Çukurçarşı district where the depots, small industrial estates and car parks remain along with desolate vacant spaces. Transformation of these areas is now on the agenda of the municipality.

Removal of Water Banks and Separations along the River to Establish the Connection of the River to its Immediate Vicinity

Within the context of the project green zones, a pedestrian road and banisters have been built along the river removing the possibility of approaching the river without any impediments. So, the river has been separated from its immediate environment with the green band and the pedestrian road. The river can now only be approached up to a certain distance and this causes separation of the public from the river. This separation has been planned in order to prevent throwing of wastes and garbage to the river but the public wish is to be closer to the river. It is a fact that near the Adalar, garbage and wastes are dumped at the riverside which increases at times of crowds visiting the site (Bektöre, interview, 2011).

Public Transportation and Accessibility

Eskişehir is a city established on a valley, the basis of which is alluvial. When you dig the ground, after 2-3 metres, you encounter water. Also, there are too many infrastructure lines underground. These two factors increase the investment cost, thus, people did not go underground during the construction of rail system. Besides, there is no sufficient passenger density in Eskişehir that is necessary while deciding to construct an underground light rail system. Therefore, it was decided to develop tramway lines. One tramway is approximately for 300 people with a departure frequency of every 5-6 minutes. There are two tramway lines in the city as north-western-south-eastern axis and north-eastern-south-western. The tramway line was put through the city centre. Today, the road which tramway passes through was a busy road in the past. The traffic load on this load was transferred to ring roads and the road was pedestrianized with the tramway. However, the transferred roads may get stuck at some certain points since the planning to suburbs was not well done (Bektöre, interview, 2011).

Tramway and other public transportation networks were not integrated well. Tramway goes to certain points in the city and passengers need to take other transportation vehicles to reach some destinations. This means that the number of vehicles that some passengers take may go up to 3. In addition, there is a distance between tramway stops and most stops of other transportation vehicles; which consequently makes transportation more difficult. As a solution of this, EMM considers expanding tramway lines through suburbs and up to 3 routes (Bektöre, interview, 2011).

7.2.4. Non-implemented Integration Criteria

Taking into Account of the Relation of the River and the City during the River Rehabilitation

Until the 1970-80s, sightseeing on sandal over Porsuk River was a part of city life (Bektöre, interview, 2011).

In 1980, the cleaning of sludge at the bottom of Porsuk Brook was performed. A road was opened across Adalar for the trucks to pass in order to clean the brook basis. Later on, this area expanded part by part (Bektöre, interview, 2011).

By the 1980s, the wastes of industrial enterprises like Sümerbank, Tülomsaş, domestic wastes and rainswepts from urban areas began to mix with Porsuk. The negative effect of industrial wastes was high; such that it is said that the colour of Porsuk was in the colour of clothes manufactured at Sümerbank. This contamination caused not only a water degradation of Porsuk but also colmatage at the bottom. Such problems continued increasingly every year; the smell, sludge and the like started to disturb people. While the dam shutters was closed, mossing was increasing; when they were opened, sludge was mixing with the river (Bektöre, interview, 2011). In the past, no one would like to live near the Porsuk River due to flood (Bektöre, interview, 2011).

Between 1980 and 2000, Porsuk was in its most contaminated shape, namely it hit the bottom. In that time, there were recommendations for closing the top of brook. After the local elections in 1999 when Büyükerşen was elected as a mayor, the rehabilitation process was begun. One of the promises of Büyükerşen was the rehabilitation of Porsuk River. Following the 1999 earthquake, the rehabilitation project that was under consideration was speeded up (Bektöre, interview, 2011).

Until the 2000s, current cafes and restaurants of Adalar were depots, housekeepers' apartments and so on. Generally the ground floors of buildings were exposed to flood and the smell of the river was incredibly disturbing. As the project Porsuk was completed, the utilities in Adalar were transformed into cafes and restaurants (Bektöre, interview, 2011).

When the utilities on Porsuk are considered at the point of establishing a link with city, the project allows sightseeing tours on boats and gondolas. Construction of additional ports at the areas along Porsuk where the population density is high would be beneficial (Bektöre, interview, 2011).

The most vivid parts of city are *Adalar district, Doktorlar Avenue and Hamamyolu Avenue*. At eastern part of Adalar, around Çukurçarşı and beyond the old municipal building, Porsuk was improved and green bands were built (Bektöre, interview, 2011).

With the project, city centre and Adalar which is the district surrounding Porsuk had a resurrection. This resurrection is not only by the interest of city people but also by the guests coming from uptown. There may be 20-30 different tourist groups in summer time in Adalar (Bektöre, interview, 2011).

In the past, the bridges on Porsuk River had a spring shape structure that was unique in Turkey. The architecture of bridges was original; however, it was not possible for a handicapped and an old people to use. Moreover, when it snowed it was posing a threat for all pedestrians since it got frozen. While EGM renovated the bridges within the concept of Project Porsuk, it did not apply such a spring form. The Municipality provides straight crossings, stairs at the bridgeheads together with ramps for handicapped in compliance with standards (Bektöre, interview, 2011).

Participation of Stakeholders such as NGOs and Chambers to the Project

There was no cooperation with such institutions and organizations during the project and no partnerships occurred. The municipality neither referred to the public participation nor the reviews of chambers and NGOs were collected during the urban improvement project (Mut, interview, 2011).

Improvement of Bicycle Access

There is no place to maintain a bicycle path in the centre and most of the periphery of Eskişehir since the roadway width is not sufficient. However, the EGM is planning to set bicycle paths in new boulevards and roads (Çeçgel, interview, 2011). Although it is prohibited to ride a bicycle along Atatürk Avenue, a bicycle path of 250-300 meters was built on the sidewalk that is in front of the Hava Hospital (Ulsever, 2010).

In the Eskişehir Metropolitan Municipality Transport Master Plan Final Report, the plan forecasts were assessed and bicycle paths were planned in phases by taking the current situation, future envisaged potential bicycle attraction areas and intensity areas into consideration. The objective is to realize the Bicycle Master Plan in a 20 year period and this period is staged in 5 year terms (Gerçek and Demir, n.d.). Nevertheless, since the roads constructed as pavements were not suitable for bicycle transportation, nothing could have been done yet (EBB, n.d.). In order to bring bicycle, which was a significant element of transportation in Eskişehir until the recent past, back, a proper model may be developed after the applicable principles in bicycle friendly European countries are be reviewed.

Coordination of the Stakeholders and of the Responsible Institutions at Project and Catchment Level

Stakeholders in the Porsuk river project are the EGM and EWSA. Citizens, NGO's, chambers of relevant professions have not been included in the project. Yet, it may be asserted that the project has received full moral support of the citizens (Bektöre, interview, 2011).

It may be asserted that technical rehabilitation measures for urban rivers existed and were implemented long before the concept of ecocity was introduced and these measures were improved as technology developed with the innovations. The revolution that was caused by the ecocity concept is inclusion of these technical measures in a complex framework, in close interaction with the city and with the urban ecology in general. Urban ecology in this sense signifies healthy, efficient and beneficial coexistence of living and nonliving organisms. Evaluation of the urban river and water system rehabilitation process in Eskişehir shows that with the change in municipal administration, a radical technical upgrading has been achieved in the state of the river and the domestic and drinking water system of the city, which in turn shows how effective and decisive the urban administration can be.

On the other hand, the ecocity principles related to the city and ecocity principles not yet implemented show that in Eskişehir, the rehabilitation process has not yet been handled in an ecocity comprehensiveness. Some of these principles have been implemented because they are logical derivatives of river rehabilitation and they have been limited to the immediate vicinity of the river, like opening of pedestrian and bicycle roads, transformation of the banks to green parks, removal of banks and separations along the river, building of public spaces, provision of accessibility. The ecocity principles not yet implemented which include basic ecocity concepts like ecological footprints, coordination among stakeholders, development of ecosettlements/buildings, eco-blocs, design of the macroform to achieve most of the ecocity principles underline the above evaluation.

It is interesting to note that the city administrators and planners interviewed also admit their lack of detailed knowledge of this concept in the projects. Yet, the staff and the citizens which have achieved so much in such a short time and are aware and proud of it are likely to adopt the ecocity concept and catch up with and fullfill the requirements and combine what has been done with the new projects to set a new model for the country.

Table 7.4 Integration Criteria Checklist for Eskişehir

Integration Criteria	Implemented (√) / Not-Implemented (X) / Partially Implemented (P)
Achievements of the Present Image of the River	√
Taking into Account of the Relation of the River and the City during the River Rehabilitation	X
Participation of Stakeholders such as NGOs and Chambers to the Project	X
The Priorities for Entering into a Connection with the City and the Phases were Passed during the Connection Process	P
Public Transportation and Accessibility	P
Parks and Green Spaces	√
Building Intensity in the City	√
Public Spaces along the or Accessible to River	
Sufficient Pedestrian Access	√
Improvement of Bicycle Access	X
Coordination of the Stakeholders and of the Responsible Institutions at Project and Catchment Level	X
Mixed-use Urban Pattern	√
Removal of Water Banks and Separations along the River to Establish the Connection of the River to its Immediate Vicinity	P

Source: Produced by the Author

7.3 Results and Evaluation

Urban rivers are one of the major, and in certain cases, the major urban element that play the major role in the transformation projects. This attitude shows the changing role of the urban river from an unwanted, polluted urban element, which may even be better if it disappeared i.e., buried under ground and a hazard to public health, to its present role, where the river is a contribution the major attraction to the city.

Today, rivers may not continue their vital roles because they are polluted and covered up in the last decade. The fact today is that there is a need to rehabilitate the rivers in cities. If they are not rehabilitated, and the focus continues to be on sprawling out to the suburbs and to our rural areas, then we will fail to perform the mission of those cities, which depends on rivers for economic, health, aesthetic reasons. This mission is significant for us also our next generations. So, this is not just related to bring back the rivers into green spaces.

It has already been mentioned that urban administrators aim to raise the capacity of their cities through projects involving upgrading of infrastructure system and rehabilitation of infrastructural elements, eradication of low-income neighborhoods, renewal of certain urban neighborhoods, creation of gentrification areas, returning old abandoned industrial properties to productive use (brownfields), and creation of spectacular, specialized centers. All these projects aim to achieve a radical change in urban imagery the image of the city in general. In this process, all urban elements are revalued, as it is the case in the city of Eskişehir. It is also achieved an enhanced quality of life through the implementation of the mentioned transformation projects.

In this chapter, the ecocity criteria and integration criteria developed are tested in Porsuk River and the city of Eskişehir. It is observed that many of the criteria has been implemented or partially implemented besides some lacking ones. The details on these matters are summarized in the conlusion chapter. As for the sets of criteria, some local criteria may be added them while evaluating different cities. The relationship between a river and its city in the history of that specific city should be included to its criteria list. As an example, in the city of Eskişehir, the criterion of ‘removal of separation elements along the riverbanks is added to list in consequence of the relation types of the river and its citizens in its history.

CHAPTER 8

CONCLUSION

Urban rivers have always been functional and even determinative elements in the evolution of urban history. As reviewed in detail in Chapter 2, urban rivers have been one of the most important decisive elements of urban development in three different stages. In the first stage, namely the Neolithic stage, which signifies transformation from migratory to sedentary way of life with domestication of plants and of animals, abundant, flowing, clean water was one of the main supports of life and civilization. Water also provided easier protection and/or an escape route from enemies. The second stage, flourishing Neolithic settlements into civilizations also depended on development of irrigation, reservoir, and water management techniques. Navigable waterways provided channels of communication, transfer of knowledge, information, art, culture and enrichment of civilization. They also served as channels for trade, maintaining economy and enlarging its hinterland to include hitherto unreachable resources. They enabled empires to feed large populations and armies.

During the times when the highyway system was not developed as today, rivers constituted the principal trading routes. On that account, trade contributed to the development of cities situated by the rivers in two aspects: (1) the provision of the required products through the river and the sale of those produced goods in other cities by the riverside; (2) as the cities by the riverside are significant destination points and service stations in general, toll can be claimed both for accommodation and service and over the transported goods. The best example for the latter is the city of Lyon, which is located at the intersection of two rivers uniting the central areas of Europe and the Mediterranean, and thus was settled by the Italian sericulturists and transformed into a silk production center. The cities established by the side of long streams flourished and developed in the first half of the Middle Age. Therefore, most of the examples were taken from the European cities situated nearby the long streams.

The other peculiarity of cities by the riverside is the fact that they can develop dual structure in the course of time depending on the using patterns. Besides their favourable contributions such as providing drinking and potable water, and irrigation; they could threaten urban life due to floods and careless use of water. The increase in the population of cities by the riversides owing to the economic attractiveness of rivers also increases the land need for the development of agriculture and stockbreeding leading to lumbering and consequently landslides, which result in the elevation of riverbeds and therefore floods. The production units, farms and cities established by the riversides as a result of population growth and reckless use of rivers caused severe pollutions by discharging their wastes into the water. Almost all examples suffered from the same problem.

The payback for the careless and unplanned use of urban rivers came on and was added to the most common and dangerous natural hazard related to running waters, floods particularly during the Middle Ages. So from ancient times on people had learned to cope up with floods by building canals, levees and dikes. However, pollution and contamination which caused epidemics through the use of water could not be solved in an era where medical and sanitary knowledge was limited. Increasing population of settlements, development of riverside industry, location of warehouses and loading docks in addition to river commerce, stormwater runoffs, toxic wastes, human and animal wastes, deliberate dumping of trash and wastes onto primitive and limited infrastructure turned urban rivers into open sewers and garbage channels. Developing urbanization and increasing rent on urban land were added problems leading to paving over rivers, imprisoning water flows to channels or to underground. In some cities the settlement chose to develop and expand in the opposite direction leaving only production near this source of pollution.

Towards the end of the 19th century and during the first half of the 20th century development of technology and science led to *rehabilitating* of rivers. This process was mainly based on cleaning of the water, its bed and upgrading of the immediate vicinity and was limited to the river itself. The restructuring of rivers were brought to the agenda since the river pollution and overflows in the late 19th century and during the 20th century demonstrated the scale of problems they would cause. The interventions were put into practice with the features of (1) being technical-oriented and (2) only involving the river and riverside. The watercourses of rivers were arranged, high benches were built on both sides, their flow was altered and taken into the canals, their beds were dredged and artificial islands and peninsulas were formed on some of them, dams were constructed and they were even brought underground. All these works aimed at restoring and preserving the natural structure of the river and transferring it on to the next generations. It was noted that most of the examples underwent the mentioned phases and were subject to these measures.

The maltreatment of urban rivers, once their life building and location provision functions were overcome, was discussed in the study. It was underlined in this discussion that the maltreatment and mistreatment of urban rivers had reversed their main life giving function to life threatening impacts and epidemics. Planners and urban administrators responded to the impairment and ruin of this uniquely valuable component of nature by piecemeal and rehabilitation measures. It is asserted in this study that rehabilitation of rivers has been reserved to the river itself, and its banks, the aim being returning of them to their natural state and to create soft urban edges from them. In this rehabilitation process engineers who bring in the essential and current technology worked alongside with hydrologists, landscape and river ecologists who contribute to sustainability of the interrelationship between different habitats of flora and fauna that exist in the river and its wetland. The urban planner and designer has also been involved in the process especially from the second half of the 20th century and mostly contributed to provision of accessibility between the river and different residential neighborhoods in the city, with the densest locations receiving priority.

The concept of rehabilitating evolved with the 2000s and its content got enriched. The new concept; though involving technical measures, is not only focused on the river and riverside but also concentrates on the restructuring of the river within the scope of and concurrently with the city. A river is no longer a flowing component which should be cleaned and restructured separately. It has become an integral part of the city which requires to be restructured in line with the city. During the same period, the concept of *ecocity* came to the forefront among the concepts regarding the future of cities and city planning. The concept of ecocity refers to the utilization of urban resources, including urban rivers, in a manner to improve the life quality both for natural and built environment. Today, urban planning, developed under the name of structural and political plans, intend to materialize the ecocity objective or to improve the urban eco-system levels. Currently, it does not simply aim at improving the eco-system of the river; but also restructuring the ecosystem of the river in a manner to improve that of the city, as in the case with the city of Zurich and many others.

In this respect, this thesis centers on urban rivers and proposes to analyze urban rivers and their rehabilitation within the context of the changing approaches and implementations.

Urban rivers are different from other rivers in the nature as they are connected and related to human behavior and human processes. Sustainability of urban rivers depends on the living organisms, in particular citizens as urban inhabitants, and their environment. The focus here is on the intersection between urban planning and water systems. To be discussed are water sensitive cities, water as a design element in the city, water for pleasure and well-being, and interactions with other infrastructure systems. City planners and other expert dealing with water will highlight the need for and benefits of involving water at an early stage in city planning.

In this process, many of the urban elements such as *focal points* have been 'rediscovered' and are treated both individually and in total. The historical settlement neighborhoods, which in the past have been neglected and turned into transition sites, are now being evacuated, upgraded, provided with increased accessibility, connected to other urban elements. Large green parks are being redesigned, enriched with additional facilities and are connected to urban transportation network. Pedestrian walkways, cycling paths are created with recreational and entertainment facilities. It is asserted in this study that one such *rediscovered urban element is the urban river*. So, this study proposes that the concept of urban river rehabilitation be enriched by introduction of two sub-concepts; ecocity and integration. Rehabilitation was discussed in terms of technical aspects evaluated within the context of ecocity (as the most developed eco-based approach for cities) principles and in terms of integration with the city itself, which was discussed with the point of view of urban planning, relating the process of rehabilitation to the city itself.

As the deficiencies of traditional ways of rehabilitation are discussed at the beginning of the thesis, the rest of the thesis focuses on the new approaches that would unite natural and manmade environment on a common denominator. The system concept helps us recognize that there are connections between functions in a coherent structure (Lein, 2003). A river itself is a dynamic system, which has its own homeostasis, a city itself is a dynamic system as well, and beyond that, they both are parts of an interrelated dynamic system as well. Moreover, river and city can be interrelated because both of them are open systems.

The assertion at this point is that rivers in the urban areas are also different from rivers in the nature, as the former has to *coexist* with the human society, therefore, has to conform to human behavior the tempo of daily human life, the types of human activity, and with the human ideas of refreshment and aesthetics. The latter, on the other hand, has to conform to the dominant rules of nature.

Urban rivers are unique urban elements and unique natural resources. They are different from the built-up urban environment. They are also different from other urban natural elements like green areas, trees, and even lakes which cannot exceed certain sizes if they are in the city and not outside of it. It is possible to have a large green park, a large afforested area or a lake, but there is always a limit to their size as they should not function as dividing elements that inhibit accessibility in the city. If they do so, the macroform moves away from them, keeping them as refreshment areas at the periphery. Urban rivers are different; they may flow all along within the city and traverse the city so they exist within the city and with the city. They provide *a life axis* with its special biotic eco system to the city. They are large scale, impressive, aesthetic and functional natural urban elements like no other.

