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Comparative analysis of enabling factors of sustainable urban water management: a synthesis

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1 Introduction

This report is part of the SWITCH project's Work Package on 'Governance for Integrated Urban Water Management' (WP 6.1.). It has been written as part of the deliverable D.6.1.6, a 'Comparative analysis of enabling factors of sustainable urban water management' and it contains a synthesis of the case studies and the theoretical and analytical framework adopted in the activities leading to D.6.1.6.

The project 'SWITCH – Managing Water for the City of the Future' aims at developing sustainable urban water systems through a combination of research, technological development, demonstration activities and training within a Learning Alliance framework. Learning Alliances are stakeholder platforms designed to break down barriers to information sharing, thus speeding up the process of uptake and innovation (Salian and Anton, 2011).
SWITCH is part-financed by the Directorate-General for Research of the European Commission and is running from February 2006 to April 2011.

The present report aims at presenting a synthesis of the following documents:

- Lobina, E. (2010), *Comparative analysis of enabling factors of sustainable urban water management: draft methodology*, 6th Framework Programme SWITCH project, 15 p.
- Green, C. (2010), *The transition to sustainable urban water management*: London case study, 6th Framework Programme SWITCH project, 77 p.
- Green, C. (2010), *The restoration of the river Cheonggyecheon, Seoul*, 6th Framework Programme SWITCH project, 20 p.
- Dijk, M.P. van & Liang, X. (2010), *Case study brief*: Beijing, managing water for the ecocity of the future, 6th Framework Programme SWITCH project, 18 p.
- Salian, P & Anton, B. (2011), *Making urban water management more sustainable*: achievements in Berlin, 6th Framework Programme SWITCH project, 27 p.
- Salian, P & Anton, B. (2011), *The Emscher Region*: the opportunities of economic transition for leapfrogging urban water management, 6th Framework Programme SWITCH project, 23 p.

Additionally, the following documents have been consulted on the achievements on sustainable urban water management in Belo Horizonte and Porto Alegre, in Brazil:

- Nascimento, N., Costa, H., Costa, G., Dias, J. Knauer, S. (2008), *Integrated urban water management in Belo Horizonte, Brazil*, Expo Zaragoza 2008, Thematic week 2: Water and City, 16 p.
- Nascimento, N, Heller, L,. Knauer, S., Baptista, M., Heller, P., Chernicharo, C., Champs, J.R. (2006), *Long term uncertainties and potential risks to urban waters in Belo Horizonte*, 6th Framework SWITCH project, 38 p.
- Nascimento, N, Knauer, S., Champs, J.R. (2007), *USWM in Belo Horizonte LA*: legislative and strategic structure, 6th Framework SWITCH project, 19 p.
- Banco Mundial (2008), *Para um orçamento participativo mais inclusive e efetivo em Porto Alegre*, Relatório n. 40144-BR (World Bank report n. 40144-BR "For a participatory budgeting more inclusive and effective in Porto Alegre", original in Portuguese), 130 p.
- Carmona, M.V.C. (2008), *Gestão da drenagem urbana em Porto Alegre, RS, Hydroaid, Brasilia*, 110 p. ("Stormwater management in Porto Alegre", original in Portuguese).

2 Integrated urban water management and sustainability

Sustainable development, when applied to water in the urban environment, refers to aspects as follows:

- Using water more effectively (Green, 2010-a), reducing water consumption and, in consequence, energy required to water treatment, transport and distribution, economy on the use of other materials, such as chemicals for water treatment, and reduction on the volume of wastewater to be transported and treated;
- Reducing impacts on receiving bodies and contributing, when possible, to "rebuilding natural environments" in the urban area, as in the case of river recovering projects.
- Dealing with flood control and heath risk associated to water (water borne diseases) more effectively, with emphasis on non-structural methods (e.g.: flood proofing, emergency planning and management) in respect to structural ones (e.g.: lining streams, dams, etc).

There is a varied and rich collection of new technologies (or adaptation of old ones) that can meet, at least in a broad sense, these targets of sustainability. The SWITCH project contributed to develop and test many of them in 12 demonstration cities in different economic, urban an environmental contexts. In most of cases, these techniques focus on more diffuse and less structural actions, such as the use of SUDS in stormwater management or runoff harvesting and reclamation of wastewater to meet nonpotable demand.

A more generalised use of these solutions requires significant changes in water governance in the urban environment (e.g.: the involvement of multiple stakeholders) as well as alternatives for funding and taxing (e.g.: sharing capital and maintenance costs for stormwater management between public and private), people acceptance of new technologies, land use regulation, building norms, and risk management, among others (e.g.: Green, 2010-a; Novotny, 2009).

