ENVIRONMENTAL CONFLICTS AND INTEGRATION OF URBAN RIVERINE SYSTEMS

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Abstract

Together with a dominant demographic trend and an important component of global land transformations, the world's population has been concentrating in urban areas (United Nations, 1993). On the other hand, in addition to its global reach, growing populations, changing consumption patterns, expansion of urban areas and current unqualified lifestyles of urban context are seen as unsustainable in the long term (Karr, 1999) with a number of documented effects on natural systems. Within the urbanization process, humans became dominant on urban ecology and caused several alterations especially on riverine systems and their hydro-morphological and ecological structure. Therefore, presently it is more crucial to integrate urban natural systems and their functioning into urban development dynamics through social, economic and environmental dimensions.

From this point of view, in addition to functions and importance of riverine systems, the paper focuses on the problems and changes of urban riverine systems which collectively termed as 'Urban Stream Syndrome (USS)' and characterized by geomorphic and hydrologic alterations of a stream (Walsh et al., 2005). In this context, the importance of 'river health' requires special thinking of a riverine system as an ecological unit, not merely a channel that conveys water from the origin to the lowlands. The term of 'Healthy Rivers' constitutes the basis for re-naturalization of degraded riverine systems and directs the paper to investigate the criteria of healthy river characteristics not only for its functioning but also to demonstrate resilience in the face of environmental changes, including climate change, resource exploitation or other kinds of impacts resulted by human activities in urban areas. Therefore, the paper looks at urban stream syndrome from spatial planning perspective and put forward the method of 'Stream

Daylighting' as a tool for reclamation of buried and culverted riverine systems in urban areas and to better understand and integrate its functioning in to urbanization dynamics.

As is known, studies of ecology in cities have exposed environmental stresses, threats, and constraints that affect urban biota. From this point of view, the paper will focus on the significance of healthy rivers in urban ecology and their ongoing threats and challenges from urbanization dynamics together with human activities all will be discussed for better integration into spatial, social and economic development of urban settlements.

Key words: Urban riverine systems, urban stream syndrome, healthy rivers, re-naturalization, stream daylighting.

1. Introduction

Water has always played a central role in human societies (Biswas, 2008). However, according to the United Nations 2009 Revision of World Urbanization Prospects, 50.5% (3.5 billion) of the population on Earth is living in cities in 2010. Consequently, the ecological impacts of this population growth and its distribution are profound especially on water resources. With the acceleration of urbanization, as one of the essential components of natural processes, urban rivers are exposed the crisis of ecological deterioration.

In this context, "urban riverine systems" refer to those that originate from or flow through city proper, including some artificial canals and canal systems which have had the characteristics of natural rivers through the evolution of so many years (Lei and Guanghe, 2008). Riverine systems in urban areas occur at the land-water junction alongside the natural waterways and they form unique ecosystems that act as 'buffer zones' between uplands and downstreams (Lowrance, 1998). However, as a result of increasing anthropogenic activities, the functions of urban rivers are gradually weakened, the river channels are polluted, buried and the riverine characteristics have been lost. Urban rivers which were one of the zones where human activities and natural processes have had mutual benefits during the process of urbanization, have been profoundly affected through this process (Lei and Guanghe, 2008). Their functioning, structure and components were changed, degraded or lost.

From this point of view, re-naturalization and integration of buried or degraded riverine systems has become an important issue with a focus on providing mutual benefits and supporting the sustainability and integrity of riverine urban systems. Therefore, the paper analyses the current situation and problems of urban riverine systems within 'Urban Stream Syndrome' framework and proposes 're-naturalization' of these systems in order to develop their lost natural characteristics and functioning both from ecological and socio-economic perspectives.

2. Riverine Systems in Urban Areas

Throughout the civilization process, the lands around riverine systems have always been a suitable and preferred place for human beings. As can be seen from the early civilizations such as the Egyptian Civilization, Indus Valley Civilization and Mesopotamian Civilization developed near major perennial rivers (Biswas, 2008). These civilizations were all founded on their access to water by canal systems which provided the key not only to supplying freshwater, but also to agriculture, trade, transport and defense.

