A review of urban river restoration projects. Practices and challenges

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Abstract - *Urban rivers are one of the most threatened ecosystems in the world, being the focus of neglect or costly restoration. It is therefore urgent to identify appropriate technical solutions that, associated with social innovations and collaborative planning approaches, can guide new ways of treating the water of rivers threatened by urban pressures – in particular in the context of climate change, biodiversity and economic challenges. This chapter reports on a research project that attempted to examine interventions in rivers through the lens of environment, planning, technology, and societies. The Project Base Platform Urban Rivers – baseRiU aimed to expand the body of knowledge dedicated to the research on and ways to approach urban rivers. Besides providing a broad base for further research, the findings clearly have shown that resources invested in restoration, renaturing and bringing rivers back to the city make the best investment, as cities become wealthier, with more complex (green and blue) structures, more biodiverse, and environment-, climate- and people-friendlier. Creating sustainable solutions, rediscovering urban rivers' multiple values to society and the environment can be a driving force in the transition to more sustainable (urban) systems. Yet, bending the curve towards sustainability also requires a radical change in mindsets – and to guide this we need more practice-based evidence.*

Keywords - Rivers and watercourses, restoration and regeneration, riverain communities, participatory processes, place-based networks

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INTRODUCTION

A growing body of research points to urban rivers as one of the most threatened ecosystems in the world (Francis, 2012; Ceola et al., 2015; Smaniotto et al., 2015; Grizzetti, et al., 2017), as they succumb to pollution, degradation, neglect or costly restoration. There is an urgent need for a debate on global warming, climate change, economic challenges and sustainability to identify appropriate solutions that combine technical solutions with approaches for social innovation and collaborative planning. This chapter reports on a research project that attempted to examine interventions in rivers through the lens of environment, planning, technology, and societies. The Project **Base Platform Urban Rivers – baseRiU** aimed to expand the body of knowledge dedicated to the research on and new ways to approach urban rivers. The outcomes and findings help to create a reference base for the development of further research activities on the topic in the Research Group CIDATE[1], which has been already assigned the overall coordination of the network Cyted RUN (420RT0008)[2] Citizen Science and Co-creation as a way to improve river regeneration and risk minimization (01/2021 - 12/2025) involving fifteen Ibero-American partners. Thus, by reviewing past practices, the baseRiU platform aimed to systematically organise the scientific and technical foundations of urban and environmental planning related to urban rivers. It provides insights into the relationship between rivers and design interventions for urban riverside regeneration, intertwining them with citizen science and participatory processes.

UNDERSTANDING THE SCOPE OF URBAN RIVERS

The research of baseRiU is centred on rivers and watercourses under human pressure, in particular those for urban uses. "River", as used in the research and in this report, is an all-embracing term to include all kinds of watercourses of vastly different types. Thus, a river is "*a system of surface waters constituting, by virtue of their physical relationship, a unitary whole and normally flowing into a common terminus*", as suggested by UN (1997). Rivers are a natural resource that is essential for human settlements, as they provide fresh water, as a means of transport and communication, defining the urban fabric, and as a means of subsistence, as in the case of developing countries where the population depends directly on the water of the rivers. Rivers are, as Uslu & Shakouri (2013) assert, often relics of natural habitats in urban settings, building the physical link between natural, rural areas and cities and regions – therefore they are or could be an important linear connection between the natural and the manmade environments. They are also a link within cities, and for many cities they provide the scenery for their cityscape, morphology and shape. Rivers are also the link between countries serving as (transport) corridors and borders.

[1] Research group on Citizen science in understanding and transforming the territory, https://urbanismo.ulusofona.pt/en/urbanismo-lusofona-en/research/

[2] http://cyted.org/es/run, https://run.ulusofona.pt

In spite of these positive aspects, in the course of urban development, human pressure on rivers has been increasing (Hoyer et al, 2011; Ceola et al, 2015) and unsustainable urbanisation processes have contributed to the accelerating degradation of rivers in many cities "… *often to the extent that they no longer provide the services to society from which the settlements developed*" (Everard & Moggridge, 2012:295). Changes in river structures and sensible shrinkage of ecological capital raise concerns about the whole urban structure and future of life in cities. A fast and unsustainable development is part of a vaster, more widespread and complex phenomenon: the world-wide urbanisation process and multiple pressures on the environment. These lead many places to water shortage, threaten water security, cause water pollution and environmental degradation (Ceola et al., 2015), as well as the loss of biodiversity and impoverishment of the urban landscape (Geist & Hawkins, 2016). As Pattacini (2021: 1) aptly points out, rivers have "*often been forgotten, canalised, or have even disappeared into culverts*". UN-Habitat (2015:6) rightfully stresses that "*efforts to improve land management practices and the adoption of different tenure security conceptions remain limited, despite being recognized as fundamental to the provision of adequate and the eradication of poverty*". The UN (1997) calls for urgent action towards putting in place measures of protection, preservation and management related to the uses of rivers and their waters. Just as far-reaching are the consequences of the eradication of poverty, since increasing the quality of urban rivers is a guarantee of more sustainability and resilience (Leal & Sümer, 2015). During the last few decades, the issue of urban rivers as a component of urban ecology has been discussed in several studies (Everard & Moggridge, 2012; Francis, 2012; Uslu & Shakouri, 2013; Smaniotto et al, 2015; Geist & Hawkins, 2016; Grizetti et al, 2017). Also, their contributions to urban design (Smaniotto et al, 2015; Pattacini, 2021), values for community services (Ceola et al. 2015), and the interconnected benefits that restored rivers and ecosystems can provide to society (Everard & Moggridge, 2012) are being acknowledged.

Regenerating/renaturing such natural resources increases the environmental quality and enriches biodiversity in urban areas, and both become vital to ensure and safeguard a safe environment. Thus, creating the knowledge needed to respond in a timely manner to emerging needs and opportunities, as well as providing direct support to riparian communities in defining strategies and public policies, are central issues in accelerating sustainable approaches to applied tools and practices (Hoyer et al., 2011; Everard & Moggridge, 2012; Uslu & Shakouri, 2013; Smaniotto et al, 2015). To achieve the goal of creating a research base, it is essential to establish a permanent link between theoretical and applied research.

UNDERSTANDING THE VALUE OF RIVERS IN THEIR URBAN CONTEXT

The central purpose of baseRiU was to consolidate knowledge in the sphere of urban river restoration, considering for this purpose a socio-environmental and

urbanistic perspective of development. Restoration, as Vaughn et al. (2010) assert, encompasses different measures to repair damage humans inflicted to ecosystems; in this case, to watercourses that cross urban areas suffer different kinds of disturbances and pressures.

The baseRiU research combined scientific knowledge, guidelines for policy making and development strategies, which in their synergy form the scientific backbone to provide evidence for the planning of sustainable public policies (Grizzetti et al., 2017). In the search for innovative solutions, inspiring concepts such as nature-based solutions, citizen science and co-creation processes were also considered – as they allow a better understanding of the driving forces in the management and improvement of urban space. From this perspective, the analysis of examples was guided by the creation of riverbeds and bank spaces that improve environmental effectiveness and mitigate risk, along with the provision of green areas, also for recreation and leisure. Restoration, renaturalization and the recovery of urban rivers have been gaining attention in recent years (Bartalini, 2009; Hoyer et al., 2011; Everard & Moggridge, 2012; Smaniotto et al, 2015; Wohl et al., 2015, Grizzetti et al., 2017, Pattacini, 2021). The research on urban rivers is situated at the crossroads of two inseparable issues: on the one hand, there are the challenges, such as the degree of pollution, the reduction of water quality and loss of biological diversity, and the inherent risks of flooding. On the other hand, the growing recognition of the benefits to society and the economy of a healthy environment requires greater dynamism and a more significant intervention by institutions and society.

With these observations in mind, river management is an issue that can only be addressed by considering different scales - from a regional to a local scale, from the source throughout the urbanised watershed on the way to the river mouth, involving different stakeholders in partnerships that respond to local needs and harness local knowledge and capacities, thus ensuring an approach that stimulates positive and sustainable change. To this end, key issues such as inflexible and cost-intensive systems, engineering works in sensitive systems, lack of integration of stormwater management into urban design, lack of acceptance of sustainable systems, fragmented responsibilities, strong competition around open spaces, lack of public participation and institutional capacity, among others, should not be at the centre of attention. Increasing human population and land take accentuate the loss and/or deterioration of natural habitats, biodiversity and ecosystem services (Quintero et al., 2011; Uslu & Shakouri 2013; Aragão, 2014; Smaniotto et al., 2015). In a spiral of poverty, natural habitats tend to deteriorate. It is estimated that in Africa 61.7% of the population lives in informal settlements, with a projected growth from 400 million to 1.2 billion inhabitants by 2050, directly related to the decline in the prosperity of cities and environmental sustainability (UN-Habitat, 2015). Thus, combating the reduction of environmental quality and the decline of urban rivers is one of the biggest challenges faced in safeguarding the sustainability of urban areas. These

challenges become even more serious with the need to adapt to climate change and the prediction of future problems related to its management (UN-Habitat, 2015; Smaniotto et al., 2015; Smaniotto & Hoyer, 2014).

Understanding the nature of science and its relationship to society and culture is considered one of the fundamental axes of scientific literacy (McComas, 2000; Galvão, 2001; Pateman et al. 2021). This is an assumption recognised by the EC, which thus underpins its actions to promote research related to citizen science (EC, 2019a), positioning the sustainable use of natural resources and the environment as one of the three pillars of the new framework programme (Horizon Europe), an ideal reinforced in the meantime by the European ecological pact "Green Deal" (EC, 2019b). These principles correspond to the scientific-political principles of baseRiU, and contribute to building a rationale for establishing the topic of urban rivers as a strand of research at CIDATE. The foundations for this strand are already set by activities related to water courses and urban development, such as (i) the International Seminar of Urban Regeneration ReCity (2014-15) with Ribeira dos Sassoeiros in Cascais as case study, (ii) the international seminar for the creation of the Florence Regional Park (2014), (iii) the scientific exchanges with the School of Spatial Planning (Dublin Institute of Technology), Department of Forest Sciences (University of Helsinki), and Barcelona Institute of Regional and Metropolitan Studies (Universidad Autónoma UAB), which resulted in the case study analysis of water as a determinant of the urban environment, published by Springer (Smaniotto Costa et al., 2015), and (iv) a study on using mobile data in the Republic of São Tomé and Príncipe to create knowledge in a country without planning (Aragão, 2019; Aragão & Smaniotto Costa, 2022). It should also be noted that such initial assumptions are complemented by the knowledge and experience acquired in the use of collaborative and co-creative methodologies of involvement of actors in Living labs and in placemaking, of which the European projects C3Places, CyberParks and Dynamics of Placemaking[3] are representatives. Still, much remains to be explored, theorised and transformed into strategic lines of support for decision and planning.

