
Towards integrated urban water management in Belo Horizonte, Brazil: A review of the SWITCH project¹

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I. INTRODUCTION

Water management and urban planning in Belo Horizonte

The city of Belo Horizonte was established in the 1890s as the capital of the State of Minas Gerais becoming the first modern “planned” city in Brazil. Streets were laid out on a broadly spaced grid to create a pleasant living environment and facilitate the construction of houses and laying of pipes, and space was dedicated to squares and parks. Chief engineer, Aarão Reis, foresaw a broad sub-urban fringe around the city, as a transition between the urban and the “natural” environment that would also contain unlimited urban growth.



Figure 1 Location of Belo Horizonte

Source: Nascimento et al. (2007)

¹ Knauer, S. et al. 2010. *Towards integrated urban water management in Belo Horizonte, Brazil: A review of the SWITCH project*. [Online]. Available at: <http://www.irc.nl/page/58311> [Accessed 9 December 2010].

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However, the city grew rapidly and in the 1950s, a new area was developed designed by the architect Oscar Niemeyer who won a competition launched by the mayor, Juscelino Kubitchek. Niemeyer planned Lake Pampulha in the middle of the neighbourhood, partly to act as a flood controlling reservoir but also to improve the landscape. The Pampulha area acted as a laboratory for Niemeyer, applying lessons learnt in the design of the new capital city, Brasilia. In the meantime, Belo Horizonte continued to boom, particularly during the 1970s and 1980s, until it reached its current population of 2.2 million inhabitants 3.9 million if you count all the people in the 33 municipalities that make up the Belo Horizonte Metropolitan Region (RMBH).



Figure 2 Oscar Niemeyer's legacy, the Pampulha Church on the shore of Pampulha Lake

Source: Stef Smits (2008).

For a long time, water management in Belo Horizonte focused on keeping up with population growth, in many respects with success. The drinking water supply system connects 99.7% of Belo Horizonte residents (Nascimento et al, 2007) and is operating to high standards in terms of reliability of service and water quality. Coverage by sewerage systems is also high, reaching about 92% of the population (idem). However, 40% of the interceptors that transport household wastewater to treatment stations without entering the urban drainage system still need to be constructed. This lack is an important cause of seepage of sewage into groundwater, and subsequently into streams. In addition, there are many illegal connections to the separate stormwater drains, mostly from households but possibly also from industrial premises. Coverage of sewerage systems in the

neighbouring municipalities is also much lower than in the city. This means that a considerable amount of wastewater still ends up in stormwater drains and rivers.

During the period of intense urban growth from the 1970s to the mid 1990s, stormwater drainage investment was focused on lining rivers and the construction of closed drainage channels. Despite these efforts, the number of floods was not reduced. These engineering works also had very high costs, which became unaffordable during the period of hyperinflation in the early 1990s. Since the mid 1990s there has been a shift in approach towards a more environmental approach to urban drainage. Firstly, this has aimed to improve the quality of drainage effluent, and secondly to fit drainage works better into their natural contexts. Investments have gone into wastewater interception and treatment, restoration of urban creeks and piloting of technologies such as detention ponds and wetlands. Around these drainage works, parks and recreation areas have been established, in a sense reflecting the original greening principles of urban planning of chief engineer Aarão Reis and architect Oscar Niemeyer.

This change in the water management paradigm has been facilitated and reinforced through efforts to democratise decision-making processes in water management. After the end of the military dictatorship in 1985, the Municipality of Belo Horizonte (PBH) put much effort into democratisation, focusing particularly on establishing mechanisms for citizen participation in decision making about local planning and services provision. This is exemplified by participatory budgeting, a process known as OP in Portuguese, where citizens can propose works to be included in the municipal budget, and from the shortlisted projects, the ones which receive most votes from citizens are prioritised. In addition to these general mechanisms to strengthen participatory democracy, new coordination structures have also been set up for different sectors. A good example is the Municipal Sanitation Council, COMUSA, which has a mandate to prioritise investments in sanitation and in which representatives of local government and civil society participate (Smits et al., 2008a).

SWITCH in Belo Horizonte

The Sustainable Water Management Improves Tomorrow's Cities' Health (SWITCH) project is a major research partnership funded by the EC, with a budget exceeding €20 million, undertaking innovation in the area of integrated urban water management (IUWM). Rather than solely focusing on new research, the project aimed to put research into use across different aspects of the urban water cycle in order to improve integration and scaling-up, and ultimately to achieve more sustainable urban water management. One of the focus cities was Belo Horizonte.

This focus on getting research into use had implications for the way in which SWITCH was structured as a project. First of all, it called for more integrated and inter-disciplinary research, trying to study water management from different

angles in its technological, hydrological, economic and governance aspects in an integrated way. In addition, the project sought to engage relevant stakeholders and establish linkages between research providers, knowledge managers and research users through interdisciplinary bodies known as learning alliances (Smits et al., 2007a; Butterworth and Morris, 2007). The plan was that learning alliance members would help to define the research agenda, participate in the research itself and act as the main channel for dissemination and scaling up.

SWITCH started work in the second half of 2006 in Belo Horizonte, with the local aim of providing further impetus to change processes that were already underway towards more sustainable urban drainage and joined-up water governance. The intervention logic of SWITCH was to build upon changes already underway and to develop complementary activities of research, demonstration and capacity building. Learning alliances played the integrating role in linking these together.

This paper

In the final year of the project, a review was undertaken of SWITCH experiences in Belo Horizonte, building on a 2008 mid-term review, both of which involved a review of documents and interviews with a sample of key stakeholders, including researchers among University staff and students, coordinators involved in project management and learning alliance facilitation, and research users such as implementing agencies and city authorities (see Annex 1). This paper is the outcome of both assessments and presents the main results of the SWITCH project in the city, identifying lessons learnt and recommendations to support appropriate follow-up of the project in the city, as well as offering insights for other SWITCH cities and similar initiatives elsewhere.

II. SWITCH APPROACH IN BELO HORIZONTE

This section describes the way the SWITCH project has been approached in Belo Horizonte, including the way in which the activities were planned to achieve the objectives (the intervention logic), and an overview of actual activities and inputs.

Project origins and objectives

The greater emphasis on the environment and democratisation that has taken place since the mid-1990s amounts to a paradigm shift in Belo Horizonte's approach to water management. Although the Municipality, as the lead authority on urban drainage, has been in the vanguard, a range of other stakeholders have been involved. Even before the SWITCH project, the Universidade Federal de Minas Gerais (UFMG) was working closely with the Municipality, carrying out research around on issues such as hydrology, technology, costs, etc. When the opportunity to participate in SWITCH presented itself, this was seen as a logical sequel to existing activities and complimentary to what had already been done.

The expectations of the two main parties were well matched:

- The Municipality's interest lay in research into and monitoring of drainage interventions, particularly to evaluate and validate them in the real-life settings, rather than under laboratory conditions. The expectation was that the results would serve as input for its current and future drainage programmes. In addition, it had an interest in strengthening participatory management models for urban drainage and needed more research on governance and management to inform such models.
- UFMG was primarily interested in carrying out research into innovative approaches to urban drainage. It also had an interest in participating in an international network of researchers and cities to be able to exchange experiences with innovations.
- Between them, these two stakeholders met the two main objectives of SWITCH – research, and putting research into use.

Although it was understood that addressing urban drainage issues would require the involvement of a range of stakeholders, this wasn't explicitly addressed in the original outline of the SWITCH project. This was partly because several platforms and mechanisms already existed for stakeholder participation and it was anticipated that SWITCH would work through these in some form. However, after a kick-off workshop and several internal workshops, it was realised that to achieve its objectives SWITCH also needed to work in a more explicit way with a broader group of stakeholders at different levels. As a result, the main goal for SWITCH in Belo Horizonte was formulated as: "to improve development of, access to and use of information and knowledge on different aspects of urban drainage alternatives by all relevant stakeholders (authorities, researchers and community) so as to strengthen and democratise decision-making processes on urban water management". The specific objectives were:

1. To improve capacity to identify flooding risks and to respond through enhanced monitoring and use of modelling tools.
2. To introduce, test, adapt and showcase innovative urban drainage technologies which reduce flooding risks whilst contributing to an improved urban environment.
3. To assess and strengthen participatory management models for urban drainage within a broader IWRM institutional framework.

Project partners active in Belo Horizonte

The two main organisations carrying out SWITCH in Belo Horizonte have been the initiators: the Federal University of Minas Gerais (UFMG) and the Municipality. Three groups within UFMG have participated: the School of Engineering, the Institute for Geosciences and the Economics Department. A range of departments from the Municipality also became involved, as detailed in the section on the learning alliance.

