Inclusive Urban Sanitation Stories

Flood prevention via sustainable urban drainage systems, Hanoi, Vietnam

Contributed by **Bui Thi Thuy and Pham Nguyet Anh (TLU), Sam Drabble (WSUP) and Dewi Rimayani Hanoum (UN Habitat)**

Figure 1 – Yen Nghia pumping station in Hanoi, Vietnam. © Vinadicme.

Summary

Hanoi, the capital city of Vietnam, faces many challenges in wastewater and faecal sludge management which are being intensified by water pollution and urban flooding. The rapid expansion of Hanoi has led to the inadequate management of the city's wastewater and drainage system, causing damaging and costly floods. In line with the national strategy, Hanoi seeks to be water pollution and flood free by 2030. As a result, much attention has been drawn to wastewater and faecal sludge management.

Sewer pipes in Hanoi are mostly the combined type, collecting both wastewater and stormwater. This system was constructed between 1905 and 1945 during the French colonial period and covered the central part of Hanoi.

This case study details how sustainable urban drainage systems (SUDS) are contributing to urban flood mitigation. In addition, recognizing the potential and potential dangers of wastewater reuse for agriculture, authorities in Hanoi are developing institutional arrangements and policies to protect consumers, whilst enabling farmers to use nutrient-rich wastewater. Wastewater reuse, and its implication at policy level, is another focus of this case study.

Overview

Geographical information

Country: Vietnam
City: Hanoi
City population: 8,246,500

Problem

- The rapid expansion of Hanoi, in addition to high rainfall in parts of the city, has led to the inadequate management of the city's wastewater and drainage system, causing damaging and costly floods. Existing sewer systems are combined, collecting wastewater and stormwater, which has increased the charge on drains in periods of sustained heavy rainfall.
- Wastewater is commonly reused for agriculture, but guidelines for safe reuse are currently lacking.

Solution

- Extracting lessons learned, Hanoi is focusing on the separation of sewerage and drainage systems for new urban areas to better manage stormwater for flood mitigation.
- Various stakeholders involved in retention of the water basin (urban lake), wastewater and drainage management have complementary roles and responsibilities for flood prevention.
- The city of Hanoi designed and is now implementing Sustainable Urban Drainage Systems (SUDS), a Source–Pathway–Receptor approach to manage flooding and reduce pollution risks.

Problem

The rapid expansion of Hanoi has led to the inadequate management of the city's wastewater and drainage system, causing damaging and costly floods. Around 16 key locations across Hanoi suffer from chronic and severe flooding (lasting up to 18 hours), especially in Long Bien and Gia Lam districts. In these districts, the drainage and wastewater system relies on gravity and has not been developed as a full network. The existing drainage system is mainly conventional drainage infrastructure, and canals are not properly channelized.

Table 1: City of Hanoi, Demographics and water and sanitation services

Demographics	Population	8,246,500
	Population density	2,454 / km^2
	Low-income area (LIA) population	N/A
Water and sanitation services	Water network coverage (%) connections	41.9% in suburban area 70.6% in urban area (in 2010)
	Sewerage coverage (%)	>60
	Dependent on onsite sanitation (%)	>90
	Access to improved containment (%)	>90
	Dependent on shared facilities (%)	<2
	Wastewater treated (%)	28.8
	Sludge treated (%)	2-8

Source: DWASA

A project focused on the modelling of Long Bien and Gia Lam flooding indicates that a combination of natural and man-made changes will significantly increase the risk of flooding. Without appropriate measures, by 2030, the total area prone to heavy floods will increase to at least 65% and almost one fifth of the districts will be vulnerable to flooding, since the current drainage systems can only handle rainfall with a return period of 1.54 years (Figure 2 shows the cost of inaction on flood management in Long Bien and Gia Lam districts).

