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Sustainable Water Management in the City of the Future

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Deliverable D1.1.4

Progress in developing and applying sustainability and risk indicators for urban water management in the demonstration cities.

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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Progress in developing and applying sustainability and risk indicators for urban water management in the demonstration cities.

Audience

This document is of interest to medium level and higher management of municipal water departments and utilities, who are interested in including scientific assessment of urban water systems in strategic planning.

Purpose

To show that scientific assessment methods, such as City Water Balance, Mass Flow Analysis, Energy Footprint and QMRA (Quantitative Microbial Risk Assessment) are usefull instruments to develop and evaluate new strategies for urban water management. The use of sustainability indicators as a mean to link strategic planning, scientific assessment tools and decisionn making is illustrated.

Background

A number of SWITCH demonstration cities are currently in the middle of a strategic planning process. The end-product of this process is a new strategic plan or a new strategic direction for the city. These plans are based on scenario analyis and the development of new strategies, based on scientific innovations.

Potential Impact

City managers that would adopt this approach would increase the involvement of the academic world in the planning of the cities water system. This would lead to more widespread and faster uptake of scientific innovations.

Recommendations

This report is an addition to Deliverable D1.1.2; it is assumed that the reader has taken note of that report first.

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Annexes

1. Introduction; Sustainability indicators, strategic planning and action

Urban planners and managers in cities all over the world are making an effort to steer their city towards a state which we may call ‘sustainable’. Though there are many factors within and outside the city outside their control, it is crucial that they have a clear Vision of how a sustainable water system in their city would look like. Moreover, knowledge about the changes that will affect their city in the future and about the strategies that are available to bring the vision to reality, are crucial. For the water system of the city ‘sustainability’ has certain characteristics, related to water quality, water availability, energy consumption, health and safety, etc. Plans are made, at various levels, to undertake actions to achieve a sustainable urban water system. A Strategic Urban Water Management plan is an overarching plan, with the objective to steer lower level plans such that they all aim in the same direction. A strategic plan also tries to enthouse and to involve public and private parties, commercial and non-commerical into the cities journey towards sustainability. Planners and managers are confronted with the need to make decisions on new strategies and on new projects. Guiding principle for the selection of alternative options should be; how does it affect sustainability of the system? To make these decisions, information is required. This information could be in the form of:

- An assessment of the curent state of the cities water system; based on the scoring of a set of agreed ‘sustainability indicators’.
- An evaluation of the alternative options in terms of their effect on the sustainability indicators.

At present sustainability indicators are used in different ways:

- Cities that do have a Strategic Plan monitor the cities advance towards achieving the Cities Vision by scoring a set of indicators and by publishing the results. Examples are London, Seattle and Vancouver. In these cities indicators are an integral part of the strategic planning process.
- Indicators on sustainability are also used by international organisations to monitor and compare the sustainability of cities. An example is the UNHABITAT Global Urban Observator database with development relevant information, including water related information, for cities mainly in developing countries. It is however difficult to ensure sufficient committment or financial funds to score the indicators on a regular basis. The publicly accessible database of UNHABITAT (2009) has considerable data gaps. It is proobably very difficult to get committment and funds for scoring of sustainability indicators, when the the indicators are not an integral part of an active and current strategic planning process.
- Organisations such as the European Environment Agency, the OECD and others maintain large databases with environmental information that is used to score indicators, on a yearly basis. This gives good information about trends in the state of the environment in the EU or OECD countries. Indicators in this case are not directly linked to planning objectives, but are used to evaluate the effectiveness of current policies and may prompt policy makers to adjust policies in order to achieve better results. The costs for collecting the data, maintaining the databases and keeping the indicator information up-to-date are shared by the memberstates of the organisations. Though the indicators are not an integral part of a planning process, the publicly accessible databases seem to be very well updated and maintained, showing a committment of these organisations, backed by sufficient funds (EEA, 2009; OECD, 2009).