Water demand management may be another alternative leading to a reduction on water consumption, successful in cities like the SWITCH demo city Zaragoza. Nevertheless, detailed assessments on the impacts on dwelling economies related, for instance, to tariff models

conceived to influence water consumption, must be considered, particularly in the case of low income dwellings. Another aspect is related to the low elasticity of water consumption which may prevent the possibility for demand management based only on tariff models, requiring efforts on public involvement, information and considerable technical efforts for controlling water leakage, particularly high in developing countries.

Concerns on the contamination of water bodies and the perspective for the development of policies or urban water bodies recovery, particularly through river restoration initiatives are lead by purposes of protecting water resources, increasing green areas in the urban environment, recreating possibilities for biodiversity in the streams as well as adjacent green areas, offering opportunities for leisure and sociability. These policies, in a large measure, are in opposition to the urbanism which prevailed from mid-18th Century and part of the 20th Century, mainly focused in organising the urban environment according to rational basis led by purposes of traffic improvement and the reduction of the water presence through setting up a huge network of subterranean channels, including the canalisation of urban streams. Again, river restoration as in the case of SUDS, requires making room for water in urban areas, leading to significant changes in land use regulation, road and traffic planning, as well as water governance (e.g.: people involvement, multiple stakeholders).

In parallel, urban sustainability also leads to emerging questions relating to the effective land use. More dense and compact cities provide reductions on requirements of energy, particularly for transportation of people and goods, but also for the transportation of water and wastewater, as well as reductions on land demand for setting up major roads as in the case of more scattered developments. In this sense, approaches based on urban area densification make reference to the cities of the 18th and beginning of 20th Centuries, with no clear zoning, providing locally a mixture of functions (e.g.: housing, commerce and service), and therefore reducing the need for travels in the urban area and for the use of private car based transportation (Fouchier, 1997). This is a discussion present in classical references as Jane Jacobs' "The death and life of great American cities" (Jacobs, 1993, new edition of the 1961 original), although obviously not focused on sustainability as now understood, and more recent references in which sustainability is the central issue (e.g. Giddings et al, 2005; Coyle, 2011). Purposes of sustainable urbanism leading to the control of

soil and water degradation, city scattering, occupation of risky areas (e.g.: landslides, flooding) as well as protecting natural resources, cultural heritage and agricultural land use requires the use of different legal instruments (e.g.: Bernstein, 1993) and incentives (e.g.: Nascimento, Cançado e Cabral, 2005).

In the same sense, sustainability of water management may include concepts of water neutrality, which regards issues as follows (for more details see Green, 2010-a):

- **Water imports**: targeting on significant reduction of water consumption imported from areas outside the urban area**.** Rainwater harvesting of the water falling on the city can be adopted as an additional source of water.
- **Water outputs:** Target can be set taking as a reference runoff that would have occurred in natural conditions, requiring therefore the use of stormwater techniques that contribute to increasing runoff infiltration, detention and evaporation, trying to mimic natural conditions.
- **Food usage:** food production, the majority of with is produced outside the urban area, requires huge amount of water. In this sense, city areas mobilise and import large quantities of 'virtual water' (Allen, 1998 – as quoted by Green, 2010-a) which has to be included as imported water. Reduction on virtual water consumption may imply in diet changes.
- **Other virtual water**: refers mainly to the water consumption in manufacturing processes, incorporated in the product or evaporated in the process, and may lead to imported or exported virtual water**.**
- **Greenhouse gas emissions**: refers mainly to the energy required for water transportation. According to Green (2010-a), a shift to decentralised systems can be expected to increase the energy requirement.
- **Phosphorus recovery**: focus on recovering phosphorus from wastewater, as an essential plant nutrient**.**
- **Impact on riverine environment:** regards both downstream and upstream urban impacts on the riverine environment, as water withdraw for water supply and changes on flow regime and on water quality due to changes on runoff and infiltration-detention-evaporation processes in the urban environment.

- **Proportion of household income spent upon water services:** refers to the impact of the cost of water and wastewater services in low income households. In the UK, the term 'water poverty' has been defined as spending more than 3% of household income on water and wastewater services (Walker, 2009, as quoted by Green, 2010-a).

