

# Decentralized wastewater management in urban area: case study in Vientiane Lao PDR

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**Abstract:** Urban areas in developing countries, conventional centralized approaches to wastewater management have generally failed to address the needs of communities for the collection and disposal of domestic wastewater and faecal sludges from on-site sanitation, the urban areas are experiencing stagnant pollution. Unsanitary conditions and threat of seasonal pollution in selected spots is likely to occur and increase with the growing urban population. Decentralized approaches may also offer increased opportunities for local stakeholder participation in planning and decision-making, and emphasizes the importance of building the capacity of local organization in all aspects of decentralized wastewater management. Using examples of functioning systems from the operational sustainability of decentralized technologies for wastewater management in urban areas and their associated management requirement. This paper concludes that a concerted capacity building effort is required to overcome the constraints that hinder the implementation and sustainability of decentralized wastewater systems.

**Keywords:** Decentralized, policy, decision-making, implementation and institution of  
Wastewater management in Vientiane Lao PDR

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## I. INTRODUCTION

Urbanization is one of the most important demographic trends of the twenty-first century, and growth is particularly rapid in low-income countries. The majority of urban growth is associated with the rapid expansion of small urban centers development. Much of growth is unplanned and informal, with community members and informal sector developer taking advantage of the fact that the regulatory capacity of government authorities is weak, particularly in those areas that are outside official municipal boundaries. Urban areas are characterized by mixture of land uses associated with range of urban and peri-urban livelihoods. Settlements are generally inhabited by communities of different economic status relating to land prices, which are affected by location in relation to the city, and which are considerably higher than in rural areas. Due to ongoing development, urban areas are generally in a state of rapid transition that may result in serious social and environmental tensions.

At the moment, Vientiane has a population of 692,900 people with density of 176 people per km<sup>2</sup>. The population density is increasing at a rate of 4.7% per year<sup>2</sup>. The urban area is divided into 198 villages with a total area of approximately 30 Km.<sup>2</sup> The core urban population was estimated to be 180,410 people. The urban area of Vientiane is located between the Mekong River and a hinterland of swamps and ponds. The wastewater from individual households in Vientiane has been discharged into open drains along the roads and into natural wetlands in and around the city.

### 1.1 Deficiencies of centralized approaches to service provision in urban of VCC

The environmental problems associated with urban areas are consequence of the number of people producing wastes, and their high concentration. On the other hand, the large concentrations of people would appear to offer greater opportunities for centralized approaches

to the provision of infrastructure and service, which may actually reduce the per capital cost of service provision.

Overtime, Urban VCC land has been going through tremendous transformations due to sprawls in agricultural, industrial and urbanization. The changes in land use affect the ecosystem in terms of land cover, land quality and capability, weather and climate, quantity of land that can be sustained. The development projects include: (i) **Rehabilitation of Sihom Area, UNCDF/UNDP, 1991-1997**, The Vientiane Master Plan identified priority areas suffering from environmental problems related to poor drainage, household sanitation, and access to services such as waste management, (ii) **Wastewater Management of Thatluang Marsh, EU, 1993**, The Thatluang wastewater management project was designed to improve wastewater treatment and drainage out of the central Vientiane area, (iii) **Vientiane Integrated Urban Development Project, ADB, 1996-200**, The overall objective of the Vientiane Integrated Urban Development Project was to improve access to basic services and infrastructure, thus providing benefits to the urban environmental and health population of Vientiane, (iv) **Improvement of Urban Environment in Vientiane, Lao PDR, Danida, 2001-2004**, Project aimed to continue support to municipal planning with development of linkages between green and brown environmental issues and increased village involvement in environmental planning, implementation, and monitoring.

## **II. DECENTRALIZED APPROACHES TO WASTEWATER MANAGEMENT**

In response to the deficiencies of centralized approaches to service delivery, in recent years there has been increasing emphasis on the potential benefits of adopting decentralized approaches to sanitation and wastewater management, which are considered to be particularly appropriate for urban areas. According to the governor of Vientiane capital city, decentralized wastewater systems may provide a cost-effective and long-term option for meeting public health and water quality goals, particularly in less densely populated area. Broadly speaking, the implication of decentralization on wastewater management system relate to planning and decision – making, design of physical infrastructure, and management arrangements operation and maintenance. More generally, decentralization is also seen as a way of strengthening the role of local government and democracy in general, and as an effective means of addressing environmental and health concerns.

As known, urban centers are always attractive places for both educational institutions and employment opportunities, increasing in-migration from rural to urban areas is commonly observed. Currently, VCC lacks of effective systems of development control, and therefore the means to control future development and its concomitant environmental degradation are inefficient. Drainage system is shown to be inadequate. Added to that, the contamination of carried liquid waste, with faecal matter from latrines has been directly discharged into drainage channels or drains where oviform from septic tank effluents. Although decentralized system have yet to be widely accepted and implemented in practice, these do appear to offer a number of potential advantages. These relate to opportunities for grater advantages, and to the benefits of segregation of wastewater at source and compatibility with local demands for wastewater treatment.