2. Sustainability indicators in SWITCH

In SWITCH the use of sustainability indicators is directly linked to a Strategic Planning process in a number of SWITCH Demonstration Cities. Based on the experiences in these cities a general Vision for a sustainable urban water system was drafted. The Vision was translated into objectives and indicators that are felt to be relevant for most cities (SWITCH, 2008). It is realised that there is no agreed and practical definition of what 'sustainability' of an urban water system means. The definition is contested and the selection of indicators will also reflect this. A purely scientific selection of indicators will therefore not be possible. An attempt was made to this by the MISTRA project. They defined sustainability of a water system, a system that does not produce more pollution than the receiving environment can carry. As long as the carrying capacity is not surpassed, the system is sustainable (reference). Though this approach may lead to the definition of some useful environmental indicators, it is not able to define indicators in the field of socio-economics. There is also practical limitations with regard to the number of indicators a city

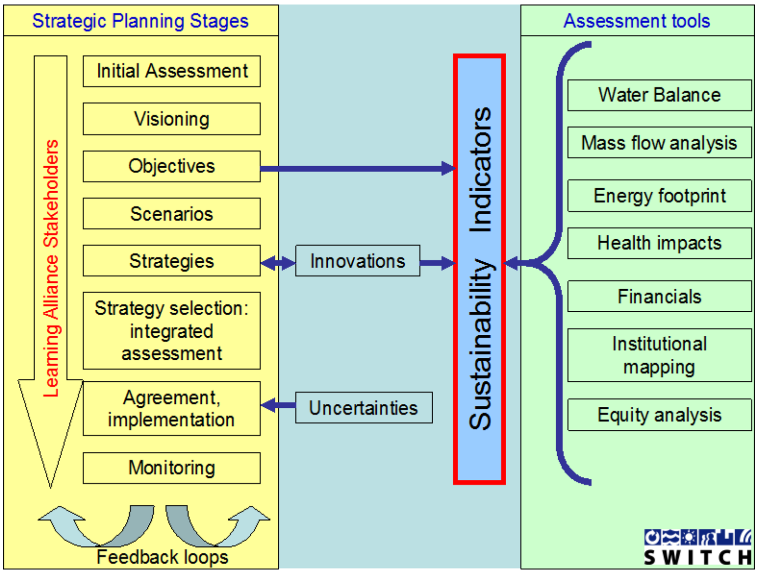

Figure 1. Overview of strategic planning exercise in demonstration cities

is able to maintain. The set of indicators is therefore always a negotiated set of indicators.
Based on the experience of 3 years in the SWITCH cities the following approach is advocated (Figure 1), hough each city would need an adjusted approach to take into account local conditions. The process consists of two interlinked activities. Firstly, the strategic planning actions carried out by the cities LA or a core-group of the LA. Secondly, the application of assessment tools, by the LA or a sub-group of the LA. Academic support is required to apply the assessment tools.
The Sustainability Indicators are linked to the strategic planning stages as well as to the assessment tools. The Vision and objectives determine which indicators are relevant to evaluate strategies. The assessment tools help to score the indicators for the various scenarios and strategies. Innovations, both technical, socio-economic or institutional, are also evaluated by using the set of indicators. Uncertainties in the score of indicators are presented to decision makers in order to arrive at well informed and balanced decisions.

The assessment tools used in SWITCH are:

City Water Balance. This is the very first information that is required to do any work on the cities water system. It deals with the current water flows (water supply, wastewater, stormwater), the elements of the system (water sources, sewer and drainage, pumping stations etc.). The result of this is a water flow scheme like shown in Box 1 for Wilhelmsburg/Hamburg. In a later stage during the process the effect of scenarios and strategies on water flows is predicted.

Mass flow analysis. This is the identification and quantification of constitutents flowing through the water system. It includes organic matter and nutrients, but also toxics like heavy metals, endocrine disruptors etc. The result of the anlaysis shows the sources of pollution in the city and quantifies the pollution loads to receiving waters. Examples of this are shown in Box 2 for an urban catchment in Accra. Mass flow analysis is part of the intital assessment and also part of the evaluation of strategies.

Energy footprint. Consumption of energy in the urban water system has received considerable attention in the last few years. Although it is not one of the larger energy consumers in the city, it still make sense for the water sector to contribute to energy saving. The energy footprint of the urban water system is caused by pumping plants, water and wastewater treatment plants and by in-house heating of water. In SWITCH a spreadsheet model is developed, based on the energy consumption per unit water, for each of the flows in the water balance. Based on the water balance one can then calculate the total energy footprint for the current system, as well as for future scenarios and strategies. Box 3 gives an example of water use and energy footprint for future strategies in Wilhelmsburg/Hamburg.