Sustainability on water management may be measured through a varied of direct and indirect indicators, as follows (based on Green, 2010-a):

- Average reuse ratio: ratio of water used to water imported.
- Average energy usage per tonne of water imported and exported.
- Average value added per tonne of water imported.
- Water usage by commercial, industrial and public sector per person per day.
- The proportion of properties adopting rainwater harvesting.
- The area of green roofs in densely occupied urban environment.
- The proportion of impermeable area converted to SUDS.
- The breakdown of consumption for different sectors by usage.
- The proportion of grey water that is reused.

A comprehensive approach on urban sustainability may also be found in the criteria stated by Van Dijk (2010 – as quoted by Van Dijk and Liang, 2010) to characterise eco cities:

1. How does the city deal with water related issues?
2. How does the city deal with sanitation issues?
3. How does the city deal with pollution issues?
4. How does the city deal with climate change issues?
5. Does the city follow an integrated approach?
6. How does the city deal with energy issues?
7. How does the city deal with solid waste issues?
8. How does the city deal with transport issues?
9. How does the city deal with housing issues?
10. How does the city deal with sustainable urban development issues?

The concept of integrated urban water management is discussed by Lobina (2010) on the base of different definitions found in the literature. Among them, one of the most encompassing concepts is that of the Australian Water Conservation and Reuse Research Program (2004 – as quoted by Lobina 2010), "Integrated Urban Water Management takes a comprehensive approach to urban water services, viewing water supply, stormwater and wastewater as components of an integrated physical system and recognises that the physical system sits within an organisational framework and a broader natural landscape. There are a broad range of tools which are employed within Integrated Urban Water Management, including, but not limited to water conservation and efficiency; water sensitive planning and design, including urban layout and landscaping; utilisation of non-conventional water sources including roof runoff, stormwater, greywater and wastewater; the application of fit-for-purpose principles; stormwater and wastewater source control and pollution prevention; stormwater flow and quality management; the use of mixtures of soft (ecological) and hard (infrastructure) technologies; and non-structural tools such as education, pricing incentives, regulations and restriction regimes".

Nascimanto et al (2008) point out significant challenges for IUWM as follows: "Integrated urban water management (IUWM) presents a wide range of different challenges to be effectively implemented. This may concern, at a first level, to promote integration of different water domains, such as water supply, sanitation, storm water management and receiving water protection at the urban environment. Due to the close relationship between water and land use, promoting IUWM requires also the development of integrated policies consistent with the territorial management. That is the case of urban development policies having major impacts on land use, such as housing and road system and transportation. Furthermore, local policies usually reflect on the water management at other territorial scales, beyond the municipal borders, usually involving the metropolitan and the river basin scales. Therefore, significant political and managerial efforts have to be developed by a wide range of institutions and stakeholders in pursuing sustainable and integrated urban water management within this complex political and institutional environment".

3 Factors contributing to changes in urban water management: Lessons learnt

Many different factors can contribute to changes in urban water management towards sustainability. A current and frequently cited reason relates to crises in the water sector. Among the case studies here assessed Berlin (Salian and Anton, 2011-a) is possibly one example where a context of crises, associated to other factors, contributed to changes in the city water management.

With the end of the 2nd World War, the division of Germany in two countries made Berlin West, the Western capitalist part of the city to become an "island" surrounded by the communist East, the former RDA. From the 1950s, the vulnerability of the city in terms of water resources became clear to the West Berlin Authorities, leading to a policy aiming at reducing dependence on the East for water through increasing water supply capacity to reach self-sufficiency and low risk in terms of water supply. Many innovative initiatives were undertaken on the water demand side, such as reducing water domestic consumption, reducing leakages in pipelines, as well as on the side of water offer side, such as extensive forms of groundwater enrichment by bank infiltration and stormwater infiltration.

From 1989 on, the unified Berlin kept the same principles that helped West Berlin to deal with the water supply crises of the 1950s up to the end of the 1980s and to innovate in terms of water sustainability, with initiatives as follows - see Salian and Anton (2011-a) for more details:

- Bank infiltration;
- Regional water law supporting a closed urban water cycle;
- Green roofs;
- Stormwater infiltration;
- Efficient demand management.

The water management in Berlin is guided by some key principles defined by the Senate Department for Urban Development (SenStadt, 1998, as quoted by Salian and Anton, 2011-a):

- the extraction of water had to occur within the confines of the city's boundaries;
- the quantity of water used for various purposes needed to be minimised;
- the withdrawal of groundwater had to be proportional to replenishment and recharge;
- the city's water bodies had to be protected from pollution as strictly as possible;
- the treated wastewater was useful for boosting the flow rate in the water bodies; and
- the retention of stormwater was a given in order to complement the limitations of the other resources.