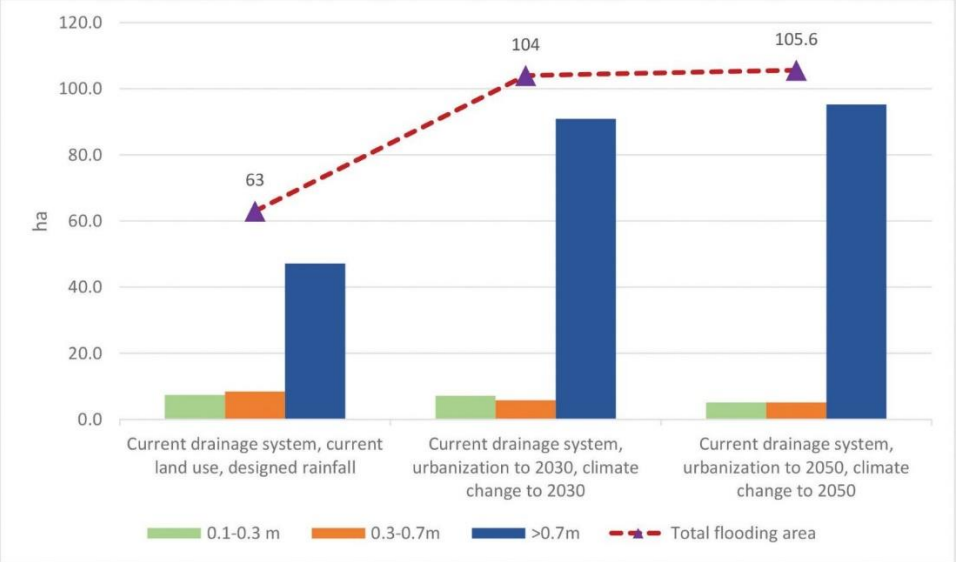

Figure 2 – Cost of inaction on flood management in Long Bien and Gia Lam districts.

Over recent decades, farmers in suburban areas of Hanoi have practiced the reuse of wastewater (directly or indirectly treated) in aquaculture and agriculture. There is evidence that about 658,000 farmers used wastewater to irrigate 43,778 ha of land in Hanoi in 2008, mostly in Thanh Tri district and Hoang Mai district, a peri-urban district in the south of Hanoi undergoing intensive urbanization. A large part of the city's wastewater flows through the district prior to discharge into the Nhue and Red rivers and is widely used by farmers living on the edge of the city.

The sewerage and drainage system in Hoang Mai was built to receive a mix of domestic wastewater and runoff and the flow is directed to the irrigation network on the fields. With increased urbanization, several canals, formerly used for irrigation, have become sewerage and drainage canals. As urban-based activities intensify, the demands on existing water resources increase and, at the same time, local watercourses become increasingly polluted. Wastewater has become increasingly used for aquaculture and irrigation, either directly or indirectly. In some wards of Hoang Mai district (such as Yen So, Hoang Liet, Thinh Liet, Tran Phu, Linh Nam), untreated wastewater is extracted from drainage channels and reused for irrigation of rice paddy fields and vegetable production, which is a traditional livelihoods activity and a major income source in Yen So Ward, Hoang Mai district.

In recent years, increasing amounts of contaminants in untreated wastewater, mostly from industrial and service activities, has led to the decline of wastewater reuse in aquaculture. Wastewater-fed ponds only use 10–30% wastewater, which is a considerable reduction from 10 years ago. Untreated wastewater for aquaculture and irrigation has become a great concern for users and farmers. Toxins in the wastewater have killed fish and some cases of poisoning due to consumption of unsafe vegetable have been reported. Nevertheless, there is still demand for wastewater.

Solution

Hanoi People's Committee (HPC), the top-tier local government, is the owner of all sewerage and drainage systems at the provincial level. District People's Committees (DPC) and Commune People's Committees (CPC) organize the registration of wastewater discharge in their areas. Hanoi Sewerage and Drainage One-member State Company Limited (HSDC), owned by HPC, oversees the management of wastewater infrastructure in Hanoi. The company is the main utility for sanitation service provision in Hanoi including management of wastewater treatment plants (WWTPs) (together with Phu Dien Construction Investment and Trading Joint Stock Company (Phu Dien Co). Services outside this core and in peri-urban areas are provided by contracts with local authorities.