Health impacts. Overall goal of the water system is to provide health and safety. It makes therefore sense to assess the microbiological and chemical risks that originate from the water system and that affect the citizens of the city. Microbial and Chemical Risk Assessment are tools that can be applied to assess the current risk, evaluate the future risks and to assess which interventions are most cost-effective from a health point-of-view. See Box 4 for the evaluation of different interventions in the urban water system of Accra from a health efficiency point of view.

Finances. The financial situation regarding the urban water system and its users can be captured in a number of financial indicators. Studies on this are on-going, especially evaluating the effects of new technological options on the financial flows in the system (Research on this topic is on-going).

Institutional mapping. The institutional set-up and governance practices in a city are given at the start of a Strategic Planning process but may change or need to change during its implementation. Some new strategies may only be feasible if certain governance and institutional structures are in place (Research on this topic is on-going).

Social inclusion. Access to water supply, sanitation and a safe living environment is often unequally distributed over the city. At the start of a strategic planning process this should be assessed and monitored during its implementation. Decisions on alternatives should include a social inclusion indicator (Research on this topic is on-going).

3. Lessons learned in SWITCH demonstration cities on strategic planning for the urban water system

The demonstration cities that are involved in the strategic planning exercise (Accra, Alexandria, Cali, Tel Aviv, Hamburg, Lodz) have progressed to a different degree (see for details Annex 1). All have prepared an agreed Vision, while most are currently defining the objectives and sustainability indicators. Some cities have started to identify scenarios and strategies.

- The methodology for strategic planning suggested to the LA's is generally well accepted. The concept of joint strategic planning, involving scientists, is uncommon to basically all LA's. The strategic planning exercise helped to give focus ot the LA process. In many cities it was the first time that a group gathered of mixed composition with representatives of most water sector institutions and academics. Some staff of water sector institutions met each other for the first time. Though the strategic planning exercise was initiated from outside (i.e. from SWITCH), in all cities there is a growing ownership of the process.

- It is clear in all cities that professional support by an interdisciplinary team with expertise in planning processes, institutional change, policy influence and political science (in addition to technical specialists) is required for a successful exercise.
- It is is important that the LA members included sufficient numbers of higher management with responsibility for strategic planning in their organizations.
- Some formal committment to the process is required, in order for the results to be taken up in official policy documents. The cities municipality is usually the key-organisation in this respect.
- Communication between city professionals and academics needs proper facilitation, in both directions. The inclusion of scientific innovations in strategic plan is not automatically, even though the improvement for the city may be obvious for the developers.
- The use of sustainability indicators is in general welcomed by the LA. Sometimes, the use of indicators is simplified too much, i.e. seen as not part of an SP process.
- Visions were defined without much disagreements, but this could change when the process becomes more official and when strategies are going to be defined.