The case of Seoul and the restoration of the urban river Cheonggyecheon (Green, 2010-b), on the other hand, is an example of factors such as the need of investments in other sectors, in the present case road infrastructure, as well as flood management, combined with political will can lead to the implementation of projects with huge visibility and demonstration potential. According to Green (2010-b), the political will in the Seoul case was mainly driven by the personal project of a mayor willing to develop an innovative and highly visible project that would contribute to his intent of becoming the President of Korea, which was successful. On the other hand, costs to refurbish a major road set up over the former channel of the river Cheonggyecheon as well as flood control measures to be implemented based on structural approaches (underground detention structures) proved to be much higher than the much more innovative river restoration project.

In this sense, the restoration of the Cheonggyecheon seems also to combine drivers such as opportunities for innovation brought by crises with the political purpose of development symbolic highly visible projects. Indeed, the Cheonggyecheon project has outstanding visibility, it is worldly famous and is frequently quoted as a major river restoration intervention in a complex urban environment, a densely occupied city centre and a traffic axis of dense circulation. On the other hand, the project has not been developed on the base of an intense process of people involvement and participation which characterises similar projects in the developed world (Green, 2010-b) and in certain cases in the developing world (Nascimento et al, 2008).

Green (2010-b) lists factors leading to a successful political symbol:

- "It can be implemented relatively quickly, generally within one political cycle (i.e. the Olympics are an exception but the political benefits are arguably in the run up).
- It is highly visible.
- It is successful and widely regarded as successful.
- It is demonstrative of the politician's wider political philosophy.
- It is expensive: cheap implies a lack of conviction and expensive demonstrates an ability to mobilise a large quantity of resources for the benefit of the politician's voters.
- It is different: it has to mark out the politician as offering something different both from their predecessors and their competitors."

Green (2010-b) sees in these criteria barriers to the implementation of sustainable urban water management since many o f the technologies involved lack visibility, are diffuse in the urban area and are slower to be implemented. One can also add that sustainable technologies require multi-stakeholder platforms strongly involved in the decision making process and also in the implementation, operation and maintenance processes.

A possible way of dealing with potential barriers and drawbacks as mentioned is associating with long terms projects on rainwater harvesting or SUDS development, for instance, symbolic projects that can not only capture the attention and participation of multiple stakeholders but also mobilise political and financial resources.

An example of this approach is the case of Belo Horizonte, in Brazil. By the mid of the 1990s the city had prepared a detailed methodology to achieve significant improvements on urban water management through a comprehensive planning process. One of the main drivers of this change was the political will of recovering the municipal capacity of stating, implementing and controlling the urban water management policy. This change coincided in time with the end of the contract with COPASA, the Minas Gerais state water utility, in charge of the water supply and sanitation services for the last 20 years, then. Recovering the planning and management capacity in the water sector was seen as essential political and technical conditions to offer the municipalisation of all the water services (stormwater

management has always being municipal) as an alternative to renewing the contract with COPASA (Oliveira, 2011). In this context, a municipal programme focusing on river restoration, the DRENURBS programme, contributed to associate to the much more abstract planning process and contract negotiations with COPASA and the owner of the majority of its shares, the Minas Gerais State government, a highly visible, tangible, and people centred intervention in the urban environment.

The DRENURBS programme focus on creek recovering in the Belo Horizonte area by means of a participatory process which also involves actions on housing, sanitation, stormwater management, health control, and the creation of green areas and leisure facilities in the urban environment. The DRENURBS programme benefits from the city experience on participatory policies, such as the participatory budgeting, the slum upgrading master plan, at the same time as it consolidates this participatory process at the catchment local level (Costa et al, 2008). In each catchment, the programme is implemented with the participation of the local inhabitants from the conceptual phase. A commission of the local community representatives ensures the required links with the administration, during the execution of the projects, transmitting demands, suggesting project adaptations or changes, and controlling the quality of the project execution. By this process, “local cultural values and backgrounds become key elements of social learning and environmental perception of the public intervention” (Costa et al, 2008).

Although one would expect that a programme such as the DRENURBS would be a product of the urban water planning process, its innovative, symbolic and visible aspects contributed to mobilise financial resources with an international developing bank (Inter-American Development Bank) not only for the programme itself bu also for the planning process and associated lower visibility water managerial actions (e.g.: implementing a water quantity and quality monitoring network; flood risk modelling and others) and to get political support for significant changes in the urban water management in Belo Horizonte.