It was stated that the relationship between urban rivers and urban structure can appear in three manners: rivers can divide cities into two equal parts or unequal parts, and pass by the city borders. The sample portfolio included in this chapter comply with the first two items. The rivers that ran through the cities and thus were required to be removed from detrimental substances were subject to technical restructuring. Pursuant to their sanitization, bridges were constructed over them in order to connect the both sides of the city, and roads were built in order to provide access to the rivers. Notably, during the 1990s and 2000s, the approaches to urban and urban planning as well as the urban management altered.

The assumptions of the discussion, in summary, involve the multi-dimensional impact of urban rivers on respective cities, whose rehabilitations are bought to the priority agenda of local administrations. It is the assertion of this study that this rehabilitation process should go beyond the treatment of the river as a pleasant urban element and should embrace the city’s cultural and historical heritages along with contemporary urban works that give identity and image to the city. Urban river when planned and rehabilitated in conjunction with these assets of the city would become a part of the urban image. In this sense, it will not only be a spectacular edge that extends along the city but it would constitute *a reference* itself planned together with the cultural, historical and contemporary aspects of the city.

Urban rivers have particular importance in this respect. To begin, they form an integral part of the history of cities. Secondly, throughout their flow along the city, they create various panoramas and establish different relations with the city and citizens at different points. Finally they provide recreation functions and a unique natural environment within the city. However, as can be noticed in the given examples from the portfolio, it does not suffice to 'unite' some of the components bestowing attraction to city and identifying it. The purpose is to interpret these components together with the living within the scope of changing and evolving mutual relations, and in this respect, to reevaluate the spatial behaviours of people vis-a-vis these particular values and to reinterpret the historical areas, important museums, historical and cultural monuments, key centers and large park areas in terms of rivers, the pivotal natural resource peculiar to the city. Here, a reference can be made to the project dated 2003 in Rome aiming at restructuring and integrating the Tiber River with the city. The project underlines and targets *'bringing the city to the river again'* (See Chapter 5.3.9 for the details).

In the context of this new approach, the components bringing attractivity, characteristic, image and identification to the city are correlatively oriented to the rivers. This *orientation* is highlighted by pedestrian zones, subway and/or other public transport nodes. The recreation areas, historical/cultural monuments, trading areas displaying local or global patterns on and/or by the riverside further enrich the image of the city. Thanks to this integrated interpretation, a person visiting, for instance, a historical place can easily access to other urban components and rivers through transportation facilities such as pedestrian zones or public transport. People can watch these views both from specifically designated spots such as the Michaelangelo Square in Florence designated as a viewing spot for river and the opposite side- Michelangelo Square in Florence) and on boats travelling through the river. The latter is underlined in the publicity texts about the city.

It is also asserted in this study that with the transformation in global socio-economic and cultural structure, the approach to urban administration and urban planning have been changed from second half of the 20th century on. The late 19th century and early 20th century city with a single dominant cultural and commercial center, homogeneous zones, well-defined suburbs and steady decline in land value away from the center has now been replaced by a multi-nodal urban structure with spectacular and specialized centers, specialized zones like high-tech corridors and socially and economically fragmented suburbs with fluctuating land value away from the center. This transformation brought new approaches and new definitions to urban concepts. Urban development is no longer defined through economic development but through quality of life and solutions are searched from bottom up. For the urban administrators, it is now important to create cities which have attractive, high quality life images and identities which would not only increase their competitive advantage in the national and global investment markets but would also increase their status in the minds of the residents, stimulating them to identify themselves with the city, protect and invest in their city.

In this new urban administration and planning approach to the city which is observed in the transformation, gentrification, modernization, upgrading work are going on in the cities along with increasing service standards. All these studies depend on the existing resources, economic, social, cultural, political but also on natural resources of the city, among which the urban river with its unique characteristics, its differences, its functional potentials, with its provision of a healty ecosystem to the city and in essence, provision of one of the most important life sources is obviously the most spectacular natural resource that exists in the city. So, it is asserted at this point that rehabilitation efforts aiming at technically controlling and monitoring the river and upgrading it aesthetically are not sufficient to fulfill the contemporary requirements demanded from the city for its wellbeing and upkeeping in the national and global investment markets and also for it to be equipped for being a passage to future generations.

It is therefore proposed that the rigorous technical protection and improvement measures implemented so far should be reversed and the context of rehabilitation should be enhanced by creative approaches. The approach proposed in the thesis may be summarized as the urban river, with its ecosystem, should be integrated with *the built-up component* of the city and with *the living component* of the city. This approach will be reflected to bring into being *the coexistency of river and city*.

Components of built-up environment which contribute to urban culture, to urban identity may be classified as historical sites and buildings, cultural buildings, cultural artifacts, modern architectural buildings housing modern functions, centers and green areas. They usually occupy point locations and are distributed in the city unrelated to each other. So, in order to reach one from the other, directions will have to be asked for or a guide book has to be referred to and still the visitor has to find out the way or the vehicle to take by himself/herself. It is interesting to note that, like the urban river, these components are rehabilitated, upgraded, gentrified, modernized in their own contexts by the relevant experts and planners. The expectation from the urban plan, which, by its nature, encloses them all, is provision of accessibility mostly between some of them and residential areas.

These *focal elements* of the city should first be integrated with each other and secondly they should be integrated with the most unique natural element and axis of the city, the urban river. This integration should be planned and designed with the urban river taken as the basic plan and design reference as observed in the cities included in the portfolio. In this way, it will be possible to create a new conceptual center integrating cultural, historical and natural assets of the city around the urban river. This center may be enhanced and crystallized by pedestrian and/or vehicular transport systems, allocation of a specific vehicle functioning only in the center, specific sign systems, specific street furniture, refreshment and open air and closed entertainment facilities distributed within the system, information facilities all leading to the urban river and to its facilities, the most important of which is the river riding and viewing the city from the river point of view.

The proposal at this point involves a new concept of center, at the time when most urban centers, if not protected especially, have turned into vehicular junctions. This new center is not location specific, does not enclose a point spot, is not bounded in its location, and does not contain homogeneous usual central functions. It is a conceptual center, encompassing the whole of the spectacular, unique, appealing, attractive assets of the city worth beholding, exhibiting, taking to national and global markets for attracting investors and visitors, and worth presenting to the citizens for creation of stronger bonds with the city to be proud of. The focus of this conceptual center is the urban river and the transport mode, pedestrian and/or vehicular, that encircles the center, unified with the ride on the river which closes the movement circle in the center.

It is also important to take concomitant administrative measures. First of all formation of this conceptual center and readjustment of movement channels to it require both a specific administrative unit empowered by the necessary authority and also participation of the public in all stages. Urban land involves rent which brings along speculation and brings planners and administrators in confrontation with the real estate people and entrepreneurs. In general, it is observed that this confrontation results in backing up of the administrators and allocation of urban space to those who can pay the hightest rent for it. This confrontation result can be reversed only with local support if not with prohibitions or with force, however, the former is often violated, and the latter is neither suitable nor acceptable in the contemporary democratic society.

In order for the public to support the new rehabilitation concept embracing the cultural and historical assets of the city and arranging them as a center with the river as *its focal reference*, certain measures should be taken. First of all, the public should be enlightened about the relevant concepts (the watershed area, ecosystem, ecological restoration, differences of urban river from rivers in natural state, water systems in the city and their function). In most water sensitive cities, waterworks museums have built which displays stages of provision of water to the city, in other words, displays the water contribution/provision/consumption history of the city and of the region. People are informed about dire and life threathening consequences of mistreatment and waste of water. Consciousness developed about dangers of using running water as waste and garbage canals and about the citywide positive impact of improvement of river ecosystem. As the public becomes sensitive to environment and river ecosystem, they can back up the administration and the NGOs.

Within the context of discussions conducted in the conceptual framework of this study, two key criteria lists were developed, one for testing the *ecocity* concept and the other is a list and visual data to see the degree of *integration* achieved with the river and other cultural and historical assets of the city. The lists aim to find out whether or not river rehabilitation exceeds the context of the river itself to enclose the city as well. Both lists and visual data have been tested on the *city of Eskişehir*, which has rehabilitated the river Porsuk successfully so as to make it the symbol of the city, unifying the image of the river with that of the city and identifying the city with the river. This is an interesting achievement for a city which has been known as the industrial center of the Turkish Republic throughout the past years up till the rehabilitation of the river. The rehabilitation process has changed the image of the city from the industrial center where even the first national car was manufactured by a national technical crew into a pleasure and service center in accordance with the contemporary urban values and concepts.

The testing of the rehabilitation process to check whether or not it conforms to the ecocity principles has revealed the fact that the technical aspects of the ecocity principles have been implemented. The domestic water, drinking water and wastewater systems in the city have been separated and enclosed in sanitary, modern and contemporary technical setups. Yet, it may be asserted that technical rehabilitation measures for urban rivers existed and were implemented long before the concept of ecocity was introduced and these measures were improved as technology developed with innovations. The revolution that was caused by the ecocity concept is inclusion of these technical measures in a complex framework, in close interaction with the city and with the urban ecology in general.

On the other hand, the ecocity principles related to the city not yet implemented show that the rehabilitation process has not yet been handled in an ecocity comprehensiveness. Some of these principles have been implemented because they are logical derivatives of river rehabilitation. However they have all been limited to the immediate vicinity of the river, like opening of pedestrian and bicycle roads, transformation of the banks to parks, building of public spaces and provision of accessibility. The ecocity principles not yet implemented which include basic ecocity concepts like ecological footprints, coordination among stakeholders, development of eco-clusters/blocks, design of the macroform to achieve most of the ecocity principles underline the above evaluation.

The integration concept includes cultural, historical and modern assets unique to the city, unified in a conceptual center of functional continuity, emphasized by transport modes and/or by other design elements used to lead, people to the focal point of this conceptual center, the urban river. To check this functional continuum in space arranged around the focal points of the urban river, a key list and visual analysis have been developed. The river rehabilitation process implemented in Eskişehir has shown that the link with the river and the city has been limited to increase the attraction of the river. Some examples include cruising of different types of vessels including some unexpected ones like the gondolla, existence of bridges which are copies of well known bridges of different cities of the world and which therefore display different styles, are of different colors and perhaps are a bit skewed due to modification in scale, plus existence of statues and other street ornaments and provision of accessibility as much as the frozen built up area allows. Therefore it may be concluded that integration with the city is reserved to creation of a new, unprecedented, impressive and attractive reference element in the city which would draw everyone to itself and facilitation of accessibility so that those drawn by this attraction would be able to reach it with ease.

On the other hand, as mentioned before, city of Eskişehir may be considered as one of the open-air museums of industry of the Republican period in Turkey. In fact, several of relics dating from earlier years of industrial dominance of the city are preserved as monuments in the city, and some of the earliest heavy industry factories of this country are located there. Besides, the city is also famous for its best quality meerschaum dressing (lüle taşı) products, which are exported providing considerable export income for the city. The city is also known as an education center. In addition to the two universities and one of the most important schools for aviation education, most of the economic base income of the city comes from Open university. There are also two large-scale green parks in the city. So, in other words, the city has several unique cultural and historical assets, which are as much worth visiting as the river yet they are dispersed in the city unrelated to each other. A visitor, even if s/he has information about their existence, will have to ask for his/her way to reach one from the other. Hence, integration with the city enclosing a wider range of the city's unique assets beyond provision of accessibility from the near environment is lacking, the exception of the city centre.

What has been achieved by the rehabilitation process of *River Porsuk* obviously cannot be ignored and deserves merit. Yet success achieved so far should be enhanced and contextually expanded to enclose the other assets of the city to provide a unified and rich identity to the city. This study argues that such a comprehensive, integrative, structural, policy and strategy laden aim cannot be fulfilled by municipal administrations but it is the realm of planning which may construct the interrelational network, support it with relevant design, build the equilibrium among stakeholders, reverse the planning process to rising from bottom up with rule of law, equity, transparency, consensus and accountability. Just as the changing organization of concomitant concepts, the urban planning context should also be reviewed and redefined to include new concepts and integrative ways to reach and link these concepts.

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APPENDIX A

URBAN POPULATION AND TOTAL POPULATION IN THE WORLD AND IN TURKEY BETWEEN 1950 AND 2010

Table A.1 Urban Population and Total Population in the World between 1950 and 2010

(Units: Thousands of People)

	1950	1960	1970	1980	1990	2000	2010
World Urban Population	736.796	996.298	1.331.783	1.740.551	2.274.554	2.853.909	3.494.607
World Total Population	2.535.093	3.031.931	3.698.676	4.451.470	5.294.879	6.124.123	6.906.558
Percentage of Urban Pop.	29,06%	32,86%	36,01%	39,10%	42,96%	46,60%	50,60%

Source:Produced based on UN ESA, 2008

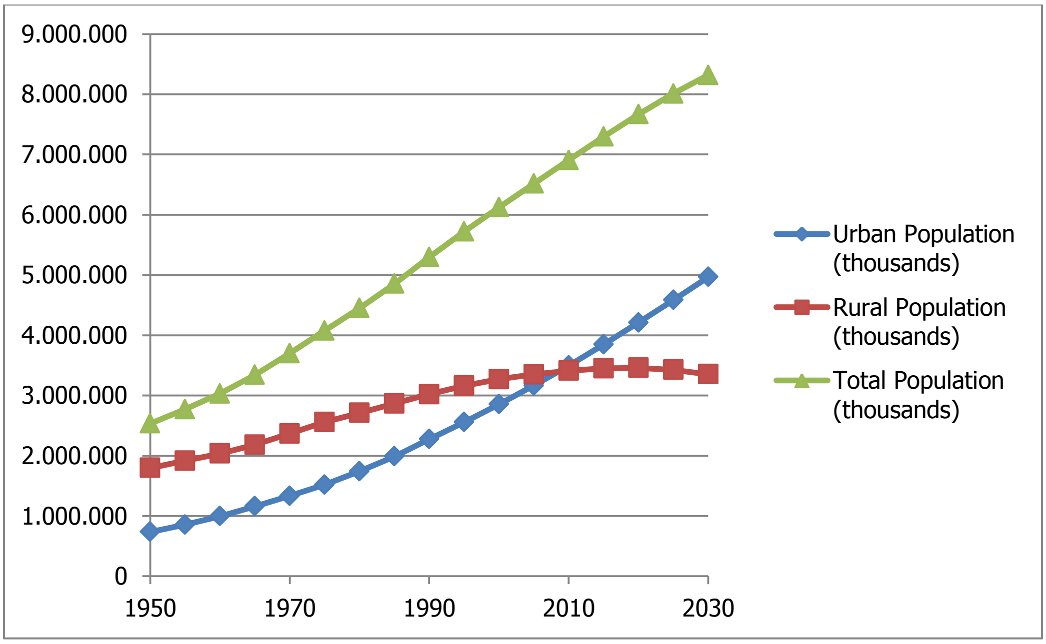
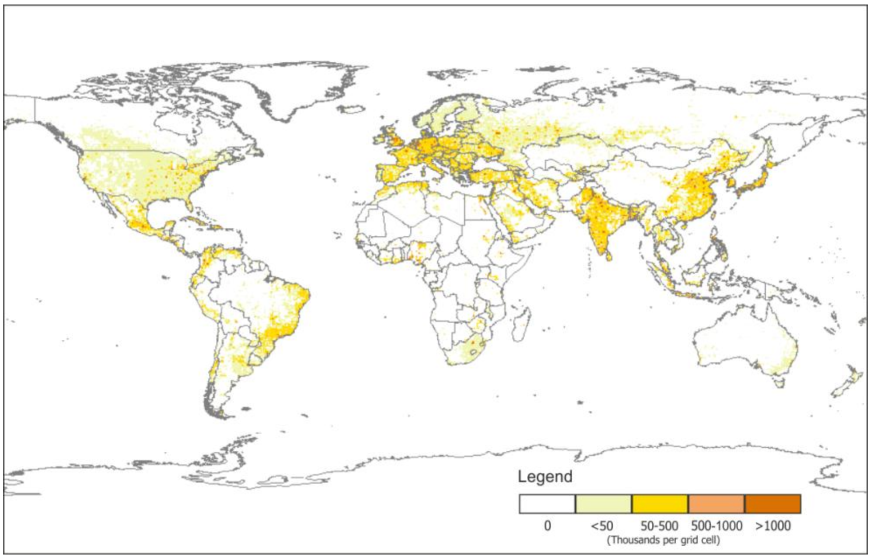


Figure A.1 Trend in Urban and Rural Population between 1950 and 2030 in the World

Source: Produced based on UN ESA, 2008



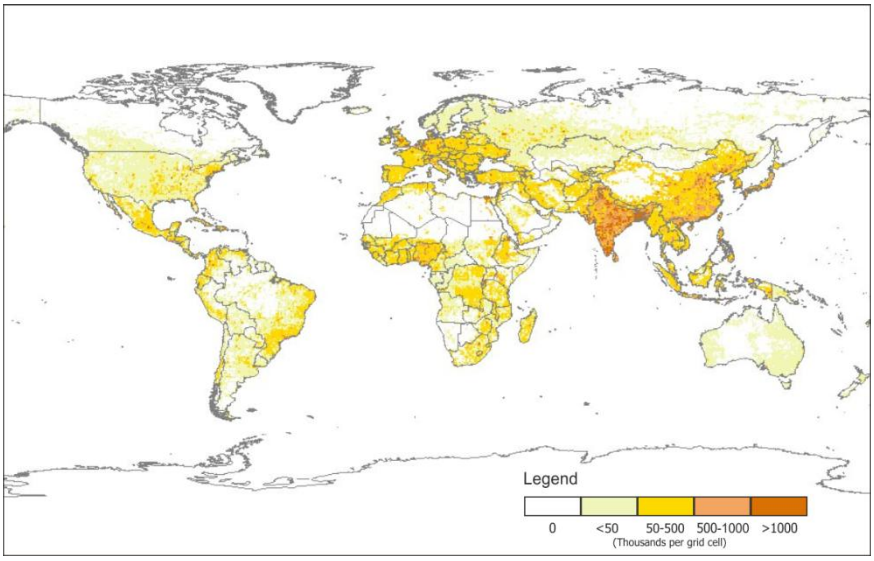


Figure A.2 Distribution of Urban Population and Total Population in the World, 2000

Source: GWSP IPO (1), n.d. and GWSP IPO (2), n.d.

