PROJECT: EXPLOITING THE SYNERGIES BETWEEN SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) AND URBAN FARMING

GUIDEBOOK

SUSTAINABLE URBAN DRAINAGE SYSTEM AND URBAN FARMING

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CONTENTS

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The project was undertaken by the NIRAS A/S – consulting engineers, Allerd, Denmark and the Institute for Environmental planning, Urban and Rural infrastructure. The Ministry of Construction and the Vietnam Institute for Urban and Rural Planning (VIUP) supervised the project on behalf of the Government of Vietnam.

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1. INTRODUCTION

Climate change (CC) is one of the global challenges in the 21 st century, requiring countries around the world to develop specific programs and action plans to respond promptly and effectively to its impacts. As announced at the COP 15 conference on climate change in Copenhagen with a geographical position, diverse topography and climatic features, Vietnam will be severely affected by climate change; especially through extreme weather events related to water such as extreme tide, sea level rise, storms, floods, urban inundation, drought, etc. Therefore, it is necessary to have a flexible, creative and effective initiatives responding to uncertainty of climate change and natural disasters in urban and infrastructure development in Vietnam.

As a country with many river systems, Vietnamese cities are formed and developed in association with "river and water" in order to utilize the advantages related to water factors to serve economic and social development. However, these cities are always faced with natural hazards related to water influence factors (such as flooding, inundation, saline intrusion, high tides, etc.). With geographic locations situated at the end of river basins, many cities are not proactive in distribution and control of water sources and signficantly affected by upstream water sources related actions. In the context of change, extreme climatic phenomena are increasingly abnormal and have caused increasingly severe consequences. Urban flooding has been occurring in many urban areas throughout territories

with increasing levels, scope and frequency. Meanwhile, the adaptive capacity of cities is currently not appropriate, leading to the risks and losses of water in urban areas more serious.

In addition to the inherent reasons due to the harsh climate causes, the impact of unreasonable urbanization in the climate change context is an issue that urban planners, designers and managers need to consider. The impact of urbanization and climate change on urban flooding are two resonant factors. The combined impacts of climate change with increasing rainfall and sea level rise along with urban expansion, surface concretization will change the flooding intensity and frequency in the future.

Currently, drainage design and planning is shifting from the conventional approach of fastest drainage to the main drainage systems to the slow drainage approach in which includes a temporary storage of water in households, neighborhoods, small basins that then slowly reasing the water to the main drainage basins. This reduces the load on the main urban drainage system and creates additional economic, social and environmental benefits (e.g. creating more green spaces combined with drainage, complementing groundwater, etc.). Especially in the climate change context, the conventional drainage systems sometimes do not solve the drainage issue when extreme weather events such as rain and storms occur abnormally and are harder to forecast, leading to inundation and causing more serious damage to infrastructure, society and economy.

Recently,there has been a focus on the construction of drainage systems in urban areas in Vietnam. However, due to inadequate, inconsistent and inadequate planning, drainage capability is not ensured. Although the drainage system in urban areas is dredged, the flow is constantly cleared, and thus

the flooding still occurs. This depends on many reasons such as: drainage channels that are blocked due to the construction process, illegal construction or not following urban plans. Also, many lakes and ponds have been filled to build houses and roads, reducing storage and drainage capacity of rain-water; high densities impervious surface, rapid increase in rainfall, loss of green space; uncontrolled waste discharge also causes the drainage system blocked, etc. Lack of water storage space and green infrastructure in urban areas is not only the cause of flooding when extreme climatic events occurs (heavy rain, high tides, storms surges, etc.) but also leads to the groundwater degradation, land subsidence, increased urban heat island, causing ecological imbalance and pollution, etc.

To cope with climate change in general, especially urban flooding, sustainable drainage initiatives are considered to support conventional drainage system.

As mentioned above, the guide is funded by the Nordic Climate Facility. This facility is in turned funded by the Nordic Development Fund , which is a donor, based on the development cooperation budget of the governments of Denmark, Finland, Iceland, Norway and Sweden that are currently giving funding to developing countries, including Vietnam. Annually, NDF calls for proposals on development assistance around the world. The NIRAS A/S - Denmark and IRURE (under VIUP) in coordination developed the project proposal on "Exploiting the synergies between Sustainable Urban Drainage System (SUDS) and urban farming in Vinh Yen City, Vinh Phuc Province, Vietnam" that was approved by the Nordic Climate Facility - under Nordic Development Fund, funding approval in 2015. Subsequently, the Ministry of Construction has issued Decision No. 294/QD-BXD on March 31, 2016 approving the project document.

Project objectives:

Applying sustainable urban drainage system and small-scale urban farming to strengthen resilience to urban climate change; minimizing risks, consequences of floods, inundation to residential communities and infrastructure buildings; increasing awareness and capacity on climate change response and SUDS; creating jobs that contribute to poverty reduction.

Project results:

Flood risk analysis for the pilot area in Vinh Yen city as a basis for pilot selection and proposes SUDS for future city project programs.

Technical guidance and training materials on sustainable drainage systems and urban farming.

Pilot construction of a sustainable drainage system and urban farming in Dong Da kindergarten and 04 households in Vinh Yen city.

Evaluation of the implementation and effectiveness of SUDS and urban farming.

2. TARGET GROUPS

The main target of this guideline is to help citizens and urban communities in Vietnam understand and be able to establish sustainable drainage system combined with urban farming through practical piloting in Vinh Yen. The stakeholders targeted includes:

- Citizens and communities in urban areas;
- Planners, designers, practitioners;
- Urban authorities and officiers being in charge of reviewing and appraising urban planning and development projects: From central to local levels - managers and decision makers in urban planning and development.
- Researchers, lecturers and students in research institutes and universities.

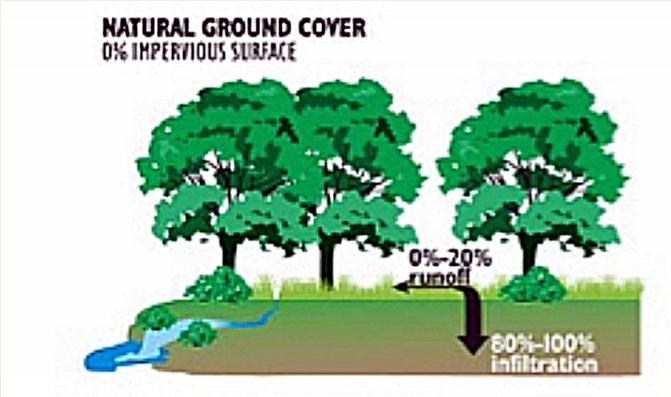
Besides, there is is also a reference for urban planners, designers, practitioners, that can integrate approaches, solutions of sustainable drainage in their work. Moreover, this document contributes to the urban authorities' orientation in local plans and specific projects on urban rehabilitation that consider integrating sustainable drainage solutions as well as guiding communities to apply sustainable drainage solutions in general and concretize by rainwater harvesting at source (at buliding scale). This is also a reference for researchers, lecturers, and students at universities and research institutes related to planning, urban development and infrastructure to help them get more information in reality in Vietnam on the application of sustainable drainage as well as the development of more intensive research and projects on this matter.

3. CONCEPT AND RATIONALE OF SUSTAINABLE URBAN DRAINAGE SYSTEM

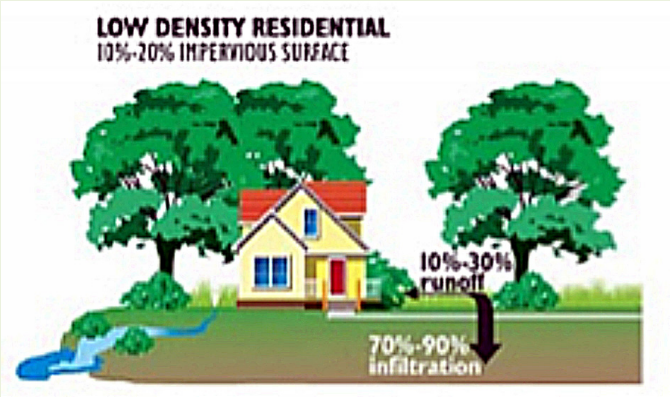
Runoff is rain water that does not evaporate or penetrate into the soil. Runoff occurs when the rain intensity exceeds the soil infiltration rate. When saturated soil is no longer permeable, if it continues to rain, this amount of rain water creates runoff.

According to the the project "Promoting Sustainable Urban Drainage Systems in Estonia-Latvia cross-border area to improve the environment for active and sustainable communities", in areas where there is almost no vegetation, when 75% -100% surface is impervious, 80-100% of rainfall creates surface flow; when 35-50% surface is impervious, 40-70% of the rainfall creates a fast and large surface flow. However, in the natural environment with high vegetation cover, only about 10% of rainfall creates runoff.