The problems and challenges described above are emerging more in developing countries, faced with population growth and territorial transformations, and where the lack of resources and technologies associated with the low level of awareness of decision-makers further exacerbate problems in the environment - city - social fabric axis. In Africa, for example, researchers face issues of relevance or applicability of their work, lack of funding and lack of a favourable environment, since research still has low political priority, amplified by the absence of internal funding for research as a structural element of innovation to support the continent's development (Mashininga, 2017). Despite its natural resources, the continent fails to adequately harness its endowments for its own sustainable development. The clash between

[3] www.c3places.eu; www.cyberparks-project.eu; www.placemakingdynamics.eu

two constraints, the (dis)appropriation of African resources by developed countries, associated with the failure of Sub-Saharan Africa to harness its natural resources, is attributable to the absence of critical mass, human capital with adequate knowledge and skills, technology, infrastructure for innovation and entrepreneurship, and incentives to innovate.

The relationship between urban fabric - river - riverine population underscores the need for a spatial analysis of "urban" development, both within the city and beyond its formal boundaries. For more sustainable solutions, it is necessary to "take advantage of the motivation of people and communities" (Smaniotto & Hoyer, 2014: 68). Solutions should not be imposed by forcing people to change their behaviour, but by creating participatory processes, which are key to achieving behavioural change (Oliveira & Brito, 2013). Indeed, collaborative approaches are gaining attention as proactive solutions to avoid conflict and pave the way to more sustainable and just environments. Collaborative approaches are also able to generate trust among stakeholders, which is fundamental for social responsibilities. Also, volunteering is a relevant issue in promoting environmental stewardship, it contributes to the communities which the volunteers are part of as well as to enlarge and enrich data collection and the results of the measures they are involved with (Cunha et al, 2017). In the rationale of CIDATE, a strong overarching association between living labs and citizen science is considered central, as both are open ecosystems for social engagement. Newman et al. (2017) and Pateman et al. (2021) acknowledge the positive impact of using place-based networks and local knowledge to improve effectiveness, collaboration, and efficiency. This stimulates citizen collaboration and motivates partnerships in innovative ways, facilitating and accelerating behavioural changes (Oliveira & Brito, 2013). Living labs as a research concept, according to Bylund et al. (2020), offer a user-centred and open innovation framework; they put stakeholder involvement into practice, generate new scientific information and research insights. That leads to the next term – community involvement. In this study, the terms community involvement and public participation are used often and with the same meaning. Both concern the involvement of community individuals that have no commercial or political interests in the river restoration process. In other words, the community, in these cases, represents a group of individuals that live and use the city and river surroundings for their everyday life.

METHODOLOGY

In order to access different concepts and practices regarding river restoration, a case study methodology was used as a primary method and methodology (Gerring & Cojocaru, 2016). As the Internet has become a gateway to a maze of vast literature, the research consisted of a world-wide electronic search for cases, mainly on the web and in published articles and proceedings. The web-based search has the advantage

of speed and the timeliness of data/information. In the search, such keywords as *river restoration, regeneration* and *renaturing*, along with *urban riverside, riverbed regeneration, nature-based solutions* and *community involvement* were used to select promising projects.

The methodological approach, based on comparative urbanism (Nijman, 2007), focuses on a systematic identification of key processes, their different articulation and their inter-contextual interpretation. To review past practices, a template was developed and used to describe the cases. The template includes the following fields: project description and goals, actions to achieve these goals and remarks. Special heed has been given to the topic *remarks*, which is populated with filtered examples of good practice – although in many cases the information available may not be as detailed as needed. This procedure facilitates comparison and the analyses of results, to enable the identification of transferable principles and ideas in the relation of rivers to design interventions and community involvement (Creswell, 2013, 2014).

One main criterion for seeking projects is the diversity of situations, in regard to budget, promoters/drivers, goals and a wide geographic focus, with an active search for projects in Latin America and Africa. This resulted in the selection of a diverse group of 15 cases – listed in Table 1. These cases were then analysed and compared in terms of their goals, the coordination/management of the restoration, the terminology used, and, as aspects, which were relevant for baseRiU, how public participation and nature-based solutions were operationalised, and the results obtained. After this comparative analysis, the conclusions were used to build a framework of good practices regarding the aspects of community and nature-based solutions in river restoration.

Due to the need to gather current data, websites were by far the most often consulted online resource for collecting information about projects worldwide. The list of consulted websites is provided in REFERENCES and, when it was possible to detect an official website for each project, these links are provided in the description of the individual cases.

OVERVIEW OF SELECTED CASES

In this section, the search findings on 15 different cases are presented and discussed (Table 1). It intends to provide an overview of the *projects* in a structured way. Based on this mapping, the next section discusses the abilities of such projects to catalyse and push for changes – in the physical urban environment, in policies, in planning and social practices, in the communities and not least, changes in behaviour patterns related to approaches to urban rivers. Given that each project uses its own terminology, this exercise resulted in a large body of river-related terms; since standardisation or in-depth-discussion on the terms is not a goal, the descriptions keep the diversity of used terms, and use **restoration** (Vaughn et al., 2010) as an umbrella term that encompasses all activities related to improving urban rivers.

	Project title	River	City/Country
1	Charles River	Charles River	Boston, USA
2	Blue Loop	River Don and Tinsley Canal	Sheffield, UK
3	Brazilian Streams	Several cities	Brazil
4	A walking workshop along the River Auji	River Auji	Auji, Kenya
5	Raising Awareness on Rivers and Environment	Malawian rivers	Lilongwe, Malawi
6	Mystic River	Mystic River	Boston, USA
7	River Irk	River Irk	Manchester, UK
8	River Torca	River Torca	Bogotá, Colombia
9	Manuelzão Project	Rio das Velhas	Belo Horizonte, Brazil
10	River Manzanares	Rio Manzanares	Madrid, Spain
11	River Sokolówka	River Sokolówka	Lodz, Poland
12	Rios Project	Several rivers	Portugal
13	Os Nossos Rios	Rivers of the council of Vila Nova de Famalicão	V.N. Famalicão, Portugal
14	H2Óctogono Azul	River Paiva	Viseu, Portugal
15	Cascais Streams	Streams in the Council of Cascais	Cascais, Portugal

Table 1: List of selected cases

1. Charles River

Project Name	Charles River Watershed Association
River name	Charles River
City, Country	Boston, USA
Website	https://www.crwa.org/

The Charles River, located on the east coast of the USA, drains water from an area of 797 km2 comprehending 23 communities, including the city of Boston, with a population of 700 000 people. This slow moving, meandering river has had, historically, a reputation for pollution and mistreatment. In 1965, concerned about the declining condition of the river, the Charles River Watershed Association (CRWA) was founded by a group of citizens to spearhead advocacy and river protection efforts in the watershed. This association has continuously been working on behalf of the river since then, it has come a long way to professionalise their activity and is now a key figure on the protection of the watershed.

The main challenges faced by CRWA are climate change, stormwater pollution, cyanobacteria (blue-green algae), water quality, streamflow, and dams. To solve these issues, the association has set the following goals:

1. Restore natural hydrology within the urban environment.
2. Address new and mounting pressures due to climate change.
3. Use river science to measure current conditions and changes.
4. Advocate for a healthy, vibrant, and climate-resilient Charles River watershed for all.

Actions

To achieve the first goal, restore natural hydrology, CRWA has focused on designing natural green corridors and infrastructure that can soak up water and carry it slowly through the city. Retrofitting buildings, streets, and parking lots to capture and treat runoff, connect isolated greenspaces, and create greenways have led to coming closer to mimicking historic natural conditions.

Achieving the second goal encompassed the development of guidelines for green streets and green areas to be implemented by the city council. The guidelines focus mainly on the efficient management of stormwater through the increase of infiltration areas, stormwater treatment, promoting the slowing of stormwater run-off through city design features, and the efficient use of water regarding the choice of the plants in green areas and their location.

The Charles River Climate Compact was established to link all stakeholders, including elected municipal officers, and to jointly develop a common strategy for climate change resiliency.

An app was created to enable people to follow in detail their water consumption patterns and compare them with others, in order to create awareness and eventually reduce water consumption.

Monitoring water chemistry, pollutant levels, cyanobacteria algal blooms, stream flows, invertebrate species, and invasive plants as well as widely disseminating the results, goes towards promoting education and awareness (goal 3). The monitoring programme, on the other hand, has led to dam removals, invasive plant control, stream naturalisation, and fish stocking.

A wide programme for engaging residents as volunteer community scientists has helped to increase awareness, and to expand participation in on-the-ground projects.

The fourth goal resulted in the close collaboration with the city council to defend environmental justice, making sure that environmental laws are respected, and act as a voice of the river regarding the challenges that it faces currently and will potentially in the future.

Results

Over its 66 years' existence, the Charles River Project has led to the following results:

– The legal protection of large natural areas upstream.
– The first public river bath indicates that the dirty, polluted river belongs to the past.

– The promotion of canoe and kayak races.
– A dramatic reduction in sewage and bacteria.
– The creation of the Clean Charles Initiative by the city council and the combined sewer overflow programme based on science produced by CWRA.
– 20 years after the creation of the water quality report card, in 2014 the river waters obtained their first grade A.
– The City Council's legal street guide with CWRA as main technical advisor.
– CWRA leading the Regional Climate Action Coalition.

Remarks

This project was selected for its professional standards and 56-year experience in river protection. The wide range of initiatives, including the interactions with urban planning and advocacy for ecological enhancements and environmental education were an interesting feature. The widespread use of nature-based solutions and the inclusion of volunteers in some of the actions as well as the availability of detailed information about the myriad measures allow us to have a clear view of goals and results.

Further interesting features include the close collaboration between the council, with political entities, and residents; and being at the forefront of river science. The latest feature has led to the use of innovative materials and solutions, like porous asphalt, stormwater bioretention treatment or redirecting stormwater into strategically placed greenspaces. Another feature was pioneering on climate change threats and including this issue in many measures, as well as the creation of a regional coalition to fight the problems at a large scale, and protect the city.

2. Blue Loop

Project Name	The Friends of the Blue Loop
River name	River Don and Tinsley Canal
City, Country	Sheffield, UK
Website	https://www.facebook.com/theblueloop/ https://the-rsc.co.uk/riverlution/blue-loop

The Friends of the Blue Loop is a volunteer-led organisation focused on maintaining and improving an area known as the 'Blue Loop' in Sheffield, UK. The Blue Loop is a 13-km stretch of waterways of the river Don and the roughly parallel Tinsley Canal, from Sheffield City Centre to the neighbourhood of Meadowhall.