In addition, staff and students from the network of SWITCH partners have contributed to different parts of the work in Belo Horizonte. Researchers from Middlesex University (United Kingdom) and UNESCO-IHE (the Netherlands) have supported technological and hydrological research, while researchers from IRC International Water and Sanitation Centre (the Netherlands) and Greenwich University (in the UK) have supported governance research. Although not a formal SWITCH partner, a visiting professor from Cereve University Paris Est at UFMG, has also supported one of the demonstration projects and carried out related research.

Students from the Ecole Polytechnique Fédérale de Lausanne (Switzerland) have carried out thesis research, particularly on modelling.

Intervention logic

In order to try and achieve the overall objective, the project team specified an intervention logic, or theory of change, consisting of three components:

- Integration and building linkages between different types of project activities
- Building upon pre-existing initiatives, and linking with other projects and programmes
- Working at different levels of scale

Linkages between different types of activities

The first part of the intervention logic of the project consisted of different types of inter-linked research, demonstration and learning activities. Taken together, the first two sets of activities were expected to generate new knowledge on urban drainage under real life conditions.

Monitoring and research of urban drainage technologies in demonstration projects under real-life conditions: Demonstration projects implemented local drainage infrastructure such as infiltration trenches, constructed wetlands and rainwater harvesting infrastructure in schools, parks and on the University campus. Research focused on the technological and hydrological aspects, as well as on the costs, of these drainage facilities.

Modelling and research on flood risks and mitigation measures at the sub-catchment scale complemented research at local scale. Demonstration activities take place at this level, but no learning alliances were set-up around them.

Learning alliances at community level act as platforms for analysis, learning and capacity building around the research and demonstration projects. Local alliances consist of community institutions (schools, health centres), individual community members, and municipal officials and technicians. Demonstration activities were used for joint learning about the different aspects of drainage. Specific capacity building events such as training and awareness raising activities were organised for these learning alliances. Particular emphasis was given to the committees

involved in the participatory budgeting process, to ensure they could promote more sustainable drainage works within the participatory budget. The main expected outcomes were strengthened capacity at community level to participate in decision-making on urban drainage, and an ability to scale up within the community and to neighbouring communities, via local officials and technicians.

A learning alliance at institutional level was set up to provide a platform to scale up results within Belo Horizonte institutions as well as at the metropolitan regional level. The main idea was to bring together key institutional stakeholders on urban water management in Belo Horizonte and the wider metropolitan region (see Box 1 for a description of the main stakeholders). The main expected outcome was strengthened institutional capacity to implement new approaches to urban drainage, and more democratic water governance, as well as the capacity to scale-up these approaches. This alliance not only analyses new knowledge on urban drainage, but has also been subject to governance research, to help improve management and coordination.

Box 1: Key stakeholders in urban water management in Belo Horizonte

The main stakeholders around urban water management in Belo Horizonte are identified below. As will be discussed later on, not all of them are fully engaged yet with the institutional learning alliance.

Prefeitura de Belo Horizonte (PBH). The Municipality is probably the most important user of research from SWITCH as it is the entity responsible for providing urban drainage services. In addition, it is the planning authority, and is responsible for the participatory budgeting process. Because of its sheer size, and multiple functions, a number of different entities and secretariats within the Municipal administration have participated in SWITCH. These include, for example:

- SUDECAP (Superintendency for the Development of the State Capital) includes amongst its responsibilities the implementation and maintenance of stormwater drainage infrastructure.
- SMAMA (Municipal Environmental Secretariat) is responsible for implementing environmental policies, and controlling environmental regulations.
- Parks Foundation is responsible for the development and maintenance of green areas and parks in the Municipality.
- International Relations Secretariat plays a role in facilitating whatever SWITCH, an international project, needs in terms of relationship development, including relations with neighbouring municipalities.
- Participatory Budgeting (OP) is the entity responsible for facilitating the participatory budgeting process, and providing capacity development support to communities.

Universidade Federal de Minas Gerais (UFMG). Within the University, three research groups participate both as project partners and learning alliance members: the School of Engineering, the Institute of Geosciences, and the Economics Department.

COPASA is the utility responsible for providing water and sanitation services in Belo Horizonte (through a service contract with the Municipality), as well as in most of the other municipalities in Minas Gerais. It is a mixed company with part of its shares owned by private investors and part by the State Government.

Projeto Manuelzão is one of the biggest civil society organisations around water management in Belo Horizonte. This NGO aims to raise awareness about environmental aspects of water management in the Velhas catchment area (see below) and to educate communities and government representatives.

RMBH Council is the platform which brings together the 33 municipalities that make up the Belo Horizonte Metropolitan Region. SWITCH has the ambition to scale up knowledge on urban drainage not only within Belo Horizonte, but also in neighbouring municipalities. Some individual municipalities (particularly Contagem and Betim) have expressed an interest.

Velhas river basin committee. Belo Horizonte is located in the catchment of the Velhas river (which itself is a tributary of the São Francisco river). As per Brazilian legislation, the Velhas has a river basin committee, made up of the main water stakeholders, including local authorities, water users and civil society groups. This acts as a deliberative body for the Velhas. A process is under way to also establish a technical agency, which would become the executive branch of the committee. As an important water authority in the region, the Velhas river basin committee is seen as a key body of stakeholders; for example, it is important to ensure that Belo Horizonte's actions match the committee's water quality targets. In addition, it is a body through which a wider audience of all water users in the region can be reached.

A final activity was the **documentation** of the change processes, to learn about how and why change is achieved.

The linkages between these activities are summarised in Figure 3, with colours denoting different types of activities. The upper part of the figure shows the central position of the local demonstration activities (pink), feeding into both the community level alliance (blue), as well as the technological research (purple). These lead to outcomes in terms of new knowledge and local capacity to scale up (green). These in turn feed into the institutional alliance, which aims to build institutional capacity to scale up. Documentation (in yellow) has been a cross-cutting activity.

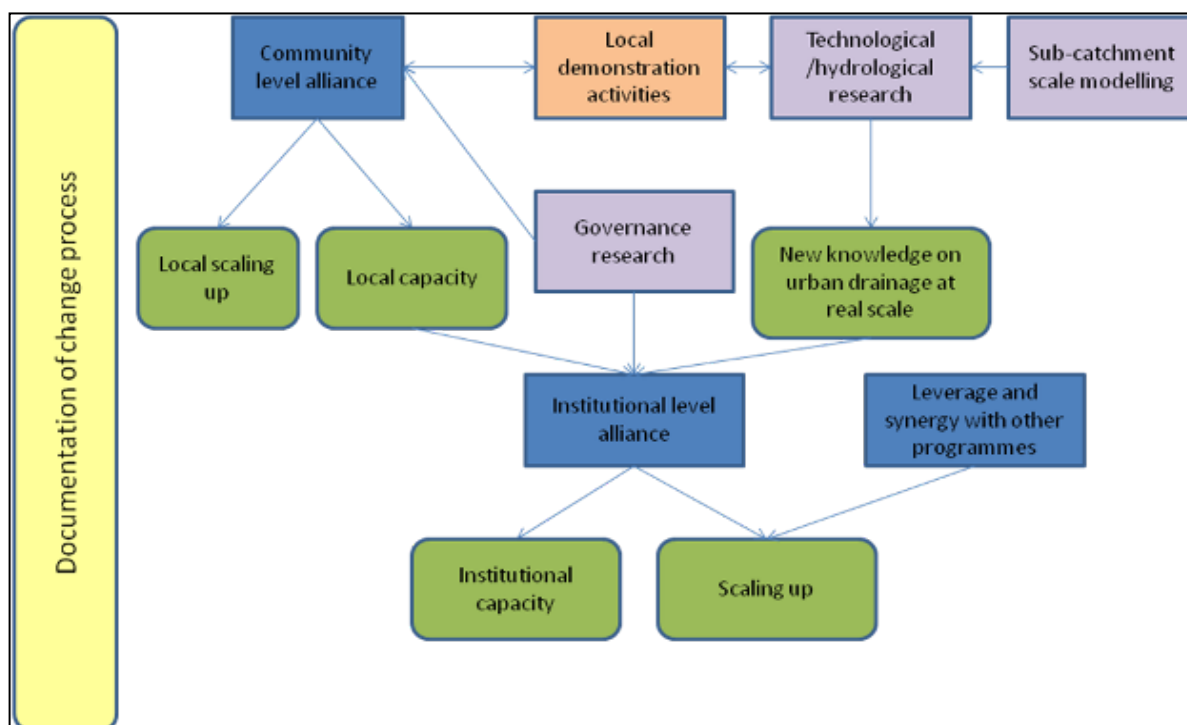


Figure 3 Diagram of the SWITCH intervention logic in Belo Horizonte

Source: Stef Smits (2008).