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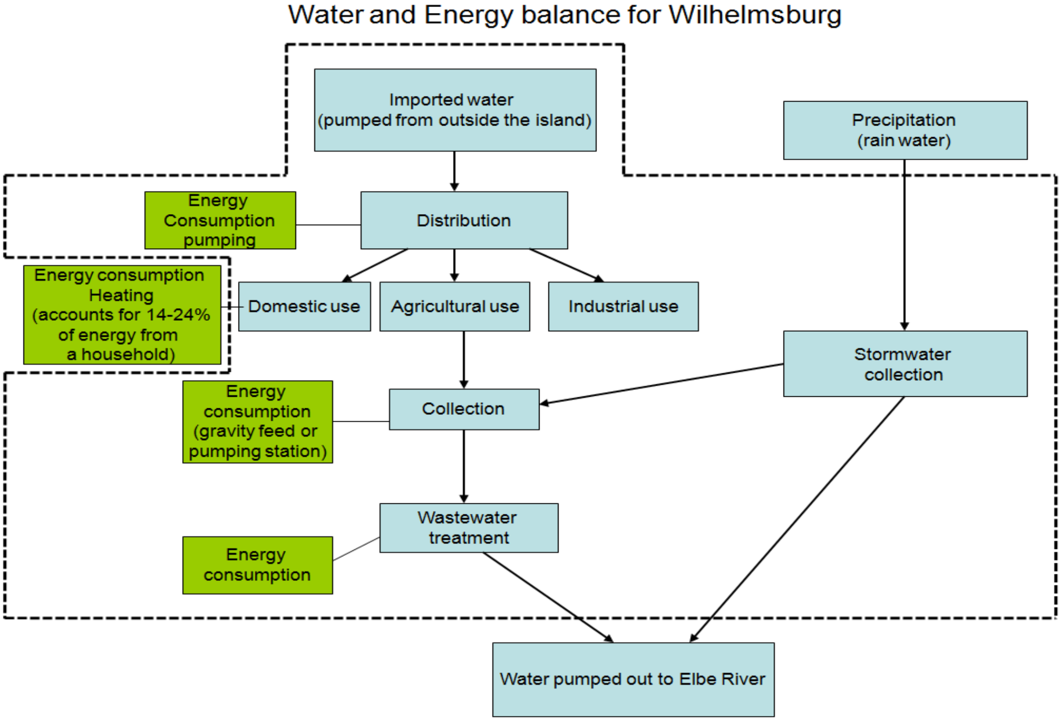
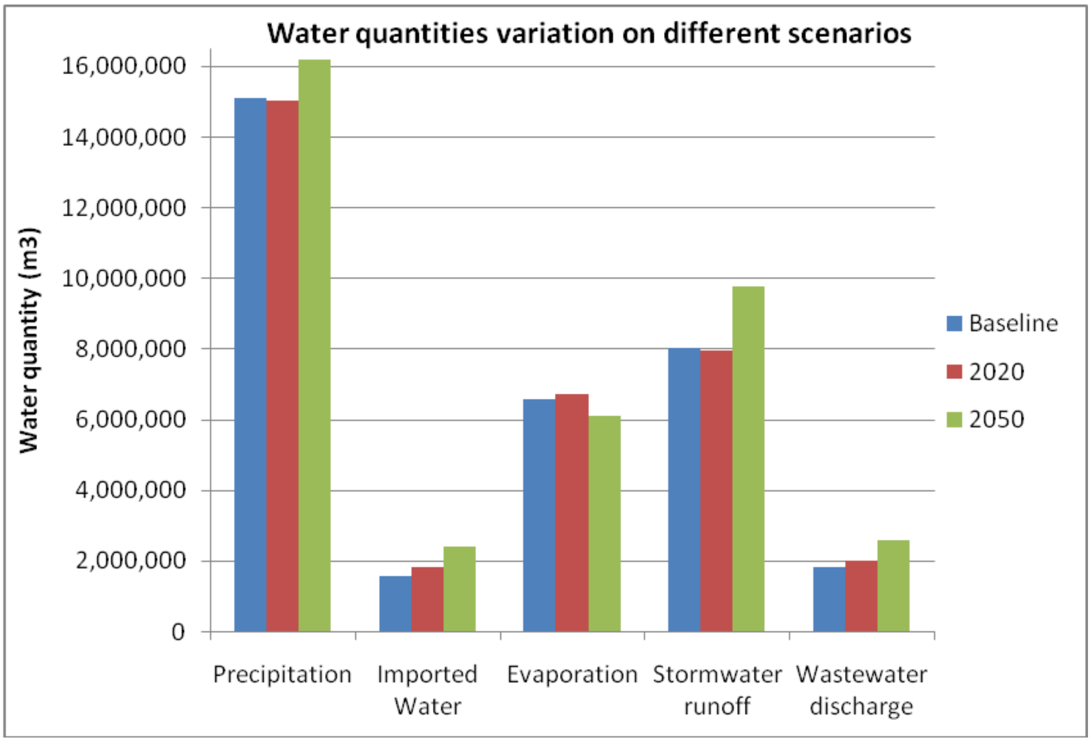
Box 1 City Water Balance

