Ecohydrology & Hydrobiology xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Ecohydrology & Hydrobiology

journal homepage: www.elsevier.com/locate/ecohyd

Original Research Article

'Stream Daylighting' as an approach for the renaturalization of riverine systems in urban areas: Istanbul-Ayamama Stream Case

Q1 Delibas Meltem [a,b,*], Tezer Azime [c]

[a] Turkish Water Institute, Uskudar, Istanbul, Turkey
[b] Graduate School of Science, Engineering and Technology, Istanbul Technical University, Maslak, Istanbul, Turkey
[c] Urban and Regional Planning Department, Faculty of Architecture, Istanbul Technical University, Taskisla, Istanbul, Turkey

ARTICLE INFO

Article history:
Received 4 July 2016
Accepted 30 December 2016
Available online xxx

Keywords:
Renaturalization
Ecohydrology
Stream daylighting
Urban stream syndrome (USS)
Ecosystem services (ESs)
Istanbul

ABSTRACT

The paper discusses the interactions between riverine systems and urban areas with a focus on the ecosystem services (ESs) provided by urban rivers and the threats they have been confronting for the last decades. Urbanization, as a global demographic trend, led to the increase in migration of people from rural regions to urban areas (especially in developing or under-developed countries) that caused congestion problems in cities with a number of documented effects on urban socio-ecological systems. Due to the urban population increase and expansion of anthropogenic activities, urban riverine systems as one of the most vulnerable components of urban ecology are exposed to the crisis of ecological deterioration. As a result, their hydro-morphological characteristics changed, crucial functions and aquatic habitats are lost. From this point of view, Ayamama Stream Watershed is evaluated in the context of the study due to its critical location in Istanbul and a conceptual model framework called 'Co-MISDAL' is developed referring to the 'Renaturalization' of buried sections of the watershed by using 'Stream Daylighting' method under the key principles of 'Ecohydrology'. Three-stage research methodology is used in the paper and 10 different practices of Stream Daylighting from 4 different regions (USA, Switzerland, Korea, Canada) are comparatively analyzed to develop Co-MISDAL as a guideline for renaturalization of the Ayamama Stream Watershed that is suffering from the extreme flood events and pollution problems. The research mainly aims to evaluate the effectiveness of Ecohydrological approach and renaturalization practices for buried and/or damaged urban riverine systems through Stream Daylighting approach.

1. Introduction

"*Take care of the land, and it will take care of you.*"
Aboriginal law.

We are living in an urbanizing world. Recently, UN Report on World Urbanization Prospects (2014) declared that 89 countries are expected to become more than 80% urban while 66% of the world population (6.4 billion) is projected to live in urban areas by 2050. Urbanization as a social, economic and territorial transition process, puts a considerable stress on socio-economic and ecological systems. In other words, since urban development changes the spatial organization of cities in a remarkable way

Q2 * Corresponding author at: Turkish Water Institute, Uskudar, Istanbul, Turkey.
E-mail addresses: meltem.delibas@suen.gov.tr, meltemdelibas@gmail.com (D. Meltem), tezera@itu.edu.tr (T. Azime).

http://dx.doi.org/10.1016/j.ecohyd.2016.12.007
1642-3593/

(Alpopi, 2005) growing populations, changing consumption patterns, expansion of built-up areas and current low qualified living of urban contexts are seen as unsustainable development patterns in the long term (Karr, 1999) with several impacts on urban ecological systems. The ecological impacts of this transformation and population re-distribution have been of interest to the scientific community for many years. Recent researches (Eagleson, 2002; Groffman et al., 2002; Karr, 1999; Lowrance, 1998; Pinkham, 2000; Platt, 2006; Walsh et al., 2005; Zalewski, 2013) declare that the accumulation of people have extensive and profound impacts on urban socio-ecological systems and the riverine systems as one of the most vulnerable zones for human-nature interactions has exposed to various impacts caused by human activities. According to Pinkham (2000), the characteristics and functions of urban rivers, which are one of the most modified aquatic ecosystems, have are gradually weakened or lost.