Building upon other projects and initiatives

Belo Horizonte already had initiatives and structures in place on urban water management when SWITCH started work in the city. A key component of the SWITCH approach was therefore to build upon these, add value to them, and to create leverage in terms of scaling up. Various approaches were considered, including:

1. Targeting and using existing planning mechanisms for scaling up. These were considered to have greater potential for scaling up than the learning alliances, as they were already institutionalised. A specific effort was made to ensure that research results were fed into these mechanisms. A good example is participatory budgeting (OP). As communities can propose works into the OP, SWITCH worked with local learning alliances on the formulation of works that could be included in the OP and also worked with officials of the participatory budgeting processes, briefing them about key principles behind improved urban drainage. In this way, communities gained a capacity to propose water-related works into the participatory budget and officials improved their capacity to check their feasibility.
2. Including lessons learnt from past and current programmes, notably DRENURBS and PROPAM which were the first programmes in Belo Horizonte applying new approaches to urban drainage. SWITCH, therefore, would use past real-scale interventions from both programmes.
3. Using existing baseline information, particularly from surveys and baseline information collection exercises carried out as part of the Municipal Sanitation Plan. SWITCH did not need to collect this information again.

4. Leveraging and synergy through links to other projects, such as PROSAB (a network of Brazilian cities working on sanitation) or the Global Change Committee (a municipal committee developing local policies to deal with climate change).
5. Learning from international best practices, through links with other SWITCH cities and other international networks.

In building on existing initiatives, SWITCH needed to define its niche and play a complementary role, mainly along the following lines:

- Evaluation and validation of drainage technologies: none of the technologies demonstrated or tested were entirely new to Belo Horizonte and some had already been used in DRENURBS. The added value of SWITCH lay in the structured evaluation and validation of these technologies, which had not been possible under these programmes.
- Critical analysis and research on governance arrangements: although various governance mechanisms had been set up, a critical analysis of these, such as governance arrangements for drainage, had not taken place. SWITCH was expected to bring in this element.
- Disseminating research results and facilitating uptake through learning alliances at local and institutional level, and other networks: although existing channels and platforms had been identified, the actual dissemination and facilitation of uptake was seen as potential added value by SWITCH. The results section later in this paper examines how stakeholders assessed this added value.

Working at different levels of scale

A final element of the intervention was the need to work at different levels of scale, as urban drainage has different implications at different spatial levels. SWITCH Belo Horizonte has tried to address relevant issues at each scale level:

- Local level (below sub-catchment level) is the lowest level for activity in SWITCH Belo Horizonte, and where technology demonstration projects and local alliances have been established. Demonstrations include, for example, a local infiltration trench or wetland and its surroundings.
- Sub-catchment level: the Belo Horizonte municipal area has been sub-divided into 256 drainage areas, or sub-catchments which are used for planning in the Municipal Sanitation Plan. SWITCH followed this arrangement and it was at this level that flood risks were analysed and interventions planned. Results of the analyses and projects at local level have also been fed into analysis at sub-catchment level.
- City level: the focus of efforts at Belo Horizonte Municipality level is in the institutional sphere, and included research on governance and the institutional learning alliance. Results of the modelling work at sub-catchment level are aggregated at this level.
- RMBH: the wider metropolitan level was seen as a level for scaling-up, for example, by involving stakeholders from other municipalities in institutional learning alliance activities.

- Velhas catchment level: although actions within Belo Horizonte have an impact on the entire Velhas catchment area, this has not been an explicit unit for analysis. Rather, stakeholders from this level are considered as a target for scaling up actions.

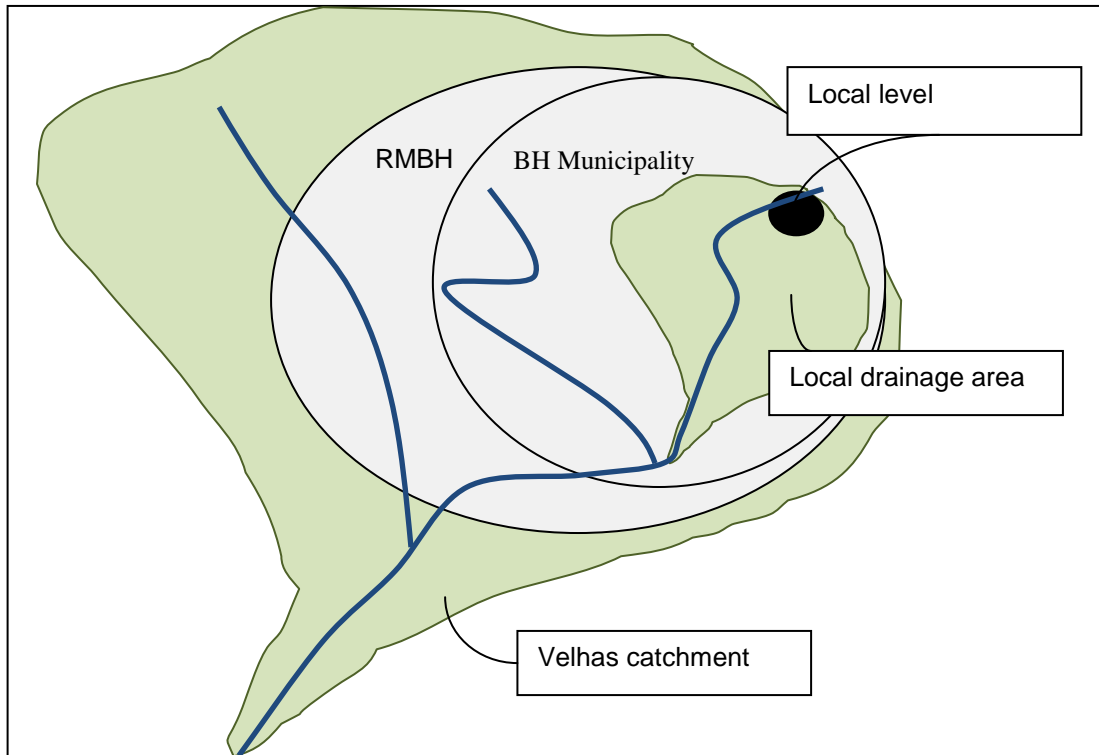


Figure 4 Levels of scale at which SWITCH is working in Belo Horizonte

Source: Stef Smits (2008).

Activities and inputs

This section summarises the main activities that have been carried out in the city at different levels, and the inputs they required. We indicate for each of the levels the types of activities undertaken and current status.

Local level

At the local level, a total of five demonstration and research activities have been selected, three of which have also established learning alliances. Table 1 provides an overview of the demonstration, research and learning alliance activities at that level. Further technical details of the demonstration activities and discussion on functioning of the alliances are provided in the next section.

Location	Demonstration activities	Research activities	Learning alliance activities
Anne Frank School	Facilities for rainfall harvesting have been constructed	The work was concluded in November, 2008. Today it's already in use and is being monitored.	Introductory meeting with the School community (2007) SWITCH participated in the environmental education seminar. SWITCH provided training courses for school cleaning and cooking staff; helped with a social-environmental survey; and kept in touch with all environmental activities
Lagoa do Nado park	Infiltration trench has been constructed.	Works concluded in May, 2010. Equipment to monitor the demonstration still has to be purchased. Monitoring is expected to begin in February, 2011.	Introductory meeting with the Parks' Foundation and Lidia Angélica School as core of local alliance (2008) Awareness raising workshop, together with the Water Messengers project (2008) Work plan for

			<p>learning alliance developed (2008). A primer has been developed for distribution to the surrounding population. (October, 2010). In November 2010 a lecture was planned to update people about the demonstration .</p>
UFMG campus	Infiltration and detention trenches have been constructed	The works were concluded in March, 2008. It has been monitored since then with some interruption.	No learning alliance was planned or established here.
Vila Guaratã	Infiltration wells functional	Perception studies and hydrological research were carried out in 2007, but the demonstration project was dropped in August 2008, due to lack of people for follow-up.	No learning alliance formed here
Vilarinho area and Pedro	Wetland is being constructed	Environmental perception assessment	Introductory meeting with school

<p>Guerra School</p>		<p>was carried out in 2007. Work started in August, 2010 and has been completed. Monitoring begins in January 2011.</p>	<p>community (2007) Feed-back meeting of the research results (2007) Awareness raising event “a day in the catchment” (2007). A lecture was given to school teachers (September, 2010), explaining what the wetland is about; activities for the children are being organized (December 2010), and a reference group is going to be created to spread this innovation.</p>
<p>Productive Garden</p>	<p>Two cisterns have been constructed using boards</p>	<p>The work concluded in May, 2010.</p>	<p>A workshop was given to the surrounding inhabitants and they have constructed the cisterns by themselves.</p>

Table 1 Overview of demonstrations



Figure 5 Installing a gully with permeable bottom, at Vila Guaratã

Source: Belo Horizonte Municipality (Prefeitura de Belo Horizonte) [PBH] (2008).