Hanoi Urban Environment Company (URENCO), owned by HPC, is responsible for faecal sludge management (and solid waste collection), collecting faecal sludge from public toilets and transporting it to the treatment site at Cau Dien composting plant. Privately owned septic tanks that are not connected to the sewerage systems are serviced by private emptying and transport companies legally registered in the city, but there is no legal discharge or treatment point for this faecal sludge.

Although responsibility for the wastewater drainage management lies within HSDC, other stakeholders are involved in retention of the water basin (urban lake), including the Department of Natural Resource and Environment, the local authority and private owners. HSDC has digitalized the network and updated it to a geographic information system (GIS)-based system and built a monitoring centre to track rainfall-related flooding events. Hanoi has also developed a management structure for extreme flood scenarios. The Hanoi Steering Committee for Natural Disaster Prevention and Control, Search and Rescue takes the central role in providing the guidance, plan development, and coordination of disaster prevention and control, that is revised annually. HPC approves Hanoi City dyke protection plans for critical dyke sections, relief plans to safeguard the lives of people in Hanoi, and plans for responding to natural disaster and to emergency situations of the City's reservoirs, complementing the districts' strategies for extreme event management and relief measures, yearly.

The city of Hanoi designed Sustainable Urban Drainage Systems (SUDS), a Source–Pathway–Receptor approach to manage flooding and reduce pollution risks. They provide an alternative to the direct channelling of surface water through networks of pipes and sewers to nearby watercourses, aiming at reduction of flooding, improvement of water quality, and enhancement of the amenity and biodiversity value of the environment.

To mitigate urban flooding risks, Hanoi has been implementing specific interventions at the source, the drainage system, and the receiving water basins (rivers). Much of the current drainage systems for Hanoi city are combined wastewater and rainwater systems that increase the charge on the drains. In response to the lessons learned from these challenges, Hanoi is now focusing on the separation of sewerage and drainage systems for new urban areas to better manage stormwater for flood mitigation.

Rainwater is harvested from the micro-scale to the medium scale. A demonstration project on drainage system improvement has been implemented for flood mitigation for Nguyen Khuyen Street and Temple-of-Literature (Van Mieu – Quoc Tu Giam) areas which are often flooded when rainfall events of 30–70 mm/hr occur. An underground rainwater tank with a volume of 2000 m3 is constructed and placed at the yard of Ly Thuong Kiet secondary school. During heavy rains, runoff is collected via a collection pipe and then stored in an underground rainwater tank. The

submerged pumps placed in the tank pump rainwater into the drainage system. With the system in place, flooding duration is reduced: for example, after rainfall of 138 mm in 2 hours, the rainwater system reduced the duration from 18 hours to 1–2 hours.

At micro-scale, roof-harvested rainwater systems have been implemented at the community level, for example at Hanoi University of Civil Engineering (Figures 3 and 4). Two roof-harvested rainwater systems installed at the University contributed to delaying the time of concentration and the peak flow of the runoff, resulting in flood mitigation at the University. Harvested rainwater was then treated to supply drinking water to the students and lecturers.

