Why DEWATS is Still Not Popular in Vietnam?

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Abstract: While large centralized sanitation projects are not affordable for most cases in urban and rural areas, the only way to increase sanitation coverage, especially for the poor, is to implement low-cost alternatives with decentralized sanitation management schemes where local community, administrative authorities and private sectors are involved in the decision making as well as in the exploitation process. Despite of that, there are some reasons discussed why decentralized wastewater management concept and its application is still not widely disseminated throughout Vietnam. Among institutional and managerial aspects there are weaknesses of environmental pollution control capacity at different, especially local levels, limitations of existing Vietnamese environmental standard system, and lacking of incentive measures to encourage consultants to go for the decentralized wastewater concept, as well as to force polluters to improve their situation. In term of finance, discussed pints are low wastewater fee, and limited participation of private sector in the business. In technical aspects, there are limited information of appropriate and proven technical options for different contexts, lessons on their performance and system setting up. Besides, difficulties in the household connection and in collection network are among factors. The paper also provides some examples of decentralized alternatives implemented in different sanitation projects at different scales in Vietnam.

Keywords: Baffled septic tank, constructed wetland, decentralized wastewater management, Vietnam

INTRODUCTION
Improvement of sanitation systems for urban, peri-urban and rural areas in Vietnam is very challenging and becoming more and more crucial issue in this fast-developing country. According to the Ministry of Construction (MOC), in the large cities, 50-80% of households use septic tanks, treating mostly black wastewater, while 10-20% uses simple pit latrines. In other cities of the 3rd, 4th and 5th categories, 20-50% of the households use septic tanks and 30-50% use pit latrines or double vault latrines. The current system does not have the capacity to respond to the demands created by wastewater and run-off from urban areas, industrial centres, and agricultural land. Water bodies such as lakes, streams, and canals increasingly serve as sinks for domestic sewage and industrial wastes. It is estimated that only 10% of urban wastewater is treated (Nguyen V.A., 2009).

While large centralized sanitation projects are not affordable for most cases in urban and rural areas, the only way to increase sanitation coverage, especially for the poor, is to implement low-cost alternatives with decentralized sanitation management schemes where local community, administrative authorities and private sectors are involved in the decision making as well as in the exploitation process (Nguyen V.A., 2004). This concept is being developed in Vietnam, even though it still requires more efforts and co-operations before it could be widely disseminated in the practice.

DECENTRALIZED WASTEWATER MANAGEMENT CONCEPT AND TECHNOLOGIES

Decentralized wastewater management concept
There is a growing tendency to argue that decentralized solutions would be more effective than a sewer-based centralized system for pollution control. Decentralization of wastewater management systems relate to planning and decision-making, design of physical infrastructure and management arrangements for operations and maintenance (Parkinson and Taylor, 2003). The decentralized approach offers important benefits, namely by the possibility of dealing with wastewater locally, and applying pollution control measures at the source. By tackling pollution problems close to their source, the large capital investment of trunk sewers associated with centralized systems can be reduced, thus increasing the affordability of wastewater management systems. Furthermore, decentralized systems allow an incremental approach to provision of facilities. In some cases, the investment may require little more than improvements to existing sanitation infrastructure (Parkinson and Taylor, 2003). Furthermore, in a agriculture-based country like Vietnam, where wastewater reuse and nutrient recycling has a long tradition, decentralized management systems are
likely to be compatible with local demands for wastewater reuse in urban and peri-urban agriculture.

Another advantage of decentralized systems in developing countries is that the systems are mostly developed and run with more community-based approach, where users are involved from the early stages of infrastructure system planning. Experience from number of infrastructure development projects in this region have shown risk of failures of centralized waste management systems due to there are no ‘‘willingness-to-connect’’ and ‘‘willingness-to-pay’’ from the local users. Local resource contribution in decentralized wastewater management systems make the system financial requirements affordable and feasible, the user participation and the decision-making process more committed. Besides availability of appropriate technologies, those conditions are necessary for sustainability of infrastructure system.

Government policies
Over the last two decades, Vietnamese Government has spent about USD 2 billion in water and sanitation infrastructure improvement. However, the coverage of water supply and, especially, sanitation services for the whole country is still lagging behind set targets. More and more stakeholders have started to recognize importance of decentralized wastewater management concept. The terminology of ‘‘decentralized wastewater system’’ is now mentioned more and more as an appropriate technical solution in a number of project documentation and legislations. For achieving that, great efforts of some Vietnamese and international partners in promotion of decentralized sanitation in the country are to be acknowledged, such as projects by Decentralized Sanitation (DESA) group initiated from the long-term cooperation of Institute of Environmental Science and Technology (IESE), Hanoi University of Civil Engineering and Swiss Institute for Aquatic Research (SANDEC, EAWAG), demonstration projects of GTZ and KfW, BORDA, etc.

Up to now, decentralized sanitation concept and technologies have been brought into teaching curricula of such courses as Water Supply and Sanitation, Environmental Technology at some Universities in Vietnam. The Wastewater Effluent Standard for not connected to the sewers and small flows TCVN 6772:2000 has been developed, and later replaced by the National Code QCVN 14:2008/ BTNMT (see Table 1). Some technical guidelines for decentralized sanitation solutions are being compiled by the Ministry of Construction, and Ministry of Health.

