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## How to Protect Water Resources in Hanoi International Water Research Alliance Saxony in Vietnam

by Catalin Stefan and Peter Werner, Dresden University of Technology<sup>1</sup>

**In several regions around the world, water-related problems are relevant and new solutions for a sustainable development are sought. The aim of the International Water Research Alliance Saxony (IWAS) is to develop system solutions to specific problems using an Integrated Water Resources Management (IWRM) approach in five model regions around the world: Eastern Europe, the Middle East, Central and Southeast Asia, and Latin America. This paper presents the project objectives and challenges in one model region (Southeast Asia) with a focus on the development of sustainable wastewater management in an emerging district of the Vietnamese capital city of Hanoi.**

### 1 About the IWAS initiative

The International Water Research Alliance Saxony (IWAS) was initiated by the Helmholtz Centre for Environmental Research – UFZ, Dresden University of Technology (TUD), and Stadtentwässerung Dresden (member of the German Water Partnership) and is funded by the German Ministry of Education and Research (BMBF).<sup>2</sup> Within IWAS, around 60 scientists from the three institutions (together with partners from science, industry and political decision-makers) are developing specific solutions to particular water-related problems in five regions around the world under the concept of Integrated Water Resources Management (IWRM): Eastern Europe, Middle East, Central and Southeast Asia, and Latin America.

As the reasons for the occurring water problems are specific to the particular conditions in the respective regions, each of the investigated areas has its own profile:

- **Eastern Europe:** The countries of the former Soviet Union which border on the European Union are under pressure to adapt to

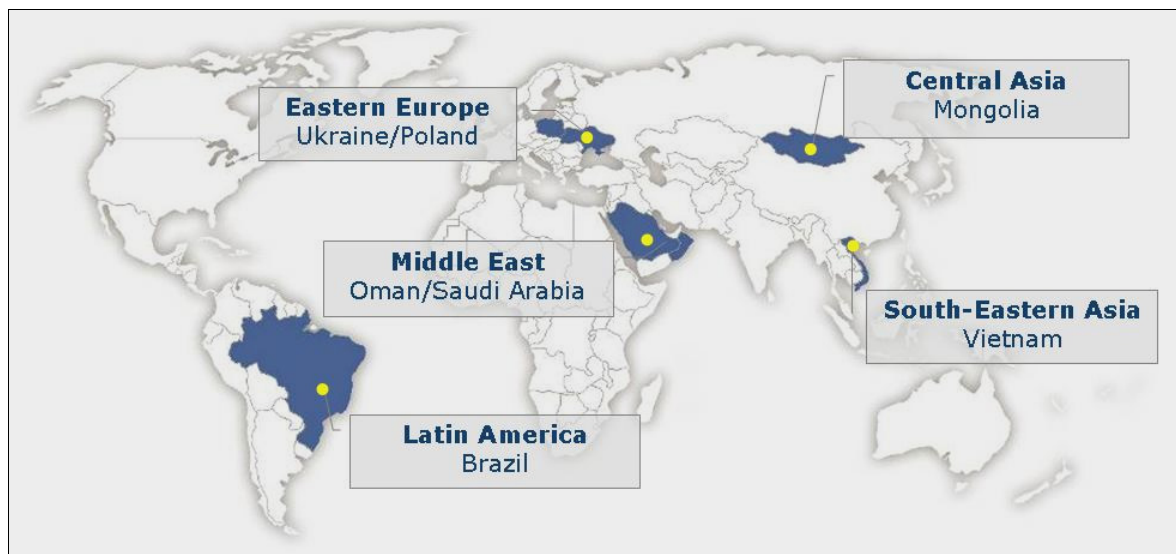
new environmental standards (e.g. the EU Water Framework Directive). IWAS investigates the development of surface water quality in response to the influences of agricultural, industrial and urban activities. As an example of regions with similar environmental conditions, issues related to urban water management, the development of adequate technologies, aspects of ecosystem services and socio-economic analyses are investigated along the river Bug, which borders the Ukraine and Poland.

- **Middle East:** New solutions for sustainable management of the scarce water resources in (semi-)arid regions are explored within IWAS in the Middle East (Oman and Saudi Arabia). The groundwater resources of this area are investigated in a systems approach: from the large-scale, highly precise determination of groundwater recharge, the storage and use of ephemeral streams (artificial groundwater recharge) through to the optimisation of water use in agriculture.
- **Latin America:** As an example for the sprawling cities of Latin America, IWAS investigates the development of Brazil's capital Brasília under the influence of climate, demographic and land use changes and seeks for solutions towards an Integrated Water Resources Management. Intensive agricultural activity is threatening the quality of surface

water bodies, which are currently the only water supply to the city. Therefore, IWAS is working on alternatives for a sustainable use of water resources in the region.