Green (2010-a) also points out the role of symbolic projects in a quite different political and economic context, the London case, where high profile developments created opportunities for incorporating sustainable urban water approaches. Examples are the Terminal 5 at the

Heathrow airport, the largest rainwater harvesting installation in London, the 2012 Olympics (ODA, 2009, as quoted by Green, 2010-a), where water management includes SUDS, rainwater harvesting, demand management, reuse, green roofs and green walls, and river restoration and the Thames Gateway (Environmental Agency, 2009, as quoted by Green, 2010-a). In the same sense, Green (2010-a) mention initiatives of big companies to adopt sustainable strategies such as green roofs as a way of demonstrating commitment to sustainability.

Incentives are employed in the UK to promote the adoption of technologies leading to sustainable urban water management by commercial organisations through tax reduction. "Companies can write off 100% of the first year capital allowance against tax on approved equipment in a series of categories" (Green, 2010-a), such as:

- Efficient washing machines
- Flow controllers
- Leakage detection equipment
- Meters and monitoring equipment
- Rainwater harvesting equipment
- Small-scale slurry and sludge dewatering equipment
- Vehicle wash water reclaim units
- Water efficient industrial cleaning equipment
- Water management equipment for mechanical seals
- Water reuse

The initiative of the civil society to demand improvements on the local environmental conditions played a significant role in the case of the Emscher region (Salian and Anton, 2011-b). The Emscher region refers to the Emscher catchment located at the erstwhile industrial centre of western Germany, the Ruhr district (Ruhrgebiet) in the federal state of North Rhine-Westphalia. For over a century this region has been central to the Germany industry, notably through its coal mines and steel plants. This left to the region a heritage of typical industrial degraded landscapes and polluted waters after the decline of the heavy industries from the 1980s. The river Emscher has been used as open waste water canal

since the end of the 19th Century and is today biologically dead. The river was lined with impervious concrete bed a solution which was favoured to an underground sewer system due to the risk of subsidence caused by coal mining.

The heritage of brown fields, degraded landscapes and the Emscher river acting as an open sewer, associated with the fall of the coal and heavy industry created the opportunity for the pressure of social groups and NGOs at local level asking for significant environmental improvement in the area. According to Salian and Anton (2011-b), "the NGOs indeed played a crucial role in keeping the environmental issues in focus by conducting many discussion forum and public consultations which further raised the awareness about the challenges in water management in the region".

Other important factor of change was the local political commitment at the regional level towards sustainable water management which materialised in a convention on stormwater management signed by 17 mayors of the region. This agreement, called the 15/15 convention is a voluntary declaration based on three fundamental principles as follows (Raasch & Schüler, 2007, as quoted by Salian and Anton, 2011-b):

- "Measures on-site should have priority over conventional discharge methods in new residential areas, existing built-up areas, as well as when modernising old houses.
- Disconnection potentials should be completely taken advantage of in areas where land use is changing e.g. where old and unused industrial sites are being converted to newer service-oriented industries, thus creating opportunities to apply natural methods of stormwater management.
- Using disconnection as a measure during planning or while remediating existing sewer systems should be done in consultation with relevant stakeholders."

Another main player in the Emscher region is the Emschergenossenschaft, the oldest water resources management association in the North Rhine-Westphalia, a self managed public association, founded in 1899, and acting as a non-profit organisation controlled by its members who represent the industries, coal mines and municipalities (Sailin and Anton, 2011-b). Nowadays, the Emschergenossenschaft has the following responsibilities in the river basin:

- Maintenance and development of water courses
- Wastewater discharge and disposal)
- Flood protection
- Stormwater management
- Planning and consultation services
- Groundwater management

According to Sailin and Anton (2011-b), "the Emschergenossenschaft was the lead organisation that initiated the 15/15 project, and as of today is still the authority supporting the initiative in terms of administrative, technical and financial measures. Although the convention was officially signed in 2005, the Emschergenossenschaft had promoted the disconnection of households and commercial buildings as demonstration projects to raise awareness of sustainable urban drainage in the region since the 1990s".

Other political changes such as process of democratisation in Brazil, following more than 20 years of military dictatorship, had at least two major consequences that create opportunities for implementing urban water sustainable management. The first one is a significant transfer of political power to the local spheres, the municipalities, compared to the highly centralised political power at the military times. Although Brazil keeps still a centralised policy at the Federal level, mainly through the centralisation of the majority of the taxes resources, which are in part later distributed to the States and the Municipalities, municipalities play nowadays a significant role on local policies formulation. The second one is the creation and implementation of a wide varied of institutional innovations promoting participatory processes for the local policy formulation and implementation, such as:

- Participatory planning;
- City conferences;
- Participatory councils, and
- Participatory budgeting.