Decentralized wastewater treatment technologies
Wastewater collection and treatment just has been put into focal consideration of the Government of society in Vietnam in the last decade, when environmental pollution due to wastewater started create more and more problems and led to different responses. Besides traditional centralized wastewater systems constructed for large urban centers, it is estimated that some thousands of decentralized wastewater systems have been installed across the country for office buildings, hotels, factories, hospitals, new communities, trade villages, Representing decentralized wastewater management systems are introduced in Table 2.

Table 1: Vietnamese National Code for wastewater effluent quality QCVN 14:2008/ BTNMT

<table>
<thead>
<tr>
<th>No</th>
<th>Parameters</th>
<th>Column A (a)</th>
<th>Column B (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>5 - 9</td>
<td>5 - 9</td>
</tr>
<tr>
<td>2</td>
<td>BOD₅ (20°C), mg/l</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>TSS, mg/l</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>NH₄-N, mg/l</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>NO₃⁻, mg/l</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>PO₄³⁻, mg/l</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Total Coli forms, MPN/100 ml</td>
<td>3,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>

(a) - Maximum allowable values for wastewater discharged to water bodies serving domestic water supply purpose.
(b) - Maximum allowable values for wastewater discharged to water bodies serving another purposes (irrigation, water transport, etc.).
Table 2: Some decentralized wastewater treatment models installed in Vietnam over last decade

<table>
<thead>
<tr>
<th>Location</th>
<th>Technologies applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitals, hotels, apartments, office buildings in the urban centers(^{(a)})</td>
<td>Activated sludge process, Trickling filter, Submerged aerated filter, A(^{2}O) Jokahso and other packaged pre-fabricated plants</td>
</tr>
<tr>
<td>Pig farms(^{(a)})</td>
<td>Biogas digester</td>
</tr>
<tr>
<td>Vietnam Friendship Village in Xuan Phuong commune, Tu Liem district, Hanoi (2008)(^{(b)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + HF CW</td>
</tr>
<tr>
<td>Low-income residential area in Vinh Yen town, Vinh Phuc province (2007)(^{(b)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Xuan Mai concrete factory residential quarter, Chuong My district, Hanoi (2007)(^{(b)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Lai Xa village, Kim Chung commune, Hoai Duc district, Hanoi (2008 – 2007)(^{(b)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + HF CW</td>
</tr>
<tr>
<td>Ta Than Oai and Huu Hoa communes, Thanh Tri district, Hanoi (2005)(^{(b)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Tam Da village, Tien Son district, Bac Ninh province (2002)(^{(b)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Wastewater collection and treatment system for Cho Ra town, Bac Kan province(^{(b)})</td>
<td>Separate low-cost sewerage, BASTAF + HF CW</td>
</tr>
<tr>
<td>Wastewater collection and treatment system for Cho Moi town, Bac Kan province(^{(b)})</td>
<td>Separate low-cost sewerage, BASTAF + HF CW</td>
</tr>
<tr>
<td>Wastewater collection and treatment system for Nuoc Hai town, Cao Bang province(^{(b)})</td>
<td>Separate low-cost sewerage, BASTAF + HF CW</td>
</tr>
<tr>
<td>Kim Bang district hospital, Ha Nam province(^{(c)})</td>
<td>ABR + HF CW</td>
</tr>
<tr>
<td>Thanh Hoa Children hospital, Thanh Hoa province(^{(c)})</td>
<td>ABR + HF CW</td>
</tr>
<tr>
<td>Bear care center in Tam Dao Natural park, Vinh Phuc province(^{(c)})</td>
<td>ABR + HF CW</td>
</tr>
<tr>
<td>Cluster in Kieu Ky Commune, Gia Lam district, Hanoi city(^{(a)})</td>
<td>Combined sewerage and drainage with CSOs, ABR + HF CW</td>
</tr>
<tr>
<td>Cluster in Lim town, Bac Ninh province(^{(a)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + Facultative pond</td>
</tr>
<tr>
<td>Cluster in flood evacuation cluster, An Giang province(^{(a)})</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + Facultative pond</td>
</tr>
</tbody>
</table>

\(^{(a)}\) – implemented by different service providers.
\(^{(b)}\) – by DESA team, IESE.
\(^{(c)}\) – by BORDA Vietnam

A\(^{2}O\) – anaerobic – anoxic – oxic treatment process.
ABR – anaerobic baffled reactor.
BASTAF – baffled septic tank with anaerobic filter.
CSO – combined sewerage with overflow chambers.
HF CW – horizontal flow constructed wetland.

In most of projects, the challenges faced are technological option selection, quality of design and construction, associated with consultants’ competency, administrative appraisal procedures, low rate of household connection, financial sustainability, local capacity for O&M, monitoring, evaluation and control in the exploitation stages, which will be discussed later.

Conventional technology with activated sludge, or high-tech packaged treatment plants are often used by commercial or public users who can afford to pay for the investment and O&M costs of the wastewater treatment systems installed in limited spaces.

