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Sustainable Water Management in the City of the Future

Integrated Project

Global Change and Ecosystems

Deliverable 1.3.1

Preliminary Report On Integration With Existing Infrastructure

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PRELIMINARY REPORT ON INTEGRATION WITH EXISTING INFRASTRUCTURE

SWITCH Deliverable 1.3.1

Contents of Report

PRELIMINARY REPORT ON INTEGRATION WITH EXISTING INFRASTRUCTURE

1. Background

Key outputs and deliverables of SWITCH are newly developed equipment, methods and techniques (*technologies and methods*) which will have a positive impact on the performance and operation of the water systems of cities around the world. The maximum impact of the novel SWITCH outputs will only be delivered if they can be incorporated into the existing water system of an existing city. This system will include both the physical network of pipes or sewers, the organization and management which installs, improves and operates the system and even the cultural context of the people requiring the water service. SWITCH must also produce a method which shows how each new technology can best be used to the advantage of the existing infrastructure of cities and thus deliver the paradigm shift which is SWITCH's overriding goal.

The purpose of work package 1.3 is to extract the best out of the wide ranging research being undertaken, and produce a tool which will enable the *technologies and methods* to be applied and used most effectively. Although the headline indicators (for example DEFRA 2003) make no reference to infrastructure, it plays an essential subservient role in developing more sustainable cities. The tool to be delivered in WP 1.3 will show how the best outputs from other research programmes can be integrated into existing water system of a city.

A non-trivial and very challenging part of this project is facilitating the implementation of the techniques into the cities. Furthermore, prior to that there is the dissemination of ideas and persuasion of stakeholders of the value of the implementation of the techniques and methods. Implementation must be seen as not only 'a good idea' but 'essential' and most importantly 'achievable', with significant cost and efficiency savings and other benefits to the city. The process of implementation must also be compatible with existing *socio-economic factors*, and should be developed through the Learning Alliances.

Although a broad ranging approach is to be taken in developing Work Package 1.3, it is probable that particular aspects of the water system will form a different focus in the individual cities. What is required is a form of master plan with stages that could be seen as a series of steps towards an ideal water system end-point. In this way, each city could tackle the most urgent issues first with a planned roll-out of measures and technologies. Integration means that each step might be quite different from the next from city to city. All the time, integration would be within a city-wide-water-framework or master plan.

This report provides an overview of the approach to be used in making the best out of the SWITCH technologies and methods. The final product will be a *SWITCH Integration Manual*.

2. Work Package Details

2.1. Objectives

The objectives of WP1.3 are as follows

- To provide a framework by which research and other developments in urban water systems can best be integrated into existing infrastructure and management systems.
- To develop this framework by building on the research undertaken in all work packages by the SWITCH partners and in the study cities.
- To draw in state-of-the-art innovative concepts, schemes and technologies relating to urban water infrastructure not specifically being examined by the SWITCH partners or in the study cities.
- To take advantage of the techniques and methods developed in other work packages and in the study cities to show how new technologies impact on existing infrastructure and operations.

These objectives will be achieved by separately investigating the *technologies and methods* and the *socio-economic factors* in the different cities. The former will be investigated through the research organizations in SWITCH while the latter will be primarily determined through the Learning Alliances in the cities.

Many good and appropriate technologies already exist that could and would be suitable for implementation in these cities. This means that there is a huge task in terms of review, collation and assessment of these techniques.

The approach proposed will have two parallel linked investigations outlined in section 4.

2.2. Planned Outputs

The outputs planned for WP 1.3 are outlined in Table 1.

Table 1 WP 1.3 Summary of Planned Outputs

Number	Month	Output
1.3.1	12	Preliminary report on integration with existing infrastructure
1.3.2	45	Review of outputs from all work packages in the context of integration into existing infrastructure
1.3.3	48	Database of integration information
1.3.4	57	SWITCH Integration Manual
1.3.5	20	Report on specifications for WP 1.2 and 1.4 products, to allow for ‘planning for transition’ and ‘integration’.

It should be noted that an additional deliverable (1.3.1(a)) is considered necessary to ensure that the needs of integration are delivered by SWITCH theme 1.