Among those instruments, the participatory councils and the participatory budgeting are possibly the most innovative (Nascimento et al, 2008). The participatory councils are usually

deliberative with members representing the civil society and the municipality and with responsibilities of (i) policy formulation; (ii) control of policy application; (iii) prioritisation of investment and actions and (iv) assessment of conformity and effectiveness of actions effectively implemented. Since these councils are organised according to specific domains, each of them has also the responsibility of developing adequate political articulation and coordination with other councils to ensure coherence and integration on their decisions and actions. According to Milani (2006), the city councils lead to a clear improvement in the state-society relationship. They constitute an improved political space for the government and the society to share responsibilities in the public administration and at the same time to deal with conflicts on policy and management (Costa et al, 2008; Milani, 2006). In this sense, they are relevant instruments in promoting, canalising and articulating popular demands on different domains of the city government agenda: health, education, transport, housing, urban development, environmental sanitation and culture (Welter et al, 2008).

The participatory budget is possibly one of the outstanding instruments leading to public participation on decision-making and to a shared management responsibility between the government and the citizens at the local sphere (Nascimento et al, 2008). In the case of Belo Horizonte, the participatory budget concerns about 50% of the budgetary resources available for investments, the total municipal budget minus resources assigned to fixed administrative costs, payment of interests and other current obligations. Considering that the participatory budget usually focus on local (district) actions, the remaining 50% of the available resources are usually employed in investments of a more general or diffuse interest for the city, not particularly related to a neighbourhood or a district. One of the major contributions of the participatory budget has been on the resource allocation profile within the city, either within socio-economic classes as well as in terms of resources distribution within the municipal territory, demonstrating to be an important instrument for social integration and inversion of priorities from investments at richer areas to investments in poor where needs in terms of infra-structure and services are more significant and where live the majority of people in cities of the developing world.

The participatory budgeting was first created and implemented in Porto Alegre, the capital of the Rio Grande do Sul State, Brazil, in 1989, as a consequence of a growing process of

demand by civil society movements for a more balanced distribution of investments in the city area which stated in the 1970s. Considering the total annual budget of the municipality of Porto Alegre, at about 12% is employed through the participatory budgeting (Banco Mundial, 2008).

Although the participatory process which is currently implemented in many Brazilian cities, as in other urban areas of Latin American countries, offers opportunities for implementing policies and strategies towards urban water sustainability, the mere existence of these processes obviously does not imply that such policies are really developed or implemented. For instance, it is quite frequent that demands for lining and covering creeks are still current in many meetings with inhabitants at local districts. The creek lining approaches are still seen in many cases as adequate ways for dealing with hugely polluted streams in the urban environment and with the risk of flooding, mainly due to people not being aware of more sustainable and environmental friendly alternatives.

Nevertheless, there is a clear tendency that sustainability becomes a key issue in the participatory budgeting and other participatory forums in Belo Horizonte and Porto Alegre. In Belo Horizonte, the SWITCH project has played an important role in this sense, particularly through the training activities and the demonstration projects (for more details, see the Belo Horizonte SWITCH website – www.ehr.ufmg.br/switch, and Butterworth et al, 2011).

In Porto Alegre, the cooperation between the Institute of Hydraulic Research of the Federal University of Rio Grande do Sul (IPH-UFRGS) led to a new municipal land use regulation (Municipal Decree n. 15371, enacted in 17th November 2006) requiring that new urban developments meet a limited specific flow fixed at of 20.8 l/s.ha to drain stormwater to the public sewer system. This new land use and stormwater regulation let to a spread and intense use of SUDS in the municipality. Also contributed to this change the environmental code with, for instance may allow a more intense urban development in an area where stormwater is not of a big concern, provided that the developer make investments on detention basins in public areas, downstream, as a compensation measure. The participatory process through the participatory budgeting, neighbourhood associations, as well as the role played by the Porto Alegre Department for Stormwater Management and by public

prosecutors working with environmental regulation in Porto Alegre are contributing to improve water management in the city towards sustainability.

