018530 - SWITCH

Sustainable Water Management in the City of the Future

Integrated Project
Global Change and Ecosystems

D2.1.1c and D2.2.2b Combined report on the stormwater management LA workshop held in Belo Horizonte, Brazil, 3 September 2007

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Organisation name of lead contractor for this deliverable: Middlesex University

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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

SWITCH Document: Report on the stormwater management LA workshop held in Belo Horizonte, Brazil, 3 September 2007

Deliverable reference: Combined Deliverables 2.1.1c and 2.2.2b

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Publication date: 31 July 2008

Audience:

The workshop which is described in this Deliverable was specifically focused on the requirements of the Belo Horizonte LA but the contents are also of relevance to other Las within the SWITCH project for which stormwater management is a major issue.

Purpose

The initial aim was to work with the Belo Horizonte LA to develop and deliver a workshop on the threats and uncertainties to stormwater control identified in Belo Horizonte together with a consideration of their major predicted impacts. However, the development of this work was not sufficiently advanced at the time to merit a full workshop on the topic. Therefore, the original aim of the workshop was revised to adopt a more awareness-raising approach of the SWITCH stormwater work being undertaken within BH, emphasising integration between technical, institutional and demonstration activities.

Background

The format and agenda for the workshop were developed through discussions between representatives of the Belo Horizonte LA, University Federal Minas Gerais (UFMG), Middlesex University (MU) and Ingenieurgesellschaft Prof Dr Sieker (IPS). The agreed workshop agenda incorporated presentations by practitioners, social scientists and physical scientists and covered on-going SWITCH activities in BH as well as the potential applications of tools developed in Theme 2 of the SWITCH project within BH. Presentations were in either Portuguese or English with the provision of simultaneous translations during both the presentation and discussion sessions

Potential Impact

Although the workshop was directed at members of the Belo Horizonte LA, it was also open to other local practitioners, scientists and students with an interest in stormwater control and management. The projected impacts for attendees were to

gain an overview of the aims and objectives of the SWITCH project, to understand how SWITCH links with ongoing and future stormwater work in BH, and to appreciate how the SWITCH approach could contribute to local developments in stormwater management and control.
Issues Positive feedback was received from the delegates regarding the content of the workshop but from the organiser's point of view the discussions sessions could have been more extensive. There were two possible factors which could have contributed to this. One was that too many topics were presented in a short time period and the other was that the professional mix of the delegates could have led to some workshop participants being cautious about expressing views which could be taken as criticisms.
Recommendations Future workshops should be longer or the number of different topics presented should be reduced. The effective functioning of a LA requires the development of 'trustful relations' between all members such that both critical and complementary interactions are possible.

Table of contents

1 Aim and objectives

The initial aim of this Task (Task 2.1.1c), as stated in the SWITCH Description of Work (DOW), was to work with the Belo Horizonte (BH) Learning Alliance (LA) to develop and deliver a workshop on the topic of addressing the threats and uncertainties to stormwater control identified in Belo Horizonte (see Task 2.1.1b), together with a consideration of their major predicted impacts. However, although progress had been made in relation to this Task (e.g. identification of threats and uncertainties to stormwater management within BH (completed October, 2006) and the development of guidelines to support an assessment of their likelihood of occurrence and magnitude of impact (completed May 2007), completion of the risk matrix approach by the BH LA, as envisaged in the SWITCH DOW, was seen as too ambitious a task at such an early stage of the LA establishment.

Through discussions with BH LA representatives (Nilo Nascimento and Jose Roberto Champs) the original aim of the workshop was therefore revised to take a more awareness-raising approach of the SWITCH stormwater work being undertaken within BH, emphasising integration between technical, institutional and demonstration activities. This aim was achieved by addressing the following objectives:

- Co-development of the workshop agenda by the BH LA, (University Federal Minas Gerais (UFMG), Middlesex University (MU) and Ingenieurgesellschaft Prof Dr Sieker (IPS)
- Agreement that presentations should focus on SWITCH activities on-going in BH or describe the potential application of SWITCH tools within a BH context
- Inclusion of presentations from practitioners, social scientists and physical scientists
- Presentations in Portuguese and English
- Simultaneous translation of all presentations and discussion sessions

Whilst the focus of the workshop was the BH LA, the workshop was also open to other local practitioners, scientists and students with an interest in stormwater control and management (informed of the workshop through the distribution of flyers; see Appendix A). It was anticipated that, by attending the workshop, delegates would gain:

- an overview of the aims and objectives of the SWITCH project
- a detailed insight into how SWITCH links with ongoing and future stormwater work in BH
- an understanding of how the SWITCH approach could contribute to local developments in stormwater management and control.

2 Agenda for the workshop "Innovations in the management of urban waters" held at the Belo Horizonte Town Hall, 3 September 2007.

09.00 – 09.30 Introduction to the SWITCH project and its links with BH; Nilo Nascimento (UFMG), Jose Roberto Champs (SUDECAP) and Mike Revitt (MU)

09.30 – 10.15 Institutional mapping and the governance of water in BH; Heloisa Costa, Geraldo Costa and Leo Heller (UFMG)

10.15 – 10.30 Coffee break

10.30 – 11.15 An introduction to the use of Best Management Practices (BMPs) for stormwater control; Lian Scholes (MU)

11.15 – 14.30 A life cycle cost calculation (LCCC) tool for stormwater BMPs Heiko Sieker (IPS)

- 11.15 – 11.45 Part A: description of the developed methodology;
- 11.45 – 12.15 Part B: demonstration of the tool using case study approach

12.15 – 13.30 Lunch

- 13.30 – 14.30 Part C: 'Hands on' practical exercise using the tool

14.30 – 15.30 Strategies and risks for stormwater management

- 14.30 - 14.50 Part A: Description of the developed methodology; Lian Scholes (MU)
- 14.50 – 15.10 Part B: The application of the approach to the city of Birmingham; Bryan Ellis (MU)
- 15.10 – 15.30 Part C: Discussion of the application of a risk management approach in BH; Nilo Nascimento (UFMG)

15.30 – 15.45 Coffee break

15.45 – 17.45 Stormwater reuse opinions to counteract water shortages

- 15.45 – 16.30 Introduction to options for stormwater reuse; Lian Scholes (MU)
- 16.30 – 16.50 Examples of stormwater reuse in Australia; Bryan Ellis (MU)
- 16.50 – 17.10 Examples of stormwater reuse in Germany; Heiko Seiker (IPS)
- 17.10 – 17.30 Examples of stormwater reuse in Brazil; Luis Palmier (UFMG)

17.30 – 18.00 Summing up of the workshop and implications for BH; Nilo Nasciemnto (UFMG), Jose Roberto Champs (SUDECAP) and Mike Revitt (MU)

3 Overview of the workshop

3.1 Welcome and introduction

The workshop commenced with Nilo Nascimento (UFMG) welcoming workshop participants and outlining the agenda for the day. Mike Revitt (MU) gave an overview of the SWITCH project (aim, objectives and partners; see Appendix B), before welcoming the first key speaker of the day, Jose Roberto Champs, Head of the Municipal Drainage Department at SUDECAP (see Appendix C).

3.2 SWITCH demonstration work in Belo Horizonte

In his presentation, Mr Champs described the current situation in relation to stormwater management in BH including routine management approaches and the current key challenges. These included the maintenance of sanitary systems, issues related to the use of combined and separate systems and the subsequent interest in the use of non-conventional solutions such as stormwater best management practices (BMPs). Mr Champs described how these systems are seen as new technologies in BH and hence a considerable amount of experimental work was on-going (both as part of SWITCH and as components of other international research projects).

Within SWITCH, several new opportunities for assessing the use of stormwater BMPs have been identified including the installation of soakaways, use of permeable surfacing materials (in association with gully pots), the use of a detention basins and the construction of a wetland system within a recreational park. Work on several of the these demonstration sites has already commenced, with a range of aspects being assessed including the perceptions of the local community on the use of these approaches (data being collected through the use of questionnaires and work with local schools) and the performance of systems in relation to reductions in both stormwater runoff volume and pollutant load. The presentation was followed by questions which mainly related to the reasons behind the selection of sites for the demonstration work.

3.3 Institutional mapping in Belo Horizonte

Heloisa Costa (UFMG) reported on the progress of her group with mapping institutional arrangements relating to stormwater management in BH (Appendix D). Dr Costa described institutional mapping as a dynamic process, which aims to identify those with power and funding to make change together with those who may be affected by any changes adopted. The work being undertaken as part of SWITCH is focusing on the interactions between the BH LA members involved in stormwater management at local, regional and national scales.

In trying to understand and map relationships between various players, Dr Costa explained that a series of contrasting views and statements were being considered such as whether water was viewed as a right or as a commodity, the development of policy in contrast to its application and the use value of water as opposed to its exchange value. The three dimensions of managing urban water were referred to as:

- water management policy and politics
- its role within urban dynamics
- the use of urban waters for social conditions

Dr Costa presented an overview of the different organisations involved in stormwater management in BH in an attempt (through the use of differing colours and fonts) to illustrate the different types of contributions the various players make to municipal governance.

This overview led to discussions on the need for further communication with LA partners to more precisely identify their role and remit and an identification of the importance of the need for integration between BH and surrounding areas e.g. Contagem. An important question which arises is should the BH LA be campaigning for a simplification of the institutional arrangements which currently govern stormwater management in BH?

3.4 Introduction to stormwater BMPs

Lian Scholes (MU) gave a general introduction to structural and non-structural stormwater BMPs, beginning with a description of the drivers behind the change from conventional to more innovative drainage approaches (Appendix E). Examples of the wide range of stormwater BMPs currently in operation in various parts of the world were presented, together with discussion of site-specific aspects which may influence their usage.

The outputs of a the FP5 sustainable stormwater management project, DayWater, were identified as useful sources of general information on stormwater BMPs. In particular, the on-line BMP catalogue, which is available through Hydropolis (a web-based adaptive decision support system), was highlighted as a relevant source of information.

3.5 Life cycle cost calculation tool

In presenting the Life Cycle Cost Assessment (LCCA) tool, Heiko Sieker began by noting that, in contrast to the extensive range of guidelines available on constructing and operating different types of drainage schemes, there are no guidelines available to support practitioners in actually making the decision on which type of drainage elements to construct in the first place (see Appendix F). Cost is clearly an essential aspect in many decision-making arenas, and although LCCA-type tools are available to support the consideration of the costs of implementing conventional drainage schemes (i.e. enabling the calculation of capital, operating, maintenance and depreciation costs over a system's life-time), there is no tool which can provide a similar level of information in a comparable format for stormwater BMPs. Addressing this identified gap is the aim of the LCCA tool developed by Dr Sieker and colleagues within the remit of the SWITCH project.

Dr Sieker described the methodology used to develop the LCCA tool (see Appendix F) and illustrated its use by application to a 10 ha case study site in which 3 alternative scenarios for handling stormwater had been proposed. These included a soil filter with a by-pass retention pond (Option 1), pumping of stormwater to a nearby river (Option 2) and on-site management (i.e. no runoff) (Option 3). Information on each scenario was entered into the LCCa tool to demonstrate and initiate discussion on the various formats in which results could be presented.

Unfortunately, due to a lack of availability of computers, it was not possible to have the 'hands on' session. However, the allocated time was used in discussion of the development of the methodology and how it may be used within a Brazilian context.

3.6 An assessment of the risks facing stormwater management

In the first presentation of this session, Lian Scholes (MU) gave a general introduction to risk assessment and described the methodology developed within SWITCH to support the consistent assessment of threats identified within various demonstration cities (see Appendix G). Dr Scholes explained that the aim of this work was to support LAs in developing a city-specific stormwater risk matrix in which data on both the likelihood and consequences of an identified threat occurring could be jointly presented. Combining this information using a scoring system enables risks to be prioritised and ranked, providing a robust and transparent knowledge base for the subsequent risk management phase where LA members can discuss whether or not identified risks are acceptable and, if not, how they can be reduced, contained or managed.

A key aspect of this methodology within a SWITCH context is that it provides LA members with a structured approach to assessing the level of risk associated with identified threats in relation to both the short-term (i.e. within the next 5 years) as well as considering the situation within the 'City of the Future' (i.e. 25-30 years time). To illustrate its use, the methodology was applied to the threats and uncertainties to stormwater control as identified by representatives of the BH LA (see Deliverable 2.1.1b).

Bryan Ellis (MU) described the application of the stormwater risk assessment approach within Birmingham (UK) including a critique of issues associated with implementing a theoretical approach in practice (Appendix H). Key questions highlighted included:

- score assignment; should a non-linear scale be adopted?
- how results should be interpreted following completion of a risk matrix
- which criteria should be selected for assessment and how should they be benchmarked? For example, is it more appropriate to consider the impact of flooding using flood depth or the number of properties flooded?
- how can data from a diversity of sources be meaningfully integrated without losing transparency and the trust of local communities?

Nilo Nascimento (UFMG) described the threats and uncertainties to stormwater management in BH (Appendix I), beginning his presentation by setting a series of questions in relation to identifying the characteristics, pollutant sources and impacts of stormwater runoff in BH. A series factors with the potential to influence stormwater quality, quantity and impact, encompassing a range of engineering, scientific, environmental, hydrological, social, planning and financial aspects, were presented, highlighting the need for an integrated approach.

Professor Nascimento went to describe how current research being undertaken within SWITCH was focussing on the management of risks related to urban flooding through combining data on probability of a flood occurrence (considered in relation to various return intervals) and the consequence of a flood occurrence (benchmarked using flood depth). The application of this approach within a BH context using GIS was presented, enabling the level of risk of flooding during various return intervals to be differentiated on a city-wide basis. Subsequent discussions focussed on how this mainly theoretical approach could be utilised within the BH LA.

3.7 Stormwater harvesting

Lian Scholes (MU) introduced the session, beginning with a general introduction to the topic of stormwater harvesting (Appendix J). Dr Scholes described the range of approaches which have been used for collecting stormwater in various contexts and gave an overview of the types of applications in which stormwater has been utilised. This included a discussion of terminologies, and how the impacts of stormwater harvesting may vary greatly depending on local conditions including the level of socio-economic development.

Following on from this general introduction, Bryan Ellis (MU) gave an overview of the use of stormwater harvesting in Australia, a country which in recent years has experienced drought conditions (Appendix K). The results of various case study developments which utilised stormwater harvesting to meet a variety of non-potable needs (from laundry use to garden watering) were presented. As well as the advantages of stormwater harvesting, Professor Ellis referred to concerns regarding the use of this approach to supplement water use, particularly in relation to possible health problems associated with the use of stormwater storage systems in tropical and sub-tropical climates. The lack of national guidelines on the use and application of stormwater harvesting systems and the resulting confusion associated with design aspects, such as correct tank size, were described. Potential issues relating to inspection and enforcement of correct operation and maintenance procedures to ensure healthy systems were also highlighted.

Heiko Sieker (IPS) presented the situation with regard to the use of stormwater harvesting in Germany (Appendix L). Dr Sieker explained that the use of stormwater harvesting tanks in non-potable applications was widespread in Germany, in both a residential and industrial context, with stormwater being collected from both roofs and roads. National standards on the use of stormwater harvesting have been developed in relation to technical aspects, but discussion on the development of hygienic standards are on-going.