Throughout the history, expansion of anthropogenic activities led riverine systems to be polluted, culverted, buried or changed (hydro morphological structure) resulted with a system failure including damaged & fragmented aquatic ecosystems. Although various solutions are developed for degraded riverine systems, repetitive problems underline the necessity of holistic approaches considering the integration of riverine systems into social and ecological systems in urban areas. The researches in the literature present water resources management in a broad spectrum but an interdisciplinary perspective combining both hydrological, ecological and social assets of the entire system has not been widely used for degraded riverine systems in urbanized landscapes. From this point of view, the research mainly aims to discuss the integration of damaged riverine systems in to socio-economic and ecological systems in urban areas through renaturalization processes with a focus on providing mutual benefits for both nature and mankind and supporting sustainability and integrity of each system.

As the main research question of Ecohydrology asks: 'How do we increase the absorbing capacity of ecosystems, and especially vulnerable water resources, to provide the conditions and time to achieve dynamic equilibrium between population density and carrying capacity?', the nature itself has the answer for a sustainable solution in long term. Other research questions shaped the context of the research are as indicated below:

1) What are the importance, role and services of riverine systems in urban areas?
2) What are the negative effects and pressures that urban riverine systems confront?
3) How 'renaturalization' of degraded riverine systems can be succeed in a multi-disciplinary perspective?

2. Conceptual framework and theoretical background

Urban rivers as one of the most essential ecological systems and vulnerable water resources in urban areas have been exposed to the ecological deterioration due to the disturbance of human activities. Over time, many urban streams have been altered hydraulically, chemically and biologically while portions of most urban streams were ecologically degraded. According to Lei and Guanghe (2008), the functions of urban riverine systems have been gradually weakened, channels were polluted, buried and the riverine characteristics have been lost as a result of increasing anthropogenic activities in urban areas. The impacts on riverine systems mostly resulted in pollution, low stream flow, loss of aquatic species and habitats, channelization or being buried channel that flows in a tunnel under built-up areas and being forgotten by the city. All these negative effects on urban riverine systems emerged the term of 'urban stream syndrome (USS)' (Walsh et al., 2005) which is characterized by geomorphic and hydrologic alterations on riverine systems and described the consistently observed ecological degradation of waterways (creeks, streams, rivers) draining in urban areas. Symptoms of the urban stream syndrome include a flashier hydrograph, elevated concentrations of nutrients and contaminants, altered channel morphology, and reduced biotic richness, with increased dominance of tolerant species, which result ecological, hydrological and morphological alterations and degradations on riverine system structure (Walsh et al., 2005). This conflict between riverine systems and human interfere with the growing pressure of urban development dynamics urges to investigate for a sustainable solution considering the continuity of hydrological processes, access to fresh water, increased flood risk, climate adaptation, increased socio-cultural needs, biodiversity protection and so on. So far, mechanistic, hydro-technical solutions have been developed and some are implemented for degraded riverine systems without considering social and/or ecological aspects in connection with the physical properties. However, in global agenda, the traditional fragmented approach is seemed as no longer viable that a more holistic context to water management is essential. Therefore, understanding of water resources as an integral component of the ecosystem, a natural resource and a social and economic good is provided by Integrated Water Resources Management (IWRM) approach, which has encouraged this research as well to adopt a comprehensive model framework based on the integration of natural thinking in engineering solutions.

"Ecohydrological Approach" which has been developed in the framework of the International Hydrological Programme of UNESCO, is used as an overarching paradigm of the research that brings an additional dimension to water management. The approach is based on scientific understanding of the hydrology/biota interplay and it provides a systemic framework for how to use ecosystem properties as a new instrument for IWRM, complementary to already applied hydro-technical solutions (Zalewski, 2010). The transdisciplinary science of Ecohydrology also considers the role of ecological processes in moderating the water cycle and combines both aspects of hydrology and ecology (Zalewski, 2002).

2.1. Healthy rivers and Ecohydrology

The debates on the 'hydrology' and ecology' interface has a long history (Hannah et al., 2004) that was embraced

Please cite this article in press as: Meltem, D., Azime, T., 'Stream Daylighting' as an approach for the renaturalization of riverine systems in urban areas: Istanbul-Ayamama Stream Case. Ecohydrol. Hydrobiol. (2017), http://dx.doi.org/10.1016/j.ecohyd.2016.12.007