

# Renaturalising the water courses: dynamic interactions between communities and nature.

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## ABSTRACT

In ecology, an ecosystem is defined as a system of interconnected elements formed by the interaction of a community of organisms with their environment. In all ecosystems, communities of organisms include people as main actors, either as designers of its infrastructure or as participants in its upgrading. Combined with urban design, landscape architecture has the power to stimulate human experiences by alluding to dynamic patterns of still or rushing water. We love landscapes as physical spaces and we also respond to landscape beauty with immense appreciation; our urban cultural ecosystems blend harmoniously with water. By being transformed into polluted artificial waterways or fiercely running rainwater discharges, sometimes our meandering water courses can endanger people as well as the environment.

How can we re-establish a balance between our ecosystems and the anthropocentric remodelling of our cities? The authors discuss the trends of renaturalisation/renaturation of water courses in some European countries, where previously water management has implied working against nature to ensure progress for mankind. Instead of only containing rivers, the new paradigm shift makes nature an ally to stabilise water levels, prevent floods in densely urbanised areas, and safeguard water uses. Water managers and city planners pursue water systems with water rules and policies backing their claim: 'living with water' and 'building with nature'. Recent projects could be easily compared with Leonardo's hydrology ideas in Renaissance. In his Treatise on Water, Leonardo focuses on moving waters and trained rivers in relation to their water cycles and the tectonics of the earth's surface with the aim of benefitting cities and people.

*Keywords: Ecosystems, green and blue infrastructure, hydrology, renaturalisation of waterways, anthropocentric city models, living with water.*

## 1. INTRODUCTION

Water courses are either important part of naturally formed historical landscapes; they are also considered as a vital part of developing ecosystems and are reinforced by design and controlled landscape management. Today infrastructure proposed and designed for urban spaces and our immediate surroundings depends on how we - as humans - value the landscapes around us. Influences to humans by ecosystems, such as water courses, are getting stronger and stronger. New management and design solutions have also emerged in many contemporary cities in which 'we build with nature' in order to accept 'living with water'. Designers and planners argue that green infrastructure which includes dynamic natural elements, such as water and native flora and fauna should be incorporated in any contemporary anthropocentric city model.

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Although green infrastructure developments may vary between locations, some authors think that: *“there is a positive association between the discussions of its value and its development within policy and practice”* [1]. This means that there is a growing understanding of what green infrastructure is and what social, ecological and economic value it can deliver in cities today; designers and policy makers are able to set its role for our sustainable and resilient cities of the future.

Although green infrastructure is a simple approach to landscape planning, it is also a complex approach, because of the large range of its principles; it has been anticipated that green infrastructure preserving and promoting ecosystems can promote landscape multi-functionality. Consequently, several authors describe green infrastructure as supporting ecological functions, social needs and economic developments [1, 2, 3]. Some authors affirm that green infrastructure planning may be not the same in all countries. For example, it is thought that UK green infrastructure planning takes a more holistic approach to the integration of socio-economic and environmental influences. Thus, it differs to other countries' predominantly water-centric approaches, such as USA, some European countries, etc. [4].

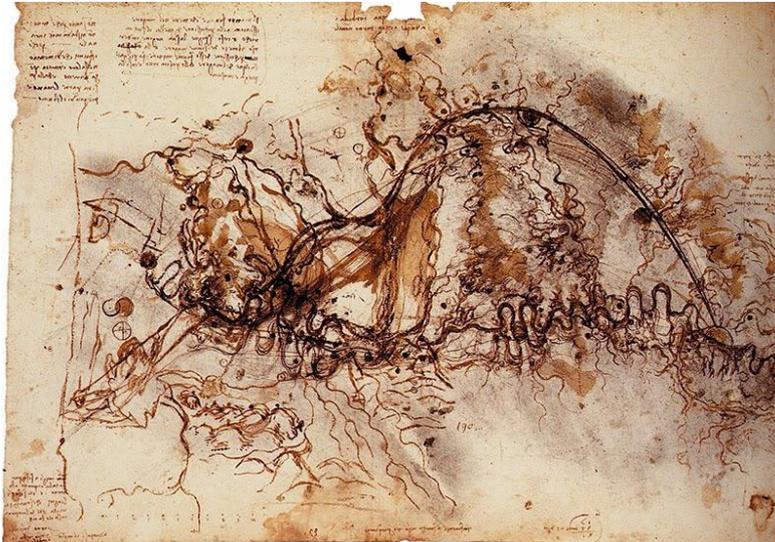
The Landscape Institute presented a number of key characteristics, which are central to our understanding of green infrastructure: *“Green infrastructure includes the network of green spaces and other natural elements such as rivers and lakes that are interspersed between and connect villages, towns and cities. Individually these elements are green infrastructure assets and the roles that these assets play are green infrastructure functions”* [5]. Hence, several authors reflecting upon this aforementioned assertion suggest that, in fact, green infrastructure is the life support system of all landscapes; it should be considered as planned interactions between socio-economic and environmental factors [3]. According to the Landscape Institute, rivers and canals, including their banks, are considered as important assets within natural England green infrastructure typology. Thus, they are included in the section of resources, which are classified as 'green corridors'. Wetlands and open and running water are also considered as important resources and are included in 'natural and semi-natural urban green spaces' [1].