Table A.2 Urban Population and Total Population in Turkey between 1950 and 2000

Turkey	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**
Urban Population	5.244.337	8.859.731	13.691.101	19.645.007	33.326.351	44.006.274
Total Population	20.947.188	27.754.820	35.605.176	44.736.957	56.473.035	67.803.927
Percentage of.Urban P..	25,04%	33,69%	38,45%	43,91%	59,01%	64,90%

Source: Belgenet, 2002

APPENDIX B

MILESTONES OF WATER-RELATED GLOBAL EVENTS SINCE 1972

Table B.1 Milestones of Water-Related Global Events Since 1972

Date	**Event**	**Output**
1972	UN Conference on the Human Environment, Stockholm	Need for a common output to inspire and guide the people of the world in the preservation of the human environment: -Action plan for the human environment -Educational, informational, social and cultural aspects of environmental issues have to be faced -Construction of a framework for environmental action -Recommendation for action at the international level -Identification and control of pollution of broad -Declaration of the UN
The International Decade, **1965-1974**	It was launched by the General Conference of UNESCO.	The purpose was to advance knowledge of scientific hydrology by promoting cooperation and by training facilities. "At a time when the demand for water is constantly increasing as a result of the rise in population and of developments in industry and agriculture, all countries are endeavoring to make a more accurate assessment of their water resources and to use them more rationally" (UNESCO, 1979, p. preface).
1977	UN Conference on Water, Mar del Plata	Mar del Plata Action Plan (MPAP)
1981 - 1990	International Drinking Water and Sanitation Decade	
1990	Global Consultation on Safe Water and Sanitation for the 1990's, New Delhi	New Delhi Statement: "Some for all rather than more for some"

Table B.1 Milestones of Water-Related Global Events Since 1972 continued

	World Summit for Children, New York	Declaration on the Survival, Protection and Development of Children
1992	UN Conference on environment and Development (UNCED Earth Summit), Rio de Janeiro The convention on Climate Change was adopted on May 1992 and opened for signature a month later at the UN Conference on Environment and Development in Rio de Janeiro, Brazil.	Agenda 21, the Rio Declaration on Environment and Development, the Statement of Forest Principles, the United Nations, Convention on Biological Diversity. As an output the subsequent follow-up mechanisms were created: Commission on Sustainable Development Inter-agency Committee on Sustainable Development High-level Advisory Board on Sustainable Development In Rio Conference, despite the ecological theme of the Summit, urban ecology is not discussed. And the chapter, in which only deals with urban issues under the heading 'sustainable urban settlements' emphasizes technological rather than natural systems in urban areas. "The precepts of Olmsted, Howard, Geddes, and Mumford regarding the functions of natural systems within cities are forgotten". (Platt, 1994, p.10)
	International Conference on Water and the Environment, Dublin	Dublin Statement on Water and Sustainable Development
1994	Ministerial Conference on Drinking Water Supply and Environmental Sanitation, Noordwijk	Action Programme
	UN International Conference on Population and Development, Cairo	Programme of Action
1996	United Nations International Conference on Human Settlements – Habitat II, Istanbul	This was the second conference organized for discussing the issue of habitation (Habitat I Conference was held in Vancouver in 1976). It specifically focused on current built environmental problems in relation to major global changes (e.g. population growth, migration towards urban areas, tourism, urban regeneration).

Table B.1 Milestones of Water-Related Global Events Since 1972 continued

1997	Conference of the Parties to the UN Framework Convention on Climate Change 2 (COP 2), Geneva	At the second COP, a large number of ministers agreed on the Geneva Ministerial Declaration, which provided political impetus to the Berlin Mandate process.
1997	Conference of the Parties to the UN Framework Convention on Climate Change 3 (COP 3), Kyoto Protocol, Japan	Targets to reduce greenhouse gas (GHG) emissions.
1998	Conference of the Parties to the UN Framework Convention on Climate Change 4 (COP 4), Buenos Aires	At COP 4 (Buenos Aires, November 1998), Parties adopted the so called 'Buenos Aires Plan of Action', setting out a programme of work both the advance the implementation of the Convention and to flesh out the operational details of the Kyoto Protocol. This programme of work was conducted in the subsidiary bodies and at COP 5 (Bonn, October/November 1999), with a deadline of COP 6 (The Hague, November 2000). However, Parties werte unable to reach agreement on a package of decisions on all issues under the Buenos Aires Plan of Action at that session. Nevertheless, they decided to meet again in a resumed session of COP 6 to try once to resolve their differences.
1999	Conference of the Parties to the UN Framework Convention on Climate Change 5 (COP 5), Bonn	Ministers and officials from 166 governments agreed on a timetable for completing the outstanding details of the 1997 Kyoto Protocol by November 2000 in order to intensify the negotiating process on all issues before the sixth COP.
2000	Conference of the Parties to the UN Framework Convention on Climate Change 6 (COP 6), The Hague and Bonn	Pledge to contribute €450 million per year by 2005 to help developing countries manage emissions and adapt to climate change. The Convention on Climate Change has been ratified by 37 countries.
	2nd World Water Forum, the Hague	World Water Vision: Making Water Everybody's Business

Table B.1 Milestones of Water-Related Global Events Since 1972 continued

2001	Conference of the Parties to the UN Framework Convention on Climate Change 7 (COP 7), Marrakesh	Parties finally succeeded in adopting the Bonn Agreements on the Implementation of the Buenos Aires Plan of Action, Registering political agreement on key issues under the Buenos Aires Plan of Action. The final Kyoto rulebook has been set. Countries must cut 80% emissions of gas. The Marrakesh Ministerial Declaration emphasizes the contribution that action on climate change can make the sustainable development, calling for capacity building, technology, innovation and co-operation with the biodiversity and desertification conventions. Up to Marrakesh, 40 countries have ratified the Kyoto Protocol.
	International Conference on Freshwater, Bonn	Recommendations for action
2002	United Nations World Summit on Sustainable Development, Johannesburg	Key objectives to reach: -A revitalized and integrated UN system for sustainable development. -A new deal on finance – enabling a deal on SD. -An integration of trade and SD. -A clearer understanding of how governments should move forward nationally in implementing Agenda 21. -A new charter which could lay the foundations for countries to frame their sustainable development policies. -A review of the work of the present set of Rio conventions – looking at the overlaps, gaps and obstacles. -A set of new regional or even global conventions. -A set of policy recommendations for the environmental security issues that face us. -A clear set of commitments to implement agreed action by the UN, governments and major groups.

Table B.1 Milestones of Water-Related Global Events Since 1972 continued

2002	Conference of the Parties to the UN Framework Convention on Climate Change 8 (COP 8), New Delhi	The usual division between developed and developing country positions on many issues was in evidence at COP 8. Parties convened in negotiating groups on a number of issues previously left off the agenda due to the pressing negotiations under the Buenos Aires Plan of Action. The Delhi Declaration reaffirms development and poverty eradication as overriding priorities in developing countries and implementation of UNFCCC commitments according to Parties' common but differentiated responsibilities, development priorities and circumstances, but it does not call for a dialogue on broadening commitments.
	World Summit on Sustainable development, Rio+10, Johannesburg	Plan of Implementation
2003 International Year of Freshwater	3rd World Water Forum, Japan	1st edition of United Nations World Water Development Report
	Conference of the Parties to the UN Framework Convention on Climate Change 9 (COP 9), Milan	According to the way the Kyoto Protocol (KP) was written, it will go into effect only if 55 of the signatories ratify. These signatories must account for 55% of the CO2 emissions at the then specified date – 1990. There is no problem with the first condition, as 121 countries have ratified the KP. But thanks to the position of the USA (the country at the forefront of greenhouse gas emissions), this is not going to represent the required minimum of 55% of emissions without a Russian ratification of the KP.
2006	4th World Water Forum, Mexico	2nd edition of the United Nations World Water Development Report
2009	5th World Water Forum, Istanbul, Turkey	The fifth World Water Forum focused upon bridging divides for water.

Sources: Adapted from Brandon et al, 2005, p.5-7; Platt, 1994; UNESCO, 1979; UNESCO, n.d.; "Timeline of International Conferences", n.d. and "World Water Day", 2010

APPENDIX C

DEFINITION AND CHARACTERISTICS OF RIVER

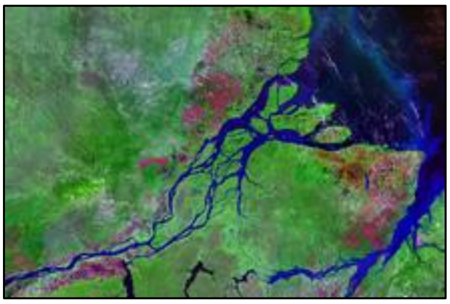


Figure C.1 A Satellite Photograph of theAmazon River in Brazil

Source: “River”, 2011

A river is a natural watercourse, usually freshwater, flowing towards an ocean, a lake, a sea, or another river. In a few cases, a river simply flows into the ground or dries up completely before reaching another body of water. Small rivers may also be called by several other names, including stream, creek, brook, rivulet, tributary and rill; there is no general rule that defines what can be called a river, although in some countries or communities a stream may be defined by its size. Many names for small rivers are specific to geographic location; one example is "burn" in Scotland and North-east England. Sometimes a river is said to be larger than a creek, but this is not always the case, because of vagueness in the language.

A river is part of the hydrological cycle. Water within a river is generally collected from precipitation through surface runoff, groundwater recharge, springs, and the release of stored water in natural ice and snowpacks (e.g., from glaciers).

Topography

The water in a river is usually confined to a channel, made up of a streambed between banks. In larger rivers there is also a wider floodplain shaped by flood-waters over-topping the channel. Flood plains may be very wide in relation to the size of the river channel. This distinction between river channel and floodplain can be blurred especially in urban areas where the floodplain of a river channel can become greatly developed by housing and industry.

The term upriver refers to the direction leading to the source of the river, which is against the direction of flow. Likewise, the term downriver describes the direction towards the mouth of the river, in which the current flows.

The river channel typically contains a single stream of water, but some rivers flow as several interconnecting streams of water, producing a braided river. Extensive braided rivers are now found in only a few regions worldwide, such as the South Island of New Zealand. They also occur

on peneplains and some of the larger river deltas. Anastamosing rivers are similar to braided rivers and are also quite rare. They have multiple sinuous channels carrying large volumes of sediment.
A river flowing in its channel is a source of energy which acts on the river channel to change its shape and form. According to Brahm's law (sometimes called Airy's law), the mass of objects that may be carried away by a river is proportional to the sixth power of the river flow speed. Thus, when the speed of flow increases two times, it can transport 64 times larger (i.e., more massive) objects.[4] In mountainous torrential zones this can be seen as erosion channels through hard rocks and the creation of sands and gravels from the destruction of larger rocks. In U-shaped glaciated valleys, the subsequent river valley can often easily be identified by the V-shaped channel that it has carved. In the middle reaches where the river may flow over flatter land, meanders may form through erosion of the river banks and deposition on the inside of bends. Sometimes the river will cut off a loop, shortening the channel and forming an oxbow lake or billabong. Rivers that carry large amounts of sediment may develop conspicuous deltas at their mouths, if conditions permit. Rivers whose mouths are in saline tidal waters may form estuaries.
Throughout the course of the river, the total volume of water transported downstream will often be a combination of the free water flow together with a substantial contribution flowing through sub-surface rocks and gravels that underlie the river and its floodplain (called the hyporheic zone). For many rivers in large valleys, this unseen component of flow may greatly exceed the visible flow.

Zones

Some researchers believe that the wide variety of both abiotic and biotic factors involved in rivers defies classification. Nevertheless, one system of river zonation has gained relatively widespread acceptance, in the francophone world at least. It divides rivers into three primary zones:
The *crenon* is the uppermost zone at the source of the river. It is further divided into the eucrenon (spring or boil zone) and the hypocrenon (brook or headstream zone). These areas are characterized by low temperatures, reduced oxygen content and slow moving water.
The *rhithron* is the upstream portion of the river that follows the crenon. It is characterized by relatively cool temperatures, high oxygen levels, and fast, turbulent flow.
The *potamon* is the remaining downstream stretch of river. It is characterized by warmer temperatures, lower oxygen levels, slow flow and sandier bottoms.

Classification

Rivers can generally be classified as either alluvial, bedrock, or some mix of the two. Alluvial rivers have channels and floodplains that are self-formed in unconsolidated or weakly-consolidated sediments. They erode their banks and deposit material on bars and their floodplains. Bedrock rivers form when the river downcuts through the modern sediments and into the underlying bedrock. This occurs in regions that have experienced some kind of uplift (thereby steepening river gradients) or in which a particular hard lithology causes a river to have a steepened reach that has not been covered in modern alluvium. Bedrock rivers very often contain alluvium on their beds; this material is important in eroding and sculpting the channel. Rivers that go through patches of bedrock and patches of deep alluvial cover are classified as mixed bedrock-alluvial.
Alluvial rivers can be further classified by their channel pattern as meandering, braided, wandering, anastomose, or straight. The morphology of an alluvial river reach is controlled by a combination of sediment supply, substrate composition, discharge, vegetation, and bed aggradation.

River "age"

Although the following classes, based on the work of William Morris Davis at the turn of the 20th century, are a useful way to visualize rivers, many other factors are at work. Gradient is controlled largely by tectonics, but discharge is controlled largely by climate, and sediment load is controlled by various factors including climate, geology in the headwaters, and the stream gradient.

Youthful river: A river with a steep gradient that has very few tributaries and flows quickly. Its channels erode deeper rather than wider. Examples include theBrazos, Trinity and Ebro rivers.

Mature river: A river with a gradient that is less steep than those of youthful rivers and flows more slowly. A mature river is fed by many tributaries and has more discharge than a youthful river. Its channels erode wider rather than deeper. Examples include the Mississippi, Saint Lawrence, Danube, Ohio, Thamesand Paraná rivers.

Old river: A river with a low gradient and low erosive energy. Old rivers are characterized by flood plains. Examples include the Yellow, Ganges, Tigris,Euphrates, Indus and Nile rivers.

Rejuvenated river: A river with a gradient that is raised by tectonic uplift.

Downstream variations

The way in which a river's characteristics vary between the upper course and lower course of a river is summarized by the Bradshaw model. Power-law relationships between channel slope, depth, and width are given as a function of discharge by "river regime".

Subsurface streams

Most but not all rivers flow on the surface. Subterranean rivers flow underground in caves or caverns. Such rivers are frequently found in regions with limestonegeologic formations. Subglacial streams are the braided rivers that flow at the beds of glaciers and ice sheets, permitting meltwater to be discharged at the front of the glacier. Because of the gradient in pressure due to the overlying weight of the glacier, such streams can even flow uphill.

Permanence of flow

An *intermittent river* (or ephemeral river) only flows occasionally and can be dry for several years at a time. These rivers are found in regions with limited or highly variable rainfall, or can occur because of geologic conditions such as having a highly permeable river bed. Some ephemeral rivers flow during the summer months but not in the winter. Such rivers are typically fed from chalk aquifers which recharge from winter rainfall. In the UK these rivers are called *Bournes* and give their name to place such as Bournemouth and Eastbourne

Uses

Leisure activities on the River Avon at Avon Valley Country Park, Keynsham,United Kingdom. A boat giving trips to the public passes a moored private boat.

Rivers have been used as a source of water, for obtaining food, for transport, as a defensive measure, as a source ofhydropower to drive machinery, for bathing, and as a means of disposing of waste.

Rivers have been used for navigation for thousands of years. The earliest evidence of navigation is found in the Indus Valley Civilization, which existed in northwestern Pakistan around 3300 BC.Riverine navigation provides a cheap means of transport, and is still used extensively on most major rivers of the world like the Amazon, the Ganges, the Nile, the Mississippi, and the Indus. Since river boats are often not regulated, they contribute a large amount to globalgreenhouse gas emissions, and to local cancer due to inhaling of particulates emitted by the transports.

In some heavily forested regions such as Scandinavia and Canada, lumberjacks use the river to float felled trees downstream to lumber camps for further processing, saving much effort and cost by transporting the huge heavy logs by natural means.

Rivers have been a source of food since pre-history.They can provide a rich source of fish and other edible aquatic life, and are a major source of fresh water, which can be used for drinking and irrigation. It is therefore no surprise to find most of the major cities of the world situated on the banks of rivers. Rivers help to determine the urban form of cities and neighbourhoods and their corridors often present opportunities for urban renewal through the development of foreshoreways such as Riverwalks. Rivers also provide an easy means of disposing of wastewater and, in much of the less developed world, other wastes.

Fast flowing rivers and waterfalls are widely used as sources of energy, via watermills and hydroelectric plants. Evidence of watermills shows them in use for many hundreds of years such as in Orkney at Dounby click mill. Prior to the invention of steam power, water-mills for grinding cereals and for processing wool and other textiles were common across Europe. In the 1890s the first machines to generate power from river water were established at places such as Cragside inNorthumberland and in recent decades there has been a significant increase in the development of large scale power generation from water, especially in wet mountainous regions such as Norway.

The coarse sediments, gravel and sand, generated and moved by rivers are extensively used in construction. In parts of the world this can generate extensive new lake habitats as gravel pits re-fill with water. In other circumstances it can destabilise the river bed and the course of the river and cause severe damage to spawning fish populations which rely on stable gravel formations for egg laying.

In upland rivers, rapids with whitewater or even waterfalls occur. Rapids are often used for recreation, such as whitewater kayaking.

Rivers have been important in determining political boundaries and defending countries. For example, the Danube was a long-standing border of the Roman Empire, and today it forms most of the border between Bulgaria and Romania. The Mississippi in North America and the Rhine in Europe are major east-west boundaries in those continents. The Orange and Limpopo Rivers in southern Africa form the boundaries between provinces and countries along their routes.

Ecosystem

The flora and fauna of rivers use the aquatic habitats available, from torrential waterfalls through to lowland mires. Although many organisms are restricted to the fresh water in rivers, some, such as salmon and hilsa, have adapted to be able to survive both in rivers and in the sea. The organisms in the riparian zone respond to changes in river channel location and patterns of flow. The ecosystem of rivers is generally described by the River continuum concept, which has some additions and refinements to allow for spatial (dams, waterfalls) and temporal (extensive flooding). The basic idea is that the river can be described as a system that is continuously changing along its length in the physical parameters, the availability of food particles and the composition of the ecosystem. The food (energy) that is the leftover of the upstream part is being utilized downstream.

The general pattern is that the first order streams contain particulate matter (decaying leaves from the surrounding forests), which is processed there by shredders like Plecoptera larvae. The leftovers of the shredders are utilized by collectors as Hydropsyche and furter downstream algae that create the primary productionbecome the main foodsource of the organisms. All changes are gradual and the distribution of each species can be described as a normal curve with the highest density where the conditions are optimal. In rivers succession is virtually absent and the composition of the ecosystem stays fixed in time.

Chemistry

The chemistry of rivers is complex and depends on inputs from the atmosphere, the geology through which it travels and the inputs from man's activities. The chemistry of the water has a large impact on the ecology of that water for both plants and animals and it also affects the uses that may be made of the river water. Understanding and characterising river water chemistry requires a well designed and managed programme of sampling and analysis.

Like many other Aquatic ecosystems, rivers too are under increasing threat of pollution. According to a study of the WWF's Global Freshwater Programme, the 10 most polluted rivers are: Ganges, Indus, Yangtze, Salween-Nu, Mekong-Lancang, Rio Grande/Rio Bravo, La Plata, Danube, Nile-Lake Victoria, and the Murray-Darling.