## **III. DECENTRALIZED DECISION – MAKING AND PARTICIPATORY PLANNING**

Decentralize planning and decision-making in wastewater management offers potential benefits relate to increased responsiveness to local demands and needs and hence, increased willingness of communities to pay for improved services. An integrated environment plan has been developed by the inhabitants of informational settlement in urban area of VCC, and this has formed the basis for local action and also for negotiating support from external agencies. Where the poor people are already involved in local agricultural system, there is possibility that improving decentralized management system will achieve a better distribution of benefits that

more centralized management approaches. Increased stakeholder involvement at the local level is often promoted by the local governments, which encourage a demand – responsive and participatory approach and often act as intermediaries to improve the flow of communication and broker agreements between community and local government authorities. In relate to the infrastructure provision, the local authority can pay a key role in assisting communities to develop their basic services, but it must also be recognized the local authority and indeed community involvement as a whole, do not offer a panacea to the deficiencies of public sector. In particular, local authority may lack the technical know – how required to plan and design effective decentralized schemes, whilst community organization will not automatically provide the stability and reliability required to provide long-term management to those schemes.

### 3.1 Financial advantages of decentralized management

The capital investment for decentralized wastewater system is generally less than for centralized system in urban areas. By the tackling wastewater problems close to source, the large capital investment of trunk sewers and pumping cost associate with centralized system can be reduced, thus increasing the affordability of wastewater management system. Decentralized approaches to faecal sludge collection and are particularly appropriate for urban area, as that reduce haulage distances and thus reduce the cost of transportation. The investment may require little more that improvement to existing informal wastewater collection system and the introduction of an appropriate form of treatment prior to disposal.

### 3.2 Segregation of wastewater at source

Domestic wastewater consists of “back” water, the mixture of water and faeces flushed from Water Classis (WCs) and pour-flush toilets, and “grey” water, the sullage from kitchens and bathrooms. Grey water contains much lower pathogen levels and has a low oxygen demand than black water and therefore represents a much smaller health and environmental health threat. Grey water and black water are produced separately, and ensuring that they remain separate can facilitate management of two wastewater streams. Grey water can than be used for irrigation or discharged into local water course with little or no treatment. Wastewater discharge in VCC, there are three main drainage channel systems including Hong Xeng, Hong Ke and Hong Khoua Khao. Hong Xeng mainly drains (Figure 1).

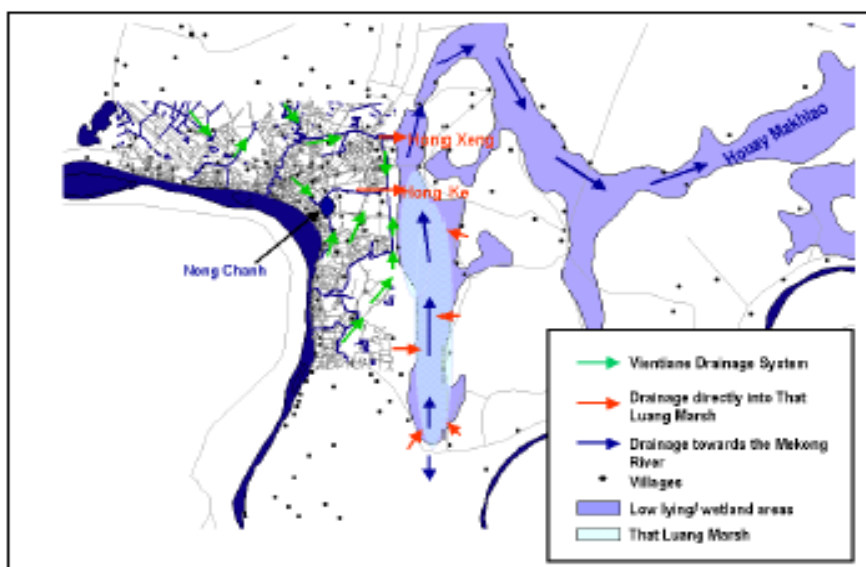


Figure 1: Wastewater Discharge in VCC

The absence of overall urban drainage plans with a functioning integrated network combined with lack of clear arrangements for maintenance cause flooding and stagnant water pools over large parts of the urban center. Sanitation system in VCC entails an on-site disposal of human waste without an introduction of full water bone sewerage with treatment facility and safe disposal arrangements (STEA, 2000s).