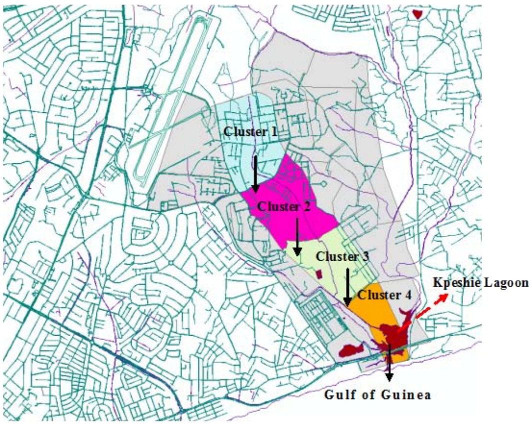
Assessment of the urban water system starts with quantifiying the flows into, within and from the city. Such a City Water Balance was prepared for Wilhelmsburg (40,000 inhabitants), a part of Hamburg. The objective of the exercise was to quantify the flows, such that strategies to save water, use stormwater or reuse wastewater could be evaluated based on their impact on the water balance. Energy consumption in the system was also linked to the water balance, by calcuating the energy expenses per m^3 for each flux. Obviously the water balance is changing with time due to population increase, climate change and other scenarios (for more details see Annex 2).

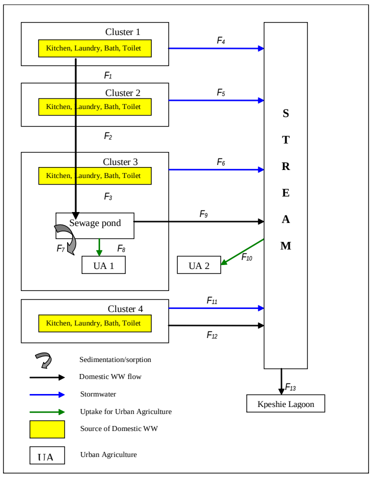




Box 2 Mass flow analysis

Mass flow analysis was used in Accra to investigate how population growth, increasing nutrient discharge from households, use of wastewater in urban agriculture and discharge to receiving waters were related. Mass flow analyisis was carried out for different future scenarios and strategies. The case study was carried out within the Kpheshie catchment in Accra. The catchment is not yet fully urbanised, but a mixture of residential areas, urban agriculture and natural lagoons. Currently the wastewater from the residential areas is discharged into a stream, from where urban farmers take irrigation water for their fields. The AquaCycle model was used to quantify the water fluxes. The mass flows for nutrients were subsequently calculated. Based on the nutrient flux calculations and the nutrient demand in agriculture, it was concluded that the domestic wastewater could supply 175 ha, 84 ha and 47 ha of urban agriculture for N, P and K, respectively. For more details, see Annex 3.





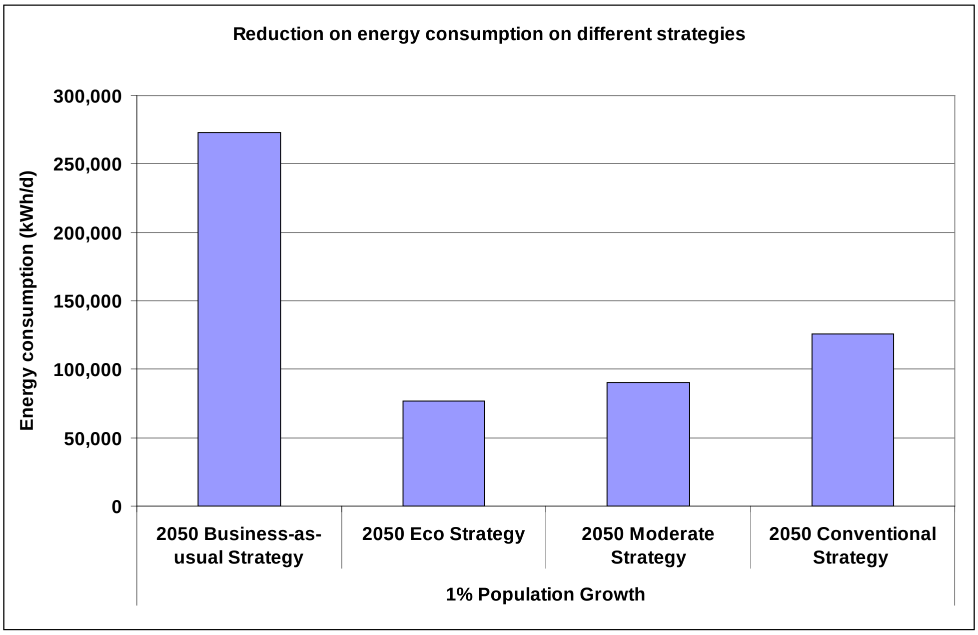
Box 3. Energy footprint

The energy footprint was calculated for the current urban water system in Wilhelmsburg (Hamburg; see Box 1) as well as for 3 future strategies. The energy consumption occurs in the following points in the water system:

- Ground water pumping
- Water distribution network
- Household water heating
- Pumping of stormwater to the river Elbe
- Collection and transport of wastewater
- Wastewater treatment
- Sludge digestion (biogas) and incineration

The following strategies were tested:

Business-as-usual: no specific interventions.
Eco-strategy: Rainwater roof collections systems are introduced adn the water is used in the kitchen,bathroom, for laundry and for toilet flushing. Wastewater is collected and treated and decentralised scale and is reused for toilet flushing. Stormwater is also collected a decentralised scale and used for toilet flushing.
Conventional strategy: Rainwater roof collection systems are introduced and the water is used in the kitchen, bathroom, for laundry and for toilet flushing.



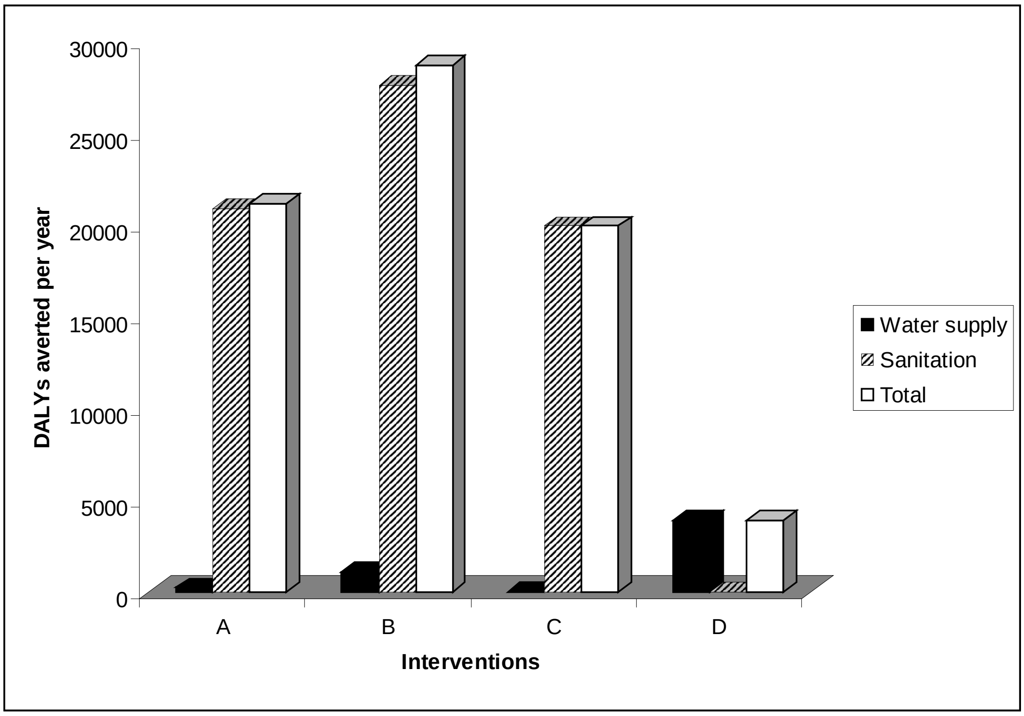
Box 4 Health impacts

A quantitative microbial risk assessment was applied to evaluate the microbial risks of the Accra Urban Water System (AUWS). The exposure assessment was based on the count of indicator organisms in wastewater from open roadside drains, water and sand samples from the beach. The predicted total disease burden generated in a representative catchment of the AUWS (Odaw Catchment) was 32,826 Disability Adjusted Life Years (DALYs) per year, of which 13% and 87% are caused by, respectively, shortcomings in the water supply system and inappropriate sanitation. The DALYs per person per year was above the WHO reference value. The open roadside drain had the highest contribution to the disease burden. Of four possible interventions evaluated for health risk reduction, the highest efficiency in terms of DALYs averted per euro invested are achieved by providing covers for the open roadside drains.

The four intererventions that were tested were:

Intervention A: sewerage network and sanitation facilities
Intervention B: sewage network and sanitation facilities combined with treatment plant.
Intervention C: coverage of the roadside drains**.**
Intervention D: further improvement of water supply system.

For more details see Annex 4.



Annexes

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