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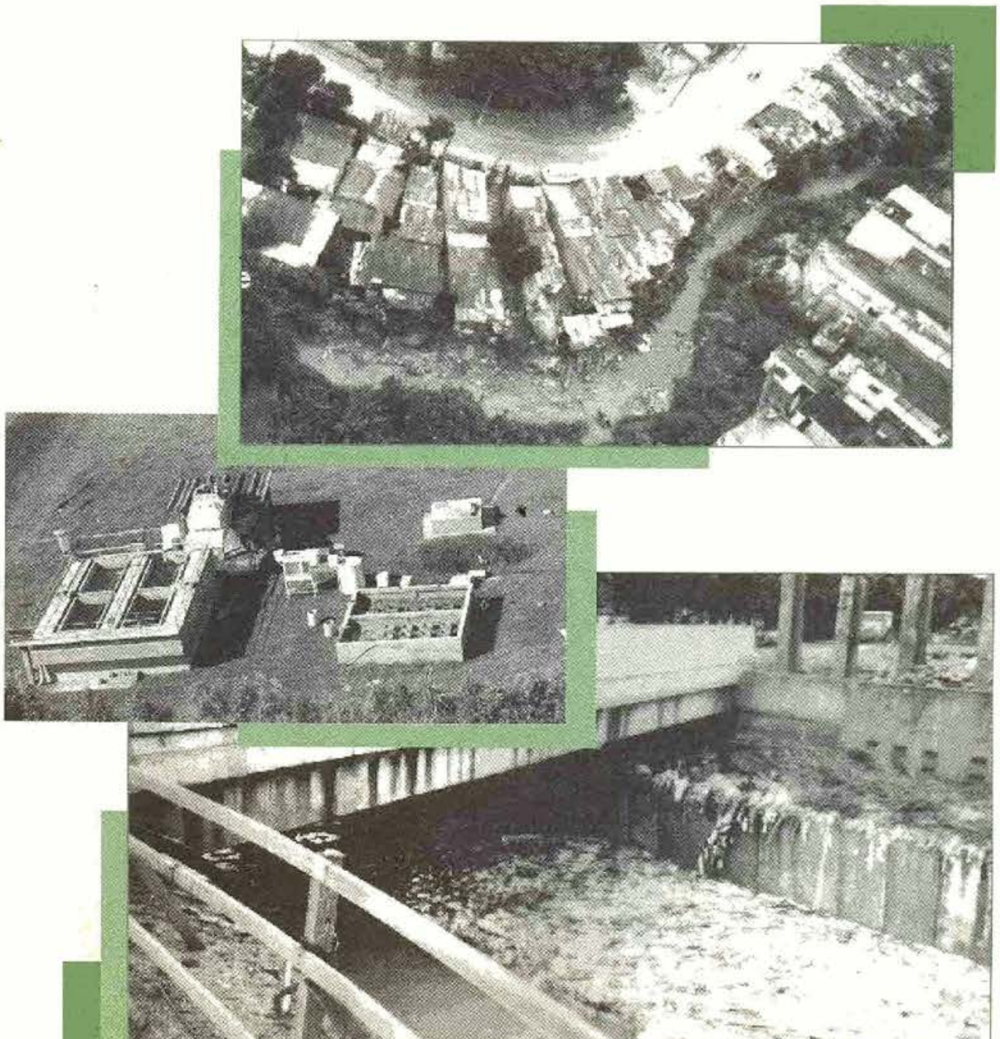
International Environmental Technology Centre (IETC)

PROCEEDINGS OF THE WORKSHOP ON SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

Regional Workshop for the Latin America and the Caribbean - 27-31 March 2000



PROCEEDINGS OF THE WORKSHOP ON SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

Regional Workshop for the Latin America and the Caribbean

Rio de Janeiro, 27-31 March 2000

In collaboration with ABES-Rio, ROLAC, and the World Bank

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MAP OF THE AMERICAS

PROCEEDINGS OF THE REGIONAL WORKSHOP ON SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

Rio de Janeiro, Brazil, 27 to 31 March 2000

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Part I

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REGIONAL WORKSHOP ON SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

Rio de Janeiro - Brazil, 27 to 31 March 2000

PROGRAMME

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9:00 – 9:20 Registration
9:20 – 9:30 Opening & welcome address
Mrs. Lilia GC. Casanova, Deputy Director of UNEP-DTIE-IETC
Mrs. Eliane Barbosa, President of ABES-Rio
Mr. Haroldo Mattos de Lemos, President of Instituto Brasil PNUMA
9:30 – 9:40 Guidance to Workshop
9:40 – 10:15 Self-introduction
10:15 - 10:30 IETC's video-film

10:30 – 10:45 Coffee Break

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11:40 – 12:25 Technology Choice and Sustainable Development in Wastewater Management - **Dr. Goen Ho**

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- Group 2: Cross-cutting issues
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Part II

P R E S E N T A T I O N S

CRITERIA FOR EVALUATION OF TECHNOLOGY FOR SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

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ABSTRACT

A wide range of technologies is available in the market place for wastewater and stormwater management from simple on-site to complex centralised systems. Not all of these are suitable for developing countries, and particularly not those which require a large capital cost and on-going maintenance and operating costs. There are many other equally important factors which need to be considered besides cost. Criteria for evaluation of technologies are therefore needed, particularly if we want to achieve long term sustainability of the technology. Three case examples are examined to help stimulate our thinking about the criteria that are required. Criteria for selection are then suggested. These can be grouped into criteria for (1) Protection of public health and the environment, (2) Economic/financial affordability and (3) Social/cultural appropriateness. These criteria are elaborated and a framework for achieving integrated waste management suggested.

KEYWORDS

Sustainability, wastewater, stormwater, technology, evaluation, criteria.

INTRODUCTION

There is a wide range of technologies available in the marketplace for wastewater and stormwater management. Criteria for evaluation of technology are therefore required to determine which technology is most suited to a particular situation. This is especially so when our aim is to ensure that sustainability is achieved.

Examples of application of technologies which are not sustainable abound. In developing countries wastewater and stormwater collection and treatment systems based on the activated sludge process are not operating to specifications, or not operating at all due to lack of spare parts, funds for maintenance, trained personnel or related factors. The activated sludge process has been a dominant technology in developed countries. It is instructive therefore to examine the background to the development of this technology, and to look more closely at the question of sustainability of large scale centralised systems.

A simple technology 'SanPlat' is gaining popularity in sub-Saharan Africa and helps to overcome public health problems associated with the lack of sanitation facilities. It will be instructive as well to consider the factors that lead to its acceptance and to examine the sustainability of this technology.

What technologies were used before we had technologies such as the activated sludge process and SanPlat ? It is instructive as well as of historical interest for us to examine at least one such technology. I have chosen the chamber pot to illustrate what might have been the criteria for their selection.

Having considered the above three examples, I will outline criteria which I believe we should consider for the evaluation of technology for sustainable wastewater and stormwater management. This paper is based on an 'International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management', which is being published by UNEP IETC. I am Managing Consultant for this Source Book, which has contributions from 12 international experts from all regions of the world.

This paper should be read in conjunction with my two accompanying papers in this series: 'Technology choice and sustainable development in wastewater management' and 'Alternative technologies for wastewater management'. The first of these emphasises the need for an integrated approach in addressing not only wastewater and stormwater management, but also solid waste management, if we are to achieve public health improvements. The waste management hierarchy and the concept of sustainable wastewater management are also introduced in this paper. The second paper presents the range of major technologies available for wastewater collection, treatment, reuse and disposal, together with decision making tools for selecting technology. Possible scenarios for sustainable practices are presented in this paper.

These three papers should also be read together with the two papers written by my colleague Professor Maksimovic, which cover the corresponding aspects for stormwater technology and management. In addition Professor Maksimovic prepared the slides for the Training Modules based on the International Source Book. A number of these slides are used in our papers, and illustrate how these slides can be used for training purposes.

THREE EXAMPLES TO STIMULATE OUR THINKING ABOUT CRITERIA FOR SELECTION OF TECHNOLOGY

There is limited good documentation of technology used for the management of human excreta in ancient times. A conveyance system (aqua duct) is known to exist in Roman time. Direct disposal to rivers or onto land appears to be common practice. The spade is an implement that has been used for digging a hole for burial of human waste, and can be considered an early technology for waste disposal.

The chamber pot can also be considered to an early and simple technology for managing human excreta in cold climate. Because of the low temperatures it is more convenient to collect the waste in a pot indoors. It may have been noticed that separation of urine and faecal materials reduces odour that is produced. Separate collection of urine also enables its direct use as a plant fertiliser. The faecal materials can be buried, or stored and used as fertilisers. Its use is therefore not different from the use of animal manures as fertilisers. There is a recognition here of the nutrients for plant growth that are contained in the wastes. The use of the chamber pot is no longer common, and may have been discontinued for the convenience of other technologies for handling human excreta.

Direct disposal of human excreta to rivers and onto land can create public health problems, because of the likelihood of transmission of human pathogens in the excreta through the faecal-oral cycle (Figure 1). This likelihood is increased with an increase in population density. Epidemics of diseases were common at the end of last century in cities in Europe, where a high population density accompanied by inadequate human excreta management contaminate sources of drinking water. A response to this was the construction of sewers to convey wastewater and stormwater away from people and houses. An extensive network of sewerage is required. The net work of interceptor sewers in London is illustrated in Figure 2. The network consists of large pipes buried deep beneath the ground to allow for gravity flow the water. Manholes are required at intervals along the sewer to allow for inspection and cleaning if necessary. Pump stations are generally required to pump water when gradient is not sufficient for gravity flow alone.

The combined wastewater and stormwater was not generally treated. A consequence of this was pollution of rivers with organic materials contained in the wastes. Consumption of these organic materials by bacteria is accompanied by depletion of oxygen and the production of odorous gases. Fish, which rely on oxygen, are driven away. This was the condition of the Thames river passing through London until the 1960s. Efforts were made to treat the wastewater to reduce its oxygen demand.

Figure 1. The Classical Waterborne Disease Infection Cycle

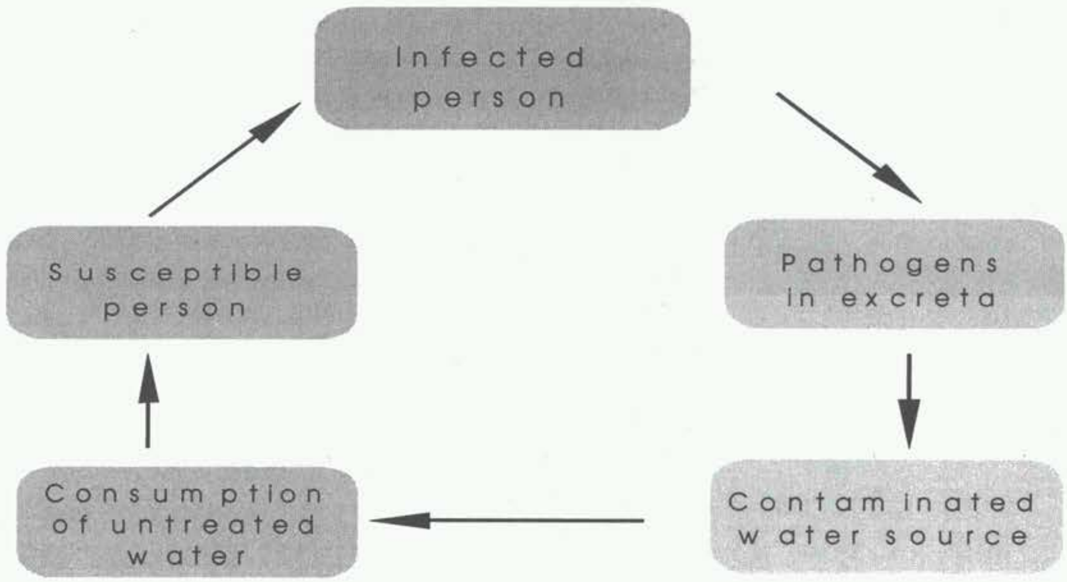
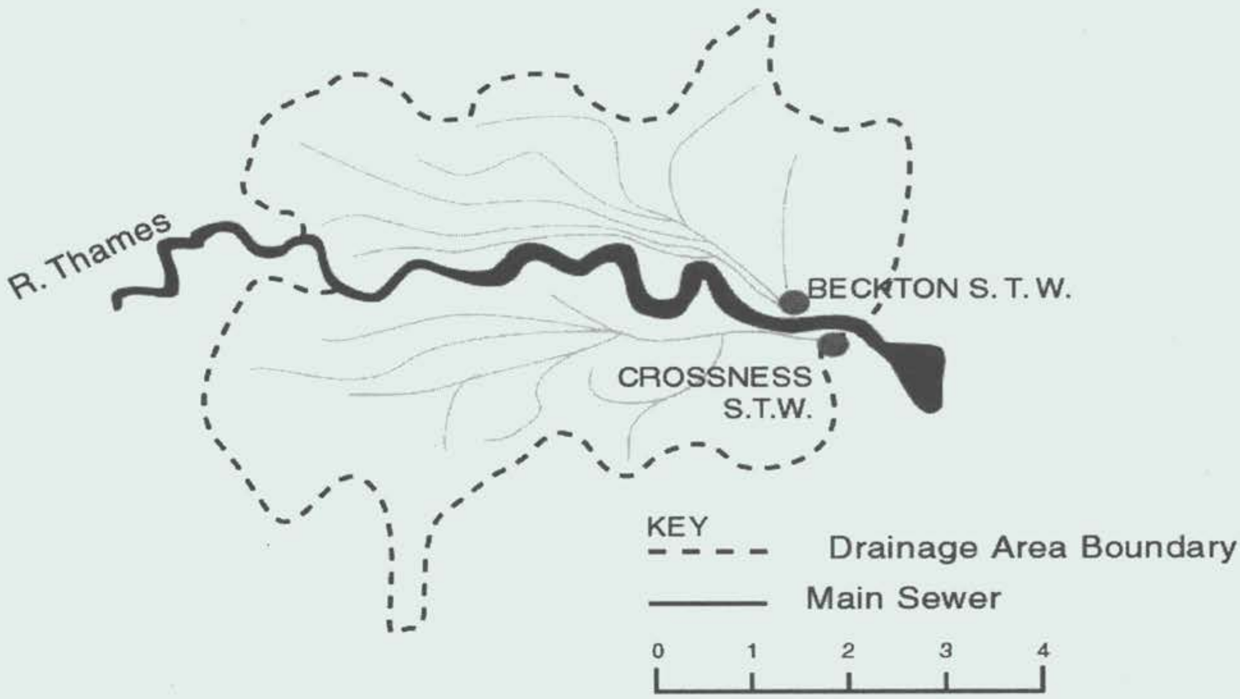


Figure 2. Network of Interceptor Sewers in London



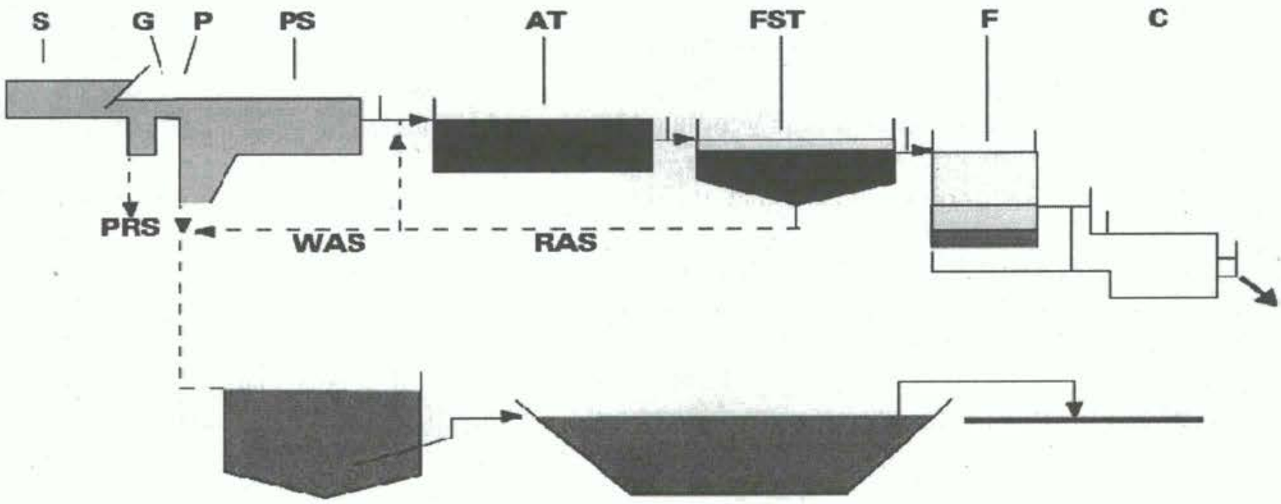
The treatment process that has been developed is what is now commonly termed the activated sludge process. It is based on the concept of separating solids from the wastewater and aerating the wastewater to satisfy its oxygen demand. Although the concept is simple many mechanical devices are required (Figure 3). These include bar screens to remove large objects, grit chambers to sediment out sand and similar particles, settling tanks, aeration tanks and associated air compressors. Furthermore sludge separated from the wastewater needs further treatment prior to disposal.