Although riverine systems make up 2% of all freshwater on Earth, they have an important role for the continuity of natural processes as part of the 'Water (hydrological) Cycle' which is essential for existence of freshwater resources on the land surface. Riverine systems serve as roads to carry water, organisms, important gases and nutrients to many areas. They also help drain rainwater and such dynamic systems provide a wide range of ecological niches supporting a diverse flora and fauna with providing travel routes and recreation opportunities for people in connection with nature (White and Keith, 2005).

Riverine systems also have an important role as part of the urban ecology. These systems in urban areas not only provide important source of water and material but also have an ecological importance with the riparian areas which are the hotspots of interactions among plants, soil, water, microbes and people (Lowrance, 1998).Therefore, if the integrity of each system is succeed then the urban ecology can be a better linkage among the three components of sustainable development (social, economic, environmental) (UN, 1987). Herein the integration of such principles in to practice has some challenges and requires scientific & pragmatic tools. One such pragmatic approach to apply this principle in to practice is that of 'ecosystem services', which describes the multiple benefits provided to people, both directly and indirectly by ecosystems and biodiversity (Daily 1997). These services were defined and grouped by the UN Millennium Ecosystem Assessment (MEA) (2005) into four categories: 'provisioning services' (extractable resources), 'regulatory services' (processes that regulate the natural environment), 'cultural services' (culturally- valued benefits) and 'supporting services' (processes essential to maintenance of the integrity, resilience and functioning of ecosystems). In this context, watershed areas including headwater streams provide important ecosystem services such as clean drinking water, habitat for aquatic life, and rapid processing and uptake of nutrients which can reduce delivery of nitrogen and phosphorus to downstream coastal waters. According to Elmore and Kaushal (2008), riverine systems in urban areas, as another component of this system, also serve as a variety of functions: urban drainage and flood management, public and community amenity (including linkages to open space), and can include special cultural and community significance (Table 1). In addition to the importance of their ecological functions, they also can integrate the history with modern city features and provide a

social cohesion among generations. Hence, riparian zones are foci for human-nature interactions and can serve as catalysts for ecological and socio-economic revitalization in urban systems (Groffman et al., 2003).

Table 1: Ecosystem services of riverine systems in urban areas

Ecosystem Services of Riverine Systems in Urban Areas	
Provisionary	Freshwater, Food, Fibre, Aquatic Habitats, Energy Production
Regulatory	Flood Management, Disease control, Water & Air Pollution Control, Urban Drainage
Cultural	Public & Community Amenity , Recreation, Aesthetic Value, Ecotourism
Supporting	Soil Fertility, Water Cycle, Material Carrying (Water & Sediments Carrying), Mass & Energy Exchange

However, even it has been recognized that water is an essential requirement for humans and ecosystems' survival; the ecological researches of terrestrial urban systems include many contrasts among economic development, social wellbeing and ecological conservation in urban areas. Hence, as the human population steadily increased over time and the range of the human activities also expanded, especially after the Industrial Revolution, and urban ecological systems are largely exposed to several pressures caused by anthropogenic impacts. Due to the growing demands of population especially for water resources, in terms of both quantity and quality of riverine systems started to come under increasing stress in many parts of the world than ever before (Biswas, 2008). Over time, many streams and river basins in urban areas were altered hydraulically, chemically, and biologically through navigation and flood control projects, wetland dredge-and-fill activities, industrial activities and waste discharge. According to Bernhardt and Palmer (2007), the most obvious and immediate consequences of urbanization are an increase in impervious surfaces resulted as the increased runoff to receiving streams, higher peak discharges, greater water export and higher sediment loads. As a result of increasing impervious cover in developing catchments, evapotranspiration and soil infiltration are reduced, peak discharges and flashier stream flows increased. The changes in channel morphology disconnect the stream from its flood-plain, decrease meandering, and homogenize stream profiles that increase flood risk and degradation of aquatic habitats and biodiversity. Therefore, an

altered hydrography with high peak flows and reduced base flows is the most obvious and consistent effect of catchment urbanization on stream hydrology (Walsh et al., 2005).