3. Drivers and Barriers

SWITCH envisages a range of possible cities, or parts of cities, which will have real options for sustainable water management. However, except in a very small number of locations, any new vision for the water system is constrained by the limitations of the existing supporting infrastructure whether it be water supply, potable water treatment, distribution, sewerage, sewage treatment, stormwater, river lake, sea or other water systems. There are clear drivers for improvement which are imposed by water scarcity in some cities and water surplus in others and the infrastructure and geography of each city dictates that they are all different. Some examples of how the drivers could be put into practice in existing infrastructure are;

- Decentralising treatment of foul sewage and stormwater management would greatly reduce the number of large sewer pipes and pumping stations required with reduced costs of disruption, construction and maintenance.
- Using local groundwater or rainwater resources would reduce the length of expensive trunk & distribution mains and storage tanks. Since the quantity of treated water required would reduce, the amount of chemicals used would also decline.
- Making use of landscaping to store rainwater in multifunctional open space which might have multiple biodiversity, recreational and flood prevention benefits. This requires infrastructure change on a grand scale.
- Applying increasingly strict effluent standards, particularly for pharmaceuticals, might reduce inputs by consumers or be a driver for implementing urine- separation systems at a domestic scale. Both of these drivers might significantly reduce the need to install expensive specialist processes at existing treatment works.

Unfortunately there are many barriers to integrating these new visions of the urban water world into the existing infrastructure. The list of barriers in Table 2 is adapted from an excellent summary (by Hunt & Rogers 2005) of the barriers which require to be addressed by SWITCH. The issues raised in this paper will be one of the starting points for the development of the integration manual.

Table 2 Barriers to the Implementation of Sustainable Water Options

Lack of knowledge or awareness	Public perception
High initial costs	Public behaviour
Running costs	Social acceptability
Long payback periods	Lack of legislation
Cheap mains water	Lack of information
Risk aversion	Politics
Lack of visible targets	Water companies need to make money
Complex systems	Water quality
Lack of communication	More pressing issues
Lack of experience	Lack of visible monitoring

Adapted from Hunt & Roger (2005)

Clearly the cost of making the changes to the infrastructure required is the most significant hurdle, but, just as important, are the societal changes which would also be required. For

example, most cities have a water utility which is responsible for delivering many aspects of the water system in a way that each individual, household or organisation needs only to pay the charge for the service and is not concerned with any specific actions to maintain the water system. Should any of these functions be decentralised, for example through rainwater harvesting, centralised organisation becomes more difficult and the individual becomes much more responsible for operation and maintenance of component parts. It is not clear that society will accept such an increased role, and possibly the greater health risks of distributed water sources since these were overcome in the 19th century in European cities by the construction of large scale water and drainage infrastructure works.

4. Proposed Methods of Assessing Integration

4.1. Existing tools and approaches

The planned SWITCH Integration Manual will build on other infrastructure rehabilitation and integration projects, in addition to the outputs from SWITCH itself. Because of the importance of water infrastructure to modern urban society, a great deal of work is always ongoing, and in particular, rehabilitation of systems is an ongoing subject for research and innovation. In the UK for example, the concept of retrofit sustainable urban drainage systems (SUDS) embodies the key technical elements of attempting to install improved systems into existing cities with the desire for better quality urban environments. A range of SUDS retrofit solutions have been identified by Stovin at Sheffield University in the UK in a report to SNIFFER (SNIFFER 2005). This report includes a generic decision making methodology for retrofitting SUDS and is applicable at locations where diffuse pollution is a major driver. An alternative adaptive decision support system for stormwater was also developed in the EU funded DAYWATER programme (Thevenot & Forster 2005). Although not of critical importance to SWITCH, the WAND project in the UK (Water and New Developments) is providing new strategies for the provision of water services for large communities under development on the periphery of long established cities (Butler et. al. 2006).

Drainage and sewer systems constitute very significant parts of the urban water infrastructure and methods for their assessment have developed because of the need for urban expansion and the avoidance of overburdening the existing infrastructure. The UK Water Research Centre produced the Sewerage Rehabilitation Manual (WRC 1983) which included a risk assessment method for identifying critical sections of infrastructure, and more recently the European Interreg project (APUSS) has developed rules for assessing the performance of sewers using performance indicators (Cardoso et. al. (2005). Directly addressing environmental issues, methods for improving and rehabilitating the river environment have been developed by organisations such as the River Restoration Centre (RRC 1999).

To address these issues of integration successfully requires consideration not only of technical issues, but also of the management systems within which the *technologies and methods* will work. Thus, there will be three stages to the assessment process;

1. Reviewing and assessing the *technologies and methods*
2. Assessing the physical infrastructure within which the *technologies and methods* will be expected to work.
3. Assessing the organizational and *socio-economic* structure of the city.

This purpose of deliverable 1.3.2 is to produce a coordinated set of information on the existing infrastructure of each city in the light of the issues discussed above. However, in order to

harmonise approaches in reaching that information, an interim stage of agreeing specifications for the modeling and the interpretation packages is required. This will form deliverable 1.3.5 which is required by months 20 of SWITCH.