Most of decentralized wastewater management systems introduced by DESA team have been selected with participation of the public who has been persuaded by the advantages of the systems such as low cost, simple technology and construction, etc. Awareness raising and local capacity building through IEC campaigns played very important and unavoidable roles for ensuring of the project success.
Barriers for dissemination of decentralized wastewater management concept

There are some reasons discussed why decentralized wastewater management concept and its application is still not widely disseminated throughout Vietnam as follows.

**Institutional and managerial aspects.** Overall, a lack of government commitment to address wastewater related problems creates a political and institutional environment, which has few incentives to manage wastewater effectively (Morel *et al.*, 2009).

Vietnamese environmental standards are still not fully developed. There are still big gaps and contradicting matters among effluent standards, water resource classification, values for parameters, etc. For example, it is still not clear which class of B or C of the Vietnamese regulation QCVN 14/2008-BTNMT is applied for wastewater discharge from restaurants, hotels and other services within Hanoi city. Besides, values of some parameters set in said standard do not comply with available and affordable technologies. For example, conventional activated sludge or combination of anaerobic treatment followed by single-pass aerobic treatment step in trickling filter, sand or gravel filter can allow to achieve allowable value of organic parameters in the column B, QCVN 14:2008/BTNMT (see Table 1). However, in order to achieve standard values for nutrients (N, P), the treatment system should consist some additional steps such as tertiary treatment component, or provision of high rate of flow return to the anaerobic/anoxic tank for nitrogen removal. This complexity leads to inefficient expenses and inequity in relation to different wastewater discharges.

The successful adoption of pollution control measures at the source is limited by the need to ensure that the operation and maintenance of the chosen technologies are compatible with the levels of knowledge and skills available on local level (Parkinson and Taylor 2003). There is often a lack of knowledge of decentralised options and shortage of a qualified work force and skills for operation and maintenance. It is very common situation in decentralized wastewater treatment projects, where the capacity building component during project implementation is poor, very limited human, technical and financial resources available for the system O&M, where out-sourcing service are often not available or not affordable in the area.

The studies conducted by IESE (Nguyen V. A. *et al.*, 2003), CENTEMA (Van Buren J. *et al.*, 2008), Vietnam EPA show that the monitoring and control activities on existing wastewater treatment plants are very weak. Weak environmental pollution control capacity at different, especially local levels is among key factors. Van Buren *et al.* (2008) have indicated that actors in each step of the operational chain have responsibility to prevent and avoid failures. The work of designers in Vietnam may be hindered by a lack of data, knowledge and experience, and a tightness of budget (e.g. to carry out pre-design fact-finding studies). The constructor in principle builds according to a design approved by authorities (provincial Department of Natural Resources and Environment - DONRE and Department of Construction - DOC). Designers and constructors blame many of the operational problems to the owners. Owners are in their eyes responsible for disrepair, lack of funds for operation and maintenance and insufficient training of their operators. Lacking of incentive measures does not encourage polluters to improve their situation.

Another argument is relevant to an important player in technology selection and processing of the design for the system, the consultants. Currently the design consultants still do not get encouragement in low-cost options from the Government policy when the fee for the design service is calculated based on the project construction cost percentage. Design quality and its appraisal is also an issue especially in the remote areas where local administrative departments have limited professional knowledge and experience. Application of new technologies and their certification are often not in interests of both consultants and appraisal authorities. Besides, lack of third-party testing and certificating organization for the wastewater treatment technologies and equipment is among important matters.

**Technical aspects.** In technical aspects, there are still very few decentralized technical options developed and applied. In addition, the systematic review of their performance and public acceptance has not been conducted.

Decentralized wastewater treatment systems can have significant advantages versus centralized
ones when the low-cost wastewater and sludge treatment processes are applied. Representing low-cost wastewater and sludge anaerobic treatment processes are BASTAF, ABR, biogas digester, or their combination. Biogas digesters are often applied for high strength wastewater flows from pig farms, slaughter houses, public toilets, etc. High removal efficiencies could be achieved in the BASTAF or ABR systems treating domestic wastewater at hydraulic retention times of 48–72 hours. The average COD and SS removal in the different lab-scale and pilot-scale BASTAFs was 72–90% and 78–94%, respectively (Nguyen V.A. et al., 2007). Despite the high treatment efficiencies, BASTAF effluent is still exceeding Vietnamese wastewater effluent standards, making clear that a polishing step is required before the treated flow can be discharged to the environment.

Low-cost post-treatment steps can be infiltration trenches, constructed wetlands or sand filters. However, while most of anaerobic treatment facilities can be constructed underground, including multi-purpose individual or public areas, large space required for following treatment facilities can be limitation of those systems. In order to solve this problem, some alternative options are being proposed combining anaerobic and aerobic treatment steps in a packaged system, such as BASTAFAT system by IESE (Nguyen V.A. et al., 2007), or Japanese Jokahso. A matter of balancing of the investment costs, and the O&M costs, via required space, consumable manpower, energy and chemicals is always to be considered. Comprehensive studies and appropriate technical guidelines are still lacking.