- **Central Asia:** Process studies on ecosystem functions are conducted in the pilot region Central Asia (Mongolia), an area which shows near natural, but extreme climatic conditions. Its population growth, demographic shifts and the resulting changes in industrial and agricultural activity are indicative for a developing country. Adequate solutions for these complex problems can only be developed through a combination of field studies on natural processes, socio-economic analyses, adaptation of technologies, and an integrated modelling (climate, hydrology, soil-plant-atmosphere, etc.).
- **Southeast Asia:** The growing megacity of Hanoi (Vietnam) is facing serious water problems due to population and economic growth in the whole area. Steps towards an improved wastewater treatment situation taken in IWAS are: adequate wastewater treatment, artificial groundwater recharge and sludge recycling with the according technology development and the teaching of local scientists and operators.

**Figure 1: The five model regions of the IWAS initiative**



Source: Own compilation

## 2 IWAS Vietnam – Challenges and Reasons to Act

In Vietnam, as well as in other Southeast Asian countries, the rapid population growth is accompanied by severe conflicts and great challenges: dense urbanisation and rapid industrialisation with resulting exposure and pollution of the vital water resources, accompanied by climate change with extreme weather conditions. In megacities like Hanoi, the high population growth and the extreme population density triggers continuous expansion of residential areas merging adjacent provinces and districts into the metropolitan area. The downside of this rapid development is the impossibility of providing timely and adequate services to population and industry, works on infrastructure being delayed or partially inexistent. Moreover, the solutions adopted are often too short-term problem-oriented and not following a sustainable approach in terms of integrated water resources management. The long-term consequences are reflected in various aspects, from severe flooding to, for example, aquifer depletion and subsidence of land surface caused by overexploitation of groundwater resources.

To overcome these challenges, consequent priorities have to be set for this topic. To find appropriate sustainable solutions for this complex task, an integrated concept and design for the protection of water resources is needed. This concept should comprise an integrated guideline for the development of the entire water resources of a city or a part of it: surface water, rainwater, sewage, drinking water, and groundwater. The aim is to examine, provide guidelines and make a conceptual design in order to create an urban water landscape with a clear connection between the underlying structures of topography, hydrology and soils as the major structuring foundation of urban form, including the use of catchments as the basis for physical planning and regulation.

For this purpose, the Long Bien urban district of the capital Hanoi has been chosen as a model district for implementation of the project's objectives due to its specific environmental and anthropogenic characteristics: The district is situated in northern Hanoi at the convergence of two rivers (Red River and Duong River), with an area of about 6,000 ha and over 200,000 inhabitants, with estimated 350,000

inhabitants by 2020. Due to its geographical position and rapid development, Long Bien district will soon become one of the centres for trade, service, and transportation (road, rail and airway) for connecting Hanoi with other provinces in the North of Vietnam.

As the old urban areas and some new unprompted residential estates have not yet been developed with a systematic drainage system, flooding occurs in some areas. Wastewater of many residential estates, factories, manufacturing, hospitals is not drained and treated decentralised by septic tanks or centralised in a treatment plant. Hence the pollution risk from wastewater is high and affects the welfare of people. The area of Long Bien is one of the areas of Hanoi where a draft master plan for the further development already exists. Within this project the existing master plan for urban water management will be refined according to new sustainable approaches.

## 3 Objectives and methodologies

The overall objective of IWAS in Vietnam is the development of a sustainable drainage concept based on the existing master plan for Long Bien district and its integration into the existing local water cycle in respect to: supporting further urban development, avoidance or minimisation of flood, and improvement of the quality of surface and groundwater. This will be achieved by applying three main concepts considered as pillars of the IWAS Initiative in all five model regions:

- a) *Systems analysis*: With respect to local requirements (climatic conditions, population growth, estimated land use, etc.), the optimisation and further development of the existing draft master plan will take place in collaboration with the local sewage company. The general drainage concept will rely on sustainability criteria, being mainly based on strict separation of sewage and rainwater in newly developed areas, treatment of sewage and polluted rainwater, implementation of infiltration and rainwater harvesting facilities, as well as restoration or construction of ecologically valuable open channels and ditches. The conceptual design for domestic sewage and for the pretreatment of industrial waste-

water will include the sewage network, pumping stations and treatment facilities. A cost-benefit analysis will help to estimate the necessary number and location of treatment plants. In addition, a sustainable rainwater drainage system making use of the existing urban landscape will consist of a network of infiltration ponds, canals, open ditches, pumping stations, etc. The special conditions that have to be considered in Hanoi (heavy precipitation, high population development index) impose customised, flexible solutions suitable for a step-by-step realisation and implementation of project requirements.