All these negative effects of urban areas on riverine systems emerged the term of 'Urban Stream Syndrome (USS)' (Walsh et al., 2005) which describes the consistently observed ecological degradation of streams draining urban land. It is also used to describe a consistent pattern of hydrological, physical, and biological conditions seen in aquatic ecosystems downstream of urban inputs. Although, urban-impacted riverine ecosystems are degraded due to the complex and multiple factors of the major anthropogenic impacts which can be ascribed in few large-scale groups including urban storm water runoff, land use, deforestation and pollution (Table 2). In this context, symptoms of the urban stream syndrome include 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 systems (Walsh et al., 2005).

Table 2: Impacts of urbanization on riverine systems within (USS) framework

Drivers ……▸	**Symptoms** ……▸	**Results**
• Urban storm-water runoff • Land use • Deforestation (for riparian vegetation) • Polluters	• Water Quality (Nutrients & toxics increase) • Temperature (Temperature increase) • Hydrology (Altered channel morphology) • Physical Habitat (Biotic richness decrease & tolerant species increase)	• Ecological, Hydrological and Physical Degradation on Riverine Systems

3. Re-naturalization of Riverine Systems in Urban Areas by Stream Daylighting

Over the last couple of decades, river restoration has emerged as an important intervention to overcome the long-term deterioration effects of human manipulation on rivers (CRSSR, 2012). The earliest river restoration projects were launched in Europe. The US started the activities around mid 1970's, and later some examples took place in China. In Europe, the US, Japan and many other countries, there have been many restoration practices for small river ecosystems with mature restoration technology

(Zhao et al., 2007). Up to date, however, these practices have focused solely on stream channel design and mechanics with focusing on a specific area (site-by-site solutions) with a narrow scope. Such that, the main purpose of river restoration is to eliminate constraints to river's natural patterns or biodiversity, which caused by human activities (Ebersole, 1997), but not necessarily to rehabilitate certain natural structures and conditions of river ecosystems or keeping a state of ecological balance and the original status of the ecosystem. Therefore, a holistic approach for the restoration of riverine systems including groundwater exchange, geochemical cycling, establishment of appropriate ecological processes and systems including integration with urban systems (ecological and socio-economical systems) is required. According to Zhao et al., (2007), urban river restoration planning should be the trade-off of a consideration in river ecology, applied restoration technology measures and socio-economical supporting conditions.

Therefore, especially for the recent years, there is a growing concern on the upgrading of riverine systems' ecological status. Also, it is realized that the successful stream rehabilitation requires a shift from narrow analysis and management to an integrated concept of the interconnectedness of human actions and river health (Booth et al., 2004). Herein, the approach of 're-naturalization' constitutes a complementary role to reach beyond the 'good-status' to original ecosystem. In other words, the measures that help a system to go back to natural status in a naturalistic way are usually referred as re-naturalization with an aim which has evolved towards the concept of bringing watercourses 'close to a natural state' rather than creating a truly natural state (Table 3). This also can be explained by 'connectivity' approach which is an ecological term that describes the 'natural habitat continuum throughout the landscape as being the antithesis of the fragmentation'. Therefore, rivers and riparian corridors are connecting elements (or landscape corridors) between patches and serve as paths along which animals can move and plants can spread (Harrison, 1996).

Table 3: The shift from rehabilitation/restoration approach to re-naturalization

From Rehabilitation and Restoration ..... ▸ **To Re-naturalization**	
• Solely focuses on stream morphology or channel design • Considers precautions for flood damages • Causes changes & relocation of river bed morphology. • Aesthetic concerns are mainly prioritised • Lack of historical data usage (original situation & original status of the river)	• Holistic approach • Includes a broad framework of integration between ecological, social, economic systems • Considers connectivity between aquatic variables within ecosystem structure and functions • Aims to be 'Close to nature' in urban, semi-urban, rural, natural landscapes

The approach of re-naturalization indicates the importance of system health and is based on the 'healthy river concept' which refers a system whose social and natural functions can be balanced or compromised in terms of the socio-economic, ecological and environmental values associated with the river. According to Karr (1999), healthy rivers approach demonstrates good health by being resilient in the face of environmental changes, including climate, resource exploitation or other impacts of human activities. Also, it implies a long-term balance whereby the integrity of the natural system is preserved while meeting human needs and providing a system whose social and natural functions can be balanced or compromised in terms of the ecological, socio-cultural, and economic values associated with ecosystem services generated by the riverine systems (Table 4).