Table 3: Treatment performance, system configuration, construction cost and operation and maintenance requirements of ABR and CW (Morel A. et al., 2009).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Anaerobic baffled reactor</th>
<th>Constructed wetland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment performance</td>
<td>Removal efficiency: COD = 72–90%; BOD = 72–83%; SS = 78–94%; TP = 33%; TKN= 47%</td>
<td>Removal efficiency: COD = 80 – 90%; BOD = 75 – 85%; SS = 80 – 95%; TN = 40 – 60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effluent quality: BOD &lt; 30 mg/L</td>
</tr>
<tr>
<td>Unit configurations</td>
<td>1 sedimentation chamber (50% of total volume) and 2–3 up-flow chambers; HRT= 48 hours (0.2 – 0.3 m² per person) Critical up-flow velocity = 0.5–0.7 m/h</td>
<td>Series of vertical-flow units, horizontal-flow units, free-water surface units ; 2 vertical-flow units Sizing: 14.5 m³/m²/day or 0.35 PE/m² HRT = 4 days Pre-treatment is required</td>
</tr>
<tr>
<td>Construction costs</td>
<td>Vietnam: 150–200 USD/m³ of wastewater</td>
<td>Thailand: 400 – 650 USD/m³ of wastewater (land price not included)</td>
</tr>
<tr>
<td>Operation and maintenance</td>
<td>Desludging frequency: 2–3 years</td>
<td>Regular harvesting of wetland plants</td>
</tr>
<tr>
<td></td>
<td>Reactor start-up period: 90 days</td>
<td>Removal of oil and grease on the CW surface</td>
</tr>
<tr>
<td></td>
<td>Critical hydraulic peak-flow factor = 4</td>
<td>Cleansing of CW unit surface</td>
</tr>
<tr>
<td></td>
<td>Dead space = 15% at peak-flow factor = 4 or lower</td>
<td></td>
</tr>
</tbody>
</table>

One important aspect linked to wastewater treatment is the collection of wastewater, including design of sewers and open drains, manholes, overflows and other structures, and pumping stations. There is little national and international experience in use of combined drains in conjunction with septic tanks. Design guidelines are still lacking. Most of urban sanitation projects neglect tertiary network. Most of rural sanitation projects just focus on on-site sanitation facilities, whereas environmental sanitation and infrastructure planning of the community is lacking.

In fact, there is still very weak environmental technology industry in Vietnam despite of economic boom and intensive transition period. Poorer performance of installed systems than promised in advertisement cannot save truth of users, where the information and knowledge of stakeholders involved: donors, local authorities, users, local private sector – service providers is still lacking. Furthermore, from different sources, import of hi-tech products accompanied with “heavy armed” marketing campaigns are contributing to weaken this young industry.

Financial aspects. Since wastewater fees are still very low (10% surcharge on water bills) in urban areas, and zero in rural areas, no one from private sector can be interested in investing in this business. That situation looks more difficult in small communities. No recovery for O&M and system upgrading, lack of financial sustainability after construction works are among major concerns.
Social aspects. Social reasons including traditional acceptance of wastewater disposal untreated by most of people. Besides, untreated grey water, and traditional black water septic tank effluent discharge into open drain or infiltration pit has became almost single option of wastewater disposal in many urban and rural areas in Vietnam. Awareness raising and capacity building for local users are still under a long way to go.

In relation to wastewater reuse, the attitudes of the public and the policy makers of the perceived risks to public health still hinder the adoption of wastewater treatment and reuse systems. The main challenge is to create informed demand for improved wastewater management systems.

RECOMMENDATIONS

Institutional and managerial aspects

Decentralized wastewater management approach is and will be always the appropriate choice for many places to overcome disadvantages of the traditional centralized systems in developing and developed economies. However, for its dissemination, efforts in political advocacy, technical promotion and capacity building for all involved stakeholders should be continued.

Effluent requirements should be further developed in accordance to the available technologies. Step-wise approach in standard and code system establishment is here recommended.

Besides, monitoring and inspection regime should be improved especially with efforts by the local environmental protection agencies.

Decentralized wastewater management is a great environment for the creation of new ideas of technical solutions, managerial and financial approaches, etc. It is important that the Government should create favour conditions for those new ideas to be developed and verified. More suitable system for the appraisal of the wastewater treatment technologies and equipment should be established whereas some third-party organization could take part besides bureaucratic government offices.

It is recommended to create a special professional society dealing with decentralized wastewater management in Vietnam.

It is necessary to provide adequate technical information and to build up capacity in adequate education and training formats for all stakeholders involved in decentralized wastewater management “industry” including decision makers, planners, designers, operators and other service providers, different level authorities, users, etc. Currently relevant Technical guidelines in local language are being developed by the IESE DESA team in cooperation with MOC, MOH, Vietnam – Germany wastewater cooperation project, etc.

Technical aspects

There is no “general solution” applicable for everywhere. In general, combination of different options, including centralized treatment systems for high-density urban centres, decentralized sanitation systems for lower density clusters, and on-site sanitation systems for not connected, individual households in low-density peri-urban and rural areas is a most common and appropriate solution for wastewater system planning (see Figure 1).

(a) Conventional scheme mostly for the urban centres.

(b) Combination of on-site, decentralized and centralized scheme in “sanitation for all”.