Sub-catchment level

In total three sub-catchments were selected for research activities (Table 2). At this level, no learning alliance was planned.

Location	Demonstration activities	Research activities
1o de Maio drainage area	Retrofitting of infiltration trenches has been carried out	The works are concluded, but there are no monitoring activities at this demonstration.
NS Piedade drainage area	Retrofitting of infiltration trenches has been carried out	Constructed in 2008 and has been monitored since then.
Agua Funda drainage area	Wetland	This demonstration has been discarded due to lack of people to work with.

Table 2 Overview of demonstrations activities at sub-catchment level

City level

At this level, no specific locations for demonstration and research were identified. Table 3 provides an overview of generic activities at city scale and above (i.e. RMBH and Velhas catchment scale).

2006	<p>The beginning of the project in BH</p> <p>Visit of IRC and establishment of the first goals</p>
2007	<p>Approval of SWITCH Project actions at Anne Frank Municipal School</p> <p>August – One day workshop on SUDS and IWRM planning, held at Belo Horizonte City Hall and involving Abertay University</p> <p>September – Socio-environmental survey in Vilarinho Neighbourhood to understand local environmental perceptions</p> <p>October – Feedback of results to the population during “Um dia na bacia” (a day at the catchment) event, where the community enjoyed cultural activities and research results were presented</p> <p>November – Beginning of the first demonstration activities</p>
2008	<p>Start of the activities at Anne Frank Municipal School</p> <p>April – SWITCH Project Seminar at Belo Horizonte City Hall: “Building Learning Alliances for Urban Water Management in Belo Horizonte”</p> <p>May – Visit by Danielle Mitterand (President of Fondation France Libertés)</p> <p>June – Construction completed of detention and infiltration trenches, two demonstration projects at UFMG</p> <p>June – Demonstration construction completed – creek restoration, detention pond and green corridor at N.S. da Piedade, Baleares and 1º de Maio Parks</p> <p>June – Learning Alliance projects begin at municipal schools: to build an infiltration trench and a permeable permanent floor at Lídia Angélica School; at Pedro Guerra School – a children’s commission is established to follow the project</p> <p>June – Environmental seminar at Anne Frank Municipal School</p> <p>August – Seminar on urban waters in Belo Horizonte: <i>Building a vision of the future</i></p> <p>October – Seminar on Urban Waters in Belo Horizonte: building future scenarios; installation of the rainwater collector at Anne Frank Municipal School</p> <p>November – At Anne Frank School: Water Course, staff interview, and the visits of the Reference Group (made by students) to Confisco Park, UFMG/DESA Laboratory, and the cities of São João Del Rey and Tiradentes to learn about sustainable management of urban waters, followed by the development of related educational activities.</p> <p>November – Ouro Preto Workshop Advancing Learning Alliances to Increase Research Impact</p> <p>December – The 3rd SWITCH Project Scientific Meeting which gathered 150 participants from different countries in Belo Horizonte</p>
2009	<p>March – Celebration of World Water Day: inauguration of the rainwater harvesting facilities at Anne Frank School</p> <p>April – Urban Waters Sustainable Management Course at Lagoa do Nado Park</p> <p>May – SWITCH Project visits Arrudas Sewage Treatment Station (ETE Arrudas) with 23 employees from Lagoa do Nado Park</p> <p>June – Wall painting – celebrating the week of the Environment and Rainwater Harvesting Guide Release</p> <p>June – Visit to Hilda Nunes School by SWITCH Project and Anne Frank Reference Group to see a different method of rainwater collection.</p>

	<p>June – Meeting with the managers of the participatory budget (COMFORÇAS)</p> <p>August – Proposals made to the COMFORÇAS members for training courses on alternative drainage techniques</p> <p>September – Urban Waters in Belo Horizonte: building strategies for the future</p> <p>September – Course and Workshop on building cistern boards at the Urucuia Cultural Centre and the Barreiro Productive Garden</p> <p>October – Strategies seminar to discuss COPASA planning for Belo Horizonte’s future water management with SUDECAP and the Municipal Park Foundation.</p> <p>September to December – Training courses with the COMFORÇAS in five regions (Pampulha, Centro-sul, Leste, Oeste and Venda Nova).</p>
2010	<p>February – Learning Alliances Assessment (Visit of John Butterworth and Emanuele Lobina)</p> <p>March – Lecture about watersprings at Lagoa do Nado Park, for celebrating the World Water Day.</p> <p>April – Beginning of Documentation Process Planning; and support for Julie Bouit and Jean Legroux research in Belo Horizonte</p> <p>May – Support for and elaboration of Social-environmental Survey at Anne Frank School; conclusion of Barreiro Productive Garden cisterns works; and of the infiltration trench at Lagoa do Nado Park</p> <p>June –Social-environmental Seminar at Anne Frank School (data and conclusion presentation)</p> <p>July and August – Continuation of COMFORÇAS training courses</p> <p>August – Beginning of the Wetland works.</p> <p>September – Planning and organization of Belo Horizonte SWITCH Film and the resumption of learning alliance’s work at Pedro Guerra School.</p> <p>October – Conclusion of Belo Horizonte SWITCH Film and organization of learning alliances activities at Pedro Guerra School and Lagoa do Nado Park</p>

Table 3 Time line of activities



Figure 6 Training community health workers at Venda Nova, May 2007

Source: Belo Horizonte Municipality (Prefeitura de Belo Horizonte) [PBH] (2007).

Facilitation of SWITCH Belo Horizonte and its learning alliance

In addition to these activities, there has been a lot of effort on the coordination and facilitation of the process. This role has been shared between UFMG and the Municipality, with UFMG taking overall responsibility for coordinating the project and the Municipality taking responsibility for the facilitation of the learning alliance process and links with other stakeholders. A part-time facilitator was appointed within the SUDECAP department of the Municipality. It has been her responsibility to organise meetings, to ensure that documentation takes place, and to ensure linkages between the research, demonstration and learning alliance activities at local level. She has been supported by a community mobiliser, particularly for alliance activities at local level. Other staff within the Municipality also contribute to facilitation – for example, the International Relations Secretariat provided logistical support for larger events and played a useful role in inviting participants from outside the Municipality.

At the beginning of the process, facilitation mostly involved introducing the project to existing contacts through bilateral face-to-face meetings and information leaflets. There were parallel tracks at different scales with the local and institutional alliances. Later, more emphasis was put into organising dedicated meetings for all learning alliance members. For example, a series of workshops were held to develop a long term vision and strategy for IUWM. With the local learning alliances, communication happens on a frequent, often weekly, basis around the demonstration activities through emails, phone calls and face-to-face meetings. A website has been set up at www.ehr.ufmg.br/switch/

In Belo Horizonte, the total combined SWITCH budget for UFMG and the Municipality was €1,772,509, of which the Municipality provides an in-kind contribution of €957,509. Up to November 2010, €695,489 had been spent from the combined budgets, mainly directed towards the demonstration activities, the purchase of equipment and the meetings and courses promoted by SWITCH BH. Learning alliance expenditure included the learning alliance meetings, training the learning alliance facilitator and publishing the SWITCH newsletter. In-kind contributions from both partners were provided in the form of meeting rooms and media equipment, voluntary work of PhD and MSc students as well as staff. A scholarship programme from UFMG, with the support of Federal and State level funding agencies, provides about 90% of scholarships for PhD and MSc students, who are involved in research related to the SWITCH project in Belo Horizonte.

III. FINDINGS AND DISCUSSION

In the previous section, we have considered the logic behind the SWITCH approach to achieve integration, and the activities actually being carried out. This section presents an assessment of project progress to date. It gives emphasis to the barriers and progress made towards achieving change and putting research into use.

Demonstration activities at the heart of SWITCH

Demonstration activities have formed the heart of SWITCH. These are the activities which have tested innovations in use, where local learning alliances have been mobilised, research carried out to evaluate technologies, and awareness raising and capacity building concentrated. The types of technologies trialled has varied from simple technologies and smaller-scale demonstrations completed earlier during the project, often involving schools, and more complex and large-scale demonstrations, most of which have been completed. The demonstrations have focused on sustainable urban drainage (especially infiltration trenches to reduce flooding from roads, and constructing more permeable areas etc.) and rainwater harvesting from roofs (providing a small storage benefit, but mainly providing a resource for gardens in schools and parks to reduce demands on COPASA for expensive irrigation water). Demonstrations involved both retrofitting new technologies into old infrastructure, and new construction. The largest demonstration project, to construct the Vilarinho Wetland to treat polluted urban storm and wastewater was completed in November 2010 and monitoring will begin in January 2011.