The canal opened in 1819 to enable navigation from the river Don to the new harbour in the centre of Sheffield. With a width of 4.65m, the canal was never enlarged, and is today with the river Don a relevant component of the green and blue infrastructure of Sheffield, offering walking, boating, wildlife-watching and all-round relaxation.

Working with the Canal & River Trust, the care activities of Friends include footpath maintenance, cutting and pruning vegetation, removing invasive plant species as well as trash, litter pick up from the footpaths and river/channel. Initiatives are organised at regular monthly intervals on the canal or riverbanks. The organisation provides, besides tools and equipment, training when necessary. The training sessions aim to enable the participants to look after the wildlife and habitats of the Blue Loop.

Remarks

As the Friends is a local, environmental conservation organisation, the information made available, outside of social media, is quite limited. Nevertheless, it is considered an interesting project, as it is promoted, led and put into practice exclusively by volunteers, in a continuous effort to protect and improve the Blue Loop's quality.

The regularity of initiatives and the training provided make it more likely to drive further interested volunteers to join, while the training support allows local people to gain valuable work experience and skills.

3. Brazilian Streams

Project Name	The contribution of volunteer-based monitoring data to the assessment of harmful phytoplankton blooms in Brazilian urban streams
River name	Brazilian streams
City, Country	Several cities in Brazil
Website	https://pubmed.ncbi.nlm.nih.gov/28169029/

This academic project covered the analysis of 64 rivers in Brazilian urban areas, and was focused on producing scientific information on water quality, with the help of volunteers. The study aimed to identify potential drivers of the phytoplankton community and determine thresholds for cyanobacteria development. Volunteers helped to detect the turbidity in each stream using colorimetric and optical methods, and recorded environmental conditions in the immediate surroundings of the sites through visual observations, according to the authors.

The evaluation of the benefits of a volunteer-based monitoring to support decision making was also part of the project. The analysed dimensions were water turbidity and chemical characteristics of the sampling collected between the dry (July 2013 and July 2015) and warm (February and November 2014) seasons. The results reinforced the need for nutrient abatement and restoration of local streams. They also highlighted the benefits of volunteer-based monitoring to support tackling the research goals and to enlarge the research base.

Remarks

The project is interesting for the mixed-method it included in the research design. Being an academic project, it focused on creating sound information with the overarching aim to inform decision making.

Another interesting feature is the inclusion of citizen science as part of this project's structure, and the combination of data collected by scientists and volunteers. The inclusion of volunteers enabled a wide range of cases (64 urban streams) and datasets (n=117) to be integrated. The results highlighted the benefits of volunteer-based research and the successful collection of data to increase the data-base so that a threshold for cyanobacteria blooms could be established.

4. A walking workshop along the river Auji

Project Name	Applying Urban Tinkering principles in Kisumu: A walking workshop along the River Auji
River name	Auji
Country, City	Kisumu, Kenya
Website	https://cbc.iclei.org/applying-urban-tinkering-principles-in-kisumu-a-walking-workshop-along-auji-river

This project focuses on the River Auji in Kisumu, Kenya's third largest city. The project is part of The Urban Natural Assets for Africa: Rivers for Life (UNA Rivers[4]), an initiative coordinated by ICLEI (Local Governments for Sustainability), which with the focus on restoration and revitalization of rivers in cities aims to bring together communities, local and regional government, researchers and urban planners. In workshops stakeholders identify challenges and develop solutions to urban problems. Based on urban tinkering principles, a three-day workshop was organised involving different stakeholders.

Tinkering, as advocated by ICLEI[5], is an alternative approach to planning. It combines approaching living systems with the built environment together in order to increase the quality of existing landscapes through small-scale "urban experiments". In the Auji, the workshop consisted of walking together along a 3km stretch of the river, and developing solutions for identified sites to overcome urgent challenges. The overarching aim was to initiate shifts in the way rivers are treated and adopt alternative perspectives.

[4] https://cbc.iclei.org/urban-natural-assets/

[5] https://africa.iclei.org/posters_infographics/urban-tinkering-an-alternative-approach/

Results

Collective insights helped to generate innovative ideas for tackling the recurring flooding, and this with low-cost, nature-based solutions that can be implemented by the riverain population over time. ICLEI lists the following results:

- Integration of grey, green and blue infrastructures – this enables a more powerful and integrated identification of citizens' needs and expectations.
- With the "safe-to-fail" approach, tackling the issues from a variety of angles and stakeholders' views decreased expectations, but also increased the awareness that some initiatives might fail.
- Bringing different stakeholders - with different kinds of knowledge and experience - to walk together along the river resulted in many different perspectives and expanded the discussion over other, partly controversial, challenges. One quoted example refers to the idea of covering part of the river to prevent illegal dumping. This raised concerns about the loss of plant species that help clean and purify the river water.
- Building on what you have on the ground – this principle is used to value the local landscape and local knowledge, and from there to create innovative and context specific solutions. One group discussion was directed at raising awareness of the impact of pollution and garbage dumping in and round the stream, as these have direct consequences for people's own well-being.
- Everyone and every idea count - making clear this issue proved to be an asset to pooling experiences and practical knowledge. This also enabled the development of ideas on reusing existing urban elements to serve multiple, often unrelated, functions.
- Informality, which is a common feature of urban processes in Africa, has to be seen as an opportunity, especially where planning and infrastructure do not keep pace with the rapid urbanisation. Tinkering, as advocated, unlocks the innovation in informality and allows for greater levels of flexibility and adaptability in planning.

Remarks

Introducing Tinkering to one of the poorest communities in Kenya, along with valuing the local situation and knowledge led to a different approach to river restoration. The low financial support forced the participants to develop a set of measures that recycles structures and materials available on site, and to be creative with existing infrastructures.

Another interesting fact is the concept of bringing together different stakeholders (communities, local and regional government, researchers and urban planners) and together identifying challenges and developing solutions on site. This is an interesting and seemingly productive concept. Unfortunately, there is no further information on when the workshop took place nor on future plans or discussed implementation ideas.

5. Raising Awareness on Rivers and the Environment

Project Name	Innovative ways of engaging with communities on the importance of rivers
River name	Malawian rivers
City, Country	Lilongwe, Malawi
Website	https://cbc.iclei.org/innovative-ways-engaging-communities-importance-rivers/

This project carried out in Lilongwe, the capital city of Malawi, focused on environmental education and raising the population's interest in protecting the rivers through the creation and spread of the song "Rivers for Life" (trans. from Chichewa). The project was promoted by ICLEI, an NGO based in South Africa that provides technical consulting to local governments to meet sustainability objectives. This project, like the above described Auji River Project, was also developed under the UNA (Urban Natural Assets) programme.

The lyrics of "Rivers for life" tackles the value of urban rivers and the need to protect them. The renowned Malawian singer-songwriter Lulu wrote and produced it. On 12 June 2018 the music video was launched in Lilongwe, after Lulu and the UNA Rivers project entered into a partnership to raise awareness about the importance of rivers in cities.

The lyrics of the song and the upbeat rhumba rhythmics quickly became a great success, turning Lulu into a sort of ambassador for the project.

Results

The song was broadcasted first by using a common way to share information in Malawi: cars moved around with the song blasting from the speakers. Also 2,000 CDs were distributed in different areas of the city. The song was also handed over to "burn centres", which in Malawi, according to this project, store and sell songs to local communities. Thus, they are the most effective way of engaging with the masses. Here songs were loaded directly onto cell phones and USB flash sticks.

Through a live performance, the song was officially launched in a press event, attended by community members, politicians, newspapers and radio stations reporters. The event was also used to spread information about the UNA Rivers project and the value of nature in urban settings. The event was showcased on three local radio channels and in newspapers. According to ICLEI, until 2019 the song has had more than 6,000 downloads, and more than 8,000 views on Youtube.

ICLEI reports an informal indicator, namely when its team heard the song on the taxi trip to the airport. Upon the recommendation of a friend, the taxi driver had downloaded and listened to the song.

Remarks

Although the Project focused on the (limited) goals of increasing environmental education and awareness on urban rivers in general, it stands out for its innovative and practical approach. Making use of the local infrastructure, the project acted on the first step of river regeneration, which is raising community's awareness, and did this through music.

Since the concern was to reach the largest number of people possible, the project's response is a creative and effective approach. As music can be considered a great means of communication, it can help raise awareness in that it reaches – mostly unconsciously – the heart of people.

6. Mystic River

Project Name	Protect and Restore the Mystic River
River name	Mystic River
City, Country	Boston, USA
Website	https://mysticriver.org

This project concerns the restoration of the Mystic River Watershed, located on the East coast of the USA. The watershed comprises a network of rivers, streams and lakes that drain into the Mystic River. With around 600,000 people living in 21 different communities in the watershed area, the area and the rivers suffer from the harmful effects of urban growth.

To protect and restore the watershed, MRWA (Mystic River Watershed Association) was created to address the following issues on a long-term basis:

1. Provide environmental education
2. Improve greenways
3. Monitor the herring population
4. Combat invasive plants
5. Increase climate resilience and water quality
6. Reduce trash flowing down the rivers.

Results

In order to achieve the goal of improving education and raising awareness about the Mystic River watershed, the association has developed formal education programmes for school and youth groups. The programmes explore the different values and challenges of the watershed in a fun and interactive way. Such programmes can be purchased by schools and educators.

The greenways initiative aims to protect the river banks and the riparian vegetation and to foster the construction of around 40 km of pathways. Several projects that together form the Greenway are currently in the design and construction phase.

The goal of monitoring herring comes into practice with the help of volunteers. They come together between April and June to count and record the number of herring moving towards the traditional spawning areas. This data is used by the Division of Marine Fisheries to estimate herring population size. In 2017 the association also installed an underwater fish cam and an online counting platform to gather more data about the number and behaviour of herring.

Volunteer resources are also used for invasive plant control. They report sightings of invasive plants and animals and take part in actions to remove them. Over 1,000 volunteers are engaged in the two management programmes to tackle key invasive species, one dedicated to invasive aquatic plants, and the second to invasive species in waterfront parks.

MRWA addresses climate change with 3 different initiatives: 1) The fund-raising programme Resilient Mystic Collaborative gathered support and collaboration from organisations and business leaders from 19 out of the 21 communities in the Mystic River watershed and raised over $1.7 million for regional climate resilience projects. 2) The volunteer-based campaign The Wicked Hot Mystic helps to identify heat islands and cooler areas through heat mapping. This mapping supports planning decisions and prevents potential health impacts of extreme heat on people. 3) Green Infrastructure projects to manage stormwater impacts. MRWA is working with municipalities to create more nature-based solutions throughout the watershed, such as bioretention swells, trenches and stormwater wetlands.