Figure 1: Increased sanitation coverage and system sustainability can be realized by application of sanitation schemes suitable to the local contexts
In order to have scientifically based evidences of technico-economic benefits of wastewater management options there is a big need to conduct comprehensive monitoring and evaluation of the implemented projects in the country and in the region. Cost-benefit analysis of different sanitation options should be developed. The graphs in Figure 2 illustrate unit cost of different sanitation options with different values of population density. Unit costs include investment and O&M expenses. The line 1 and line 2 are unit costs of low-tech and high-tech, respectively, on-site sanitation facilities which do not change under varying population density. The lines 3, centralized systems, and the line 4, decentralized systems, have decreasing unit cost values when population density is increasing. However, when population density is high enough, decentralized systems may not have advantage in comparison with centralized ones due to high land values in those places. Values of B, C, D to identify optimum zone BCD for decentralized wastewater system application is to be identified for each case. Designers should address wastewater collection and treatment in an integrated way based on a thorough analysis of the local conditions.

**Figure 2:** Change of unit costs of sanitation options with different population densities

**Updating of national codes and standards**

There is a need to develop appropriate standards to be utilized for the design and construction of decentralized wastewater systems. The introduction of the ABR technology in national urban infrastructure and environmental sanitation/hygiene standards of Vietnam is believed to be an important step for its wider implementation in the country (Ministry of Construction and Ministry of Health, 2010). Besides, more Technical guidelines should be developed. Some series of those Guidelines like US EPA experience for decentralized wastewater management could be a good lesson to consider. Development of such guidelines for Vietnamese practice would result in better design and construction works, considering also the issues of management, monitoring, sludge management and safety, etc.

Decentralized wastewater management concept and technologies as well as other aspects of wastewater management should be brought systematically into teaching curricula at universities and technical schools. Besides, continuous capacity building in the forms of short-term training courses should be provided especially for the decision makers and decentralized wastewater management service providers. Some special programs for monitoring, evaluation of the installed systems, to get evidences and lessons from project formation, construction, O&M activities could play important role in decentralized approach advocacy and capacity building.

In any case, consideration of decentralized wastewater management model from the early stages of the urban and rural infrastructure planning should be considered in the holistic concept of integrated water resource management. That would enable to book adequate space and control construction ground level which are very crucial in sewerage and drainage management. Besides, needs in reuse of treated wastewater, sludge in agriculture should be considered in urban sanitation projects.
Financial aspects
One of the most important aspects of providing sanitation to the public is financing. Worldwide practice has clearly shown the need to mobilize different financial sources but government budget in order to make sanitation improvement possible and sustainable, in terms of both investment and O&M stages. The latest studies have shown good success of implementation of micro-financing approaches such as revolving fund for low-income household sanitation improvement in urban areas, and micro-credit through local bank of social policies in rural areas in Vietnam (Nguyen V.A., 2010, Trémolet S. et al., 2010). For medium and wealthy households, the practical survey figures show that in urban areas of Vietnam, investment for construction the septic tank and connection to the public sewer lines cost only 0.1 – 1%, where construction of the toilet and bathroom normally cost only 0.3 – 5% of the total cost spent for the land and the building. Understanding the needs for sanitation improvement will certainly lead household owners to invest for their infrastructure at the early construction stages and reduce overall expenses. While Government can only invest for the urban infrastructure like sewerage and drainage system, an adequate awareness will also enable users to pay for recovery of the wastewater system O&M expenses.

So far, private sector participation in sanitation in Vietnam is found only in such activities as provision of pre-fabricated septic tanks and other sanitary wares, septic tank emptying service, solid waste collection – treatment – recycling – disposal. Recently, there are some new models of private sector participation in the sector where the Government attracts private sector to investment in wastewater treatment in the area where they can then own the land for commercial purposes (e.g. BT project by Gamuda Berhad, Yen So wastewater treatment plant, Hanoi city, 45 city lakes restoration project, Hanoi city) (Nguyen V.A., 2010). Decentralized wastewater management concept seems more appropriate for attracting private sector participation since it often requires less amount of capital. However, special and appropriate policies should be developed, and more initiatives should be promoted when those policies are adopted in local contexts.

Social aspects
Advocacy at the political level is required and, at the community level, campaigns to promote the benefits of improved wastewater management are necessary. The positive examples in Vietnam (Beauséjour et al. 2007), where decentralised technologies for wastewater management have been introduced in demonstration projects, indicate the important role of such projects to stimulate a wider interest in the benefits of decentralised wastewater management.

One good example is a community-based project in Lai Xa village, Hanoi. The actor relationship analysis in the Lai Xa project has shown that traditional social-political-structures like social mass organizations and user group representatives, under the People’s committee (PC) coordination role, are major actors with very significant influence on project outputs and activities (Figure 3).

Figure 3: Local management scheme in Lai Xa community-based decentralized sanitation project
CONCLUSIONS
Decentralized wastewater management approach is and will be always the appropriate choice for many places to overcome disadvantages of the traditional centralized systems in developing and developed economies. However, for its dissemination, efforts in political advocacy, technical promotion and capacity building for all involved stakeholders should be continued.