Proper operation and control of the activated sludge process is essential to handle the variation of flow on a daily basis with peak flows in the morning and evening. In addition during wet weather the large volume of stormwater may need storage and treatment during dry weather, or the by-passing of the peak stormwater flow to prevent the wash-out of bacteria used for the treatment of the wastewater.

Because of the extensive network of sewerage and the complex mechanical equipment required to operate an activated sludge process, the investment cost for such a system is high. Specialised equipment is needed to lay the sewer and trained and skilled personnel are required to operate and maintain the system of sewer and treatment systems. Considerable experience and expertise have been accumulated in the developed countries to build and operate this system that it has been regarded as the norm or conventional system for the management of wastewater.

Figure 3.

CONVENTIONAL ACTIVATED SLUDGE PROCESS



LEGEND

S - screen
G - grit chamber
P - pre-aerator
PS - primary sedimentation
AT - aeration tank
FST - final sedimentation tank
F - tertiary filter
C - chlorination
PRS - primary sludge
WAS - waste activated sludge
RAS - return activated sludge

Questions have been raised about whether a large centralised system as the conventional sewerage and activated sludge treatment is sustainable. A large amount of energy is used for pumping water and for aerating the waste. The treated wastewater has a reduced content of materials demanding oxygen and of suspended solids, but nutrients (nitrogen and phosphorus) are not removed. The nutrients can cause blooms of aquatic plants such as algae causing depletion of oxygen when the algae die and decompose. Standards for discharge for nutrients are becoming stricter, thus additional treatment is necessary beyond the conventional activated sludge process. If nutrients are to be reused on agricultural land a network of pipelines to carry the treated wastewater is necessary, because agriculture may not be near the treatment plant. Implicit in the conventional system of sewerage and treatment is that water is used as a conveying medium for human excreta and treatment involves separating the waste from the water. The wisdom of this is questioned from the point of view of water conservation and reuse of the nutrients.

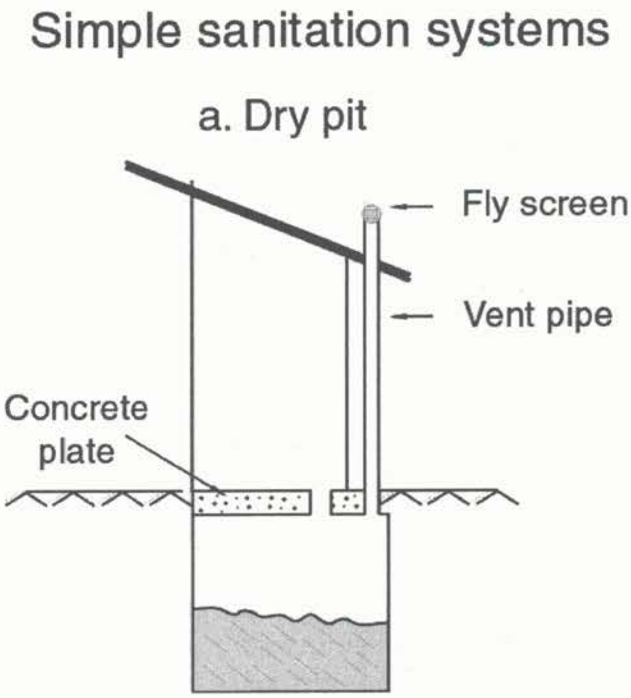
The high cost of investment and of operating a conventional sewerage and activated sludge treatment process, the specialised equipment necessary for laying sewers, the complex mechanical equipment for the activated sludge process, the level of expertise needed to operate the mechanical equipment largely explain why these systems fail in developing countries. They are not sustainable because they are not financially affordable. They rely to a large extent on expertise, spare parts and equipment from sources outside the country.

The SanPlat (Sanitation Platform) is a low cost sanitation technology that is gaining popularity in sub-Saharan Africa. This consists of a reinforced concrete platform with an opening and footprints (Figure 4). This platform is placed on a hole dug into the ground. The hole acts as a pit to accumulate human excreta. A simple housing is built on the platform to provide privacy (Figure 5). A vent from the pit is essential to control odour and reduce insect infestation. The vent acts to draw air from the housing through the opening in the platform via the pit into the atmosphere. A variation of this technology is termed VIP toilet (Ventilated Improved Pit toilet).

Separation of people and human excreta is achieved using this technology, and transmission of pathogens through contact with waste is greatly reduced. The platform can be constructed using materials available locally with local expertise associated with the building industry. The excavation of the pit can be carried out by the local people. When the pit is nearly full another pit can be dug and the platform relocated. The old pit is then covered by soil. Decomposition of the organic waste takes place, and after a period of time plants can be grown on the pit, thus recycling the nutrients contained in the waste.

Figure 4. SanPlat (Sanitation Platform)

Figure 5 . Low Cost Sanitation Using SanPlat



The SanPlat cannot be used when the ground is rocky, because it is difficult to excavate the pit. It is undesirable when the groundwater is close to the surface, because insects proliferate in the pit and groundwater is heavily polluted. Pollution of groundwater occurs because of the unlined pit. The SanPlat is suited to localities where the unconfined groundwater is relatively deep and the climate is arid. The balance between the benefits of improved public health from separation of people from waste and the pollution of groundwater is difficult to assess. If local groundwater is not utilised and drinking water is available from an unpolluted source then the low cost technology achieves the objective of improved sanitation with minimal impact on the environment.

CRITERIA FOR SELECTION OF WASTEWATER MANAGEMENT TECHNOLOGY

The above examples illustrate the need to consider historical and local factors in the selection of technology. Technologies have advanced considerably in recent years and we have a wider range of choice other than conventional sewerage and the activated sludge process or a simple pit latrine (The range of available technologies is elaborated further in the paper 'Alternative technologies for wastewater management'). Our understanding of the scientific basis for the technologies has similarly progressed such that we have the technology for producing drinking quality water from wastewater. We are, however, only beginning to rediscover the need to achieve long term sustainability by reusing the water and nutrients contained in wastewater. Economic affordability is now recognised as very important to sustain a project and is touched upon in two of the examples above. More importantly local social and institutional conditions are now recognised as being extremely important if we are to achieve sustainability and should be taken into account in selecting the correct technology.

The criteria for selection can be broadly classified into those that will ensure that the technology:

1. Protects of public health and the environment
2. Is economically affordable
3. Socially appropriate

1. Protects public health and the environment

Technology for wastewater management achieves improvement in public health by providing the means for breaking the transmission of diseases through the oral-faecal cycle (Figure 1). The technology should facilitate the separation of human excreta from people as soon as it is produced. This in itself is not sufficient to prevent transmission of disease, because transmission occurs through other means, such as not washing hands which have been in contact with excreta. Thus hygiene education is also an essential factor to improve hygiene practice. This practice should include proper maintenance of the technology hardware.

Technology for wastewater management protects the environment by not contaminating it with pollutants. The pollutants in wastewater are pathogens, organic materials which demand oxygen, solids, nutrients (nitrogen and phosphorus) and other harmful substances which may be disposed with human wastes. The latter may include household cleaning agents, solvents, medicines and other chemicals. Technology prevents pollution by treatment to remove these pollutants prior to discharge to the environment. Generally it is difficult to remove all pollutants from wastewater, but sufficient should be removed so that the assimilative capacity of the environment to absorb the pollutants are not exceeded.

It is recognised now that rather than treating wastewater for disposal it is better to reuse the wastewater. In this way the environment is not polluted and valuable resources in the waste is recycled back to nature. Ways of achieving this are discussed in the paper 'Technology choice and sustainable development in wastewater management'.

2. Economically affordable

For any service provision in a community to be sustained in the long term, there should be the ability in the community to pay for continuing operation and maintenance of the service. This should include the repayment for the initial investment cost, if it is not provided from outside the community.

Fortunately we have a range of available technologies for wastewater collection, treatment, reuse and disposal that can fit with local conditions to achieve economic affordability. The choices enable trade-off between capital cost and provision of land or in-kind contribution of community members in the form of labour for construction or for maintenance.

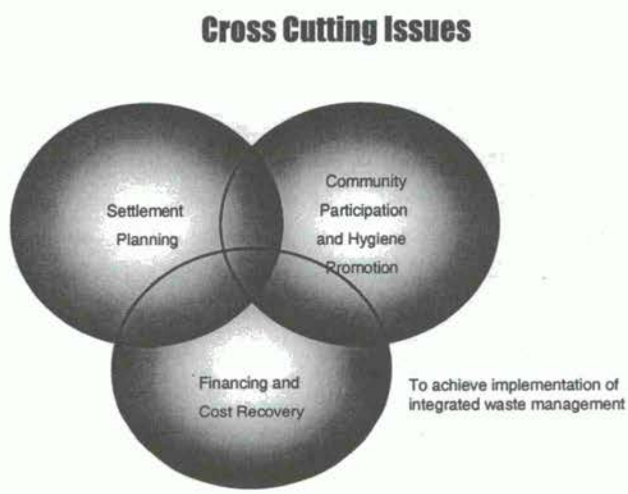
3. Socially appropriate

Within each community there is an established process of decision making and the associated institutions for making and implementing decisions. The process may straight forward and the institutions that are involved may be few if the decision is wholly within the ambit of the community. This may be the case when a community wishes to install a wastewater management system affecting only the community and not impacting on other communities or the surrounding environment. There is generally a more complex process because a number of government departments are involved in regulating public health, assessing environmental impact of projects, monitoring environmental quality, allocating funds for infrastructure, and for planning over a wider region which includes where the community is located.

It has been recognised that community participation in arriving at the right technology choice is essential to achieve sustainable service provision, because in the end the community has to pay for the service. Inability or unwillingness by the community will not result in continuance of the service. For a community to be able to make the right choice it is essential that it has all the information that is necessary to make a decision. Hence information on technology and on hygiene should be made available.

The economic and social factors that need to be considered in selecting a technology is termed 'cross-cutting' factors or issues (Figure 6).

Figure 6.



Settlement planning or lack of it is a major cause of difficulty in providing wastewater management services. Settlement planning involves:
- planning ahead of site occupation
- area is set aside for waste management
  - area is set aside for on-site system or sewer and treatment plant
  - area is set aside for wastewater reuse
  - area is set aside for stormwater infiltration

Community participation and hygiene promotion are discussed above, and in particular the following points should be considered.

Community participation to ensure
- The wishes of the community are taken into account
- The willingness and ability to pay ascertained
- Participation of women (usually responsible for sanitation)

Hygiene promotion to ensure
- Awareness of the relation between illnesses and lack of sanitation
- Knowledge of sound hygiene practices
- Knowledge of alternative sanitation technologies and correct choice

Many government departments are generally involved in decision making in wastewater and stormwater management. These are usually as follows:

Planning Department
- Coordination of planning for major infrastructure projects

Public Health Department
- Jurisdiction over maintenance of public health
- Responsibilities in monitoring, inspection, and enforcement of public health
- Promotion of hygiene

Public Works Department
- Jurisdiction over large infrastructure projects
- Responsibility for operation and maintenance of centrally operated systems
- Overview of systems operations by contractors

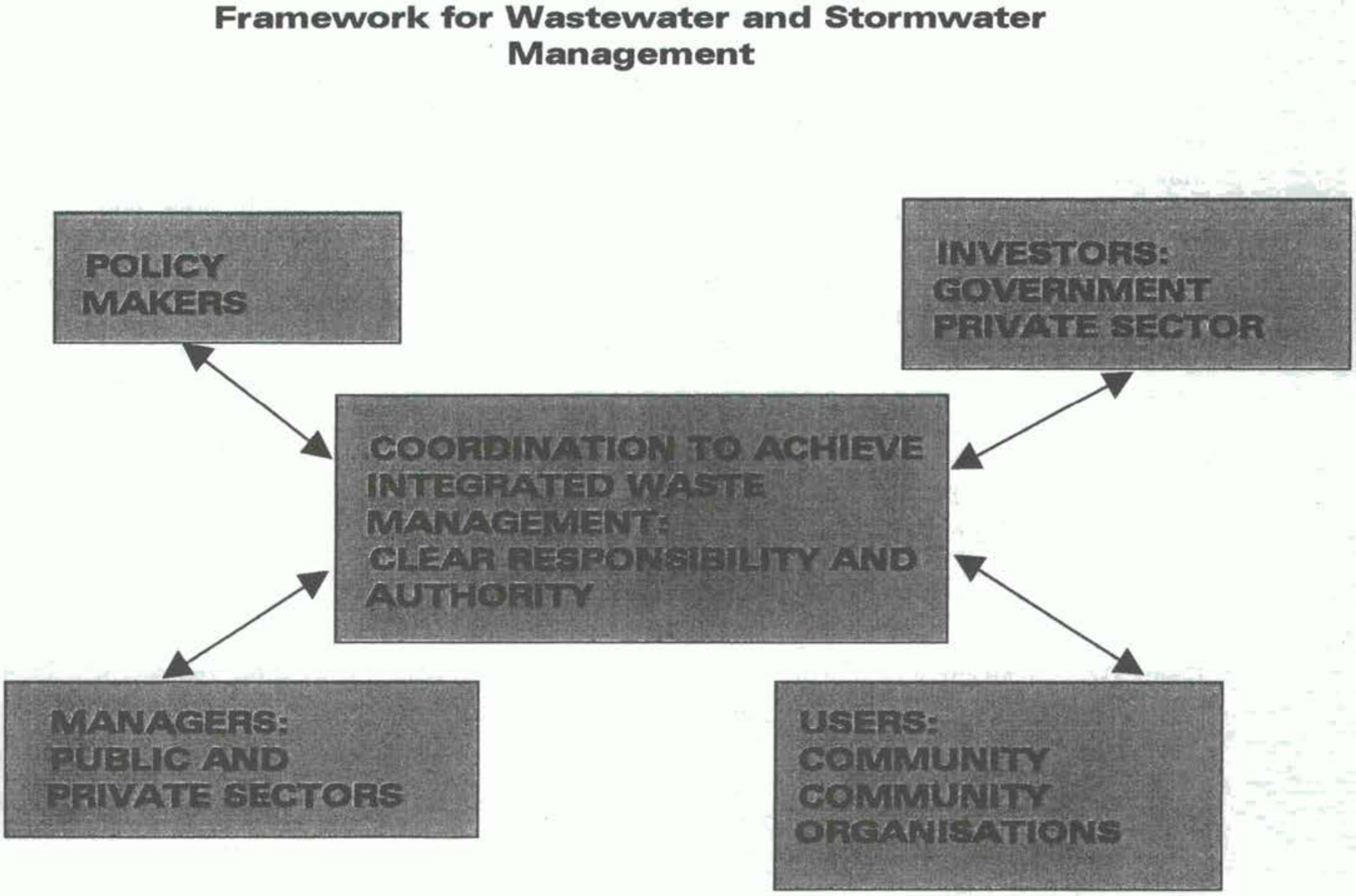
Environmental Protection Department
- Policy input in waste management
- Assess impacts of major infrastructure projects

Criteria for evaluation of technology need to be considered by all the stakeholders of the users (community), policy makers (government), managers (public or private sector) and investors (government or private sector). More importantly these should be coordinated with a clear line of responsibility. A framework is required to achieve this coordination (Figure 7).