Urban development changes the natural water cycle The natural water cycle comes from rain, and returns to groundwater through transpiration, intrusion and flow. However, urbanization

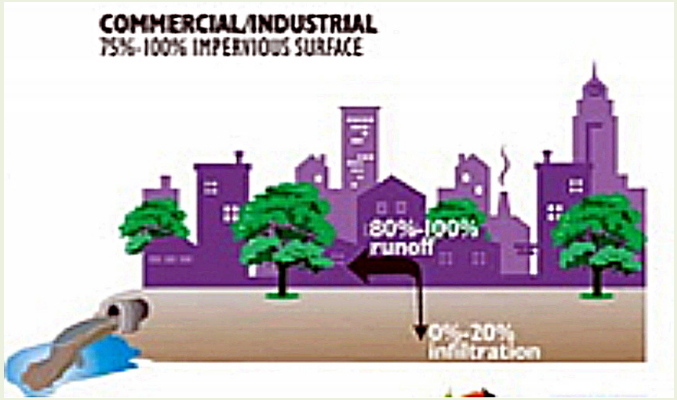


Infiltration in natural areas is 80-100%, surface runoff isn't happening. Surface runoff could be zero.



In low density residential areas (rural areas) with green trees and carpet system, so the surface flow accounts for 10-30%. Infiltration is from 70-90%.

The urban residential areas still have trees, however the surface has been built and concreted so the surface runoff rate has increased to 40-70%, the water infiltration is about 30-60%.



In the commercial and industrial areas, the surface runoff rate is almost 75-100% due to the high rate of concreting, while the water infiltration is almost zero (0-20%).

Source: City of Lincoln – Water program (https://lincoln.ne.gov/city/ltu/watershed/runoff)

has largely disrupted this process. Impervious surfaces (traffic, construction, etc.) completely change the natural cycle of the flow. In the climate change context with extreme climate events (such as heavy rain, flashfloods etc.). Hence, surface runoff in urban areas can lead to flooding and inundation. Urbanization and concreting increase surface flow by creating a lot of impervious surfaces such as sidewalks, buildings, road systems, and storm water flows directly into sewers, ditches, ponds. The final recipient also caused erosion and sedimentation. In addition, human activities make pollutants easily flowing to surface and groundwater sources, which changes the chemical properties of water. This is the reason why urban rainwater quality is also an increasing issue.

Conventional drainage systems are traditionally designed for the fastest drainage. Costs for construction and operation and maintenance of sewer lines are often very large, while their capacity is limited and not easily upgraded. The conventional system creates bottle necks during intense rain situationan as capacity is reached and lead to increased flood risk, erosion and pollution in downstream areas. The rainwater conveyance in conventional system also leads to the loss of in-situ replenishment of groundwater. In order

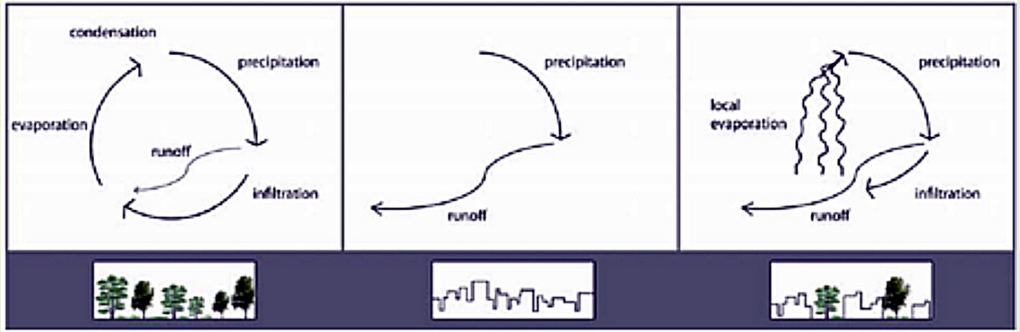
to overcome these issues, alternative technical initiatives were developed with an approach toward maintaining and recovering natural water cycle characteristics in terms of capacity, intensity and quality; maximally controlling the flows at sources, minimizing direct catchment areas, on-site water retention and pollution control - that is a sustainable drainage approach.

Definition of "Sustainable Urban Drainage System (SUDS)" is a drainage system based on utilizing natural ecological functions to build a drainage system with different priciples from conventional drainage principles. That is, instead of how to quickly drain rain-water from urban areas by straight channels, underground drains, box drains, the SUDS slows down the above processes and brings rain water to serve communities with techniques in which to thoroughly utilize the ability to store and clean natural ecosystems to improve water quality, supplement groundwater, and harmonize natural landscapes. In particular, the treatment of pollution caused by dispersed waste and flood prevention is the main and urgent problem.

Indeed, sustainable urban drainage system brings benefits as follows:

Integrate and improve ecology in urban physical space:
- Support and transform conventional drainage system towards more natural cycles.
- Reduce impervious surface area.
- Increase infiltration capacity.
- Improve local micro-climate and environmental quality.
- Increase green space within urban the cityscape.
- Minimize the "urban heat island".
- Support, recover, enhance biodiversity.
- Support the natural water treatment process, water environmental protection.

Reduce load on drainage infrastructure
- Reduce load on the existing drainage network.
- Reduce load on water treatment facilities.
- Minimize risks of flooding and inundation as well as respond to extreme weather events in the climate change context.



Water cycle: in nature (left); in urban areas without sustainable drainage (middle); and in urban areas with sustainable drainage (right). Source: HCU Hamburg

Increase and improve landscape and health of urban communities.

- Enable the whole community and society to be visually and mentally connected to the open water systems.
- Create areas of recreation.
- Create opportunities for people to connect with each other and be more responsible for the environment.
- Create space for education, enhance awareness of ecological issues and urban environment.

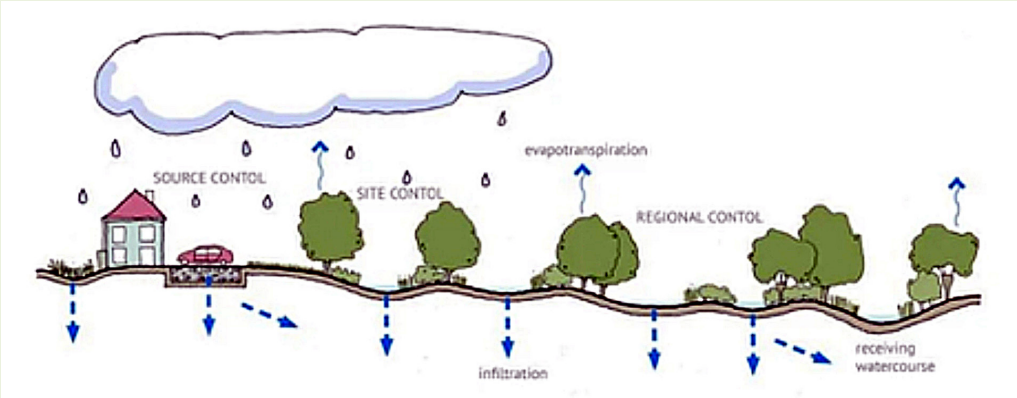
The approach of sustainable drainage system is based on the close relation among sustainable drainage management train from the smallest management level as building (at source) to larger scales such as area and regional scales with a wider range. Finally, rain water is discharged to recipients such as rivers, canals, lakes, etc.

(i) At source control, rainwater should be retained as much as possible to minimize surface flow in order to reduce the load on public urban drainage systems. At the source management level, rainwater is managed as close to the source as possible with solutions such as green roofs, rainwater haversting and reuse, permeable paving.

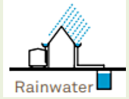
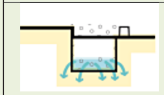
(ii) Area control is often applied to a specific area (eg. residential area, neighborhood, etc.) such as filter strips, swale, infiltration trences, bio-retention.

(iii) At regional control, runoff is stored before discharging to the final recipients with solutions such as retention, detention or reservoirs, constructed wetlands.

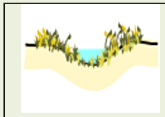
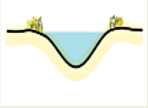
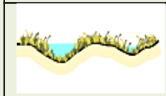
There are a wide variety of sustainable drainage systems which can be linked together in sequence, so that a designer can tailor surface water management to the local context. The following table presents common types of SUDS, their most suitable setting and their typical land take.



Levels of sustainable drainage management

SUDS methods	Description	Sites	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation	Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation	Building	Water storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	Building/ open space	Dependant on runoff volumes and soils.
 Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	Open space	Minimum length 5 metres
Permeable paving	Paving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into ground below	Street/ Open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens	Street/ Open space	Typically surface area is 5-10% of drained area with storage below.

