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Success story #1

Sustainable urban drainage systems (SUDS)

The problem

Floods occur frequently in Viet Nam's cities. In addition to seasonal flooding, random extreme flood events have disastrous economic and civilian impacts. The flood in the year 2000 alone took over 800 lives. Of all natural hazards present in Viet Nam, flooding is the most frequent, the most economically damaging and the deadliest.

Vulnerability to floods rests largely upon the poor. Despite remarkable progress, poverty reduction in Viet Nam is not complete, and it has become more difficult. With increased rural-urban migration, poverty rates in cities are expected to rise as new urban dwellers settle from the country-side with little or no resources and capacities available to create income above the poverty line. Reducing vulnerability to floods will help vulnerable groups living in marginalized areas improve their resilience to shocks and stresses.

Cities in Viet Nam overly rely on traditional drainage systems to discharge surface-runoff. Often, when overflowing rivers concur with intense rainfall, this underground infrastructure does not have the capacity to drain the water in time. Inadequate execution of construction works, low quality materials, deteriorated and under-dimensioned pipe networks and insufficient operation and maintenance efforts further amplify this situation. As a result, areas with high population density, critical infrastructure, such as hospitals and schools, and low-lying areas, where the poor and vulnerable often dwell, get flooded. In particular in the Mekong Delta, urban flooding will increase due to rising sea levels and more frequent intense rainfall events. Continuing rapid urbanization further amplifies these challenges. The share of total population dwelling in urban areas has grown from 29% to 36% between 2008 and 2018. By 2025, half of Vietnam's population are estimated to dwell in one of the country's 1000 urban centers. Investments in drainage infrastructure capacities face difficulty keeping up with that pace. Neither current nor future flood risks are effectively considered in urban planning. Unregulated growth of often illegal dwellings expands into natural flood plains. Sealed surfaces and densely compacted soil replace the naturally permeable landscape resulting in reduced natural drainage capacity, higher quantities and an increased speed at which surface-runoff reaches and overloads drainage pipes (see Figure 1). The result is serious flooding of urban areas, pollution, damage to habitat, preventable losses of human life and contamination of groundwater sources.

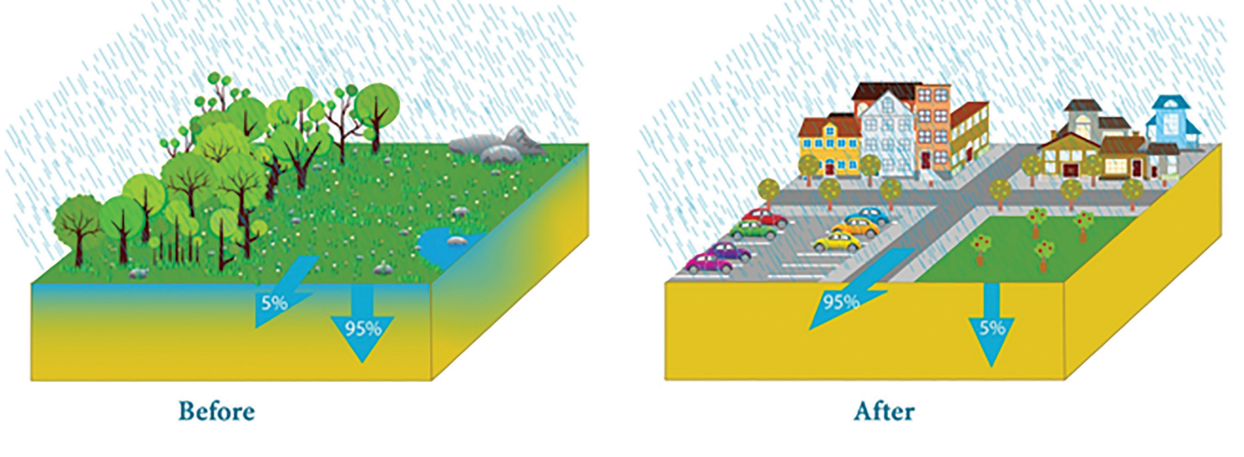
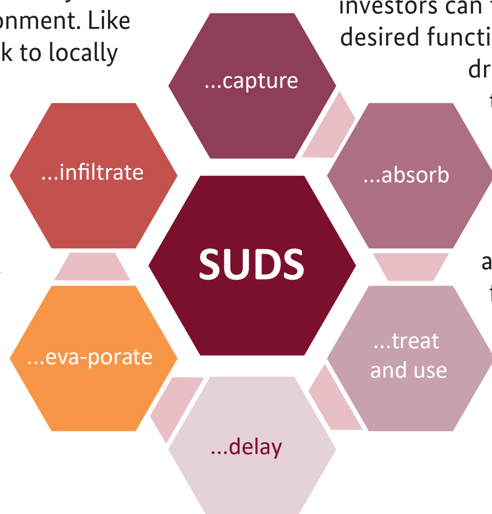