It is still rather early to assess the results of the demonstration projects and the effectiveness of the new technologies. However, we can identify the role of the demonstration projects in helping to mobilise learning alliances and facilitate research. Many of the demonstrations have been made visible, and made SWITCH visible as a result, through extensive community involvement and awareness raising activities. In some cases, such as at the Anne Frank School, the value of the environmental education activities around the demonstration probably far exceeds the value of testing the technology testing, which is not to say it has not been useful. The next section focuses on these processes and benefits.

The technically simpler demonstrations such as rainwater harvesting and infiltration trenches were completed faster enabling research and dissemination activities at these sites to run for a period of time. But all the demonstration activities suffered difficulties: which is the nature of the task when making efforts to engage stakeholders with a view to uptake. In the process of design and tendering for the works, long delays have occurred. The same has happened with the procurement of some of the monitoring equipment, for example at the Vilarinho wetland, and these delays have at times run the risk that learning alliance members would lose interest and the process would stall. The main reason for these delays was the procurement procedures that need to be followed within the Municipality. However, this reflects the reality of municipal service delivery, with all its strengths and weaknesses and short-cutting such procedures would have led to false impressions about the potential for scaling-up. The rooting of the demonstrations (and the learning alliance activities) in the Municipality has enabled strong links to be made with replication in mind. For example, the

DRENURBS⁶ project will invest US\$ 500m over the next 10-15 years, and the Environmental Monitoring and Planning Department will approve environmental standards.

Rainwater harvesting is not innovative in rural areas of Brazil but is innovative in the urban context and strong interest has been generated in scaling this up. For example the Municipal Parks Foundation say that they will now consider roofwater harvesting wherever possible to reduce the demands on mains water in parks and agro-ecological centres. This policy decision has been made and uptake is considered very likely, showing that SWITCH seems to have effectively targeted and involved parks staff at both senior management and frontline levels. A key factor in this outcome seems to have been that number of parks staff were involved in training (at the productive garden demonstration) so they now have developed an interest and have acquired skills that they can replicate.

Demonstrations at sub-catchment scale have been of a different nature. The focus has been more on alternative infrastructure (such as infiltration trenches, collector drains, and the development of surrounding parks), and carrying out related monitoring and research, generally without a local learning alliance or broader stakeholder involvement. The results have also fed into an institutional level learning alliance developed during the second part of the project. Research and learning around the wetland demonstration could be compromised by delays in construction of demonstrations which were completed or due to be completed near the end of the project. However, commitments to support the Municipality have been made by the University and COPASA, (for example by offering laboratory facilities for water quality testing. Because these organisations are interested in the results, this research should still happen as part of the ongoing work of those organisations after the end of the SWITCH project.

Local learning alliances mobilised around demonstration projects

Around the smaller scale demonstration projects, several local learning alliances have been set up (the members typically involved are summarised in Box 2). Through involving local stakeholders, scaling-up has been attempted in three ways. Horizontal scaling-up takes place via the schools and the school community, as students and teachers are able to share their knowledge and information with the broader community, to become aware of urban drainage issues, and take local action. Institutional scaling-up occurs where local officials, e.g. of the Parks Foundation, are able to scale-up new knowledge to other areas in their jurisdiction (Box 4). Finally, where some members of the local alliances are also active in the institutional alliance, such as the Education Secretariat and staff from SUDECAP, they form the active link between both alliances, and can promote scaling up via the institutional alliance.

⁶ DRENURBS is a participatory programme with a main focus on river restoration, pollution control and flood control, but also with relocating people from high risk areas and creating green areas and leisure facilities.

Box 2 Members of local learning alliances

Around the smaller scale demonstration projects, several local learning alliances have been set up. These alliances typically have had the following members:

- Schools and their communities (teachers, students and parents) have been identified as central to the establishment of local learning alliances and provide excellent locations for technologies to be demonstrated. School communities have the capacity to mobilise the broader community in their neighbourhoods. As municipal establishments, they also represent the Municipality in the community, and they often have contacts with other technicians and municipal officials in their neighbourhoods. By carrying out demonstration activities at schools, it is also of course possible to involve pupils in the research, covering part of their science curriculum for example.
- Broader group of community members.
- Officials and technicians of different municipal units with presence in the neighbourhood such as staff from health points, the participatory budgeting or of the Parks Foundation.
- Officials from the Regional Offices of the Municipality. Belo Horizonte is divided into 9 regions, and each region has its own office that acts as first point of entry to the Municipality for the community.
- Officials and engineers from the central level of the Municipality, such as SUDECAP and the Education Secretariat

The local demonstration projects have generated a lot of enthusiasm and expectations among the local alliances. Their expectations are a mix of local impacts and scaling up:

- Gaining access to information and knowledge about local water management – schools in particular want access to this in order to expand and improve educational material on environmental education.
- Being able to carry out science experiments around the SWITCH demonstration technologies – again, particularly an expectation of the school community.
- To improve environmental and water conditions around the schools and community – the ultimate goal of the demonstration technologies around which the learning alliances are organised.

Box 3: Learning about drainage at three schools

Three of the demonstrations have been at schools. The types of technologies that are demonstrated at these sites are different, as have been their trajectories of involvement in the project so far.

The **Pedro Guerra School** is located in the Vilarinho sub-catchment. It was affected by local flooding, until traditional major drainage works (big concrete culverts) were undertaken in the traditional way. However, the old stream beds are still in a poor condition because of, amongst other reasons, pollution. A wetland was proposed by

SWITCH to remove part of the pollution, create a more natural and greener environment and provide a recreation area. Pupils were involved in carrying out a study on the perception of water management in the area which served as a basis for technology selection and design. They are now playing a role in mobilising the broader community and monitoring the implementation of the works. The work took a long time to get started, and the learning alliance works at the school were interrupted for a while. Construction of the wetland finally began in August, 2010, and learning alliances activities resumed with lectures and the creation of a reference group.

The **Anne Frank School** was not selected by SWITCH to become a demonstration project, but the school was working on water-related and environmental education and approached the project team, seeing SWITCH as an opportunity to expand its work. The demonstration activity consisted of a rainwater harvesting facility, not because access to water was an immediate priority for the school (it is connected to the main water supply system), but because this technology allows the school to undertake experiments on water conservation and reuse for purposes of school gardens and cleaning the school grounds. It became a major partner for Learning Alliances. They always have kept in touch, demanding support for their social-environmental activities, especially those involving the water theme.

The **Lidia Angelica School** is located next to the Lagoa do Nado Park where some of the streams have caused floods in the past. In response, large gabion structures that do not fit with the green environment were built. SWITCH set out to demonstrate alternative forms of drainage that are in better alignment with the park surroundings. The school is a key partner since it uses the park for recreation and science education. Unfortunately, due to political changes, we have faced many difficulties on maintaining close contact and frequent activity at this school. Our goals are now directed towards Lagoa do Nado Park surrounding area.



Figure 7 Edgar Garcia Maciel, headmaster at Pedro Guerra School indicating the map of the Vilarinho neighbourhood, one of the demonstration areas

Source: Stef Smits (2008).

The degree and path of development of these local alliances has differed across the localities. All have seen a number of bilateral meetings in combination with an awareness raising or community mobilisation event, around environmental education activities that the schools were organising. An example is an event organised in the Vilarinho catchment, called “*um dia na bacia*” (a day in the catchment). During this day, the school community together with a group of officials and the broader community visited the local drainage area, identifying good and bad practices around water management and organising competitions for the young people. Around the Lagoa do Nado Park alliance, an awareness raising event was held, linked to the Water Messengers Project, at which Danielle Mitterand, former first lady of France and now President of the Foundation France Libertés was present. At the Pedro Guerra School some more activities have taken place around the environmental perceptions study.



Figure 8 **Um dia na bacia (a day at the catchment), held in the Vilarinho, September 2007**

Source: Belo Horizonte Municipality (Prefeitura de Belo Horizonte) [PBH] (2007).



Figure 9 **Existing gabion and concrete structures in the Lagoa do Nado Park**

Source: Stef Smits (2008).



Figure 10 Danielle Mitterand, President of Fondation France Libertés, at Lidia Angélica

Source: Belo Horizonte Municipality (Prefeitura de Belo Horizonte) [PBH] (2007).