The Nile is an example of a wave-dominated delta that has the classic Greek delta (Δ) shape after which River deltas were named. Some rivers generate brackish water by having their river mouth in the ocean. This, in effect creates a unique environment in which certain species are found.

Flooding

Flooding is a natural part of a river's cycle. The majority of the erosion of river channels and the erosion and deposition on the associated floodplains occur during flood stage. In many developed areas, human activity has changed river channel form, altering different magnitudes and frequencies of flooding. Some examples of this are the building of levees, the straightening of channels, and the draining of natural wetlands. In many cases human activities in rivers and floodplains have dramatically increased the risk of flooding. Straightening rivers allows water to flow more rapidly downstream increasing the risk of flooding places further downstream. Building on flood plains removes flood storage which again exacerbates downstream flooding. The building of levees may only protect the area behind the levees and not those further downstream. Levees and flood-banks can also increase flooding upstream because of back-water pressure as the upstream water has to squeeze between the levees.

Flow

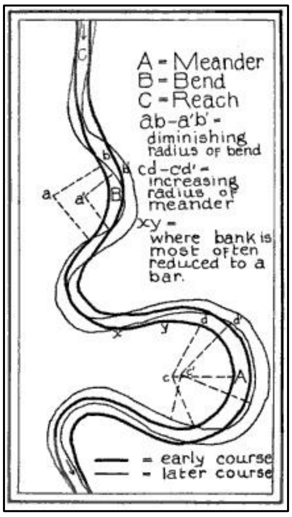


Figure C.2 River Meandering Course
Source: "River", 2011

A common misconception is that most, or even all, rivers flow from north to south. Rivers in fact flow downhill regardless of compass direction. Sometimes downhill is from north to south, but equally it can be from south to north, and usually is a complex meandering path involving all directions of the compass. Three of the ten longest rivers in the world - the Nile, Yenisei, and Ob - flow north, as do other major rivers such as the Rhine, Mackenzie, and Nelson.

Rivers flowing downhill, from river source to river mouth, do not necessarily take the shortest path. For alluvial streams, straight and braided rivers have very low sinuosity and flow directly down hill, while meandering rivers flow from side to side across a valley. Bedrock rivers typically flow in either a fractal pattern, or a pattern that is determined by weaknesses in the bedrock, such as faults, fractures, or more erodible layers.

Rate

Volumetric flow rate, also called discharge, volume flow rate, and rate of water flow, is the volume of water which passes through a given cross-section of the river channel per unit time. It is typically measured in cubic meters per second(cumec) or cubic feet per second (cfs), where 1 m^3/s = 35.51 ft^3/s; it is sometimes also measured in litres or gallons per second.

Volumetric flow rate can be thought of as the mean velocity of the flow through a given cross-section, times that cross-sectional area. Mean velocity can be approximated through the use of the Law of the Wall. In general, velocity increases with the depth (or hydraulic radius) and slope of the river channel, while the cross-sectional area scales with the depth and the width: the double-counting of depth shows the importance of this variable in determining the discharge through the channel.

Management

Rivers are often managed or controlled to make them more useful, or less disruptive, to human activity.

Dams or weirs may be built to control the flow, store water, or extract energy.

Levees, known as dikes in Europe, may be built to prevent river water from flowing on floodplains or floodways.
Canals connect rivers to one another for water transfer or navigation.
River courses may be modified to improve navigation, or straightened to increase the flow rate.
River management is a continuous activity as rivers tend to 'undo' the modifications made by people. Dredged channels silt up, sluice mechanisms deteriorate with age, levees and dams may suffer seepage or catastrophic failure. The benefits sought through managing rivers may often be offset by the social and economic costs of mitigating the bad effects of such management. As an example, in parts of the developed world, rivers have been confined within channels to free up flat flood-plain land for development. Floods can inundate such development at high financial cost and often with loss of life.
Rivers are increasingly managed for habitat conservation, as they are critical for many aquatic and riparian plants, resident and migratory fishes, waterfowl, birds of prey, migrating birds, and many mammals.

Rating systems
International Scale of River Difficulty – The scale is used to rate the challenges of navigation—particularly those with rapids. Class I is the easiest and Class VI is the hardest.
Strahler Stream Order – The Strahler Stream Order ranks rivers based on the connectivity and hierarchy of contributing tributaries. Headwaters are first order while the Amazon River is twelfth order. Approximately 80% of the rivers and streams in the world are of the first and second order.

Source of Appendix C: “River”, 2011

APPENDIX D

DEFINITION AND CHARACTERISTICS OF STREAM

A stream is a body of water with a current, confined within a bed and stream banks. Depending on its locale or certain characteristics, a stream may be referred to as a *branch*, *brook*, *beck*, *burn*, *creek*, *crick*, *gill* (occasionally *ghyll*), *kill*,*lick*, *rill*, *river*, *syke*, *bayou*, *rivulet*, *streamage*, *wash*, *run* or *runnel*.

Streams are important as conduits in the water cycle, instruments in groundwater recharge, and corridors for fishand wildlife migration. The biological habitat in the immediate vicinity of a stream is called a riparian zone. Given the status of the ongoing Holocene extinction, streams play an important corridor role in connecting fragmented habitats and thus in conserving biodiversity. The study of streams and waterways in general is known as *surfacehydrology* and is a core element of environmental geography.

Types

Figure D.1 A A Rocky Stream in Hawaii, United States
Source: “Stream”, 2010

Figure D.2 A Creek in Australia
Source: “Stream”, 2010

River

A large natural stream, which may be a waterway.

Creek

- In North America and Australia, a small to medium sized natural stream. Sometimes navigable by motor craft and may be intermittent.
- In parts of New England, the UK and India, a tidal inlet, typically in a salt marsh or mangrove swamp, or between enclosed and drained former salt marshes or swamps (e.g. Port Creek separating Portsea Island from the mainland). In these cases, the stream is the tidal stream, the course of the seawater through the creekchannel at low and high tide.

Tributary

A contributory stream, or a stream which does not reach the sea but joins another river (a parent river). Sometimes also called a branch or fork.

Brook

A stream smaller than a creek, especially one that is fed by a spring or seep. It is usually small and easily forded. A brook is characterized by its shallowness and its bed being composed primarily of rocks.

Other names

In the United Kingdom, there are several regional names for a stream:

- *Beck* is used in Yorkshire, Lancashire , Dumfriesshire and Cumbria.
- *Bourne* is used in the chalk downland of southern England (although strictly a bourne is wet in summer and dry in winter).
- *Brook* is used in the Midlands, Lancashire and Cheshire.
- *Burn* is used in Scotland and North East England.
- *Nant* is used in Wales.
- *Stream* is used in Southern England.
- *Syke* is used in lowland Scotland and Cumbria.

- *Allt* is used in Highland Scotland.

In North America:

- *Kill* in southern New York, Pennsylvania, Delaware, and New Jersey comes from a Dutch language word meaning "riverbed" or "water channel", and can also be used for the UK meaning of 'creek'.
- *Run* in Ohio, Pennsylvania, Maryland, or Virginia can be the name of a stream.
- *Branch*, *fork*, or *prong* can refer to tributaries or distributaries that share the same name as the main stream, generally with the addition of a cardinal direction.
- *Branch* is also used to name streams in Maryland and Virginia.
- *Falls* is also used to name streams in Maryland. Little Gunpowder Falls and The Jones Falls are actually rivers named in this manner, unique to Maryland.
- *Stream* and *brook* are used in Midwestern states, Mid-Atlantic states and New England.

Parts of a stream

Bar

A shoal that develops at the mouth of a river as sediment carried by the river is deposited as the current slows or is impedded by wave action. The Temperance River on Lake Superior's north shore is so named because it is one of the few rivers flowing into the lake that does not have a bar at its mouth.

Spring

The point at which a stream emerges from an underground course through unconsolidated sediments or through caves. A stream can, especially with caves, flow aboveground for part of its course, and underground for part of its course.

Source

The spring from which the stream originates, or other point of origin of a stream.

Headwaters

The part of a stream or river proximate to its source. The word is most commonly used in the plural where there is no single point source.

Confluence

The point at which the two streams merge. If the two tributaries are of approximately equal size, the confluence may be called a fork.

Run

A somewhat smoothly flowing segment of the stream.

Pool

A segment where the water is deeper and slower moving.

Channel

A depression created by constant erosion that carries the stream's flow.

Floodplain

Lands adjacent to the stream that are subject to flooding when a stream overflows its banks.

Stream bed

The bottom of a stream.

Thalweg

The river's longitudinal section, or the line joining the deepest point in the channel at each stage from source to mouth.

Waterfall or cascade

The fall of water where the stream goes over a sudden drop called a nickpoint; some nickpoints are formed by erosion when water flows over an especially resistant stratum, followed by one less so. The stream expends kinetic energy in "trying" to eliminate the nickpoint.

Mouth

The point at which the stream discharges, possibly via an estuary or delta, into a static body of water such as a lake or ocean.

Sources

Streams typically derive most of their water from precipitation in the form of rain and snow. Most of this water re-enters the atmosphere by evaporation from soil and water bodies, or by the evapotranspiration of plants. Some of the water proceeds to sink into the earth by infiltration and becomes groundwater, much of which eventually enters streams. Some precipitated water is temporarily locked up in snow fields and glaciers, to be released later by evaporation or melting. The rest of the water flows off the land as runoff, the proportion of which varies according to many factors, such as wind, humidity, vegetation, rock types, and relief. This runoff starts as a thin film called sheet wash, combined with a network of tiny rills, together constituting sheet runoff; when this water is concentrated in a channel, a stream has its birth.

Drainage basins

The extent of land basin drained by a stream is termed its ‘drainage basin’ (also known in North America as the ‘watershed’ and, in British English, as a ‘catchment’).[4] A basin may also be composed of smaller basins. For instance, the Continental Divide in North America divides the mainly easterly-draining Atlantic Ocean and Arctic Ocean basins from the largely westerly-flowing Pacific Ocean basin. The Atlantic Ocean basin, however, may be further subdivided into the Atlantic Ocean and Gulf of Mexico drainages. (This delineation is termed the Eastern Continental Divide.) Similarly, the Gulf of Mexico basin may be divided into theMississippi River basin and several smaller basins, such as the Tombigbee River basin. Continuing in this vein, a component of the Mississippi River basin is theOhio River basin, which in turn includes the Kentucky River basin, and so forth.

Source of Appendix D: “Stream”, 2010

APPENDIX E

REVIEW OF EXISTING STREAM CLASSIFICATION SYSTEMS

Table E.1 Review of Existing Stream Classification Systems

Existing classification system	Description	Classification Type
Davis (1899)	Classification of streams into three classes based on stage of adjustment: youthful, mature, old age	Process based
Melton (1936)	Empirical classification of floodplain streams	Form based
Horton (1945)	Basic empirical stream morphology relations (i.e., Horton's laws, stream slope, stream length)	Watershed scale form based
Leopold and Wolman (1957)	Classification of streams into three pattern classes: straight, meandering, braided	Form based
Strahler (1957)	Watershed scale classification of stream order based on the number of upstream tributaries draining into a given stream reach	Watershed scale form based
Lane (1957)	Classification of stream patterns based on slope-discharge relationships: braided, intermediate, meandering	Form based
Schumm (1963, 1977, 1981, 1985)	Classification based on channel stability (stable, eroding, or depositing) and mode of sediment transport (mixed load, suspended load, and bedload)	Process based

Table E.1 Review of Existing Stream Classification Systems continued

Culbertson and others (1967)	Classification using depositional features, vegetation, braiding patterns, sinuosity, meander scrolls, bank heights	Form based
Thornbury (1969)	Classification of channel pattern based on valley type: antecedent, superposed, consequent, and subconsequent	Form based
Khan (1971)	Quantitative classification for sand-bed streams based on sinuosity, slope, and channel pattern	Form based
Brice (1973)	Classification of channel pattern based on degree and character of sinuosity, braiding, and anabranching	Form based
Kellerhals and others (1972, 1976), Galay and others (1973), Mollard (1973)	Descriptive classification applied to Canadian rivers that has utility for aerial photo delineation and for describing gradual transitions between river types	Form based
Rhodes (1977)	Empirical classification based on comparing the hydraulic geometry of stream channels (b-f-m diagram)	Form and process based
Brice and Blodgett (1978)	Classification of four channel pattern types: braided, braided point-bar, wide-bend point-bar, and equi-width point-bar	Form based
Hill (1979)	TWINSPAN – A program for arranging multivariate data in an ordered two way table by classification based on River Channel Typology (RCT)	Process based
Brice (1981)	Classification of channels as degrading, aggrading, widening, shifting at both banks, or shifting laterally	Process based

Table E.1 Review of Existing Stream Classification Systems continued

Mosley (1987)	A broad review of river classifications that concludes that all classifications must examine spatial and frequency distributions of variables, rather than average values	Probabilistic reivew
Brookes (1988)	Classification that combines instream adjustments with classes that account for bed degradation, armoring, thalweg sinuosity, bar development, and bank erosion	Process based
Simon (1989)	Process-based classification based on stages of channel evolution for disturbed, degrading channes	Process based
Nanson and Croke (1992)	Classification of floodplains based on particle size, morphology of channels, and bank materials	Form based
Whiting and Bradley (1993)	Process-based channel classification for headwater streams based on gradient, valley width, channel with, channel gradient, channel depth, and sediment size	Process based
Rosgen (1994)	Classifies streams into eight streams types based on six morphologic measurements: entrenchment, width-depth ratio, sinuosity, number of channels, slope, and bed-size	Form based
Downs (1994, 1996)	Classification that links observed trends and patterns of adjustment to the fluvial and sediment processes responsible for driving channel change	Process based

Table E.1 Review of Existing Stream Classification Systems continued

Miall (1996)	Classification based on identifiable depositional environments with tree major classes – gravel dominated, sand dominated with high sinuosity, and sand dominated with low sinuosity	Process based
Woolfe and Balzary (1996)	Process-oriented classification with eight categories representing a spectral segment relating rates of channel to floodplain aggradation and degradation	Process based
Raven and others (1997)	River Habitat Survey: a national (UK) classification of river habitats based on topographic and photographic information, basic and detailed form, channel dimensions, bed and materials, and natural artificial features	Form and habitat based
Montgomery and Buffington (1997)	Classifies alluvial, colluvial, and bedrock streams into classes based on response to sediment inputs: cascade, step-pool, plane-bed, riffle-pool, dune-ripple, and braided	Process based
Schueler (2000)	Urban stream classification that presents three primary classification categories based on percent of impervious cover: (1) sensitive (<10%), (2) impacted (11%-25%), and (3) non-supporting (>25%)	Form and process based (Urban Development)

Source: Niezgoda, S.L., Johnson, P.A., 2005, p.581-582.

APPENDIX F

MAJOR RIVERS IN THE WORLD

The size and importance of the world's rivers are measured in terms of discharge and length. A river's importance may also be measured in terms of local and regional water availability and population. A small river flowing through a densely populated, aridregion may be extremely important, for example.

Rivers flow downhill from their sources to their mouths at the sea. The sources of the world's major rivers are often in highly elevated or mountainous areas, but there are exceptions. For example, the source of the Mississippi River is Lake Itasca, Minnesota, which lies only about 461 meters (1,515 feet) above sea level.

Although the world's major rivers flow through many different types of terrain, they provide similar physical and biological functions. Rivers transport sediments from their basins to the sea through the processes of erosion, transport, and deposition. In a river system's upland areas, erosion is the dominant process. Tectonic processes result in the uplift and formation of major mountain chains, while the world's major river systems help erode those mountains. For example, the Colorado River of the southwestern United States flows through the Colorado Plateau region. The Colorado River's world-famous canyons were created over millions of years as the river eroded its way downward through the Colorado Plateau, which was being driven upward by tectonic forces.

A river's flow is halted when it reaches the sea, where the river deposits its sediments and creates a delta. River deltas commonly assume a triangular pattern that resembles the Greek letter delta (Δ)—a letter based on the shape of the Nile River delta in northern Egypt. Fresh water and salt water meet in these deltas, which are some of the world's most biologically productive areas.

The world's major river systems are storehouses of biological productivity and diversity. Rivers and their floodplains provide habitat for aquatic and terrestrial species. Many of the world's large rivers experience an annual flooding cycle that is important for spreading water, nutrients, and sediment into floodplains as well as providing reproductive cues for fish.

Large dams for reducing floods and producing hydroelectricity have been constructed on many of the world's large rivers. Flood damage reduction works, such as dams and levees, encourage people to move into floodplains; however, the loss of this annual flood cycle often has had negative ecological consequences. Water resources managers and scientists around the world are exploring ways to restore parts of these annual flood cycles in order to restore natural river processes and habitat. Controlling the releases of waters from reservoirs to mimic natural flood patterns is a notion under discussion in many areas of the world.

Asia

The Yangtze (*Chang*) River of China is Asia's largest river in terms of discharge. Like many of Asia's major rivers, the Yangtze's headwaters are in central Asia's Himalaya Mountains. The Yangtze has a history of devastating

WORLD'S TEN LARGEST RIVERS BY DISCHARGE

River	Country	Average Discharge at Mouth (Thousands of cubicfeet per second)
Amazon	Brazil	7,500
Congo	Congo	1,400
Yangtze	China	770
Brahmaputra	Bangladesh	700
Ganges	India	660
Yenisey	Russia	614
Mississippi	USA	611
Orinoco	Venezuela	600
Lena	Russia	547
Parana	Argentina	526

The Brahmaputra River is the world's fourth-largest river, and the Ganges River the fifth largest. Both rivers have their headwaters in the Himalayas and, along with the Meghna River, merge in Bangladesh to form a river that has 2.5 times the discharge of the Mississippi River. Floods during the summer monsoon season in this river system are immense and often cause tens or hundreds of thousands of deaths. But the floods represent a paradox for Bangladesh, as the annual floods are essential to maintain soil fertility and fisheries.

Southeast Asia's Mekong River flows through six nations: China, Myanmar, Laos, Thailand, Cambodia, and Vietnam. The Mekong has been noted for its relative lack of development, although this is changing, as China is constructing dams on the upper Mekong River. The Mekong also is noted for sustained international cooperation on river basin planning in the lower basin. Today's Mekong River Commission represents an international organization that has existed in many forms since its establishment in the late 1950s.

The Indus River and its river basin represent one of the world's highly developed and regulated river systems, with a history of massive inundation canals dating back four millennia. The Indus flows from the western flank of the Himalayas in Tibet and then primarily through Pakistan on its way to the Arabian Sea, but several of its large tributary streams are in India. Expansion of irrigated agriculture in the basin continues, with gains in agricultural production offset by salinity, waterlogging, and flood losses.