The current situation with regard to the use of stormwater fees was described, whereby all property owners are required to pay a stormwater management fee, with the level of fee being based on the amount of impermeable surface area associated with a property. The introduction of stormwater fees was identified as a key factor in the increased use of stormwater harvesting systems in Germany in comparison to other EU countries.

Luiz Rafael Palmier (UFMG) described the use of stormwater harvesting in Brazil, explaining that although the approach was widely practised in some rural areas of South America (e.g. the use of 'water in air' harvesting in Chile), demand was also growing in urban cities such as Rio de Janeiro and Sao Paulo.

As an example of a major stormwater harvesting initiative which is on-going in Brazil, Professor Palmier described the Programa 1 Milhão de Cisternas (Programme for 1 million tanks (P1MC)). This initiative, funded by the Brazilian government, takes a participatory approach to bringing together approximately 900 non-governmental organisations (NGOs) to provide training in water resource management and, more specifically, to construct 1 million rainwater harvesting systems. The project is being implemented in a decentralised manner,

with initiatives operating at household, community, micro-region and regional levels. By early 2007, over 100,000 cisterns had been constructed.

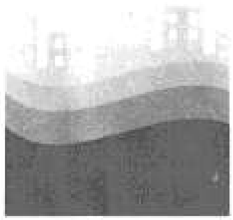
Professor Palmier concluded his presentation by noting that, as well as providing a vital resource to some of the poorest people in Brazil, rainwater harvesting was also being favoured by some of its more wealthy residents with the use of residential stormwater harvesting systems in some central city areas being seen as a fashionable 'added extra' to be highlighted in the marketing of expensive properties.

4 Conclusions

Mike Revitt (MU) concluded the workshop by summarising the presentations given, and thanking speakers and participants for their comments and questions. Whilst feedback on the day was positive, the level of interaction between presenters and delegates could have been more extensive. This could not be attributed to a language problem as the excellent translation service enabled all participants to follow the presentations. However, there are two factors which may have contributed to the reduced level of discussion. Firstly, the wish to make the most of the opportunity to meet with the BH LA meant that a large number of topics were presented and this may have been somewhat overwhelming. Secondly, the workshop participants consisted of a mix of local authority representatives, policy makers, practitioners and students, and it is possible that one reason for the apparent reticence of some members of the audience could have been due to concerns about expressing views that may appear to be critical of organisations which are currently responsible for managing stormwater in BH.

A solution to the first issue would be to make future workshops longer and/or reduce the number of different topics presented. The second factor represents a more difficult issue to address and one which could be summarised as the need to 'develop trustful relations' between all members of the LA. Recommendations of how this may be achieved is not within the scope of this report however, it is recognised as a crucial aspect to tackle if an LA is to be effective and is therefore a key topic for consideration within the SWITCH project.

Appendix A: Programme for the Belo Horizonte workshop



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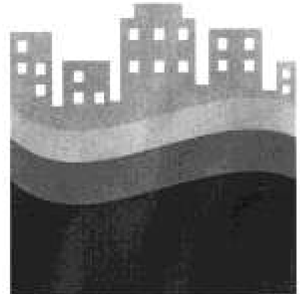
Middlesex University   SWITCH

UFMG   PREFEITURA BH TRABALHO PELA VIDA



INOVAÇÕES NO MANEJO DE ÁGUAS PLUVIAIS URBANAS

03 de setembro de 2007

Auditório da Prefeitura de Belo Horizonte
Av. Afonso Pena, 1.212 - Centro

Middlesex University   SWITCH   UFMG   PREFEITURA BH

PROJETO SWITCH: INOVAÇÕES NO MANEJO DE ÁGUAS PLUVIAIS URBANAS

Programação

08h30 às 09h00: Abertura. Representantes convidados da PBH e da SUDECAP

09h00 às 09h30: O projeto SWITCH em Belo Horizonte - Prof. Mike Revitt, Middlesex University, UK; José Roberto Champs SUDECAP, PBH; Prof. Nilo Nascimento, Universidade Federal de Minas Gerais, Brasil

09h30 às 10h15: Mapeamento institucional e governança da água em Belo Horizonte - Prof. Heloisa Costa; Prof. Geraldo Costa; Prof. Léo Heller, Universidade Federal de Minas Gerais, Brasil

10h15 às 10h30: Coffee break

10h30 às 11h15: Técnicas compensatórias de drenagem pluvial, uma introdução - Dr. Lian Scholes, Middlesex University, UK

11h15 às 14h30: Uma ferramenta para o cálculo de ciclo de vida de técnicas compensatórias de drenagem pluvial - Heiko Sieker, Ingenieurgesellschaft; Prof. Dr. Sieker mbH, Germany

- **11h15 às 11h45:** Parte A: Metodologia adotada para o desenvolvimento do software
- **11h45 às 12h15:** Parte B: Demonstração do emprego do software em estudos de caso

12h15 às 13h30: Almoço

- **13h30 às 14h30:** Parte C: Trabalho prático de uso do software

14h30 às 15h30: Estratégias e análise de risco no manejo de águas pluviais em meio urbano - Prof. Bryan Ellis; Dr. Lian Scholes, Middlesex University, UK; Prof. Nilo Nascimento, Universidade Federal de Minas Gerais, Brasil

- **14h30 às 14h50:** Parte A: A metodologia de análise de risco - Lian Scholes
- **14h50 às 15h10:** Parte B: Estudo de caso na cidade de Birmingham, UK - Bryan Ellis
- **15h10 às 15h30:** Parte C: Aplicação de análise de risco em BH - Nilo Nascimento

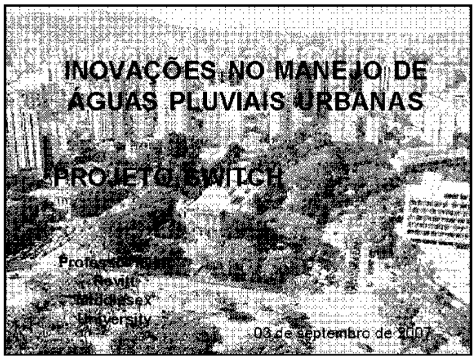
15h30 às 15h45: Coffee break

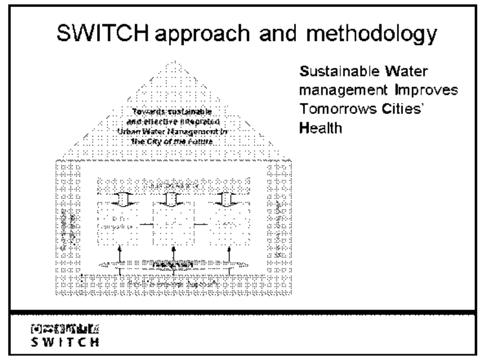
15h45 às 17h45: Captação e uso de águas pluviais em meio urbano - Prof. Bryan Ellis; Dr. Lian Scholes, Middlesex University, UK; Heiko Sieker, Ingenieurgesellschaft; Prof. Dr. Sieker mbH, Germany; Prof. Luiz Rafael Palmier, Universidade Federal de Minas Gerais, Brasil

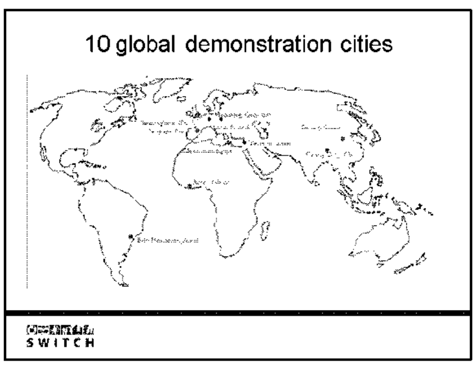
- **15h45 às 16h30:** Alternativas para a captação e uso de águas pluviais - Lian Scholes
- **16h30 às 16h50:** Exemplos de captação e uso de águas pluviais na Austrália - Bryan Ellis
- **16h50 às 17h10:** Exemplos de captação e uso de águas pluviais na Alemanha - Heiko Sieker
- **17h10 às 17h30:** Exemplos de captação e uso de águas pluviais no Brasil - L. R. Palmier

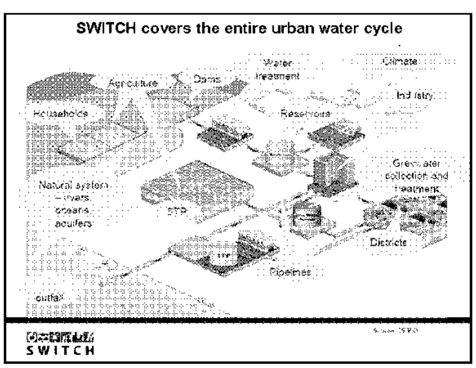
17h30 às 18h00: Conclusões e fechamento do workshop - Prof. Mike Revitt, Middlesex University, UK; José Roberto Champs, SUDECAP, PBH; Prof. Nilo Nascimento, Universidade Federal de Minas Gerais, Brasil

Appendix B: Introduction to the role of the SWITCH project in Belo Horizonte (Mike Revitt)









The role of Belo Horizonte in SWITCH

Focus is on Theme 2: Stormwater management and on two work packages:

- Technological options for stormwater control under conditions of uncertainty
- Decision-making processes for effective urban stormwater management

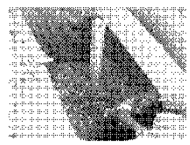
Contributions to the achievement of sustainable and effective urban water management in the 'City of the Future'

SWITCH

SWITCH objectives for demonstration projects/ training activities

•To show that demonstration projects can result in urban water management with better efficiencies in terms of the environment and socio-economical aspects.

•Through dissemination and training activities, to demonstrate to urban water managers throughout the participating countries that SWITCH demonstration projects could be successfully replicated in their own cities.



SWITCH

Proposed demonstration project/ training impacts

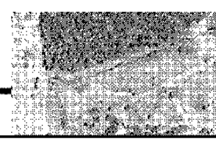
•To demonstrate that the application of the SWITCH-approach (developed during the research phase) in practical cases results in urban water management with better efficiencies in terms of environment and socio-economy.

•Through dissemination and training activities, to demonstrate to urban water managers throughout Europe and the participating developing countries that SWITCH demonstration projects could be successfully replicated in their own cities.

SWITCH

Learning Alliance role in SWITCH

To guide and support the implementation of research and demonstration activities in the identified Demonstration Cities, taking account of local problems and needs and leading to effective integration of activities both within the Demonstration and other cities.



SWITCH

The Belo Horizonte Learning Alliance

includes representatives from

•UFMG

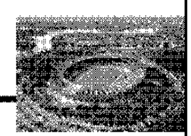
•SUDECAP

•Ministry of Brazilian Cities

•COPASA

•SEMAD

•and neighbouring municipalities



SWITCH

Possible impacts from Learning Alliance operations

•To improve the communication between water sector institutions in the demonstration cities.

•To increase the transparency of and the scientific basis for decision making processes in the demonstration cities.

•To help to break down the political barriers to solving global urban and global water issues.

•To enable better representation of all stakeholders in the decision making processes

•To show to other sectors (public health management, agriculture, spatial planning etc.) that using the Learning Alliance approach is feasible and results in better efficiencies.

SWITCH

Workshop topics

•Institutional mapping and water governance

•Stormwater source control (BMPs)

•Life-cycle cost calculation tool for BMPs

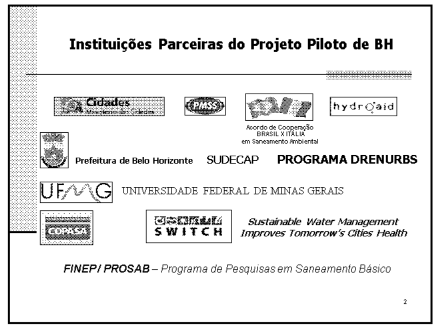
•Strategies and risks for stormwater management

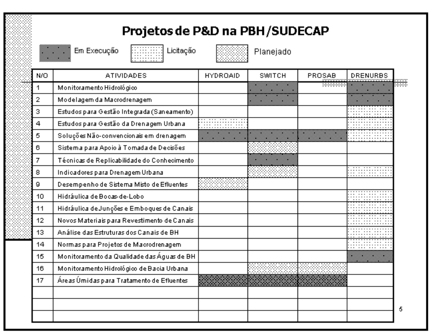
•Stormwater reuse options

SWITCH

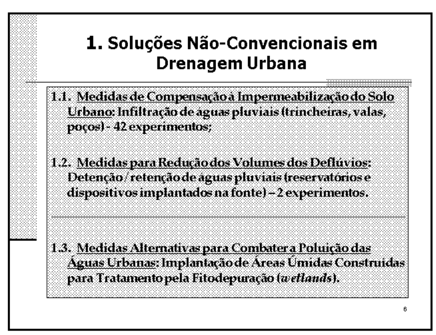
Appendix C: Development of drainage technologies for an integrated municipal water system (Jose Roberto Champs)

01 July 2008





N/O	ATIVIDADES	HYDROAID	SWITCH	PROSAB	DRENURBS
1	Monitoramento Hidrológico				
2	Modelagem da Macrodrenagem				
3	Estudos para Gestão Integrada (Saneamento)				
4	Estudos para Gestão da Drenagem Urbana				
5	Soluções Não-convencionais em drenagem				
6	Sistema para Apoio à Tomada de Decisões				
7	Técnicas de Replicabilidade do Conhecimento				
8	Indicadores para Drenagem Urbana				
9	Desempenho de Sistema Misto de Efluentes				
10	Hidráulica de Bocas-de-Lobo				
11	Hidráulica de Junções e Emboques de Canais				
12	Novos Materiais para Revestimento de Canais				
13	Análise das Estruturas dos Canais de BH				
14	Normas para Projetos de Macrodrenagem				
15	Monitoramento da Qualidade das Águas de BH				
16	Monitoramento Hidrológico de Bacia Urbana				
17	Áreas Úmidas para Tratamento de Efluentes				



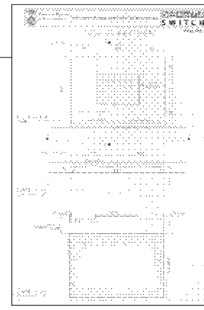
1.1. Medidas de Compensação à Impermeabilização do Solo Urbano: Infiltração de águas pluviais (trincheiras, valas, poços 43 experimentos;

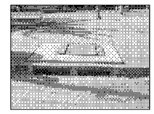
Experimentos com base na padronização para drenagem da SUDECAP

- Poço de Infiltração (1);
- Trincheira em logradouro público sob sarjeta (37);
- Trincheira em logradouro público sob passeio (2).