The Trash Free Mystic programme consists of several actions. It starts with a series of webinars in April and May for municipal staff and volunteers on measures and best practices on tackling the problem of trash in rivers. Trash booms were installed to block trash from flowing down the rivers. These serve as an educational tool and as a monitoring tool to start measuring the amount of plastic entering the stormwater system. Trash assessments, undertaken with help of volunteers, record data in order to detect the source of water-borne trash.

Remarks

The special feature of this project is its holistic approach and the strong involvement of volunteers, engaged and coordinated by an Association. The growth in terms of results and volunteers involved is a matter of professional guidance, derived from setting up several programmes every year. The results are, on the one hand, a significant improvement in the health and aesthetics of the river, and, on the other, increased experience and financial availability to back the actions.

These factors, together with the range of actions and their different strategies, put this project at the forefront of river restoration. The strong integration of nature-based solutions and volunteer involvement were also key points.

Once again controlling invasive species, and collecting observational data on species by training and empowering environmental stakeholders bear good fruits. The

engagement of volunteers to map temperature around the city, aimed at informing public policies to mitigate the effects of heat islands, and transform the watershed into a cool, pleasant area of the city, is another example of how engaging people with their environment is put into practice.

7. River Irk

Project Name	Bringing the River Irk to Life
River name	River Irk
City, Country	Manchester, UK
Website	https://naturalcourse.co.uk/2021/01/04/project-update-bringing-the-river-irk-to-life-bril/

The River Irk runs from the outskirts to the Manchester city centre. According to the project, the Irk is mostly a neglected and unloved channel. The Natural Course programme, funded by the EU Life IP project, is developing the action plan "Bring the River Irk Back to Life" aiming at transforming the river corridor into an environment people will want to live and work in as well as visit. Greenspaces are planned to provide places for well-being and recreation along a cleaner and more natural river, one which will be, where possible, reconnected to its flood plain. Throughout the river catchment these measures will result in connected habitats where wildlife might thrive, and with fewer threats to migrating fish. Another goal is to get the river corridor recognised as an asset and this to be reflected in protection and enhancement through the land use planning and regional development process.

Actions

The first action of the project was to open a discussion about the River Irk. Over time, the collected opinions were collated into a list of potential actions that could help improve the Irk for both the environment and people. In March 2021 workshops with stakeholders from the public, private and community sectors further developed the action list into a shared vision for the River Irk.

An online tool was created to enable the community to report the issues they identify in the river and along its corridor. The tool contains maps showing the current ecological status of the rivers in the Irk catchment, as well as opportunities/solutions identified so far.

Results

The development of the Action Plan is an ongoing process, and a new update has been issued in October 2021. According to the available information, 161 stakeholders participated in a workshop in March 2021 and analysed the locations of existing or proposed schemes, and the potential opportunities to increase the

Action Plan. Some priorities were defined in the workshop:

- Re-naturalization, better access to and reconnecting the river with the city and surroundings
- Transforming the Irk so it becomes the "people's river".
- Supporting planning policies and decisions that promote more investment in green and blue infrastructure.
- Cleaner water, less rubbish and more wildlife.

The list of mentioned problems includes weirs and culverts, invasive alien species and the loss of biodiversity, artificial channel, poor water quality and other nuisances, such as litter, sewage and unpleasant smell, as well as the disconnection of the river from the floodplain.

The consultation resulted in 13 initiatives. Across the catchment, they ranged from litter picking to the development of plans for the removal of a weir or the construction of bypass channel to aid fish passage, the creation of wetland, and control of discharged sewage to improve water quality.

Remarks

This project is quite unique regarding the importance of the community's involvement in vital parts of an action plan: in the identification of problems and challenges as well as in prioritising the measures. According to the information released by the project promoter, engaging a wide range of stakeholders is the key source of information and knowledge for the elaboration of the action plan.

Another interesting feature is the innovative way in which the community became engaged, namely through the creation of an online platform with a detailed map of the river and its features, making it easy to visually explore the areas. This led to an effective submission of identified problems and suggested solutions. Such a working approach reinforces the use of local knowledge and skills.

8. River Torca

Project Name	Elementos de recuperación de ríos urbanos
River name	River Torca
City, Country	Bogotá, Colombia
Website	

The River Torca runs for approximately 14 km though the city of Bogotá, Colombia, and drains an area of 1,400 ha. It is a tributary of the River Bogotá. Originally the Torca was part of a vast wetland system extremely rich in biodiversity. Over the years, though, part of its course has been channelised, and experienced a dramatic decrease in its ecological, aesthetic and social values (Quintero et al., 2011). This

project proposes a new way of looking at the river, presenting a very complex action plan for its renewal. The plan was developed at the University Antonio Nariño (Bogotá), by an interdisciplinary team composed of experts in biology, urban sanitation, hydraulic and environmental engineering, social services, architecture and urban planning and design.

The goals set are:

1. Naturalise the riverbed and its surroundings.
2. Improve landscape and aesthetic values.
3. Promote biological diversity and improve riparian habitats.
4. Increase the sustainability and autonomous regeneration of fluvial ecosystem.
5. Improve water quality and its drainage capacity.
6. Promote a better interconnection of the community with the river in a safe way.

Actions

The proposed actions targeted three major topics:

– Revegetation of riverbanks
– Community engagement
– Landscape and urban design

Revegetation - The proposed process of revegetation consisted of mapping the existing riparian vegetation, and inventorying the plant species on the riverbed and around it. This enabled a good overview of endemic and exotic species. The plan suggests reintroducing native riparian species as well as low maintenance non-riparian species among the already existing vegetation, following Bogotá's guideline for urban forest management. The revegetation measures aim to increase ecological dynamics and aesthetical value as well as waterflow.

Community Engagement - To facilitate the community engagement, street stands were located along the river with detailed information of the past of the river and its future design. Other mobile stands with information about the environment and native/exotic plants were installed in order to promote further activities, such as garbage cleaning or a thematic carnival parade. Another quoted example is the stand to raise awareness of the amount of garbage in the Torca and the need to recycle the solid waste thrown in the river.

Landscape and Urban design - This topic is where most of the content about the project is available. The project produced dozens of maps and design images where the planned intervention for each part of the river is clearly visible. The maps also display existing facilities and opportunities, such as urban art, playgrounds, events areas and workout areas. The whole riverbed will be transformed into a linear park with pedestrian walkways, jogging paths and cycle lanes. Regarding ecology and the environment, together with the above-mentioned revegetation of the riverbed, the implementation of this new park will work as a link, a bioecological corridor

between the city and the mountains around it. Bird watching spots and ecological information panels are also proposed.

Finally, the project suggests the protection of the riverbed and the riparian vegetation to limit urban expansion.

Results

The main result of this project is the unprecedented complete in-depth study of the existing challenges and possibilities to regenerate a river under urban pressure. The decision of what and where to implement the different facilities, public services as well as vegetation, is taken based on sound local knowledge. This enables the proper integration of all individual measures.

The well-prepared visual aids, storytelling with easy-to-understand visualisations and dashboards proved quite relevant, as they allow anyone to understand the ideas and the expected results. Such visual means are of immense value to decision makers and, in the end, to the community.

In the field, the only actions that were put in place are the two days of solid waste removal, a poster with environmental information, four events held with 48 specialised environmental promoters, and the thematic carnival parade.

Altogether, 170 members of the community of Usaquén, the neighbourhood which the river crosses, got involved.

Remarks

This project is included in the list because it represents a perfect combination of the scientific and academic methodology with the practical approach of a restoration plan to be presented to decision makers. The integration of state-of-the-art approaches with new concepts from different disciplines and expertise make the plan for the Torca restoration an interesting project. The interventions backed by a nature-based concept and some methods to foster community engagement in the whole process, makes the project a great fit for the group of cases studied.

Another interesting feature is the visual aids, such as maps and different perspective views, created to display the planned measures.

Unfortunately, there is no information about the implementation of this project.

9. Manuelzão Project

Project Name	Manuelzão Project
River name	Rio das Velhas
City, Country	Belo Horizonte, Brazil
Website	https://manuelzao.ufmg.br

The Manuelzão project has been working continuously on the restoration of Rio das Velhas, in the state of Minas Gerais, Brazil, since 1997. This river has a basin of 29,173 km2 and crosses 51 municipalities that together gather around 5 million people and contribute 62% of the whole state's GDP. When the Rio das Velhas flows through the city of Belo Horizonte, the state capital, it is already highly affected by human activities and urbanisation.

The project was first founded by a group of professors from the Medicine Faculty of the Minas Gerais Federal University. The project roots were laid out by public health issues, as its backbone was an upgrading in the provision of health and preventive medicine services for specific riverain communities. Medicine professors and students launched a movement to treat the single source of many illnesses in the region: the pollution in the Rio das Velhas.

The central goal of the project is to improve the river's environmental conditions with a view to increasing health conditions and quality of life of riverain communities. It started in 2003 with the programme "meta 2010", setting the following general goals: to make sailing, fishing and swimming possible in the river again; to connect the community with the river and raise awareness among the community to the value of the river.

In order to effectively have an impact on each section of the river, the project created local committees, each one responsible for a different area of the river basin. Each committee involved the participation of community members, local politicians and other stakeholders. A multi-disciplinary Mobilization and Education Group provides guidance and support for each committee.

Actions/Results

The project's focus is mostly on raising awareness and on environmental education. The "Manuelzão goes to school" initiative was created by the central coordination and then applied locally by the committees, thus covering the whole river basin area. The action consists of introducing river protection awareness in schools situated around the river basin. Further initiatives, such as seminars, workshops, mini expeditions, were also offered as school activities.

One of the most successful actions was a river expedition in 2006. A kayak trip and a hiking group down the 804 km of the river were ideal to attract the attention of a large number of people. The crowd gathered along the river to watch the kayakers. During the trip, further awareness-raising events were organised, such as presentations, cultural activities and small hiking trips. Also, the unique experience of both groups made them exceptionally aware of the river issues. They are considered multipliers for future actions. Another successful initiative reported is the "Festivelhas", a 5-day festival to celebrate the cultural and artistic diversity and wealth of the riverain population. Here, too, the environmental and educational component was a central component.

The project also carries out a water quality monitoring programme, the results of which are widely disseminated.

Locally, each committee organises several initiatives in their areas, which include:

- Mapping biodiversity along the river and in backyards, in partnership with the University.
- Technical supervision for housing construction.
- Creation of a linear ecological park in Belo Horizonte.
- Support for the city council in projects that have an impact on the river basin.
- Establishing bioretention areas as sewage treatment.
- Garbage removal and replanting riparian species.
- Support for recycling and selling reusable bags.