Sustainable drainage solutions are often integrated in planning and design of green infrastructure and green space in urban areas. Although, SUDS has lower initial investment costs than conventional drainage systems. However, according to the experience of some developed countries (e.g. Denmark), the system operation and maintenance requires regular work with high labor costs is a limiting factor in the application of SUDS. However, in many urban areas of Vietnam, the trend of home-grown vegetables (on terrace, balcony, garden) is becoming popular in recent years. Therefore, this is a potential and extremely important factor in combining the urban farming model with the sustainable drainage system to overcome the above challenges when applying SUDS. This approach is very suitable to apply to the management level

 Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration	Street/ Open space	Account for width to allow safe maintenancce typically 2-3 metres wide.
 Hardscape storage	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.	Open space	Could be above or below ground and sized to storage need.
 Pond / Basin	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge	Open space	Dependant on runoff volumes and soils.
 Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	Open space	Typically 5 - 15% of drainage area to provide good treatment.
 Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation	Open space	Dependant on runoff volumes and soils.

at source and area. Therefore, SUDS solution is applied to collect rain water for urban farming and reduce the urban drainage system load and indirectly reducing the flooding risk.

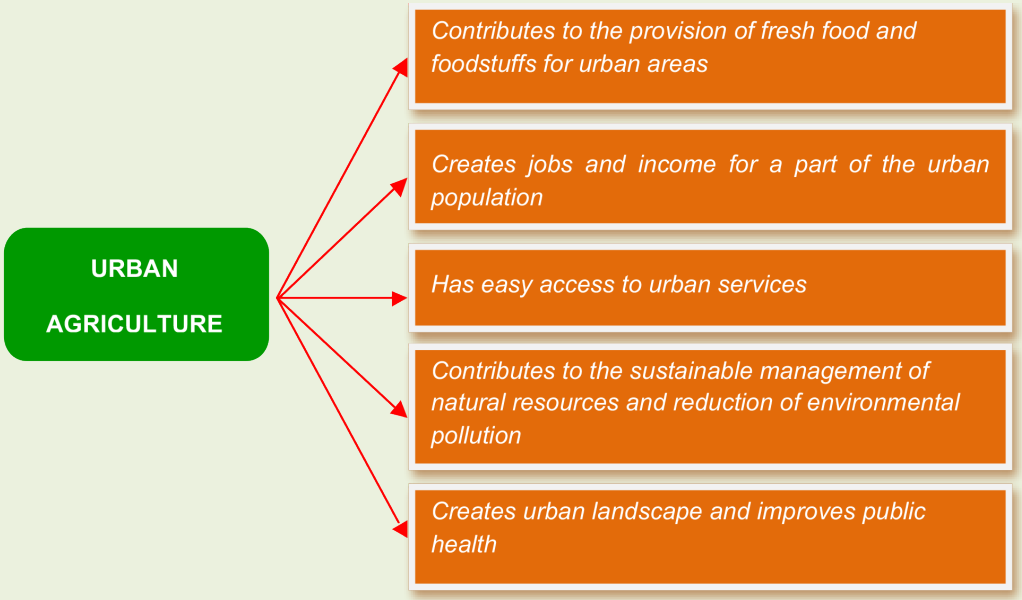
4. CONCEPT AND RATIONALE OF URBAN AGRICULTURE/FARMING

Along with the development of urbanization, the agricultural land area is getting smaller. Urban agriculture development is considered an aspect to meet the requirements of food in some localities. It is a growing trend in major cities in Vietnam as well as in the world. In the view of FAO (The Food and Agriculture Organization), urban agriculture is defined as follows: Urban agriculture is a manufacturing sector in the urban areas and surrounding areas that provides food and foodstuffs.

Urban agricultural space is one of the solutions to solve environmental problems in urban areas (provide green space,

improve micro-climate, support urban drainage…), especially in the context of climate change.

In addition, in urban areas, people currently have tend to switch to self-supply of food due to lack of transparency of the origin of foods as well as concerns about the quality of products on the market. It has started to grow vegetables and fruits on the terrace, home gardens, etc., with different sizes and forms of cultivation. This movement, does not only increase the resilience of the environment, but it also indirectly enhances social relationships, especially with regard to women and the elderly.



This diagram shows the six benefits of urban agriculture with details as follows:

Urban agriculture contributes to the provision of fresh food and foodstuffs for urban areas

The size of the urban population is constantly increasing in the process of urbanization, which also pushes peri-urban poor households into losing their main means of production and increases the number of poor households and low income households in urban areas . The supply of high quality food and foodstuffs is expensive and target the high income households, which leads to an explicit risk of food shortages and meet the basical needs of disadvantaged households. To ensure sustainable development, reduce the lack in the essential nutritional needs of the urban people, urban agricultural development is really an

important solution today. If the organization of production is well planned, it can create a source of fresh and safe foods on site, which greatly contributes to meet the consumption and demand of urban residents.

Urban agriculture creates jobs and income for a part of urban population

Due to common objectives of urban areas in the urbanization process, the problem of downsizing of peri-urban farmers' agricultural land is widespread. Due to losing productive assets, people are forced to change their careers in the context of disqualification, limited capital, and experience, to adapt their lifestyle and to industrial behavior, which make employment problems especially the peri-urban families become more urgent.

Urban agriculture has easy access to urban services

In the context of limited urban and coastal land, the application of new technologies to agricultural production to increase crop and livestock productivity is a matter of necessity and urgency. Urban agriculture has many advantages by applying scientific and technological services into the production. In addition, it is capable of developing specialized models to provide a variety of services to the cities such as greenery, flowers and foods for hotel, providing tourism and convalescence services, etc ...

Urban agriculture contributes to the sustainable management of natural resources and reduction of environmental pollution

Agriculture is a manufacturing industry that requires a huge amount of water. By properly collecting and using rainwater, it is possible to improve water resources management towards sustainable urban development. Collecting rainwater also add urban areas to a higher degree to mimick nature and contribute to a more natural water cycle. Greening the urban areas benefit climate change adaptation by reducing rainwater runoff and cooling the city. One of the important tasks of urban agriculture is to regenerate soil nutrients through the recycling of organic wastes from urban activities. This contributes to reducing the environmental pollution in urban areas while reducing the chemical inputs of fertilizer and cost of fertilizer as well. The quality of products is safe and at the same time a great amount of large vehicles in urban areas as well as traffic accidents and pollution to urban areas are greatly reduced

Urban agriculture creates urban landscape and improves public health

"Eco-urban" or "green-urban" development is the term that is becoming popular in today's urban development forums. The goal to be reached is to plan and build cities that are environmental-friendly and nature friendly along with good public health standards. It will create a system of landscapes and meaningful green belts to urban areas (trees, parks, green spaces on balconies, green belts around perimeters, etc., are considered products of the urban agriculture). Urban agriculture production, on one hand, must meet the nutritional needs, on the other hand, must act as a form of labor and entertainment, and contributing to improving the physical strength of urban residents.

5. CULTIVATION TECHNIQUES IN URBAN AGRICULTURE/FARMING

A/ Soil

Choosing soil is an important step in determining productivity, quality and cost. Vegetables can be grown on many types of soil, but such types of soil must be good at physio-mechanical properties, humus-rich, retaining water and retaining manure .

Each type of vegetable requires a certain soil combination. In the period of seedlings plants contain 2 - 2.5 times lower concentration than that of mature plants. When choosing a nursery soil, it is important to choose good types of soil with lots of humus, water retention effect, low soil solution and white soil should be avoided.

Appropriate pH of some vegetables

Vegetable type	Appropriate pH	Vegetable type	Appropriate pH
Cabbage	6 – 7	Watermelon	5,5 - 6,5
Field cabbage	6 - 7,5	Wild bean	5,5 - 6,7
Cauliflower	5,5 – 7	Peanut	5,3 - 6,6
Napa cabbage	6 - 6,5	Soybean	5,5- 7
Lettuce	6 - 6,5	Indian bean	5,5 - 6,7
Eggplant	6 - 6,5	Potato	5 - 6,5
Tomato	6 – 7	Radish	6 - 7,5
Cucumber	5,5 – 7	Carrot	5,5 – 7
Red pumpkin	5,5 - 6,5	Taro	5,5 - 7

With the model of urban agriculture, traditional soil will be replaced by a mixture of long-term nutrition sources, environmentally-friendly, no toxic, harmful microorganisms, without fertilizers and chemical pesticides. The main contents of this soil include organic matter from coconut dust, wormwood fertilizer, seaweed, useful microorganisms and fermented oil, creating high nutrition helps plants grow and grow well. After harvest, the remaining land can be reused to grow new sprouts or supplement organic fertilizer to grow other vegetables.