Some of the world's large rivers are in Russia. The Yenisey (sixth largest), Lena (ninth), and Ob (thirteenth) Rivers are among the world's twenty largest rivers. All these rivers flow northward to the Arctic Ocean.

Africa

As Africa is the world's most arid continent, its rivers are of great importance. Most of Africa's rivers are characterized by annual climate cycles that alternate seasonal rainfall with seasonal drought. Fifty-four of Africa's river basins cross international borders. There is thus a need for international collaboration if these large African rivers are to approach their full potential in balancing the demands of meeting human needs and sustaining ecosystems.

The basin of the world's second-largest river, the Congo River, covers eleven western African nations. The world's longest river, the Nile, is in northern Africa; its river basin is shared by twelve nations. The Nile is well known for the ancient civilizations that inhabited its valley. The Egyptian civilization depended greatly on the Nile and the irrigated agriculture in its floodplains. The Nile flooded annually, and the silt from these floods replenished agricultural soils, and the water helped flush salts that had accumulated in the irrigated fields. In the 1960s, the Aswan Dam was constructed on the Nile River. Although the dam eliminated this annual flooding cycle, it has brought several benefits to Egypt, especially hydroelectricity.

Europe

Europe's largest river is the Danube, which flows eastward through more than a dozen nations on its way to the Black Sea. The Rhine River flows northward through several European nations before emptying into the North Sea. Both these rivers flow through many cities and are heavily used. Floods generally do not present problems in these rivers, but pollution is a concern in both of them. For example, a large chemical spill in 1986 in the upper Rhine killed fish far downstream, and prompted the formation of a pollution warning system along the river.

North America

The Mississippi River is North America's largest river. Joined by the Ohio River to the east and the Missouri River to the west, the Mississippi is the world's seventh-largest river when it reaches the Gulf of Mexico. The Mississippi is well known for its great floods. A great flood in 1927 initiated changes in federal water planning that have lasted for several decades. Even with improved planning and flood control, the 1993 Mississippi floods still caused widespread damage.

Canada and the United States share two of North America's great rivers: the Columbia and the St. Lawrence. The Columbia is in the Pacific Northwest, and its dozens of dams constitute the world's largest hydropower system. The Columbia also is famous for its legendary salmon fisheries and the conflicts between fisheries interests and operators of the hydropower dams. The St. Lawrence forms the boundary between eastern Canada and the United States and is the outflow of the Great Lakes to the Atlantic Ocean.

The Colorado River of the southwestern United States flows through an arid and highly populated region and is an important source of water for millions of people, especially in southern California and Arizona. The Colorado was well known for its wide variations in streamflow and the tremendous amounts of silt it carried to the Gulf of California. The Colorado has been so extensively dammed and diverted that it no longer reaches its mouth (terminus), instead drying up in the Mexican desert. Several environmental groups are currently investigating strategies for restoring these flows.

South America

South America combines the world's highest average annual rainfall values with the world's highest evaporation and is the site of the world's driest area (Atacama Desert) and the world's largest river, the Amazon.

The Amazon has its headwaters along the eastern flank of the Andes Mountains and drains the largest river basin on earth. The average flows of the Amazon are larger than the combined average flows of the world's next ten largest rivers.

Other large South American rivers include the Orinoco (eight largest), which flows northward through Venezuela, and the Parana (tenth largest), which flows through Brazil, Paraguay, Argentina, and Uruguay.

Source of Appendix F: Jajobs, n.d.

APPENDIX G

LIST OF MAJOR RIVERS BY LENGTH

Table G.1 List of Major Rivers by Length

	River	Length (km)	Drainage Area (km²)	Average Discharge (m³/s)	Outflow	Countries in the Drainage Basin
1	Nile – Kagera	6,65	3,349,000	5,1	Mediterranean Sea	Ethiopia, Eritrea, Sudan, Uganda, Tanzania, Kenya, Rwanda, Burundi, Egypt, Democratic Republic of the Congo
2	Amazon – Ucayali – Apurímac	6,4	6,915,000	219	Atlantic Ocean	Brazil, Peru, Bolivia, Colombia, Ecuador, Venezuela, Guyana
3	Yangtze	6,3	1,800,000	31,9	East China Sea	China
4	Mississippi – Missouri – Jefferson	6,275	2,980,000	16,2	Gulf of Mexico	United States (98.5%), Canada (1.5%)
5	Yenisei – Angara – Selenga	5,539	2,580,000	19,6	Kara Sea	Russia (97%), Mongolia (2.9%)
6	Yellow River	5,464	745	2,11	Bohai Sea	China
7	Ob – Irtysh	5,41	2,990,000	12,8	Gulf of Ob	Russia, Kazakhstan, China, Mongolia
8	Paraná - Río de la Plata	4,88	2,582,672	18	Río de la Plata	Brazil (46.7%), Argentina (27.7%), Paraguay (13.5%), Bolivia (8.3%), Uruguay (3.8%)
9	Congo – Chambeshi	4,7	3,680,000	41,8	Atlantic Ocean	Democratic Republic of the Congo, Central African Republic, Angola, Republic of the Congo, Tanzania, Cameroon, Zambia, Burundi, Rwanda
10	Amur – Argun	4,444	1,855,000	11,4	Sea of Okhotsk	Russia, China, Mongolia

Table G.1 List of Major Rivers by Length continued

	(Heilong Jiang)					
11	Lena	4,4	2,490,000	17,1	Laptev Sea	Russia
12	Mekong	4,35	810	16	South China Sea	Laos, Thailand, China, Cambodia, Vietnam, Mya nmar
13	Mackenzie	4,241	1,790,000	10,3	Beaufort Sea	Canada
14	Niger	4,2	2,090,000	9,57	Gulf of Guinea	Nigeria (26.6%), Mali (25.6%), Niger (23.6%), Algeria (7.6%), G uinea (4.5%), Cameroon (4.2%), Burkina Faso (3.9%), Côte d'Ivoire, Benin, Chad
15	Murray – Darling	3,672	1,061,000	767	Indian Ocean	Australia
16	Tocantins – Araguaia	3,65	950	13,598	Atlantic Ocean, Amazon	Brazil
17	Volga	3,645	1,380,000	8,08	Caspian Sea	Russia
18	Euphrates	3,596	884	856	Persian Gulf	Iraq (60.5%), Turkey (24.8%), Syria (14.7%)
19	Madeira	3,38	1,485,200	31,2	Amazon	Brazil, Bolivia, Peru
20	Purus	3,211	63,166	8,4	Amazon	Brazil, Peru
21	Yukon	3,185	850	6,21	Bering Sea	United States (59.8%), Canada (40.2%)
22	Indus	3,18	960	7,16	Arabian Sea	Pakistan (93%), India, China
23	São Francisco	3,18	610	3,3	Atlantic Ocean	Brazil
24	Syr Darya – Naryn	3,078	219	703	Aral Sea	Kazakhstan, Kyrgyzstan, Uzbekis tan, Tajikistan
25	Salween	3,06	324	3,153	Andaman Sea	China (52.4%), Myanmar (43.9%), Thailand (3.7%)
26	Saint Lawrence	3,058	1,030,000	10,1	Gulf of Saint Lawrence	Canada (52.1%), United States (47.9%)
27	Rio Grande	3,057	570	82	Gulf of Mexico	United States (52.1%), Mexico (47.9%)
28	Lower Tunguska	2,989	473	3,6	Yenisei	Russia
29	Brahmaputra	2,948	1,730,000	19,2	Bay of Bengal	India (58.0%), China (19.7%), Nepal (9.0%), Banglade sh (6.6%), Disputed India/China (4.2%),Bhutan (2.4%)

Table G.1 List of Major Rivers by Length continued

30	Danube	2,888	817	7,13	Black Sea	Romania (28.9%), Hungary (11.7%), Austria (10.3%), Serbia (10.3%), Germany (7.5%), Slovakia(5.8%), Bulgaria (5.2%), Croatia (4.5%),
31	Zambezi	2,693	1,330,000	4,88	Mozambique Channel	Zambia (41.6%), Angola (18.4%), Zimbabwe (15.6%), Mozambique (11.8%), Malawi (8.0%),Tanzania (2.0%), Namibia, Botswana
32	Vilyuy	2,65	454	1,48	Lena	Russia
33	Araguaia	2,627	358,125	5,51	Tocantins	Brazil
34	Ganges	2,620[10]	907	12,037	Bay of Bengal	India, Bangladesh, Nepal, China
34	Amu Darya	2,62	534,739	1,4	Aral Sea	Uzbekistan, Turkmenistan, Tajikistan, Afghanistan
35	Japurá	2,615	242,259	6	Amazon	Brazil, Colombia
36	Nelson	2,57	1,093,000	2,575	Hudson Bay	Canada, United States
37	Paraguay	2,549	900	4,3	Paraná	Brazil, Paraguay, Bolivia, Argentina
38	Kolyma	2,513	644	3,8	East Siberian Sea	Russia
40	Pilcomayo	2,5	270		Paraguay	Paraguay, Argentina, Bolivia
41	Upper Ob -- Katun	2,49			Ob	Russia
42	Ishim	2,45	177	56	Irtysh	Kazakhstan, Russia
43	Juruá	2,41	200	6	Amazon	Peru, Brazil
44	Ural	2,428	237	475	Caspian Sea	Russia, Kazakhstan
45	Arkansas	2,348	505	1,066	Mississippi	United States
47	Olenyok	2,292	219	1,21	Laptev Sea	Russia
48	Dnieper	2,287	516,3	1,67	Black Sea	Russia, Belarus, Ukraine
49	Aldan	2,273	729	5,06	Lena	Russia
46	Ubangi – Uele	2,27	772,8	4	Congo	Democratic Republic of the Congo, Central African Republic, Republic of Congo
50	Negro	2,25	720,114	26,7	Amazon	Brazil, Venezuela, Colombia
51	Columbia	2,250	415,211	7,5	Pacific Ocean	United States, Canada
52	Colorado (western U.S.)	2,333	390	1,2	Gulf of California	United States, Mexico

Table G.1 List of Major Rivers by Length continued

53	Pearl – Zhu Jiang	2,2	437	13,6	South China Sea	China (98.5%), Vietnam (1.5%)
54	Red	2,188	78,592	875	Mississippi	United States
55	Ayeyarwady	2,17	411	13	Andaman Sea	Myanmar
56	Kasai	2,153	880,2	10	Congo	Angola, Democratic Republic of the Congo
57	Ohio – Allegheny	2,102	490,603	7,957	Mississippi	United States
58	Orinoco	2,101	1,380,000	33	Atlantic Ocean	Venezuela, Colombia, Guyana
59	Tarim	2,1	557		Lop Nur	P. R. China
60	Xingu	2,1			Amazon	Brazil
61	Orange	2,092			Atlantic Ocean	South Africa, Namibia, Botswana, Leso tho
62	Northern Salado	2,01			Paraná	Argentina
63	Vitim	1,978			Lena	Russia
64	Tigris	1,95			Shatt al-Arab	Turkey, Iraq, Syria
65	Songhua	1,927			Amur	P. R. China
66	Tapajós	1,9			Amazon	Brazil
67	Don	1,87	425,6	935	Sea of Azov	Russia, Ukraine
68	Stony Tunguska	1,865	240		Yenisei	Russia
69	Pechora	1,809	322		Barents Sea	Russia
70	Kama	1,805	507		Volga	Russia
71	Limpopo	1,8	413		Indian Ocean	Mozambique, Zimbabwe, South Africa, Botswana
72	Guaporé	1,749			Mamoré	Brazil, Bolivia
73	Indigirka	1,726	360,4	1,81	East Siberian Sea	Russia
74	Snake	1,67	279,719	1,611	Columbia	United States
75	Senegal	1,641	419,659		Atlantic Ocean	Senegal, Mali, Mauritania
76	Uruguay	1,61	370		Atlantic Ocean	Uruguay, Argentina, Brazil

Table G.1 List of Major Rivers by Length continued

77	Blue Nile	1,6	326,4		Nile	Ethiopia, Sudan
78	Churchill	1,6			Hudson Bay	Canada
79	Khatanga	1,6			Laptev Sea	Russia
80	Okavango	1,6			Okavango Delta	Namibia, Angola, Botswana
81	Volta	1,6			Gulf of Guinea	Ghana, Burkina Faso, Togo, Côte d'Ivoire, Benin
82	Beni	1,599	283,35	8,9	Madeira	Bolivia
83	Platte	1,594			Missouri	United States
84	Tobol	1,591			Irtysh	Kazakhstan, Russia
85	Jubba – Shebelle	1,580*			Indian Ocean	Ethiopia, Somalia
86	Içá	1,575			Amazon	Brazil, Peru, Colombia, Ecuador
87	Magdalena	1,55	263,858	9	Caribbean Sea	Colombia
88	Han	1,532			Yangtze	P. R. China
89	Oka	1,5			Volga	Russia
91	Pecos	1,49			Rio Grande	United States
92	Upper Yenis ei	1,48			Yenisei	Russia, Mongolia
93	Godavari	1,465			Bay of Bengal	India
94	Colorado (Te xas)	1,438			Gulf of Mexico	United States
95	Río Grande	1,438	102,6	264	Ichilo	Bolivia
96	Belaya	1,42			Kama	Russia
97	Cooper – Barcoo	1,42			Lake Eyre	Australia
98	Marañón	1,415			Amazon	Peru
99	Dniester	1,411 (1,352)			Black Sea	Ukraine, Moldova
100	Benue	1,4			Niger	Cameroon, Nigeria
101	Ili	1,4			Lake Balkhash	P. R. China, Kazakhstan
102	Warburton – Georgina	1,4			Lake Eyre	Australia

Table G.1 List of Major Rivers by Length continued

103	Sutlej	1,372			Chenab	China, India, Pakistan
104	Yamuna	1,37			Ganges	India
105	Vyatka	1,37			Kama	Russia
106	Fraser	1,368	220	3,475	Pacific Ocean	Canada
107	Mtkvari (Kura)	1,364			Caspian Sea	Azerbaijan, Georgia, Armenia, T urkey, Iran
108	Grande	1,36			Paraná	Brazil
109	Brazos	1,352			Gulf of Mexico	United States
110	Cauca	1,35			Magdalena	Colombia
111	Liao	1,345			Bo Hai	P. R. China
112	Yalong	1,323			Yangtze	P. R. China
113	Iguaçu	1,32			Paraná	Brazil, Argentina
113	Olyokma	1,32			Lena	Russia
115	Northern Dvina	1,302	357,052	3,332	White Sea	Russia
116	Krishna	1,3			Bay of Bengal	India
116	Iriri	1,3			Xingu	Brazil
117	Narmada	1,289			Arabian Sea	India
118	Lomami	1,28			Congo	Democratic Republic of the Congo
119	Ottawa	1,271			Saint Lawrence	Canada
120	Zeya	1,242			Amur	Russia
121	Juruena	1,24			Tapajós	Brazil
122	Upper Missis sippi	1,236			Mississippi	United States

Table G.1 List of Major Rivers by Length continued

123	Rhine	1,233	198,735	2,33	North Sea	Germany, France, Switzerland, Netherlands, Austria, Liechtenstein, Italy (minimal), Belgium,Luxembourg
124	Athabasca	1,231	95,3		Mackenzie	Canada
124	Elbe	1,252	148,268	711	North Sea	Germany, Czech Republic
126	Canadian	1,223			Arkansas	United States
127	North Sask.	1,22			Saskatchewan	Canada
128	Draa	1,218			Atlantic Ocean	Morocco
129	Vaal	1,21			Orange	South Africa
130	Shire	1,2			Zambezi	Mozambique, Malawi
131	Nen	1,19			Songhua	P. R. China
132	Kızıl River	1,182	115	400	Black Sea	Turkey
133	Green	1,175			Colorado	United States
134	Milk	1,173			Missouri	United States, Canada
135	Chindwin	1,158			Ayeyarwady	Myanmar
136	Sankuru	1,15			Kasai	Democratic Republic of the Congo
137	James (Dakotas)	1,143			Missouri	United States
138	Kapuas	1,143			South China Sea	Indonesia
139	Desna	1,13	88,9	360	Dnieper	Russia, Belarus, Ukraine
140	Helmand	1,13			Hamun-i-Helmand	Afghanistan, Iran
141	Madre de Dios	1,13	125	4,915	Beni	Peru, Bolivia
142	Tietê	1,13			Paraná	Brazil
143	Vychegda	1,13			Northern Dvina	Russia

Table G.1 List of Major Rivers by Length continued

144	Sepik	1,126	77,7		Pacific Ocean	Papua New Guinea, Indonesia
145	Cimarron	1,123			Arkansas	United States
146	Anadyr	1,12			Gulf of Anadyr	Russia
146	Paraíba do Sul	1,12			Atlantic Ocean	Brazil
148	Jialing River	1,119			Yangtze	P. R. China
149	Liard	1,115			Mackenzie	Canada
150	Cumberland	1,105	46,83	862	Mississippi	United States
150	White	1,102			Mississippi	United States
152	Huallaga	1,1			Marañón	Peru
152	Kwango	1,1	263,5	2,7	Kasai	Angola, Democratic Republic of the Congo
154	Gambia	1,094			Atlantic Ocean	The Gambia, Senegal, Guinea
155	Chenab	1,086			Indus	India, Pakistan
156	Yellowstone	1,08	114,26		Missouri	United States
158	Aras	1,072	102	285	Kura	Turkey, Armenia, Azerbaijan, Iran
159	Chu River	1,067	62,5		none	Kyrgyzstan, Kazakhstan
160	Seversky Donets	1,078 (1,053)			Don	Russia, Ukraine
161	Bermejo	1,05			Paraguay	Argentina, Bolivia
162	Fly	1,05			Gulf of Papua	Papua New Guinea, Indonesia
163	Guaviare	1,05			Orinoco	Colombia
164	Kuskokwim	1,05			Bering Sea	United States
165	Tennessee	1,049			Ohio	United States
166	Vistula	1,047	194,424	1,08	Baltic Sea	Poland

Table G.1 List of Major Rivers by Length continued

167	Aruwimi	1,03			Congo River	Democratic Republic of the Congo
168	Daugava	1,02	87,9	678	Gulf of Riga	Latvia, Belarus, Russia
169	Gila	1,015			Colorado	United States
170	Loire	1,012	115,271	840	Atlantic Ocean	France
171	Essequibo	1,01			Atlantic Ocean	Guyana
172	Khoper	1,01			Don	Russia
173	Tagus (Tajo/Tejo)	1,006	80,1		Atlantic Ocean	Spain, Portugal