Table 4: Ecosystem services generated by healthy riverine systems in terms of ecological, socio-cultural and economic systems

Socio-cultural	Ecological	Economic
• Water supply • Clean potable water • Flood control • Recreation	• Riverbed (Favorable riverbed & energy exchange and transportation) • Water quality (Acceptable water quality) • River Ecosystem (Purifying water and nourishing river ecosystem) • Flow regime / Run off (Compatible runoff)	• Flood control • Land use patterns • Infrastructure • Navigation

In this context, the river health criterion should reflect the river's natural function status, which includes the riverbed, water quality, river ecosystem and runoff. However, the variety and quantity would be different for different rivers depending on different natural features and social background (Changming and Xiaoyan, 2009). According to Platt (2006), for a healthy riverine system, natural functions show the life signs of the system and ultimately determine the sustainability of human societies.

On the other hand, the riverine systems which are exposed to several impacts by human activities lose their natural functioning and structure mainly by channelization or culverting activities in urban areas. These increasing anthropogenic interventions mostly caused chain alterations on their ecological and hydro-morphological features and

resulted with a system failure including damaged & fragmented aquatic ecosystems. According to Buchholz and Younos (2007), in European and American cities prior to the mid-1800's, small neighborhood grids allowed for the management of water with a localized supply and treatment approach that included collecting rainwater in cisterns and designing useful channels in narrow roads and alleys. However, when the industrial revolution came to full force and it was no longer possible to manage city water flow using pre-industrial methods. Therefore, many riverine systems are culverted in to pipes, buried and covered with concrete or asphalt covers and so the development of cities continued over these forgotten underground ecosystems. Communities and decision makers mistakenly believed that they took the control of these natural systems to mitigate for future threats such as pollution, spreading diseases and floods.

According to Paul and Meyer (2001), the process known as stream burial (where streams are directed into culverts, pipes, concrete-lined ditches, or simply paved over) is probably the most extreme impact of urbanization on streams. It results in the destruction of the natural stream channels and contributes to downstream habitat degradation, aquatic habitat fragmentation, enhanced transport of polluted water and toxic contaminants, and reduction of ecosystem services such as nutrient and sediment retention (Walsh et al., 2005). Because they constitute the largest fraction of stream length and are the most economically feasible to bury, the smallest streams are among those most affected by urbanization (Elmore and Kaushal, 2008). However, with the beginning of the twenty-first century, a turning point is precipitated by the deterioration of industrial-era pipes that were built to capture storm water runoff and led to think and ultimately build a more holistic future for American cities. This situation brought awareness of the problem reflected by the development of a policy to prevent culverting or to promote the removal of these structures and to restore urban rivers back to a more natural condition.

Herein, the 'daylighting' activity has steadily increased especially across the United States, and it is even more widespread in parts of Europe. According to Pinkham (2000), Daylighting" as a new phenomenon, became perhaps the most radical expression of this change in intervention and implementation to surface waters. The term describes projects that deliberately expose some or all of the flow of a previously covered river, creek, or storm water drainage. In short, daylighting projects usually remove a stream from an underground pipe and restore the waterway to open air. In this context, removing culverts and daylighting projects has a high potential to improve aquatic and marginal habitats. Deculverting also could therefore significantly improve fish passage by removing migration barriers (Wild et al., 2010). In addition, it could provide aesthetic values with recreational opportunities and a new open public space for city dwellers and educational opportunities as an outdoor laboratory for students. Also, it provides to give a place a sense of identity. In general sense, the benefits of these removal & improvement projects in terms of socio-economic perspective is reported in several cases which were located in areas suffering from crime and a 'near-silent, pedestrian and

cycling environment is provided after daylighting riverine corridors. Other reported economic benefits include rising nearby property values and leveraging private investments (Pinkham 2000) or attracting new business nearby.

4. Assessment of Implemented Stream Daylighting Projects

The newly emerging socio-economic/ecologic intervention of urban stream daylighting is a distinctly valuable and viable tool for the integration of buried riverine systems in to urban ecosystems with the second chance it provides to be 'natural' again. Over time, many implementations are completed all over the world and miles and miles of riverine systems are turned back to their natural status (the closest status to river's original ecosystem functioning). In order to understand the 'daylighting' concept in depth and assess the implementations from different national backgrounds, ten case studies are selected and compiled according to their general features and characteristics.

