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INSTITUTIONAL REQUIREMENTS FOR APPROPRIATE WASTEWATER TREATMENT SYSTEMS

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1.4 Institutional Requirements for Appropriate Wastewater Treatment Systems, *J. Frijns & M. Jansen, IHS*[1].

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1.4.1 Unsustainable sewerage and treatment methods

It goes without saying that the uncontrolled release of domestic wastewater in the urban areas of the developing countries causes severe pollution problems and negative health effects. This asks for proper solutions, which appear to be not readily available. The magic answer is not yet there. Besides, straightforward and uniform solutions do not exist, each location requires a specific approach.

In this paper there perhaps will be more questions than answers forwarded. In our view, the problem with sewerage and wastewater treatment is either the use of an inappropriate technology system and/or a poor institutional arrangement for the management of the system (Box 1).

Box 1: General reasons for problems

1. lack of adequate institutional arrangements
   - little attention for treatment
   - no long term planning & lack of coordination
   - lack of involvement community & private sector
   - inadequate resource mobilisation

2. low technical sustainability of the waste handling systems
   - inappropriate and costly methods of collection and treatment
   - high tech, large scale, capital intensive, centralised treatment
   - irrational, water-borne, high cost, extensive sewer collection system

■ *Inadequate management*

It are the municipal authorities who have the task to provide sanitation services. So far, however, local authorities have been unable to provide the service to an adequate level. Institutions dealing with sanitation often lack a service orientation and are not customent oriented.

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The institutional problems related with water and sanitation have to do with:
- proliferation of agencies
- fragmentation of their efforts
- inadequate powers at local authority level
- engineer oriented, top down approach
- lack of comprehensive technical and organisational policies
- lack of finances, etc.

As the service should be paid for by the users, they should provide the service that people want and are willing to pay for. However, local governments have often difficulties in an adequate mobilisation of sufficient financial resources. The lack of resources not only results from a general lack of funds at the municipal authority level, but also from an inadequate municipal tax collection and problems with cost recovery.

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■ *Inappropriate technologies*

It is more and more being realised that conventional wastewater treatment methods, developed in Western countries and transferred to developing countries, are rather inappropriate. Conventional treatment is generally centralised (off-site), water-borne, large-scale, capital intensive and high-tech. It's inappropriateness relates to the involved high costs, the often insufficient pathogen removal, the limited reuse possibilities, the release of large amounts of contaminated sludge, and the required knowledge and institutional support for operation and maintenance. Over the years, many treatment systems have been developing rapidly achieving higher efficiencies with reduced financial and environmental burdens. It is thus nowadays not accurate to refer to Western systems as all being conventional.

However, the conventional concept for treatment has as an important precondition the transfer of the wastewater to the facility, thus requiring an extensive sewer system for collection. It is especially this sewer system which forms a major constraint for its adoption. Its exceptionally high cost makes it out of reach for most cities in developing countries (Cairncross & Feachem, 1993). Other limitations are listed in Box 2.

Box 2: The limitations of conventional sewer systems

1. Cost: Very high capital construction cost and annual exploitation costs.
2. Water use: To transport wastes along thepipes large volumes of water are required. Households have to have individual water supply connection.
3. Construction: Complex technology requiring careful and skilled construction and thus skilled people.
4. Sewer-laying: To dig large trenches in straight lines through (squatter) settlements will often necessitate the demolition of houses. It requires large excavations.
5. Phasing: Sewer systems need to be implemented along with water and housing. It is difficult for sewerage systems to be developed incrementally.
6. Blockage: Prone to blockage if large objects such as solid waste are fed into them. And an irregular water supply may lead to clogging of the sewers.
7. Leakage: Leakage is very hard to detect. Yet, it occurs frequently, causing groundwater pollution.
8. Irrational use of resources: Irrational from the point of view of sensible utilisation of resources; dilution of waste with clean water for transport, after which it will be separated again in a treatment facility at high cost.