Figure 1: Illustration of the effects of urban surface sealing on ground infiltration

The solution

Sustainable urban drainage systems (SUDS) are systems designed to efficiently manage the drainage of surface water in the urban environment. With the objective to minimize the sealing of surfaces in order to reduce surface-runoff and allow groundwater aquifers to refill, SUDS mimic nature and manage rainfall close to where it falls. They can provide an alternative to, or addition to, traditional drainage systems where surface water is drained directly and quickly into underground pipes and conveyed to lower-lying areas.

SUDS adopt techniques to deal with surface water runoff locally, through collection, storage, and cleaning before allowing it to be released slowly back into drainage pipes or the environment. Like a ‘sponge’, SUDS techniques seek to locally capture, use, delay or absorb rainwater, rather than try to drain it away as quickly as possible. Moreover, sustainable drainage is moving away from the traditional thinking of designing only to manage flood risk, where runoff is regarded as a nuisance, to a philosophy of where surface water is a valuable resource and should be managed for maximum benefit.



Sustainable drainage delivers multiple benefits. Besides delivering high quality drainage whilst supporting areas to cope better with intense rainfall, SUDS can also improve the quality of life in urban spaces by making them more vibrant, visually attractive, sustainable and resilient to change by improving urban air quality, regulating building temperatures, reducing noise and delivering recreation and education opportunities.

Types of SUDS

Since more than half a century, SUDS are a common sight in cities across the globe. A wide range of SUDS techniques exists, each offering specific advantages and drawbacks that need to be carefully considered during planning and design. Urban planners and investors can tailor systems to their needs considering desired functionality, runoff surface area, existing drainage capacities, available space, topographic conditions, costs and maintenance efforts. SUDS can be installed in public spaces (e.g. road sides, traffic refuges, campuses, car parks, city squares, public buildings), at commercial or industrial spaces (e.g. factories, malls, trade centers), or at household spaces (e.g. roofs, gardens, yards, lots). Typical SUDS techniques are illustrated in Figure 2 and described in more detail in Table 1.