Remarks

This project is interesting especially for its scale and structure. The local committee strategy, working like a franchise, seems to be effective in engaging local stakeholders in problem solving related to their neighbourhood, while relying on a comprehensive and specialised guidance and advice from the central organisation/university. This allows the project to implement and disseminate the actions across a large portion of the river basin.

This project goes well beyond raising awareness and environmental education; it has found some creative forms of directing attention to their issues, namely, the river expeditions and festivals.

It is a comprehensive project as it manages not only to involve the riverain communities' actions, but also influence policy making.

10. Manzanares River

Project Name	Plan de Renaturalización del Rio Manzanares a su Paso por la Ciudad de Madrid
River name	River Manzanares
City, Country	Madrid, Spain
Website	https://www.ecologistasenaccion.org/32924/

This project tackles the restoration of the River Manzanares on its passage by the capital city of Spain, Madrid. As a typical Mediterranean river, it has limited flow rates, particularly in the summer. To respond to the intense urbanisation throughout the 20th C, the river has been set in a concrete canal, its flow dramatically changed by water retention sluice gates. These changes have strongly reduced its ecological function as well as its aesthetic and social value.

In 2004 the organisation Ecologistas en Acción (Ecologists in action) submitted a restoration plan to the city council of Madrid. The city council, backed by that plan,

created its own project in order to conform to European legislation and the Spanish national strategy for river restoration, and in 2008 came up with a final document to guide the restoration of the Manzanares. This had the following goals:

1. Functionally reconnect the river with the city, and restore its environmental and social quality.
2. Restore original landscape elements and structures typical of Mediterranean riparian zones and create new greenspaces along the banks.
3. Partially restore natural fluvial hydrodynamics.
4. Improve riparian ecosystems and lateral connection of the river with the tributaries.
5. Improve the ecological corridor function of the river, connecting habitats from upstream and downstream.

Actions/Results

To achieve these goals the following initiatives were undertaken:

Morphology, Vegetation and Fauna – to improve water conditions, pollutant sources were removed and where possible the bank's topography was changed. Opening holes in the channel walls and removing exotic species allowed the revegetation of river slopes with trees and bushes typical of riparian thickets.

Social Use – transforming the riverbanks into meeting places for citizens with Riverbank balconies, walking paths and cycle lanes; linking the river to other leisure, sports and cultural facilities in the city.

Fluvial hydrodynamics – the permanent opening of the water retention gates, and the introduction of deflectors changed the flow dynamics for a more natural performance.

Indicators

The main indicators of change are mostly linked with the restoration of the natural hydrodynamics of the river. The opening of the retention gates led to the spontaneous formation of sediment islands, where native plant species, shrubs and even trees found a habitat. This is working as a basis to greatly change the biodiversity and can be taken as an indicator for the river as a green corridor. Also reported is an increase in native birds and fish species; the return of otters, which had been absent for 50 years, is an indicator that the river is healthy again. Water and odour quality as well as landscape aesthetics have also been clearly improved.

Remarks

This project was implemented in an interesting way, with a strong community-linked organisation, Ecologistas en Acción, creating and submitting a restoration plan to the city council. From another perspective, the plan fell on understanding ears at the city council, which provided the financial resources to put such a huge project into practice.

Another interesting feature of this project was how a simple nature-based solution like restoring the natural hydrodynamics of the river had such a significant impact on its ecological improvement, backed up by impressive biodiversity indicators.

11. River Sokolówka

Project Name	Urban river restoration: a sustainable strategy for storm-water management in Lodz, Poland
River name	River Sokolówka
City, Country	Lodz, Poland
Website	https://climate-adapt.eea.europa.eu/metadata/case-studies/urban-river-restoration-a-sustainable-strategy-for-storm-water-management-in-lodz-poland

The River Sokolówka runs through the city of Lodz, Poland, and is described as highly influenced by the city's heavy urbanisation process, in particular in the 19th century, when the textile industry expanded in the city. Like most of the urban watercourses in the region, the River Sokolówka was regulated and canalised. Nowadays its flow depends mostly on all the run-off water coming from the high number of impermeable surfaces in the city (Wagner et at., 2007). Serious flooding events and high pollution levels have been the results. The lack of greenspaces and open waterways are problems identified in the city, thereby contributing to a decreased quality of life for citizens and the raising of urban heat island effect.

To answer these challenges, a restoration plan was developed by the SWITCH Project - a partnership of 33 organisations from 15 different countries, focused on scientific, technological and socio-economic innovation for a sustainable management of water in the "City of the Future" (Hoyer et al., 2011). The restoration plan aimed at regenerating the river to reduce flood risks and improve the urban ecosystem, and with these ameliorate the microclimate. The Sokolówka project is a testbed for a number of ideas developed by SWITCH while acting as an example of strategy to be implemented by city councils.

The Sokolówka project was developed based on the Blue-Green Network and nature-based concepts. It assumes that rivers and greenspaces have to be connected to the city and its development processes. Through the project, a framework for river management should be put in place, tackling the retainment of rainwater, increasing green infrastructure, encouraging healthy lifestyles, attracting businesses, and making the city more resilient to global climate change.

Actions

The adopted solutions for the restoration of the Sokolówka include strong stakeholder involvement through the creation of a "learning alliance". This concept

consists of a stakeholder forum for exchanging ideas, plans and interests. At its peak, the key stakeholders in the Lodz Learning Alliance had partners from 25 different organisations, including political power, local water management and treatment companies and agencies, research institutes and several NGOs (Wagner et al., 2007). Apart from the "heavy weights" in this alliance, there were several forms of community participation, i.e. meetings, trainings and workshops. Workshops with young people were organised to raise their awareness of environmental issues and to create interest in the city's hidden rivers.

Acquired baseline data (e.g. chemical analysis of water and sediments, biological and ecological data, and models for stormwater management) provided the SWITCH project and the learning alliance with a sound foundation to develop appropriate measures. The regeneration plan included the design and construction of three stormwater reservoirs (completed in 2006, 2009 and 2010) and a sequential sedimentation bio-filtration system for stormwater purification (completed in 2011), which was patented by SWITCH.

Results

Renaturing the riverbed with a meandering canal with biofiltration system, as well as ponds and reservoirs placed in series help:

- Regulate the flow peak and thus reduce extreme flows, increase water retention in the city, improve water quality, and increase groundwater level.
- create new habitats for fauna and flora - increased water quality and new ecotone zones are associated with enriching the urban landscape and creating new aesthetic values along the river corridor.
- Create a healthier urban environment by improving and incorporating the blue-green network into the city.

The pilot and the restoration activities were considered a success, since the Lodz city council and water management agencies, acknowledging the results, plan to expand the measures through a project called Sokołówka Valley, and to connect the renatured area with parks and greenspaces through an ecosystem themed educational path and bike lanes. The Sokołówka model was also replicated on the Arturówek, Lódz reservoirs under the EU Life+ programme.

Remarks

Integrating nature-based solutions into infrastructure projects as main strategy sets the Sokołówka project as a flagship for joint initiatives. The measures for increasing the city's environmental response associated with the learning alliance programme, which gathered key stakeholders, are a particular output of this restoration plan design. The availability of detailed information about this project and the fact that it had a focus on innovation and replicability were other remarkably interesting factors.

12. Rios Project

Project Name	Rios Project
River name	Several rivers in Portugal
City, Country	Portugal
Website	https://aspea.org/index.php/pt/projeto-rios-conhecer

The concept adopted by the Rios Project in 2006 was originally created and implemented in Catalonia, Spain and then replicated in Portugal by the Portuguese Association of Environmental Education (ASPEA). This project aims to make community participation a crucial part of river conservation and management. The idea of bringing this project to Portugal derives from the visible deterioration of rivers and the clear lack of involvement of the populations in their recovery.

The project focuses on environmental education and awareness raising. Through different initiatives, it aims to arouse curiosity and change people's minds to take an active role to promote a better future for rivers.

Actions

Open to any person or entity (i.e. councils, parishes, agencies, schools, companies, etc.) interested in the subject, this project aims to bring a group of people together to volunteer in environmental actions (management of natural resources, waste and biodiversity related to water management). Each group assumes the care of a 500m section of a river, adopting this stretch to develop an action plan jointly. In this way, through the active involvement of the community, the project aims to cover as much of the Portuguese rivers as possible.

The local actions of each group are supported by the technical staff of ASPEA, therefore differing for each stretch of river. Among the common activities that should be mentioned are workshops, seminars, monitoring courses, development of communication material, river valley clean-up days, exotic species removal, and monitoring walks around the adopted areas.

Results

Among the several activities carried out, the most important are the series of lectures throughout Portugal, the monitoring of field trips, and the training courses for monitors.

The National Meeting of the Rios Project and "Portuguese rivers in motion" are events aimed at bringing the groups together to exchange experiences and to disseminate the initiatives.

Apart from all the results linked with the actions in the different sections, between 2006 and 2019 this project has published several indicators of their practical outcome:

– 577 river sections adopted in 141 different municipalities.
– 289 km of rivers adopted.
– 730 environmental monitors trained in 45 courses
– 5,165 Facebook followers.
– More than 50,000 people were involved in the activities.

Remarks

This project is interesting for its effective and wide-ranging concept. The way it is organised efficiently promotes community engagement, as each group is responsible for environmental actions in the adopted section.

The extension of activities and the territory covered by the project are quite remarkable.

On the other hand, the focus on education and awareness as part of river management attracts most attention, maybe putting ecological restoration, landscape management, and improvements in water quality to one side. Reasons for this could be the fact that the project is coordinated by an environmental education association. However, this fact does not diminish the results, since other improvements need much more effort, and raising awareness, as already stressed, is the first step to change people's mind. Most participants come from local associations (101) and schools (331), and this is an impressive outcome.

13. Os Nossos Rios

Project Name	Os Nossos Rios
River name	Rivers of the municipality of Vila Nova de Famalicão
City, Country	Vila Nova de Famalicão, Portugal
Website	https://enea.apambiente.pt/content/os-nossos-rios

The project "Our Rivers" is promoted by the Portuguese Environment Agency in collaboration with the Ministry of Education and the city council of Vila Nova de Famalicão. Creating awareness for riparian systems and promoting environmental education is at the core of the project. It is financed by the environmental fund "National Strategy for Environmental Education 2020 (ENEA)".

The goals are as follows:

– Increase the skills of municipal staff regarding the protection.
– Create a municipal programme of environmental education and motivate target audiences to transfer knowledge for potential multiplier effects.
– Develop workshops focused on capacity building for key stakeholders to support the protection and management of water resources.
– Create a pilot area to demonstrate best river management practices.

Actions/Results

The actions of this project are divided into 4 major areas:

Active public participation – with initiatives such as garbage removal, control of invasive species, planting riparian trees and shrubs, and water quality monitoring; as well as on-site seminars to demonstrate the values of the measures.