End-of-pipe solutions tend to be imposed on the total system. In such a way a pre-occupation with a certain wastewater treatment technique may lead to the development of sewer systems where a (partial) on-site system would possibly have been more appropriate.

1.4.2 Available treatment alternatives

What then are suitable alternative methods for water-borne sanitation and wastewater treatment? In any case, it requires an appropriate technology which is affordable (note the difference with low-cost), simple, and aimed at reuse of valuable resources (see Box 3). A very important requirement, also in relation to reuse options, is that the technology has to be effective in hygienic perspective. Most of the, in Western countries, used treatment technologies were not developed with the aim of pathogen removal. The spreaad of diseases is, however, the most severe problem of domestic wastewater in developing countries.

Over the years, several interesting technology alternatives have been developed and tested, which overcome the main problems of conventional systems and apply to a large extent to the mentioned criteria.

Several modifications of the sewer system are currently being used which have lower costs, reduced water requirement, minimal excavations, and less maintenance requirements. Among the modifications is the shallow sewerage system, a network of small-diameter pipes laid in shallow trenches with small inspection chambers, usually in the backyards and alleys of settlements (Vines & Reed, 1990).

Box 3: Criteria for Appropriate Sanitation Technologies

- Technically Sound
  - effective & efficient
  - flexible
  - simple in O&M
  - process stability & long life span
- Environmentally Sound
  - integrated: no diffusion of pollution to other compartments
  - hygienically safe
  - limited environmental impact (pollution & resources)
  - aimed at recovery & reuse
- Affordable
  - cost-effective & low cost (construction, infrastructure, O&M)
  - financially feasible
  - using local materials & low energy requirements
- Socially & Culturally Acceptable
  - meeting needs
  - local labour-intensive
  - convenient for user

Alternative treatment technologies are developed as well which can be served by these relatively low-cost collection systems. Certain water-borne treatment systems could be applied at a smaller scale, i.e., community on-site, in which the wastewater at a residential area of limited size is collected in a small-bore sewer and treated at the site of the concerning community at some proper location. This could be an alternative as well to conventional on-site sanitation systems which frequently suffer from a rather low treatment efficiency.

Anaerobic treatment using the UASB-system is one of the promising technologies for application at this level (Lettinga et al, 1993). Effective treatment and some recovery of biogas is achievable with limited maintenance and sludge disposal. Post-treatment for effective pathogen removal, however, is still required. The method most suitable for tropical countries for pathogen removal is stabilisation ponds. The main disadvantage of ponds is that they take up a lot of space. In urban areas where land is scarce or very expensive, ponds may have to be rejected. However, great savings in space can be achieved by incorporating anaerobic pre-treatment, thus the application of a relatively small stabilisation pond at the site of the community as a post-treatment method could become feasible. It should be born in mind that often one of the best investments a municipality can make is to buy land for ponds on the outskirts of the urban area. Moreover, such 'simple' sanitation programmes can be upgraded in a planned sequence of incremental improvements, whenever the socio-economic status allows this.

Even more alternative technologies exist, albeit none of them perfect. The question remains, however, why then are these technologies not (yet) widely applied?

1.4.3 Conditions for the implementation of alternative methods

It is important to note that the application of interesting alternative wastewater treatment methods not only is determined by the technology it self. In practice, the choice of sanitation technology will depend on various local circumstances as well (Box 4).

The dissemination of technology depends on the socio-economic setting in which the technology is introduced. Although an alternative sanitation can be indeed less costly per capita than conventional sewerage, many do have on-site (investment) components, requiring efforts and resources from the residents. The question of affordability remains, depending on site conditions. Acceptability could be a problem as alternative sanitation is seen in certain areas as second-rate options to conventional sewerage by professionals and residents.

If we have a closer look to the proposed alternatives for wastewater treatment, it might become apparent that although a method in itself is appropriate from a technological point of view the local setting does not allow a successful introduction. In other words, the institutional framework is often not in place to create local conditions favourable for the alternative treatment methods. This very much explains the difficulties with technology dissemination. The engineer tends to overlook the importance of an effective institutional setting which can support the application of the developed technology. A poor or incomplete institutional framework prevents satisfactory performance of any sanitation technology, even when they are technically properly designed and constructed.