4.2. Proposed Methodology for Reviewing and Assessing the *technologies and methods*

- A common methodology for assessing the relative merits of the different *technologies and methods* will be developed. Part of this process will be to adopt the best way of defining the merit or value (technical, economic, social, environmental) in this context.
- The *technologies and methods* used in SWITCH will be reviewed and collated in the common methodology to enable consistent comparisons. The different innovative equipment and techniques will be listed after detailed discussions with the developers of these techniques.
- A comparison approach will be used to rank the *technologies and methods* to evaluate the most suitable for a range of technical applications. Effectively this will result in a matrix of sustainability dependent on application, location and other relevant factors.
- Appropriate modeling will be carried out to assess the effect of the *technologies and methods*. The actual modelling will be undertaken in SWITCH Work Packages 1.2 (Modelling for management & decision making) and 1.4 (Strategic approaches in planning, implementation and performance assessment). The role of WP 1.3 is to ensure that the modelling is specified correctly and delivers outputs which can be used in planning the transition from current systems and methods to the new water management paradigm.
- The effect of each on the indicators will be evaluated to refine the comparisons.
- *Technologies and methods* from other research work will be incorporated into the methodology. This will assure that SWITCH integrates outputs from other projects such as Daywater, Harmoni and OpenMI.
- The product of this stage will be a matrix of information relevant to infrastructure integration.

4.3. Approach to *Integrating into the Existing Infrastructure*

It is a key aspect of SWITCH that a range of methodologies should be developed which have a very wide range of applications. The infrastructure of every city is different and it is anticipated that general rules will be developed from a common assessment of each city's infrastructure. This means that there will be a very wide number of variables to be accounted for.

- The cities will be approached to assess their water infrastructure.
- The learning alliances will assist the assessment process by hosting an integration workshop in each city.
- The comparison of infrastructure will be robust and technically sound. It will be based on the best available information/ data/ intelligence relating to the *technologies and methods*

- The comparison of infrastructure will also be flexible and result in a suite of options of methods to allow effective integration of the approaches. In addition, new/novel ideas or alternative technologies and methods may have to be accommodated as implementation occurs, as it may only become apparent what these are once the process is underway.
- Consultation with the Learning Alliances on principles and lessons will be of paramount importance.

4.4. Integrating – allowing for *socio-economic factors*

A separate assessment of the methods by which integration of new technologies will be evaluated in the social, economic and cultural background will be undertaken. It is a central assumption that, within cities, the policy-makers and the communities have the desire or need to improve the water system in their city and each Learning Alliance will identify these desires and needs as a starting point. However, different cities have different systems working to different standards and each has different aspirations for the future of these systems. These aspirations are inherently place-specific and closely linked to economic and cultural realities and expectations at each location.

Examination of the condition and efficiency of the existing water system of a city will give initial insight into the history of investment in time, money, scientific advancement and public initiative that has already occurred and thus will indicate to some degree the willingness or ease of adopting new technologies and methods. At a practical and technical scale, the best option for improvement may be adoption of new methods, even new equipment and infrastructure, thus requiring capital investment to improve the system. In addition (or alternatively) at a citywide or catchment scale it may be possible to engender a public sense of responsibility and ownership of the water system to encourage non-technical improvement in the system through prevention of pollution. This would have to be supported and encouraged through innovative research, such as that delivered through SWITCH initiatives, but also supported by public policy and dissemination/education drives as appropriate to the location.

The different approaches exemplify the ideals of SWITCH. It is essential that research and development in the scientific arena can be applied for practical and societal gain but can also use different types and scales of approaches and methodologies to enable the best option to applied for the best result in the best place – to fit with existing technical, economic and societal realities, opportunities and limitations.

5. Future Work

The bulk of the work in Work Package 1.3 will be the stages of investigations outlined in section 3 above. The deliverables are indicated in Table 1, and the principal deliverable will be the development of a *SWITCH Integration Manual* and the dissemination of the knowledge contained in it.

The manual, will be part of the Decision Support System (DSS) which will be developed and tested in work packages 1.2 and 1.4. It is essential that the models which underpin the DSS fully meet the needs of integration. To meet this requirement, a module in the Decision Support manual titled ‘planning for transition’ will be produced under WP 1.3. This will ensure integration both of the products of theme 1 and of the new *technologies and methods* into the existing infrastructure of a city.

The *SWITCH Integration Manual* will be a manual for implementing the new technologies to enable them to be applied in any city round the globe. The manual will enable the three stages of the assessment process to be followed in each city. The tool will be a form of an expert system.

Key components of the *SWITCH Integration Manual* will be;

- Description of the *technologies and methods* with an assessment of the application of each and the relative merits of each. SWITCH cities will be able to recognize these *technologies and methods* and use the descriptions to characterize their water system.
- Flowcharts for integration into the existing physical infrastructure. These will be able to be followed by stakeholders and technical experts alike.
- Flowcharts for using the DSS along with the integration process.
- Approaches for integration which address social, economic and cultural issues.
- A series of case studies from examples at each of the cities.

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