We also find that, with the increasing impacts of climate change, landscape planners and urban designers working together are now looking at alternative solutions to establish more effective and sustainable landscape practice. Now there is a flexibility to green infrastructure planning that enables its users to address a range of development scenarios en bloc [1, 6]. For example, water management, biodiversity conservation, as well as climate change, are some areas where a green infrastructure approach has been successfully applied [1]. Another advantage is that green infrastructure planning can be applied at a number of scales, therefore, offers a flexible approach to private and public investment. For example, by relying on some international policies, such as the Water Framework Directive, green infrastructure practitioners have managed to make use of spatial characteristics to scope management at a regional and landscape scale. Green infrastructure investments can be often presented as an approach to landscape resource management that promotes the use of landscape networks/ecosystems (as an integrated approach to investment) [7].

Nowadays, the renaturalisation of the water courses is included as a dynamic part of several contemporary projects, which propose innovation in green infrastructure, and therefore, offers new opportunities for investment at a variety of scales, as we see further in our discussion of specific case studies selected and investigated by the authors of this paper. However, the notion of renaturalisation has appeared, when life styles had to be improved to accommodate healthy living via mobility by walking or by using a bicycle. So, we often find out that recently many projects refer to 'riverside (re-)developments', which extend to recreating natural environments in conjunction with artificial interventions; the intention is to revitalize heavily polluted and/or neglected areas around water courses, which have been abandoned for many years. Now these areas are developed to provide modern cities with both built environment growth and integrated green infrastructure. We are now dealing with 'water-sensitive' design and 'blue infrastructure' management.

Nevertheless, in history, water has been always considered as a powerful element which either divided or brought together people from different backgrounds and also disciplines, such a

scientists, artists, architects philosophers and political leaders. Leonardo Da Vinci in his *Art of Water* suggests that “*the body of the earth is of the nature of a fish ... because it draws water as its breath instead of air*” [8]. Leonardo spent as much time observing and drawing rivers and waterways as he did by observing dissected bodies in Santa Maria Nuova Hospital morgue. In fact, he compared the human body’s vascular system – veins and arteries with the flow of rivers and their feeding streams, thus, he perfectly understood the importance of healthy systems and patterns of arteries preserving healthy lifecycles.



**Fig. 1. Leonardo’s deviation of the Arno River; bypassing a stretch of the river with an artificial canal (never put into practice). (Source: Royal Collection Trust at <https://www.royalcollection.org.uk/collection/912279/a-scheme-for-a-canal-to-bypass-the-arno>).**

## **2. INVESTIGATION ON RELEVANT LITERATURE - CASE STUDIES**

### **2.1 Leonardo Da Vinci and his fascination with hydrology**

Leonardo is known to many scholars across a variety of disciplines for “his fascination with water and rivers, which pervaded his art and science” [9]. His interest in hydrology can be seen in his paintings and maps; he was fascinated especially by the power of water, when the rivers become furious and flood the plains; no artefact or human being can oppose enraged rivers. However Leonardo followed the seasons to observe dangerous rivers, such as the River Arno, and proposed solutions, some of them attempted or abandoned; he is an exceptional artist in his combination of the arts, science and engineering.

His background makes him often eager to search for a funding generous patron, and he passed to a range of them. He was hired for a variety of works by powerful people, such as Ludovico Sforza (Duke of Milan), Cesare Borgia (Pope Alexander VI son), Charles d’Amboise, French governor in Milan, and many others until his death in 1519 at the court of Francis I, King of France. Thus, his deeds were often related to or combined with defense projects or masterminded political trickery, such as “*Niccolò Machiavelli’s dream to change the course of Florentine history*” by diverting the Arno River as part of the war effort against the nearby seaside city of Pisa [10]. This project failed as the Arno River destroyed the weir and related canals after a heavy rainfall and flood.