The institutional setting determines as well the optimal scale of operation/application of the selected treatment technology.

Box 4: Local conditions determining the choice of sanitation technology

1. Physical environment
climatologic conditions & hydrogeology
soil conditions & topography

2. Socio-cultural aspects
defaecating habits & attitude towards excreta handling
urbanisation pattern (population density)

3. Infra-structural aspects
the present water supply system & stormwater drainage system
local and individual building standards

4. Financial capabilities of the target group
affordability & willingness to pay
residual value of, and market for, processed wastewater

5. Management requirements for operation and maintenance
institutional support
skills & training

6. Institutional framework
planning and policy
organisational setting
human & financial resources

1.4.4 Institutional requirements for successful support of appropriate methods

One of the important lessons of the UN Water and Sanitation Decade is the emphasis on 'making systems work' instead of the mere provision of facilities. Institutions need to be developed in response to the tasks and activities as required to keep the chosen wastewater treatment system operating and effective. Sanitation projects require an institutional framework that allocates authority and responsibility for planning, construction, operation and maintenance, and monitoring of the schemes.

Can simple on-site systems be handled within the individual family and neighbourhood, by contrast a high-tech wastewater processing plant will require trained people, procedures, risk management and elaborate cost recovery mechanisms. The more elaborate collective system applied, the more elaborate the institutional support should be. Large and complex programmes tend to be demanding in their technical as well as their managerial components, and require the commitment of different levels of government.

Box 5: The institutional framework provided by local government

- comprehensive policy for the sector
- planning and management
- agencies with adequate capacity for implementation
- appropriate regulatory legislation and capacity to enforce
- financing and revenue generation
- market oriented (both for the service and waste products)
- operation and maintenance of the system
- provision of training
- quality control and monitoring of pollution levels
- providing infrastructural facilities
- coordination with other policy areas (health, housing, settlement planning, etc.)

Therefore, each chosen system should be analysed as to the required tasks connected to its sustainable functioning, which in turn should provide a strong indication of its ultimate feasibility. Thus, local government should ensure a proper institutional setting, consisting of planning, coordination, resource mobilization, etc. (see Box 5).

A good organisational structure is required, based on a steady, long-term government support, and a clear national policy supporting the sector. At city level, a sectoral agency is needed to provide technical support. Coordination with other policy areas is an important task, ensuring no fragmentation among a variety of institutions (no overlapping responsibilities). Stable, autonomous institutions have to be set up, which can secure sufficient funds and competent staff (opportunities for training and salary increase).

■ *Local government as facilitator*

Many municipal authorities appear not to be able to provide the required service to an adequate level. Too often no adequate division and allocation of responsibilities at community, municipal or central government level results in malfunctioning and deterioration of the wastewater systems. It is therefore recommended, that the role of local government should change from direct intervention towards the enabling of public and

private institutions to deliver services. The role of local authorities could become more one of a facilitator (see Box 6).

One of the important tasks remaining the responsibility of the public sector will be the coordination between interrelated subsectors. The interlinkages and integrated approaches between sewerage, solid waste systems, water supply, and drainage, should be kept in mind. Any solution to be successful will have to be positioned within a multi-variant environment.

Box 6: New role of local government

- facilitator
  allocating authority & responsibility
  supervision & monitoring
- partnership approach
  private sector
  community participation
- overall coordination
  linking user - engineer
  part of urban environmental management

■ *Partnership approach*

In facilitating the provision of wastewater treatment conditions have to be created that enables the involvement of local partners. The institutional arrangements should be geared to shared responsibility (decision making at the lowest level) and service delivery institutions that are responsive and accountable to users. This thus implies local partnership to ensure effective community participation and a greater role for the private sector (Bartone, 1995). A partnership approach, however, also needs an appropriate institutional framework, which clearly lays out the roles and responsibilities of each party.