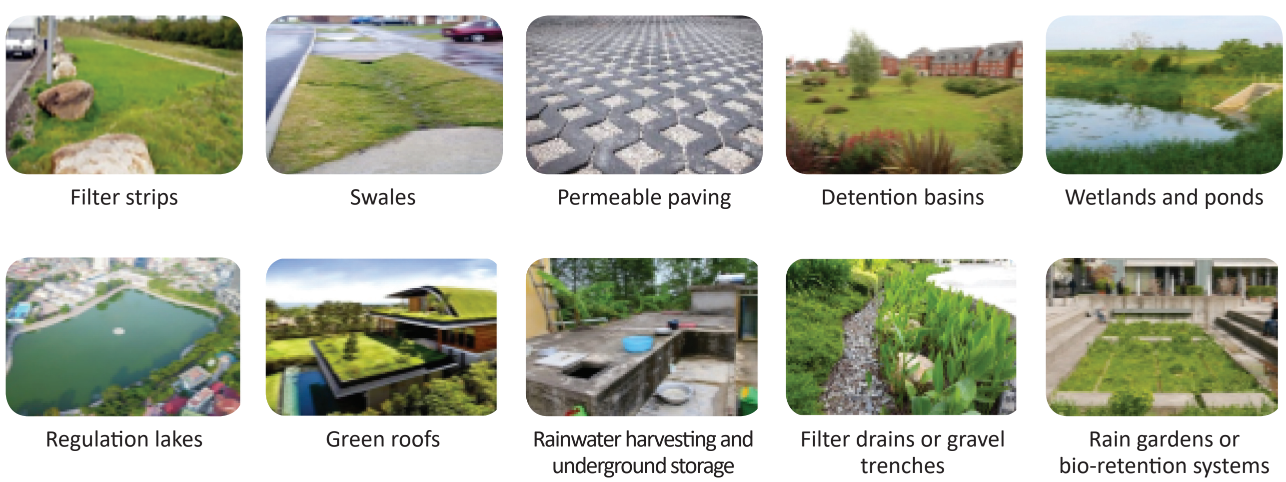


Figure 2: Typical Types of SUDS

Table 1: Description of Typical SUDS Techniques

Filter strips	Filter strips are strips of ground where water running off a site can pass, allowing some or all of it to soak away. The rest often enters a swale - shallow drainage channel - or another sustainable urban drainage systems (SUDS) component. This strip of ground can also be used to filter grit and other particles from the run-off.
Swales	Swales are shallow, grass-lined, natural or man-made drainage ditches with gentle side slopes in the ground where water running off a site can collect and be transported away. Some of the flow infiltrates into the ground. There may be an overflow at the end into another form of infiltration device or a watercourse. Artificial swales often have underground structures, designed to temporarily detain water runoff, filter pollutants, and increase rainwater infiltration. Swales are particularly suitable for treatment of runoff from small residential developments, parking areas and roads.
Permeable paving	Permeable or porous paving can be used as a source control measure for small roads, pavements, car parks and yards. Rain passes through the surface, either through gaps between individual blocks or permeable material such as gravel or porous asphalt, trapping pollutants below. Once there, many pollutants are broken down by natural processes. By using permeable paving you can also prevent water pooling on impermeable surfaces, avoiding puddles and ice on car parks. Large amounts of water can be stored temporarily under the surface. This reduces the chances of flooding.
Detention basins	You can use detention basins to store run-off from large areas, such as parts of housing estates, major roads or business parks. Water usually runs into these from conventional drainage systems or from upstream SUDS. Detention basins let run-off spread across a wide floor area and only fill after heavy rainfall, when they will hold large volumes of water. This lets pollutants settle out before the water soaks away or discharges slowly downstream. Other than ponds and regulation lakes, detention basins store water for shorter periods of time.
Wetlands and ponds	Wetlands and ponds are used to store water for longer periods. This allows natural processes, using bacteria and sunlight, to break down pollutants before the water eventually flows into downstream watercourses. Ponds can also be a welcome addition to urban areas, encouraging plants and wildlife. You should never use existing ponds or wetlands to treat run-off. Always create new ponds to avoid damaging or disturbing the wildlife that is already in the area. Wetlands contain a larger amount of vegetation and are more suitable for treating contaminated run-off than ponds. Newly created ponds and wetland areas are ideal for treating lightly contaminated water from farmyards and farm roads.
Regulation lakes	Regulation lakes are a common sight in many cities in Vietnam. They form part of the urban central drainage infrastructure, are usually man-made, embanked and surrounded by roads and housing. Regulation lakes have inlets and outlets that are connected to drainage pipes or channels upstream and receiving water bodies or pipes or channels downstream. Inflow and outflow is controlled by man-operated valves or sluice gates. Other than detention