Leonardo’s passion to depict landscapes in his paintings including impressive views of rocks emerging through vegetation and falling waters as well as his hydrological maps and projects has been main focus in several publications by Martin Kemp, art historian, since some decades now. Kemp’s *Leonardo da Vinci: The Marvellous Works of Nature and Man* was published three

times; in 1981 he won Mitchell Prize. This book was reprinted with minor revisions, 1989 and a revised edition came out in 2006 [11, 12].

Leonardo's fascination with hydrology and evolution of natural environment is also present in one of his most famous paintings: Mona Lisa or La Gioconda; he had included one of the most important natural developments in the history of the plain between Florence, Prato and Pistoia. This plain was occupied by a huge lake for several millions of years until Roman times. Because of erosion caused by water, a crevice was created and a river (the Ombrone River) went through it to flow in the Arno River.

The lake waters which were pressing the massive rock of Gonfolina disappeared and the entire landscape was transformed; hills are visible, as we can see in Zocchi's far fetching view, including the Lastra a Signa Bridge on the right (where nowadays we find Carmignano train station). Gonfolina is shown in Giuseppe Zocchi's print in 1744, some centuries after Leonardo's walks to this place, probably when visiting his mother and grandmother's native home at Carmignano (Toia's house and inn – still existing at Bacchereto village in Carmignano). The rock on the left and the entire bridge (in part demolished in Zocchi's time) appear behind Mona Lisa's shoulders; you can see Gonfolina and the Ombrone River by her right shoulder and the Lastra a Signa Bridge in its entirety over her left one. Leonardo's hydrological drawings and attempts demonstrate that nature finds always its own way to shape natural landscapes whatever artificial interventions the humankind may attempt, such as the case studies discussed in this paper further [13].



**Fig. 2. Zocchi's View from a village (Lastra a Signa) to the Arno River through "Golfolina" (or Gonfolina rocks). (Source: [Public domain], via Wikimedia Commons) at [https://commons.wikimedia.org/wiki/File:Zocchi,\\_ville\\_18\\_gonfolina.jpg](https://commons.wikimedia.org/wiki/File:Zocchi,_ville_18_gonfolina.jpg))**

## 2.2 Modern hydrology: greenways and first blue infrastructure

One of the most influential approaches that shaped green infrastructure was the development of parkways and greenways. Greenways are linear features, which have been primarily constructed of environmental features, such as trails imprinted by regular flows of people; these trails originally aimed to facilitate movement from urban areas into the wider landscapes and countryside. Greenways appeared from the late 1800s onwards, and firstly developed in the USA to be utilized later worldwide.

Greenways performed as a cost-effective method to landscape management, as urban dwellers were seeking increased accessibility to nature; they also managed to strengthen a widening participation of the people and/or interactivity with the surrounding landscape which is now claimed as leisure time. Access to public transport also helped, as distances became less time-consuming. As a result, people were able to explore the countryside effortlessly, especially where nature was located in close proximity to urban centres (i.e. along and across green parks

and along river banks); access to nature was enabled by the implementation of organised trails [15].

After the 1800s we see green infrastructure along the boulevards and parkways, and in spacious commons. During a second era of development of the cities, we see the establishment of trail oriented recreational greenways. The current greenways uses have been extended with intend to develop multi-functional networks, which are able to promote a range of leisure, economic and environmental benefits.

The most famous greenway development included in available literature was constructed in Boston by Frederick Law Olmsted; it aimed to help the city's adaptation to its specific climate. Boston's Emerald Necklace covers an area of more than 1,100 acres; it was designed to manage the ice or snow melt of the Charles River, which led to annual flooding [3]. It is stated that:

The success of this investment helped the city of Boston to limit some of the negative impacts of urbanization through the development of a constructed wetland system. The investment also brought extensive socio-economic benefits to the city, with Boston Common acting as a hub for community activities, which is still the case today. [1]

Following Boston's success in investment, several North American cities, such as Indianapolis, Toronto and Montreal, benefitted from greenway-led regeneration. However, each city had a different approach to the development and management of greenways, which are often linked to waterfronts and/or water courses. According to Little, these greenway interventions fall into five distinct categories of investment: *"urban-riparian corridors, recreational greenways, ecological corridors, scenic and historic routes and comprehensive networks"* [14].

Although Little prescribes how greenways were historically developed, we see that contemporary investments utilize more than one type. Nowadays a 'features-led' understanding of greenways is promoted; this is because authors wish to indicate a greater relevance to green infrastructure planning [1]. In contemporary greenways literature, authors affirm that greenways are *"linear features that are spatially applied at different scales, which promote connectivity between people and place, and support a wide range of socio-economic and ecological benefits"* [1, 15]. Hence, most greenways key elements, such as, for example, connectivity are also integrated into green infrastructure planning. And the most relevant element is that, most of the times greenways are strictly linked to water courses' uses, as it happens in present-day renaturalisation of the rivers.