Source: “List of Rivers by Length”, 2011

APPENDIX H

MAJOR CITIES AND RIVERS PASSING THROUGH CITY CENTERS AROUND THE WORLD

Table H.1 Major Cities and Rivers Passing through Cities around the World

City	River
Europe	
Amsterdam, Netherlands	Amstel River, The Canals
Basel, Switzerland	Rhine River
Belgrade, Serbia *	Danube River, Sava River
Berlin, Germany	Spree River, Havel River
Bonn, Germany	Rhine River
Brussels, Belgium	Seine (Senne) River
Budapest, Hungary *	Danube River
Cambridge, UK	Cam River
Chernivitsi, Ukraine	Prut River
Dublin, Ireland	Liffey River
Duisburg, Germany	Rhine River
Düsseldorf, Germany	Rhine River
Florence, Italy *	Arno River
Frankfurt, Germany	Main River (a tributary of Rhone?)
Geneva, Switzerland *	Rhone River
Glasgow, UK	Clyde River
Hamburg, Germany	Elbe River
Hanover, Germany	Leine River
Heidelberg, Germany	Neckar River
Kiev, Ukraine	Dnieper River
Köln, Germany	Rhine River
Leicester, UK	Roar River
Lisbon, Portugal	Tagus River
London, UK *	Thames River
Lyon, France *	Rhone River, Saone River
Madrid, Spain	Manzanares River
Malmö, Sweden	Malmö River

Table H.1 Major Cities and Rivers Passing through Cities around the World continued

Mostar, Bosnia Herzegovina	Neretva
Munich, Germany *	Isar River
Paris, France *	Seine River
Prague, Czech Republic	Vltava River, Moldau River
Riga, Latvia	Daugava River
Rome, Italy *	Tiber River
Rotterdam, Netherlands	Rhine River, Meuse River
Ruhr, Germany	Ruhr River
Salzburg, Austria *	Salzach River
Sevilla, Spain	Guadalquivir River
Saint Petersburg, Russia *	Neva River
Strasbourg, France *	Ille River (a tributary of Rhine)
Turin, Italy	Po River
Ulm, Germany	Danube River
Uppsala, Sweden	Fyris River
Vienna, Austria *	Danube River
Warsaw, Poland	Vistula River
Zurich, Switzerland *	Limmat River, Sihl River
America	
Austin TX, US	Colorado River
Bogotá, Colombia	Bogotá River
Boston MA, US *	Charles River
Buenos Aires, Argentina	Río de la Plata River
Calgary, Canada	Bow River
Denver, Colorado	South Platte River
Edmonton, Canada	North Saskatchewan River
Los Angeles, California US	Los Angeles River
Lima, Peru	Rímac River
Manaus, Brazil	Amazon River
Montreal, Canada	St Lawrance River
New Orleans, Louisiana US	Mississippi River
New York City NY, US	Hudson River
Oquago NY, US	Delaware River
Ottawa, Canada	Carp River
Philadelphia PA, US	Schuylkill River
Pittsburgh PA, US	Ohio, Allegheny and Monongahela rivers
Portland OR, US	Willamette River
Quebec, Canada	Saint Lawrence River
Sacramento, California US	Sacramento River, American River
San Antonio, Texas US *	San Antonio River
Santiago, Chile	Mapocho River

Table H.1 Major Cities and Rivers Passing through Cities around the World continued

São Paulo, Brazil	Tietê River
Seattle, WA, US	Cedar River
Toronto, Canada	Don River, Humber River
Vancouver, Canada	False Creek
Washington DC, US	Potomac River, Anacostia River
Asia	
Baghdad, Iraq	Tigris River
Bangkok, Thailand	Chao Phraya River
Calcutta, India	Hooghly River
Chengdu, China *	Fu Nan River, Jin River
Damascus, Syria	Barada River
Delhi, India	Yamuna River
Guangzhou, China	Zhu Jiang (Pearl) River
Ho Chi Minh, Vietnam	Saigon River
Hong Kong, China	Pearl River
Isfahan, Iran	Zayende River
Jakarta, Indonesia	Liwung River
Kazan, Republic of Tatarstan	Volga River
Kolkata, India	Hooghly River
Kuala Lumpur, Malaysia	Klang and Gombak rivers
Moscow, Russia	Moskow River
Musul, Iraq	Tigris River
Seoul, South Korea *	Han River
Shanghai, China *	Huangpu River, Suzhou Creek
Shenyang, China	Liao River
Singapore, Singapore *	Singapore River
Tbilisi, Georgia	Kura River
Tokyo, Japan	Sumida River
Varanasi, India	Ganges River
Africa	
Alexandria, Egypt	Nile River
Cairo, Egypt	Nile River
Brazzawille, Republic of the Congo	Congo River
Cape Town, South Africa	Liesbeek River
Australia	
Brisbane, Australia	Brisbane River
Melbourne, Australia	Yarra River
Perth, Australia	Swan River
Sydney, Australia	Wolli Creek

Source: Produced by the Author based on http://maps.google.com/

APPENDIX I

MAJOR CITIES AND RIVERS PASSING THROUGH CITIES IN TURKEY

Table I.1 Major Cities and Rivers Passing Through Cities in Turkey

City	River	Position of the River relative to the City		
		Diametral	**Eccentric**	**Tangential**
Adana	Seyhan River	√		
Adapazarı	Sakarya River			√
Ağrı	Murat Nehri		√	
Amasya	Yeşilırmak	√		
Bayburt	Çoruh River		√	
Diyarbakır	Tigris River			√
Edirne	Meriç River, Tunca River		√	√
Elbistan	Ceyhan Nehri		√	
Eskişehir	Porsuk River	√		
Gümüşhane	HarşitÇayı		√	
Hatay	Asi River	√		
Mersin	Müftü Creek	√		
Osmaniye	Ceyhan River			√
Samsun	Çoruh River	√		

Source: Produced by the Author based on http://maps.google.com/

APPENDIX J

MATRIX ON RIVERS, PHYSICAL ATTRIBUTES, THEIR RESPECTIVE CITIES, AND THEIR REHABILITATION PROJECTS

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects

River	City	Location of River within the City	Rehabilitation Project and Year
Cheonggye River **Physical Attributes of River:** **Length:** 6 km **Width:** 10 to 30 m **Depth:** 40 cm **Flow Rate:** 0,24 m/sec **Catchment Area:** 50 km² **Age:** Flowed through 600 years of Seoul	**Seoul, South Korea**	**Diametral** In the city center of Seoul (it has been a symbolic boundary defining Seoul geographically, politically, culturally, and socially)	**Cheonggye River Restoration Project, 2005** Cheonggye River Restoration Project was put into shape. Restoration area is 5,5 km². The Project includes cultural heritages such as Stone bridge as well as traditional events reproduction. *Problems:* -Covered by a road (1967-1976) -The road became old and despite reinforcement, it became dangerous for use due to aging. *Solutions:* -Removing the road -Restoring the river Cheonggye River was covered by a road (1967-1976). The road became old and despite reinforcement, it became dangerous for use due to aging. Solutions drawn with Cheonggye River Restoration Project are mainly, removing the road, and daylighting a buried stream that was under highway. The project was put into shape in 2005 on the 5, 5 km2 restoration area. This is the world's first case of urban re-development Project by removing the road and restoring the river. The Project includes developing a linear park, open watercourses handle flooding rains and global warming, , increasing fish an bird species, transportation changes like expanded bus service, restrictions on cars and higher parking fees, ancient pillars as remnants of (and reminders of the folly of) the former highway that occupied the space, and art installations, cultural signature bridges.
Danube River **Physical Attributes of River:** **Length:** 2850 km **Width:** 820 km² **Depth:** 1 to 8 m Width to depth ration is 60 **Flow Rate:** Average water discharge at the mouth is 6430 m3/sec. **Catchment Area:** 817.000 km² **Age:** Known to history as one of the long-standing frontiers of the Roman Empire.	**Vienna and Bratislava**	**Out of Urban Area**	Plan is on Vienna and Bratislava. Plan is on Vienna and Bratislava. Main targets are navigation, river-bed stabilization, and ecological improvement. Plan completed on the base of interdisciplinary expert agreement, pilot works and river bank restoration underway – environmental assessment to be submitted in late 2007. The project involves a variety of infrastructural and ecological measures to improve navigation, the stability of river bed as well as the ecological conditions along 50 km stretch of the Danube.

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects continued

Rhine River **Physical Attributes of River:** **Length:** 1300 km **Width:** 100 to 500 m Average width is 400 m in Germany. **Depth:** 1 – 2 m **Flow Rate:** Average discharge is 2200 m3/sec The maximum flow rate at the river's mouth exceeds 11000 cu m per sec. **Catchment Area:** 224.000 km² **Age:** Rhine Falls were formed some 500,000 years ago during the ice age	**Baden Wurttenberg, Germany**	**Out of Urban Area**	**Comprehensive Rhine River Flood Control Plan** Decided by Baden Wurttemberg State, Germany. In the plan, measures for flood control and for conserving and restoring the basin area's ecosystem are proposed. Plan area is 270 km2
Besòs River **Physical Attributes of River:** **Length:** 40 km **Width:** 130 m **Depth:** Braided morphology across a 300 m wide. **Flow Rate:** 2400 m3/s **Catchment Area:** 1000 km² **Age:**	**Barcelona, Spain**	**Diametral** Besòs River is a torrential river flowing through the urban area of Barcelona.	**Restoration of Besòs River** The river has been named the most contaminated river in Europe during the 1970s and 1980s. Since the mid-1990s, however, the river has been in the process of recovery. The design of a meandering low flow channel within the floodway is dealt with. Constructed wetlands to improve water quality were planned for the floodplain on both sides of this channel. It is received funding 20 million US dollars for 6 km of the river path from European Community in 1996.
Fu-Nan River **Physical Attributes of River:** **Length:** 17 - 40 m ? **Width:** 4,5 - 12,5 m ? **Depth:** **Flow Rate:** Mean annual runoff is about 3.5 billion cubic meters **Catchment Area:** 660 hm² **Age:**	**Chengdu, China**	**Diametral**	**Funan River's Comprehensive Revitalization Project,** The biggest venture of the project is The Living Water Garden, a 5,9 acre (about 2,4 ha) park on the river. The river passes through the center of Chengdu, a city of nine million. The Park workings started in 1996 and finished in 1998. since the park opened, it has become the most popular park in the whole city. In the park there are pumps, settling ponds, reconstructed wetlands, natural water purification system, various plant species, steps going down to the river to provide public access, and various sculptures as public arts to raise awareness of the pollution in the Funan River.It is received funding 20 million US dollars for 6 km of the river path from European Community in 1996.

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects continued

Los Angeles River **Physical Attributes of River:** **Length:** 82 km. **Width:** 21 - 79 m **Depth:** 1 - 5 m **Flow Rate:** **Catchment Area:** 2160 km² **Age:** The river provided a source of water and food for the Gabrielino Indians for hundreds of years prior to the arrival of the Spanish.	**Los Angeles, CA, US**	**Some parts are eccentric of tangential** The river was originally an alluvial river that ran freely across a flood plain that is now occupied by Los Angeles, Long Beach, and other townships in Southern California.	**Los Angeles River Revitalization Plan** 2002 -? 36 months planning process The plan is intended to guide construction of a series of parks along 48 kms of the river from Canoga Park to downtown Los Angeles over 25 to 50 years. It consists of 239 projects, most of them small. Implementing all of them would cost more than $2 billion. In 2007, the city adopted a master plan for the revitalization of the 32-mile long river with visions to 'reconnect, re-imagine, and re-claim' the forgotten watershed. The plan details strategies to realize the city's goals of revitalizing the river, greening neighborhoods, capturing community opportunities, and creating value. The plan is intended to guide construction of a series of parks along 48 kilometers of the river from Canoga Park to downtown Los Angeles over 25 to 50 years. It consists of over 200 projects, most of them small. Revitalizing the Los Angeles River would address not only the need to rehabilitate the ecological functions of the watershed, but would also target the city's deficiency of neighborhood parks. Furthermore, the plan's focus on public outreach, job creation, and youth participation shows efforts to be culturally sensitive and economically relevant.
Singapore River **Physical Attributes of River:** **Length:** 11 km **Width:** **Depth:** **Flow Rate:** **Catchment Area:** **Age:** The history of the Singapore River started the period of pre-colonial.	**Singapore, Singapore**	**Diametral** The Singapore River forms a central artery in Singapore's densely packed Central Business District.	Once the lifeline of the nation, the river was the economic artery of Singapore where pioneers lived and worked together.Starting in the 1880s, there was heavy traffic on the Singapore River due to rapid urbanization and expanding trade. By late of 1970s, the government was starting to take action to clean up the river. Today, the waterway has become a major leisure and tourist attraction. A long promenade was constructed to offer shady walkways, art venues, restaurants for alfresco dining, entertainment and retail establishments in conserved shophouses for rest and recreation. Key points of restoration are: 1. Water purification 2. River development unified with the city. After ourification, alnd value was raied, fish returned to river, some catchments are opened to the public for boating and swimming. The 2nd theme covers hat waterfront is a key for high-quality of life: sand beaches have been created in riverbeds, paved walking trails have been prpared on the both side of Singapore River, old shops and warehouses have been repaired into restaurants and cafes.
Porsuk River **Physical Attributes of River:** **Length:** 448 km **Width:** 30 m on average **Depth:** **Flow Rate:** **Catchment Area:** 11.188 km² in Eskişehir and Kütahya provinces **Age:** Since the times of Romans	**Eskişehir, Turkey**	**Diametral** Flows throuh the city centre	**Porsuk River Rehabilitation within the Eskisehir Urban Development Project, 2001** Eskişehir's Porsuk River, which passes through downtown area, was restored in 2001 the Eskişehir Greater Municipality under a package project. Eskişehir Urban Development Project has 3 phases: preventing flooding damage with restructuring riverbed, renewing canals and urban water system infrastructure, improving a tramway system. These main objectives were reinforced by creating parks and walking ways nearby the river, renewing old bridges and building new bridges on the river, setting up designs for boats etc. within 10 kilometers on the river, attaching river with major urban parks and with an artificial beach.

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects continued

Ille River **Physical Attributes of River:** **Length:** 216.8 km **Width:** **Depth:** **Flow Rate:** **Catchment Area:**1300km² **Age:**	**Strasbourg, France**	**Dimetral** Strasbourg is situated by the German border, where the Ill River flows into the Rhine. Strasbourg is one of the nine largest cities in France with nearly half a million inhabitants in a metropolitan area spanning across the river, on the eastern bank of the Rhine.	The Ill river and its tributaries have the characteristics of typical upland streams, with near-natural formation of riverbank vegetation, particularly in the upper reaches. The objective of the project is the restoration of a naturally stable and intact riverine system which represents a diversity of habitats for flora and fauna. The priority is to bring the condition of the stream to a high ecological status which does not require permanent management measures, and to reinstate a high level of structural diversity in the aquatic, amphibian and terrestrial environments. Furthermore, efforts are to be made to restore adjacent floodplains to a near-natural condition. Period: 1992 to 2005 Cost: 17 Mil. Euro
Rhone River **Physical Attributes of River:** **Length:** 813 km **Width:** **Depth:** **Flow Rate:** 640 m3/s **Catchment Area:** 98000 km² **Age: S**ince the times of the Greeks and Romans	**Lyon, France**	**Eccentric**	**2006** Until 2006 large portions of the riverbanks of the Rhone River are planned to be rehabilitated by the Lyon agglomeration authority Le Grand Lyon. The rehabilitation program embraces an area of about 60.000 m² that shell receives new functions.
The Blue Network **Physical Attributes of River:** Several urban river courses **Length:** **Width:** **Depth:** **Flow Rate:** **Catchment Area:** **Age:**	**Brussels, Belgium**	**Out of Urban Area**	**The Blue Network** The program involves the restoration of several urban river courses in the Central Brussels Region. The program is focesed on restoring hydrological, ecological, visual and recreational functions of the river corridors. It aims to have an integrated, durable and ecologically justified management of open waterways in Brussels. The blue network is made up of small rivers, ponds and marshes. It is dedicated to the enhancement of natural values and biodiversity while maintaining the access of the public to the areas concerned.

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects continued

Trout 2010 **Physical Attributes of River:** Many of the Urban Brooks in Hamburg **Length:** **Width:** **Depth:** **Flow Rate:** **Catchment Area:** **Age:**	**Hamburg, Germany**	**Various brooks in several places in urbanized area**	***Trout 2010*** Trout 2010 is a program to restore salmonid region habitats for selected streams in Hamburg-. Necessary improvements in canalized stream sections will be made through cooperation of "Adopt –a-brook-groups" (NGOs). The program meets the objectives of Agenda 21 for urban settings. One main task for project phases is to re-establish the river continuum by by-passing the park ponds. Being part of a cultural heritage most of these former mill ponds will have to be preserved.
Isar River **Physical Attributes of River:** **Length:** 295 km **Width:** approx. 50 m **Depth:** 1,5 to 2 m **Flow Rate:** 185 cu m per sec **Catchment Area:** 9000 km² **Age:** As early as the Early Stone Age	**Munich, Germany**	**Out of city**	**Isar Plan, 1995-2006** The Isar Plan was initiated in 1995. it is a combined programme of the State of Bavaria and City of Munich, designed to improve flood defense, ecology and recreational value on the Isar River in Munich until 2006.The plan deals with the restructure of an 8 kilometer strip of the river beginning on the southern borderline of the City of Munich up to the Deutsches Museum, located on a riverisland nearby the city center. The target was to change the artificial, inattractive riversite into a natural, attractive area with high ecologic value and a large-scale recreation area.
Various Streams in city of Zurich **Physical Attributes of River:** Various Streams in city of Zurich **Length:** **Width:** **Depth:** **Flow Rate:** **Catchment Area:** **Age:**	**Zurich, Switzerland**	**Various Streams in city of Zurich**	**The Zurich Stream Daylighting Program** A clean-water concept for separating uncontaminated water from sewage channels was extended into a stream restoration concept. The goal is to 'daylight' as many streams as possible, realigning them on the surface, to increase ecological and recreational values within the urban area of the city Zurich. Zurich has reopened covered watercourses and restored ecology of many streams for the past 20 years. With the Zurich Stream Daylighting Program, a clean-water concept for separating uncontaminated water from sewage channels was extended into a stream restoration concept. The goal is to 'daylight' as many streams as possible, realigning them on the surface, to increase ecological and recreational values within the urban area of the city Zurich. The city started to modify its combined water system to a partially separate system that serves the diversion of rainwater runoff. Zurich demonstrates that it discovered the value of streams from an ecological and urban planning perspective with a stream concept. Each new stream daylighting project made people more aware of a stream and willing to participate in the planning process. Through this program, the streams in Zurich have also become essential elements that are taken into consideration in the spatial planning.