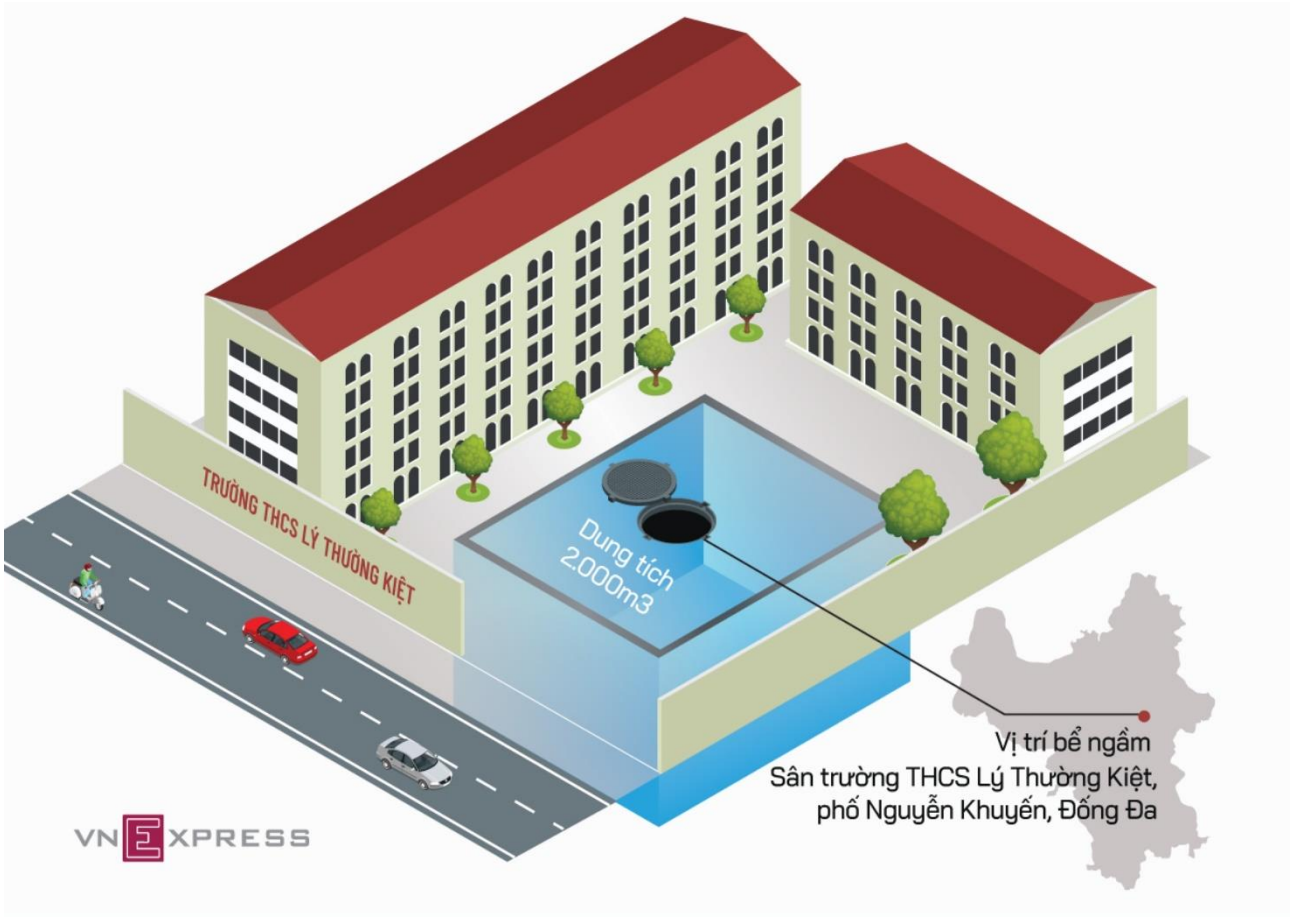

Figure 3 – Drainage system improvement at Hanoi University for flood mitigation and drinking water supply.

Figure 4 – Rainwater storage tank for flood mitigation in Hanoi University of Civil Engineering. Source: Hanoi University of Civil Engineering.

As part of SUDS to separate stormwater and wastewater for new urban areas, the Hanoi authorities also recognize the importance of wastewater-fed fish culture and have included it in the Master Plan of Hanoi City Development and in the Master Plan for Fisheries. Reuse of wastewater is a part of integrated water resources management which has become an overarching principle in Vietnam and has been reflected throughout the National Strategy on Water Resources.

National level policies have been provided to support the reuse of wastewater in the city, including development of urban drainage and wastewater up to 2025 and a vision to 2050 (Decision No 1930/QD-TTg, 2009), reuse of wastewater (Article 72 of the Law on Environmental Protection 2020) and other Vietnamese legislations.

In peri-urban areas, where HSDC does not operate, responsibility for wastewater management rests within the Department of Rural and Agricultural Development (DARD) of Hanoi city. Figure 5 explains the management arrangement (wastewater reuse in particular) in peri-urban areas of Hanoi. In Thanh Tri (south of Hanoi), the management of wastewater reuse also involves local people committees. Wastewater is extracted from drainage channels and reused for irrigation of

rice paddy fields and vegetable production for later sale in local markets in and around Hanoi. For wastewater reuse, there is internal agreement in relation to the pumping of wastewater to the paddy fields, or to individual fishponds. The fishpond owner pays pumping expenses. Pumping services are provided by a company for exploitation of water resources, under the district's Division of Planning and Rural Development.