	basins, regulation lakes are permanently filled with water to a certain level, and are only rarely completely drained for dredging and other maintenance works. Due to the combination of sewerage and drainage in combined systems in most of Vietnam's cities, regulation lakes are usually highly polluted. Although they are a habitat for certain adapted fish species and some other aquatic life, regulation lakes are not an ideal ecological habitat for wildlife and plant.
Green roofs	Green roofs are roofs that are purposely fitted or cultivated with vegetation. They are also known as living roofs, eco-roofs or vegetated roofs. Green roofs can reduce or eliminate run-off from roof areas, add insulation to a building during winter months, cool a building during the summer by evaporation, provide sound insulation, reduce the heat island effect – accelerated by the use of air conditioning – in cities and provide a habitat for wildlife. There are two types of green roofs. Intensive systems have deep soil capable of growing shrubs and even trees, while extensive systems comprise thin layers of vegetation, such as sedum mats. Green roofs add weight so they should be considered at the design stage of a new build.
Rainwater harvesting and underground storage	Rainwater harvesting is a process of collecting and storing rainwater that falls on a catchment surface (typically a roof) for use, independent from, or supplemental to the mains water supply. Storage typically happens in above- or below-ground tanks. This reduces demand on the mains supply, offers some resilience from local supply problems and reduces the amount of energy used for water treatment and transportation and also mitigates flood risk. Rainwater is a relatively clean water source. Collected water can be used for non-potable purposes such as flushing toilets and urinals, supplying washing machines, irrigation systems, vehicle washing, sprinkler systems, gardening and so on.
Filter drains or gravel trenches	Filter drains are shallow excavations lined with geo-textile and filled with gravel or stone that create temporary subsurface storage of storm water runoff. The gravel in the filter drain provides some filtering of the runoff, trapping sediment, organic matter and oil residues that can be broken down by bacterial action through time. The runoff rate is reduced, and runoff storage is also provided. Stored water can also pass through the geotextile membrane and infiltrate the soil. Some filter drains need not even lead to a watercourse at all.
Rain gardens or bio-retention systems	Rain gardens, also called bio-retention systems, are designed landscape sites that reduce the flow rate, total quantity, and pollutant load of runoff from impervious urban surfaces. Rain gardens rely on plants and natural or engineered soil medium to retain storm water and increase the lag time of infiltration, while remediating and filtering pollutants carried by urban runoff. They are designed to withstand moisture extremities and the concentrations of nutrients that are found in storm water runoff, in particular, nitrogen and phosphorus. Rain gardens provide a method to decrease ambient air and water temperature and to reduce or avoid the need for additional irrigation.

SUDS in Viet Nam

Many more economically developed countries legally limit the surface area a household or business may seal, or otherwise require that surface-runoff is managed locally. For example, some countries provide financial incentives for property owners to locally store, use or infiltrate rainwater by adding charges for introducing surface-runoff into city drainage pipes (calculated based on a household's sealed surface area, such as roofs, yards or walkways) to sewerage tariffs.

In Viet Nam, the philosophy of sustainable urban drainage is a novelty concept that only since a few years could gain the attention of policy makers and urban planners. Until recently, specific standards and regulations on SUDS did not exist and sustainable drainage was not made a mandatory aspect of urban planning. Existing legislation did not clearly define SUDS and over-emphasized the more familiar concepts of centralized regulation lakes over local permeability, detention and infiltration to re-supply ground water sources. Despite the evident need, the dissemination of SUDS in Viet Nam's cities has so far been limited to isolated projects, such as a number of green roofed buildings and rainwater harvesting at household level. Some recently developed housing estates comprise swales or filter drains. A widespread dissemination of SUDS has so far been hindered by a lack of mandatory urban planning regulations and missing incentives to encourage property owners to limit the area of surface they seal.

FPP contribution

Co-Financed by Switzerland and Germany and implemented by Minitry of Construction of Viet Nam (MOC) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the programme "Flood Proofing and Drainage for Medium-sized Coastal Cities in Viet Nam" (FPP) has been at the forefront in promoting the SUDS philosophy in Viet Nam since 2013. Under the programme, practical SUDS demonstration projects were constructed in cities at the Central Coast and in the Mekong Delta. Using the projects to demonstrate the effectiveness of different SUDS techniques in urban spaces, important gaps in the national sector policy and urban planning framework were identified and filled. The institutionalization process flattened the ground for a widespread dissemination of SUDS techniques throughout Viet Nam. Key outcomes of the FPP contribution are:

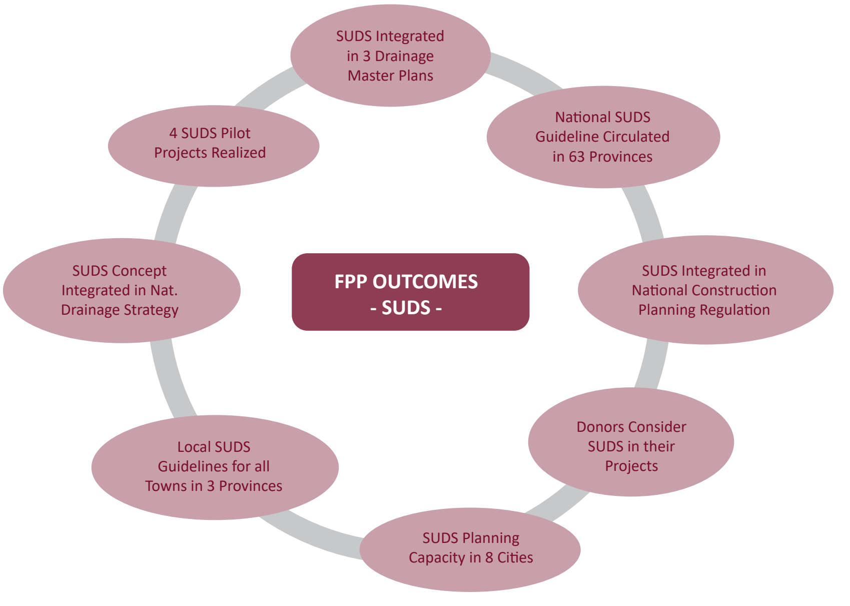


Figure 3: Key Programme Outcomes

- Four SUDS demonstration projects, applying permeable paving, underground detention and ground infiltration techniques, are operational [1];
- Officials and planners of eight cities endorse the SUDS philosophy and have the capacity to plan and design SUDS;
- Three Mekong Delta cities integrated SUDS into their urban drainage master plans;
- Three provinces compiled, approved and disseminated local guidelines to implement SUDS in district towns and other urban centers within their territory;
- The SUDS concept was integrated in revised national Orientation for Urban and Industrial Zone Drainage Development Towards 2025 and Vision Towards 2050 (approved in Prime Minister's Decision 589/QĐ-TTg on 06/04/2016);
- A national SUDS guideline – including detailed design examples – was compiled and published by MoC in November 2019 and disseminated to leaders and decision makers in all 63 provinces of Vietnam;
- The sustainable urban drainage philosophy was integrated into the new National Technical Regulation on Construction Planning (QCVN 01:2019/BXD) that was promulgated by MoC in December 2019 and that replaces the former Vietnam Building Code of 2008 (QCXDVN 01:2008); the new regulation requires urban drainage master planners to increase unsealed surface area to infiltrate rainwater-runoff of roads, parking lots and other sealed public spaces and to consider flood reduction and climate change adaptation in drainage plans.
- Other donors (e.g. World Bank) endorse the national SUDS guideline and consider to integrate SUDS in their projects in the sector;

Currently, a national guideline on integrating SUDS into urban drainage master plans is being developed by the FPP.

[1] SUDS were constructed in the cities: Quang Ngai, Long Xuyen, Rach Gia and Ca Mau.

FPP approach

FPP activities have directly influenced national and provincial level policy and framework conditions, they have increased the technical capacity across all levels and have provided best management practice examples for sustainable urban drainage as well as pilot studies for flood early warning and disaster risk management, which have the potential to be up-scaled into other provinces of Viet Nam. The FPP approach has created great interest at MOC as a model approach for climate-sensitive urban drainage in Viet Nam.