Multiplying effect – with workshops and seminars to discuss river restoration techniques and how to gain support from the population; and to increase the staff's skills to monitor and maintain the restored sections.

Environmental awareness – this encompasses different actions to promote interaction with the riparian thickets and vegetation, the need to bring out behavioural changes in treating rivers, and the production of didactic and communication materials to promote the project and its results.

A total of 3,157 people were involved in the project through social media, and another 725 people acquired skills regarding river conservation and management. Another interesting outcome was the replicability of the methodology used, which can be used by other agents or councils.

Within the scope of the project, a memorandum has been signed with a set of personal, community and political commitments regarding the valorisation of the municipality's waterways.

Remarks

This project is interesting for its smaller, but efficient, structure. As it is promoted by a city council and national agencies, it already has the necessary support. Its concept is easily replicable by other communities.

A strong focus on community participation is reinforced by conducting a pilot. This not only serves to demonstrate the value of the measures but also to improve municipal staff's skills.

14. H2Óctogono Azul

Project Name	H2Octógno Azul – Vamos Adotar o nosso Rio Paiva
River name	River Paiva
City, Country	Viseu, Portugal
Website	https://enea.apambiente.pt/content/h2oct%C3%B3gono-azul-%E2%80%93-vamos-adotar-o-nosso-rio-pavia

The River Paiva, with a strong seasonal and annual variation in water flow, runs through the city of Viseu and has an historic reputation for being badly polluted. Industrial discharges made directly into the river are the main pollution sources.

The river never played an important role in the city and has been totally neglected by its urbanisation process and, consequently, its community. This project was promoted by the local Alves Martins high school and developed by students in the year 2018, with the goal of keeping the project alive for the following years. Being a school project, the focus was on education and awareness of river challenges, restoration techniques, and how these could consequently create a multiplier effect in the community in general.

Actions

The methodology used to achieve the goals had a special focus on water quality. During the implementation process, the field work in six different periods, according to waterflow, the students were in 3 different spots of the river (upstream, in the city and downstream) and measured and analysed the water quality. The measurement included recording GPS coordinates, photographing different situations, monitoring meteorologic conditions, and collecting samples for onsite dissolved oxygen analysis, physic-chemical analyses of water (temperature, pH, conductivity, redox potential and turbidity). The physic-chemical analysis was then repeated in the laboratory.

At the end of the work, there was an interactive session with all participants in order to present and discuss the results. In two public sessions, one for the school community and the other for the general public, the project results were presented. The analyses and indicators were presented using the 8 parameters of water quality (PH, nitrates, conductivity, etc.), visually represented by a drop of water coloured differently depending on the result, blue for high values and red for low. All the drops (parameters) put together side by side created an octagon. If all parameters were very good the whole octagon turned blue; the contrary situation created a red octagon, like a stop sign.

Results

The disseminated results are linked to the increase in awareness of the importance of water resources, and in the skills of the students involved. Information materials and a scientific report have been published, and a temporary exhibition was organised in the school courtyard.

Remarks

This project was selected because of its interesting approach to the dissemination and communication of the results. The design of visually arresting graphics, such as the octagon of the drops of water indicating water quality, resulted in easy viewing and understanding of the issues of water quality. It is a creative and attractive form of engaging the community.

Another interesting factor is the fact that the project was totally promoted by a high school with the technical support of researchers of the Polytechnic Institute of Viseu.

15. Cascais Streams

Project Name	Ribeiras de Cascais
River name	Streams in the Cascais Municipality
City, Country	Cascais, Portugal
Website	https://ambiente.cascais.pt/pt/projetos/ribeiras-cascais

This project, initiated by the city council, aims at improving the ecological performance of the streams in the municipality. Cascais is part of the metropolitan area of Lisbon and is an important tourist destination, thus it is affected by urbanisation pressure. This, in turn, resulted in negative impacts on the streams. The project started in 2014, led by the Environmental Protection Department of the city hall and focuses on the ecological restoration of streams. A list of critically endangered endemic riparian species was the trigger of the project. Acknowledging the decrease in ecological quality of this streams, the city council decided to protect such valuable natural resources and set the following goals:

– Map biodiversity, stream habitats and disturbed riparian forest areas in the municipality.
– Update and enhance the knowledge base on the biotic and abiotic characteristics of streams.
– Develop measures for river ecosystems restoration.
– Control nonindigenous invasive species, and revegetate with endemic species.

Actions

The above-mentioned goals led to several actions, including:

– Mapping the riparian forests, monitoring and developing measures to restore them.
– Monitoring water flow and fish fauna, evaluating water quality.
– Controlling and eradicating invasive and exotic plant species in riparian zones, and planting native species.

These measures were supported by extensive communication and information activities, which included a wide distribution of information brochures, site information boards and an exhibition on the natural heritage of the Cascais rivers.

Voluntary programmes for garbage picking and control of invasive species enabled community participation.

Results

The implemented measures resulted in improvements in streams and adjacent areas. Several positive indicators were recorded:

– Counting species population (10,000 fishes, including endangered species, and 45,000 invertebrates).

– 343 volunteers participated in eleven initiatives, with 610 kg of waste collected.
– Mapping flora and fauna along 3,94 ha of streams and areas for the control of invasive and exotic species, and planting native species, 1,125 planted species in the Ribeira das Vinhas stream, and around 1,000 invasive crayfish removed.
– In 2018 this project received co-financing from the national programme POSEUR (Operational Programme for Sustainability and Efficient Use of Resources).

Remarks

Unlike the other Portuguese cases, which have a stronger focus on education and awareness, this Project has a very practical and efficient focus on ecological restoration, although the involvement of the community is not one strength of the project. It uses nature-based associated low-cost methodology, which seems to be efficient and easily replicable. The performance indicators make it an interesting case.

DISCUSSION OF RESULTS

This section outlines key issues and provides analysis, review and interpretation of the selected cases. This step involves a systematic identification of these key issues, common in most cases, and a reflection on them in an aggregated form.

Most prevalent issues are *Terminology* (the terms used in the cases, in particular how engaging (riverain) communities and stakeholders are referred to); *Coordination* (the management structures, project initiator/promoter, how power structures are devised), *Goal-setting* (specific goals defined by the projects); *Community Engagement* (the levels of community integration and stakeholders participation in the actions); *Approaches and Methods* (the application of frameworks to achieve the goals); and the combination of *Nature-based Solutions and Public Participation* (actions that support the integration of a community-based approach in removing sources of disturbance through nature-based solutions). When relevant, the analysis also distinguishes between national (Portuguese) and international cases and outcomes, since the premises and results are relevant for the development of a knowledge-base for the research group CIDATE.

The key issues are also considered both as priority and opportunities to improve the environmental quality of urban areas, and increase the level of public awareness of ecological issues. Table 2 summarises the measures adopted by the cases and how the community was involved.

	Main guidelines		Measures
Structure	Integration of local communities during the project design phase		• Through interactive digital platforms (River Irk) • Stakeholder meetings with community representants (River Auji) • Community workshops on site to identify problems and develop solutions (River Torca)
	Creation of a replicable and preferably scalable concept		• Creation of autonomous groups, with professional coordination (academic, organizations, etc.), on different rivers, or stretches of the river, with different stakeholders, including politicians (Rio das Velhas) • Creation of incentive programmes where different entities can apply to adopt a stretch of river and, according to the guidelines, develop a restoration plan (Rios Project) • Making the approach more professional as a long-term continuous job with skilled officers/engaged participants (Charles, Mystic, Rio das Velhas)
Goals	Foster community involvement		• Education and awareness raising • Participative design • Volunteering programmes for fieldwork
	Further ecological restoration		• Water monitoring • Habitat restoration • Ecological balance and improvement • Creation of greenways/corridors for ecological connection
	Enhance quality of life		• Climate change programme • Parks, paths and leisure facilities • Landscape values • Public health
Community Involvement	Project design		• Using interactive digital platforms • Stakeholder meetings with community and council representatives • Workshops on site
	Application		• Volunteering programmes (Charles River, Mystic River, Brazilian streams and Cascais streams) • Community is the main promoter (with professional coordination)
	Communication		• Thematic festivals/events (Rio Torca and Rio das Velhas) • Use of "influencers" (river Lilongwe) • Thematic river expeditions (Rio das Velhas) • Information centres (Rio Torca)
	Long-term sustainability		• Information centres • Social mapping to identify problems and propose solutions (Rio Torca) • Create associations/organizations composed by different stakeholders to continue the restoration work in the long term. (Charles River, Mystic River, Rio das Velhas)
Nature-Based Solutions	For community use	Through volunteer programmes or community-based projects	• Removal of garbage and control of exotic species of flora and fauna (Cascais, Rios, Os nossos Rios, Charles River, Mystic River, Rio Torca, Rio das Velhas, Blue Loop) • Planting actions and promoting native flora and fauna (Blue Loop) • Water quality monitoring (H2Óctogono, Blue Loop) • Landscape management to increase accessibility (Blue Loop, Rio das Velhas) • Bird feeding and nesting boxes (Blue Loop)
	For organizations and entities	Professional associations, schools, public entities etc.	• Biofiltration ponds (MysticRiver and River Sokolówka) • Urban design measures (porous asphalt, retention ponds, creating wetlands and directing stormwater towards green areas) (Charles, Mystic) • Opening damns and restoring fluvial dynamics (Manzanares)

Table 2: Main features and issues detected in the cases and strategies to engage communities in these issues.

Terminology

The terminology used by the cases plays an important role in the understanding of contexts and results. Our interests were confined to keywords that evoked citizen science, community-based participation, and involvement of the community. The used terms reflect, in a way, the nature of the project's promotor and coordination mechanisms.

The term citizen science is only used in academic discourse - the Brazilian Streams for example, refers to it by involving trained volunteers who help to measure water quality. In projects run by professional associations/organisations, such as the Mystic River, Charles River, River Irk and Rio das Velhas, public participation is generally referred to as volunteering, and this brings together scientists and the local community. Other projects, like the EU funded organisation that coordinates the restoration of the River Sokolówka, refers to public participation by using the term stakeholder involvement. This is also the case of the River Kisumu in Kenya.

The amateur organisation Friends of the Blue Loop uses the words friends and volunteers when mentioning the people involved. For the projects that involve deeper structural changes to their rivers and include political decision makers, community involvement is generally referred to as public participation. This is the case of the Manzanares project and the Rio Torca project.

Project coordination

Considering who assumes the coordination of the project, shown in Table 3 and Figure 1, the survey reveals that the majority of the 15 cases was coordinated by professional organisations or associations. Out of the 8, only the Charles River, the Mystic River and the River Irk projects were fully dedicated to river restoration. The Sokolówka, Lilongwe, Kisumu and Rios projects were coordinated by associations/organisations which focus on broad purposes of environmental protection. The only project that is coordinated by a high school is the H2Óctogono Azul.