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects continued

Seine River **Physical Attributes of River:** **Length:** 780 km **Width:** **Depth:** **Flow Rate:** **Catchment Area:**78.700 km² **Age:**	**Paris, France**	**Diametral**	**Operation Clean Seine, since end of 1980s** The Seine River has been the subject of major conservation efforts called 'Operation Clean Seine'. New water purification plants and separating sewers from storm drains within the context of the Clean Seine have removed pollutants and brought the salmon back to the river.
Thames River **Physical Attributes of River:** **Length:** 330 km **Width:** 46 m wide at Oxford **Depth:** Varied depth up to 20 m **Flow Rate:** **Catchment Area:** 14.250 km² **Age:** began life between 140 million years ago	**London, UK**	**Diametral**	**London South Bank Riverfront Regeneration, since the beginning of 2000s** Once-neglected South Bank is one of the the city's most vibrant promenades since the last decade (Masters at al, 2010). Entering the 2000s, London Southbank Riverfront Regeneration was implemented on the north side of the city. With the project, new usages such as museums, concert halls, cafes, recreation areas were introduced. Famous Modern Art Museum and a giant Ferris wheel (the London Eye) are among them. Southbank Project was realized in the city center; by this project a social and cultural focal point was created in the city (Babalık Sutcliffe, interview, 2011).
Muddy River (A Tributary of Charles River in Boston) **Physical Attributes of River:** **Length:** 5,6 km **Width:** **Depth:** up to 3,5 m **Flow Rate:** **Catchment Area:** 14,5 km² **Age:**	**Boston, MA**	**Eccentric**	**Muddy River Restoration Project** The objectives of the Muddy River Restoration Project include improvement of flood control, improvement of water quality, enhancement of aquatic/riparian habitat, rehabilitation of landscape and historic resources, and implementation of Best Management Practices (BMPs). Riverfront already provides a range of public spaces such as promenades, walking ways, bike paths, parks, boating, river clean-up days.

Table J.1 Matrix on Rivers, Physical Attributes, Their Respective Cities, and Their Rehabilitation Projects continued

San Antonio River **Physical Attributes of River:** **Length:** 386 km **Width:** **Depth:** **Flow Rate:** 11 m³/s **Catchment Area:** 2419 km² **Age:** the first documented record in 1535	**San Antonio, TX**	**Diametral, Eccentric**	The San Antonio River runs through downtown San Antonio. The ‘river-walk’ is already the major attraction in the city and location of many shops and restaurants, and high-class hotels. Four-phased project benefits are; ecosystem restoration, flood damage reduction, improving quality of life, developing cultural connections, and promoting economic development along and adjacent to the river.
Tiber River **Physical Attributes of River:** **Length:** 405 km **Width:** **Depth:** 2 – 6 meter **Flow Rate:** **Catchment Area:** **Age:**	**Rome, Italy**	**Eccentric**	In 2003, a new city plan was prepared for the city following the 1962 Piccinato Plan. In the new plan a section was allocated to a project for Tiber. It is mentioned in the plan that the emphasis of this project would not only be on reclamation and development of the river but also on its relation with the city as asserted in this thesis study. The main objective of this Tiber project is to ‘bring the city to the river again’. For this aim the project proposes that inner city navigability be restored, mooring near focal points should be provided, the banks of the river should be modernized with easy access points to the river, and landscape perception of the city from the river should be provided. The project also mentions that an ‘integrated’ program is vital for this rehabilitation project in which the river is perceived, evaluated and interpreted within the context of integration with the city.

Sources: Arzet and Joven, n.d.; “Atlantic Salmon”, 2009; Bauer, 2007; Conradin, n.d.; Conradin, 2004; Conradin and Buchli, 2004; “Country Profile Belgium”, n.d.; “Floating Down the River (1)”, n.d.; “Floating Down the River (2)”, n.d; Gaffin, 2008; “Isar”, n.d.; “Isar River”, 2011; “London Rivers Action Plan”, n.d.; “London Rivers Are to Be Restored”, 2009; Martin-Vide, 2001; Mink and Schuck, 2011; “Muddy River Restoration Overview”, n.d.; “Munich Isar Plan”, n.d.; Park, n.d.; “Restoration of Singapore River”, n.d.; “Rhone River”, 2011; “RiverLinks”, n.d.; “River Thames”, 2011; “San Antonio River”, 2011; Schanze et al., 2004; “Seine River”, 2011; Stein, 2009; “Tiber River”, 2011; Yuen, n.d.; “Trout 2010”, n.d.;

APPENDIX K

MAJOR PARKS IN CITY OF ESKIŞEHIR

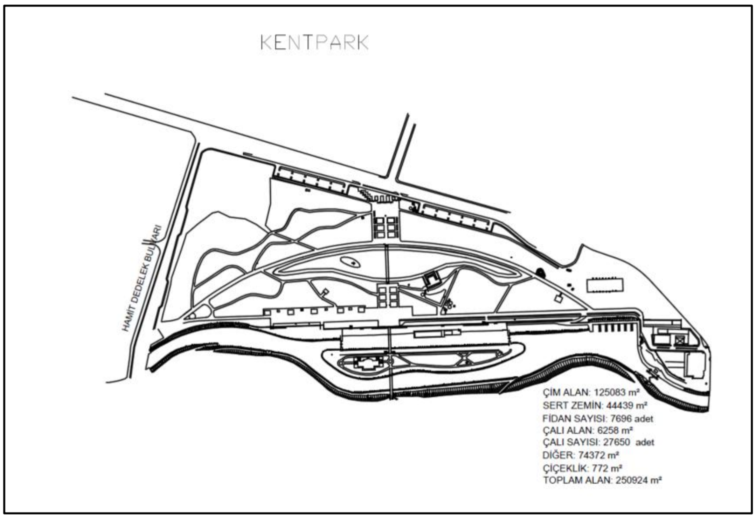


Figure K.1 Kent Park Landscape Plan
Source: The Archieve of EGM Directorate of Parks and Gardens

Figure K.2 A View from Kent Park
Source: The Archieve of EGM Department of Technical Works

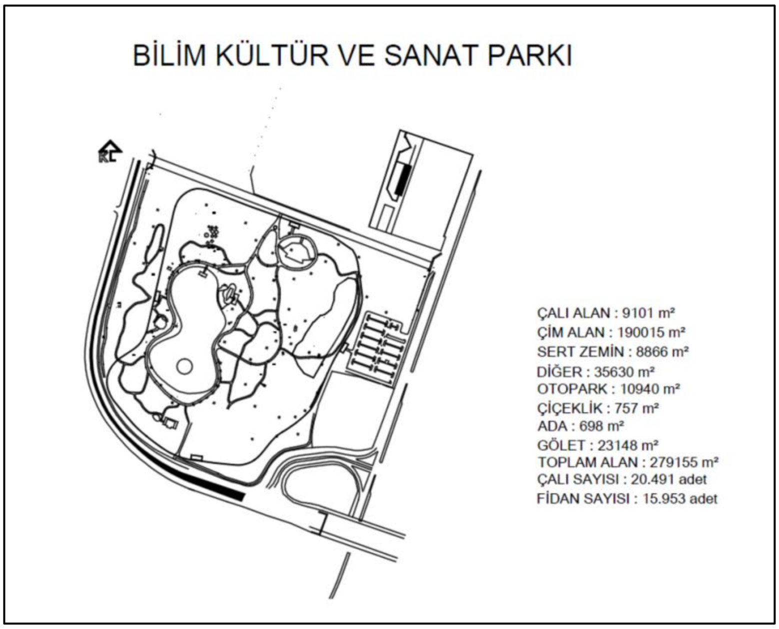


Figure K.3 Sazova Science, Culture and Arts Park Landscape Plan
Source: The Archieve of EGM Directorate of Parks and Gardens


Figure K.4 A View from Sazova Science, Culture and Arts Park
Source: The Archieve of EGM Department of Technical Works

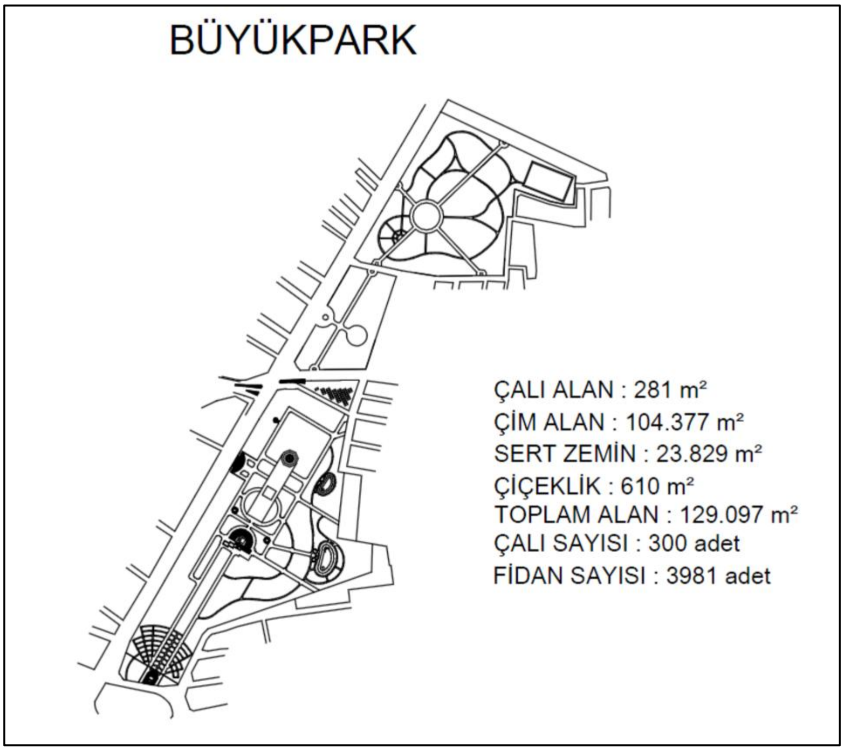


Figure K.5 Büyük Park Landscape Plan
Source: The Archieve of EGM Directorate of Parks and Gardens

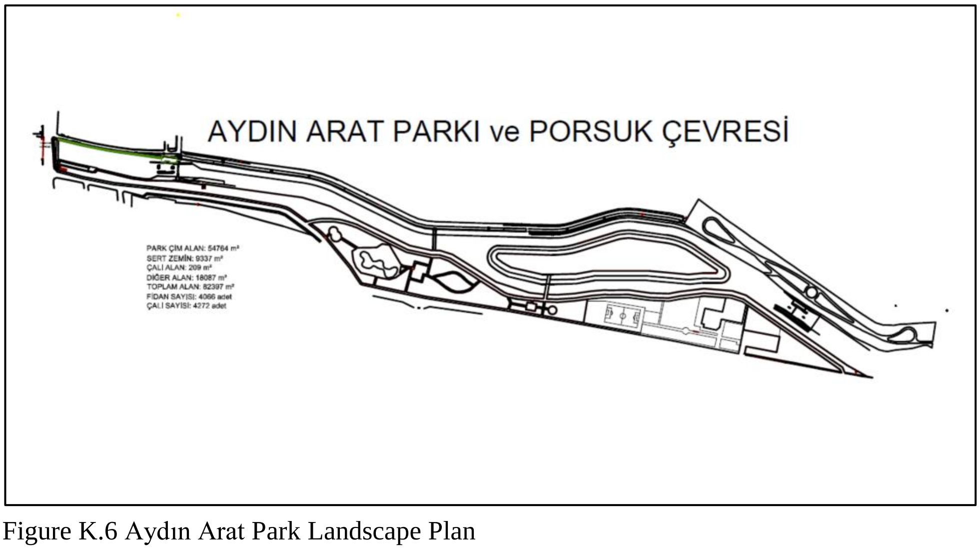


Figure K.6 Aydın Arat Park Landscape Plan
Source: The Archieve of EGM Directorate of Parks and Gardens

APPENDIX L

SAMPLES FROM REINFORCED AND REBUILT BRIDGES ON PORSUK RIVER

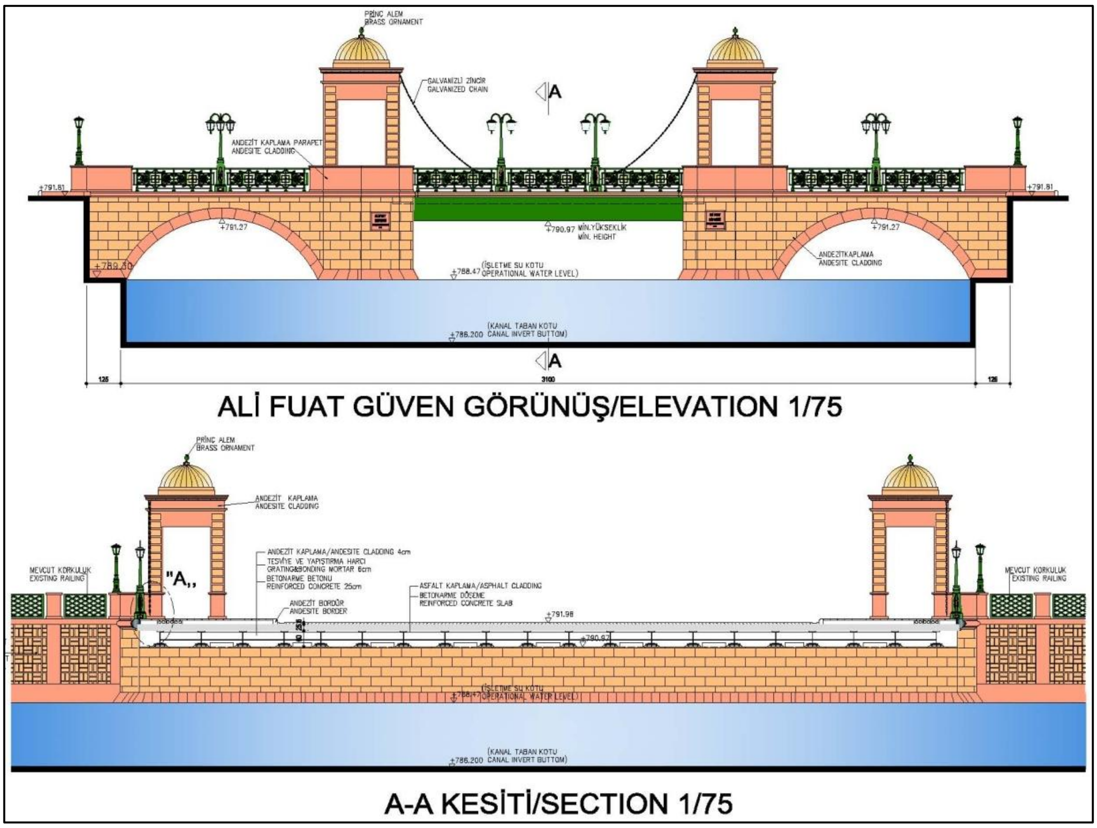


Figure L.1 Ali Fuat Güven Bridge Elevation and Cross Section
Source: The Archieve of EGM Department of Technical Works