Many other factors may play a relevant role in promoting political shifts to urban water sustainable management. Sailin and Anton (2011-a) mention, in the case of Berlin, a part from the crises role, the following main factors:

- *"Financing available*: It is estimated that Berlin was able to spend a sum of 3,800 million USD from 1950 to 1989 on investments in its wastewater reclamation and reuse infrastructure. This high level of financial commitment was necessary for Berlin to provide a stable water management system. The much-needed investment for such infrastructure was borne by the federal government and the actual costs were never reflected in the fees charged to the inhabitants of Berlin. This emphasises the financial subsidies that were offered to the authorities in West Berlin by the federal government. Post unification saw Berlin re-instated as the national capital, which symbolically and materially changed the status of the united city. The city was turned into a vast construction site, while many "prestige projects" in water management were implemented. These projects are now exhibition sites for many of the innovative trends and technologies in water management.
- *Berlin`s administrative structure as a national capital, federal state and local government*: The proximity of the three pillars of administration - i.e. of a national capital, federal state as well as a local government - provides for a unique advantage for the governance of water, wherein (a) all agencies (national, federal and local) dealing with water are closely related to each other; (b) the challenges in water management receive quicker attention and the required interventions are implemented in a shorter time span; (c) regulators in the water sector can act as independent authorities, giving them more flexibility in operations.
- *Senate as a powerful regulator:* Since water was perceived to be a scarce resource in the past, water management was given a lot of attention socially, financially and politically. Interestingly, after the reunification of Berlin, water scarcity was no longer a problem and there were ample possibilities for transporting water into Berlin from the neighbouring state of Brandenburg. But this was avoided, and Berlin still follows the same techniques of water abstraction, reclamation and reuse as in the past. Why

this is so is a puzzling question. Some reasons pointed out by the interviewees state that the Senate in Berlin acts as a very powerful regulator in environmental protection and is very proactive in introducing environmentally-friendly solutions. Within the Senate some civil servants have been ecologically conscious, charismatic and influential leaders who steered and directed the discourses in Berlin's water management. Many of the senators have also been involved in teaching at universities in Berlin, thereby closely linking science and policy making, which has proved beneficial for Berlin's water management.

- *Public awareness in water issues:* Given the urban character of Berlin, environmental issues in the city were, and predominantly still are, related to urban life. Therefore, problems relating to housing, transport, urban restructuring, clean air, waste disposal, clean water, protection of parks and green areas have received highest attention. Furthermore, water issues in Berlin gained an important boost in public awareness during the 1980s, when environmental activism gained momentum. Specific awareness-raising campaigns such as *Denk mal über Wasser nach (Think about water)* became popular through advertisements and effective public relations. These campaigns were usually tailored for specific purposes like reduction in water consumption; however, they have also generally led to a higher sensitisation of the inhabitants of Berlin regarding key issues of water in the city".

In the case of the Emscher Region, Sailin and Anton (2011-a) also refer to the following main factors:

- *Readiness for major investments*: One of the key strategies to boost regional transformation was to organise a so-called Internationale Bauausstellung (IBA - International Building Exhibition) coined IBA Emscher Park, which was carried out from 1989 to 1999. With a total investment of 5 billion DM (2.5 billion Euro), a total of 120 projects were carried out. These projects ranged from regional garden exhibitions and landscape parks to the restoration of rivers and the development of new living spaces in the region. In addition, the federal state government of North Rhine-Westphalia sanctioned the provision of 4 billion Euro for the Emscher River restoration that would span for twenty years. These important financial resources

allocated for the projects clearly played an key role in the implementation of sustainable water management practices in the Emscher Region.

- *Socio-economic and environmental benefits of using water as the central theme for large-scale restructuring:* The introduction of the IBA triggered numerous new initiatives for the socio-economic restructuring in the region, among which the rehabilitation of the Emscher River was seen as an important element to improve and transform the region's image as one with better living conditions. It was one of the unique examples where water was used as a central theme for socio-economic restructuring. The Emscher restoration projects involved many aspects of sustainable water management, such as creating new green spaces and green corridors. These projects would in turn prove beneficial to improve the local environment as well as the living conditions and thus increase investments for a service-based economic zone, as well as increase the value of real estate in the region.
- *The introduction of the European Union Water Framework Directive (WFD) in the year 2000* provided the legislative support for the rehabilitation of the Emscher River. It thus became mandatory for the federal state government to improve the river's ecological and hydromorphological status by the year 2015. The WFD also provided new funding opportunities from the European Commission for the restoration of the Emscher River and proved to be a crucial factor in the adoption of sustainable practices in the region.
- *The Emschergenossenschaft as a central force for driving the process*: The Emschergenossenschaft is an association consisting of members from municipalities, industries and coal mines. This water board has proved to be an important organisation in promoting sustainable water management practices independent from the federal state government. The association was responsible, for example, for initiating the 15/15 convention on stormwater management in the region and has been at the forefront of the restoration of the Emscher River system. The water board has also played a significant role in raising awareness of water-related issues in the region by involving local NGOs and social groups. It has implemented several pilot projects that showcase best practice examples in decentralised stormwater management at source. The Emschergenossenschaft sets an example of how an independent association with democratically-elected members can take the lead in

initiating, promoting and implementing sustainable practices in urban water management.