School

In terms of impacts so far, awareness has been raised within the communities about the importance of drainage and urban water management and some capacity has been built to identify and propose interventions in urban drainage. This is seen, for example, in the fact that the Lidia Angelica School submitted a drainage project to the participatory budget (PO) to reduce local flooding around the school, and this proposal was shortlisted. Pedro Guerra School has supported the inclusion of the wetland mentioned earlier and surrounding green areas into the participatory budget. Maintaining this enthusiasm and interest is a key challenge as the SWITCH project draws to a close, and especially to develop activities that can scale up the work done so far.

Possible ways to replicate activities with schools could now involve handing over the approach to the education department or to the water and sanitation utility, COPASA, which has a community education department, or through seeking funds from these or other organisations to continue such work. Unfortunately, the schools operate under very tight budgets and, in situations where even basic education activities are not adequately funded, poor schools always need financial support for such additional activities.

Box 4: Passionate about parks

Everyone knows him by his nickname of Guto. He is Sérgio Augusto Domingues, the Director of Department III at the Parks Foundation and is responsible for development and maintenance of parks and green areas in his part of the city. These have become very important over the last year, as part of an attempt to improve the living environment in a city that has been plagued by crime and lack of public spaces in the past. Since the

establishment of the Parks Foundation a couple of years ago, the number of public parks and green areas in the city has increased from 52 a 77. Guto is passionate about the parks in his area. As such, he is very enthusiastic about the demonstration and learning alliance at the Lagoa do Nado Park, where SWITCH is working on improving drainage conditions. This involves protecting springs that originate in the park, using more natural drainage channels instead of gabions and concrete, and reducing pollution flows. This offers a learning opportunity for the Lidia Angelica School community to participate in science experiments. But, Guto is not only there to improve the Lagoa do Nado Park, he wants to learn to use similar technologies and approaches in other parks in his area of jurisdiction, particularly the ones developed around the DRENURBS programme. In this way, he makes a significant contribution to scaling up.

Engaging higher education institutions to put research into use

SWITCH has involved a large number of students at UFMG with an impressive range of MSc and PhD research topics covering many SWITCH topics (see Box 5). Substantial SWITCH funds were provided, enough to support a strong hydrology and hydraulics group, making it possible to leverage more or less equivalent funding from Brazilian sources. A defining characteristic of most research in SWITCH has been the close links to demonstration activities, where the technologies have been the subject of research in terms of both function and performance. In Belo Horizonte, this has included both academic research and tests by the schools. This real-world research poses challenges, as compared to laboratory experiments, as it is more difficult to measure all the control factors, and it is often difficult to access the sites with monitoring equipment. However, the interviewees appreciated the added value they found in such technological research at real scale. The Municipality considered these demonstration activities to be important to test some of the technologies and approaches it has already been using, offering performance data in a real setting and reflecting the realities of maintenance, costs, etc. The results are not so much about technological innovations, but they offer knowledge on the validated use of technologies in their real settings in the city.

Box 5 Summary of research topics

Several research projects were associated with learning alliance activities in Belo Horizonte, as follows:

- SUDS experiments (detention trenches and infiltration trenches): the main focus of these demonstrations is to assess their performance in terms of runoff control and pollution abatement. Other objectives concern risk assessment of soil pollution by infiltrated flows, development of design criteria and retrofitting recommendations for built-up areas. One PhD student and three MSc students have worked on these projects;
- Rainfall harvesting: The project concerns project appraisal for the use of rain water as a source for water supply in schools, urban agriculture and households. In each case, the project is based on a detailed assessment of water consumption for uses

that do not require drinking water standards. For household water consumption the assessment considers differences in welfare and dwelling characteristics (e.g.: gardens, built surface, number of bathrooms, etc.). Eight undergraduate students have been involved in this project, including five students from French universities (L'Ecole des Ponts, Paris Tech and University of Rennes).

- Flood studies: Four main topics have been developed concerning (i) flood damage assessment in urban areas through agent based and network modelling; (ii) traffic management during flood risks; (iii) assessment of perception of flood risk by population living in or nearby to flood prone areas; (iv) assessment of the perspective of adopting flood proofing techniques (resilient buildings) in the Belo Horizonte context. Two PhD candidates, two MSc students and seven undergraduate students have been involved in this project.
- Water governance studies: Research on water governance concerns institutional mapping of water management in the Belo Horizonte municipality, the evaluation of the recently implemented model for integrated water management, including the environmental sanitation committee, the planning process and the funding system and the assessment of different models for water management in the urban context by comparative analysis. One Post-doc, two PhD students and three MSc students have been involved in this research topic.

It has, however, been a constant challenge to engage researchers in learning alliance processes, for which they are arguably the most important actors. Although some 'activist' researchers with practical interests take to it more easily, many students and academics fail to provide information in the right way or at the right time for groups of users. They may not see such engagement and outreach as part of their job and therefore not give it enough time, and it is very time demanding. There is often a cultural or professional divide where academics see their role as being to understand, criticise and provide recommendations from a distance but not directly to engage in change processes or reforms. This gap needs to be understood and bridged, and that seems to have been fairly successfully done in Belo Horizonte.

Many of the research students and studies have managed to identify channels for engagement with potential users of the research beyond the conventional academic publishing channels. These have included bilateral links e.g. with the utility (COPASA) on use of results from the proposed wetland. Students have also made inputs to practical training courses for the participatory budgeting process and engaged in activities with the public in discussion of results of flood perception risk research through the 'one day in the catchment' event. They have also presented research results in learning alliance events. Finally, there is direct involvement of Municipality staff as students, undertaking courses linked to their work, while some students involved in the project have later gone to work in the Municipality. More seminars and sharing were planned to build on these interactions as more results became available towards the end of the project.

In the research at the demonstration projects, as well on modelling, UFMG researchers received support from some of the international researchers, while results from Belo Horizonte fed back into the broader work packages within SWITCH on stormwater management. Researchers from both sides are reported to have been satisfied with the level of support and coordination, particularly on the timely inputs from both sides.

Something similar can be said about governance-related research. This is not expected to generate a completely new governance model. Rather, it has focused on understanding and validating current governance arrangements, indicating strengths and weaknesses. This helped some of the researchers and municipal staff realise that the current governance arrangements are quite well developed in terms of participatory democracy as compared to other cities in Brazil and elsewhere in the world (see Box below).

Box 6: Water perspective provides a fresh angle on urban planning

Heloisa Costa, a professor at the Institute of Geosciences within the University, trained as an architect and has been carrying out research on public policies in urban planning. Within SWITCH she coordinated the governance-related research in the city. She had contact with researchers from the School of Engineering before the SWITCH project, but had never worked on a water-focused urban research project. SWITCH has already made some contributions to her work; most importantly it has brought a water perspective into theory of urban planning, which is usually approached from a land-only perspective. Through SWITCH she has realised that water courses can also be ordering and integrating factors for urban planning. This insight will amplify some of the theoretical models used in urban planning research. SWITCH has also made practical contributions to the University itself. An inter-disciplinary course on environmental management was already on the drawing board before SWITCH started. But cooperation between different research groups within the University in SWITCH strengthened these links and gave an impetus to the development of the course, which began in 2010.

The feed-back loop from governance-related research into institutional change processes is less clear when compared to technological research. There are two main reasons. Firstly, governance research has been more analytical in its scope, analysing the current governance situation, without testing interventions in that same governance framework, while technological research does include interventions and testing. It has therefore been difficult to link governance research explicitly to change processes. Governance research has also been focused mainly at the city level rather than at local level. It has focused on understanding the main governance arrangements within Belo Horizonte, such as the relation between the Municipality and the utility, COPASA, and how the Municipal Sanitation Council, COMUSA, prioritises sanitation and how the Municipal Sanitation Plan is produced.

It has so far proved difficult to define strategies for institutionalising or scaling-up results of governance research. Some dissemination activities have been undertaken, such as presenting the result of governance-related research to the institutional learning alliance, or supervising thesis students who are municipal officials themselves. However, the scope of these dissemination efforts could be broader. At the same time, it is realised that the learning alliance is a form of institutional change and merits being researched and documented from an academic perspective. This has not happened so far, since the focus has been on adapting the learning alliance approach to the Belo Horizonte context and its establishment. It was suggested in the 2008 review that governance-related research in the second half of the project should focus on the functioning of the learning alliance and on their impacts. This has been done. A PhD student and a member of the LA staff have been working on a learning alliance assessment and documentation of the process.