- b) *Technology development*: The general drainage system proposed will be amended by technical measures aimed at the realisation of an integrated resource management by using natural processes for the treatment of sewage water. The solution proposed consists in artificial recharge of groundwater with pre-treated sewage water. Besides direct economical benefits (taking advantage of the natural processes for water purification in the subsurface), the concept will overcome major problems related to lowering of the groundwater table caused by overexploitation. The lowering of the groundwater level in Hanoi has been reported to reach up to 35 m below the initial level, which over the years has led to land subsidence of about 10–15 cm in areas near the extraction wells, causing major damages to surrounding houses, schools and factories (Nguyen, Helm 1995). While the water demand in Long Bien district, as in the whole city of Hanoi, is assumed to closely follow the demographic trend, artificial recharge of groundwater represents a sustainable method to ensure adequate water supply to a continuously growing population. On a bigger scale, the method offers short- and long-term subsurface water storage, a solution considered preferable compared to surface storage (in lakes and ponds) due to safety reasons (less exposure to human activities and negative environmental factors). By closing the water cycle (recharge and discharge units) it also permits a better management of resources in terms of sustainability at local level, with a positive impact in the long term.

The method of artificial groundwater replenishment has been successfully applied to a wide range of climatic and socio-economic conditions, from semi-arid regions in the Middle East to the sensitive environments in India. However, the number of limiting factors in Hanoi (complex hydrogeological conditions, little environmental awareness, high population density, land use, etc.) requires artificial recharge structures adapted to local requirements.

- c) *Capacity development*: The sustainable concepts proposed within the project cannot be implemented in practice without a solid long-term development of local capacity in terms of human resources, organisational development, and institutional and legal framework development. The identified issues vary greatly from organisational aspects (e.g. inappropriate division of responsibilities between institutions, financial dependence of public service providers on local governments) to human resources (e.g. inadequate qualifications and insufficient number of staff, difficulties in implementing modern technologies). Moreover, a limited awareness at community level regarding the importance of provided services reduces the providers' capacity to improve and further develop the services offered.

The measures proposed by IWAS Vietnam project to overcome these problems are structured on five target levels: national government, local government, companies, academic and local community level. Besides modular, customised training packages, workshops and roundtable discussions are organised during the project and the results will be documented in a handbook describing the conceptual design and supplemented by specific examples of existing situations (demonstration projects, case studies, etc.). Having both a particular and a general character, the resulting guidelines will also be transferable to similar regions of Vietnam and other Southeast Asian countries.

#### 4 German – Vietnamese cooperation

The project objectives will be accomplished in close cooperation between German and Viet-

namese partners. This will be achieved by working on two interconnected levels:

- *Company level:* The providers of urban drainage services in both Dresden, Germany (Stadtentwässerung Dresden GmbH) and Hanoi, Vietnam (Hanoi Sewage and Drainage One-Member State Co., Ltd. – HCDC) will contribute to the realisation of a sustainable concept of sewage management. On the German side, technical assistance is provided by the Institute for Technical and Scientific Hydrology Co., Ltd. (ITWH), a company specialised in planning and optimisation of urban drainage systems. On the Vietnamese side, the project benefits from the services of Duc Minh Co., Ltd., a consulting firm in environmental protection and sustainable development.
- *Academic level:* Four universities are involved in carrying out the research work on both German and Vietnamese sides. The Dresden University of Technology (TUD), project coordinator, is responsible for developing methods of artificial groundwater replenishment. In Vietnam, the Institute of Environmental Science and Engineering (IESE) at the Hanoi University of Civil Engineering (HUCE) will study possible applications for recycled sewage sludge, and the Hanoi University of Science (HUS), Faculty of Chemistry, will mainly perform the necessary lab analysis for wastewater and sludge.

The activities on both company and academic levels benefit from support of local authorities and are performed in agreement to responsible ministries involved. The project started with a data inventory campaign at the end of 2008 and beginning of 2009 and the official kick-off workshop was held in March 2009 in Hanoi, in the presence of a highly ranked German and Vietnamese audience from political, private and academic sectors. Regarding the project progress, a detailed concept for the drainage system is expected to be available by the end of 2009, amended by intensive research work on the scientific issues and training activities until December 2010.

## Notes

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