7

Poço de Infiltração





8

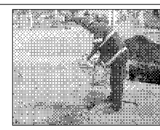
Poço de Infiltração (Guaratã)

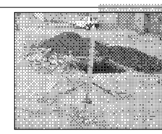
Resultados

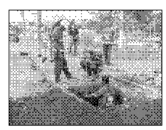
- Permeabilidade do solo: $5,85 \times 10^{-5}$ m/s;
- Área máxima de drenagem(para volume de absorção de 1,68 m^3 e chuva com duração de 15 min): 225 m^2;
- Monitoramento (pluviometria e vazão de absorção): fase de aquisição de equipamentos;
- Características físicas do solo: ensaio na UFMG;
- Características químicas do solo: ensaio na UFMG;
- Monitoramento da carga de poluição no solo: início em novembro (período chuvoso);

9

Poço de Infiltração (Guaratã)



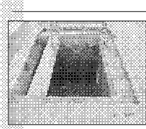


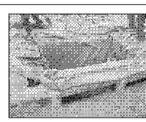


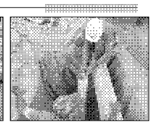
10

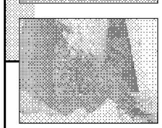
Poço de Infiltração (Guaratã)

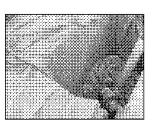
Etapas de Construção

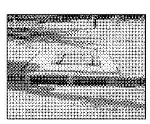






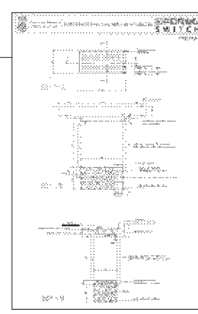


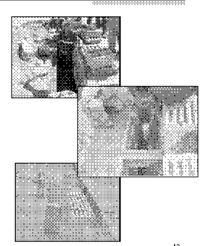




11

Trincheira sob a Sarjeta (Guaratã)





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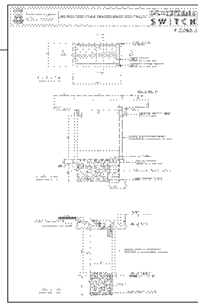
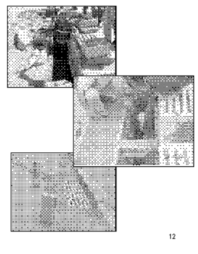
Trincheira sob a Sarjeta (Guaratã)





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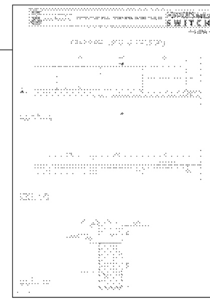
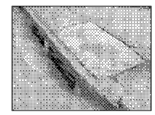
Trincheira sob o Passeio





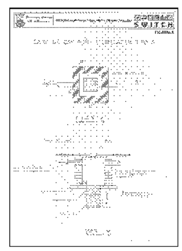
13

Monitoramento dos Experimentos (SUDECAP) para Infiltração

- Os processos hidrológicos nas áreas de drenagem serão caracterizados por monitoramento e modelagem. O monitoramento será realizado por meio de estação pluviométrica (pluviômetro com báscula). A utilização de medidor de vazão (parshall e sensor de nível) será objeto de teste.
- Os parâmetros iniciais de qualidade de água a serem obtidos das amostras serão: SS, pH, DBO, DQO, nitrogênio total, amônia, nitrogênio orgânico, nitrato, nitrito, fósforo total, fosfato, hidrocarbonetos totais, metais pesados (cádmio, cobre, chumbo e zinco). Ajustes posteriores poderão ser realizados para definição de parâmetros de qualidade de água, tendo em conta os resultados obtidos com os primeiros eventos amostrados. As coletas de amostras de água e solo serão manuais.

14

Caixa para Retenção no Lote



Artigo 50 da Lei N. 7.166 de 27 de agosto de 1.996

Características:

Volume de 30 litros para 1 m^2 de área impermeabilizada até o máximo de 20% da área do lote.

Volume da caixa experimental: 2,16 m^3.

Experimentos:

- Performance do desempenho;
- Potencial de colmatação do dreno;
- Monitoramento da carga de poluição no solo.

15

1.3. Medidas Alternativas para Combater a Poluição das Águas Urbanas: Implantação de Áreas Úmidas Construídas (Sistemas de Fitodepuração).

Áreas Úmidas Construídas

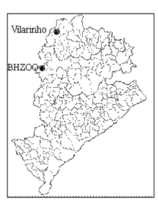
(Wetlands)

PROJETO:

- Construção de duas unidades de tratamento ecológico de águas fluviais e pluviais em áreas inundáveis na região de Venda Nova (bacia do córrego do Vilarinho) e no interior do Zoológico de B Horizonte (bacia do córrego Água Funda).

OBJETIVOS:

- Redução da poluição das águas;
- Controle das cheias durante os eventos de chuvas;
- Valorização estética das águas em meio urbano.



16

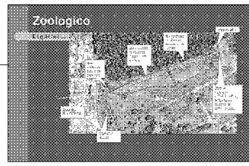
Projeto das Áreas Úmidas

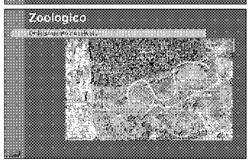
Áreas Úmidas Construídas

PROJETO DE PESQUISA:

- Monitoramento da quantidade e da qualidade das águas nos períodos de estiagem e de chuvas nas várzeas dos dois córregos. No primeiro ano os dados servirão para conhecer os regimes de vazões e as cargas de poluição o que permitirá projetar as duas unidades de tratamento ecológico. Depois da implantação das "wetlands", novas campanhas de monitoramento serão implantadas para verificação e avaliação do funcionamento.

Área Úmida BH-ZOO Água Funda





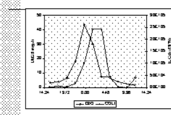
DADOS GERAIS

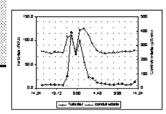
- Área de drenagem: 1,8 km²;
- Vazão tempo seco: 42 l/s
- População da bacia: 3 mil
- cobertura da rede de esgotos: 98%
- Uso do solo: residencial e comercial;

18

Área Úmida BH-ZOO

(Monitoramento)





Chuva do dia 23/05/2007 - 1,4 mm

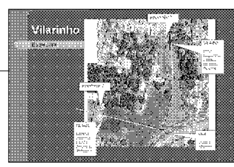
Parâmetros de qualidade da água:

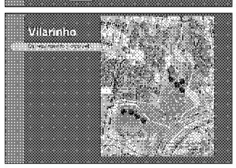
- SS, pH
- DBO, DQO
- Coliformes termotolerantes
- Nitrogênio total, amônia, Nitrogênio orgânico, nitrato, nitrito
- Fósforo total, fosfato
- Hidrocarbonetos totais
- Cádmio, cobre, chumbo, zinco

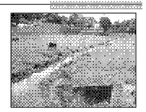
Amostrador instalado em 11 / 07 / 2007

19

Vilarinho







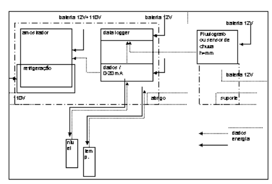
DADOS GERAIS:

- Área de drenagem: 2,8 km²
- População: 17 mil
- Rede coletora de esgotos existentes. Não há interceptores;
- Uso do solo: residencial e comercial.

20

Áreas Úmidas

Diagrama Esquemático para as Amostragens



- AMOSTRADOR AUTOMÁTICO REFRIGERADO COM 24 GARRAFAS
- Pluviômetro (com báscula);
- Sensor de vazão (de nível e calha parshall).

21

Pesquisa de Percepção (iniciada em junho de 2007)

METAS

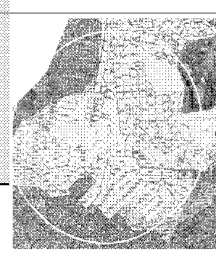
- Compreender a percepção ambiental da comunidade local;
- Verificar a percepção coletiva da importância de uma área de tratamento de águas (e de uso para o lazer);
- Incentivar a apropriação da obra pela comunidade.

ABRANGÊNCIA

- Perfil sócio-econômico
- Percepção da região e da moradia
- Percepção do saneamento básico
- Revitalização da área inundável
- Preservação da obra proposta
- Relações sociais.

22

Metodologia da pesquisa (1)



- **Perímetro da área de pesquisa**:

  1 km ou seja 15 minutos de caminho a pé no entorno da bacia de detenção.

- **Equipes da pesquisa**:

  - Agentes comunitários dos centros de saúde de Venda Nova e Mantiqueira

  - Agentes da SUDECAP

23

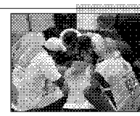
Metodologia da pesquisa (2)

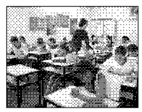
- **Objetivo :**
Questionar 100 famílias que representam aproximadamente 300 pessoas no entorno da bacia.
- **Medio :**
Aplicação de 2 tipos de questionários :

- adultos (60 perguntas)
- crianças - adolescentes (30 perguntas)

- **Modo :**
Questionar cada integrante do núcleo familiar :

- o chefe de família (mulher ou homem)
- um outro adulto que mora na casa
- uma criança (10-18 anos)





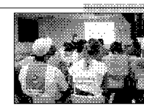
24

Etapas da pesquisa

Etapa 1 :
Reuniões de capacitação com os agentes dos centros de saúde

Etapa 2 :
Aplicação dos questionários nas casas e escolas

Etapa 3 :
Devolução dos resultados com a população no dia
« Um dia na bacia »



25

Concepção e Implementação de um Novo Modelo de Gestão para a Drenagem Urbana

Etapa Atual:

- Edital concluído a ser publicado em agosto/2007. Início dos estudos: dezembro/2007. Prazo de execução: 12 meses.
- Custo: US$ 160 mil. Origem dos Recursos: Programa DRENURBS.

Conteúdo dos Estudos:

- Diagnóstico Institucional do Sistema Atual para a Drenagem Urbana;
- Definição do Arranjo Institucional Integrado do Sistema de Drenagem Urbana;
- Sustentabilidade financeira do serviço de drenagem;
- Viabilidade ambiental do novo modelo institucional;
- Viabilidade econômica;
- Definição de uma estratégia de implantação do novo arranjo institucional.

26

Análise comparativa do desempenho dos sistemas unitário, separador e misto de esgotamento de efluentes

Objetivos

- Identificar as cargas de poluição em tempo seco e em tempo chuvoso nos diferentes sistemas de esgotamento;
- Verificar o potencial de tratamento das águas das primeiras chuvas para os sistemas misto e unitário;
- Avaliar os impactos financeiros e econômico no caso da adoção de um dos sistemas misto ou unitário;

Etapa Atual

- Não houve evolução neste estudo. Motivo: Resistência a mudanças por parte da COPASA e da comunidade técnica do setor de saneamento.

27

Modelos Matemáticos Utilizados
(HIDROLÓGICO / HIDRÁULICO)

- PROJETO PILOTO: HEC-HMS / HEC-RAS
- DRENURBS: HEC-HMS / HEC-RAS e CAbc / CLiv (FCTH)
- PROSAB: CANOE (INSA Lyon) e SWMM (*Storm Water Management Model)*
- SWITCH: MOUSE (Hidrologia / Hidráulica) e MIKE (Hidráulica)

28

.

Grato Pela Atenção

Eng. José Roberto Borges Champs
Prefeitura Municipal de Belo Horizonte, Brasil

29

Appendix D: Institutional mapping and water governance in Belo Horizonte (Heloisa Costa).

SWITCH

Workshop:
novações no manejo de águas pluviais urbanas

Mapeamento institucional e governança da água em Belo Horizonte

Institutional mapping and water governance in Belo Horizonte

Geraldo Costa, Heloisa Costa, Janise Dias, Mariana Welter, Tarcísio Nunes
Departamento de Geografia – IGC/UFMG
Belo Horizonte, 03/09/07

Água como eixo de análise

Quais águas?

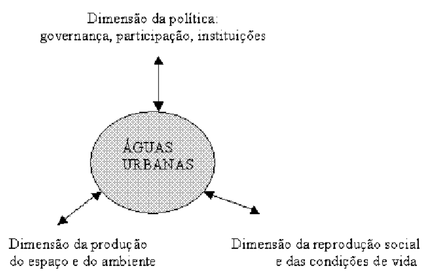
- água para consumo - abastecimento
- água para esgotos sanitários - tratamento
- águas pluviais - drenagem
- águas para fruição e lazer – paisagem urbana

Tensões identificadas:

Politicas públicas X exercício da politica
policy X politics

valor de uso X valor de troca
use value X exchange value

mediação/negociação X conflitos quanto ao uso das águas
agency X conflicts



Objetivos 6.1 – Governança para a Gestão Integrada de Águas Urbanas - GIAU
6.1 *Governance for Integrated Urban Water Management - IUWM aims:*

1 - Examinar criticamente o arranjo institucional existente, as dificuldades e as oportunidades para a implementação da GIAU.
Critically examine existing institutional arrangements, and governance constraints and opportunities towards implementing IUWM.

2 - Identificar e testar meios efetivos para o aprimoramento da coordenação e cooperação institucional, inclusive enfatizando resultados das Alianças de Aprendizado como mecanismos de mudança institucional para a GIAU.
To identify and test effective means of facilitating institutional co-operation and co-ordination, especially lessons from Learning Allinace as mechanisms for institutional change for IUWM.

3 - Desenvolver e validar recomendações para a participação de decisores em GIAU, incluindo ferramentas de comunicação.
To develop and validate replicable guidelines to support procedural enquiry in stakeholder engagement in IUWM including appraisal and communication tools

Politica Nacional de desenvolvimento urbano do Ministério da Cidades
Estatuto das cidades

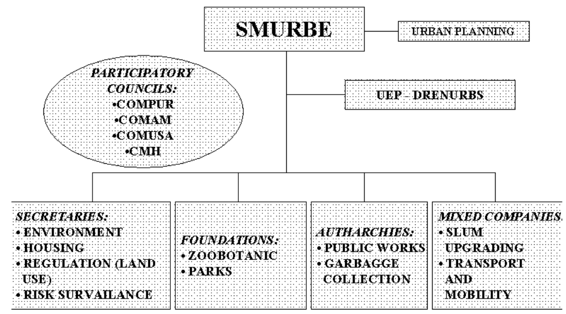
- O que se busca é a equidade social, maior eficiência administrativa, ampliação da cidadania, sustentabilidade ambiental e resposta aos direitos das populações vulneráveis: crianças e adolescentes, idosos, pessoas com deficiência, mulheres, negros e índios.
- Podemos definir o desenvolvimento urbano como a melhoria das condições materiais e subjetivas de vida nas cidades, com diminuição da desigualdade social e garantia desustentabilidade ambiental, social e econômica.
- Ao lado da dimensão quantitativa da infraestrutura,dos serviços e dos equipamentos urbanos, o desenvolvimento urbano envolvetambém uma ampliação da expressão social, cultural e política do indivíduo e da coletividade, em contraponto aos preconceitos, à segregação, à discriminação, ao clientelismo e à cooptação.
- O objeto de uma política de desenvolvimento urbano é o espaço socialmente construído. Não estamos tratando das políticas sociais, de um modo geral, mas daquelas que estão relacionadas ao ambiente urbano

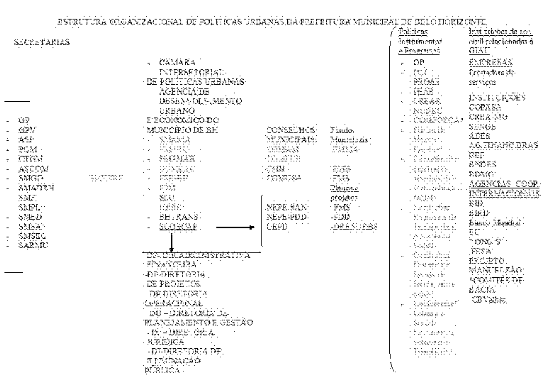
PROPOSTAS ESTRUTURANTES DA PNDU

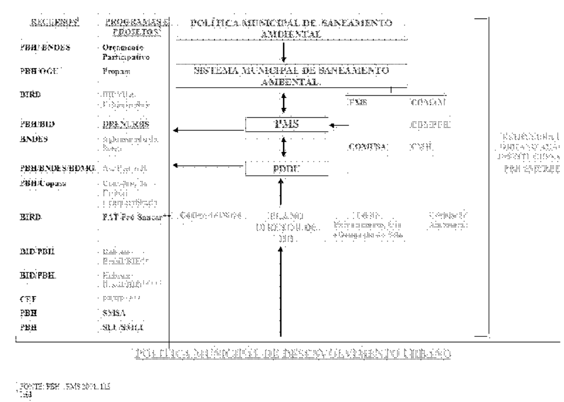
- O reconhecimento de que políticas setoriais são indispensáveis e podem ser estruturantes do desenvolvimento urbano é fundamental para entender que elas tanto mais o serão, na direção hoje pretendida, quanto mais estiverem integradas numa Política Nacional de Desenvolvimento Urbano que, ela também, se articule com outras políticas governamentais – horizontalmente, no âmbito federal, e verticalmente, na direção de estados e municípios.