Three cases were coordinated by academic institutions, but only the Ribeiras do Brazil project also includes a scientific experiment. The Rio das Velhas and Rio Torca projects were coordinated by universities and besides restoring the respective rivers, also aim to create and disseminate knowledge. Three other cases were led by their respective city council. Finally, only one project was led by an informal group of citizens (Friends of the Blue Loop) who decided to come together and lead some river restoration actions on their local streams.

There seems to be no direct relationship between the project coordination (government, association, academic, etc.) and the results and restoration indicators; also, there seems not to be any pattern or trends related to the nature of the coordinator and the ways the local communities became involved.

Project coordinator	Project
City councils	Manzanares, Ribeiras de Cascais (Cascais City Council), Os Nossos Rios (V. N. Famalicão City Council)
Professional Associations/Organizations	Charles (Charles River Watershed Association), Mystic (Mystic River Watershed Association), Irk (Natural Course), Sokolówka (Switch Project), Lilongwe and Kisumu River (ICLEI. CBC), Rios Project (Portuguese Association of Environmental Education) and H2Octógono Azul (Highschool Alves Martins)
Academy	Rio Torca (University Antonio Nariño), Rio das Velhas (Federal University of Minas Gerais) and Brazilian Streams
Local Groups	Friends of the Blue Loop

Table 3: The list of the main promoters and coordinators of the projects

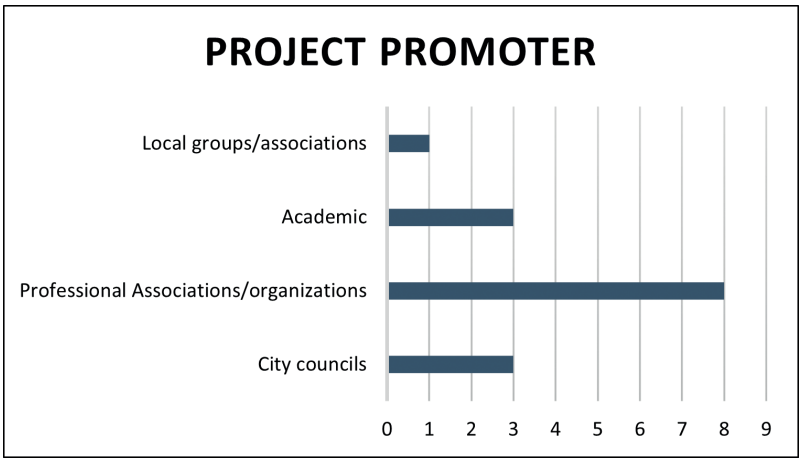

Figure 1: The four main groups of project promoters

Goal-setting

The next step encompasses the analysis of established goal(s) in each case. These specific goals depend on the objectives and opportunities of each situation; however, their analysis and comparison with those of other cases allow a better grasp of the strategic scope of each project as well as of trends regarding focus and approaches. This analysis addressed the stated goals of each project, the wealth and the achievement of such goals, depending on the availability of data. One challenge is that they are described with varying degrees of detail. Table 4 lists the goals of international cases and Table 5 those of the Portuguese cases.

Stated goals / Projects	Water quality, ecology, climate change resiliency						Community's quality of life						Community awareness and involvement		
	Implement eco-hydrological principles	Manage stormwater	Manage waterflow	Restore Habitats	Restore natural fluvial dynamics	Improve the relation between artificial features and river	Use existing materials and creativity	Develop a systemic and replicable approach	Improve parks and pathways	Foster community health	Improve relation between city/people and river	See urban informality and tinkering as an opportunity	Create awareness of river restoration importance	Use the community to identify problem and solutions	Enhance volunteers' work efficiency
Charles River		X	X	X	X					X	X				
Mystic River		X		X					X				X		
Brazilian Streams				X											X
Rio das Velhas										X	X		X		
Rio Torca		X		X							X				
River Lilongwe													X		
River Auji							X				X	X		X	
Rio Manzanares				X	X	X					X				
River Irk														X	
Blue Loop			X												
River Sokolówka	X	X	X	X				X			X				X

Table 4: The established goals of the international cases

Looking at the 15 cases and their goals, one can identify a great range of objectives, which cover most aspects of river restoration giving a fairly representative picture of river renaturing projects. The majority of the cases establish several intertwined goals - with ecosystem restoration (in a wider sense) at their core, since this was key for the research. Tackling ecosystem restoration lies at the heart of the Blue Loop, Charles, Manzanares, Rio Torca and Sokolówka projects; other cases like the Auji, Irk, Lilongwe, and Rio das Velhas have their main focus on enhancing active community engagement and increasing quality of life. Two cases, Brazilian streams and the Mystic River, divide their goals almost equally by the different approaches.

The goals that were mentioned the most are:

- restore habitat - 6 out of 11 cases
- Improve the relationship between city/people and the river - common to 5 cases

Further common goals, shared by 2 or 3 cases are:

- Manage stormwater
- Manage waterflow
- Create awareness of river restoration value
- Restore natural fluvial dynamics
- Use the community to identify problem and solutions

The goals that are specific to a single case are the majority, namely, 8 out of the 15 mentioned goals. These are:

- Develop a systemic and replicable approach – River Sokolówka
- Implement ecohydrological principles – River Sokolówka
- Improve the relation between the built environment (artificial features) and river – River Manzanares
- Use existing materials and local creativity – River Auji
- Improve parks and greenways – Mystic River
- Improve community's health – Rio das Velhas
- See urban informality and tinkering as an opportunity – River Auji
- Enhance volunteers' work skills – Brazilian streams

It is interesting to note that 3 out of the 4 goals set by the River Auji case are specific to it and are not mentioned by any other cases.

The Portuguese cases

Since the Portuguese cases were extremely specific about their goals, revealing numerous nuances to the same general aim, it is more interesting to divide them into 3 general goals, as presented in Table 5.

The analysis of the Portuguese cases reveals a strong tendency of the cases to focus on the development of education and public awareness-raising, with 3 out of 4 cases targeted to these issues. In the case of H2Óctogono Azul, the focus is towards improving the skills of students since this project was promoted by a school. The "Rios" project also put their efforts into raising awareness and disseminating

General Goals	Undertake Environmental Restoration	Enhance Quality of Life	Develop Awareness and Education
Rios	-	X	X
Os Nossos Rios	X	-	X
H2Octógono Azul	-	-	X
Ribeiras de Cascais	X	-	-

Table 5: The main goals of the Portuguese cases

information since it was promoted by the Portuguese Association of Environmental Education. The project "Os Nossos Rios", promoted by the city council, also focuses mostly on disseminating knowledge and raising awareness, but in this case, this is part of the main goal to act directly on the ecosystem restoration of the rivers. In the complete opposite end, the project "Ribeiras de Cascais", led by the Environment Protection Department of the Cascais Municipality, focuses completely on the ecosystem restoration of the rivers and streams. None of the goals mentioned for the four cases involved the relationship between the river and the community, or improving health, leisure or landscape issues.

Community engagement / Public participation

The analysed cases in river restoration projects with public participation revealed an interesting diversity when it comes to how the community is involved. In this context, it is important to remember that "community engagement", also referred to as citizen participation or public involvement, is understood here as any process that directly engages the public or local stakeholders in decision-making and/or opens up the projects to participants giving them opportunities to provide inputs and thus influence decisions and outcomes that might affect them. Table 6 presents a brief description of the goals and measures and how the community was involved in the analysed cases.

In the Charles River, Mystic River, River Irk and Torca River projects the local community participated through associations or organisations that coordinated each project. Individually, each volunteer signed up to be a part of the solution through different actions. The involvement of the community in the "Ribeiras de Cascais" and "Os Nossos Rios" projects was made possible through an individual application for volunteering - both projects were coordinated by the corresponding city council. The H2Octógono, run by a high school, was directed to the students, without involving the community. In other cases, like the rivers Manzanares, Sokolówka and Kisumu, public participation was engaged through organisations that, albeit not being the main promoter, would use the outcomes to inform decision-making. In the River Manzanares project, for example, the organisation "Ecologistas

en Accion" was charged by the Madrid City Council to enact public participation, as it represents 300 groups of ecologists and activists spread across Spain.

	Main guidelines		Applications (examples from the cases)
Structure	Integrating local communities during the project design phase		• Stakeholder meetings with the community (Auji River) • Through interactive digital platforms (River Irk) • Street community workshops on site to identify problems and solutions on a map (Rio Torca)
	Creating replicable and scalable concepts		• Independent groups with professional coordination (academic, organizations, etc.), with different stakeholders, including politicians (Manuelzão) • Programmes adopt a stretch of river and present a regeneration plan according to guidelines (Rios) • Long-term jobs and offices for the different river stretches instead of isolated projects (Charles, Mystic, Manuelzão)
Goals	Main aspects of river restoration	Community involvement	• Education and awareness • Project design participation • Field/volunteering programmes
		Ecological restoration	• Water monitoring • Habitat restoration • Ecological balance and improvement • Greenways and corridors for ecological connection
		Quality of life	• Programmes addressing - Climate change - Parks, corridors, and leisure facilities - Landscape values - Public Health
Community Involvement	Throughout the whole process	Project design	• Interactive digital platforms • Stakeholder meetings with community representants • Community workshops on site to identify and map problems and solutions
		Application	• Volunteering programs (Charles river, Mystic rivers, Brazilian streams, and ribeiras de Cascais) • Community is the main promoter (with professional coordination)
		Communication	• Thematic festivals/events (Rio Torca and Manuelzão) • Through "influencers" (Lilongwe river) • Thematic river expeditions by boat/kayak (Manuelzão) • Info centres for raising awareness (Rio Torca)
		Long term sustainability	• Info centres with mapping to update problems and suggesting solutions (Rio Torca) • Associations/organizations with different stakeholders to continue the restoration work in the long term (Charles river, Mystic river, and Manuelzão)
Nature-based Solutions	For the community	Volunteering programmes or community projects	• Removal of garbage, invasive plant and animal species (Ribeiras de Cascais, Rios, Os nossos Rios, Charles river, Mystic river, Rio Torca, Manuelzão, and Blue Loop) • Planting actions with endemic species and promoting native fauna (Blue Loop) • Water monitoring (Blue Loop) • Trimming vegetation to increase accessibility (Blue Loop) • Bird feeding and nesting boxes (Blue Loop)
	For organisations and government	Professional associations, schools, public entities etc.	• Biofiltration lakes or deposits (Mystic river and Sokolówka river) • Permeable pavements for biofiltration and retention, directing stormwater towards green areas and wetlands (Charles and Mystic river) • Opening damns and restoring fluvial dynamics (Manzanares river)

Table 6: Major goals, measures and community involvement forms in the analysed cases

On the issue of public participation, the case of Rio das Velhas is interesting. The leading coordination entity, the Federal University of Minas Gerais (a public university), divided the river into small sections, and created for each one a fairly

independent local community group. Making use of the knowledge that citizens are more interested in their immediate vicinity, these groups became the potential actors in measures to restore their river section. The Brazilian Streams project focused actively on hiring volunteers and measuring the efficiency of using their help was one of the key goals of this academic research. This project was the only one that specifically mentioned special training to the volunteers and measured the efficiency of using them.