### 3.3 Compatibility with local demands for wastewater.

Decentralized wastewater systems are likely to be compatible with local demands for wastewater re-use in urban areas where water and the nutrient content in the wastewater increase agriculture productivity and contribute to the livelihoods of urban communities. Wastewater may also be reused for aquaculture, in which aquatic plant biomass is used either directly or as an ingredient in a feed – mix raise fish or livestock for human consumption. Wastewater re-use can promote incentives for local people to operate and maintain local systems, and thus help to ensure long – term operation and financial sustainability. The re –use of wastewater can increase local agricultural productivity, resulting in increased revenue for local producers.

#### **IV. OPTIONS FOR DECENTRALIZED WASTEWATER TREATMENT**

In order to ensure that decentralized wastewater management systems protect against adverse impacts on health and the environment, some form of treatment will be required before effluents are discharged or re-used. The relative sophistication of conventional treatment processes presents difficulties for operation and maintenance at the local level, and these technologies are unlikely to be appropriate for local use because they require carefully and skilled attendance. Although these technologies are less dependent upon power for operation than more advanced technology, they require increasing amounts of land, especially where wastewater re-use. A potential constraint on localized management is therefore the limited availability of land for treatment facilities. This is particularly important in the case of simple options such as waste stabilization ponds and constructed wetlands. Land ownership can constrain the implementation of decentralized wastewater management systems due to the ineffective planning and control over information development.

##### **4.1 Wastewater stabilization ponds**

Wastewater stabilization ponds include anaerobic ponds, facultative ponds that combine aerobic and anaerobic processes, and purely aerobic maturation ponds. The obvious advantage of ponds systems is their simplicity. A second advantage is their long retention time means that they are better than most treatment options at reducing pathogen levels. They can produce economic benefits in that maturation ponds provide good environment for growing fish such as tilapia. The effluent from ponds has fairly high algae concentration, so it is good resource for irrigation. One disadvantage of waste stabilization ponds is that they require a relatively large area of land, especially when combined with wastewater re-use. Wastewater stabilization ponds may be integrated with re-use systems for the production of plants (e.g. duckweed and water hyacinth).

##### **4.2 Construction wetland**

Construction wetland (reed beds) can provide a low cost and appropriate technology for the treatment of domestic wastewater and fecal sludge's, but will normally require pretreatment and so can only be considered as a second treatment option. Like waste stabilization ponds, they can be fairly good at removing pathogens, but facilities have to be designed and operated in a way that controls disease vectors, especially mosquitoes, and odours. Little examination of industrial wastewater production around the city is little known about the extent of industrial water pollution. According to the country's Environmental Law (Provisions on discharge of waste water from factories, Ministry of Industry and Handicraft decree No. 180/H) industries are responsible for the treatment of all wastewater and by-products produced as part of industrial processes. The Water Resources and Environment Administration (WREA) are responsible for assessment and monitoring of wastewater quality. WREA is currently in the process of developing an environmental monitoring system for the country as a whole but at this point very little information is available about the industrial waste.

In relation to Sanitation and Wastewater purification, Thatluang Marsh is currently performing wastewater treatment services of domestic wastewater that is being drained into the marsh. There are two major types of costs that are associated with artificially replacing the wastewater treatment and water purification services of Thatluang marsh:

- Construction or improvement of household sanitation facilities in areas that drain directly in the marsh
- Extension of the waste treatment plant so that it can deal with increased waste load.
- According to the ADB survey in Sanitation, Drainage, and Wastewater Management, the households which directly discharge their sewage directly into surface water and draining their wastewater into Hong Ke and Thatluang marsh.

It should be noted that with high water table and impermeable soils throughout Vientiane Municipality, sanitation using cesspools or elevated soak ways are largely inefficient and provide inadequate services.

## **V. RECOMMENDATIONS**

There are a range of technologies for the treatment of wastewater that are suited to decentralized management systems and which may be adopted for use in low – income urban communities. However, most of these have not been utilized widely and remain in localized areas and pilot project. The constraints to sustainability of these systems and the opportunities for replication have been described. In order to overcome these barriers to widespread implementation, a concerted capacity – building strategy is required. As proposed below, this is based upon four targeted levels associated with advocacy, development of appropriate policies, institutional strengthening and training.

### **5.1 Advocacy**

Due to the demand for improved wastewater management, the main challenge for planners and practitioners. Vientiane urban development administration authority (VUDAA) is to create informed demand for improved systems, focusing not only on health but also on the improvements in the local environment and in the household finances that may be achieved through improved wastewater management. Advocacy at the political level is required and, at the community level, awareness campaigns to promote the benefits of improved wastewater management, involving extensive social communication and mobilization, are necessary. VUDAA has technical assistant support from JICA's technical; and urban research institute to develop the master plan of VCC. This suggests and need to document experience and encourage the implementation and monitoring of additional demonstration project in order to stimulate a wider interest in the benefits of decentralizes wastewater management.