CONCLUSIONS

A range of technologies is available for wastewater and stormwater management. Assessment and selection of technology should be based on criteria that consider protection of public health and the environment, ensure that the technology is financially affordable to the community it is provided and that it is socially appropriate. The latter two factors need to be integrated to the decision making processes within the community in the context of its wider setting. The importance of considering local physical, environmental, economic, and institutional factors cannot be over-emphasised.

Figure 7.



DISCUSSIONS

David Duncan Mara- "About groundwater pollution : I don't think we should knock on-site sanitation systems for polluting the ground water. In most cities in the United Kingdom, urban ground water after 100 years or more of sewerage is grossly polluted. And that is something we accept and that we are particularly worried about. So I think we have to be careful when we say that this advantage of a good on site sanitation technology is ground water pollution. It may or may not happen and it may or may not be important, so I think we should recognize that."

Arthur Archer - "In the Caribbean and other parts of the world we usually have latrine pits, but the compost pit that we saw is something new, so maybe you can explain that to us."

Goen Ho - "You are right : composting requires oxygen and so, here we have material that are buried and so oxygen is not available. So this is not the true aerated composting.

Definitely bacterial degradation takes place, which stabilizes the materials. I will show an example from the Pacific where a noble composting product is used".

Glen Laville (Bahamas) - "Just following up on the ground water contamination topic. In Bahamas most of the areas get their water supply from the ground, so therefore, ground water contamination becomes an important issue . Also a lot of households have individual wells that they get the water supply from, so again ground water contamination is a very important issue. So I think that the issue is really whether you have potable or municipal water supply available to the people as opposed to, whether they get their individual supplies from the ground."
Goen Ho - " I agree : I think it is very true if you depend on your water supply from the ground water beneath you, well, obviously you should not contaminate your ground water."

Josefina Gomez (Dominican Republic) - "I just want to say that it is the same situation in the Dominican Republic. The major potable water source is well water and it is in the city itself."

Goen Ho - "I just would like to use these examples as illustration to show there is a choice. We are going to discuss the process of each technology later."

Richard Middleton - "About ground water contamination, you are going to have to have some form of sanitation to protect public health. The typical system is that a donor agency puts a well in a middle of a village and somebody else builds latrines all around it and then you are amazed when the wells become contaminated. It is usually a lot easier to move the well (and people will carry water) than it is to move the sanitation, for example, providing a sewerage system. If you do basic economics, it makes sense to have sanitation systems in the house. Then think how you protect the water supply. So I support Duncan's point: you cannot just reject on-site sanitation because there is a well in a middle that is going to get into trouble. You've got to have a sanitation system and how to protect people's health."

Arthur Archer - "It is a common method particularly in areas where you have an aquifer from which you are going to pump water for potable purposes. You must filter the effluents from the septic tank or the latrine before it goes into the ground. You should also apply chlorination to it, to filter coliforms and so on. "

Richard Middleton - "I am sorry but I have to speak in defense of on-site technologies. You said that they may not provide adequate treatment. Duncan is better qualified than I to say this, but in fact, conventional sewage treatment also does not in fact result in sufficient pathogen reduction, unless you chlorinate it, to produce a safe effluent. It may reduce nutrients but what you discharge into waters is still pathogen latent and may have other problems of all sorts . I think we can say that on site technologies really do the job.

Manoherlal Kerof (Trinidad & Tobago) - "About Caribbean specifically, where to draw the line ? What are the criteria to draw the line to select on-site system ? Is it the cost alone or is it some other factor ? Of course cost and population density are the first factors that come to the mind, but what are the other ones ?"
Goen Ho - "The criteria are protecting public health and the environment (environmental practices), the economic factors (affordability) and the social institutional factors. Because who decides the technology to be used is usually the up-down system, the government (what kind of sewage treatment, or physical location), or the bottom-up approach, community . So I would like to introduce all these concepts and then we will at the end apply these criteria to specific situations.

Manoherlal Kerof (Trinidad & Tobago) - "I would like to add one more important factor. It is policy. The policy requires effluent standards. But probably most of this criteria may not be fit to achieve the standards on economic ground and on the technology. In the case of Trinidad, we have these three main standards, but at the same time we know only 30% of the country has conventional sewerage systems. And those systems are not functioning properly. But you still have the law and the requirements. The technical people like us that have to take decisions, have to abide by that. The same government policies want development in the country, building schools, projects, and on-site systems, but there are no policies to draw the line."

Carmen Olano (El Salvador) - "In my country we need a policy that regulates all about sewerage systems. The environmental law was created only in 1996. That is a very serious problem."
Goen Ho : " This is an important observation. In many places there are good laws and good policies, but the implementation is the main problem" .

Luiz Gamez (Costa Rica)- "It is important as well that the criteria is not isolated but requires an appropriate institutional framework. Another issue is the sustainability. It should be a long term policy goal; not only should we look at economic but also at the financial issues, which must be well distinguished. I think we should also talk about cost recovering and appropriate cost pricing, that must not be separated from the technological aspects."
Goen Ho : "Yes, it is important because governments deal with economics, but the local people have to pay for the projects".

Carmen Arevalo - "I have a comment related to cost coordination. In Latin American countries previous settling planning is very difficult. Another problem has to do with the community participation and the information for the community. To take part in the alternative technology selection choosing, the community needs information, but there is a cost on that information process. When we look at the privatization processes going on, we see that the private companies can not afford the cost of informing the population. This conflict needs to be solved."
Goen Ho - "That is true. To ensure community participation, it is important that it is well informed, and that is the aim of the Water Source Book ."

Josefina Gomez (Dominican Republic) - "Talking about participation, in my country we have another type of participation which is people having enough money and making their houses and apartments with a good income. The point is that they do not take into consideration all the things. Most of these people make urbanization through bank financing and banks do finance houses but they do not finance wastewater or water treatment. So public participation should be considered not only in terms of very low income on communities but also the knowledge that they do not put attention to those issues. In my country there is a huge amount of apartments in construction with the same sewerage system and this is really a problem."
Goen Ho - "That is a very important point. While preparing the Source Book, I have found out that even in Europe the cost of sanitation is between 5% or 10% of the cost of the house. So if you set aside in your building project 5 to 10% of the cost of the house and the land, you can have a technology that is appropriate for that."

Cristobal Morejón (Cuba) - "For Latin American and Caribbean countries it is very important to know deeply this low cost technology. In many of these countries the resources are insufficient and there is not enough money to construct adequate plants, specially in rural and per-urban areas. Another important point is the direct participation of the population on low cost sewerage systems construction.
Besides that, we must also educate people about environmental and sanitary aspects. The population must be conscious about the environmental impacts they are going through and also about the solutions given by the project.

Terrol Inniss (Barbados) - "What provision do we need for the development and the cost of providing the relevant wastewater disposal ? Is it necessarily what the people can pay for, so you settle them in an the area but you do not have the financial capabilities of paying for the sewerage system for that particular settlement. What provisions have been put in place for that ? "
Goen Ho - "The answer involves so many facts that I think we should discuss that during the workshop."

Carlos Landin (Ecuador) - "Better than community information, what we have to do is community development, which means to apply a development process that includes sanitary information and paying taxes to maintain the basic services."
Goen Ho - "Yes, the ability to raise taxes is one factor".

Lilia Casanova - "I would just like to make a comment on some of the comments of our colleagues here. Starting with one from the Dominican Republic, where she mentioned middle income class, and the awareness of the need to provide for the cost of wastewater treatment facility and the comment from Trinidad & Tobago when he said about the need for policy and this relates very well to the Barbados' question on the issue of what about those people who have been there before the idea of the development came in.

How do we provide for their needs, for the problem of wastewater treatment facility ? One of the important factors is considering provision of wastewater treatment facility or sanitation at the settlement planning. Settlement planning is a very important aspect in policy decisions. Before you do anything it is ideal to have a policy on settlement planning. Unfortunately, many countries do not have this policy, or even have policies, but these are not updated.
I guess this is going to be a very important aspect in our discussion. Maybe we have to be remembered of all that. Because when we talk about technologies we are always thinking of hardware, or hard technologies and those are not the only solutions."

TECHNOLOGY CHOICE AND SUSTAINABLE DEVELOPMENT IN WASTEWATER MANAGEMENT

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ABSTRACT

The problems facing communities without adequate sanitation are highlighted to illustrate the need for integrated waste management to achieve significant public health and environmental improvements. This involves addressing caused not only by wastewater, but also by solid wastes and stormwater. Only when these three are addressed simultaneously will we overcome the public health problems and improve the amenity value of our environment. The waste management hierarchy is introduced to stress the importance of separating wastes and particularly of industrial wastes that can irreversibly contaminate wastes that can be reused or recycled. The concept of natural purification is presented as a basis for developing sustainable and unsustainable wastewater management practices, one where the material cycles are closed, and the other where the material cycles are not closed.

KEYWORDS

Integrated waste management, waste management hierarchy, sustainable wastewater management.

INTRODUCTION

Protection of public health and the environment, affordability and social appropriateness have been suggested as criteria for selection of technology for sustainable wastewater and stormwater management in my previous paper. A framework for wastewater and stormwater management has also been suggested that emphasises the need for coordination between all stakeholders (policy makers, investors, managers and users).

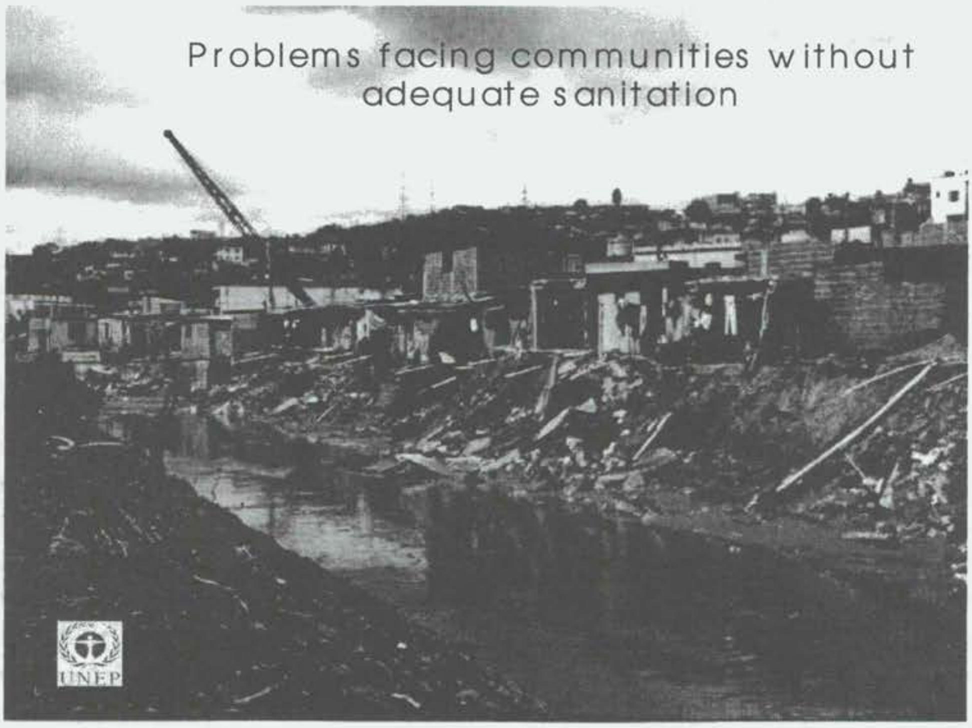
In this paper technology choice is related to sustainable development. The problems facing communities without adequate sanitation is first of all described so that the need for integrated waste management becomes obvious if we want to achieve significant public health and environmental improvements. The waste management hierarchy is then introduced to stress the role of prevention rather than cure, and the need to separate wastes to achieve integrated waste management. The concept of sustainable development in wastewater and stormwater management is finally elaborated by considering natural purification processes and the need to maintain the material cycles of potential environmental pollution (organic carbon, nitrogen, phosphorus). This paper is also based on 'International Source on Environmentally Sound Technologies for Wastewater and Stormwater Management', which is being published by UNEP IETC.

PROBLEMS FACING COMMUNITIES WITHOUT ADEQUATE SANITATION

Inadequate sanitation facing a substantial proportion of the world's population is well documented. This is well illustrated in the papers presented by participants of the workshop.

In general these communities are located in an environment which has a relatively high population density. Water supply may or may not be adequate. In cases where water is supplied through pipes, there are not the corresponding pipes for removing the wastewater generated. The wastewater is simply allowed to flow by gravity through the natural drainage of the landscape ending in low lying areas, water courses, lakes or the sea. The natural drainage carries stormwater run-off during rainfall events, and during flood events stormwater mixes with wastewater, and polluted water is spread over a much wider area than the drains. In addition solid waste is also generally dumped into the drains or natural water courses resulting in flooding at lower rainfall events. Water-borne diseases are therefore endemic in these communities. The environmental conditions of the area are degraded, because water containing decaying organic substances from sewage and garbage give foul odour, the water is depleted of oxygen and is putrid. Groundwater in the area is also generally polluted, because of the infiltration of polluted water to the groundwater aquifer. The general physical environment is as illustrated in Figure 1.

Figure 1 . Urban settlement with high population density, sewage disposed to drains, pollution of drains, streams, river/sea and groundwater



If the population density is very low, the environment has the capacity to absorb the wastes generated and environmental degradation is negligible. Water quality of streams and rivers in this environment is generally excellent.

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When the amount of wastes disposed to the environment increases with the increase in settlement population, the capacity of the receiving environment to assimilate the wastes is exceeded and degradation of the environment takes place. Communities have responded in different ways to the public health problem and environmental degradation that are created. Even though there have been numerous ways in which the problem has been addressed, we may generalise these in terms of the following stages.

Because of the importance of dealing with health problems caused by wastewater within the community, wastewater is transported away from the community. This is done by improving drainage, while still conveying both wastewater and stormwater through the same drains. Measures to reduce the incidence of flooding are usually applied, by for example, deepening drainage channels, preventing solid wastes from being dumped into drains, and covering of the drains represents the first attempt to provide a sewerage system. In this way wastewater and the inherent human pathogens in it are removed from the community as a source of public health threat.

Environmental degradation of the receiving water still continues. If the wastewater is disposed to a river the water will affect people using it for bathing and washing, and downstream communities may withdraw the water for drinking purposes. The amenity value of the river for recreational purposes, for fishing, agriculture and industry is devalued. The classification of rivers is a good illustration of how the quality of a river is determined by its pollution load (Table 1).

Table 1. River pollution classification (based on National Water Council (UK) classification, 1970)

Class	Description	DO. & BOD*	Characteristics
Class I	Unpolluted or recovered from pollution	BOD < 3 mg/L	No toxic or suspended discharges which affect the river
Class II	Doubtful quality and needing improvement	BOD > 3 mg/L, toxic and reduced DO in dry flow times	Toxic and suspended discharges occur but have no major effect on biota
Class III	Poor quality, improvement is a matter of some urgency	DO < 50% for considerable periods	River changed in character, suspected of being actively toxic. Subject to serious complaint

The river pollution classification (Table 1) provides an illustration of the ability of the environment (here the river) to cope with small waste discharges of organic wastes. Small discharges of BOD are diluted by the river water to low levels. If the concentration of BOD in the river water is less than 3 mg/L the river remains 'unpolluted'. The oxygen uptake by bacteria, as they consume the organic wastes, is replenished by the continuous transfer of oxygen from the atmosphere to the water. The dissolved oxygen (DO) concentration in the water remains high. This simple process explains the reason why a stream in an undisturbed forest remains clean despite the natural organic wastes produced by animals in the forest. Other physical, chemical and biological processes take place which help in the ability of nature to purify wastes.

On the hand the river pollution classification shows that it does not take much for an unpolluted river (class I) to become a grossly polluted river (class IV). When the BOD concentration in the river water is greater than 12 mg/L, the transfer of oxygen from the atmosphere cannot replenish the oxygen demand and the water becomes completely deoxygenated. It is incapable of supporting fish life. The water is dominated by bacteria that thrive on the organic wastes but able to extract oxygen chemically from substances like sulphates in the wastes. Gases such as hydrogen sulphide (rotten egg gas) and methane are generated by these bacteria. Foul odours are the result, and the appearance of the water is grey black with bubbles frothing up.