Although public involvement in the river Lilongwe case was only achieved through awareness of river pollution issues, the case must be highlighted for its innovation and effectiveness. Having a nationally recognised star singing a song called "Rivers for Life", coupled with the intense broadcasting of the song, lent a helping hand in spreading the message and reaching a wider public. By using an "influencer", this project adopted a proven method of communication in order to obtain the best results possible for education and bringing the issues of water pollution to attention.

Another interesting way to raise awareness is the interactive digital map of the River Irk, where anyone could pinpoint existing problems and suggest possible solutions. This strategy enabled citizens to provide concrete inputs in terms of locations and actions that could be implemented along the river and its surrounding areas. This expanded the range of issues to be addressed, adding to the experts' view more local and lay views. Also, the proposed countermeasures could make a real difference in people's lives as they constitute answers to local shortcomings. The digital map also induces a higher commitment from both the local community and the council in the restoration process. This strategy enables a large number of people to participate in the decision-making process and to have real impact upon the projects' results and outcomes.

Further creative forms of reaching out to a substantial part of the riverside community can be the thematic public events and festivals, as well as the cases of "Rio das Velhas", the thematic carnival parade "Rio Torca" in Bogotá, and the kayak expeditions in the "Rio das Velhas". This kind of thematic activities, involving entertainment and culture, have a great potential for reaching a large portion of the community and consequently have a strong impact on how people see their local river and urban rivers in general.

Ecosystem restoration and nature-based solutions

Among the diverse methods used to increase the river's ecosystems and their connection to the cities, some cases revealed some interesting instances of creativity and efficiency in the use of nature-based solutions. Besides the more common measures of river restoration, like garbage removal, control of exotic species or water quality monitoring, we can highlight those cases which apply a wide range of measures and ideas in their river restoration proposals.

The Mystic and Charles Rivers have the more holistic approaches, as both also developed measures to reduce stormwater pollution to be implemented in the riverside areas to prevent the pollution of the rivers. Since the stormwater runoff is the major source of pollution and algal blooms, both the Mystic and the Charles river watershed association have managed to apply nature-based concepts to filter the runoff water before it reaches the rivers. The stormwater is directed into sidewalk flower beds or tanks/ponds to improve biofiltration. Apart from the importance of reducing the polluting nutrients reaching the river, such measures also help decrease the speed of the flow which makes the river water level rise. The same principle was used in the River Sokolówka, with biofiltration ponds created along the river course. These projects make use of nature's help to increase water quality and benefit from the ecological and social improvements arising from it.

Another case to mention is the Manzanares river project, although the level of community involvement is not as high as seen in other cases. The river Mansanares was channelised, and for nearly 60 years sluice gates controlled the waterflow on its passage through Madrid. This channel-like effect significantly affected the natural hydrodynamics of the river. The removal of the sluices restored natural hydrodynamics and sediment dynamics, thus creating more natural conditions. The natural formation of sand banks, water oxygenation and right breeding conditions enabled native plant and fish species to return to the area and to thrive, attracting more birds and even river otters that had not been seen in the area for over five decades. This is a good example of how a simple, inexpensive nature-based solution has brought biodiversity back into the heart of a large city like Spain's capital, improving water quality and landscape values. Even minor rehabilitation measures of degraded ecosystems can bring back some biodiversity and key services (Geist & Hawkins, 2016).

Nature-based solutions and public participation

In order to obtain an overview of the level of importance ascribed to nature-based solutions and public participation in each case, the percentage of nature-based solutions and the (potential) results were compared with the effectiveness of the different forms of public participation. Three key issues of public participation were considered:

1. Diagnosis and problem-solving processes
2. Active participation in measures and actions
3. Awareness-raising dimension

In this way, the balance and interactions between nature-based solutions and public participation could be better understood. The results are depicted in Figure 2.

Most projects (10 out of 15) can be located between the values of 1 and 3 when it comes to the importance of public participation to the project's outcomes; with only two projects achieving 4 and 5, and two others situated between 0 and1 on the

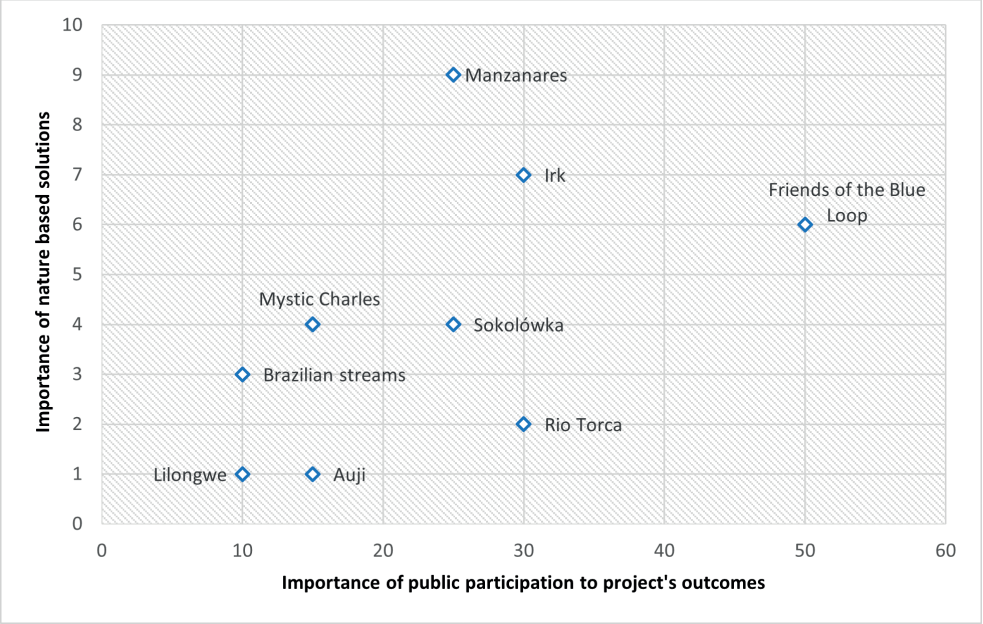

Figure 2: Level of public participation and nature-based solutions in river restoration projects

opposite end. Regarding the importance of nature-based solutions, there is a much more balanced distribution of the cases, with 2 or 3 cases in each level except for the top tier (between 4 and 5), where there is only one case.

Considering the total outcome, the case of the River Lilongwe, in Malawi, is one with the least involvement of public participation and nature-based solutions. This case is, therefore, far from the goal of engaging the community in creating nature-based solutions. This surely results from the fact that this project was launched to draw attention to the need to better protect the River Lilongwe. On the other hand, the Portuguese project "Rios" showed the highest level of importance allocated to public participation because the whole project was developed by the community, just like the project Friends of The Blue Loop. The difference between the two lies in the fact that the latter did not include awareness raising as part of its methods.

Focusing on the importance of nature-based solutions, the Manzanares river project scores the highest value. That is due to the far-reaching changes undergone by the fluvial hydrodynamics with more natural river landscapes, which were central goals in this project.

CONCLUSION - NEW PERSPECTIVES FOR URBAN RIVERS AS A RESEARCH STRAND

Analysing such a range of cases has enabled the BaseRiU Project to gain more knowledge and benefit from experiences. Buried underground or highly modified urban rivers are a common feature worldwide. Due to the loss of habitats, decrease

in water, environmental and landscape quality, cities around the world are opting to bring rivers back to life. For our research group (including the BaseRiU Project) it is relevant to identify best practices that can guide further research efforts. The cases cover a wide range of approaches, which enables a better vision of the different issues of river restoration that may need attention in the future.

The cases confirm the assertion that there is a strong interplay between the role of rivers in the process of urbanisation and the impact of urbanisation on rivers. Analysing the commonalities and differences between the various cases, their approaches and results provides us with a holistic understanding of both rivers as ecosystems and the role of restoration as a social process. Even though all cases have the aim of restoring rivers, each one has its own set of goals, approaches and measures, making the experiences on river regeneration a rich endeavour.

For a holistic river restoration process, as the cases show, there are 3 main pillars that should be taken heed of: ecosystem restoration, public participation, and education and awareness development. The cases confirm the major significance of involving the local community, besides showing that artificial habitats created for one purpose can be modified to enhance biodiversity and provide services that benefit the community. To achieve this, the community must be involved to be better informed and thus committed. In effect, it may sound like a cliché, but, as Geist & Hawkins (2016) assert, the first step in enabling recovery of any degraded ecosystem is to remove or reduce current impacts. The second, is that prevention is much better and mostly less expensive than cure. Thus, the call is to make greater efforts in conserving existing rivers and their ecosystems. In this way we can ensure a healthy environment. Developing strategies to better integrate the community in the river restoration process is one of the main focuses of this work. This was confirmed by all analysed projects in the most decisive manner – even with different levels of public participation. When it comes to the community's quality of life, the response should focus on improving the relationship between people and the river (through landscape improvements, parks, paths, leisure facilities, etc), health and safety.

The discussion on environment protection, biodiversity and climate change is leading to an increasingly sensitive urban society. These issues need to be resolved by environment-sensitive planning and its implementation along with effective management and monitoring. A river environment is itself a highly complex system with a variety of processes continuously changing along its course, and in urban areas rivers become more complex systems with more intensive human activities. Regarding the ecological restoration of urban rivers, the analysed cases show a variety of paths to achieve this: the focus should be multidimensional, encompassing recovering the natural hydrodynamics, managing stormwater flows and habitat restoration (removal of invasive species, garbage, etc.). This way, integrated, efficient and sustainable restoration can be achieved. Responding effectively to a sustainable solution will require (1) changes in our environmental behaviour, (2) a shift to more

ecologically sound urban design, techniques, taxes, and laws, (3) an increase in investments for ecological restoration projects, and (4) increased investments in research, knowledge transfer and education. The cases show that the results of tackling urban river issues as an ecosystem are largely independent of whether the whole river, parts of it, or entire river networks, in small-, medium-, long-term and large-scale projects, are considered. All projects have the ability to catalyse changes and push for policy changes. This calls for better understanding the projects' practices and the challenges faced.

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