Novo marco legal para o saneamento ambiental

- 1) instituir diretrizes definidoras da natureza e dos padrões mínimos da prestação dos serviços públicos;
- 2) instituir uma Política Nacional de Saneamento Ambiental a que Estados e municípios possam aderir em função do planejamento integrado que o setor requer







Plano Municipal de Saneamento Ambiental de Belo Horizonte

- O Plano Municipal de Saneamento de Belo Horizonte se constitui em um dos instrumentos do Sistema Municipal de Saneamento e foi institucionalizado quando da sanção da Lei 8.260 de 03 de dezembro de 2001, que instituiu a Política Municipal de Saneamento
- Foi concebido num modelo de gestão público e integrado, que assegure a qualidade na prestação dos serviços, a democratização e a transparência dos processos decisórios, com mecanismos eficazes de controle social e participação popular, bem como a indispensável "subordinação das ações de saneamento ao interesse público".
- "Destinado a articular, integrar e coordenar recursos tecnológicos, humanos, econômicos e financeiros, com vistas ao alcance de níveis crescentes de salubridade ambiental."

Plano Municipal de Saneamento Ambiental de Belo Horizonte

- *O PMS é, na verdade, um processo absolutamente dinâmico de planejamento das ações e serviços de saneamento em Belo Horizonte. Para tanto, é indispensável um monitoramento permanente dessas ações e serviços, de forma a que seja possível aprimorar a sua gestão, através da produção e divulgação sistemática de dados e de informações atuais e confiáveis, da conseqüente geração de indicadores e de índices setoriais e do ISA – Índice de Salubridade Ambiental que reflitam a realidade local, da valorização e garantia do controle e da participação popular*

Fundo Municipal de Saneamento e Conselho Municipal de Saneamento

- O Fundo Municipal de Saneamento - FMS, outro instrumento que compõe o Sistema, também instituído na mesma Lei 8.260/2001 e posteriormente regulamentado pelo Decreto 11.289 de 24 de março de 2003, “de natureza contábil e com autonomia administrativa e financeira”, destina-se “a financiar, de forma isolada ou complementar, os instrumentos da Política Municipal de Saneamento, cujos programas tenham sido aprovados pelo Comusa” - Conselho Municipal de Saneamento.

Plano Diretor de Drenagem Urbana de BH

- A percepção dos responsáveis pelo planejamento da infra-estrutura municipal, onde foi instituído o princípio da participação popular no processo de aplicação dos recursos públicos, indicou que um novo modelo de gestão da drenagem se fazia necessário e propôs a instituição de um Plano Diretor de Drenagem Urbana - PDDU, onde se apóia a concepção do Programa DRENURBS.
- No PDDU foram estabelecidos novos princípios para o tratamento da drenagem, enquanto um dos elementos estruturadores da paisagem urbana, tais como:
- Gestão solidária – onde se entende a cidade como elemento de diversidade territorial e social, onde a população deve participar das decisões de interesse comum;
- Integração do planejamento da drenagem com os de redes de infra-estrutura viária, de saneamento, etc;
- Conhecimento atualizado do sistema, através de diagnóstico geral e atualizado;
- Não transferência de impactos entre bacias, evitando as ocorrências de jusante;
- Revalorização e incorporação paisagística dos cursos d'água, como elementos do tecido urbano.

Plano Diretor de Drenagem Urbana de BH

- A área de abrangência do PDDU foi composta pelos cursos d'água existentes no município de Belo Horizonte, distribuídos nas bacias do ribeirão Arrudas, ribeirão do Onça, ribeirão do Isidoro e afluentes diretos do Rio das Velhas.
- O PDDU foi concebido para ser implantado em 4 fases, onde a primeira consistia em
- (i) diagnóstico do sistema existente, por bacia hidrográfica,
- (ii) cadastro de macro e micro drenagem,
- (iii) implantação de Sistema de Informações Geográficas para a drenagem urbana.
- Em linhas gerais, as fases subseqüentes conceberiam
- (i) campanhas de qualidade das águas e medição pluviométrica,
- (ii) estudos para a gestão do sistema de drenagem, com modelagem específica,
- (iii) campanhas de controle de poluição dos corpos d'água, plano de execução de obras e
- (iv) estudos para a operação otimizada do sistema, com programa de alerta contra inundações.

Atribuições NEPE-SAN

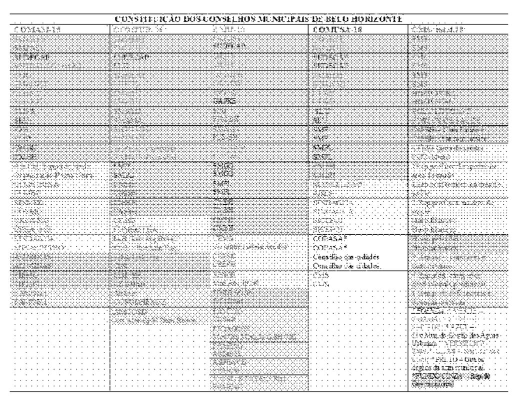
- realizar estudos referentes às atividades de gestão dos serviços locais de abastecimento de água e esgotamento sanitário do Município;
- assessorar o COMUSA na aplicação dos recursos do Fundo Municipal de Saneamento;
- atualizar o Plano Municipal de Saneamento - PMS, e elaborar o relatório "Situação de Salubridade Ambiental do Município de Belo Horizonte";
- acompanhar e fiscalizar as ações da Companhia de Saneamento de Minas Gerais - COPASA, no Município;
- fornecer subsídios à SMAMA para análise dos estudos de impacto ambiental;
- assessorar tecnicamente a Vigilância Sanitária Municipal na implementação da vigilância da qualidade da água para o consumo humano;
- apoiar a implementação e o monitoramento do Plano de Gestão Ambiental e Social - PGAS, do Programa DRENURBS;
- apresentar relatórios semanais ao Superintendente da SUDECAP, informando sobre as atividades desenvolvidas pelo NEPE-SAN.

Atribuições NEPE-PDD

- Objetivo: implementar o Plano Diretor de Drenagem Urbana, visando a implantação de um novo modelo de gestão para as águas circulantes na cidade, com aplicação do conceito de manejo integrado das águas e compartilhando as responsabilidades desta gestão com as comunidades envolvidas.

Compete ao NEPE-PDD:

I - formular uma estrutura de gestão para a drenagem urbana no Município;
II - implantar uma rede hidrométrica para o monitoramento hidrológico e hidráulico do sistema de macrodrenagem;
III - gerenciar e atualizar os cadastros de micro e macrodrenagem;
IV - gerenciar o sistema de informações geográficas para a rede de drenagem pluvial - SIG-Drenagem;
V- propor inovações tecnológicas em drenagem urbana;
VI - coordenar o Projeto SWITCH - Gestão Sustentável das Águas para a Saúde das Cidades do Futuro;
VII - apresentar relatórios semanais ao Superintendente da SUDECAP, informando sobre as atividades NEPE-PDD.



Appendix E: Introduction to stormwater Best Management Practices (BMPs) (Lian Scholes)

PROJETO SWITCH: INOVAÇÕES NO MANEJO DE ÁGUAS PLUVIAIS URBANAS

Técnicas compensatórias de drenagem pluvial, uma introdução

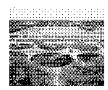
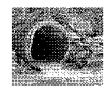
Dr Lian Scholes
Urban Pollution Research Centre,
Middlesex University, UK

SWITCH

Middlesex University

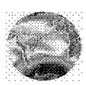
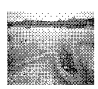
Traditional approaches

- Directly drain stormwater to sewage treatment works
- Directly drain stormwater to receiving watercourse
- Avoid flooding and risk to human health

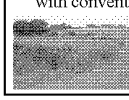
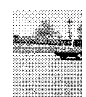
Why a new approach is needed

- Global drivers e.g. sustainability issues, climate change and rapid urbanisation
- Increasingly stringent legislation
- Overloading of sewage treatment works
- Downstream erosion and flooding
- Restriction of fauna and fauna to pollution tolerant families

Stormwater Best Management Practices (BMPs)

- Treats stormwater as close as possible to its source
- Infiltration/detention followed by discharge at a controlled rate
- May provide social amenity/recreational benefits
- Jointly address stormwater control from water quantity, quality and public amenity perspectives
- Used individually, in a treatment train or in combination with conventional piped systems

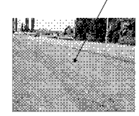



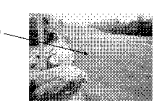
BMPs: 4 general groups

- Filter strips and swales
- Infiltration systems
- Storage facilities
- Alternative road and paving structures

Filter strips and swales

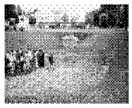
- Enhancement of sedimentation by slowing incoming flow
- Physical filtration of flow increasing retention of particles
- Bioaccumulation of pollutants





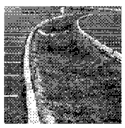
Infiltration systems

Infiltration basin

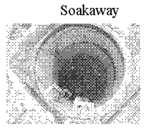


- Filtration of stormwater through a natural or artificial media
- Close contact between stormwater and substrate promotes pollutant removal

Infiltration trench



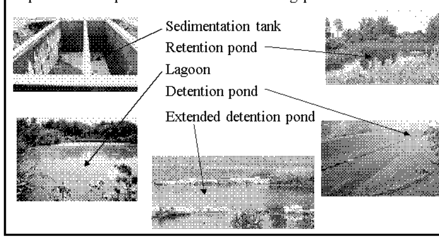
Soakaway



Storage facilities (1)

Involve temporary or permanent water body:

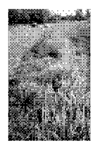
- reduction in stormwater velocity
- promotion of quiescent conditions enhancing pollutant removal



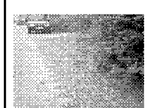
Storage facilities (2): Constructed wetland treatment systems

Generally more complex with enhanced

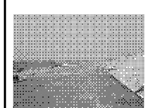
- microbial degradation
- filtration
- plant uptake



Alternative road and paving structures



Porous paving: porous surface material with reservoir structure



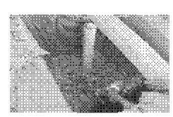
Porous asphalt: porous surface material

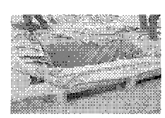
General comparison of conventional systems with BMPs

	Piped systems	BMPs
Cost to construct	May be equivalent but potential of multifunctional use of BMPs may reduce overall cost	
Cost to operate and maintain	Established	Unclear for some systems; further work required
On-site flood control	Yes	Yes
Down stream erosion and flood control	No	Yes
Potential for water re-use	No	Yes
Potential for groundwater recharge	No	Yes
Potential for pollutant removal	Low	High
Public amenity benefits	No	Yes
Educational benefits	No	Yes
Performance lifetime	Established	Not established for some systems: further work required
Land take	Not significant	Dependent on type of system: varies between low & substantial
Design criteria	Established	Not established for some systems: further work required

Site-specific factors affecting the use of BMPs

- Depth to water table
- Soil type; hydraulic conductivity; infiltration rate
- Contributing drainage area





Construction of the first infiltration trench demonstration experiment in the Guarată city district

1

Further information on BMPs (1)

Daywater site www.daywater.cz (username and password: Guest)

- BMP catalogue: performance, photographs, operation and maintenance, costs, case studies
- MCC (Multi-criteria comparator): provides support in assessing 15 BMPs against technical, environmental and socio-economic criteria
- Variety of other tools and databases

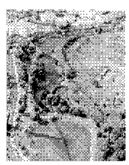
On-going river restoration at 1st May and N.S. Piedade catchments

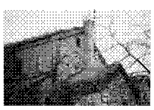
Further information on BMPs (2)

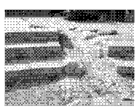
- www.ciria.org.uk/suds
- www.bmpdatabase.org
- www.suds-sites.net
- www.sustainabledrainage.co.uk
- Brazilian BMP design manual under discussion

Overview of BMPs

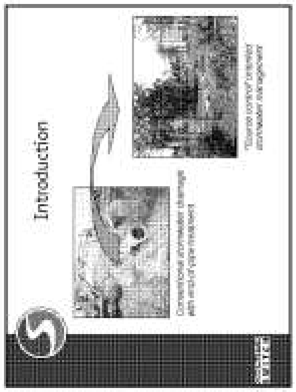
- Wide variety of types of BMPs
- Used on an individual household to catchment scale
- Different BMPs offer different potential to:
  - Store stormwater
  - Remove pollutants
  - Provide amenity and recreation

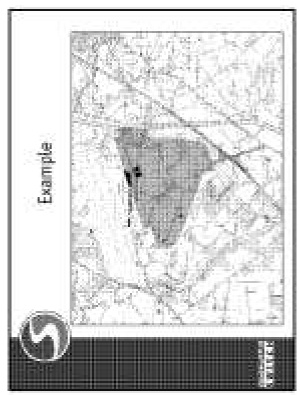


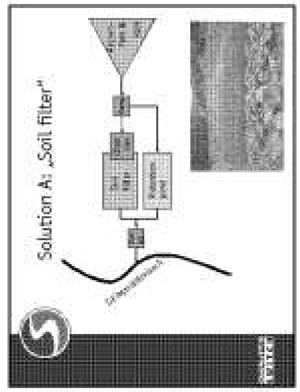


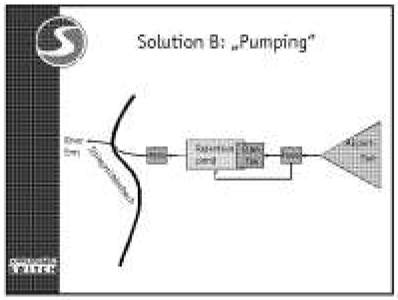


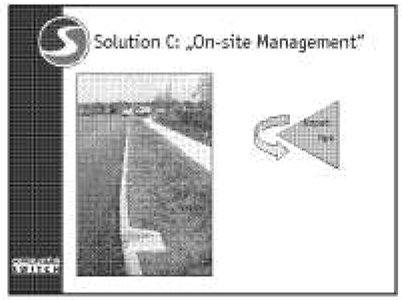
Appendix F: Life cycle cost assessment (LCCA) tool for stormwater BMPs (Heiko Sieker)