### **2.3 Recent hydrology: renaturation (renaturalisation) of the Aire River**

The authors have come across an interesting and professional network, Landezine, which owns a web site started in June 2009. Since then, this network has been showcasing landscape architecture projects created by architects/landscape architects from around the globe [16]. Today Landezine claims that this is an internationally renowned landscape architecture network with more than 5,000 visitors from all over the world visiting its site every day. In 2016, Landezine expanded its network and empowered its voice in the global community by opening their "Landscape Issues" section and launching Landezine International Landscape (LILA) Award.

The renaturation of the Aire River project has been promoted by Landezine since 2016. This project is a finalist for Rosa Barba Prize by Atelier Descombes & Rampini, Superpositions group, and it was presented at the International Biennial of Landscape Architecture in Barcelona on 29 September 2016. Hargreaves Associates' Queen Elizabeth Olympic Park in London won the Rosa Barba International Landscape Prize at the International Biennial of Landscape Architecture in Barcelona on the 30th of September 2016. The project was selected from a shortlist of ten finalists.

Nevertheless, the Public Opinion Prize was voted by the attendees of the Biennial; it was awarded to Atelier Descombes & Rampini Architects for their project Renaturation of the Aire River in Geneva. Their client is the République et Canton de Genève (State of Geneva). The

architects have collaborated with B+C Ingénieurs (Engineers), ZS Ingénieurs civils, Biotec SA (Biology). Chronology of the construction period: Phase 1 (2002 – 2006), Phase 2 (2009 – 2011), Phase 3 (2012 – 2015), Phase 4 Ongoing. The length of the project is 5 km and the surface 50 Ha [17].

The group has considered the fact that the Aire River flows through valleys historically devoted to farming. Nevertheless, since the late 19th century, it was progressively canalised, and as canal it was used in many ways during the industrial revolution era. In 2001, the State of Geneva proclaimed a competition with the idea of restoring the river to its original shape by demolishing the canal. Superpositions instead proposed to combine the canal with a vast discharge area for overflowing river waters, quite similar to Leonardo's idea for the Arno River back in the 15th century in Florence.

As the group states: *"in the process the canal becomes the pointer for the transformations, a reference line giving the possibility to understand the before and after"* [17]. This new flowing development overlaps with previous geometries shown as a rigid diamond grid in its previous construction phase. However, nature has managed to overcome any rigid previous artificial restrictions by creating free-flow lines of water. Along and across this project, several greenways blend with the river flowing free to fill designed discharge areas according to seasons.



**Fig. 3. Renaturation of the Aire River – construction of a channel/landscape architecture – Aerial view showing evolution between June 2014 and May 2015. Courtesy © Superpositions.**

The official interpretation for the competition programme was based on natural balance. The legitimate necessities for environmental improvements suppressed any other considerations and entailed antagonism between nature and culture. The group affirms that their project attempts to propose an alternative process, in which the urgent ecological shifts are amalgamated into a larger cultural change.

The complex organisation of the design links the new river space and a linear series of gardens inside the former canal. In reality the whole design becomes a linear garden. The original morphology of the mountains and the traces of human interventions embrace and contain the whole water course; this long river garden organises the locations, views, confrontations, presences, aiming at introducing questions, worries, hopes into this fragile and precious territory. The essential calm and interiority yields organized sequences of differentiated places and paths, allowing a reasonable distribution of people and movements. The footprint of the canal is a key device for building the necessary calm and interiority; without it, there is no real garden. It is a

permanent trace which introduces a complex temporality, both past and future, memory and desire [17].



**Fig. 4. Naturalisation of the River Aire – River waters' discharge area and ex-canal used as integrated greenways. Courtesy © Superpositions.**

Superpositions group also explains that:

For the drawing of the river itself – conscious of the impractical effort to design a fixed river bed and aware that a river usually loves to design itself freely – we instead proposed an initial pattern, the form of which addresses the play between the river flow and the prepared terrain. This diamond-shape pattern opens a complex series of undetermined channels for the flows. These channels were excavated along the entire new river by removing layers of mud accumulations and maintaining a precise control of the longitudinal profile of the river. The dimensions of these lozenge-shaped islands were configured to be able to 'accept' the general sizes of the former meanders. The result is spectacular and suggests devices created by land artists, who clearly disturb nature by artificial interventions. Thereafter, the artificial is left to the mercy of natural forces. One year after the opening of the new river space, the results are beyond our expectations; the river flows by displacing diverse materials, pebbles, sand, and the geometrical matrix of lozenges has been significantly modified. We must accept this paradox: the more defined the grid given to the river, the more the river will be free to design itself [17].