Several departments and groups within the University have been involved to a greater or lesser extent, including the hydraulics and hydrology group, the management/governance group, and geosciences. In addition to stimulating research into use, SWITCH also promoted integration between different research areas aiming to address urban water management issues in an integrated manner. Research in Belo Horizonte has studied urban drainage from different disciplinary perspectives, including engineering, hydrology, political sciences and economics. Some interviewees characterise this mainly as multi-disciplinary research, as opposed to inter-disciplinary research – different groups study urban drainage from different disciplinary perspectives, but with limited integration of results and limited space to study urban drainage from the outset in interdisciplinary teams. Ideas to establish interdisciplinary spaces have not always translated into practice. Various proposals have been made, such as organising monthly research seminars, promoting interdisciplinary student theses, and developing a web-based platform where researchers and students from different disciplines can more easily get into contact with each other. Contacts between different research departments have mostly been on an individual basis, and not institutionalised. However, SWITCH does seem to have supported genuine collaboration across departments and this did eventually lead to further joint collaborative activities e.g. work on sanitation plans for state.

Institutional learning alliance: scaling up within the Municipality and beyond

A strength of the project in Belo Horizonte has been the high level of involvement of the Municipality, and especially of SUDECAP, the Superintendency responsible for the development of Belo Horizonte. The Municipality was an official consortium partner, which was not the case in all cities where SWITCH worked. This made it possible to make important connections with potential for uptake in the Municipality and to make links with ongoing government programmes, such as DRENURBS, IGAM (the state water management agency), and the Municipal Parks

Foundation etc. Municipal procedures also have their disadvantages, making some small things difficult and, as described earlier, leading to delays in demonstration projects. But this is considered a necessary price to pay for the project being rooted within the key organisation able to support uptake of the research and demonstrations.

The Municipality allocated a senior staff member to facilitate the learning alliance and she has been able to make SWITCH visible and mobilise others at a high level, which has greatly increased the impact of the project. That said, it has not proved easy or possible to involve all municipal departments adequately and if more resources had been available, more could probably have been done. It also took a long time for the project to gain momentum, and while training provided to the learning alliance facilitator was reported to have been useful and vital, more support could have been provided from the project consortium. The project story and vision is perhaps not the only way that SWITCH could have 'sold' its ideas. The overall goal of the SWITCH project is to catalyse change towards more sustainable urban water management in the "City of the Future" and in Belo Horizonte the main aim has been to strengthen and democratise decision-making processes on urban water management. It could also have focused on how new approaches can reduce operation and maintenance costs, especially since financing stormwater operation and maintenance is a key issue.

The Municipality has arguably been considered as the most important potential user of SWITCH research and efforts focused on mobilising a range of municipal entities with a role in water management. This is considered to have been an important step in integration before engaging in the development of a wider learning alliance. A number of ways in which SWITCH approach and results are being institutionalised within the Municipality can be identified:

- Inputs into the water technical group of the municipal climate change committee (SWITCH helped to coordinate this group).
- Inputs made to environmental planning (Green Gold) for the football 2014 World Cup – Belo Horizonte is one of 12 cities in Brazil where matches will be played.
- The use of more natural technologies is now considered as a condition for projects to be approved by the Municipal Environmental Secretariat, SMAMA.
- Strengthening the capacity of the Commission for Control of Participatory Budgeting Works, COMFORÇAS, training its members in aspects of innovative urban drainage technologies so that they can better address proposals submitted to the participatory budget.
- Validating and providing feedback with lessons on DRENURBS approaches. DRENURBS works closely with SWITCH, as they are using similar approaches on technologies and intervention methodologies.

These are all important mechanisms for scaling-up elements of the SWITCH approach, but it must also be said, that many of these processes had already started, for example through DRENURBS, and cannot solely be attributed to

SWITCH, which has found its niche in validating the approach and disseminating results among different municipal entities. There are still big challenges in scaling up SWITCH concepts within the Municipality, in particular the more participatory way of working. There is some openness to change approaches in technology, but less so to more participatory ways of working among municipal engineers, or even outside contractors. Many municipal engineers have not been trained in the importance and application of these approaches, which they may even see as a challenge to their authority.

The Municipality is not, of course, the only avenue for scaling up. During the project many different alternatives occurred or were promoted, including involvement in the development of the (32 municipality) Belo Horizonte metropolitan area development plan. Several invitations were accepted to talk about the Belo Horizonte project: including at São Paulo Municipality, Rio de Janeiro State University, the IWA Development Conference in Mexico (2009), Stockholm Water Week (2010) and others.

Responding to suggestions in the 2008 assessment, over the later parts of the project SWITCH was able to develop more intensive learning alliance activities at city and larger scale that engaged a number of important actors beyond the Municipality and University in what was termed an institutional-level learning alliance. Some of the new active members include IGAM the state water management agency, the Rio Velhas river basin committee, the utility COPASA, and other higher education institutions such as Incisa College. During 2010 these platforms provided important potential channels for further uptake of SWITCH concepts and findings for example through inputs to World Water Day and in an international seminar organised by IGAM in May 2010 with SWITCH inputs from other cities including Lodz, Poland.

One lesson learnt is how important it is to keep trying repeatedly to engage organisations. It took many months for SWITCH to engage with interested people in the utility COPASA despite many contacts. Interest by COPASA staff with a remit for research and development was triggered by their presence at a workshop where they became aware of a wetland demonstration. Based on their interest in using this technology, they offered to support analysis and provide lab support. This is important given that the demonstration construction was only due to be completed right at the end of the project and research around the demonstration depends on the ongoing activities of SWITCH partners after the project is over. COPASA may also be an important source of support to continue and scale up SWITCH community education activities with schools, and to continue to develop roofwater harvesting which has a potential demand management benefit for the utility.

Box 7 Key institutional level learning alliance members

The key stakeholders that have actively engaged with SWITCH either bilaterally or in the alliance include:

- Various entities and programmes under the Municipality. These include amongst others SUDECAP, SMAMA, the participatory budgeting secretariat, Education Secretariat, International Relations Secretariat, the Global Changes Committee, COMUSA and the DRENURBS programme. These all have contributed in a proactive manner to SWITCH and have engaged in analysing its research results which is elaborated later.
- Various departments within UFMG. They are not only participating as researchers but also as members of the learning alliance.
- RMBH and neighbouring municipalities. They have so far been passive recipients of information about SWITCH, but have already expressed interest in learning more and becoming actively involved.
- IGAM the state water management agency,
- the Rio Velhas river basin committee,
- COPASA the utility for towns and cities across the state including Belo Horizonte
- Incisa College, a private higher education institution

See Box 1 for further explanation of the roles of some these actors.

Initially it proved difficult to develop the institutional-level alliance, perhaps because there are fewer concrete activities at this level around which to engage. In 2008, a new series of activities started with the institutional alliance focused on the development of a long-term vision and strategies for urban water management in Belo Horizonte. This visioning exercise provided a concrete set of activities around which interested stakeholders could come together. World Water Day events have also been well supported.

Box 8 International networks

There is a tradition in the city of engagement in regional/ international networks and knowledge exchange activities. Belo Horizonte is an enthusiastic member in many networks and has become a sufficiently mature partner to be able to take the lead. These networks are not water focused but rather deal with broader governance, planning and sustainability issues where water has an important place. The activities provide opportunities to disseminate the results of SWITCH and to continue similar types on collaborative activities with other cities. The Municipality's international relations representative is an enthusiastic follower of the SWITCH project and is committed to making sure the city capitalises on the results.

Process facilitation and documentation

The SWITCH team has also facilitated and documented the change process. In Belo Horizonte, facilitation responsibilities were centred in the Municipality, and largely

been taken up by the learning alliance facilitator. In other cities in SWITCH, and other projects with a learning alliance, this role is usually located in a knowledge institute or resource centre (Smits et al., 2007b) as these are seen to be more neutral by all stakeholders. The facilitator's role has in Belo Horizonte has been organising meetings and seminars, day-to-day communication with entities within and outside the Municipality and coordinating alignment of the demonstration activities and local learning alliances. She has been supported by other facilitators, such as from the DRENURBS programme and by others in the Municipality. The International Relations Secretariat has played a role in mobilising stakeholders from outside the Municipality, and in providing logistical support (see Box 8). The Environmental Secretariat SMAMA played a role in presenting SWITCH's work to the Municipal Council.

The fact that the facilitation role lies with the Municipality has had a major impact on institutionalising the SWITCH approach and results into the different entities of the Municipality. It would have been difficult for an outside facilitator to mobilise those units and ensure that results were institutionalised in such a broad range of sub-units. It would also have been much more difficult to align and link SWITCH to implementation programmes such as DRENURBS. However, there have also been some disadvantages. Being placed in the Municipality limits capacity to mobilise stakeholders from outside, since certain protocols and procedures need to be followed and can take a long time. The Municipality also has no formal jurisdiction to mobilise other municipalities or State level agencies, leading to the view that it may have been easier if mobilisation were done by a State level entity. However, during the later parts of the project it did prove possible to engage such agencies in the institutional-level alliance.