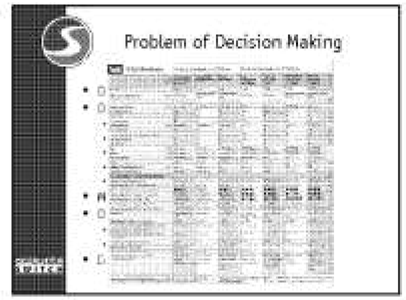


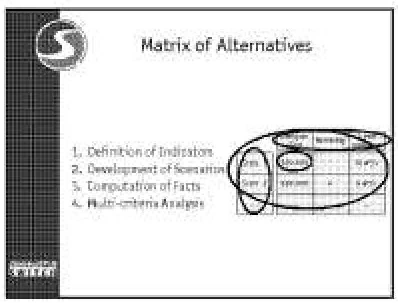


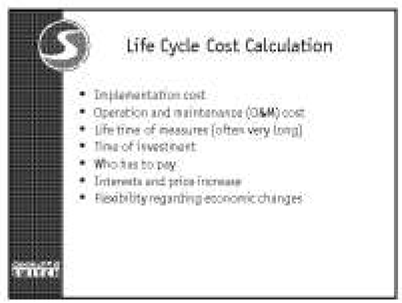


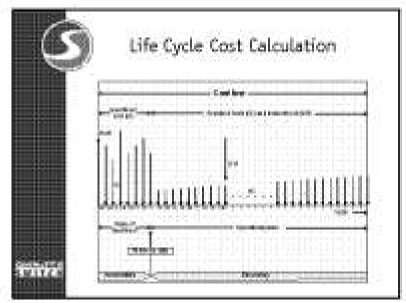

Solution B: „Pumping"

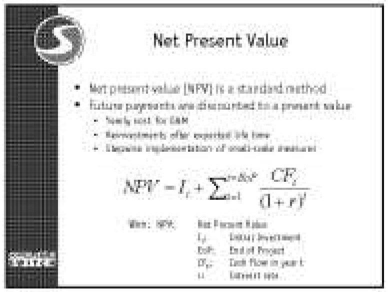

Solution C: „On-site Management"

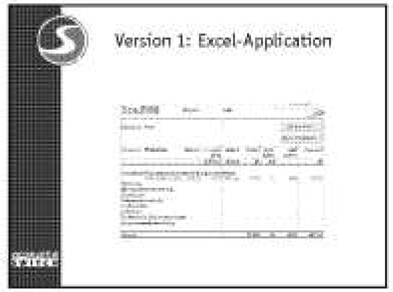

Problem of Decision Making

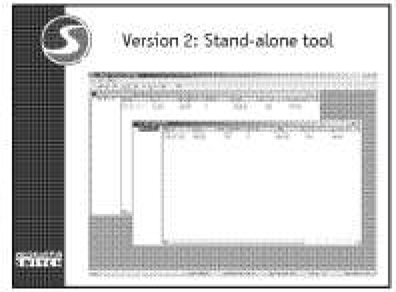

Matrix of Alternatives
1. Definition of Indicators
2. Development of Scenarios
3. Computation of Facts
4. Multi-criteria Analysis

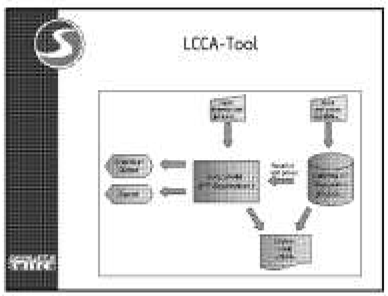

Life Cycle Cost Calculation
• Implementation cost
• Operation and maintenance (O&M) cost
• Life time of measures (often very long)
• Time of investment
• Who has to pay
• Interests and price increase
• Flexibility regarding economic changes

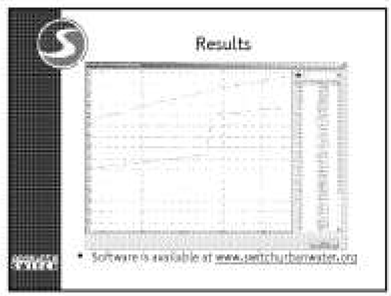

Life Cycle Cost Calculation


Net Present Value
Net present value (NPV) is a standard method


Version 1: Excel-Application


Version 2: Stand-alone tool


LCCA-Tool


Results


Thank you for your attention

Appendix G: A methodology for the analysis of risk (Lian Scholes)

PROJETO SWITCH: INOVAÇÕES NO MANEJO DE ÁGUAS PLUVIAIS URBANAS

Parte A: A metodologia de análise de risco

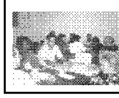
Dr Lian Scholes
Urban Pollution Research Centre,
Middlesex University, UK

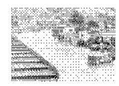
SWITCH

Middlesex University

Introduction

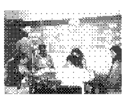
- Support Learning Alliances (LAs) in the development of integrated urban water management strategies
- Sustainable stormwater management
- Stormwater as a water resource rather than a wastewater
- Contribution to meeting the demands of other parts of the urban water cycle

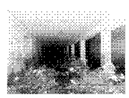




Working with LA representatives to:

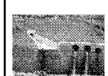
- Document current stormwater management strategies and opportunities
- Identify threats and uncertainties to stormwater control (short-term and long-term)
- Develop and implement a transparent risk assessment methodology
- Prioritise and manage risks
- Support stakeholders in developing risk management approaches

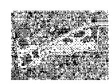




Working with LA representatives to:

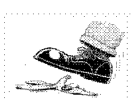
- Document current stormwater management strategies and opportunities: LA representatives and UFMG
- Identify threats and uncertainties to stormwater control in both the short-term and long-term: LA representatives and UFMG
- Develop and implement a transparent methodology to support the systematic assessment of risks: current stage
- Prioritise and manage risks within stormwater design or strategic policy approaches
- Support stakeholders in the development of risk management approaches

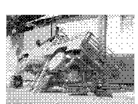




Overview of generic stages involved in the completion of a risk assessment approach

- Identify threats and uncertainties (system failure)
- Assess the consequences (severity) of such an event occurring
- Assess the likelihood (probability) of such an event occurring
- Compile above information to develop a 'risk score'
- Risk score can be used to prioritise or rank risks
- Provide framework to facilitate decision-making

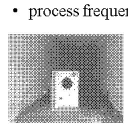




Guidelines to completing the SWITCH risk assessment

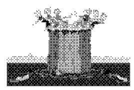
To ensure clarity:

- hazards must be unambiguously and precisely identified
- classifications of consequences and likelihood of occurrence briefly justified
- process frequently iterative



Assessing the consequences of an identified failure occurring

- What will happen if the system fails?
- Knowledge of the expected level of performance
  - Clear and unambiguous e.g. direct and indirect costs
  - Ambiguous e.g. provision of amenity
- Develop grading system based on either absolute or relative terms

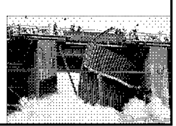


Guide to assessing the level of consequence of an identified threat occurring within the SWITCH stormwater matrix

Level of consequence (grading)	Example descriptors for relative grading	Numeric value associated with grading level
Very high consequences	Critical: complete system compromise; unacceptable under any circumstances; catastrophic; loss of life; extreme cost	5
High consequences	Damaging: Substantial failure to meet regulatory requirement; substantial impact such as flooding of properties; temporary loss; considerable cost	4
Medium consequences	Significant: moderate impact; potential to cause political, administrative and/or financial strain or pressure; tangible damage	3
Low consequences	Minor: minimum impact; some additional costs/efforts required	2
Very low consequences	Insignificant: negligible or no impact felt	1

Assessing the likelihood of an identified failure occurring

- How often is the system/component likely to fail?
- Knowledge of the expected level of performance
  - Published data, historic evidence, modelling or expert judgement etc
- Develop grading system based on either absolute or relative terms



Guide to identifying the likelihood of occurrence of an identified failure occurring in the SWITCH stormwater matrix

Level of consequence (grading)	Example descriptors for relative grading	Numeric value associated with grading level
Very high probability	Almost certain to fail to meet required criteria during anticipated design life; failure during every wet weather event	5
High probability	High likelihood to fail to meet required standards; frequently fails during storm events	4
Medium probability	May not meet required standards	3
Low probability	Normally meet required standards throughout design life	2
Very low probability	Unlikely to fail during lifespan	1

Development of risk scores

- Two sets of information in relation to an identified threat:
  - consequence of event occurring
  - likelihood of event occurring
- Multiple numeric values to develop a risk score
- Repeat process for each identified threat
- Ranking of risk scores in descending order supports prioritisation of risk failure

Interpretation of risk scores

Likelihood of occurrence	Severity of consequence				
	Insignificant (1)	Minor (2)	Significant (3)	Damaging (4)	Critical (5)
Very low (1)	1	2	3	4	5
Low (2)	2	4	6	8	10
Medium (3)	3	6	9	12	15
High (4)	4	8	12	16	20
Very high (5)	5	10	15	20	25

Interpretation of overall risk: High = 12-25 (red)
Medium = 6-11 (orange)
Low = 1-5 (green)

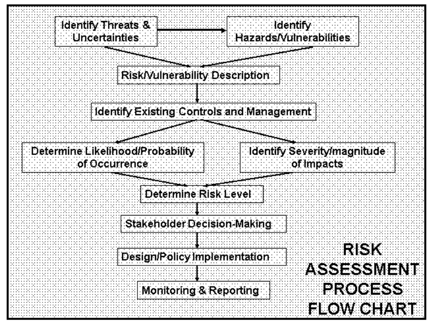
Note of caution!

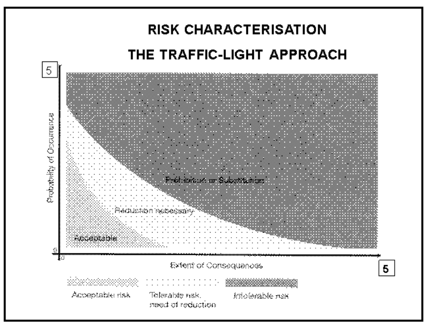
- Many criteria/component aspects not readily quantified in comparable or absolute terms
- Exercise in expert judgement
- Methodology susceptible to value judgements
- Use of numbers within a risk-rating matrix should not be given too much 'power'

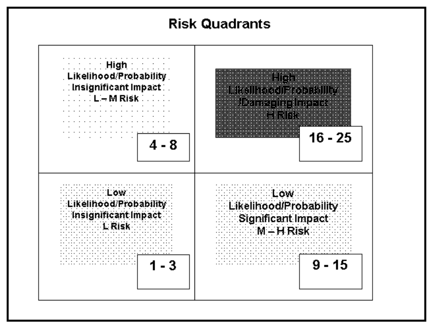
Completion of the SWITCH risk assessment process

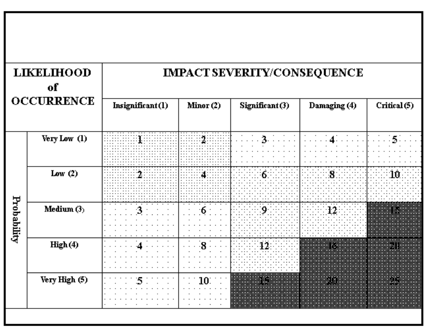
- Prioritisation of risks in an open and transparent manner
- Facilitates stakeholder engagement
- Contribute to the process of weighing policy alternatives
- Supports the identification of appropriate and acceptable prevention and control options

Appendix H: Stormwater risk assessment case study in Birmingham, UK (Bryan Ellis)

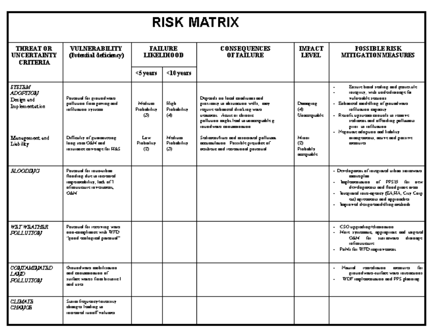








LIKELIHOOD of OCCURRENCE		IMPACT SEVERITY/CONSEQUENCE				
		Insignificant (1)	Minor (2)	Significant (3)	Damaging (4)	Critical (5)
Probability	Very Low (1)	1	2	3	4	5
	Low (2)	2	4	6	8	10
	Medium (3)	3	6	9	12	15
	High (4)	4	8	12	16	20
	Very High (5)	5	10	15	20	25



RISK MATRIX

THREAT OR UNCERTAINTY CRITERIA	VULNERABILITY (Potential deficiency)	FAILURE LIKELIHOOD		CONSEQUENCES OF FAILURE	IMPACT LEVEL	POSSIBLE RISK MITIGATION MEASURES
		<5 years	<10 years			
SYSTEM ADOPTION Design and Implementation	Potential for groundwater pollution from paving and infiltration systems	Medium Probability (3)	High Probability (4)	Depends on local conditions and proximity to abstraction wells; may require enhanced drinking water treatment. Acute or chronic pollution might lead to unacceptable groundwater contamination	Damaging (4) Unacceptable	- Ensure local sealing and geotextile integrity, with underdrainage for vulnerable aquifers - Enhanced modelling of groundwater infiltration capacity - Retrofit upstream controls to remove sediment and offending pollutants prior to infiltration - Negotiate adoption and liability arrangements, active and passive measures
Management and Liability	Difficulty of guaranteeing long term O&M and insurance coverage for H&S	Low Probability (2)	Medium Probability (3)	Sedimentation and associated pollutant accumulation. Possible prejudice of aesthetic and recreational potential	Minor (2) Probably acceptable	
FLOODING	Potential for intra-urban flooding due to increased impermeability, lack of infrastructure investment, O&M					- Development of integrated urban stormwater masterplan - Implementation of PPS25 for new development and flood plain areas - Integrated inter-agency (EA,HA, City Corp etc) agreements and approaches - Improved design/modelling methods
WET WEATHER POLLUTION	Potential for receiving water non-compliance with WFD "good ecological potential"					- CSO upgrading/diminution - More systematic, appropriate and targeted O&M for stormwater drainage infrastructure - PoMs for WFD improvement
CONTAMINATED LAND POLLUTION	Groundwater mobilisation and contamination of surface waters from historical land uses					- Natural remediation measures for groundwater-surface water interactions - WDF implementation and PPS planning
CLIMATE CHANGE	Storm frequency/intensity changes leading to increased runoff volumes					

INITIAL RISK ASSESSMENT

- hydraulic performance
- water quality performance

ALSO

- amenity and ecological potential
- cost (capital and O&M)
- litigation potential
- health and safety risks
- resource and energy use (sustainability)
- re-use/recycling potential

HYDRAULIC PERFORMANCE

CRITERIA	INDICATOR	DETAIL	MEASURE
Internal flooding @100 years	No. of properties affected	Flood depth range; depth and duration	?
External flooding@30 years	Volume of flooding (climate change??; allow 20%increase?	Flooding: range of volume at given node	?
Downstream flooding@100 years	Volume v greenfield volume	Design storms and time series rainfall	?
Downstream flooding; urban drainage	Change in flood volume in receiving drains	Design storms: change at any node	?
Flood routing @ 100 years	Flood routing	Performance under 15-60 minutes duration event; maximum flood depth	?
Risk of failure (robustness; adaptability)	Sensitivity to blockage/failure	Probability and consequences of blockage; uncertainty levels	?