To ensure sustainability of outputs and outcomes, FPP applies a holistic approach to capacity development that has proven highly effective. For FPP, flood proofing is an institutional, financial, technical and social issue and as such, FPP partners include leaders and officials from different state management and legislative agencies at central level[2], and Provincial People's Committees and relevant departments and agencies at provincial level[3]. Capacity development efforts of FPP emphasize information flow, learning and experience sharing along both vertical (central–local) and horizontal (intra- and inter-provincial) lines of administration, ensuring a high degree of effectiveness, improved local capacities and strong ownership of activities and outputs.

The effectiveness of the FPP approach can be illustrated by the example of the programme's work on sustainable drainage. Figure 4 illustrates how the FPP approach creates sustainable impact on a local and national scale.

[2] Central level partners include various agencies and units of: Ministry of Construction (MOC), Ministry of Environment and Natural Resources (MONRE), Ministry of Agriculture and Rural Development (MARD), Ministry of Planning and Investment (MPI), Office of the Government (OoG) and Committee for Science, Technology and Environment of the National Assembly (CSTE).

[3] Local partners include: Provincial People's Committees (PPC), City People's Committees (CPC), Ward People's Committees (WPC), Departments of Construction (DOC), Natural Resources and Environment (DONRE), Agriculture and Rural Development (DARD), Planning and Investment (DPI), Health (DOH), Finance (DOF), Provincial Statistical Offices (PSO) and Urban Drainage Operators (UDO).

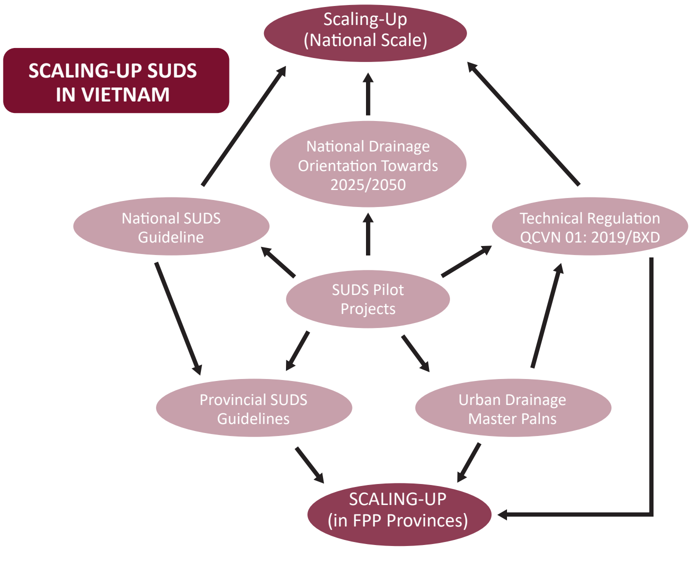


Figure 4: Scaling-up SUDS in Viet Nam

The work process in this area of work followed four key stages:

1. **Consensus building:** The FPP team introduced the approach of SUDS as an adaptation strategy that reduces the water load on the piped drainage system through increased infiltration and storage of rainwater in the ground. A wide range of provincial stakeholders were involved via the formally established provincial working groups and a consensus was established that the integrated approach was practical and suitable for short-term and long-term investments.

2. **Piloting:** The working groups agreed on the piloting of SUDS projects in each province. FPP inputs included project design, design appraisal and approval, contribution to project construction as well as construction and financial monitoring and supervision. Working group officials were closely involved and actively steered each step of the piloting process, ensuring strong ownership and the development of capacities for future replication of the systems.

3. **Horizontal cross-exchange:** The results from the pilots provided valuable input during the preparing of the urban drainage master plans. The working groups agreed to integrate SUDS into these plans, reducing the load on central drainage systems, resulting in a reduction of system design capacity and investment costs.

4. **Vertical cross-exchange:** Results of the provincial work were used to institutionalize SUDS at central level by

providing inputs for the National Technical Regulation on Construction Planning and as a factual basis to develop the national SUDS guideline (bottom-up). The national guideline has the aim to scale-up SUDS to all cities in Vietnam (top-down), and also served as a basis for the development of provincial SUDS guidelines in the three provinces of FPP phase two. The provincial guidelines draw on relevant parts of the national guideline and provide practical advice to decision-makers at all levels of government in each province. The guidelines were approved in each province and distributed to all districts for local scaling-up.