Another limitation is documentation of processes. The facilitator and others in the team have made a register of the activities that have taken place, such as events and meetings. But, analysis and synthesis of the process and learning and adaptation based on such analysis has been difficult. This kind of documentation is rarely done within public offices, and the skills and expertise to do so are lacking. It is also very time consuming and time is hard to find in addition to the facilitation itself. Additional resources could have been allocated to the documentation role, and these assessments perhaps also undertaken more frequently with support from the wider SWITCH consortium. In 2009, as recommended in the previous assessment, a website was established bringing together all documentation.

Although the learning alliance facilitator has obtained support through attending training on learning alliance facilitation, process documentation and monitoring of learning alliances, additional back-up would have been useful in the application and adaptation of these broad concepts to the specific Belo Horizonte context. Given the specific situation of the position of the facilitation responsibility in the Municipality, it is felt that more support could have been provided to the facilitation team from the international SWITCH network. Learning alliances need to be seen as a broad methodology or framework which needs to be adapted and

applied in the context of a city like Belo Horizonte, with its pre-existing structures and mechanisms for multi-stakeholder dialogue and decision-making. It would have been useful to have a sparring partner, or peer, with whom to exchange ideas. Such a person could help thinking through how the local adaptation and contextualisation could take place, act as a back-up to the facilitator and her team, and also provide feed-back to plans and ideas for the learning alliance through distance-support and occasional visits.

The language barrier has also limited international support. Although the facilitator speaks English, others in her team do not. A lot of time has gone into translating supporting documents from the international network. The language barrier has limited the participation of other team members in training, or other interaction with international network members.

IV. CONCLUSIONS AND RECOMMENDATIONS

Within SWITCH, Belo Horizonte has set an example, acting as a laboratory for IUWM, just as it has been a testing ground for urban planning from the times of chief engineer Aarão Reis and Oscar Niemeyer.

The project has developed a balanced mix of research involving faculty and students at UFMG, activities from simple local demonstrations to complex technologies at a sub-basin scale, networking and information sharing, community education and public awareness raising, and focused training. SWITCH in Belo Horizonte has generated a high level of impact and visibility and its concepts are clearly recognised in the city. Several interviewees said SWITCH is an important 'brand' that they need to find ways to continue with after the end of the main project in January 2011.

The involvement of both the Municipality and University as partners, and the strong performance of the learning alliance facilitator (located inside the Municipality) and City Coordinator (located in the University), with effective, more or less equal working relations, have been a crucial factor in the success of SWITCH in the city and in implementing a balanced set of activities that engaged a wide range of stakeholders. This does mean it has been easy, but the team has successfully overcome a number of barriers to keep going. The city team also clearly responded to key recommendations made in the 2008 assessment to improve the city SWITCH process (e.g. developing the website and strengthening the institutional level learning alliance).

The wetlands demonstration was seen as especially important to successful completion of SWITCH activities in the city. Construction was completed in November, 2010.

Opportunities to access international experiences in other cities are valued and SWITCH is seen to have delivered in this respect. The 2009 City summit in Delft was important for strengthening the local city process since it engaged some carefully selected key actors in the city beyond the core SWITCH team. The 5th SWITCH Scientific Conference held in Lodz, Poland, in October 2010 created an important opportunity for the SWITCH Belo Horizonte team to sum up the main results of the project in Belo Horizonte and to share these with other cities and learn about their experiences. The assessment of the SWITCH project during this conference pointed out important achievements and suggested ways for progressing, including new proposals for research and demonstration projects by networks of SWITCH project members.

One specific recommendation in terms of sharing experiences is that the SWITCH book on experiences in all cities should be made available at least in Spanish to reach an interested audience in Belo Horizonte and elsewhere in Brazil, and that this paper itself be also published in Portuguese.

V. ACKNOWLEDGMENTS

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REFERENCES

- Butterworth, J.A. & Morris M. 2007. *Developing processes for delivering demand-led research in urban water management*. SWITCH Working Paper. [Online] Available at: http://www.switchurbanwater.eu/outputs/pdfs/WP6-2_PAP_Developing_processes_for_demand_led_research_in_UWM.pdf [Accessed 22 October 2010].
- Nascimento, N.O. et al. 2007. *Long-term uncertainties and potential risks to urban waters in Belo Horizonte*. Paper presented at SWITCH Scientific Meeting, 9-10 Jan. 2007, Birmingham, UK.
- Smits, S., Moriarty, P. & Sijbesma, C., eds. 2007a. *Learning alliances: scaling up innovations in water, sanitation and hygiene*. [pdf] Technical paper series; no. 47. Delft, The Netherlands, IRC International Water and Sanitation Centre.

[Online] Available at: <http://www.irc.nl/page/35887> [Accessed 22 October 2010].

Smits, S, García, M. Moriarty, P. & Laban P. 2007b. Building learning alliances – some initial findings. [pdf] In: Smits, S., Moriarty, P., and Sijbesma, C., eds. (2007a) *Learning alliances: scaling up innovations in water, sanitation and hygiene*. Technical paper series; no. 47. Delft, The Netherlands, IRC International Water and Sanitation Centre. [Online] Available at: <http://www.irc.nl/page/35887> [Accessed 22 October 2010].

Smits, S.J. et al., 2008a. *Governance of urban environmental sanitation: a case from Belo Horizonte, Brazil*. SWITCH Working Paper.

Smits, S., et al., 2008b. *Strengthening capacities for democratic decision-making on integrated urban water management through learning alliances*. A mid-term review from Belo Horizonte, Brazil.

ANNEX

Annex 1: Interviewees

Interviewees for 2010 assessment

Researchers	Facilitators	Research users
- Heloisa Costa (Institute of Geosciences UFMG)	- Sonia Knauer (SUDECAP PBH)	- Jose Nelson (Velhas RBC)
- Leo Heller (School of Engineering UFMG)	- Nilo de Oliveira Nascimento (School of Engineering UFMG)	- Marilia, IGAM
- Incisa college		- Anne Frank School
- Students at UFMG (Janice, Pedro, Tarcisia, Vanessa, Matthias, Rodrigo, Andrea, Paulo)	- Rodrigo de Oliveira Perpetuo (International Relations Secretariat PBH)	- Silvana
		- Ilda
		- Vamir Augusto de Assis Oliveira(COPASA)
		- Carola (DRENURBS)
		- Weber Coutinho (Environmental Secretariat PBH)
		- Solange (DRENURBS)
		- Jorge (Parks Foundation)
		- COMFORCAS

Interviewees for 2008 assessment

Researchers	Facilitators	Research users
- Heloisa Costa (Institute of Geosciences UFMG)	- Valdete Bontempo (DRENURBS Programme PBH)	- Sérgio Augusto Domingues (Parks' Foundation PBH)
- Janise Dias (Institute of Geosciences UFMG)	- Weber Coutinho (Environmental Secretariat PBH)	- Edgar Garcia Maciel (Pedro Guerra School)
- Leo Heller (School of Engineering UFMG)	- Sonia Knauer (SUDECAP PBH)	- Dulce Guimarães (Lidia Angelica School)
- Tarcisio Nunes (Institute of Geosciences UFMG)	- Silmara Machado Teixeira (Environmental Secretariat PBH)	- Antonio Leite Alves (Projeto Manuelzão)
- Mike Revitt (Middlesex University)	- Nilo de Oliveira Nascimento (School of Engineering UFMG)	- Sandra Mara Vicente (Anne Frank School)
- Martin Seidl (Cereve University Paris Est/visiting professor UFMG)	- Rodrigo de Oliveira Perpetuo (International Relations Secretariat PBH)	- Sandra Regina Silva (Anne Frank School)
		- Ronaldo de Sousa (COPASA)
		- Ronaldo Vasconcelos (Deputy Mayor and chairperson of Global Change Committee PBH)

ACRONYMS

COMUSA	Municipal Sanitation Council
COPASA	The utility responsible for providing water and sanitation services in Belo Horizonte
DRENURBS	An early programme in Belo Horizonte applying new approaches to urban drainage
IGAM	The state water management agency,
IUWM	Integrated urban water management
IWRM	Integrated water resources management
OP	Participatory budgeting
PROPAM	An early programme in Belo Horizonte applying new approaches to urban drainage
PBH	Belo Horizonte Municipality (Prefeitura de Belo Horizonte)

RMBH Council	Brings together the 33 municipalities of the Belo Horizonte Metropolitan Region
SUDECAP	Superintendency for the Development of the State Capital
SMAMA	Municipal Environmental Secretariat
UFMG	Universidade Federal de Minas Gerais
UNESCO-IHE	Institute for Water Education (Delft, the Netherlands)