To prevent degradation of the receiving environment wastewater needs to be treated. This treatment is usually carried out at the point of discharge, also called 'end of pipe' treatment. Treatment consists of removing solids from the wastewater and reducing its BOD. The degree of treatment that is required is dependent on the capacity of the receiving environment to assimilate the remaining organic wastes.

Because the wastewater treatment facility is generally designed for dry-weather flow, its capacity is exceeded in wet weather. Treatment efficiency drops during wet weather, and in high rainfall events a significant volume of combined wastewater and stormwater is not effectively treated. To overcome the problem of wet-weather flow, and recognising that stromwater may not be as contaminated as wastewater, separate collection of wastewater and stormwater have been implemented, with stormwater treated only to remove gross solids.

It is worth noting that the severe sanitation problems currently facing many cities in developing countries were experienced in Europe as recently as at the end of the nineteenth century, with epidemics of water borne diseases occurring in London then. The section of river Thames passing through London was grossly polluted until the 1970s. Sewage discharges to the river were treated to reduce BOD concentration and raise DO to enable fish to return.

While the stages of development of sewerage and drainage portrayed above are generalisation of observation in many cities, they are by no means the only way to overcome the problems of sanitation. Various options are described in my next paper, together with their advantages and disadvantages, and a general strategy for selecting the most appropriate option for a particular case suggested.

INTEGRATED WASTE MANAGEMENT

The description of problems facing communities without adequate sanitation above shows the importance of addressing the problems in an integrated manner. Simply solving the problem of wastewater without taking into account of solid wastes and stormwater will not achieve sufficient sanitation improvement to protect public health and the environment. UNEP IETC has published an International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management, which provides guidance on the selection of technology for the management of solid waste. The present UNEP IETC Source Book complements this publication, and is intended to provide the means to achieve the integrated approach.

In discussing integrated waste management we need also to consider solid wastes and wastewater produced by industry. In many instances these may not differ in characteristics from domestic wastes, consisting primarily of biodegradable organic substances. Industry, however, produces numerous types of wastes which may be toxic to bacteria that are utilised to treat domestic wastewater. The practice in many communities is for industrial wastes to be disposed with domestic wastes.

One principle that logically emerges from adopting an integrated approach to waste management is that different types of waste should not be mixed (Figure 2). Solid wastes should not be dumped into stormwater drains, but should be collected, recycled, reused, or treated and disposed separately. Dumping of solid wastes in stormwater drains will not only restrict the flow of stormwater, they contaminate stormwater. Treatment of the stormwater will involve separating the solids and other contaminants from the water. Similarly industrial wastes should be treated separately, and industrial wastewater should be pre-treated if they are to be discharged to the sewer.

Figure 2. Integrated waste management

All wastes should be considered together to achieve environmental and public health improvement. Wastes should be separately collected and managed.

A useful tool that can help towards achieving integrated waste management is the waste management hierarchy. It has been used to direct waste management towards achieving environmentally sound practice. The waste management hierarchy in its most general form is shown in Table 2.

Table 2. The waste management hierarchy

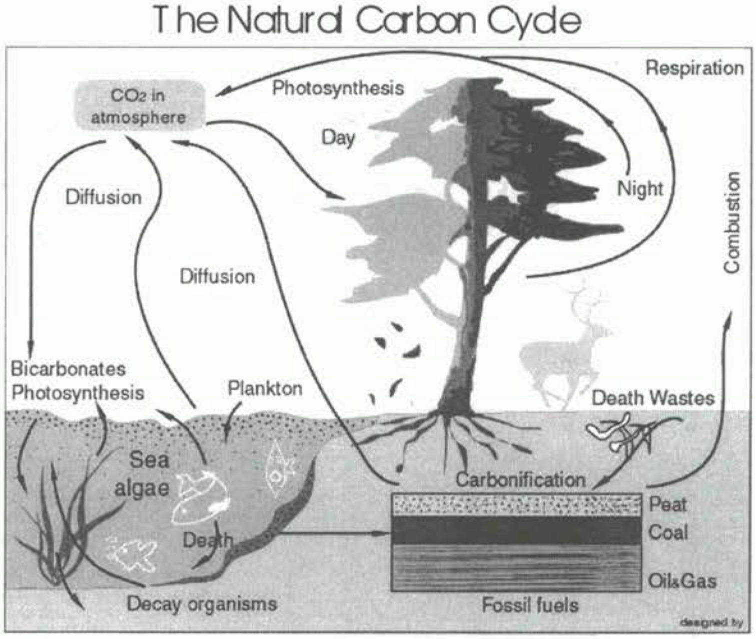
1	Prevent or reduce waste generation
2	Reduce the toxicity or negative impact of the waste
3	Recycle waste in its current form
4	Reuse waste after further processing
5	Treat waste before disposal
6	Dispose in an environmentally sound manner

We cannot prevent the production of human excreta or stormwater, but we can prevent other materials from being disposed with human excreta, or solid waste with stormwater. We can use less water to achieve the same purpose (e.g. flushing toilet) and hence produce less wastewater. We can avoid toxicity of wastewater by preventing toxic household or industrial wastes to be disposed with biodegradable organic wastes. A reuse example is the use of urine as a liquid fertiliser, while composting can convert human excreta into a soil conditioner. Other examples will be discussed in my next paper, but it should be recognised that all waste management practices have costs as well as benefits. The application of the waste management hierarchy therefore needs to consider economics as well as other factors (e.g. some culture may not allow reuse of human wastes).

NATURAL PURIFICATION PROCESSES

Before considering technologies for wastewater and stormwater management it is instructive for us to examine natural processes that cycle waste materials. In nature waste materials are produced by living organisms (plants, animals and people). These wastes include faecal materials, leaf litter, food wastes and dead biomass. Yet streams and rivers flowing through a forest, or freshwater lakes in a forest, have generally an excellent water quality. Thus there are natural processes which purify the naturally produced wastes. These wastes are characterised by their organic nature (that is derived from living or once living organisms). They consist of carbon, nitrogen, phosphorus and other elements which constitute the building blocks of living organisms. These elements are continuously cycled in nature. Three of them (carbon, nitrogen and phosphorus cycles) and the water cycle are relevant to wastewater and stormwater management. Figure 3 shows the natural carbon cycle.

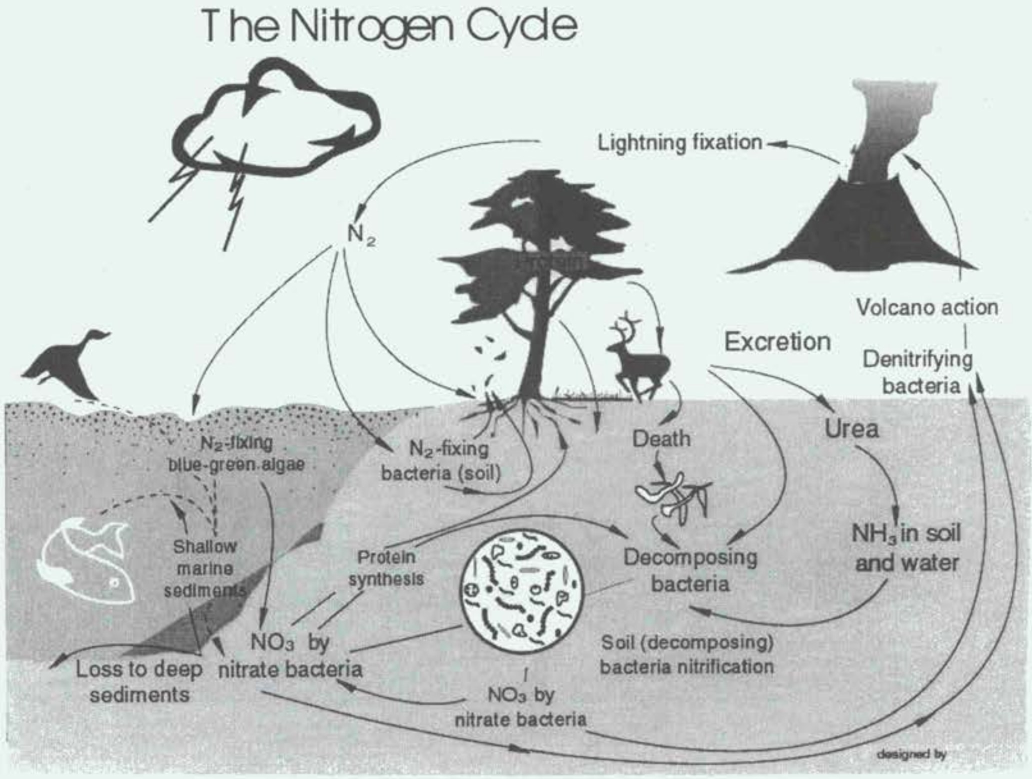
Figure 3 . Carbon cycle



The following transformation processes occur in the carbon cycle. Plants photosynthesise glucose from carbon dioxide gas and water, and in turn more complex organic matter is synthesised. Plants are consumed by plant-eating animals, which in turn are consumed by meat-eating animals. Organic carbon compounds are digested by these animals and re-synthesised into other forms, which are useful for energy, cell growth and cell multiplication. Carbon dioxide is released into the atmosphere during the process of respiration. The respiration process releases energy for the organism through oxidising the organic carbon. Plants and animals produce waste materials and will eventually die. Leaf litter, animal wastes and dead organic matter are decomposed by bacteria and other decomposers releasing the carbon as carbon dioxide thus completing the carbon cycle. Oxygen is required in the process of respiration and oxidation of organic carbon, and this is the reason for the oxygen demand of organic wastes. Some organic matter from dead animals and plants is, however, stored in nature, particularly in sediments, and slowly turns into peat or more stable carbon-rich materials.

In the process of decomposition not only is carbon released as carbon dioxide, but other minerals are released. These minerals are involved in other cycles, such as the nitrogen cycle (Figure 4) and phosphorus cycle (Figure 5).

Figure 4 . Nitrogen cycle

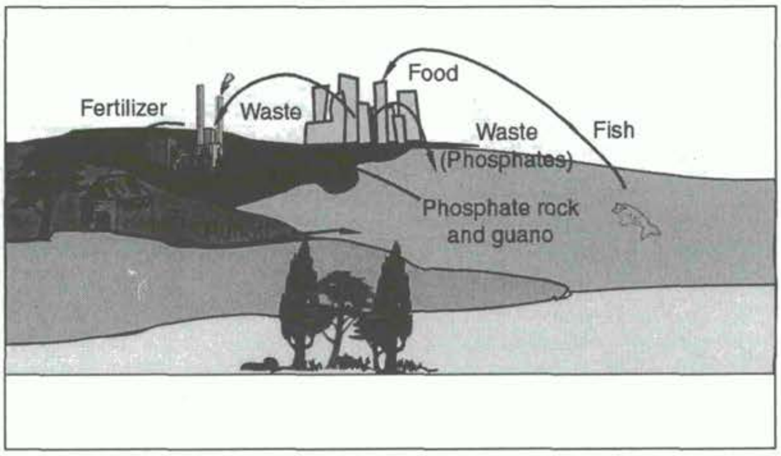


Ammonia is generally the form of nitrogen released from the decomposition of organic wastes. Provided that oxygen is available the ammonia is oxidised by a group of bacteria (termed nitrifiers) to nitrate. This process is another that exerts oxygen demand on the environment. Nitrate is the form of nitrogen that is normally taken up by plants for protein synthesis. Nitrate may on the other hand, under conditions devoid of oxygen (anaerobic conditions), be converted by a group of bacteria (termed denitrifiers) to nitrogen gas. Denitrification generally takes place in sediments, where anaerobic conditions and availability of organic carbon promote the process.

Nitrogen gas in the atmosphere is very large in quantity, but is inert. Relatively small quantities are converted into forms that can be utilised by plants. These are converted through the activity of nitrogen-fixing bacteria in the root-nodules of some plants, nitrogen-fixing blue-green algae or through lightning. Some is contributed by volcanic eruption. The amount of nitrogen cycled in a natural environment is therefore relatively small and is rapidly absorbed by plants.

Figure 5 . Phosphorus cycle

The Phosphorus Cycle

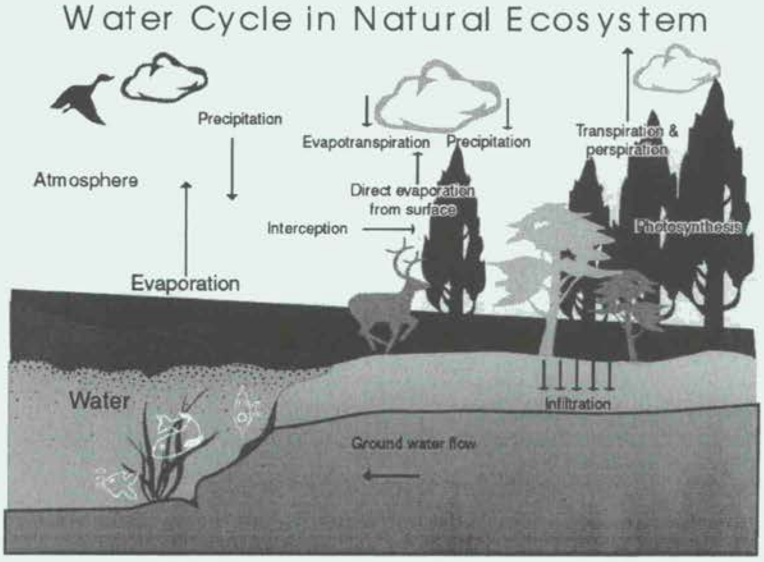


Phosphates are the products of decomposition of organic matter by decomposers and these are also the forms that are taken by plants. Phosphate rock, from which phosphate for fertiliser is mined, is an accumulation of phosphorus from the excretion of the guano birds and that is not utilised by plants at the deposition site.

From examination of the above natural cycles it is clear that very little organic wastes and nutrients are leached from natural ecosystems. In addition in a forest ecosystem the surface run-off has a low peak and extends over a longer period, thus solids are filtered from the water, and nutrients have a higher likelihood of being absorbed by plants. The soil in a forest ecosystem can provide additional purification processes. Soil bacteria will consume organic carbon and reduce BOD. Soil minerals (particularly clay minerals) can adsorb metals and phosphates. Plant roots take up nutrients released by bacterial decomposition from water percolating through the soil.

Pathogens, if any, generally die-off, because of unfavourable conditions outside their hosts for an extended period and competition with naturally occurring mirco-organisms. The water cycle therefore produces surface water and groundwater of very high quality (Figure 6).

Figure 6 . Water cycle



The natural cycles (also termed biogeochemical cycles) can provide an insight into the natural basis of wastewater and stormwater management. For disposal of wastewater and stormwater into a natural ecosystem, as long as the natural purification capacity of the ecosystem is not exceeded, we can rely on the existing natural processes to assimilate the wastes without degrading the quality of the environment. On the other hand once the natural capacity is exceeded, engineered systems are required. There is no reason, however, why the same physical, chemical and biological processes taking place in nature cannot be used as a basis for technology development and for waste management.

We note that in nature the cycling of the elements provide a pathway for reuse of the materials in the wastes. We should consider how we can use the same processes to recycle wastewater and stormwater. A limitation of natural purification processes is that they can only handle naturally occurring wastes. The latter can include human wastes, but not toxic chemicals that stop the natural processes. In addition a large human settlement removes a large area of natural ecosystem and generates a large amount of wastes, and the combination of the two rapidly and significantly impact on our natural environment. Clearing of vegetation reduces evapotranspiration, while roads and houses introduce impervious surfaces. Consequently rainfall run-off has a higher peak and is generated rapidly, promoting local flooding.