No matter what kind of soil is used, over time, land use will be hardened, reduce the porosity, so it is necessary to improve it to increase nutrients for the soil. Old soil after harvest, remove the trees, we carry out tillage, sun drying from 2 to 3 days to destroy the pests remaining in the soil, and collect the green trees will be distributed further development, avoiding the situation of losing nutrition. During the time of soil drying, we should sprinkle more amount of lime powder (reach 1 in the palm of the hand for 1kg of soil), it will make the soil balance the pH and help the soil to germinate well. Allow soil to contain more nutrients for the next batch of vegetables, use organic fertilizers (cow dung, fish manure), micro-organic fertilizer or earthworm and mix it with the soil.

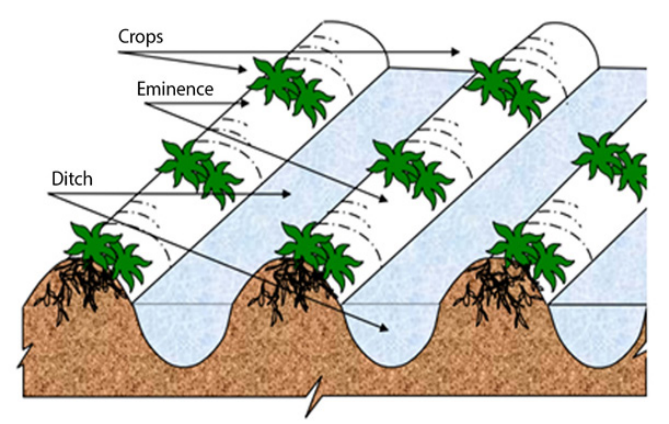
- Land reclamation with organic fertilizer, microbial fertilizer (1: 1 mixing ratio): this type of fertilizer is benign to plants, friendly to the environment, does not generate heat.

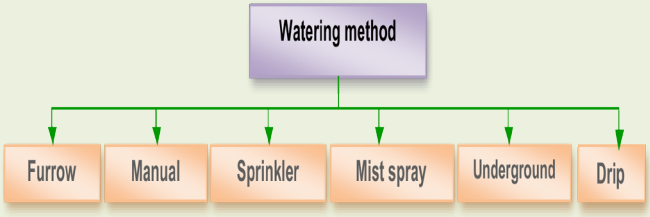
- Land reclamation with earthworm (1: 1 mixing ratio): helps to decompose residual organic matter during planting and harvesting, helping to soften soil, adding organic matter to plants.

The final step is to take the soil out into the sun and spread it dry.

B/ Irrigation water

The water used for irrigation purposes should meet the quality standards of QCVN 39:2011/BTNMT





Furrow irrigation: Let the water flow into furrows, and then soak into the vegetable beds. Let the water flood 1/3 - 1/2 of the furrows and after 3 - 6 hours remove the excess water because of poor flood-resistance of vegetables.

Manual irrigation: Use buckets, watering cans, irrigation containers for manual watering depending on the moisture of the soil.

Sprinkler irrigation: Using irrigation systems with water pipes and high pressure nozzles to make water dispersed in space into small particles such as rain. This irrigation system can be hung or laid on the ground.

Mist spray: It uses the same irrigation system as sprinkler irrigation, but when spraying with high pressure the water appears into the form of mist.

Underground irrigation: Plastic or metal perforated pipes at a certain distance are placed on a bed of vegetables (placed deep in the bed or next to the vegetable). When watering, water is pumped into the pipes and trickles through small holes that supply water directly to the root system.

Drip irrigation: Plastic perforated water pipes, with small holes at certain distances are placed in the middle of the beds (in case of two rows / bed), next to the bed (in case of one row). When watering, the water drips from the infiltration holes to the beds.

C/ Plant protection with organic "medicines"

Pesticides from garlic: 5 crushed garlic bulbs mixed with 500ml of water, then incubated for 24 hours. Must be diluted dilute with 4 liters of water when sprayed. It should be noted that the use of fertilizer should be limited, when spraying this garlic organic solution, as fertilizer reduces the ability of garlic to kill pests.

Epsom salt: One teaspoon of epsom salt mixed with one liter of water is sprayed directly on the leaves. Alternatively, you can sprinkle epsom salt around the stump as a supplement to the plant.

White oil: Mix vegetable oil with liquid natural soap. Then shake evenly until it turns white. Before spraying plants; dilute one tablespoon of white oil with 1 liter of water. Spray plants again after 5-7 days.

Insecticides made from essential oils: Rosemary essential oil helps repel flies, fleas, mosquitoes and insect larvae like cabbage caterpillars. Peppermint essential oil removes aphids, stink bugs, ants, spiders, beetles and fleas. Musk essential oil helps fight insects and insects like ticks. Clove essential oil helps reduce many flying insects.

D/ Some suitable crops for urban agriculture

Within the content of this thematic report, we focus on identifying categories and give a list of crops (mostly vegetables) suitable for the urban agriculture model and conditions of Vietnam such as Vinh Yen city, Vinh Phuc province.

There are many vegetables classification methods, but classification based on cultivation methods and biological properties of vegetables is best, to meet production requirements and understand biological features and cultivation techniques suitable for each type of vegetables.

Plants within the same cultivation method group is identically affected by worms and similar diseases in general:

- Vegetables, edible roots and roots: carrots, radish, beetroot.
- Eating tuber vegetables: potatoes, sweet potatoes.
- Short Leaf vegetables: lettuce, rice, sticky rice, spinach, fennel, sweet cabbage, broccoli, chrysanthemum, celery.
- Cruciferous vegetables: cabbage, cauliflower, improves bixen, kohlrabi.

- Vegetables garlic: garlic, onion, Piro.
- Vegetables and legumes: beans, peas, beans dragon.
- Solanaceous vegetables: eggplant, peppers, tomatoes.
- Vegetable gourd: gourd, pumpkin, cucum ber, watermelon, melon.
- Perennial Vegetables: asparagus, bamboo shoots, artichoke.
- Aquatic vegetables: lotus, water spinach.
- Mushrooms: mushrooms, wood ear fungus (mushrooms), oyster mushrooms.

** Details of some suitable vegetables and fruits are cited in the Appendix*

E/ General process

- Selection of seeds: healthy seeds, high germination rate, no pests. Treat seeds before sowing to destroy pestilent germs and at the same time stimulate seeds to germinate quickly (hot water, kitchen ash water).
- Sowing time: ensure proper heat and light regime for vegetables to grow and develop smoothly. The winter-spring crop sown in September and October for low-temperature vegetables (cabbage, kohlrabi, tomatoes, potatoes, mustard, carrots, bulbs, beans). Spring and summer crops are usually sown in March 2-3 for high temperature vegetables (gourd, tomato, spinach, spinach).
- The soil after sowing should be kept moist often. Clean grass as soon as it appears. Prune and remove weak seedlings.
- Taking care of plants (cultivating soil, killing weeds): When cultivating the soil, pay attention not to overgrown because the roots are usually shallow and mainly distributed in the soil layer 3 cm to 30 cm. Farming deep or shallow depending on the age of the tree.
- Regulating the growth of plants: Some cucurbits produce many branches and tassels, need to remove the branches with less fruit to focus on the nutrition for the tree. For eggplant, remove the branches from the root to the first fruit. For tomato, press tops only 1-2 stalks, and tops to 5-7 bunches of flowers. The melon is cut off all branches from the ground up to 40-50 cm. Prune old leaves.
- For soils with high water holding capacity, the amount of irrigation water can be reduced. Under high temperature and low humidity conditions, the amount of water needs to be increased. When watering, pay attention to ensure a reasonable ratio between air and water in the soil. Do not let standing water in the flowers easily cause flower rot or rupture of pollen grains. Plants have very clear reactions to lack or excess water (cabbage leaves cover a grayish-white layer when water is lacking and purple-pink when excess water; turnip leaves when lacking water have long, small purple leaves, when excess water has veins of light brown green).
- Should choose organic fertilizers, biological fertilizers. Applying the correct technique, enough necessary quantity, balancing inorganic minerals, fertilizing at the right time of growth, right method.
- In order to effectively protect vegetables, it is necessary to adopt a synthetic vegetable protection system (use pest resistant varieties, apply advanced technical measures, regular checks to detect pests and diseases, use careful and reasonable control measures). Clean soil before sowing. Regular weeding to eradicate shelters of many types of worms. Promptly remove diseased and pruned trees, leaves.

6. URBAN AGRICULTURAL/FARMING IN RELATION TO SUSTAINABLE DRAINAGE SYSTEM

Urban agriculture/farming contribute as an element in urban farming through ranwater harvesting. By collecting rainwater e.g. in water barrels or tanks, the rainwater runoff is retained, used in the agricultural system and through evapotranspiration contributes the natural water cycle. Overflow and additional water from the urban agricultural system is to be lead to the conventional drainage system to avoid local flooding. Urban agriculture/ farming can be regarded as one mean that benefit many factors in the urban setting and which can be implemented by local inhabitants without the planning, management and costs of authorities. It can, however, not be regarded as a stand alone climate change adaptation solution, instead it should be regarded as a mean that together with other means in a SUDS system (as excemplified in Table X with SUDS methods) reduces runoff in urban areas. Urban agriculture/ farming is thus one element in a whole system, however, an element with a variety of benefits that futher contribute to the urban environment e.g. greening the city, contributing to the natural water cycle, sustainable food growth, low costs etc.