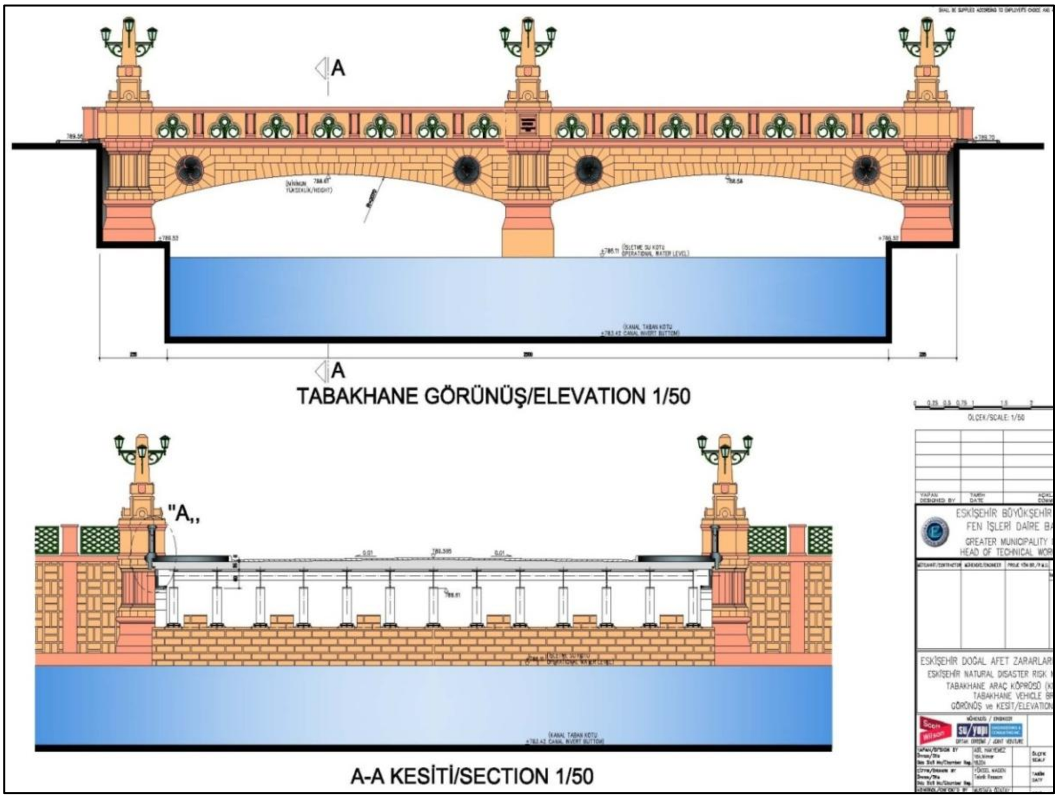


Figure L.2 Elevation and Cross Section of Tabakhane Bridge

Source: The Archieve of EGM Department of Technical Works

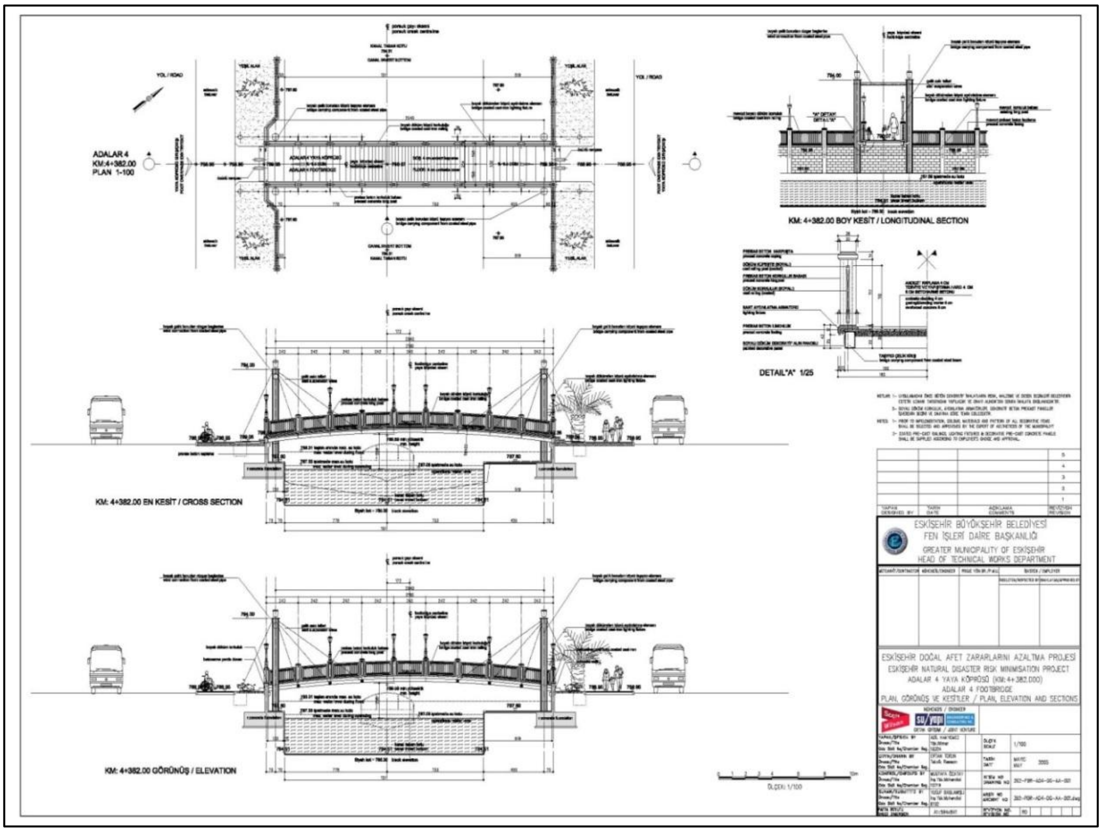


Figure L.3 Plan, Elevation and Cross Sections of Adalar 4 Pedestrian Bridge

Source: The Archieve of EGM Department of Technical Works

Figure L.4 Old (1999) and New (2010) Situation of İki Eylül Vehicle Bridge

Source: The Archieve of EGM Department of Technical Works

APPENDIX M

PLANS PRODUCED ON THE PORSUK RIVER

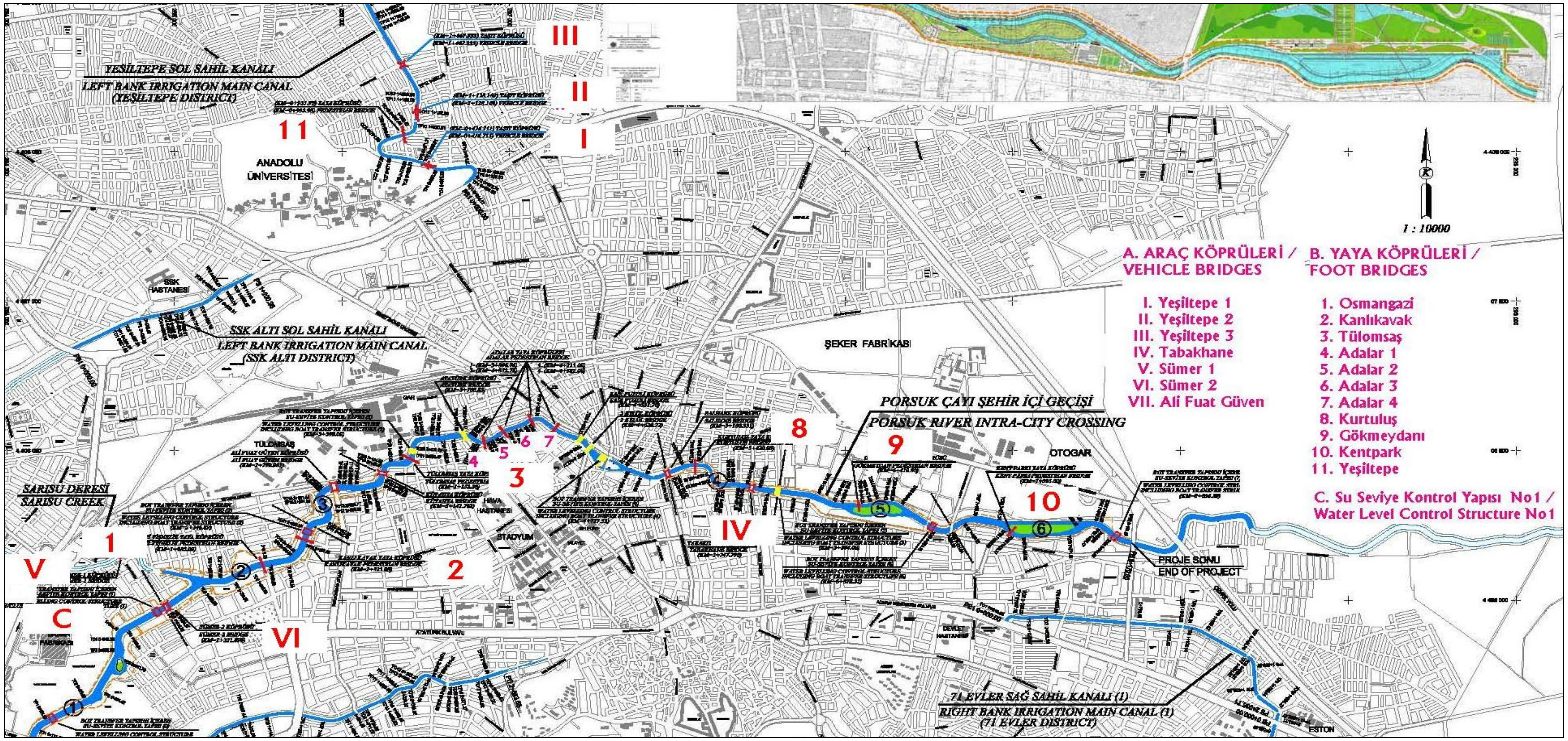


Figure M.1 Layout Plan that Shows Vehicle Bridges, Pedestrian Bridges, and Water Level Control Structures

Source: The Archieve of EGM Department of Technical Works

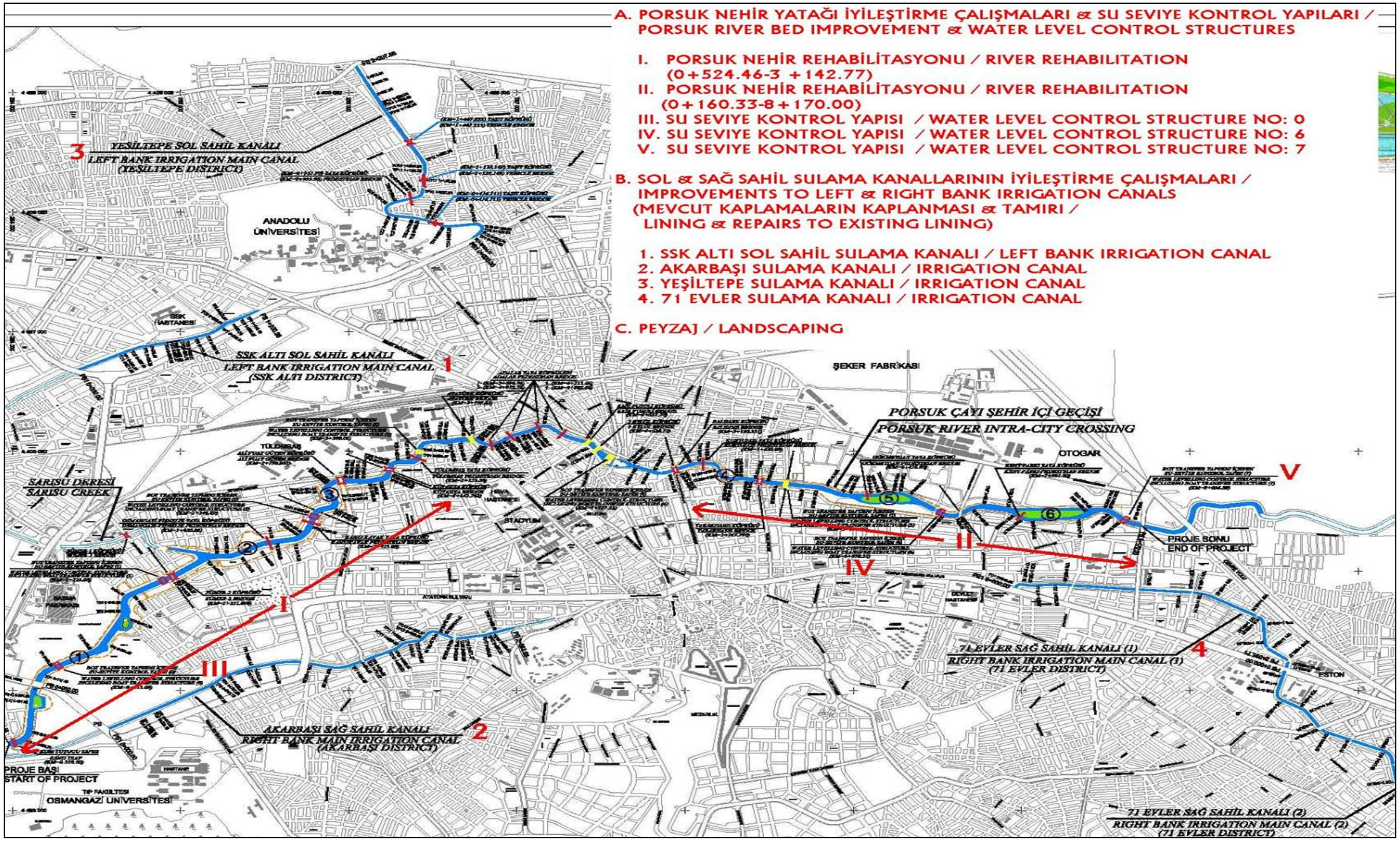


Figure M.2 Layout Plan that Shows Porsuk River Bed Improvement, Improvements to Bank Irrigation Canals and Landscaping

Source: The Archieve of EGM Department of Technical Works

Fıgure M.3 Landscape Planning of Porsuk River - Part I

Source: The Archieve of EGM Directorate of Parks and Gardens

Figure M.4 Landscape Planning of Porsuk River - Part II

Source: The Archieve of EGM Directorate of Parks and Gardens

APPENDIX N

INTERVIEW QUESTIONS

On the Ecocity

-Is cleaning of waterways carried out? How?

-Is control of erosion and of sediment deposition carried out? How?

-Is building of buffer zones on problematic areas next to the river carried out?

-Is rehabilitation of rivers and river corridors carried out? Which project?

-Is rehabilitation of wetlands carried out?

-Is quality of domestic water improved? How?

-Is urban water system infrastructure improved? How?

-Is there a wastewater treatment plant?

-Are sewage and stormwater networks separated? Obtaining Energy from Used Water – Is obtaining energy from used water introduced?

-What is the type of urban water system, is it hybrid, open or closed-loop?

-Is stormwater reused for garden watering and irrigation?

-What is the ratio of pervious surface area? Are there attempts to decrease impervious surfaces in the city?

-Are there any measures developed to decrease impervious surfaces in new urban plans and projects?

-Are waterways those had taken to underground daylighted, and linked with green spaces?

-Is there an approach of mixed use planning and design in plans and policies of the city?

-Is there a mass transport system through the city? Are transport nodes accessible? Is there a connection between various modes of public transport?

-Is current or prospective mass transport system environmental sensitive?

-Are pedestrian roads developed?

-Are bicycle roads developed?

-Are stream catchments in periphery mostly transformed to green parks and open spaces?

-Is there an operation to reduce ecological footprint?

-Is there any efforts on reduction of carbon expansion?

-Is there a vision to replace concrete piped (grey) infrastructure system -when it is aged- with green infrastructure system?

-Is there a vision to renew inefficient building stock in order to decrease Carbon Footprint of the city?

-Is there a vision to decentralize of urban water system to neighborhoods?

-Are rainwater collection systems developed?

-Is there any efforts on building stormwater detention parks?

-Do planning practices reflect smart growth to obtain compact and dense urban tissues to achieve less consumption of land, water and other resources?

-Are there any projects on development of eco-sites / eco-blocks / eco-buildings that can recycle their wastes and produce their own energy?
-Is there any coordination of the stakeholders and of the responsible institutions at project and catchment level?
-Does awareness for protection of hydrophilic habitats like rivers, lakes, wetlands and groundwater increase?

On the Integration
-As the river's relation with the city been considered during the river rehabilitation? If yes, from which aspects?
-What are the priorities for entering into a connection with the city? Which phases were passed during this connection process and which measures were taken? (Such as improving accessibility, designing riverfronts and providing links towards the other local elements of the city)
-What is your opinion regarding the present image of the river? Do you think it is successful? If yes, in what aspects? If no, in what aspects?
-What do you think about the ways of handling the cities in which a river flows?
-What do you think about the public transportation and accessibility?
-Who are the stakeholders? Is there any participation of NGOs or chambers? For example, was any cooperation considered with the Chamber of Architecture?
-What do you think about housing and building intensity in the city?
-Your opinions regarding the parks, green areas?
-Is the pedestrian access sufficient?
-Is it possible to improve bicycle access?
-What do you think about the bridges on Porsuk?
-Is the planning pattern mixed-use?
-How would you define integration of the urban river with the city?
-What measures should be taken, what should be done in order to provide for this integration?
-What does the term "intergration of the urban river with the city" mean to you? What visions does the term evoke in your mind?
-In your opinion what are channels of integration of the urban river with the city?
-What parts, which components of the city should the river be integrated to?
-Is provision of accessibility sufficient for achievement of a feasible level of integration of the urban river with the city?
-Which parts, components of the city should receive priority in provision of accessibility to the river?
-What are means of provision of accessibility to the river? How is it achieved?
-What does provision of spatial accessibility to the river mean?
-What do you think about the integration of historical, cultural and even modern, contemporary assets of the city which are capable of providing image and identity to the city into a conceptual whole, into a conceptual center, accentuated by provision of certain transport modes leading to the urban river?
-Do you think this could be achieved in Eskişehir and if "yes" how?

APPENDIX O

LIST OF INTERVIEWEES

Mr. Murat - Tepebaşı Municipality, Directorate of Housing and Urban Development (Urban Planner) (03/11/2010)

Evrim Koç - Tepebaşı Municipality, Directorate of Housing and Urban Development (Urban Planner) (03/11/2010)

Hatay Özkaykı - Eskişehir Provincial Directorate of Industry and Trade (Mechanical Engineer) (04/11/2010)

İsmet Kenar - Eskişehir Provincial Directorate of Industry and Trade (Specialist) (04/11/2010)

Fırat Bilgili - Eskişehir Greater Municipality, Department of Technical Works (Civil Engineer) (04/11/2010)

Tufan Mut - Tepebaşı Municipality (Consultant, Urban Planner) (04/11/2010)

Gülin Yıldız - Tepebaşı Municipality (Urban Planner) (04/11/2010)

Mr. Dilaver - State Hydraulic Works 3rd Regional Directorate (05/11/2010)

Mr. Osman - State Hydraulic Works 3rd Regional Directorate (Environmental Engineer) (05/11/2010)

Bülent Dülger - State Hydraulic Works 3rd Regional Directorate, Etude and Planning Department (Civil Engineer) (05/11/2010)

Metin Arslanbay - Bank of Provinces Eskişehir Regional Directorate, Directorate of Construction (Director) (05/11/2010)

Koray Yeler - Eskişehir Greater Municipality, Directorate of Parks and Gardens (Landscape Designer) (16/03/2011)

Sinem Çepelen - Eskişehir Greater Municipality, Department of Environmental Protection and Control (Environmental Engineer) (16/03/2011)

Fahrettin Çeçgel - Eskişehir Greater Municipality, Directorate of Public Transportation (Director) (17/03/2011)

Birol Utkular - Eskişehir Greater Municipality, Department of Housing and Urban Development (Head of Housing and Urban Development, Urban Planner) (17/03/2011)

Dilek Aykaç - Eskişehir Greater Municipality, Department of Housing and Urban Development (Urban Planner) (17/03/2011)

Memduh Şuur - General Directorate of Eskişehir Water and Sewage Administration, Information Technologies Department (Head of Information Techologies Department) (17/03/2011)

Serdar Bektöre - Self-Imployed (Urban Planner, MSc) (18/03/2011)

Ebru Kıyak - Eskişehir Water and Sewage Administration, Department of Planning (Civil Engineer) (18/03/2011)

Zeynep Erkul - Eskişehir Water and Sewage Administration, Water Treatment Laboratory (Environmental Engineer) (18/03/2011)

Şenay Subaşı - Eskişehir Water and Sewage Administration, Water Treatment Laboratory (Environmental Engineer) (18/03/2011)

Garip Yıldırım - Eskişehir Water and Sewage Administration (General Director) (18/03/2011)

Ali Işık - Eskişehir Water and Sewage Administration, Water Treatment Plant (Technician) (18/03/2011)

Celal Çeliker - Eskişehir Water and Sewage Administration, Water Treatment Plant (Technician) (18/03/2011)

Ayşegül Dinç - Ministry of Public Works and Housing (Urban Planner) (28/04/2011)

Savaş Çekin - Ministry of Public Works and Housing (Urban Planner) (28/04/2011)

Abdullah Solokoğlu - Ministry of Public Works and Housing (Urban Planner) (28/04/2011)

Meral Güngör - Ministry of Public Works and Housing (Architect) (03/05/2011)

Tansı Şenyapılı - METU Department of City and Regional Planning (Prof. Dr.) (26/02/2011)

Ela Babalık Sutcliffe - METU Department of City and Regional Planning (Assoc. Prof. Dr.) (28/12/2010)

Demet Çalışkan Önder - METU Department of City and Regional Planning (Res. Asst.) (06/01/2011)

Süphan Nakiboğlu - METU Department of City and Regional Planning (Res. Asst.) (26/02/2011)

Özgül Acar Özler - METU Department of City and Regional Planning (Res. Asst.) (06/01/2011)

VITA

PERSONAL INFORMATION

Surname, Name: Şimşek, Gül
Nationality: Turkish (TC)
Date and Place of Birth: April 11, 1977, Kütahya
Marital Status: Single
Phone: +90 312 210 6225
Fax: +90 312 210 7965
E-mail: sgul@metu.edu.tr, gulsims@hotmail.com

EDUCATION

Degree	Institution	Year of Graduation
BS	Gazi University Department of City and Regional Planning	2001
High School	Hasanoğlan Atatürk Anatolian Teacher High School, Ankara	1995

WORK EXPERIENCE

Year	Place	Enrollment
2002 - Present	METU Department of City and Regional Planning	Research and Teaching Assistant
2001-2002	Bel-Da Urban Planning Firm	Urban Planner

FOREIGN LANGUAGE

Advanced English

PUBLICATION & PRESENTATION

1. “IWRM at River Basin Level and Some Mediterranean Experiences” (presented paper), CAIWA 2007 International Conference on Adaptive & Integrated Water Management, Basel, Switzerland, November, 2007.

2. “Havza Düzeyinde Yönetim ve Planlama, Türkiye” (published paper), Karadeniz Technical University, 11th Regional Science and Regional Planning Congress, Trabzon, Turkey, October, 2004.

HOBBY

Painting, Ceramics & Pottery, Photography, Travelling