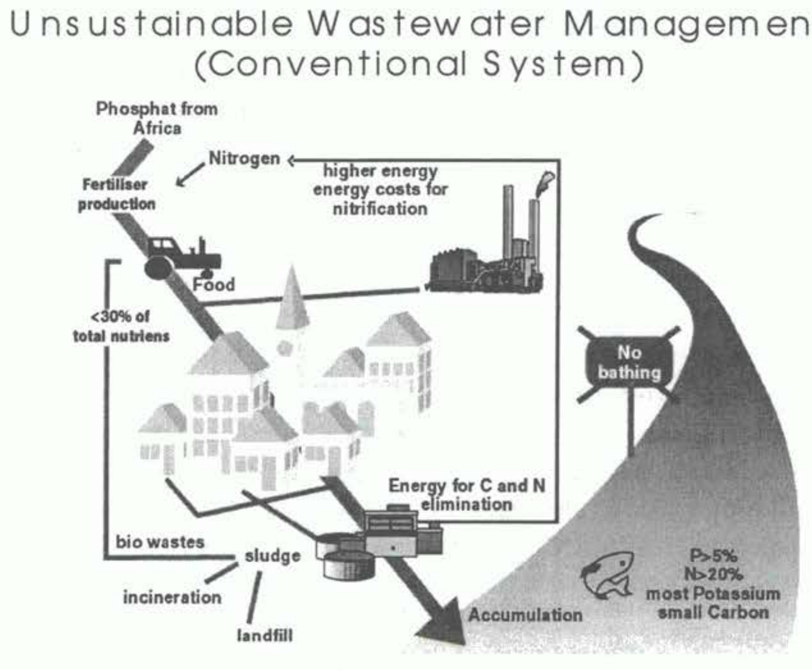
SUSTAINABLE VERSUS UNSUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

The natural purification processes and biogeochemical cycles described above provide a basis for determining what is environmentally sustainable management practices for wastewater and stormwater. Discharge of wastewater and stormwater into an environment exceeding the natural purification capacity of that environment will result in the accumulation of organic materials (carbon), nitrogen, phosphorus or other

SUSTAINABLE VERSUS UNSUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT

The natural purification processes and biogeochemical cycles described above provide a basis for determining what is environmentally sustainable management practices for wastewater and stormwater. Discharge of wastewater and stormwater into an environment exceeding the natural purification capacity of that environment will result in the accumulation of organic materials (carbon), nitrogen, phosphorus or other pollutants that cannot be absorbed by the ecosystem constituting the receiving environment. Accumulation of organic materials will result in a high oxygen demand that cannot be met by oxygen transfer from the atmosphere. Undesirable anaerobic conditions are a consequence. Figure 7 illustrates an unsustainable practice where the natural purification capacity of a river into which wastewater is discharged is exceeded, and where in addition the local biogeochemical cycles are not closed.

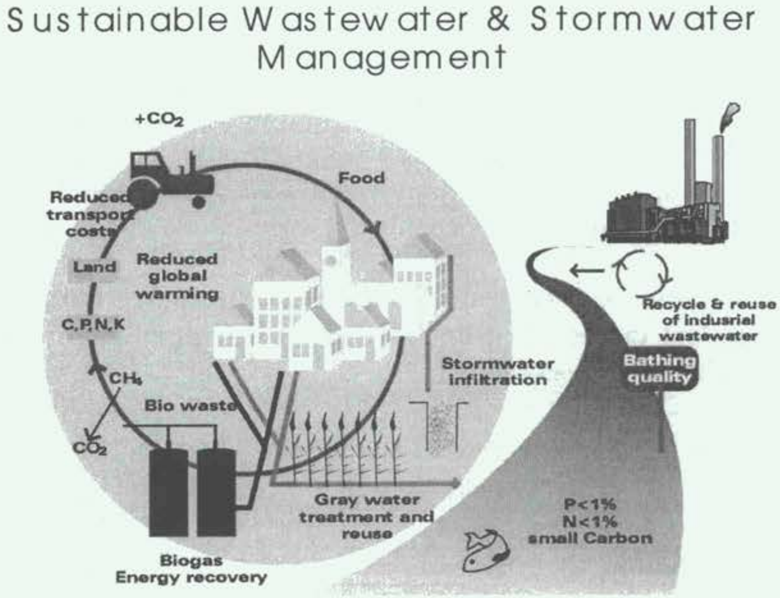
Figure 7 . Unsustainable wastewater management practice from not closing the local biogeochemical cycles resulting in the natural purification capacity of the receiving environment to be exceeded



Nitrogen and phosphorus in wastewater are discharged to a river resulting in their accumulation in the river. Eutrophication of the river is an outcome. The nitrogen and phosporus in the wastewater come from food consumed by people. To grow this food fertilisers containing nitrogen and phosphorus are required. These are manufactured chemically from atmospheric nitrogen and from phosphate rock. The flow of materials (N & P) is one way from the atmosphere for N and from the phosphate rock mine for P into the river. There is depletion of a resource (mined phosphate rock) and accumulation and pollution in the river. This practice is unlikely to be sustainable in the long term, because phosphate rock deposits will be exhausted and pollution of the river by N and P needs further treatment of the wastewater.

One way of managing the wastewater sustainably is by closing the material cycles locally (Figure 8).

Figure 8. Sustainable wastewater management practice by closing the local biogeochemical cycles



Nutrients in the wastewater are reused to grow food. In this way there is not the need to manufacture chemical fertilisers and at the same time there no discharge of nutrients to the river. The problem of resource depletion and pollution of the river is overcome by closing the material cycles. Figure 2.9 also emphasises the need to treat industrial wastewaters containing toxic substances separately, and not to mix industrial wastewaters with domestic wastewater. In addition stormwater should be separately collected and treated and infiltrated locally.

CONCLUSIONS

The right choice of technology is dependent on local environmental, economic and social conditions. It is clear, however, that we need to address solid waste, wastewater and stormwater in an integrated manner if we want to achieve significant public health improvements and environmental protection. Ironically to achieve integrated waste management we should not mix wastes, but each should be addressed separately. The waste management hierarchy is suggested as a means to prevent or reduce the amount of wastes generated.

Sustainable wastewater and stormwater management can be defined in terms of the cycling of elements important for sustaining life (Carbon, Nitrogen, Phosphorus and other essential elements). Closing the cycles will prevent pollution and achieve long-term sustainability.

DISCUSSIONS

Richard Middleton- "Of course we can deal with the nutrients cycle. What I am very often concerned with is the pathogen cycle. In the countries where I work, a large number of children have a very high worm load. They typically excrete in the property or close to it, generally on the floor or yard. Those pathogens survive very happily in a humid climate and do not get into the water but they reinfect other people through a fecal oral contact, not getting into wastewater. And the only way of cleaning those up or dealing with those pathogens is time and temperature by separating them from everybody else in the general environment. Yes, nature has its own cycles, but we have mention the pathogen problems which are within a household and infect people on a local level, before going to a water body."

David Duncan Mara- "Talking about environment protection is very important. But I think what is equally or more important is the protection of human health and we don´t seem to be doing this here, at least not with the same vigor that we are protecting the environment. I would just like to read the title of a paper published in the middle of 1999 in one leading Medicine journal: "The association of early childhood diarrhea with entail physical fitness and cognitive function 47 years later in a poor urban community Northeast of Brazil". For the first time we have good evidences that diarrhea is associated with entailed physical and mental development many years later. So I think we have to take the human health side very seriously and if we do that, than it tells us certain things about how we manage our wastes, how we recycle or not, or what the costs are.

I think we should have these two guiding principles: human health protection and environmental protection. To me human health protection is the most important. You have mentioned that the river Thames in London was grossly polluted until 1960's. We in England have lived in polluted rivers not only in London but in all parts of the country for over a hundred years simply because we did not know how to treat wastewater properly early in our industrial revolution. And when we did, it was too expensive.

We used the rivers as a sewer and that is fine as long as you know what you are doing. OK, we are sacrificing our rivers for our industrial development. As long as we do that with our eyes opened and it does not compromise human health. So I think that is OK because eventually a society will have enough money and the wish to improve the quality of its river waters."

Goen Ho - "In fact, we have emphasized both aspects equally in the source book. But with this particular example I just want to illustrate the sustainability of waste management from the environmental point of view. As you can note that we have staples here. I want to convey the idea that the concept of environmental sustainability is being debated very much in the developed world where the activate sludge process is also being questioned. I would like to learn from the mistakes in the given examples, so that we can actually achieve development and also protection of the public health and the environment."

Julio Torres (Panama) - "We have to think that when we are using rivers for a sewerage system, we also have to keep in mind that, like in Panama, the rivers are used also to run into basins and lakes and then that water is made into potable drinking waters. Therefore, the more polluted the rivers become, the harder it is to get healthy drinking water for people. That is the biggest problem in Panama."

Louise Zuilen (Suriname) - "I do not agree totally with Duncan Mara because prevention is cheaper than cleaning. In our country, at the capital, we have a conventional combined sewage system, where 1/5 goes to the river without treatment. And we can not develop first and then clean because the little pollution we have costs a lot for the government to clean it. I think we have to prevent now and that must be the policy for developing countries: prevent instead of cleaning."

Lilia Casanova - "About Duncan's comment, I think there is no choice: we must protect both. I think the virtue of looking at environmental health is because this is the very reason why we talk about sustainability. It is because human health has not been protected in developing countries , because there was less concern about it. When you pollute a river, you are avoiding or preventing people from having long-term quality of water. I think it is good to protect human health but we must not forget that it is because of our lack of consideration for the environmental health that in the end we are sacrificing human health."

Luiz Gamez (Costa Rica) - "About natural ecosystems, I believe it is important to consider environmental services because many of them are providing functions and services that are not obvious to us and inadequate management land use can destroy those services. I do not believe that public health protection excludes environmental protection. On the contrary, they are complementary and should be integrated . Especially because of costs, the replacement cost of catchment area can be immense. It would be very expensive if we think on the alternative of bringing water from elsewhere, because it would implicate canals and high investments. Wet lands will help to recycle and keep an equilibrium and replacing that would imply in higher investments for treatments plants. So there is also an economic reason for protecting ecosystems as well, for the sake of public health."

Arthur Archer - "I have heard about a disposal of effluents and exporting into rivers. That is something which has to be corrected. Especially because in rural areas, you find people washing clothes and taking water from rivers for potable purposes, so the sewage must be properly treated, chlorinated, filtered before it is discharged into rivers."

Richard Middleton - "One of the phrases economists use is that 'wastes are a resource in the wrong place.'
About planning, most of us are working in countries where very high speed urbanization is taking place and I have seen one estimate that says that 60% of new housing is "illegal" and that tends to be left out of the planning process. You cannot use these sophisticated recycling models unless you involve these illegal people, and that has huge

political and policy implications which we probably can not cope with. If you ignore 60% of the people living in the town, it will remain insanitary. We have to solve it."

Viviana Rocco (Uruguay) -"I agree. In my country we have been working for the last 20 years in drawing a master plan where U$300.000.000,00 will be invested in sanitation that will benefit 1.500.000 people. On the other hand we have to invest U$100.000.000,00 to integrate irregular settlements , where 150.000 people are settled in wrong places. So I think that we actually have a very big expense in incorporating those settlements to our urban environment.
About Arthur's river usage comment, I think we have to consider sustainability issues after we decide what we want to do and for what we are using our rivers. For the sake of human health we must definitely protect our water sources, whether they are ground water or rivers, but we have urban rivers that are not going to be used for direct human contact or potable water sources. So we can actually accept to have them polluted to a degree that the community accepts and not allow them to be used for anything else but to that."

Eugenio Barrios (Mexico) - "The planning aspect can be completely different in our countries. In fact, most of the times, we can rarely do any planning.
Other point is the discussion between health and environment. It is very important to consider that as long as it help us to solve our problems."

Luiz Gamez (Costa Rica) - "Many of the high speed legal urbanization are sacrificing ecosystems which are providing water supply. They are degrading the quality of resources that can be used. Therefore, we have to invest more and more in treatment plants to make that water of good quality and that is very expensive. So, protection of the key areas such as catchment areas, water supplies and wetlands, which are providing services to society, is very important, also considering costs. Replacing those ecosystems services is going to be very expensive."

Lilia Casanova - I would like to add another comment. Naivasha, Kenya, is a place near Nairobi, that depends very much on tourism revenues, because there is a lake inhabited by a large group of flamingos . A certain country assisted Naivasha with a very sophisticated and very efficient wastewater treatment facility. It cleaned the lake waters very well, but in such a way that the flamingos could not find enough nutrients, so they started looking for another habitat, and now Naivasha is loosing the flamingos and consequently the tourists. This is just another example that when one makes technology choice, there must be various considerations.

TECHNOLOGY CHOICE AND SUSTAINABLE DEVELOPMENT OF STORMWATER SYSTEMS

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http://www.urbanwater.net

ABSTRACT

The concept of sustainable development is provoking a profound rethinking in our approach to urban water management (ASCE/UNESCO-IHP, 1998). Sustainable development is that which "meets the needs and aspirations of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987). So, sustainable solutions have both a "now" and a "then" component, and improvements though necessary in the present must not be carried out at the expense of future needs and situations. An alternative definition (IUCN-UNEP-WWF, 1991) asserts that sustainable development is that which "improves the quality of human life while living within the carrying capacity of supporting ecosystems". Here, the emphasis is placed on mankind's demand for and impact upon earth resources and the environment. Finally, Agenda 21 behoves us to "think global, but act local". Public participation becomes important and demands individual responsibility. Sustainable services must be environmentally friendly, socially acceptable and financially viable into the next millennium (Maksimovic et al (1999)).

The above considerations determine the role of urban stormwater and wastewater systems as part of the integrated urban water systems.

The role of urban drainage (thus of storm drainage) is changing. The global rise of environmental concern results in the awareness of the role of pollution management. Successful pollution management in urban areas can only be achieved by considering all sources of pollution (or water related ones) and by understanding their interactions.

Urban stormwater management has, until relatively recently, been focused on solving flooding problems by transferring large amounts of water downstream, as quickly as possible. They were usually considered without taking into account their interactions with wastewater systems and in extreme cases (mostly in developing countries), with solid waste. This inevitably increases volumes and peak discharges causing damage not only to the downstream reaches but also to the natural receiving bodies, and thus to the environment as a whole. However, it is becoming increasingly apparent that this solution is no more acceptable. Alternative solutions are being sought. Source control is an alternative strategy, which tries to emulate natural catchment conditions and so pre-empt or reverse the negative implications of urbanization. The general philosophy is

to reduce and attenuate the storm flows before they reach the drainage network and to improve water quality by allowing natural treatment to take place.

The applicability of a specific type of source control facility is dependent on a large number of factors: the level and sensitivity of the groundwater table, land use type, density of vegetation and the porosity of the soil as well as socio-economical conditions in the particular urban areas (Macropoulos (1998)). Successful and appropriate selection of source control measures is thus highly area dependent. More details on source control will be given in the second presentation on alternative technologies.

The integrated effect of all storm drainage systems contributing to the balance of surface water and to the flux of suspended sediment and other pollutants has to be taken into account at the level of river basin or sub-basin upstream of the point under consideration, especially in densely populated areas. The interaction of storm drainage systems with downstream municipalities and water users is strong in those cases where the drainage peak flow uses up the capacity of the river channel, so that no capacity is left for downstream runoff. In these cases, the downstream-upstream relationships and links have to be analyzed in order to either share the existing capacity or to share the costs of its enlargement. Small river basins in densely populated areas are therefore more sensitive to this problem and shall be analyzed in the following discussion. On the other hand, the rivers carrying water from large catchments serve as receiving water bodies for both solid and dissolved pollutants. Therefore the effect of urban storm water disposal has to be analyzed from the point of view of its pollution and contribution to the silting of downstream water, including reservoirs.

In additions to reduce flood risk, modern storm drainage systems have to be designed and operated in such a way that they also contribute to pollution reduction and to the improvement of urban amenity.

Apparently the level to which all three aspects can be tackled and successfully applied depends on the economical development of the country, but the change of paradigm in which stronger involvement of public in dealing with problems of this nature enables all countries to exercise sustainable practice and find appropriate solutions. This presentation provides fundamentals of the interactions between wastewater and stormwater systems, and gives examples of unsustainable solutions and emphasizes the methodological framework under which the analysis, design, maintenance and management of these systems can be practiced by relying on modern informatics technology.