When combining urban farming with SUDS, especially two important features are to be consideres. The soil composition and the rainwater collection system. Below the soil compostion is elaborated, the rainwater collection system is elaborated in section 7.

One particular characteristic of urban agriculture is to produce on a small area but with high productivity, quality, economic, social and environmental friendly efficiency. Vegetables are often considered one of the most suitable objects for urban agriculture. It can be both a commodity for sale and a product for home consumption.

When growing vegetables, flowers in combined form in the house and applying many advanced techniques, it is possible to create a good environment for their growth and development to achieve high productivity and quality, even absolutely high productivity and quality because the productivity is 5-10 times higher than traditional farming. For example, tomatoes 400-500 tons/ha (in the world), 200-300 tons/ha (in Lam Dong), vegetables, water spinach 500-600 tons/ha/year (already in Ba Ria Vung Tau, Binh Duong). In terms of quality, growing vegetables, flowers in the house is often implemented in a clean process to be ensured throughout the production process, especially on the growing medium or hydroponics; as a result, vegetables can be harvested with high quality and food safety.

6.1. Growing vegetables in the house on normal soil

Advantages: This type is featured by a wide range of advantages such as limited investments, not high technical requirements, possibly applied by many people; possibility to plant mostly leafy vegetables and some vegetables. Without rain, soil used for growing vegetable is dry which helps people to take the initiative for fertilization, watering and spraying pesticide. In the situation of no rain, pesticides is not washed away which make the use of pesticides higher and higher. Dry soil in dry indoor environment also limits many pests and diseases in the soil.

Especially, vegetables are not damaged by rain and leaves are not torn and with a nice appearance.

Disadvantages: Since there are still many pests and diseases in the soil, it is not optimized with nutritions, causing difficulties in achieving peak productivity and quality.

To grow vegetables according to this model, it is necessary to make houses with polyethylene roof (nylon), surrounded by nylon in combination with the net. Depending on the available funds, the frame can be made of iron, iron combined with nulgar bamboo or merely nulgar bamboo. In the case of growing fruit trees with climbing rope, the frame must be sturdy enough to hang the tree itself and its fruits. In these houses, vegetables beds can be created and grown as usual (outdoor growing). The issue to be researched in each place is the height of the house and roof heat dissipation to that the house is airy. In general, all types of leafy vegetables can be grown in this type of house; while only particular fruit vegetables are suitable for this type of use (still to be able to pollinate in case of no butterflies and bees).

6.2. Indoor growing on planting rooms

Advantages: The farming environment is clean, limiting almost all pests and diseases, especially pests that reside in the soil. This makes vegetables having very few pests and diseases and have favorable conditions to achieve the highest yield and quality. It is possible to grow many types of leafy vegetables and some fruit vegetables, but it is necessary to have a system of cultivation (container of growing medium, irrigation systems, nutritional supply systems).

Disadvantages: More capital is required, especially with high cost of creating clean environment (floor, growing medium, water, seedlings need to be clean); more advanced techniques are demanded than that applied for growing on soil. The growing medium as well as the container and proper irrigation must be well selected.

Basically, vegetable grown on the growing medium is the same as the type of vegetable grown on the ground, but the "interior" section

seems to be much different. In details: the floor must be clean and usually lined with a special tarpaulin underlayment. People have to make the right tools or forms to store the growing medium. For example, plastic pots or plastic bags are used to store the growing medium in case of growing tomatoes, cucumbers, melons, sweet peppers. In case of growing leafy vegetables, troughs or vegetables beds (with banks) must be created to store the growing medium. In our country, some materials that can make a good growing medium are coconut husks, rice husk, volcanic foam or sand. In case of using this method, the grower must provide artificial nutrition to the plant. In general, the nutrients is mixed with a mixture of salts, providing the plant with enough multipurpose, medium and micronutrients, and the main method for providing nutrients is to use a drip irrigation system.

6.3. Indoor planting by hydroponics method

Actually, growing on the growing medium mentioned above, in the world, is still called Hydroponics. However, we use the hydroponics term for this method to indicate a method of planting that does not use the growing medium but grows directly in the solution.

Advantages: The cultivation environment is clean, free of pests and diseases from the soil. With an open system of hydroponic (without residual solution and recovery solution) and floating culture style, there is a low risk level of host disease spreading in the solution. Cistern cleaning after each crop is very simple. This makes vegetables have very few pests and diseases and have favorable conditions to achieve the highest yield and quality.

Disadvantages: More capital is needed, especially cost of creating clean environments (floors, tanks, nurseries and plantations); higher techniques are required in compared with planting on soil.

When applying the hydroponics under "floating raft" method, vegetables are sown or transplanted into porous holes and floats on a solution in a tank. Like the vegetable growing house on the growing medium, this house must also have a very clean background, isolated from the soil. Depending on the available funds, the frame can be made of iron, iron combined with nulgar bamboo or merely nulgar bamboo. Nutrition for vegetables in this cultivation method is also mixed from salt of all kinds and supplied to the tank.

The material to be prepared is a foam box with a length of 40cm - 50cm, a height of 15cm, a black nylon lining the box, a plastic basket with a diameter of 5cm, a height of 2.9cm, a height of 7.3cm, a substrate (rice husk) and nutrients that can be sold on the market. Put the hydroponic barrel directly on the cement floor, balcony, yard, .. where the sun is shining, making nets to shield insects. Styrofoam boxes must be lined with black nylon at the bottom of the meeting, black nylon has the effect of keeping the solution and creating a favorable environment for root growth. Drill holes into boxes of the same diameter as the mouth in the plastic, the distance of the holes according to the density of the plants.

There are many recipes for mixing hydroponic solutions. Put the nutritious powder bag into 6l of plain water and then dissolve it in every 0.5l foam box with main solution and add the water level for 12l of water / foam box and stir well the vegetable growing solution.

During the care of vegetables we must regularly check the vegetable boxes to avoid leaking nutrient solution of plants. Need to add clean water until harvest for once-harvested vegetables such as choysum, broccoli. If the vegetables are harvested many times, it is necessary to supplement the nutrient content with 30% of the nutrient content of the main for the first time after each harvest.

6.4. Nursing vegetables in industrial way

This is a technology that has long been used in advanced countries. Vegetable seedlings are planted on the grills with premixed growing medium. The whole production line is placed indoor in clean housing conditions. Depending on the level of investment, it is possible for people to mechanize and automate up to 80-90% of the work.

Nursery seedlings available can bring the vegetable growers the following benefits: (1) Proactively schedule crops and plan without missing crops, (2) Provide enough seedlings as planned and not wasting field space, (3) High quality, uniform, clean

and pest-free seedlings (4) Allow to transplant even in sunny weather because seedlings are potted, (5) After transplanting, the recover quickly with high survival rate due to the absence of roots, growing of vegetables, efficiency of seed use, expensive hybrid seeds, sowing and home care.

These vegetable varieties are industrially produced depending on the type of vegetables in each region. Generally people usually produce and supply the following types: Tomatoes (grafted or not grafted), spicy peppers, sweet peppers (grafted or not grafted), eggplant, cabbage, cauliflower, pickled vegetables, lettuce, watermelon, cucumber and onion.

The soil must be clean and porous. The incubation should be arranged in a clear, uncovered area for hardy young trees and less infested. Seedlings need to be tall, easy to drain, flat so that light and irrigation water are evenly distributed.

Seeds must be treated before sowing by: light sun for a few hours or soak in warm water (2 boiling + 3 cold) to stimulate germination.

Seeds are sown at moderate density, avoiding wasting seeds and seedlings that are not crowded and weak. If possible, sow seeds in perforated nylon pots or coconut leaves and banana leaves. or sow seeds on the seedlings very thick and then pluck them into pots when the plant has the first true leaf.

6.5. Terrace and rooftop garden

Terrace vegetable gardens may be designed with an area of 10m^2 upwards. Depending on the area, priority can be given to trendy vegetables: mainly spices for small areas, spices and leafy vegetables for large areas, and fruit vegetables for even larger areas. In general, dozens of vegetables can be grown such as chili, onions, cilantro, basil, sweet basil, perilla, laksa leaves, leaf lettuce, rice paddy herb, lettuce, broccoli (mustard greens, Chinese cabbage, Chinese broccoli, crown daisy, etc.), amaranth, Malabar spinach, jute, water spinach, star gooseberry, cucumber, bitter melon, loofah, winter melon, lemon, okra, beans, cowpea, tomato, eggplant and African eggplant.