### **5.2 Policy and recommendations**

VUDAA is a need to incorporate wastewater management systems within an integrated framework of water resources management and other services of water supply and solid waste management. Official design standards may not be framed in a way that supports the develop of decentralized systems. There is therefore a need to develop appropriate standards to utilize for design and construction of decentralized wastewater system, and also to promote realistic and acceptable standards for treatment where wastewater is re-used. The policy need to be developed in close collaboration with organization involved with those communities that the decentralized wastewater system are designed to serve. The processes of planning and implementation VUDDA addressed in partial aspects of environmental problem, since there are may be an ability to handle wastewater disposal within municipality borders. However, water and sanitation disposal often calls for city-wide solution, metro-level authority to plan, coordinate, and execute

a wastewater disposal program. The planning has generally not been an effective environmental tool, although monitoring varies according to the city's level of economic and human resource development. In terms of environmental coordination and decision making process, intersected coordination to manage urban environmental affairs has been lacking and has become a problem in VCC, although below coordinating mechanism has been established for urban development in VCC:

- At the central government level, there is a planning body that is in charge for synchronizing interdepartmental coordination for urban activities.
- At the VCC level, there is a community to coordinate sectoral program and projects from loans (i.e., ADB loans).
- For implementation of infrastructure activities, there is a program to coordinate investment and institutional strengthening (i.e., VUDAA, PWREO).

### **5.3 Institutional strengthening**

This involves a change of focus of activities, whereby traditional centralized agencies take on a different role, focusing on the need for capacity strengthening to develop new skills to respond to the need and demands of communities. This places greater emphasis on the role of recentralized agencies as facilitating organization, providing technical assistance and focusing on improved system for coordinating the activities of different stakeholder group involve in decentralized wastewater management. Lao government strategies on the development and maintenance of urban environment infrastructure are based on achieving sustainable and affordable environmental improvement of its main urban center (WREA, 2004). Implementation priorities relate to specific urban center needs, which would be identified along with urban hierarchy adopted by government. Such urban drainage plans with the need for creating and maintaining functioning drainage network, including identification of final points of discharge must be emphasized.

### **5.4 Training and dissemination of technical information**

The choice of technology is limited by the need to ensure that the operation and maintenance requirements of the chosen technology are compatible with the levels of knowledge and skill available at the local level. There is often a lack of knowledge of decentralized option and a shortage of qualified workforce and skill for operation and maintenance. The management requirement in terms of the local availability of skills and knowledge to operate and maintain technologies and service for wastewater and faecal sludge management are therefore critically important. There is therefore focus on the training of stakeholders to enable them to understand how various technologies operate their operation and maintenance requirements, and the implication in term of possible effluent re-use. There is also the need to disseminate technical information in appropriate forms and languages, in ways that are understandable and relevant to need of those who are responsible for the design and operation of decentralized wastewater and faecal sludge collection and disposal systems.

## **VI. CONCLUSIONS**

Sanitation, including wastewater treatment is an important environmental service that is closely linked to water management. In VCC, outfall from poor functioning central sewage system contaminates water resources. Moreover, urban VCC land has also been going through tremendous transformations due to sprawls in agricultural, industrializations and urbanization, there has been little sustainable built of project design resulting in discontinued use of the wastewater stabilization ponds and limited use of the waste treatment plant in Thatluang marsh. Access to and affordability of adequate sanitation is always a problem for the poor, especially in the low-income household.

## 6.1 Public-Private Participation

In response to the deficiencies of centralized approaches to service delivery, in recent years there has been increasing emphasis on the potential benefits of adopting decentralized approaches to sanitation and wastewater management. These relate to opportunities for stakeholder involvement in decision-making and planning, financial advantages, and benefits of segregation of wastewater at source and compatibility with local demands for wastewater reuse. In general, central elements that shape the institutional setting for environmental management include: a) the key actors in the public and private sectors whose motives and mandates significantly affect the urban water and sanitation, b) management functions that can be use to address environmental issues in urban city, including instruments of intervention and mechanism for coordination, and c) existing initiatives that affect effort to wastewater and sanitation problems.

## 6.2 Wastewater and Sanitation Management Function

Management function consists of policy and other instruments that actors can apply to affect environmental quality and mechanisms in coordinating environment-oriented decision. Urban governance often adopts policies to deal with wastewater and sanitation management problems. Based on that, the government will formulate a long-term national wastewater and sanitation strategy to guide any future investment in water and sanitation activity. The most prevalent tool for environmental management that affect city is that of legislation and regulation. The sophistication and effectiveness of this tool is low in Laos, since there are only few environment standards and an incomplete set of environmental laws. Moreover, lacking of enforcement is a pervasive problem. However, environmental impact assessment (EIA) process is being positively promoted and selectively implemented in Lao PDR.

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