A lack of government commitment to address wastewater related problems creates a political and institutional environment, which has few incentives to manage wastewater effectively. There are some reasons discussed why decentralized wastewater management concept and its application is still not widely disseminated throughout Vietnam. Among institutional and managerial aspects there are weaknesses of environmental pollution control capacity at different, especially local levels, limitations of existing Vietnamese environmental standard system, and lacking of incentive measures to encourage consultants to go for the decentralized wastewater concept, as well as to force polluters to improve their situation. In term of finance, discussed pints are low wastewater fee, and limited participation of private sector in the business. In technical aspects, there are limited information of appropriate and proven technical options for different contexts, lessons on their performance and system setting up. Besides, difficulties in the household connection and in collection network are among factors. A matter of balancing of the investment costs, and the O&M costs, via required space, consumable manpower, energy and chemicals is always to be considered.

Decentralized wastewater management is a great environment for the creation of new ideas of technical solutions, managerial and financial approaches, etc. It is important that the Government should create favour conditions for those new ideas to be developed and verified. Special and appropriate policies should be developed, and more initiatives should be promoted when those policies are adopted in local contexts.

REFERENCES


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1. INTRODUCTION

- **3/2010:** ~760 cities and towns, 30% of total population
- Improvement of sanitation systems for urban, peri-urban and rural areas in Vietnam is very challenging and becoming more and more crucial in this fast-developing country.
- In the large cities, 50-80% of households use septic tanks, 10-20% use pit latrines.
- In other cities (class 3-5), 20-50% use septic tanks, 30-50% use pit latrines or double vault latrines.
- **10%** of urban wastewater is treated.

- **The only way to go:** to implement low-cost DESA alternatives where local community, authorities and private sector are involved in decision making as well as in the exploitation process.
Conventional wastewater management

✓ Not affordable
✓ Big investment. Leakage.
✓ Difficult reuse
✓ Limited participation
✓ ...

Decentralized w/w management

✓ More affordable
✓ Less investment and O&M costs
✓ On-site reuse
✓ Encouraging participation
✓ Low-cost technologies
✓ Step-wise approach…

2. DEWATS concept and technologies in Vietnam

Government policies

- Over the last two decades: about USD 2 bio. for water and sanitation infrastructure improvement.
- More and more stakeholders have started to recognize importance of DEWATS.
- This term is now mentioned more and more as a solution.
- Great efforts are to be acknowledged:
  - projects and activities of DESA group, IESE,
  - projects of GTZ and KfW, other donors,
  - BORDA, etc.
- DESA concept and technologies have been brought into teaching curricula at some Universities.
Government policies (cont.)

- Effluent Standard for not connected to the sewers, and small flows: TCVN 6772:2000 has been developed, later replaced by the National Code QCVN 14:2008/BTNMT.
- Some technical guidelines are being compiled.
- Some thousands of DEWATS systems have been installed for office buildings, public toilets, hotels, factories, hospitals, new communities, trade villages, ...

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### Vietnamese National Code for wastewater effluent quality
**QCVN 14:2008/BTNMT**

<table>
<thead>
<tr>
<th>No</th>
<th>Parameters</th>
<th>Column A&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>Column B&lt;sup&gt;(b)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>5 - 9</td>
<td>5 – 9</td>
</tr>
<tr>
<td>2</td>
<td>BOD&lt;sub&gt;5&lt;/sub&gt; (20°C), mg/l</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>TSS, mg/l</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>NH&lt;sub&gt;4&lt;/sub&gt;-N, mg/l</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>NO&lt;sub&gt;3&lt;/sub&gt;-, mg/l</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>PO&lt;sub&gt;4&lt;/sub&gt;³-, mg/l</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Total Coliforms, MPN/100 ml</td>
<td>3,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>

<sup>(a)</sup> - Maximum allowable values for wastewater discharged to water bodies serving domestic water supply purpose.

<sup>(b)</sup> - Maximum allowable values for wastewater discharged to water bodies serving another purposes (irrigation, water transport, etc.).
## Decentralized wastewater treatment technologies

<table>
<thead>
<tr>
<th>Location</th>
<th>Technologies applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitals, hotels, apartments, office buildings in the urban centers&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>Activated sludge process, newly MBR Trickling filter, RBC Submerged aerated filter A&lt;sup&gt;2&lt;/sup&gt;O Jokashou and other packaged pre-fabricated plants</td>
</tr>
<tr>
<td>Pig farms&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>Biogas digester</td>
</tr>
<tr>
<td>Vietnam Friendship Village in Xuan Phuong commune, Tu Liem district, Hanoi (2008)&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + HF CW</td>
</tr>
<tr>
<td>Low-income residential area in Vinh Yen town, Vinh Phuc province (2007)&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Xuan Mai concrete factory residential quarter, Chuong My district, Hanoi (2007)&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Lai Xa village, Kim Chung commune, Hoai Duc district, Hanoi (2006 – 2007)&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + HF CW</td>
</tr>
<tr>
<td>Ta Thanh Oai and Huu Hoa communes, Thanh Tri district, Hanoi (2005)&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
<tr>
<td>Tam Da village, Tien Son district, Bac Ninh province (2002)&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF</td>
</tr>
</tbody>
</table>