WATER QUALITY PERFORMANCE

CRITERIA	INDICATOR	DETAIL	MEASURE
Impact on downstream morphology	Peak flow frequency compared with greenfield	Design storms and time series rainfall	?
Treatment train potential	Area land use/loss	Link to receiving water use e.g fish	?
Pollutant (TSS HCs HMs…..)	Annual average estimates (EMCs???)	Sediment management techniques; TMDLs (BUT what about performance variability??)	?

SOCIAL & COMMUNITY ACCEPTANCE

CRITERIA|	INDICATOR	DETAILS	MEASURE
Public Understanding	Adequacy/extent of campaigns Public education & awareness	Cost allowance at design stage Evaluation post-project	Fuzzy assessment and/ordescriptors e.g H/M/L
Community Participation	Community participation and care Condition of facilities	Post-project evaluation Post-project evaluation	Levels of local "buy-in" and usage Willingness to pay O&M costs
Litigation	Issues affecting claim	Mitigation requirements Insurance costs	Cost of claims

Appendix I: Analysis of stormwater risk management in Belo Horizonte (Nilo Nascimento).

Inovações no Manejo de Águas Pluviais Urbanas

SWITCH

Workshop

Análise de Risco e Manejo de Águas Pluvias em Belo Horizonte

Nilo de Oliveira Nascimento - Federal University of Minas Gerais
Belo Horizonte, Setembro de 2007

Inovações no Manejo de Águas Pluviais Urbanas

Plano da apresentação:

- Algumas questões do SWITCH em Belo Horizonte: águas pluviais
- Análise de risco: inundação
- Gestão do risco de inundação

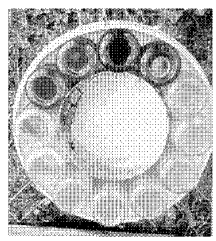
SWITCH

Inovações no Manejo de Águas Pluviais Urbanas

- O emprego de técnicas compenstórias em BH:
  - Infiltração, áreas úmidas artificiais
- Gestão do risco de inundação

SWITCH

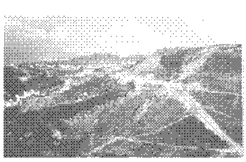
Algumas questões:



Quais são as características da poluição de origem pluvia em BH?

SWITCH

Algumas questões:



Quais as origens da poluição de origem pluvial em BH?

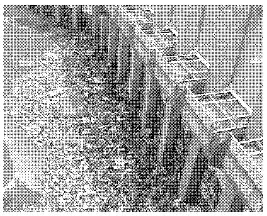
SWITCH

Algumas questões:

Quais seus impactos sobre meios receptores?

SWITCH

Algumas questões:

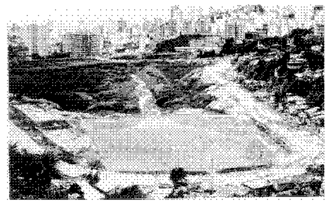


Quais seus impactos sobre soluções compensatórias?

SWITCH

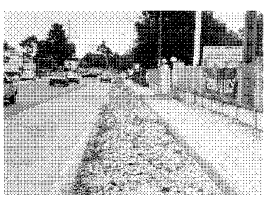
Algumas questões:

Quais seus impactos sobre soluções compensatórias?



SWITCH

Algumas questões:

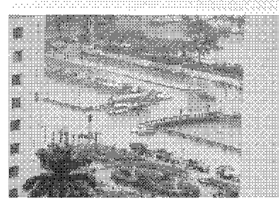


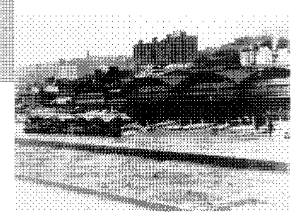
Outras questões sobre soluções compensatórias:

- Desempenho
- Critérios de projeto
- Custos
- Inserção em espaços construídos
- Aceitação
- Riscos:
  - Probabilidade de falha
  - Contaminação de solos e lençol
  - Saúde pública

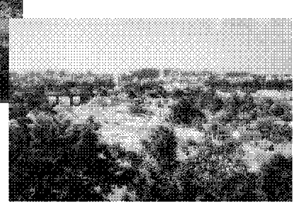
SWITCH

A questão das inundações





A questão das inundações



A questão das inundações

Gestão do Risco

- Gestão do Risco
  - Planejamento para Gerir o Risco
  - Operacionalização da Gestão de Risco

Gestão do Risco

- Gestão do Risco
  - Planejamento para a Gerir o Risco
  - Operacionalização da Gestão de Risco

Gestão do Risco

- Planejamento para Gerir o Risco
  - Conhecer o Fenômeno Diagnosticar os Problema Estimar o Risco
  - Medidas de Controle e de Redução do Risco
  - Desenvolver o Plano de Prevenção do Risco

Gestão do Risco

- Planejamento para Gerir o Risco
  - Conhecer o Fenômeno Diagnosticar os Problema Estimar o Risco
  - Medidas de Controle e de Redução do Risco
  - Desenvolver o Plano de Prevenção do Risco

Conhecer o Fenômeno: A Questão do Risco

$$R = 1 - \left(1 - \frac{1}{T}\right)^n$$

- T = 100 anos, então:
  - Se n = 1 ano, então R = 1%
  - Se n = 10 anos, então R = 10%
  - Se n = 50 anos, então R = 40%

Conhecer o Fenômeno: A Questão do Risco

Pergunta: o que ocorre quando ocorre uma cheia com $T > T_{referência}$?

- A resposta é: depende!
- Um conceito importante:

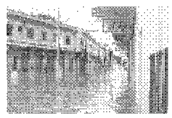
VULNERABILIDADE

Conhecer o Fenômeno: A Questão do Risco

Risco = probabilidade X conseqüências

Probabilidade ⟶ Risco Hidrológico

Conseqüências ⟶ Vulnerabilidade



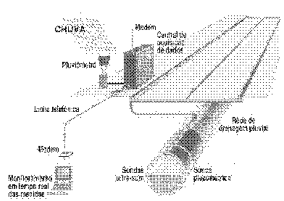
Conhecer o Fenômeno: A Questão do Risco

Três componentes fundamentais no enfoque:

- Monitoramento
- Modelagem
- Análise de vulnerabilidade

Monitoramento hidrológico

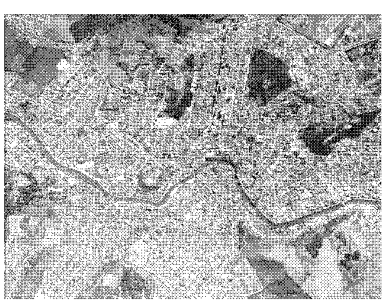
- Conhecer o fenômeno
- Requisito para modelagem
- Previsão e alerta
- Operação do sistema em tempo real
- Avaliação de ações e políticas



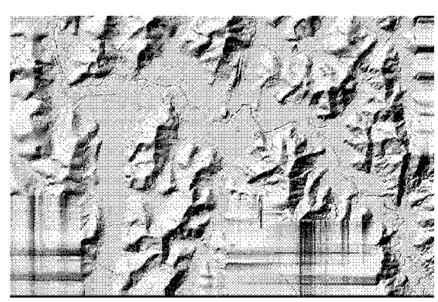
Modelagem

- Conhecer o fenômeno
- Planos de prevenção de risco
- Avaliação de ações e políticas
- Previsão e alerta
- Operação do sistema em tempo real

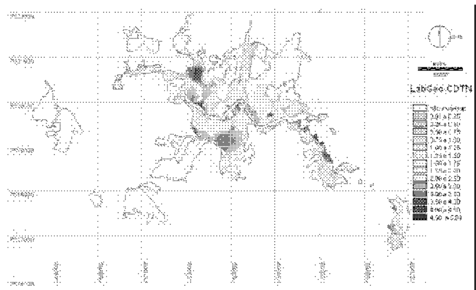
Modelagem: área urbana



Modelo digital de terreno



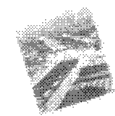
Mapa de profundidades de inundação para T = 100 anos



Source: Nascimento et al, 2007

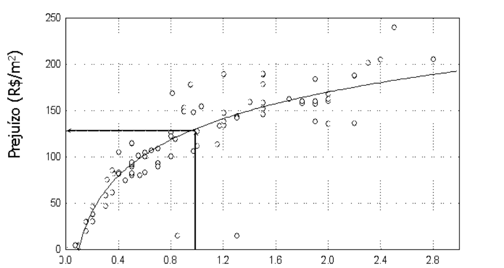
Análise de vulnerabilidade

Hipótese



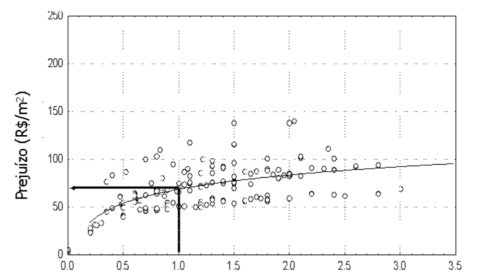
vulnerabilidade ⇢ danos, prejuízos

Curvas de Prejuízo por Profundidade



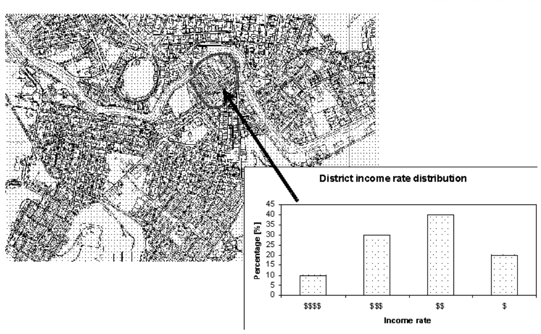
Source: Nascimento et al, 2007

Curvas de Prejuízo por Profundidade

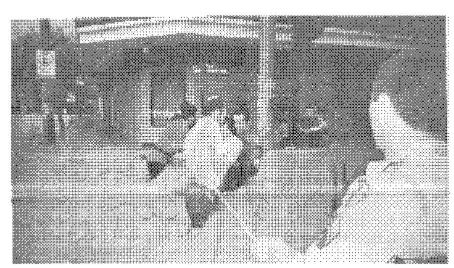


Source: Nascimento et al, 2007

IBGE: setores censitários

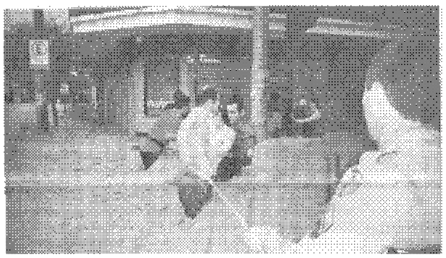


Mas, não só profundidade



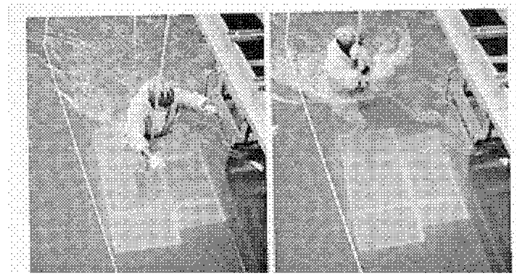
Source: Diário da Tarde, 13th January 2004

Mas, não só profundidade



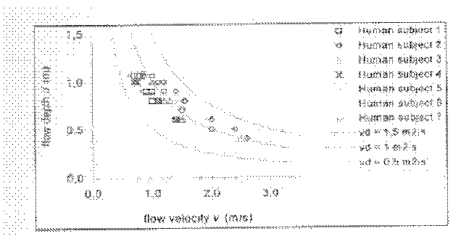
Source: Diário da Tarde, 13th January 2004

Mas, não só profundidade



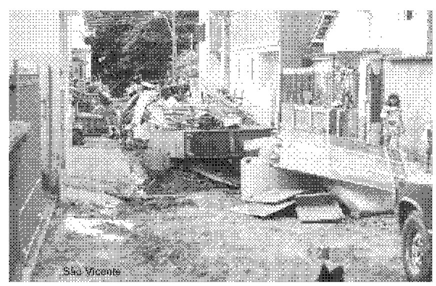
Source: RESCDAM, 2000

Mas, não só profundidade

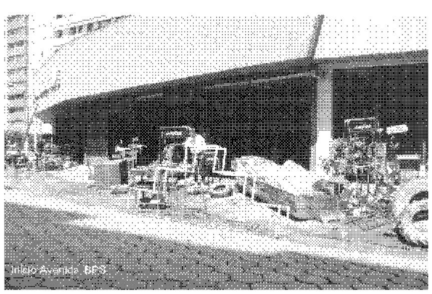


Source: RESCDAM, 2000

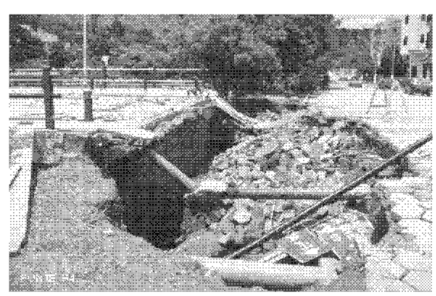
Vulnerabilidade a inundações

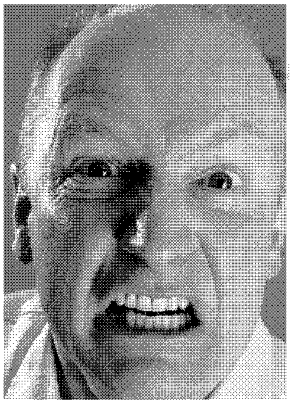


Vulnerabilidade a inundações



Vulnerabilidade a inundações



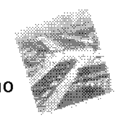


Vulnerabilidade

Análise de vulnerabilidade

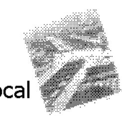
- Características físicas da inundação:
  - y, A, u
- Bens expostos:
  - Construções, conteúdos
  - Redes urbanas