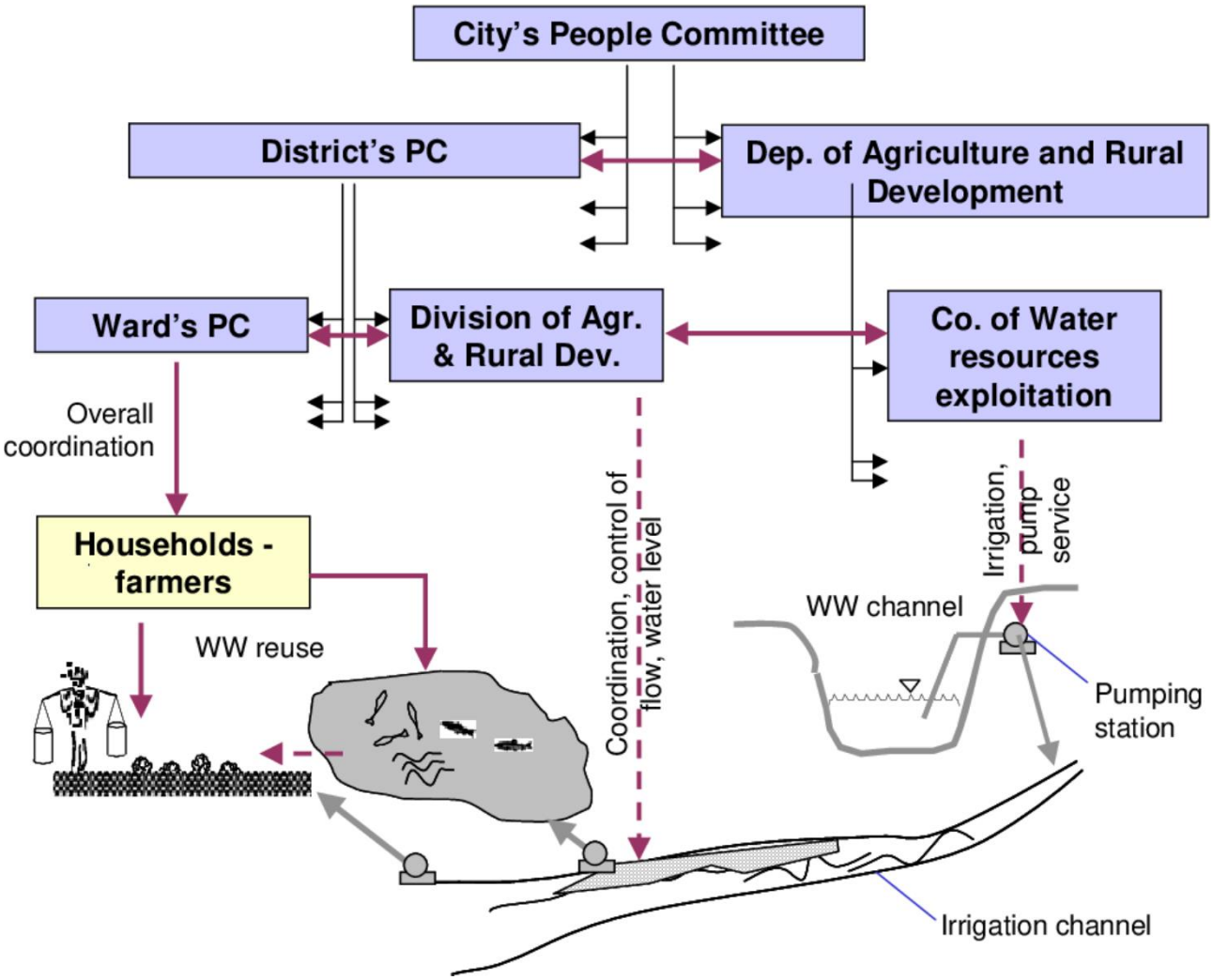

Figure 5 – Management arrangements for wastewater management in peri-urban areas of Hanoi.