- A<sup>2</sup>O – anaerobic – anoxic – oxic treatment process.
- ABR – anaerobic baffled reactor.
- BASTAF – baffled septic tank with anaerobic filter.
- CSO – combined sewerage with overflow chambers.
- HF CW – horizontal flow constructed wetland

<sup>(a)</sup> – implemented by different service providers.
<sup>(b)</sup> – by DESA team, IESE.
<sup>(c)</sup> – by BORDA Vietnam

## Decentralized wastewater treatment technologies (cont.)

<table>
<thead>
<tr>
<th>Location</th>
<th>Technologies applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater collection and treatment system for Cho Ra town, Bac Kan province&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Separate low-cost sewerage, BASTAF + HF CW</td>
</tr>
<tr>
<td>Wastewater collection and treatment system for Cho Moi town, Bac Kan province&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Separate low-cost sewerage, BASTAF + HF CW</td>
</tr>
<tr>
<td>Wastewater collection and treatment system for Nuoc Hai town, Cao Bang province&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Separate low-cost sewerage, BASTAF + HF CW</td>
</tr>
<tr>
<td>Kim Bang district hospital, Ha Nam province&lt;sup&gt;(c)&lt;/sup&gt;</td>
<td>ABR + HF CW</td>
</tr>
<tr>
<td>Thanh Hoa Children hospital, Thanh Hoa province&lt;sup&gt;(c)&lt;/sup&gt;</td>
<td>ABR + HF CW</td>
</tr>
<tr>
<td>Bear care center in Tam Dao Natural park, Vinh Phuc province&lt;sup&gt;(c)&lt;/sup&gt;</td>
<td>ABR + HF CW</td>
</tr>
<tr>
<td>Cluster in Kieu Ky Commune, Gia Lam district, Hanoi city&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, ABR + HF CW</td>
</tr>
<tr>
<td>Cluster in Lim town, Bac Ninh province&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + Facultative pond</td>
</tr>
<tr>
<td>Cluster in flood evacuation cluster, An Giang province&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>Combined sewerage and drainage with CSOs, BASTAF + Facultative pond</td>
</tr>
</tbody>
</table>
Challenges in most of projects

- Lack of knowledge of decentralised options
- Quality of design and construction, associated with
  - consultants’ competency,
  - administrative appraisal procedures,
- Low rate of household connection,
- Capacity building component during project implementation is poor,
- Financial sustainability,
- Problems in O&M, M&E
- Shortage of qualified work force and skills for O&M.
- Out-sourcing services are often not available or not affordable in the area.
- Others.

3. BARRIERS FOR DISSEMINATION OF DECENTRALIZED WASTEWATER MANAGEMENT CONCEPT

- Institutional and managerial aspects
  - Lack of commitments.
  - Vietnamese environmental standards are still not fully developed.
    - Still some gaps and contradicting matters
    - Class B or C is applied within a city?
    - Value of some parameters do not comply with available and affordable technologies.
      - QCVN 14:2008: secondary treatment can allows to achieve column B for BOD, TSS.
      - However, for nutrients (N, P), pathogens; some additional (tertiary) treatment, high rate of flow return (A²O), strong disinfection is required.
      - This leads to inefficient expenses and no-equity among different wastewater dischargers.
### Actors in each step

- **Designers:**
  - lack of data, knowledge and experience, tightness of budget (e.g. to carry out pre-design fact-finding studies).
  - Design consultants do not get encouragement in low-cost options: the *design fee* is calculated based on the project construction cost percentage.
  - Design quality and its appraisal is also an issue especially in the remote areas.
  - Lack of *third-party testing and certificating* organization for the wastewater treatment technologies and equipment.

- **Constructors:** build according to a design approved by authorities.
  - Designers and constructors blame many of the operational problems to the owners.

- **Owners:** disrepair, lack of funds for O&M, insufficient training of operators.
  - Lacking of incentive measures does not encourage polluters to improve their situation.

- Studies by IESE, CENTEMA, Vietnam EPA: weak environmental pollution control capacity at different, especially local levels.

### Technical aspects

- There are still very few decentralized technical options developed and applied.

- Systematic review has not been conducted:
  - DEWATS system performance, public acceptance, etc.
  - Balancing of investment, and O&M costs, including required space, manpower, energy and chemicals.