These cases are selected from four different geographical regions (US, Canada, Europe-Switzerland and Korea) including different social, economic, legal and environmental backgrounds with various circumstances and results they face off. Six of the projects are selected from USA where this approach is emerged and one from other countries. The selected case implementations are indicated below (Table 5).

Table 5: Selected 10 case studies from implemented daylighting projects

Location	**Name of the Riverine System**
USA	1.Napa Creek- San Francisco Bay 2. Strawberry Creek- Berkeley 3. Jolly Giant Creek- California 4. Arcadia Creek- Michigan 5. Dunes Creek- Indiana 6. Castro Valley Creek- California 7. Thornton Creek- Seattle
Switzerland	8. Zurich Daylighting Programme
Canada	9. Taddle Creek- Toronto
Korea	10. Cheonggyecheon River- Seoul

The general assessment of the implemented projects consist of 6 main and 12 sub-issues including; the general info about each project, technical details, economic, social, legal,

institutional backgrounds and the results of the implementations. Also in detail the sub-issues are determined as: Project location, date, primary objective(s), length of daylightened corridor, implementation type, total cost & funding, land characteristics, legal support, stakeholders, challenges and benefits. Assessment of the general characteristics of the implementations provides an overview for the approach in each sub-issue to generalize and to bring out summarizing findings for future implementations. Therefore, the general assessment of different practices from different countries and backgrounds will provide a broad spectrum of implemented daylighting experiences including different contexts and backgrounds. It will also help to understand the details and general features of each implementation process including their positive and negative aspects which can guide the future practices both in rural or urban areas. This task is handled in the conclusion sub-title (Table 6).

5. Conclusion

The areas including riverine systems have always been important sites for human beings to settle and live with the utilities provided by water sources such as transportation, defense, irrigation or recreational amenities. As can be seen from many cities both from ancient times and present, the urban rivers have been always the foundation for settlements' existence, containing city's rich history and culture and embodying modern city's peculiar features and picturesque scenes. Riverine systems in urban areas have continued their role of to be the interaction zones between human and nature over the centuries. However, the modern era has not been kind to urban streams and riverine systems especially in urban areas where they are exposed to several anthropogenic impacts causing a chain of alterations on the whole system's functioning.

As a result of case study assessment, the results of implementations are determined with in a broad framework including urban infrastructure benefits (cost of sever system repairs), increase property values, in neighborhoods, creating an outdoor laboratory for students, improved air & water quality, temperature reduction, increased biological biodiversity, recreational opportunities, flood protection and increase public awareness & participation. In addition to these positive effects, each project indicates a number of situations that should be considered during the project process such as old infrastructure problems, combined sewer systems, challenges of densely urbanized areas, difficulty of establishing the channel geometry and consensus & collaboration between stakeholders. A variety of stream daylighting implementations are given in Table 6 where the main challenges, drivers of implementation, participation and legal backgrounds within different scopes and major results are presented including the most important results under each theme in grey background. The assessment demonstrates that the requirement of daylighting implementation for a degraded or forgotten riverine system

originates from similar conditions and problems in different places. Such that, many projects are taken into consideration according to the increased flood problems, ecological deterioration, decrease on water quality and aquatic species, pollution & sanitation problems and economic issues related with increasing amounts of water needed treatment. On the other hand, although the main goal of each implementation may differ from each other with its priority among generalized riverine corridor problems but they are dealt with a common perspective of 'ecological restoration and re-naturalization'. Many projects were supported by public authorities and local organizations with significant public involvement which was the key component for the success of each project. On the other hand, legal support for daylighting projects were inadequate as a result of its newly emerged but in two cases it was seen that, the efforts of daylighting could shape the policy tools (Jolly Giant Creek-New Drainage Master Plan) or the current water-related policies could support a city-wide daylighting project (Switzerland-Zurich Daylighting and Sewage Separation Program under 1991 Swiss Law). Although, it is a new concept which needs a multidisciplinary approach and support, the daylighting implementations are mostly resulted with a number of positive impacts in terms of social, economic and ecological aspects including improvement of aquatic habitats, water & air quality, social cohesion and increase of land property values.