The presentation is based on use of the Training Module (TM) - Maksimovic and Ho (2000) developed under UNEP – IETC framework.

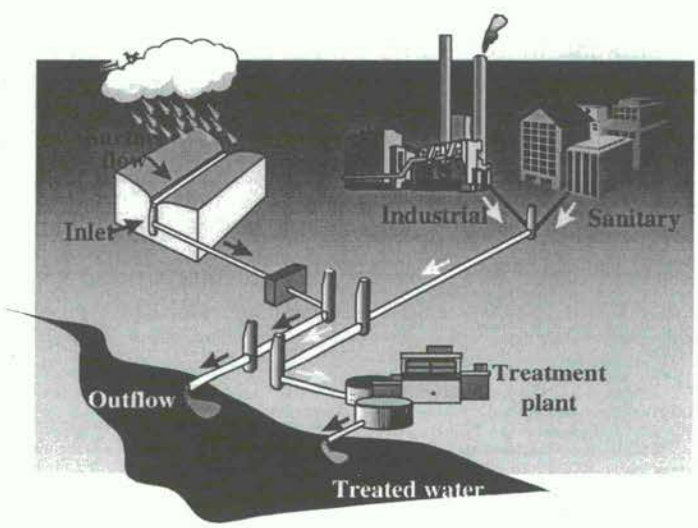
Examples from the host country - Brazil are to be used in order to demonstrate the spectrum of problems and a range of viable solutions. The situation in large cities in Brazil is similar to many other countries, in which urban streams serve as recipients of not only stormwater but also wastewater and solid waste, thus jeopardizing public health and the environment.

BASIC PRINCIPLES OF STORMWATER MANAGEMENT

Conventional storm drainage systems are designed so that they collect storm water and dispose it by buried pipes or open ditches to the nearest stream or other water body, such as a lake, wetland or coastal water. If separated form the wastewater system, the storm drainage network would traditionally contain no treatment elements. More advanced systems tend to include treatment plants for wastewater (Fig 1), while stormwater is disposed directly into the receiving water body. Similarly, storm water systems may include a separation of solid phase (mostly oil and grease, especially if water is disposed into the wastewater network like in a combined system presented in Fig 2.

Sewerage systems can be classified into combined sewerage and separate sewerage systems. Combined sewerage carries both stormwater and wastewater, while separate sewerage carries stormwater or wastewater separately. Recent trends have been aimed towards the development of separate sewerage systems. The main reason for this is that stormwater is generally less polluted than wastewater, and that treatment of combined wastewater and stormwater is difficult during heavy rainfalls, resulting in untreated overflows (commonly known as combined sewer overflow). In practice there is usually an inflow of stormwater into wastewater sewerage pipes, due to unsealed pipe joints, and illegal connections of rainwater run-off. Unintentional or illegal wastewater connections to stormwater sewerage might exist as well.

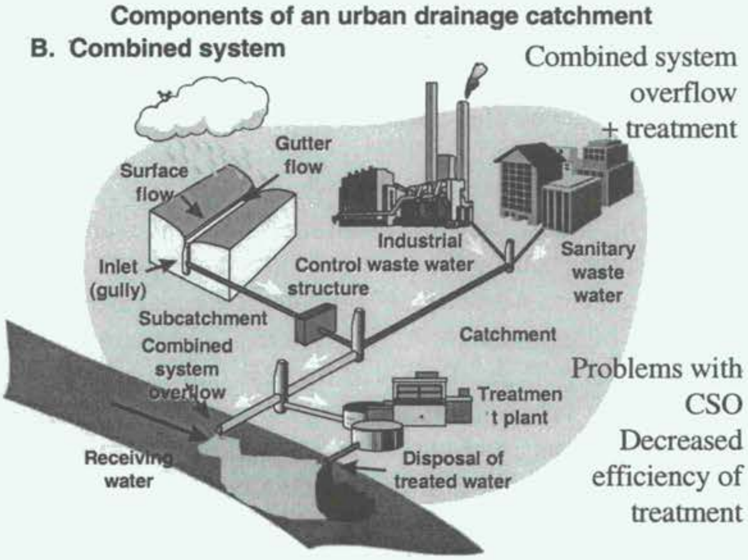
Figure 1. A conventional separate system: foul sewerage (wastewater) is treated and stormwater directly disposed into receiving water body



However, in many countries wastewater and stormwater is mixed into a common (combined) system (Fig 2). If treatment plants are built, these systems include CSOs (Combined Sewer Overflows), allowing the surplus water to overflow into the nearest receiving water body during storm events.

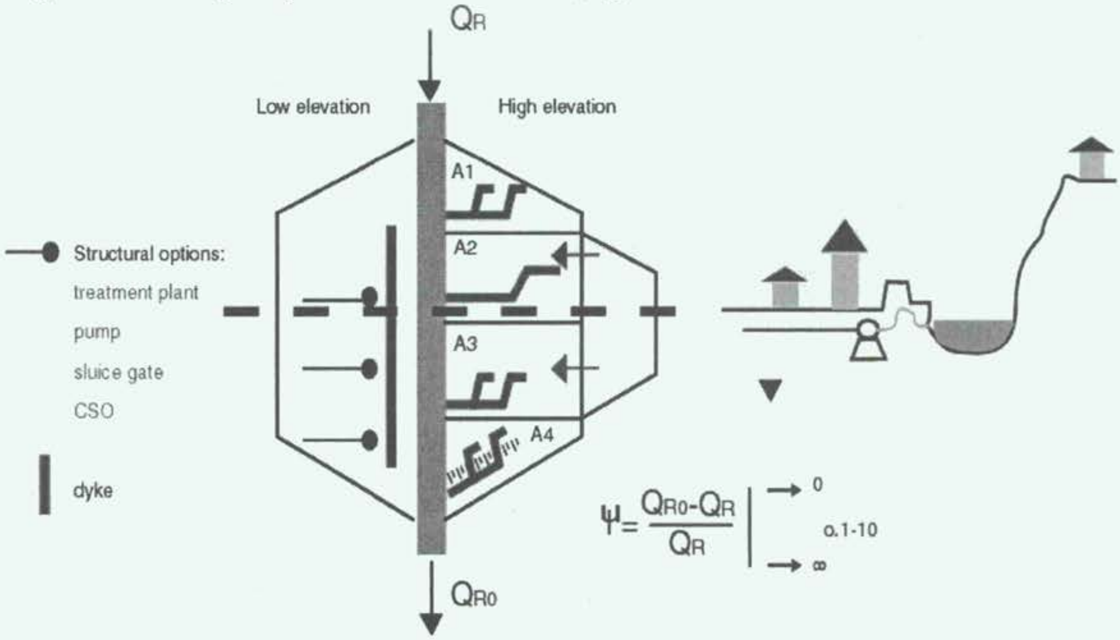
Parallel to these constructed systems, natural stormwater drainage occurs in urban and rural areas, where stormwater run-off flows to a common point of discharge, and by doing so forms small urban streams, creeks and rivers.

Figure 2. A combined system with CSO and a treatment plant



The water in urban catchments originates from local rainfall occurring within the catchment boundary. Urban catchments may also have transient waters (Fig. 3) which pass through the lowest portion of the urban catchment and can considerably aggravate the situation, as they bring additional flooding water and pollution. This water may also cause flooding by itself or in combination with the locally generated surface storm runoff water.

Figure 3. Principal systems of storm drainage



Lowland of the city situated on the on the left hand side of the figure drains storm water which might flow by gravity in the periods in which water level in the receiving river is low, but the water has to be pumped during extreme events i.e. during high water level in the receiving water body. Gravity flow takes place in the elevated parts of the city situated on the right hand side of the figure. Storm runoff in A1 sub-catchment is drained by a piped system and in A2 by open ditches or urban streams. Stormwater from suburban areas flows though the sewer network (A2) or through urban streams (A3). In both cases this transient water can cause flooding. The character of the flood defence system depends on the ratio • of the peak flows originating from the local runoff ($Q_{R0} - Q_R$) and the relevant incoming flow (Q_R) in the receiving water.

One of the common problems in both combined and separate systems is that wastewater and stormwater are inevitably intertwined. Since wastewater may be disposed into the stormwater drainage system and wastewater and stormwater may be collected in the same sewer, cross-connections exist even when wastewater and stormwater are separately collected. If mixed with wastewater, stormwater is treated jointly with wastewater, this causes major problems due to e intermittent character of the storm water . It causes disruptions to treatment process.

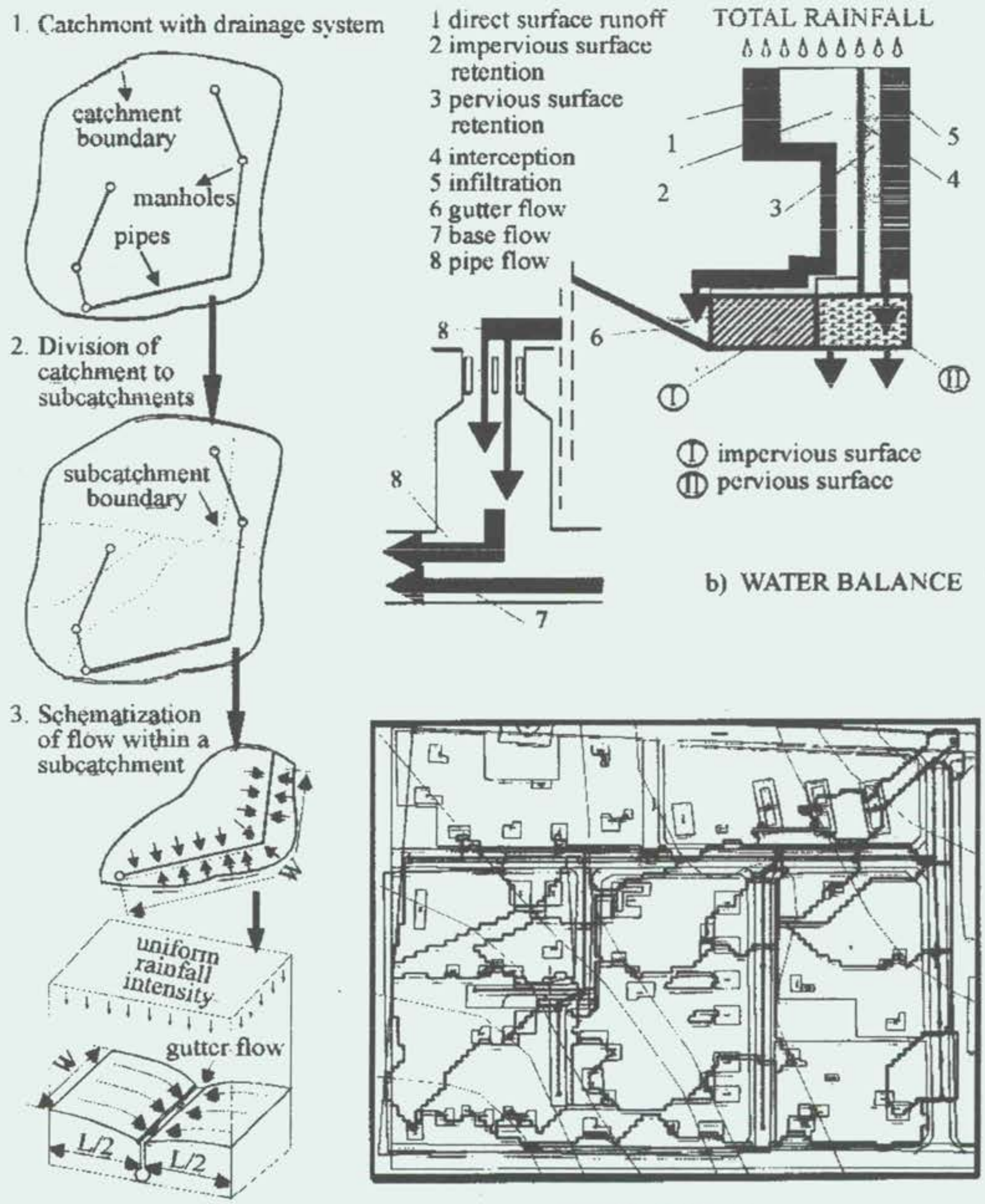
It is also common for both wastewater and stormwater to be discharged into receiving water bodies without any treatment and in most developing countries is almost a norm. Illicit connections of wastewater to stormwater systems (and vice-versa) are made as a consequence of uncontrolled urbanization and the absence of inspection by municipal agencies.

The change of the role of urban storm drainage (USD) and developments of information processing technology have imposed a need for new tools and products to be used in the problem solving procedure. Methods for flood protection by local storms as well as for assessment of the effects of pollution transported by storms on receiving waters have been significantly improved during the past two decades with the introduction of computer based simulation, design, optimization, real time control and management. The achievements of modern informatics (i.e., a higher level of information processing) have made a significant impact on all aspects of problem solving. However, despite the major development achieved, there is still a large gap to be bridged. A compact and reliable package that adequately predicts dynamics and spatial distribution of urban floods and also incorporates source control measures is yet to be developed and verified.

The conventional approach to modeling of storm drainage systems is based on the decomposition of the process into sub-processes such as: interception - mostly surface depression, infiltration, flow over the surface (overland flow), flow along the street (gutter flow), flow through inlet structures and flow in sewer networks. This concept is used as a basis for almost all commercially available urban drainage models.

Once the water is collected into the pipe or pipe system (network), the method of analysis for design and operational management varies depending on the goal. Simpler methods are used for preliminary design and for the analysis of "end of pipe" elements, whereas for the network analysis, retrofitting of individual pipes and model calibration etc. more advanced models are needed (Marsalek et al.).

Figure 4. Decomposition of an urban catchment into smaller units sub-catchments for modeling purposes



a) DELINEATION PRINCIPLE

b) WATER BALANCE

c) AN EXAMPLE OF DELINEATED URBAN AREA

EFFECTS OF CONTROLLED AND UNCONTROLLED URBANIZATION ON STORMWATER SYSTEMS – DEVELOPMENT OF SUSTAINABILITY CRITERIA

The impacts of development on the water cycle are well known. Roofs and paved areas do not allow rainwater to soak into the ground as effectively as green-field sites. This increases the amount of direct runoff from developed areas. The use of pipes and concrete channels allows the water to drain rapidly and reach areas downstream much

EFFECTS OF CONTROLLED AND UNCONTROLLED URBANIZATION ON STORMWATER SYSTEMS – DEVELOPMENT OF SUSTAINABILITY CRITERIA

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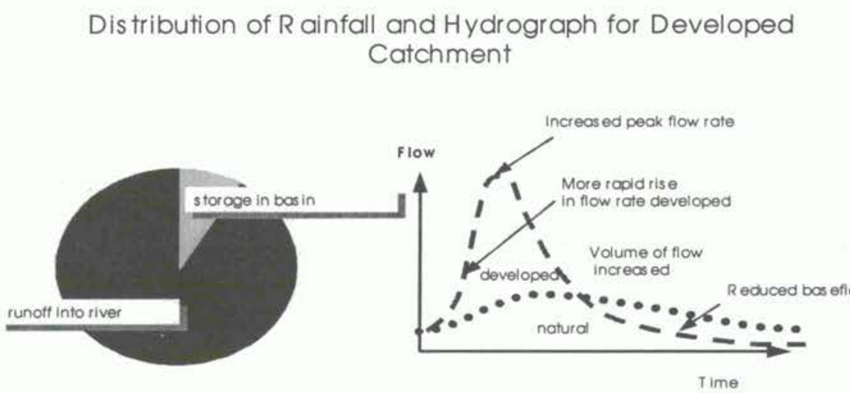
Flows in vegetated areas have greater times of concentration and smaller peak flowrates. As the total paved area increases, the time of concentration is greatly reduced and the flowrate increases. The natural storage in the basin is reduced mainly due to the greater paved area and reduced infiltration, thus causing the runoff into the receiving stream to rise.

The rainfall distribution and hydrographs for both natural and developed catchments are Shown in Fig. 5.