The human impact

Mr. Tran Nhat Tam is a Rach Gia city resident and lives near the location of the SUDS demonstration system that was constructed by FPP. In an interview, Mr. Tam shares his observations and thoughts on flooding in his city:

Figure 5: Mr. Tran Nhat Tam, Rach Gia resident

"Rach Gia is a beautiful city, facing the ocean. However, the location means that our drainage system is impacted significantly by tides. Our drainage system is designed to drain rain water from the city into the sea, so all the large main pipes lead there. At times, however, tides are so high that ocean water flows back into the openings of these drain pipes and is pushed into the city. It then appears from street inlets and manholes and floods streets or entire residential areas. What comes out of those manholes is smelly and black wastewater mixed with rubbish, dead rats and other disgusting things. I have told my kids to always stay away from that water to avoid catching a disease. The flooding is even more severe whenever it rains during high tide. Then, the sea water blocks the pipes and so rain water cannot drain away.

Me and my neighbors have noticed that the inundations have become more frequent and also more intense in recent years. There is a lot of talk about climate change on TV and in online newspapers I read. They say the Mekong Delta is among the most severely affected regions in the world. I am no weather expert, but I think that what we have been noticing here with the rain and local floods must be related to climate change somehow. We all fear that these events are going happen more often in the future and that the flooding here will get worse. I heard at a local ward meeting that the new system that was recently constructed here under the sidewalk opposite to my house shall help drain rain water more efficiently. Since construction was completed my family did not yet witness any flood here. However, also there was no big rain storm yet, so let's wait and see how effective it is. If it works, I hope they will have the money to build more of these all over Rach Gia. A solution is needed for the entire city."

Mr. Nguyen Viet Xo lives in Ca Mau city, close by the location of a SUDS demonstration system completed under FPP. Having observed the construction of the system and having witnessed its impact over the past half year, Mr. Xo shares his assessment:

Figure 6: Mr. Nguyen Viet Xo, Ca Mau resident

"My house lies at a big road intersection in Ca Mau city, just across from where the sustainable urban drainage system was constructed last year. There is a big sign on the site that shows that the city received financial and technical support from Switzerland and GIZ for design and construction. I am always very interested when I come across construction sites for urban infrastructure, so I often went over there during construction and talked to the workers and some of the site engineers I met. They explained to me what this system is called and how it is supposed to function. They also told me that this site here was selected because it is a flooding hot spot in Ca Mau, and I couldn't agree more.

My family has lived here since many years now, and in that time we have witnessed countless floods in the intersection. It always floods whenever there are big rain storms. And these seem to have become more frequent over the past decade. The rain water usually mixes up with sewage from the drains and so the water that stands in the road is always extremely dirty and polluted. On average it takes 3 to 5 hours for the flood water to fully drain away after the rain has stopped.

Occasionally the water has even entered the ground floor of our house, creating a big mess and a lot of work for cleaning up afterwards. The smell usually stays in the house for several days. Luckily our power outlets are very high above ground, so we have not yet had any severe accidents or power shorts. Electrical appliances we always disconnect and carry upstairs when a flood is imminent. So we could limit the property damage so far. However, I don't know how the frequently returning water will impact the foundation of my house and the walls in the long run.

I understand that the SUDS is designed to collect and store the rain water that accumulates here on the intersection and then slowly infiltrate that water into the ground during and after the rain. This functional principle makes perfect sense to me. I remember my childhood home in the countryside. There was not much concrete that covered the ground, so rain water always soaked directly into the soil. Now we need to apply this principle in the city and find a way to soak the rain water away near where it lands. Our drain pipes cannot cope with these ever increasing masses of water.

From my observations so far, the SUDS that the city constructed here seems to have an effect. It has been almost a year since completion now and there have been some heavier rains in that time. Flooding was noticeably reduced and water drained away much quicker than it used to. In particular my wife and kids are happy that the intersection now looks much nicer than before. There is new infrastructure underneath, but you don't notice anything. It looks like a nice small green garden island in the middle of the hot, grey road surface."

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