Although there are minimum standards, enforcement and monitoring have been difficult due to limited financial resources. City authorities have called on farmers to observe safe and hygienic production practices, but the enforcement of regulations is still limited.

Lessons learned

The innovations now being deployed in Hanoi provide valuable learnings for other cities experiencing sustained high rainfall and needing to upgrade citywide sanitation systems to promote climate resilience. The SUDS can be considered as a Source–Pathway–Receptor

approach to manage flooding and pollution risks and to mitigate urban flooding risks. It is particularly notable that Hanoi is now focusing on the separation of sewerage and drainage systems for new urban areas, to better manage stormwater for flood mitigation, in response to existing combined wastewater and rainwater systems increasing the charge on the drains.

Wastewater reuse is receiving attention in the city and district development plans. However, techniques and skills developed are far from being sustainable and optimal in achieving the dual objectives of aquaculture production and treatment of wastewater. Further studies are required to improve the effectiveness of wastewater-fed fishpond systems in terms of wastewater treatment and reuse through aquaculture, rice and vegetable culture and their potential health risks. In addition, there are limited guidelines to facilitate implementation, and especially to mitigate potential health and environmental impacts.

Useful links

Statistical Yearbook of 2020-General Statistics of Vietnam

https://vinadicme.com

Global Report on Sanitation and Wastewater Management in Cities and Human Settlements | UN-Habitat (unhabitat.org)

Further reading and references

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About the author

Dr Bui Thi Thuy works at Thuyloi University (TLU), leading Division of Environmental Engineering and Management, Faculty of Chemistry and Environment. She has more than a decade of working in water, wastewater and sanitation. She has a background in environmental engineering, and previously worked in both academia and industry for water and wastewater treatment.

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The case study in this story is a further detailed of the case study presented at the Global report for Sanitation and Wastewater Management in Cities and Human Settlements.

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About the institution / organisation

Thuyloi University (TLU) is a public university, founded in 1959, under the supervision of Ministry of Agriculture and Rural Development. TLU is recognized as the leading technical university in Vietnam with high ability to integrate into tertiary education systems in the region and globally. TLU focuses on multi-disciplinary curricula including water resources, hydropower, mechanics, transportation, construction, water supply and sewerage, information technology, information systems, software engineering, natural resources, environment, disaster management, economics and climate change. https://en.tlu.edu.vn/

Water & Sanitation for the Urban Poor (WSUP) is a non-for-profit company that helps transform cities to benefit the millions who lack access to water and sanitation. WSUP was created in 2004 as a response to the urban explosion that has left many cities unable to provide basic services, such as access to a toilet or drinking water, to low income communities. https://www.wsup.com/

UN-Habitat is a United Nations agency that works for a better urban future based in over 90 countries and promotes the development of socially and environmentally sustainable cities, town and communities. UN-Habitat strives for adequate shelter with better living standards for all, and advocates for urbanization as a positive transformative force for people and communities, reducing inequality, discrimination and poverty. https://unhabitat.org/

About the IWA Inclusive Urban Sanitation Initiative

IWA's Inclusive Urban Sanitation initiative responds to a huge and growing public need - safe sanitation in combination with access to safe drinking water and hygiene underpins good health. The aim of this initiative is reshaping the global urban sanitation agenda by focusing on inclusive sanitation service goals--and the service systems required to achieve them - rather than the traditional singular focus on expanding sewer networks and treatment works. This forms part of IWA's larger agenda to promote inclusive, resilient, water-wise, and sanitation-secure cities.

About the Inclusive Urban Sanitation Stories

The Inclusive Urban Sanitation stories are documenting some of the policies, practices, and approaches that demonstrate how stakeholders especially those in urban areas (e.g., public sector, operators, academics, regulators, and other key actors) are taking part or contributing to Sustainable Development Goal 6 which require water and sanitation concepts and norms to look beyond technology and the usual focus on building infrastructure. Increased focus is on safety, inclusion, environment, public health, and multiple technology solutions tailored to different geographies and socio-economic contexts for building climate-resilient cities. The stories aim to inspire urban stakeholders to discuss ways for advancing inclusive urban sanitation, especially in low- and middle-income countries.