With private sector involvement it is aimed to enhance efficiency, lower cost, and mobilise resources. Competition, accountability and transparency should be the basis for successful privatisation. In Mexico, for example, municipalities are granting concessions to the private sector to build and operate wastewater treatment plants. However, in general private sector involvement is illusory, and their willingness to invest in this sector is limited. Moreover, involvement of the private sector is in no way a substitute for a proper overall institutional setting. Public sector capacity even has to be strengthened to regulate private sector participation, e.g., to establish standards to guide private contractors, to assess performance indicators, etc.

The user plays a key role, which is not always realised by the sanitation specialists. Community participation could be solicited in planning, financing, construction, use and maintenance. On-site sanitation schemes may be completely or partly managed and financed by the users themselves. The role of government organisations may be important nonetheless, for example through public information campaigns, or to assist technically (desludging services). Effective communication between the users and the local officials is a prerequisite.

For example, the application of shallow sewerage in high density areas requires extensive promotion of community awareness at the planning stage, together with house-to-house and physical surveys, and good quality control during construction. An additional problem is that such on-site systems have to be considered as private goods. How then is inspection and maintenance on private land to be organised? In case of the so-called condominial sewerage

system in Brazil this is done by the users themselves, which works satisfactory. Water boards supervise the building and provide information on maintenance to the users (UNCHS, 1986).

In case of off-site systems community participation may be equally important but rather difficult to achieve. Experiences with for example solid waste management learned that involvement of the community is essential for its success. Likewise in wastewater treatment participation of the people is needed, e.g., to prevent release of toxic waste substances in the sewer, to assist in site selection, for financial contribution, to achieve environmental and health improvement, etc. But how can involvement for wastewater treatment be established? The user generally is not interested at all in the processing part. Treatment has low priority, as by then waste is already out of sight. The problem is that the benefits of treatment do not really accrue to those who generate the waste. In fact their real priority is to move the wastewater out of their own front yard. One has to be very careful about pre-supposing considerable knowledge, as perhaps done too often by sanitation technologists, about wastewater systems among the user groups. For them it disappears underground, period.

Once people have been connected they tend to become reluctant in paying their dues. Defaulting is very common. Switching off is physically not possible; other sanctions do generally not work. Who indeed can disconnect them? A mechanism of charge collection by a related authority, e.g., the water supply company, could be an effective answer for cost recovery, especially when sanctions can be applied through disconnecting the water supply.

As in a partnership with the private sector, the involvement of the community requires as well a proper institutional setting to ensure its success.

1.4.5 Conclusions

Although several interesting appropriate wastewater treatment technologies have been developed over the years, the magic answer does not seem to be there yet. Besides, appropriate solutions will differ anyhow with the site conditions where they have to be introduced. Moreover, successful implementation very much depends on the institutional framework that creates the conditions for its operation and management.

The development of even more innovative appropriate technologies, for example aimed at full reuse opportunities, does not change this prerequisite and is thus as such no guarantee for successful dissemination.

All too often the developments are technology driven, after which conditions for the required institutional framework have to be established. It could prove to be a better strategy to start from the existing institutional setting, see how this can be improved, and then look at which technology fits best.

As said, it is the often poor or incomplete institutional framework that causes sanitation programmes to fail. Adequate institutional arrangements are needed that incorporate long term planning, coordination, and resource mobilisation. A partnership approach, involving the community and private sector, could assist local authorities.

The role of local authorities changes to one of a facilitator, allocating authority and responsibilities. This new role does not imply a reduced involvement of local government but a different one. In fact, a proper institutional framework is the more important. It should provide for a link between the users and the engineers. For a sustainable system a design and a management framework is needed that knows how to deal with the technical processing underground as well as the part above ground dealt with by the user.

Local governments have to take up their responsibility in the overall coordination of urban environmental management and ensure wastewater treatment service as part of this. Recent urban environmental management experiences stress an integrated approach, in which professional and sectoral barriers have to be removed. Indeed, this is not an easy task.

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