Análise de vulnerabilidade

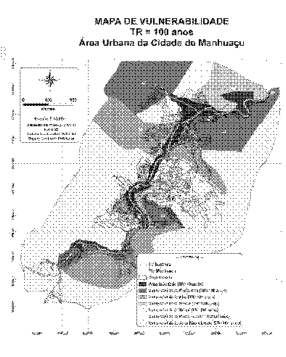


- Medidas preventivas:
  - Plano de desenvolvimento urbano
  - Plano de prevenção de riscos
  - Plano de ação emergencial
- Previsão e alerta
- Capacidade de ação de emergência

SWITCH e Inundações em BH



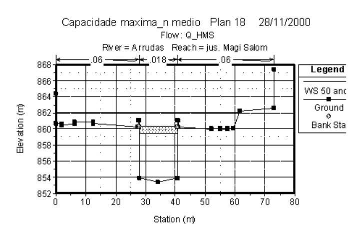
- Percepção de risco
- Capacidade de organização local
- Características demográficas:
  - Nível de renda
  - Faixas etárias expostas



Source: Cançado et al, 2007

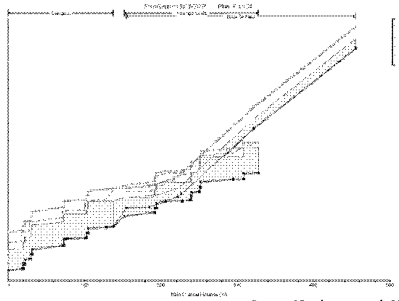
SWITCH e gestão de risco

Contribuir para aprimorar a modelagem



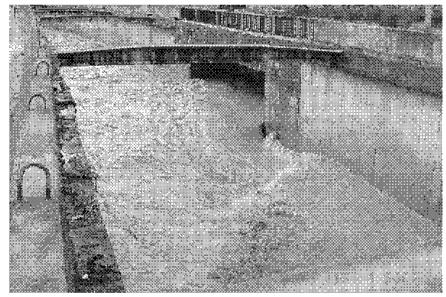
Source: Nascimento et al, 2000

SWITCH e gestão de risco



Source: Nascimento et al, 2007

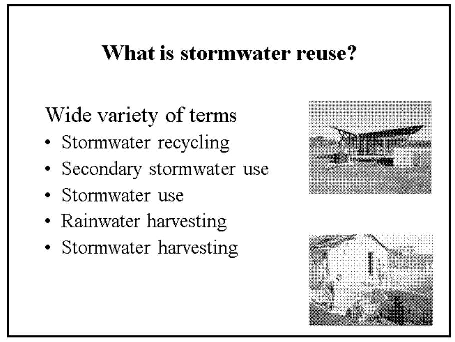
SWITCH e gestão de risco

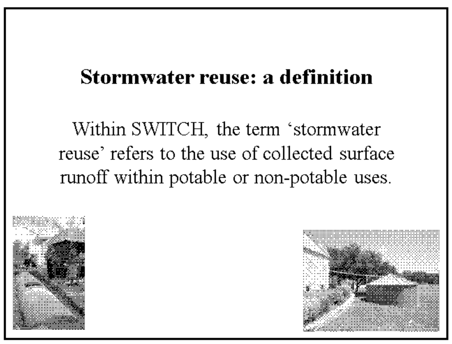


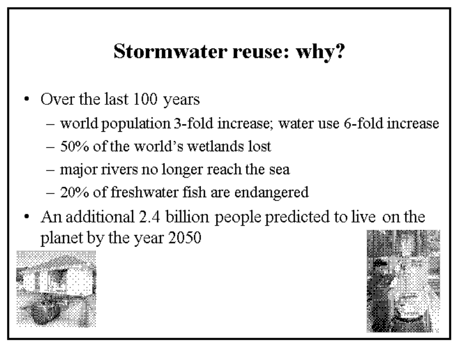
SWITCH e gestão de risco

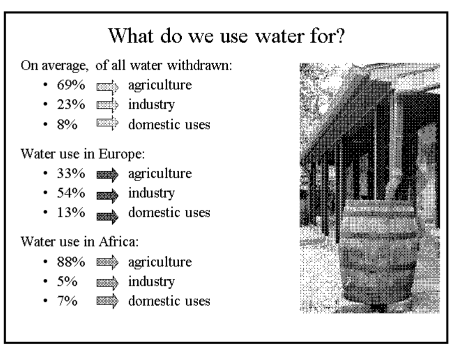
- Conceber e avaliar alternativas para previsão e alerta de inundações
- Planejamento e gestão do risco de inundação

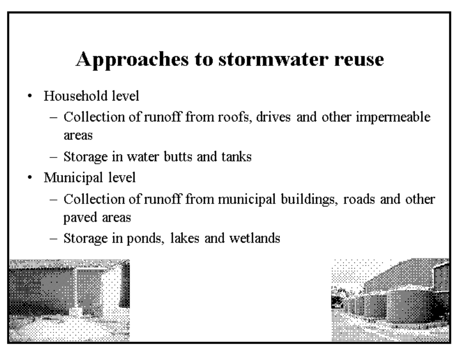
Appendix J: Introduction to stormwater harvesting (Lian Scholes)



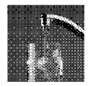




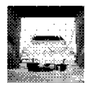


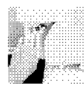


Stormwater reuse: where?

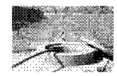


- Groundwater recharge
- Drinking water
- Non-potable use in homes e.g.
  - garden watering
  - toilet flushing
  - hot water
  - car washing
- Non-potable uses in industrial uses e.g.
  - cooling towers
  - cleaning processes
  - electricity generation
  - toilet flushing

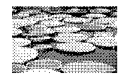


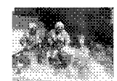


Stormwater reuse: where?



- Irrigation e.g.
  - grazing lands
  - crops
  - golf course
  - parks
- Creation of artificial water bodies e.g.
  - lakes
  - wetlands
  - ponds
- Recharge of natural wetlands
- Commercial vehicle washing
- Fire fighting



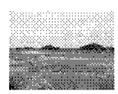


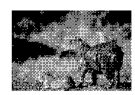
Examples of stormwater reuse in different countries and continents

	Australia	Brazil	China	Germany	Ghana	USA
Aquifer recharge and reuse (artificial process)	X					
Groundwater recharge (natural process)			X		X	
Drinking water	X	X			X	
Non-potable use in homes e.g.						
– garden watering	X	X	X	X	X	X
– toilet flushing	X	X	X	X	X	X
– hot water	X	X		X	X	
– car washing				X	X	
Industrial uses e.g.						
– cooling towers	X		X	X		
– cleaning processes				X		
– electricity generation	X		X	X		
Irrigation e.g.			X			
– grazing lands	X				X	
– crops	X					
– parks and golf courses	X		X			X
Creation of artificial water bodies e.g.						
– lakes, ponds and wetlands	X		X			X
Commercial vehicle washing			X	X		

Stormwater reuse benefits in more economically developed countries

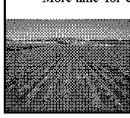
- Local municipalities, developers and planners
- Water companies
- Environmental regulators
- Community benefits

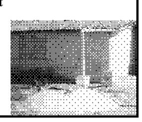




Stormwater reuse benefits in less economically developed countries

- Reduction of burdens of the poor
- Reduction in water-related diseases as quality is usually better than water from traditional sources
- Improved health status as excess stormwater used for vegetable and crop growing
- Less back problems and growth reduction particularly among children and women
- More time for education and personal development





Stormwater reuse: concerns

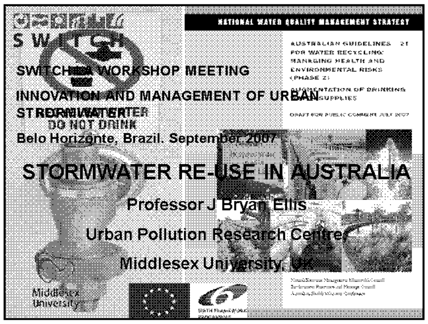
- Water quality
  - Microbiological quality
  - Metals
- Mosquitoes
- Lack of regulations/guidelines

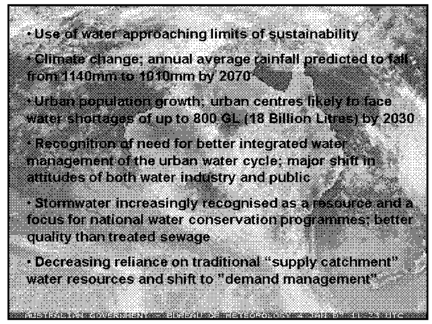
Stormwater reuse and SWITCH

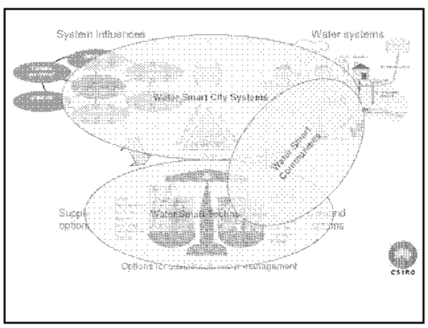
- Can operate on a variety of scales
  - individual plot to catchment
  - household to industrial to agricultural
- Contribute to the integrated management of urban water cycle:
  - Direct impact on volume and quality of stormwater runoff generated
  - Indirect impact on sanitation
  - Conserves drinking quality water supplies
  - Generates water supply for urban agriculture/other uses
- Existing technology
- Compatible with traditional water supply and drainage technologies
- Local supply for local needs

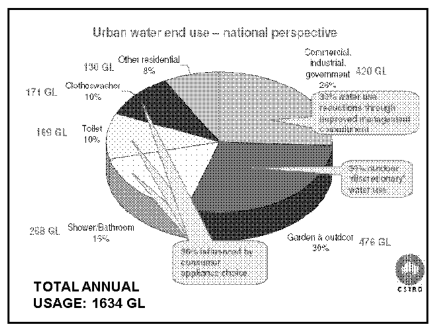
SWITCH

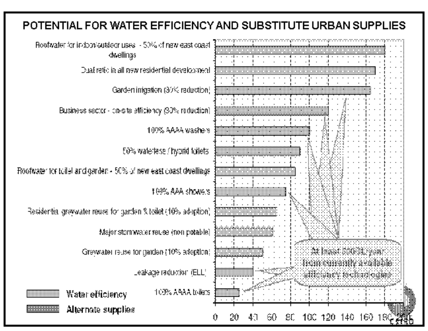
Appendix K: Stormwater re-use practices in Australia (Bryan Ellis)

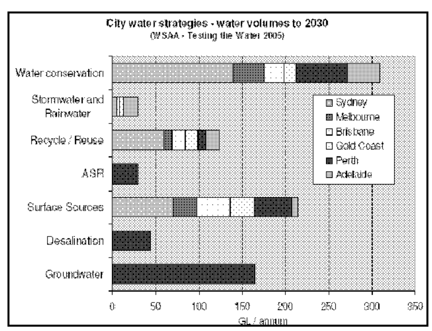












HOUSEHOLD WATER USE IN SYDNEY REGION, 2004

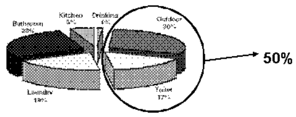


Fig 1: Single household water use categories

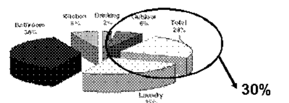
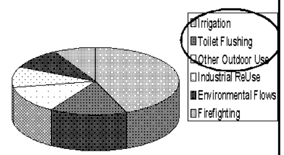


Fig 2: Multi-unit water use categories

STORMWATER RE-USE TECHNIQUES

Aquifer Storage & Recovery (ASR)
Rainwater Tanks (Stormwater)
Water Harvesting (Off-line river water)
Industrial Re-Use
Unplanned Re-Use
Water Sensitive Urban Design
Urban Wetlands & Lakes

Frequency of End Use Types (%)



2% - 3% stormwater recycling in major cities; Adelaide 10%

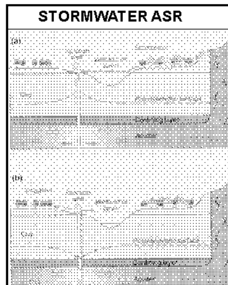
9% sewage wastewater recycling

TARGET: 20% - 30% recycling by 2010

STORMWATER RE-USE: BENEFITS AND LIMITATIONS

BENEFITS	LIMITATIONS
• Reduction in potable water use • "Regulation" of potable water usage • Protection of receiving water regime, ecology and environment • Public/community awareness of stormwater multiple uses • Public participation in water supply systems	• Public health risks • Cost • Extra O&M requirements • Reliability of supply; not there when needed • New operational standards and practice • User education and awareness • Developer and buyer resistance; new unproven approach • Issues of environmental flows and wastewater efficiency

STORMWATER ASR



• Clogging of infiltration interfaces

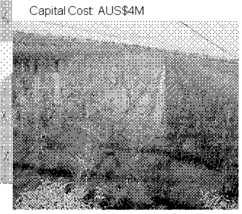
• Loss of impermeability due to cation exchange

Salisbury, Adelaide, S Australia

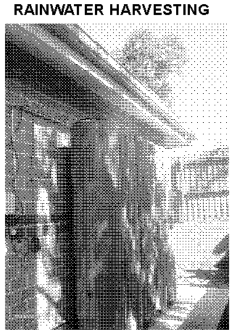
Stormwater Wetland Harvesting and ASR; 70% of runoff captured;

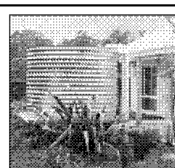
3000 Ml/year or 2% of demand; 40% to water supply and 60% injected to ARS