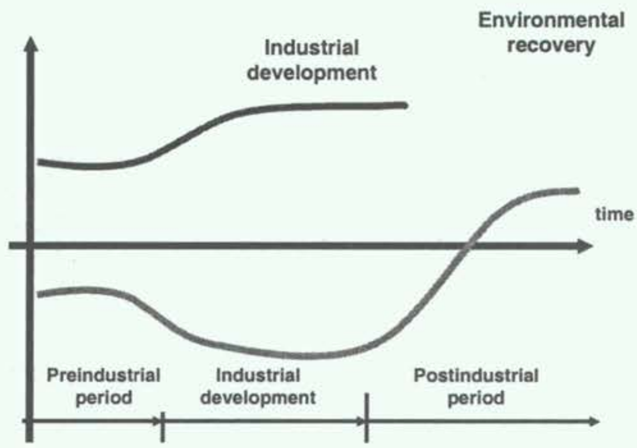
Figure 5. Urbanization increases runoff peak and volume



Contrary to the conventional wisdom, urban runoff also has a very adverse impact on water quality. The runoff from roads washes silt, organic matter and debris into the drains. It can contain pollutants such as oils, heavy metals and chemicals from vehicle exhausts and industrial emissions, some of which could be toxic. As roofs and paved areas are only washed intermittently by heavy rain, the pollutant loading varies during a storm, with contaminants becoming concentrated in the portion of the runoff that follows high intensity spells of storms. This has an impact on the receiving watercourse leading to a degradation of the water quality.

In early civilizations, due to the low level of urbanization, the pollution level was much lower than at present. As the level of urbanization rose in the post-industrial period, the level of environmental degradation greatly increased. In the periods of pre-industrial and industrial development, the environmental recovery inversely followed the industrial development, and then greatly increased in the post-industrial period.

Figure 6. Industrial development (top curve) caused environmental degradation (bottom). It may take the same time to the environment to recover.



Water quality is also affected by an increase in water quantity. In cases where drains are connected to a combined sewerage system, the increase in flow can be too great for the sewer to cope with, thus causing the water to overflow. This can either result in flooding of an area or in a discharge to a watercourse. As the sewer carries both stormwater runoff and foul water, the floodwater will contain fecal material and other pollutants hazardous to health. These problems are very common in developing countries where storm drainage systems are either poorly developed, nonexistent or storm water flows through the area in an uncontrolled fashion.

In many developing countries, especially in low income parts of urban areas, land is occupied and "shanty towns" are built without proper infrastructure. In some cases water is supplied through improvised pipes, and no corresponding pipes exist for removing the generated wastewater. The wastewater is simply allowed to flow by gravity through the natural drainage system, ending in low lying areas, water courses, lakes or the sea. The natural drainage carries stormwater runoff during rainfall events, whereas during flood events stormwater mixes with wastewater, and polluted water is spread over a much wider area. In addition to that, solid waste is also generally dumped into the drains or natural water courses, resulting in flooding during lower rainfall events. Water-borne diseases are therefore endemic in these communities. The environmental conditions of the area are degraded, because water containing decaying organic substances from sewage and garbage produces a foul odor, and the water is putrid and depleted of oxygen. Groundwater in the area is also generally polluted, because of the infiltration of polluted water to the groundwater aquifer.

This situation is illustrated in Fig. 7 taken in the Sao Paulo urban area. A settlement is formed in a flood plain, and both wastewater and solid waste is dumped into "urban stream" which serves as an open-air sewer. In the absence of a proper solid waste management system, flooding spreads through the areas during storms. In order to prevent more serious flooding in downstream (central –higher income) parts of the city, usually caused by the clogging of the inlets of the downstream culverted urban stream, solid waste has to be picked-up manually form the streams and handled separately (Fig. 8).

Figure 7. Urban stream as a recipient of stormwater, wastewater and solid waste

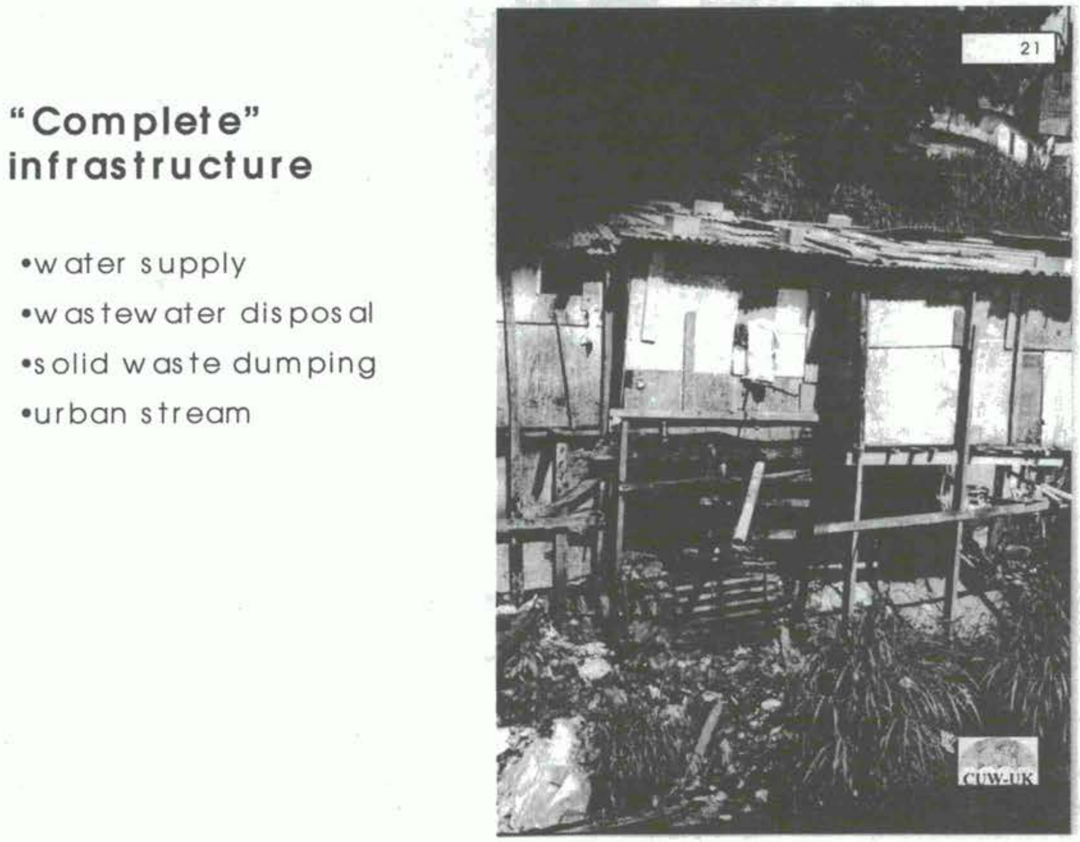
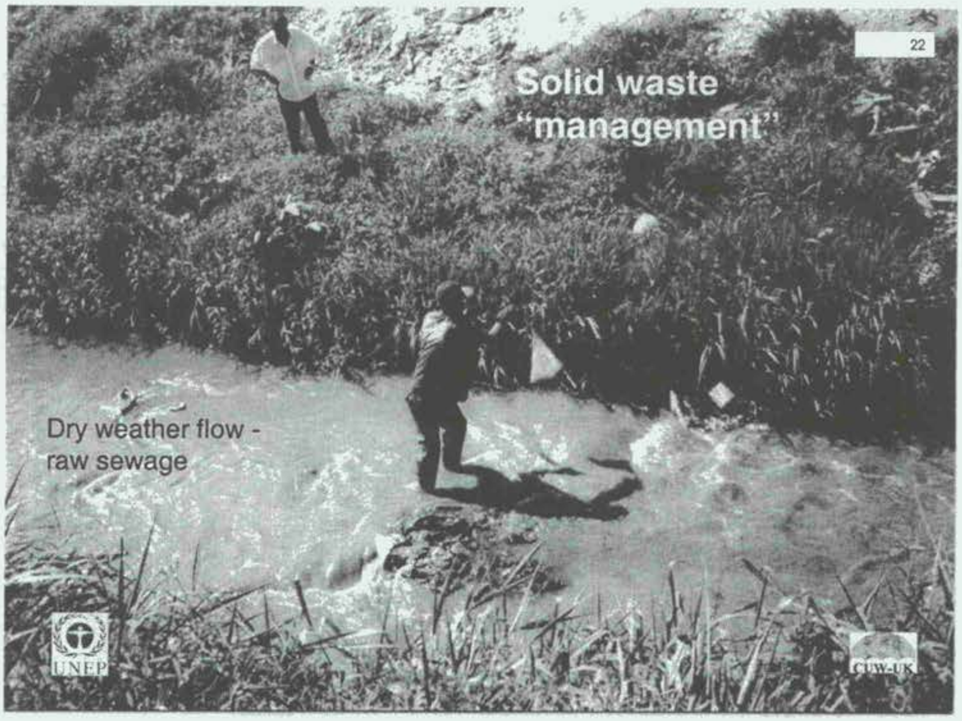


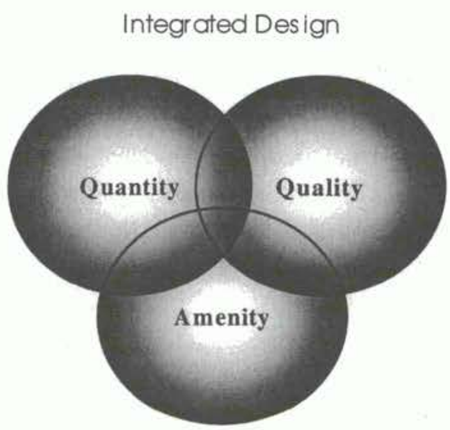
Figure 8. Solid waste "management" in order to prevent clogging inlets of downstream culverts during storm periods.3



The effects of flooding can be severe. Water levels in drains, streams and rivers rise considerably and the flow of water can erode soils and embankments. Sediments which have been deposited in quiescent stretches of a stream can be re-suspended and transported further downstream. In urban areas the water collects litter and solid wastes in its path as well as other diffuse pollution sources, and spread that material in downstream flooded areas. Aquatic environments and animal habitats can be destroyed, which may take some time to recover. All these effects are more severe during short intensive storms. The amenity value of urban streams and other water bodies such as: recreational lakes and small detention ponds can be severely degraded. Engineered structures, such as culverts and bridges, can be choked with wastes and debris, causing more widespread flooded areas.

Also, the simple inconvenience of dealing with large quantities of water in the streets is often experienced by everyone. Traffic is severely hampered, and disrupted sometimes for long periods of time. Structural damage often occurs, and temporary structures (small huts, vending machines) are often dislocated. The property value naturally decreases with the occurrence of floods. Polluted runoff enters streams and lakes, thus greatly reducing the water quality and posing a threat to human health. The time has come for the pollution by storm drainage to be tackled with equal importance given to quality, quantity and amenities (Fig. 9). Amenity values must not be forgotten even in low-income settlements. Parikh (1999) presents an interesting example of a successful rehabilitation project in such an area in India.

Figure 9. Urban amenities given an equal importance as quality and quantity



In the past the, storm drainage problems have been dealt with at a local level by structural means, response has been to try to build structures in order to transfer the storm water downstream urban area as soon as possible. Developments in the upper reaches of a catchment have resulted in the need to increase the size of sewers downstream. The contaminated nature of the runoff has usually been ignored. The intermittent nature of storm drainage inform to treatment plants lead to its reduced efficiency. Building separate stormwater and wastewater systems sewers are one attempt to reduce the problem, but the washing off of contaminants from impermeable areas and continued flooding problems still occur.

Separate sewers were built in the upper parts of urban streams, but inlet clogging occurred (see figures below) As pollution occurred upstream, a high percentage of raw sewage is present during the dry and hot weather (smaller amount of available water), which caused great environmental concern at the downstream reach.

The modern concept of dealing with storm drainage aims at dealing with problems at source. As much of the storm water as possible is infiltrated, stored or its runoff delayed so that the impact on downstream reaches is reduced. In addition to reducing peak flows and volumes (quantity), water quality is improved by letting the storm water flow over grassed areas, swales where it detoxicates and some pollutants degrade. Additionally, storm water can be used as a resource for fire fighting, garden watering, toilet flushing etc. All these measures are considered to be more sustainable. The systems based on these principles are called Sustainable Urban Drainage Systems (SUDS- CIRIA (2000)). They will be presented in the next lecture.

INTERACTIONS OF STORMWATER AND WASTEWATER SYSTEMS AND THE NEED FOR INTEGRATED SOLUTIONS

The conventional approach means managing wastewater, stormwater and often, solid waste, separately. In order to better protect public health and improve the environment, the management solutions are being rethought and planners are striving towards a more integrated approach. Simply solving the problem of wastewater without taking into account solid wastes and stormwater will not achieve sufficient sanitation improvement to protect public health and the environment. One principle that logically emerges from adopting an integrated approach to waste management is that different types of waste should not be mixed. Solid wastes should not be dumped into stormwater drains, but should be collected, recycled, reused, or treated and disposed separately. Dumping of solid wastes in stormwater drains will not only restrict the flow of stormwater, but will also contaminate it. Stormwater treatments a new topic and should not involve its directing to conventional treatment plant. Solution to this problem has to be sought though selective application of SUDS and their combination of both on-site and off-site water management. It will involve separating the solids and other contaminants from the water. Similarly industrial wastes should be treated separately, and industrial wastewater should be pre-treated if it is to be discharged to the sewer.

A common feature of all sound technologies is that there is a scientific basis for the physical, chemical and biological processes for the removal of pathogens and pollutants from the water. These processes are largely akin to the purification and recycling processes taking place in nature. If properly designed, constructed, maintained and operated these technologies can achieve protection of public health and the environment, and can recycle water and nutrients which are beneficial to sustaining ecosystems and life.

Associated with each technology hardware is a philosophical basis or approach, such as the separation of waste components (dry conservancy), or conveying all wastes away with water (water based conveyance), minimizing capital costs, minimizing maintenance requirement; or maximizing reuse).

The choice of technology in both stormwater and wastewater is determined by environmental, economic and social factors.

ACKNOWLEDGEMENT

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Finally the professional co-operation and support of Mrs. L. Casanova and Mr. S. Matsumoto of IETC-UNEP enabled this product to be developed tested and made available.

The satisfaction of the future TM users and overall international raising of awareness will be a reward for their enthusiasm and professional assistance and support.

REFERENCES

1. Ho, G. and Maksimovic, C. (2000). International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC -UNEP, Technical Publication .
2. Maksimovic, C. and Ho, G. (2000) Training Module for the International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC.
3. Group of Authors: Regional Overviews for the International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC.
4. Sustainable Urban Drainage Systems – Best Practice Manual for England, Scotland, Wales and Northern Ireland, CIRIA Report 523, London (2000).
5. Sustainable Urban Drainage Systems – Design Manual for England and Wales, CIRIA (C522).
6. Sustainable Urban Drainage Systems (SUDS) - Training Material (CD) CIRIA (2000).
7. IETC- UNEP Manual for Running Training Course (Role game).
8. Maksimovic, C., Butler, D., Graham, N., (1999). Emerging Technologies in Water Industry, in Water Industry Systems: Modeling and Optimization Applications, Edited by D. Savic and G. Walters, Research Studies Press , 39-64 .
9. Macropoulos, C., Butler, D., Maksimovic, C. (1999) GIS Suported Evaluation of Source Control Applicability in Urban Areas, Water Science and Technology, Vol. 39, Number 9 ISSN 0273-, p. 209-216.
10. Marsalek, J., Maksimovic, C., Zeman E., and Price,, R. (1998). Hydroinformatics in Planning, Design, Operation and Rehabilitation of Sewer Systems, ASI Series, Published by Kluwer .