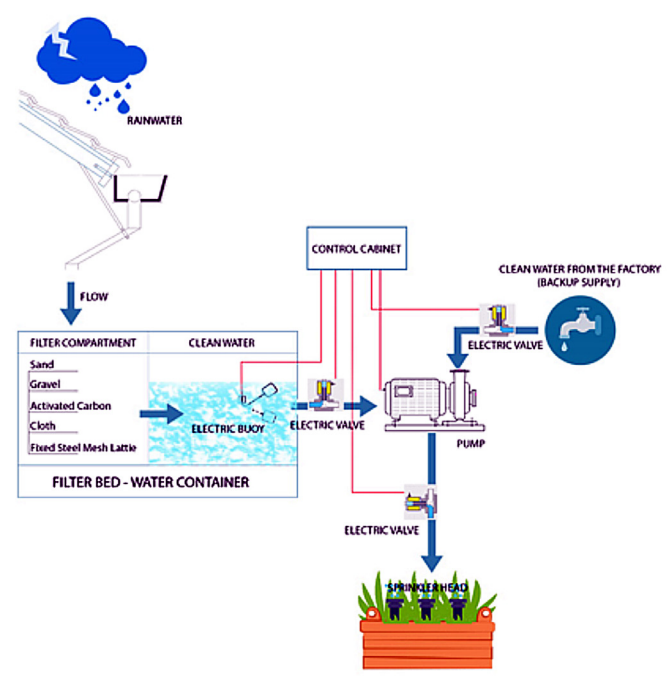
To grow vegetables on the terrace around the year, a roof must be made of light polycarbonate. Vegetable trays are also specialized for terraces and have good uniformity; which can store the growing medium. Every day, the vegetable garden is irrigated by the drizzle system or spraying drip irrigation system. Chemical fertilizers or bioremediation mixture must be used on a weekly basis. As usual, a vegetable garden about 30-40m^2 is basically sufficient enough for a family of 4-5 people. Vegetables will be very clean because of being planted at height, with clean growing medium and free from pesticides. Biological medicine, herbal medicine may be used instead.

7. SETTING UP AND OPERATION OF SUSTAINABLE DRAINAGE SYSTEM COMBINED WITH URBAN FARMING AT BUILDING SCALE

Based on the pilot project in Vinh Yen City, this section provides specific guidance on sustainable drainage application by collecting rain water at source (on the roof) combined with urban agriculture. (use rain water for watering trees, vegetables at the garden, balcony). The following diagram shows the principle of establishing and designing a sustainable drainage system in conjunction with farming at construction level.

Operational principle of the system is based on sustainable drainage control at source. Rainwater is collected from the roof of buildings (households, schools, etc.) to a reservoir with filtering system and control point water level through electric buoy system. Clean water is brought to the irrigation system through electric valve, pump and pipeline network system. All system operations are monitored through the control cabinet. This source of rainwater is irrigated to the plant and vegetable systems on the roof, balcony and garden of the buildings.

If the urban buildings all adopt this solution, they will contribute to a huge reduction in the overall drainage system, which indirectly minimizes urban flooding. The operation of this model is seen as a potential and sustainable solution to maintain a sustainable drainage system by binding to the direct benefits of the application (save water, have self-sufficient food sources, reduce costs to buy vegetables, health safety, etc). Detailed guidance on the



A principle diagram of a sustainable drainage system combined with urban agriculture

content, operational principles, specific set up and operation for each component of the sustainable drainage system is presented below.

7.1. Rainwater harvesting system

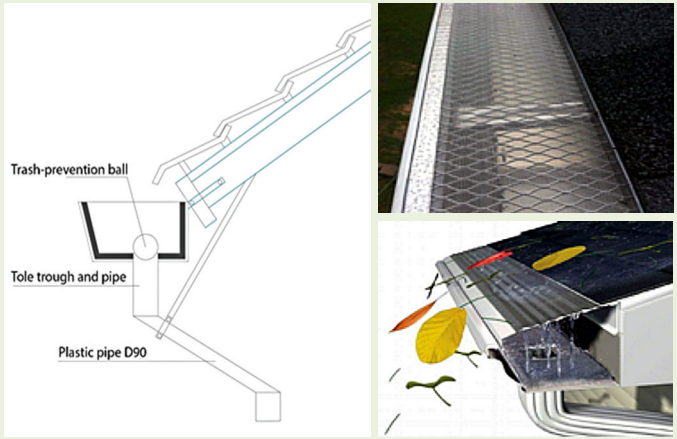
When setting up a rainwater harvesting system the following four steps are to be considered:

1) Determine the location or construction will proceed to collect rainwater. The selection of works is classified into two categories:
+ Public works: priority criteria are community access and potential to be inovated. Applicable public facilities are offices, schools, markets, cultural and sport centre, apartments etc.
+ Civil works (residential houses): it can be applied widely.

2) Assessment of the current status of the rainwater collection and drainage system of the buildings to determine rainwater harvesting spots as well as solutions to improve the appropriate drainage system.

Rainwater is mainly collected from the roofs, so it is necessary to consider and evaluate:
+ Roof water collection system.
+ Pipeline of drainage system.

3) Rooftop rainwater harversting system
+ Determine the water collection catchment (entire or a part of roof).
+ Determine the main harvesting location and detaching points from the roof drainage system of the buildings.



Rainwater harvesting system with gutters

Rainwater harvesting from roofs to storage tanks

4) Pipeline system:

+ If the building has a good collection pipe system, it can take advantage of the current pipelines, installing gutter system and connecting to the new collection pipe system to storage tanks. For buildings where the system is poorly collected or not available, installing the collection system from the building's roof, and installing the gutters (e.g B10 steal net) to prevent garbage and dust.

+ Connect the collection pipeline system (from 60 to 100 mm diameter) from the existing drainage pipe to storage.

7.2. Storage Tank

On-ground tank

Underground tank under pavilion

When implementing a storage tank the following 3 steps are to be considered:

1) Determine the tank position: based on current status of building.

+ Buildings with gardens: tank can be placed underground.

+ Buildings with no available space, tank is built or installed on the roof.

+ On-ground tank: there are 2 types: constructed tanks or ready-to-buy tanks. On-ground tank system has advantages of fast construction, easy to repair but small storage capacity. With a ready-to-buy tanks, it is required to set up a separate filtration system.

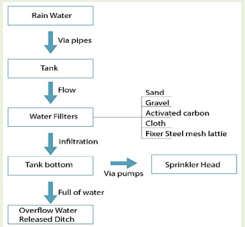
+ Underground tank: Normally a constructed tank, reinforced with solid foundation. Advantages are large capacity, do not impact aesthetic and landscape but it is difficult in repair.

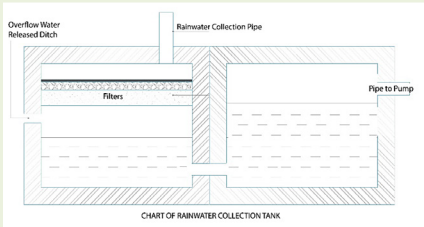
2) Tank design

The tank is divided into 2 compartments: filter and clean water compartments

Filter compartment structure includes: white sand (about 30cm thick), activated charcoal (about 30cm thick), sand layer (about 10cm thick), small gravel (about 10cm thick), filter cloth.

+ Other facilities of tanks include auxiliary water supply systems (operating in case of no rain), drainage systems and spill-proof system.





3) Determine tank capacity:

Tank capacity is calculated based on the monthly average rainfall and the demand of consumption. Depending on the characteristics and area of each building, it can be proposed appropriate tank

capacity with calculation. For the buildings with enough area and space to establish a tank system, rainwater from roof should be haversted. Therefore, if it is determined to collect rainwater of building roof, it is necessary to consider at the design step or review the renovation plan to establish a tank to maximize capture all amount of rainwater from the roof.

Storage tank capacity is calculated by formula:

$$V_{lt} = (Q_{mưa} \times F_{lv}) - (Q_{sd} \times N)$$

Where:

$Q_{mưa}$: monthly rainfall in the study area

F_{lv}: catchment basin area

Q_{sd}: daily used water

N: average number of days in a month, N = 30,5 (days/month)

$(Q_{mưa} \times F_{lv})$: collected water into the tank

$(Q_{sd} \times N)$: used water from the tank

Example: Calculation of tank capacity for a pilot case in Vinh Yen.

At Mrs. Cau's house, with catchment area of $F_{lv} = 77m^2$ and daily use for watering is $Q_{sd} = 0{,}33m^3$. Collect 100% rain water from the roof area of $77m^2$.