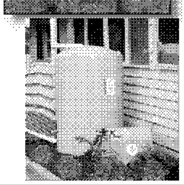
Capital Cost AUS$4M

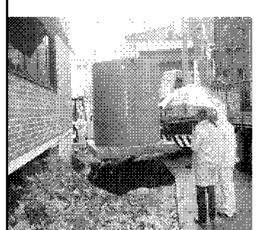


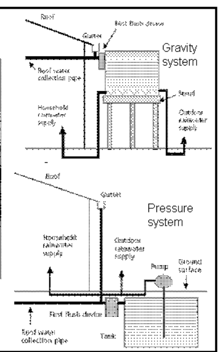
RAINWATER HARVESTING

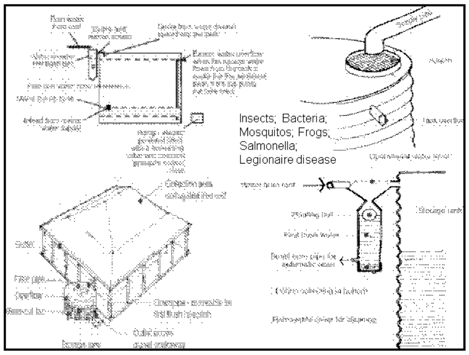


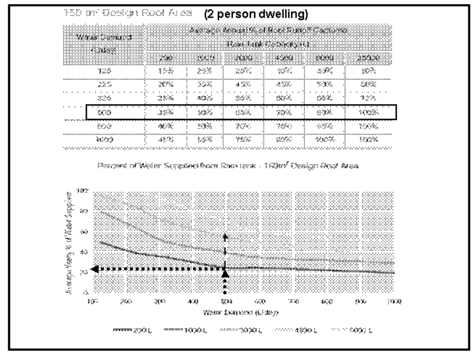


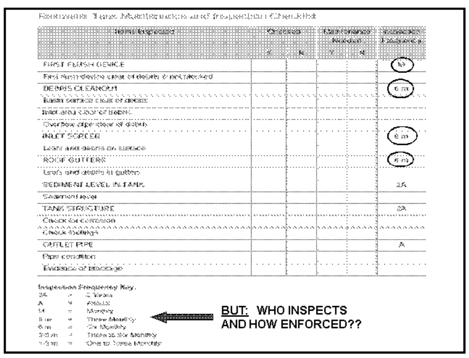


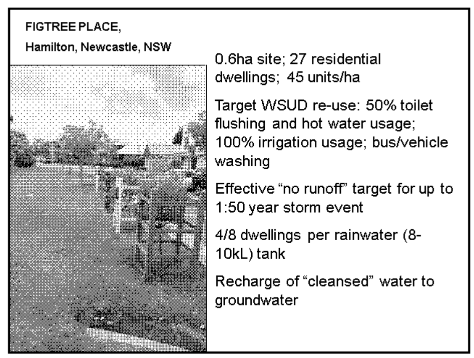


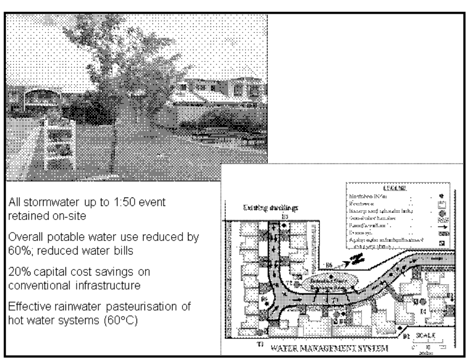


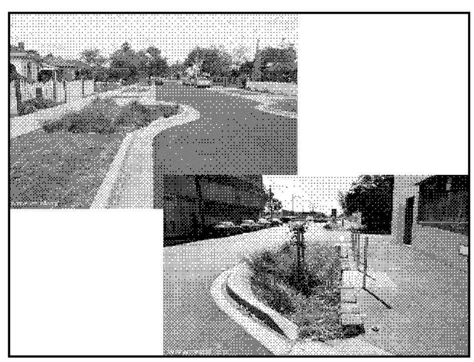

Insects; Bacteria;
Mosquitos; Frogs;
Salmonella;
Legionaire disease

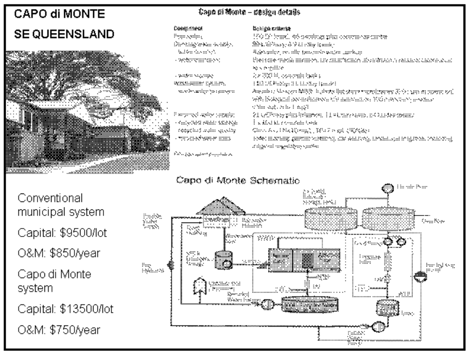

(2 person dwelling)

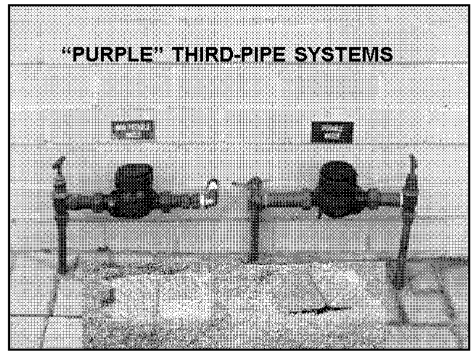

BUT: WHO INSPECTS
AND HOW ENFORCED??

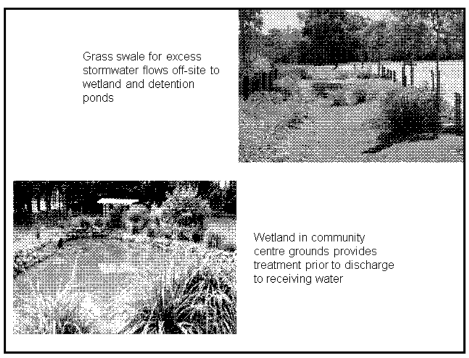

FIGTREE PLACE,
Hamilton, Newcastle, NSW
0.6ha site; 27 residential dwellings; 45 units/ha
Target WSUD re-use: 50% toilet flushing and hot water usage; 100% irrigation usage; bus/vehicle washing
Effective "no runoff" target for up to 1:50 year storm event
4/8 dwellings per rainwater (8-10kL) tank
Recharge of "cleansed" water to groundwater

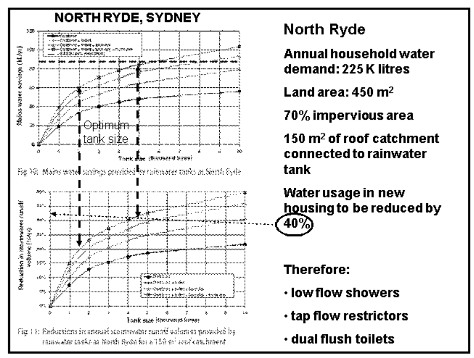

All stormwater up to 1:50 event retained on-site
Overall potable water use reduced by 60%; reduced water bills
20% capital cost savings on conventional infrastructure
Effective rainwater pasteurisation of hot water systems (60°C)
WATER MANAGEMENT SYSTEM

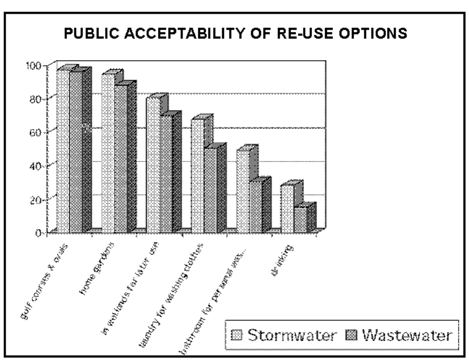












PERCENTAGE RESPONDENTS OPPOSED TO RECYCLED WATER

	ARCWIS (2002) N=665 %	Sydney Water (1999) N=? %	Lohman, Milliken (1995)* N=403 %	Milliken, Lohman (1983)* N=399 %	Bruvold (1981)* N=140 %	Olson et al. (1979)* N=244 %	Kasperson et al. (1974)* N=486 %	Stone & Kahle (1974)* N=1000 %	Bruvold (1972)* N=972 %
Drinking	74	69	67	63	58	54	44	46	56
Cooking at Home	-	62	55	55	-	52	42	38	55
Bathing at Home	52	43	38	40	-	37	-	22	37
Washing clothes	30	22	30	24	-	19	15	-	23
Toilet flushing	4	4	4	3	-	7	-	5	23
Swimming	-	-	-	-	-	25	15	20	24
Irrigated dairy pastures	-	-	-	-	-	15	-	-	14
Irrigated vegetable crops	-	-	9	7	21	15	16	-	14
Irrigated vines	-	-	-	-	-	15	-	-	13
Orchard irrigation	-	-	-	-	-	10	-	-	10
Irrigated alfalfa hay	-	-	-	-	-	8	-	9	8
Home garden irrigation	4	3	3	1	5	6	-	6	3
Irrigated parks	-	3	-	-	4	5	-	-	3
Golf course irrigation	2	-	-	-	4	3	2	5	2

*cited in Bruvold (1988) - these studies were conducted in the US

COSTS FOR SELECTED AUSTRALIAN STORMWATER RECYCLING SCHEMES

	capital cost ($)[1]	mean annual runoff (ML)	percent collected	volume runoff collected (ML)	potable water savings ($/yr)	pollution control	
						quantity TN removed (kg)[3]	cost range ($/ha catchment)
Oaklands Park	73,000	75	100[2]	75	22,500	53 - 450	237 – 2,036
Inkerman Oasis	434,000	7.6	20[1]	1.52	456	1.1 - 9.1	884 – 5,887
Parafield	4,500,000	2,210	100[1]	2,210	663,120	1,547 - 13,262	761 – 6,523
Homebush Bay	15,800,000	1,179	100[2]	1,179	353,700	825 - 7,074	855 – 7,325
Hawkesbury	3,900,000	600[1]	50[1]	400	120,000	280 - 2,400	2,204 – 18,889
Figtree Place	109,900	6.3	63[1]	5.2	1,569[1]	3.7 - 31	2,636 – 22,454
Kogarah	629,000	9.4	85[1]	8.0	2,387	5.6 - 48	4,400 – 37,700

[1]As reported

[2]Conservative estimates based on qualitative data

[3]Quantity removed = concentration x volume collected

DESIGN AND OPERATION ISSUES

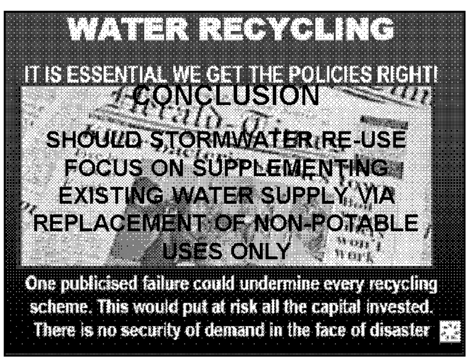
- stormwater recycling restricted to smaller sites
- end-usage mainly for schemes having low potential for human contact (H&S concerns)
- recycling utilises conventional WSUD (pollution control) techniques; WSUD control systems not designed to deliver consistent high quality water and reliability remains an issue
- limited awareness of full range of available recycling techniques; especially for "advanced" treatment
- lack of adequate monitoring, O&M, inspection; particularly a problem on small sites having limited experience, finance and awareness
- variability in costing and performance data approaches; no transparency in pricing mechanisms
- rising water tables and salinity levels

IMPLEMENTATION ISSUES

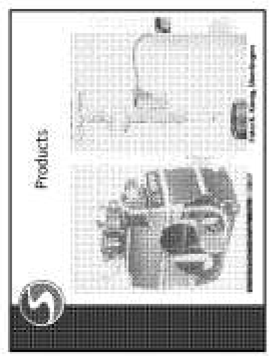
- no national/state regulations specific to stormwater recycling; guidelines expected in 2008 but will not constitute enforceable standards
- approval certificates by local health authorities/councils on case-by-case basis (??); who can collect and sell water??
- absence of definite design and operational criteria; deterrent given cost, health and legal implications
- little consideration given to how stormwater recycling can be integrated into overall urban water cycle (probably due to over-riding concern with flood mitigation)
- H&S major public and water industry concern; bacterial/viral infection from cross-connections or inadequate treatment; mosquito and vermin infestation of rainwater systems
- space and landscaping requirements and interaction with public infrastructure

MAJOR OBSTACLES TO STORMWATER RECYCLING

- lack of clear regulation and operational/performance criteria
- lack of enforceable design criteria and guidelines
- lack of method(s) to adequately assess costs and benefits
- institutional issues; integration of stakeholders; water "rights"



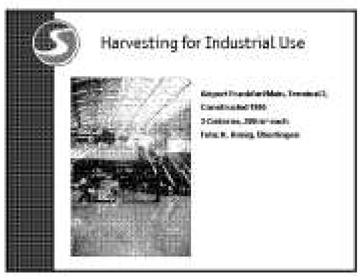
Appendix L: Stormwater re-use in Germany (Heiko Sieker).

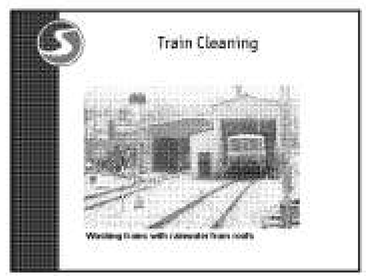


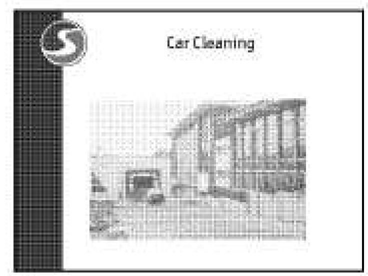

Harvesting in Public Buildings


Harvesting in Public Buildings


Harvesting for Industrial Use
Stormwater harvesting for industrial uses e.g.
cooling towers
cleaning processes
electricity generation
toilet flushing


Harvesting for Industrial Use


Train Cleaning
Washing trains with rainwater from roofs


Car Cleaning

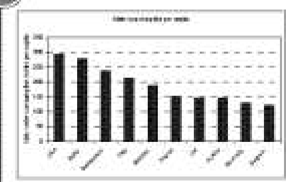
Harvesting for Municipal Level

- Demo-Project in Berlin: Ufa-Fabrik
- Stormwater runoff from roofs and roads is collected
- Treatment by sedimentation, filtration and UV
- Conclusion
  - Processing of polluted stormwater runoff is possible
  - Efficiency under Berlin conditions??
  - But in (semi-)arid areas maybe suitable (in comparison with de-salting)

Standards

- Drinking water ordinance
  - Explicitly allows stormwater harvesting for
  - Garden watering
  - Toilet flushing
  - Washing (with exceptions e.g. for hospitals)
- DIN 1989 (DIN: German Institute for Standardization)
  - Defines technical standards e.g. for
  - Refilling of cisterns with drinking water
  - Labeling of pipes
  - Notification of drinking water supply company

Driving forces



Statistics

Number of cisterns in Germany	1,5 Mill.
New systems per year	80.000
Annual turnover	340 Mill.
Number of jobs	~ 4.000 - 5.000
Drinking water saved	15 Mill. m³

Rainwater Harvesting is well established in Germany

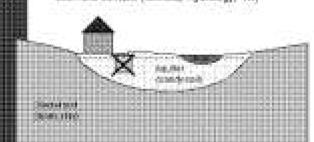
urce Wall, 2005

Problems

- Although, standards are available: on-going discussion about hygienic standards
- Water supply companies are working against stormwater harvesting
- German Water Association neglects stormwater harvesting: special association for stormwater reuse has been founded in 1990 (FBR: www.fbr.de)

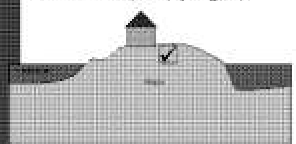
Is Rainwater Harvesting sustainable?

- It depends...
- ...on the context (climate, hydrology, ...)



Is Rainwater Harvesting sustainable?

- It depends…
- …on the context (climate, hydrology, …)



Aquifer and Groundwater Recharge

- Stormwater infiltration is obligatory for new developments by law in most of the Federal states
- 69% of the drinking water in Germany is taken from groundwater; in Berlin 100%
- Aquifers are a cheap cistern: it is more efficient to renew groundwater resources than to collect rainwater in man-made tanks
- Property owner can save stormwater fee by infiltrating rainwater (disconnection)

Stormwater Infiltration

Technology vs. Objectives

- Discussion about the best technology is of less importance…
- …more important is the discussion about the right objectives
- The goal is not to harvest rainwater or to infiltrate stormwater…

The objective is to keep up the water balance!

Conclusion

- Stormwater reuse is common practice in Germany: many examples are available
- Harvesting and infiltration have a positive image
- From economical point of view stormwater infiltration is sometimes more efficient than harvesting (under German conditions)
- Nevertheless: operators of conventional systems are sometimes opposing stormwater reuse