**Fig. 5. Renaturation of the River Aire – Discharge area of the river still showing signs of an artificially shaped flow via a diamond-shape pattern. Courtesy © Superpositions.**

### 3. OUTCOMES FROM THE STUDY - DISCUSSION

Renaturation or renaturalisation projects with reference to water courses take place in diverse conditions; not only this depends from varied microclimate worldwide, but also is due to the variability of understanding between academics, policy-makers and practitioners in relation to the restoration of water courses. Therefore, it is obvious that there has been no unified consensus yet on how we should plan for reinstating and re-designing landscape resources. Often green infrastructure materialises as both a sum of its parts (by using and/or promoting certain ecosystems), and as an intrinsically context-specific approach [18]. In some countries, such as the UK and USA, we find out that there are several barriers to green infrastructure developments, such as policy formation, application and political support, support of other sectors (i.e. transport, sanitation or housing), and, most importantly, public responses to development (political/financial) [1]. Although these barriers and differences suggest that: *“there is a level of consistency to green infrastructure discussions in different locations, there are nuanced understandings or applications of the concepts and principles in different locales”* [1].

With reference to the aforementioned renaturation of the Aire River, we may see more flexibility in policy-makers by accepting a project which restores a long portion of a river that was artificially damaged for many years by being transformed in a canal. Perhaps persisting problems with frequent overflow and floods, and pollution, may have had a real impact on their decisions. Another important point raised by the team who has designed and is still delivering this project is their attempt to create spaces which will improve healthy conditions and human wellbeing. For citizens of urban spaces today, this is what is very much needed.

Greenways in some countries, such as North America, Switzerland (as above), etc. can be considered as a key precursor to green infrastructure planning, whereas in the UK planners have drawn more often on the principles of the garden cities' movement in order to include these debates. The relationship between garden cities and green infrastructure has been comprehensively explored by the UK Town & Country Planning Association. The promoter of the garden cities movement has been Ebenezer Howard; his proposed principles support the civic need to address a vast range of issues in the late 1800s and 1900s (socio-economic, health and wellbeing) [19].

Howard attempted to place social equity at the centre of urban development; his vision for garden cities aimed to reinstall the critical link between health, wellbeing and human-environment interactivity that is also evident in the Aire River project, too [19]. Howard's vision echoed the design principles of Olmsted in Boston and New York, where Olmsted had wanted a ground where people could go after work; we can say that: *“Howard aimed to incorporate the functional elements of urban and rural landscapes into his designs to achieve greater livability and multi-functionality”* [1]. In the Aire River project, urban and rural landscapes blend within the focused restoration of the water course to achieve livability of spaces which were previously abandoned and maybe out of control for several decades.

Several authors believe that for a number of years during the initial conceptualisation of the green infrastructure, water was to be underrepresented [3]. However this may vary spatially in some countries, such as the USA, for example, heavily emphasising the role of water source management mainly in the discussions of green infrastructure, and thus, introducing blue infrastructure management related to stormwater issues in urban areas and functional values of water by instigating terrestrial resources' debates. In the USA, the engineered management of water is of national importance [2, 6]. Although the USA dominates the discussions of water-focused green infrastructure research, there has been a growing exploration of similar issues in Europe, as we have seen above [17]. *“Many cities in the former industrial heartland of central and northern Europe in the Netherlands, Belgium, Germany, etc. have been at the forefront of this, examining ways to re-establish value in polluted and derelict water bodies”* [1]

## **4. CONCLUSION**

The authors have found that, although water managers and city planners pursue water systems with water rules and policies backing their claim 'living with water' and 'building with nature', some projects in progress need more time to be fully accomplished. This happens not because of lack of policies and/or financial support, but, because nature has to come back and respond to artificial manipulations. Nature has the final word of regenerating itself and renaturalising water courses.

Projects, such as the Aire River renaturation/renaturalisation in Geneva could be easily compared with Leonardo's hydrology ideas in Renaissance for the areas surrounding Florence. We find Leonardo's ideas in his Treatise on Water, in which he focuses on moving waters and trained rivers in relation to their water cycles and the tectonics of the earth's surface. All his studies and efforts managed to reduce problems in Florence and adjacent plane areas. Nevertheless, today danger of floods and damages is still a threat for central urban areas in proximity of the Arno River. More needs to be done along the extension of this river, and mostly in discharge areas. Perhaps examples as the Aire River renaturation could help many more cities to get meaningful green and blue infrastructure with a view to current and future needs and necessities of their citizens who are currently demanding healthy living conditions persistently.

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