With the assumption, the rainy season starts from May to October every year, the dry season is from November to April each year. Start collecting water from the time of May every year. Collect 100% rain water from the roof.

	Basin: $77m^2$											
	Pumping / irrigation: $0.33m^3$/day											
Month	Jan	Feb	Match	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	22.2	23.8	41.8	92.8	173.2	248.5	262	300.1	186.2	126.8	53.8	17.6
Input [m^3]	1.7	1.8	3.2	7.1	13.3	19.1	20.2	23.1	14.3	9.8	4.1	1.4
Output [m^3]	9.9	9.9	9.9	9.9	5.0	5.0	5.0	5.0	5.0	5.0	9.9	9.9
Difference [m^3]	-8.2	-8.1	-6.7	-2.8	8.4	14.2	15.2	18.2	9.4	4.8	-5.8	-8.5
Accumulation [m^3]	47.7	39.6	32.9	30.2	8.4	22.6	37.8	56.0	65.3	70.2	64.4	55.9

Thus, the amount of water needed to store enough for a year for Mr. Lich's house is:

$$V_{lt\ năm} = V_{lt\ tháng\ 10} - V_{lt\ tháng\ 4} = 70.2m^3 - 30.2m^3 = 40m^3$$

Storage tank should be $40m^3$

However, there is limitation of space, storage tank is only $5m^3$, the remaining water is overflowed to conventional sewer system.

7.3. Pump system

When installing a pump system the following 3 steps are to be considered:

1. Pump system: Using 2 types which are vacuum and pressure generator pumps.

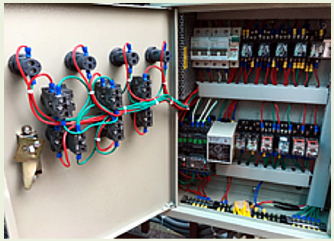
+ Vacuum pump is used to pumb water from the tank. It is applied in completely underground storage facilities. With on-ground and semi-underground tanks, vacuum pump is not required.

+ Pressure pump: will directly provide pressure to pumb water into distribution pipes and sprays. Applied in all systems to ensure adequate pressure for the entire system (because the sprinkler numbers and the length of the irrigation system is not uniform, it must use a pressure pump to ensure pressure in the whole irrigation system).

+ Pumping capacity: Currently on the market, there are many types of pumps with different capacities, however, the pilot project in Vinh Yen uses pumps with a capacity of 250W. This is a common capacity pump with moderate price, high durability and stability.

2. Electrical and electronic systems (automatic control on pump system): The main components in electrical systems and automatic control systems include:

+ Main power supply (220v).
+ Control box (main breaker, automatic control chip, control circuit etc.)
+ 1-way solenoid valve system.
+ Electric buoy system to control pump system with different water level in storage tank.



Electric box - control system

Pump system and protection box

3. Operational principle of the pump system and control system:

The water supply system consists of 2 water sources: rainwater (main source) and tap water (backup source in case of no water in dry season).

In case the tank is full of water, the suction control buoy will close the circuit for the pump to operate, pumping water from the tank for irrigation.

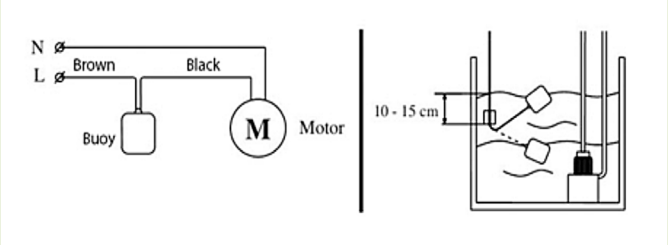
When the tank runs out of water, the suction control buoy will automatically switch to a separate pump to get tap water for irrigation and has a two-way valve to control the input and output water.

- Structure and operational principles of electric buoys

- Control of pump:

When the tank is full of water, the buoy will float and lie in the weight position, the ball through the leverage structure does not affect the contact point relay, the spring in the contact switch release and close the circuit from the brown to black wire, and then close electric for pump operation.

When the tank runs out of water, the buoy will be under the weight, the ball through the lever mechanism impacts the contact point of the switch, which will force the spring of the switch to break the brown-black wire circuit breaker, causing the power to stop and transfer to tap water pump system.



- Control box:

The control cabinet can be assembled by components (the assembler is recommended to be technical savvy when self-connecting the cabinet circuit) or can be bought with ready-made products.

The main components of the control cabinet include:

+ Automatic irrigation controller (already integrated with control circuit, easy to assemble but high cost) or control chip.
+ Magnetic starter kit for the pump
+ Aptomat for the pump
+ System of warning lights and control switches
+ Wifi transceiver set

7.4. Irrigation system

Irrigation network is arranged to every sprinkler in the tree beds or each plant box, including:

+ Main D21 pipeline network (21mm diameter): Connected after the solenoid valve system, supplied with water under pressure from the booster pump
+ Large gardens: D21 PVC pipe network is used to distribute to every sprinkler.
+ Plant box: Water is distributed to sprinklers by D6 (6mm diameter) pipelines (directly connected to the main D21 pipe system).
+ Sprinkler system: Choose suitable sprinklers for purpose of irrigation and the type of plant (mist sprinkler, sprinkler tip, flow-sprinkler head, etc.)

Garden pressure-adjust sprinkler heads

Pot pressure-adjustable sprinkler heads

By wifi transceiver set in the control box the irrigation system can be controlled automatically and remotely via the internet.

The smartphone control application is eWeLink (Sonoff control system was used in the pilot project in Vinh Yen). eWeLink can control the irrigation timing, turn on and off the automatic pumping system and create irrigation cycles for the whole year via wifi and the Internet.

Remotely & electrically controlled water valve and ewelink application interface on cellphone

However, at present, there are many options for the automatic irrigation control chip (made in Europe, China and Vietnam) with each chip having its own control application. Besides, the system can be controlled via the internet with smartphones (for Evergreen irrigation system provided by Vietnam).

These smart home applications allow setting the time of irrigation during the day with automatic setting of the duration. This is extremely convenient as it saves time for taking care of the plants.

7.5. System repair & maintenance

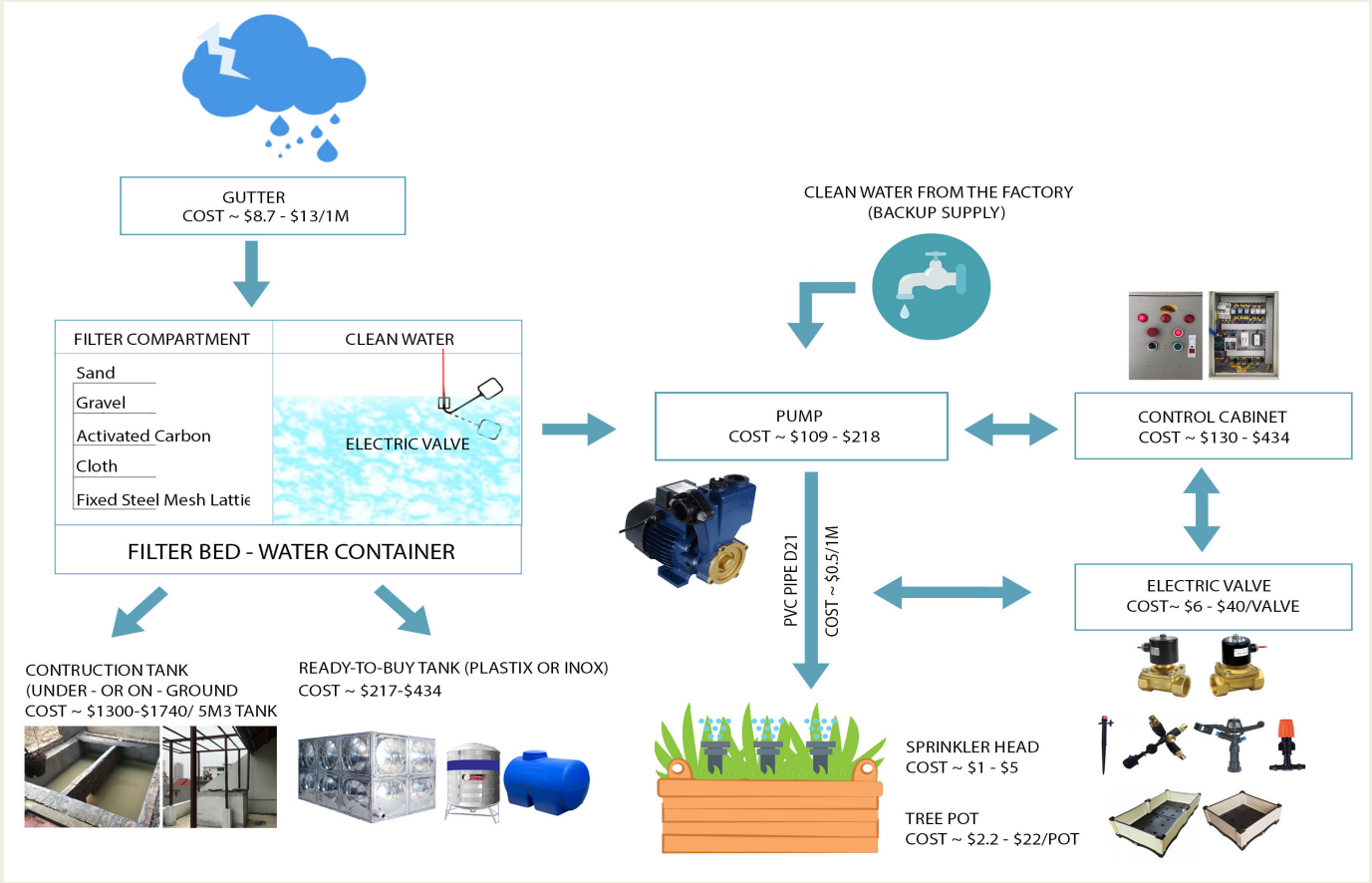
Conduct system inspections every 3 to 6 months:
- Check and maintain the pump system.
- Check, clean, replace filter layers.
- Pipeline system should be checked to avoid damage.
- Replace damaged or clogged spinklers.
- Check plant box, check soil nutrition, conduct additional improvement of soil quality to ensure nutrition and crop quality.