- After AD (mostly under-ground), polishing step (*large space*) is required.
  - Alternative options: Packaged system BASTAFAT, Jokashou, etc.
Features of built systems (BASTAF + CW)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Baffled septic tank</th>
<th>Constructed wetland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment performance</td>
<td>Removal efficiency: COD = 72–90%; BOD = 72–83%; SS = 78–94%; TP = 33%; TKN= 47%</td>
<td>Removal efficiency: COD = 80 – 90%; BOD = 75 – 85%; SS = 80 – 95%; TN = 40 – 60%</td>
</tr>
<tr>
<td></td>
<td>Series of vertical-flow units, horizontal-flow units, free-water surface units ; 2</td>
<td>Effluent quality: BOD &lt; 30 mg/L</td>
</tr>
<tr>
<td></td>
<td>vertical-flow units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical up-flow velocity = 0.5–0.7 m/h</td>
<td></td>
</tr>
<tr>
<td>Unit configurations</td>
<td>1 sedimentation chamber (50% of total volume) and 2–3 up-flow chambers; HRT= 48</td>
<td>Series of vertical-flow units, horizontal-flow units, free-water surface units ; 2</td>
</tr>
<tr>
<td></td>
<td>hours (0.2 – 0.3 m³ per person)</td>
<td>vertical-flow units</td>
</tr>
<tr>
<td></td>
<td>Critical up-flow velocity = 0.5–0.7 m/h</td>
<td>Sizing: 14.5 m²/m³/day or 0.35 PE/m²</td>
</tr>
<tr>
<td>Construction costs</td>
<td>150–200 USD/m³ of wastewater</td>
<td>HRT = 4 days</td>
</tr>
<tr>
<td></td>
<td>(land price not included)</td>
<td>Pre-treatment is required</td>
</tr>
<tr>
<td>Operation and maintenace</td>
<td>Desludging frequency; 2–3 years Reactor start-up period: 90 days Critical hydraulic</td>
<td>Regular harvesting of wetland plants Removal of oil and grease on the CW surface</td>
</tr>
<tr>
<td></td>
<td>peak-flow factor = 4</td>
<td>Cleansing of CW unit surface</td>
</tr>
</tbody>
</table>

(Morel et al, 2007)

- **Technical aspects (cont.)**
  - Collection of wastewater: little national and international experience in combined drains + septic tanks.
  - Design guidelines are still lacking.
  - Most of urban sanitation projects: neglect tertiary network.
  - Most of rural sanitation projects: focus on on-site sanitation facilities.
  - Environmental sanitation and infrastructure planning of the community is lacking.
  - Environmental industry is still very weak. Lack of firms’ capacity for R&D, marketing strategy, etc.
  - Import of hi-tech products with "heavy armed" marketing campaigns are contributing to weaken this young industry.
Financial aspects
- **Wastewater fees** is still very low in urban areas, and zero in rural areas (Decree 88...)
- **Private sector** is still not interested in this business.
  - No recovery for O&M and system upgrading
  - Lack of financial sustainability after construction works.

Social aspects
- Traditional acceptance of untreated wastewater disposal by most of people.
- Wastewater reuse attitudes of the public and policy makers hinder the adoption of wastewater treatment and safe reuse systems.
- The main challenge is to create informed demand for improved sanitation.

4. DISCUSSION & RECOMMENDATIONS

Institutional and managerial aspects
- For DEWATS dissemination: efforts in political advocacy, technical promotion and capacity building for all involved stakeholders should be continued.
- **Effluent requirements** should be further developed in accordance to the available technologies.
  - Step-wise approach in standard and code system establishment.
- Monitoring and inspection (by the local environmental protection agencies).
- DEWATS: environment for new ideas (technical solutions, managerial and financial approaches).
  - Government should create favour conditions for those new ideas to be developed and verified.
  - Suitable appraisal system of technologies and equipment.
- A special professional society dealing with DEWATS! DESARA!
Sanitation has to be started from the household!

- In-door sanitation
- Cluster sanitation
- Centralized sanitation facilities
- Discharge/Reuse

4. DISCUSSION & RECOMMENDATIONS (Cont.)

- Technical aspects
  - Combination of different options
  - Cost-benefit analysis of different sanitation options should be developed.
  - We need information of unit costs of different sanitation options, in different local contexts
Change of unit costs of sanitation options with different population densities

- Unit costs: investment + O&M expenses.
- 1, 2: low-tech and high-tech on-site sanitation facilities.
- 3: centralized systems
- 4: decentralized systems.
- BCD: Optimum zone for DEWATS application

4. DISCUSSION & RECOMMENDATIONS (Cont.)

- Updating of national codes and standards, technical guidelines.
- Capacity building
  - teaching curricula
  - short-term training courses
- Consideration of DEWATS approach from the early stages of the urban and rural infrastructure planning, IWRM.
- Crucial: to book adequate space, and to control construction ground level.
- Reuse should be considered in urban sanitation projects.
4. DISCUSSION & RECOMMENDATIONS (Cont.)

- Financial aspects
  - To mobilize different financial sources.
  - Micro-financing
    • Revolving fund in urban areas
    • Micro-credit in rural areas
  - In urban areas:
    • ST & connection to sewer: 0.1 – 1%
    • toilet & bathroom: 0.3 – 5% of the total cost spent for the land and the building.
    • Understanding will certainly lead house owners to invest for their infrastructure early & reduce overall expenses.
    • & to pay for recovery of O&M expenses.

4. DISCUSSION & RECOMMENDATIONS (Cont.)

- PSP in sanitation:
  - Currently:
    • pre-fabricated septic tanks and other sanitary wares,
    • septic tank emptying service,
    • solid waste collection – treatment – recycling – disposal.
  - New models:
    • BT project by Gamuda Berhad ($400 mio. vs. 324 ha, $1 bio)
    • Hanoi city: Call for 45 city lakes restoration projects ($80 mio.)
4. DISCUSSION & RECOMMENDATIONS (Cont.)

- Sustainable Sanitation Model

Thank you very much for your attention

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