In the context of this paper, it is clarified that the improvement and re-naturalization of degraded, buried or culverted riverine systems is feasible with the 'stream daylighting' method even in highly urbanized areas. The assessment of ten cases leads to generate an assessment of the projects under specific titles. In addition to general assessment, the implemented projects can also be analyzed and discussed with different themes. This assessment compiles the cases according to eight key themes which are determined according to the highlights and crucial points of each project and constitutes a route for understanding the key components of daylighting practices. Under each theme, the projects can be assessed with the features related to their scope & goals, drivers, feasibility, public participation, stakeholders, funding, legal background, positive impacts and results which will be anticipated as the major issues of future urban stream daylighting assessments and feasibility applications.

As a conclusion, the necessity, feasibility and the importance of 'daylighting' for damaged or lost riverine systems especially in highly urbanized areas are clarified by the assessment of cases from different backgrounds. The assessment demonstrates the applicability of the method including its positive impacts and beneficial results in each case. Moreover, through the analysis of implemented projects, it is seen that the daylighting method provides degraded riverine systems to reach the closest stage of their original status by 're-naturalization' approach which is based on the health of the ecosystem and requires to be supported by relevant legal tools, governmental and local authorities as well as by public involvement to be adopted and become widespread.

Table 6: Assessment table of implemented daylighting projects under key themes.

Implement -ation Year	1970's	1984	1988	1995	1997	1998	2005	2006-2009	2007	2009
Case Studies / Key Themes	**Napa Creek, San Francisco Bay Area**	**Strawberry Creek, Berkeley**	**Zurich, Switzerland**	**Arcadia Creek, Michigan**	**Jolly Giant Creek, Arcata**	**Taddle Creek, Toronto, Canada**	**Cheong Gye Cheon River, Seoul**	**Dunes Creek, Indiana**	**Castro Valley Creek, California, US**	**Thornton Creek, Seattle, Washington, US**
Primary Goals & Scope	'Re-exposion of a previously hidden stream ' (only cover removal without re-naturalization concerns)	Creek ecological restoration (archetype of daylighting projects)	'Sewer Separation' program on citywide	'Re-develop-ment of an unhealthy core area' (business centre) in Kalamazo city and reduce flooding	'Creating an outdoor ecology laboratory'	'To give new life to the hidden creek at the heart of the city'	'Preserv ing the unique identity of the natural environ ment and historic resource s of Seoul'	'Opening the entire Dunes Creek system to Lake Michigan and reduce the urban impact to the surrounding natural area'	'To increase the creek's capacity to carry a 100-year flood and restoring essential habitat for wildlife species'	Improving water quality and flood Protection also create public amenity
Drivers	Uncovering the waterway as a part of ongoing urban renewal project, Prominent landscape architects and urban planners envisioned protection of riparian corridors in Bay area	Creek is a heavily impacted bu urbanisation (erosion loss of fish species, flooding, decreasing of water quality, sediment contamina-tion)	Flow of stream waters in to sewer system and limited wastewater treatment plant capacity, need for natural environment in the city	Part of a major downtown re-development project, a national design competition for re-development zone of the city brought the idea of daylighting	Biology teacher in a high school proposed daylighting for biology courses (to create an outdoor laboratory for students)	Increased pollution levels, (complaints from residents) create concerns about public health	Sanitation and Safety Problems (traffic load, air pollution, aging road structures, unwholeso me-some environ-ment)	Enclosure of Dunes Creek, a tributary to Lake Michigan had been contributing to the presence of E. coli in the lake effects the beaches	The District saw opportunity to restore and enhance the library and improve the environment	Homeowners downstream of the Northgate mall began to note the deteriorating conditions of creek and marked increase in flooding incidents.