7.6. Setting up cost

The exact cost to establish the system depends on specific building characteristics, including the garden area, roof balcony, pipe network's length to collect rainwater, irrigation water pipes, number of pots, spinklers, etc.

However, based on the actual pilot construction of sustainable drainage system and urban farming in Vinh Yen City, the cost for the basic components required is shown in the following diagram at 40-60 million VND (~ $1800-2800)

Besides, in order to reduce cost, the system should be simplified with prefabricated tank, rainwater collection, manual irrigation and vegetable plant box. This depends on resources and intention of different household and investor.



Basic construction cost of sustainable drainage systems combined with urban farming at building (household) scale

8. PEST CONTROL

Openly exposed food items are an attraction to rats and other rodents. If rats can find an environment with food and shelter, they will appear. Rats can overall be fought by two methods – prevention or capture. The later includes various options likes traps, poison and high frequent sound. Traps has the disadvantage that rats - being smart animal – over time figure out how to avoid and work around them. The same goes for poison, which in addition is a hazard to humans (especially kids) and other mammals. In general rats removed by capture methods are only to be replaces by other rats as long as they can find food and nesting grounds. Consequently, to permanently fight rats access to food and nesting areas must be limited. Food item should be fenced as best as possible with wire fence or similar. Ripe and ready to eat fruit and vegetables should be picked from the gardens and stored in a confined space. It is advisable to use organic waste as fertilizer in gardens, but the waste should gradually be covered by a layer of soil to avoid attracting rats. Situations like the picture below should be minimized.

Rat nests are prevented by sealing holes and removing hiding places. Access to sewage systems should be sealed by e.g. plugging old pipes and drains, and ensure manhole lids are maintained. Hiding places like piles of wood or bricks should be avoided. Absence of rats can never be 100 percent guaranteed.

Hence, fruit and vegetables picked from gardens must be rinsed well before consumption – also be remove possible contamination from other disease vectors likes e.g. flies.

Stagnant water is a potential mosquito breeding ground – especially in the rainy season. Excessive irrigation should be avoided to prevent stagnant water for more than 3 hours. This is also beneficial for the root net of plants, which often does not tolerate long periods of flooding. Stagnant water is also avoided by ensuring garden surfaces and irrigation channels are somehow levelled for prevent pond formation (see pictures above). Pond formation might also happen if the soil is too compact.

APPENDIX

NON-ROLLING CABBAGE (Field cabbage, Mustard greens, White cabbage)

- Suitable temperature: 15 - 22oC
- Sowing seeds from August to October
- Watering: Frequent, moisturizing (80 - 85%)
- Harvest the whole vegetables when it has tubers, without making it flowering
- Pests control

The vegetables often have pests such as leafy green caterpillars, aphids, silkworms, jumping beetles. The main diseases that cause harm to vegetables are usually root rot, rot and withered state

LETTUCE AND LOOSENHEAD LETTUCE

- Suitable temperature: 13 - 16oC
- Sowing: From July to February of next year
- Humidity maintained in 70 - 80%
- Harvest the whole vegetables 45 days after sowing or 30 days after growing. There are varieties that can be harvested in phases

WATER SPINACH

- Can be planted all year round.

- Before being sewn, the seeds should be soaked in warm water at the rate of 2 boiling water: 3 cold water after about 60-90 minutes then picked out the baskets and covered overnight, mixed one time and then be sewn after sprouting.

- After sowing, thin layers of straw or nylon netting should be used to prevent rainwater or irrigation water from splashing the seeds, while limiting weeds and sandy soils.

- Watering: Maintaining moisture 70 - 80%

- Pests and disease control: Leafhopper, diamondback moth, stemborer and superworm: often harmful in young trees (2-3 new leaves). White rust (caused by Albugo Ipomoea), is a very common and widespread disease in the rainy season. In order to prevent these diseases, it is necessary to raise a high bed for good drainage.

- Harvest may be carried out after vegetables are sown about 22-25 days.

AMARANTH

- Suitable temperature: 25 – 30oC. High humidity will help to produce more leaves.

- Sowing seeds from February to July Because the seeds are very small, it is necessary to make the soil thoroughly (making the soil smooth) to allow seeds to germinate. After sowing about 25

- 30 days, the plants are plucked (trees 10-15 cm high), and planted with distance: 15 x 15 cm or 12 x 20 cm.

- Pests and disease control: Amaranth leaves are less prone to pestilent insect pests, mainly caterpillars, deep worms, armyworm.

- After planting 25 - 30 days in the garden, harvesting is carried out. It is usually harvested by spitting, rarely picking.

MALABAR SPINACH

- Suitable temperature: 25 – 30 oC. It is a fast-growing, soft-stemmed vine, reaching 10 meters in length.

- It can be planted directly in rows or sewn seedlings and pruned when 2-3 leaves. The distance is about 20-25cm x 20cm / vine

- It is easy to live, less pests and diseases. The diseases are mainly diseases from pests with common disease as leaf spot.

- When the vine reaches 40 days after sowing, it is usable. When it is old, there is no need to harvest.

AROMATIC VEGETABLES (Onion, Coriander, Perilla, Mint, etc.)

In the urban agriculture model, aromatic vegetables can be planted and tended easily in all external conditions. It is possible to intercrop between other leafy vegetables.

Vines Group

Smooth luffa, Wax gourd, Bitter melon

- The bed 2.5m wide, each bed only grows 1 row. Put in 2-3 seeds on range 30 cm. Started in May.

- Making truss 2m high. When the melon is on a trellis, cut off all the leaves at the base to make it airy.

- From planting to harvesting 80-100 days, The harvest time may last until September.

- Types of destructive insects: crickets, deep soil, cultivars, amulets, thrips, aphids, aphids.

- Diseases: Root rot, leaf blight, leaf spot.

GREEN BEAN

- Belonging to the group of cold-tolerant plants, light-loving, deep root system.

- Making beds: 1m wide, 0.2m high, bed ditch 0.2 0.25m. Sow 2 rows on the bed, distance of 60cm, particle distance 12 - 15cm. After 1-2 days, use the spray to gently irrigate the bed surface.

- Regularly moisturizing soil during the period of flowering and fruit making (70%). When flowering plants proceed to prune old leaves. The fruit is fully ripened (the fruit turns from dark green to light green, clearly visible on the stem).

- The main pests and diseases: Leaf-biting flies, Bollworm, Root rot disease.

CUCUMBER

- Planted all year round. In order to quickly germinate, soak seeds in plain water for 1 night, remove them and drain them before sowing.

- Water melon contains more than 93% water and almost 97% water dispenser so it needs a lot of water. Plug a 1-1.5m high rig A.

- Pests and diseases: ladybug, aphids, leaf droppings.

MELON

- Fruit vegetables have a short growth period (70 days), growing many crops in the year.

- The seeding medium is coconut coir mulch treated with tannin, organic fertilizer (wormwood or manure).

- Planted with white plastic bags of size 40 cm x 40 cm, perforated at the bottom of the bag. Planting beds 30 cm high, 30 cm wide and 20 - 30 m long.

- When planting 7-10 days, start hanging the rope fixed to the tree, to the stage of flowering to pollinate with bees or crafts.

- The main pests are thrips and chalk. Some common diseases are harmful: powdery mildew, plastic blisters.

PROJECT: EXPLOITING THE SYNERGIES BETWEEN SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) AND URBAN FARMING

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