In the case of Beijing, considerable institutional changes are being implemented in parallel to a significant number of initiatives in agreement with concepts of urban water sustainability. Van Dijk and Liang (2010) mention the following recent changes:

- *Changes in water governance*: With the aim of reducing the number of agencies and bureaus involved in water management, China is reforming the national water governance, starting by Beijing. A new water authority has been created, the Beijing Water Authority (BWA) in charge of water resources and services management. The responsibility of the BWA is (Van Dijk and Liang, 2010): 1) to formulate the policy, regulation and administrative rules on water management, 2) to formulate the regulations on water tariff and wastewater fee, 3) to supervise the water services and the standard of technology, 4) plan and organize the water supply and water allocation, 5) manage the institutions concerned with the wastewater discharge and reclamation.
- *Water and sanitation management*: Beijing is a water scarce city and is interested in closing the water cycle, "defined as the link between the resource, its use for drinking water and the eventual reuse to allow the water to flow back in the resource" (Van Dijk and Liang, 2010). Actions implemented focus on the reduction of the industrial water consumption, per industry unity by 30% and to increase the coverage for water and sanitation facilities. One of the technologies promoted is rainwater harvesting in the urban and in the rural areas. In the sanitation area, a decentralised approach is promoted for new developments although it seems not to be financially feasible for developers (Van Dijk and Liang, 2010). A centralised large scale wastewater treatment plant, the Gao Bei Dian plant is also the largest wastewater reclamation plant of Beijing. The reclaimed wastewater will be used for agricultural irrigation, industrial cooling water, green lands irrigation and residential toilet flushing and car washing. Beijing is also a unique example in the world of a city that forces by legislation all major new buildings to separate brown and grey water and to treat their grey water on the spot. Two demonstration projects highlight the different technical, managerial and economic aspects of this grey water reuse regulation, the

Qing and the BNU grey water project. The late one seems to be more successful, using grey water for toilet flushing at the campus of the Beijing Normal University. In the Qing project, a refusal of at about 20% residents is reported due to the opinion that the reclaimed water is too dirty to be used for toilet flushing.

- *Sustainable urban development issues*: According to Van Dijk and Liang (2010), "sustainability does not seem to be the major principle used for developing Beijing. For the Olympic Games in 2008 some efforts were made to give a greener impression of the city. (…) After cannibalizing natural resources such as land, water and clean air, Beijing now starts to realize that a greener approach to urban development is necessary. However, just moving polluting industries to other cities is not going to do the job. (…) Also public campaigns on television are good, but certainly not enough to change attitudes of households and entrepreneurs, who have been lax as far as sustainable development is concerned".

For a more detailed assessment of Beijing accord to criteria for defining eco cities, please consult Van Dijk and Liang (2010).

In the case of London, Green (2010-a) also mention some other factors or comparative advantages the city has to making changes for water sustainability:

- "It has a strong and effective system of planning and building regulation; that is, a system with which there is a high level of compliance.
- It has had a system for collecting and disposing of solid waste since the middle of the nineteenth century and hence the pressure on using component of water systems to dispose of waste is reduced.
- Compared to Asian, African and South American cities, it has a low population density and also a very large ratio of open space to total area.
- It has a temperate climate; whilst overall rainfall is small, it is entirely adequate to support rain fed agriculture, and rainfall intensity and both inter- and intra-year variability is low.
- It sits on an old flood plain and hence is relatively flat, and importantly is not downstream of a mountainous area".

Green (2010-a) also mention the fact that "changes have been piggy-backed in on the two higher profile issues of sustainable development and adapting to climate change. This has been helped by the much low costs of delivering sustainable urban water management than of carbon neutral energy services. It has been seen that successive UK governments have, since 1989, defined climate change as perhaps the biggest threat facing the country and have reacted accordingly. That piggy-backing can be seen as a version of the commonly used approaches of attaching some proposed change to some vision of modernism and the invocation of some moral principle; now, the avoidance of 'waste' whilst the moral principle attached the nineteenth century reforms was the attack on 'filth'. Those opposing any change are consequently framed as being out-of-date and immoral".

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