Feasibility	All projects in bay area was in densely developed areas has similar challenges (old infra-structure etc.)	As an first implemen-tation, the biggest challenge 'fear' is removed, lack of modern tools	Combined sewer systems in densely urbanized area+ large impervious surfaces	The Arcadia Creek watershed is mostly urban and a densely populated area	The biggest challenge was establishing the channel geometry in a floodplain and major effort is needed to remove concrete slabs (costly)	A very polluted creek in a highly built-up part of the city. Also creek run combined with sewer made daylighting difficult	Physical (resolv--ng inconve nience) and environ mental (rainy seasons) constrai ns.	Creek is heavily-modified also collapse of the the parking lot over creek due to the heavy rain, need to repair	The site's steep gradient presented challenges.	One of the most abused creeks in the city due to the intensive development of the watershed
Public Participa---tion	Local firms and groups supported the activity, designers have pushed hard for significant public involvement	High school students from low income families worked for maintaining tasks(paid)	The initiative of the neighbourhoo d was very important and helped to raise the money for the project.	Public involvement in planning, and preliminary engineering, campaigns	Many students have been involved in restoration and maintenance process	University o Toronto developed proposals fo daylighting project + community support	Intensiv e public involve ment program s were operated (Wall of Hope Program)	A live camera uploaded images on internet to alleviate public concerns and questions	Collaborati on with local agencies during the process	Citizen groups worked actively in the project
Stake-holders & Funding	For the following daylighting projects in the bay area, cooperation between government, business, non-profits and citizen groups play an important role	The entire park project was completed from city funds (City of Berkeley). Cooperation with Berkeley Youth Alternatives and University of California	Zurich City Council has a key role with the supports of all the relevant city departments , politicians, and the population	Downtown Development Authority funded and coordinated the project including engineering studies with its consultants, 'STS Consultants Ltd.'	-Humboldt State University, -Community groups - Government Arcata High School - Natural Resources Services Division of the Redwood Community Action Agency (RCAA)	- The Taddle Creek Watershed Initiative, - University of Toronto, - City of Toronto - Business, - Local envi-ronmental groups worked together	Operated by Seoul Metro-politan Govern-ment, recommend -dations given by KSCE, Funded by Federal Emergency Manage-ment	-The Indiana Department o Natural Resources, -Save Dunes Conservation -JFNew partnered and Funded by NOAA, (ARRA of 2009) and FEMA	-The Alameda County Flood Control and Water Conservation District, -Alameda County General Services Agency, the - City of Union City,	Thornton Creek Alliance Citizens for a Liveable Northgate Thornton Creek Legal Defence Fund

Legal Back-ground			1991 Swiss Law- 'Removal of clean water inputs to combined sewer system'		The efforts shaped the city policy 'New Drainage Master Plan' is prepared					
Positive Impacts	Offers urban infrastructure benefits (expensive repairs),Several daylighting projects followed in bay area, increase storm flow capacity	Property values in neighbourhood have increased, and an old place with high crimes turned to a family oriented area, and won many awards	Excellent example of citywide daylighting program 'Creek Concept' encouraged by city policies	An unhealthy (crimes, flood risk) area transformed to an attractive business centre (increased investments)	Increased pedestrian traffic by students and accessibility to the outdoor laboratory. Also a new natural public space is created.	Unfortunately the project could not realized because of the challenges which are difficult to overcome	Improved Air quality & Temperature reduction, Increased Biological Diversity and land property, Recreation &Restoring Historical Centre	Natural connection between large watershed and Lake Michigan and Improve water quality & aquatic habitat, flood protection, recreation	Water quality improvement, enhanced wildlife habitat, and public awareness and enjoyment (amphitheatre) playground, recreation park are built	The majority of water flows through the underground pipe but small amount is routed through channel to provide a constant flow of water
Results & Lessons Learned	Removing the cover did not fix the problems, a damaging flood occurred in 1986	Successfully implemented first project, inspired many other projects, and shows importance of public participation and reuse of materials	City policies can encourage creek daylighting projects	Daylighting used in very dense urban area, decrease crime and increase land properties, book published for children	Daylighting projects can help to shape city policies. Also an outdoor laboratory for the school and valued natural area for the community is created.	The project show that there is a multitude of options even for the same creek.	Daylighting projects c have positive impacts both economically, environ-mentally, physically and socially. & Importance of local communi-ties	A live camera that uploads images to the Internet every 15 minutes at NOAA.gov, project won many Awards	Second phase is completed in fall 2010. Increase public awareness The project highlights the possibilities for restoring streams in urban areas.	Community process led to large scale water quality project and major private redevelop-ment.

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