2b

Overview of Presentation

Fundamental Principles of Stormwater Management

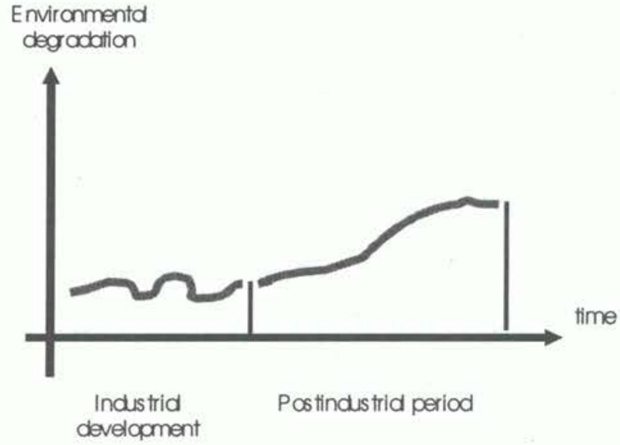
- Conventional role of Storm Water System
- The role within the Integrated Urban Water Systems
- Origin of surface Water in Urban Areas

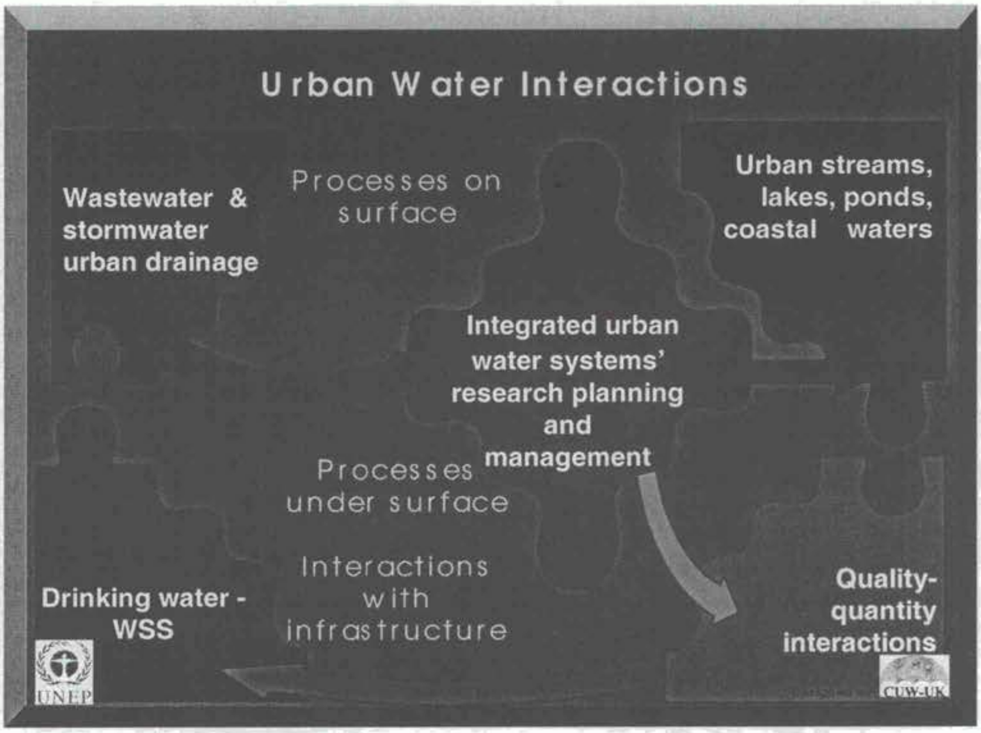
Effects of Urnbanisation on stormwater System's Development
From the early civilisations to modern uncontrolled urbanisation
- Examples of Unsustainable Systems
- Balance of Water and Pollutants determine the solutions
- Tools to be used and their shortcomings
- Developed vs. Developing Countries' solutions
- Sustainable scenarios

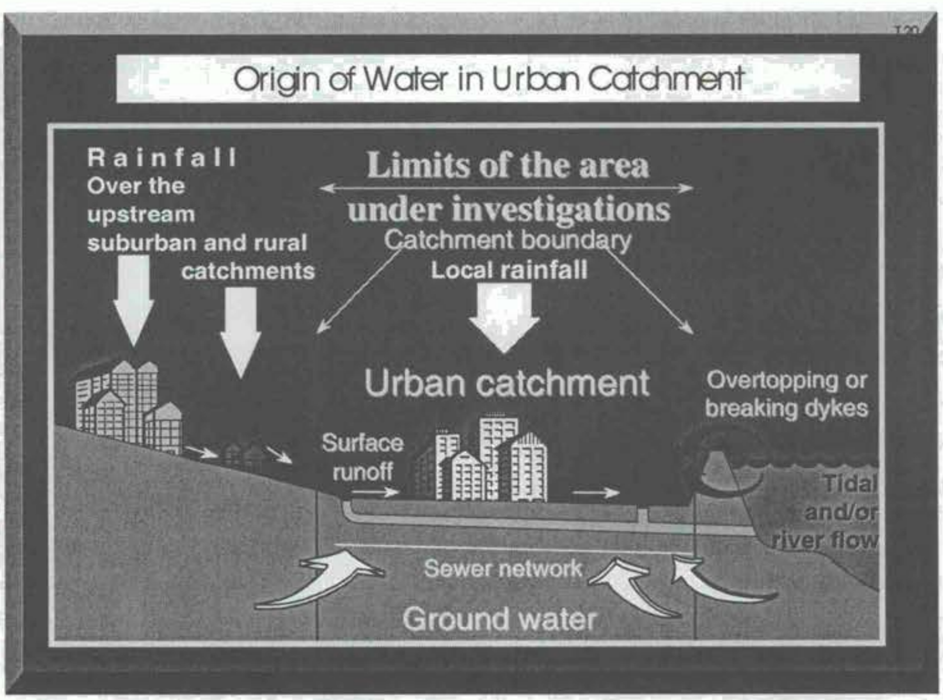
Interactions of Stormwater and Wastewater Systems - Need for Integrated Solutions
- Options for the future

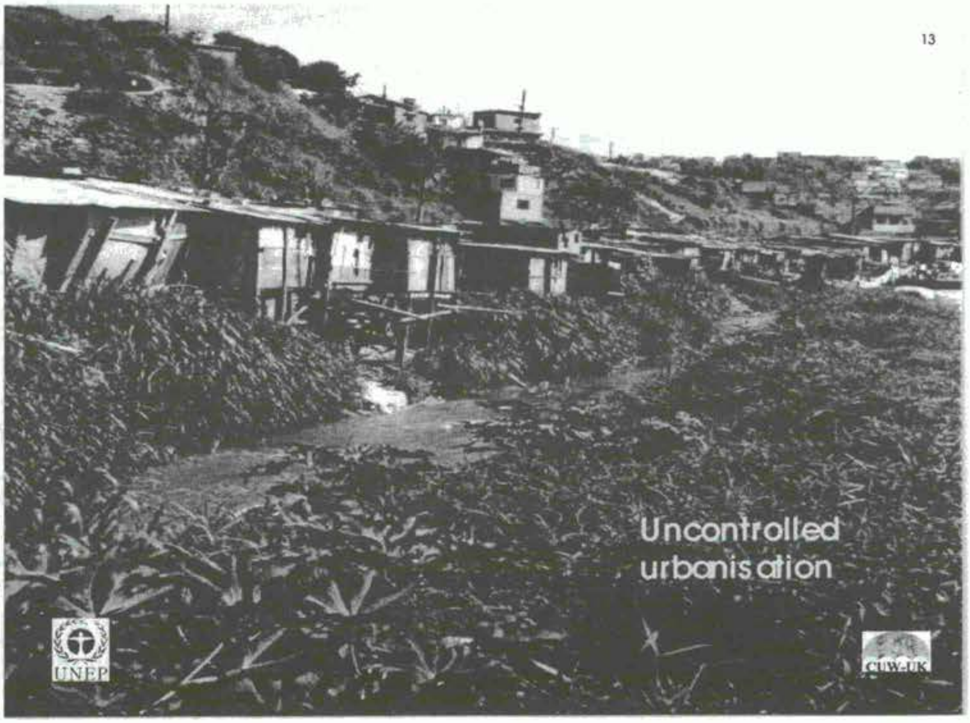
T35a

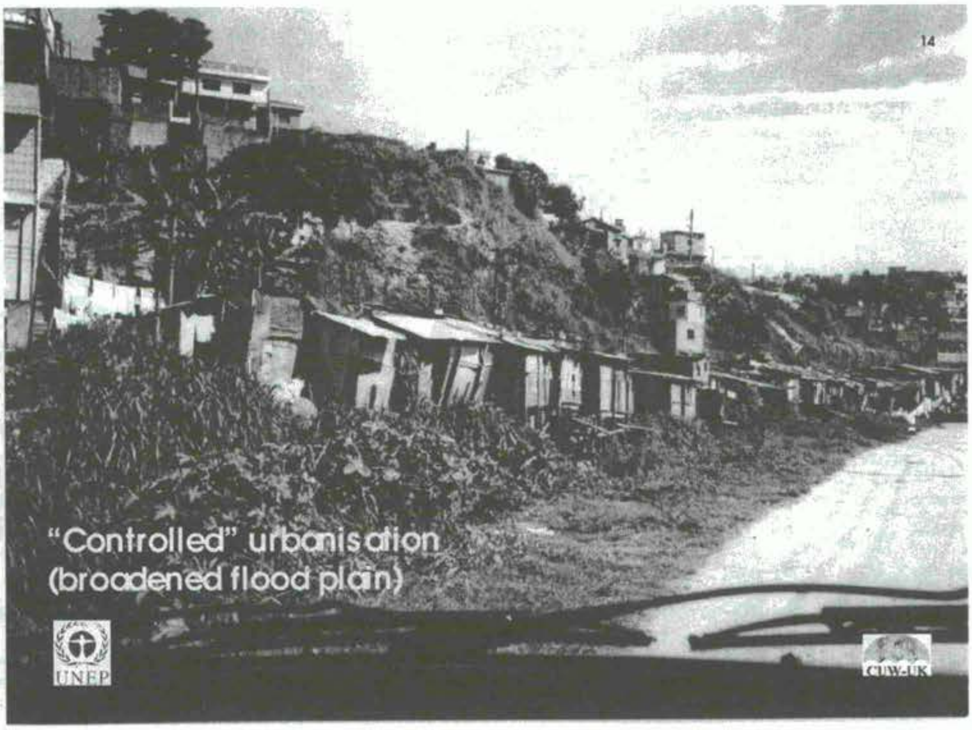
Environmental Degradation Caused by Industrial Development




Urban Water Interactions
Wastewater & stormwater urban drainage
Processes on surface
Urban streams, lakes, ponds, coastal waters
Integrated urban water systems' research planning and management
Processes under surface
Interactions with infrastructure
Drinking water - WSS
Quality-quantity interactions
UNEP
CUW-UK


Origin of Water in Urban Catchment
Rainfall
Over the upstream suburban and rural catchments
Limits of the area under investigations
Catchment boundary
Local rainfall
Urban catchment
Overtopping or breaking dykes
Surface runoff
Tidal and/or river flow
Sewer network
Ground water


13
Uncontrolled
urbanisation
UNEP
CIUW-UK


14
"Controlled" urbanisation
(broadened flood plain)
UNEP
CIUW-UK

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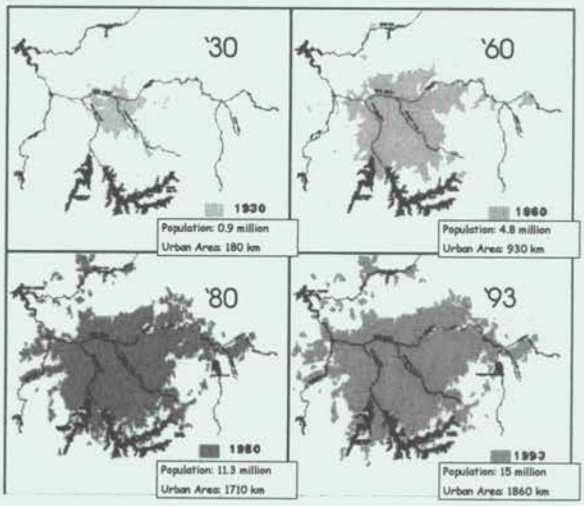
Urbanization of Sao Paulo 1930 - 1999



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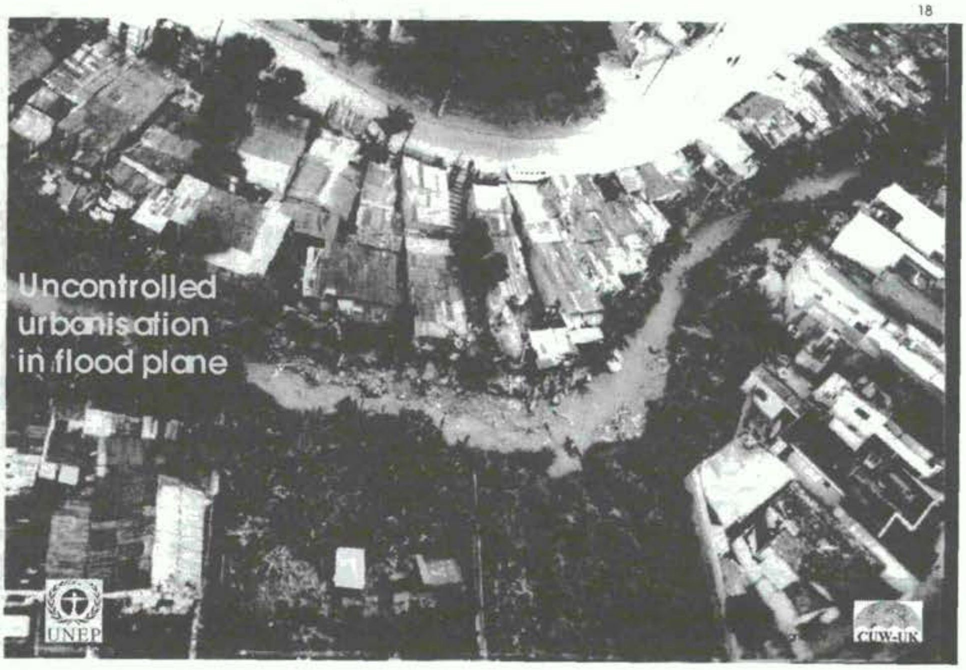
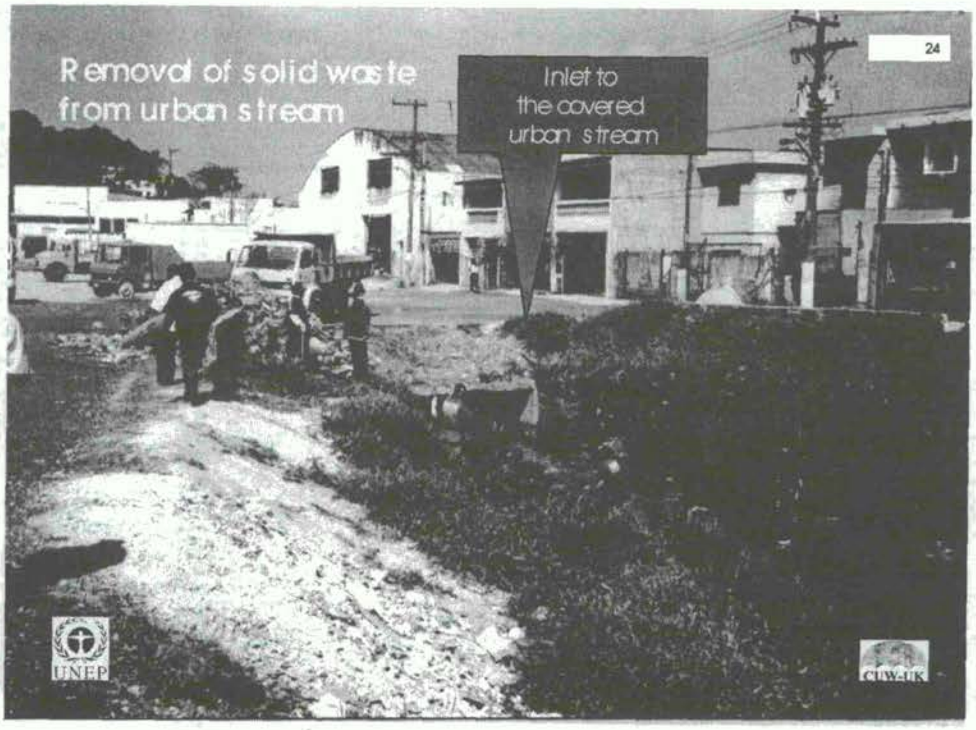
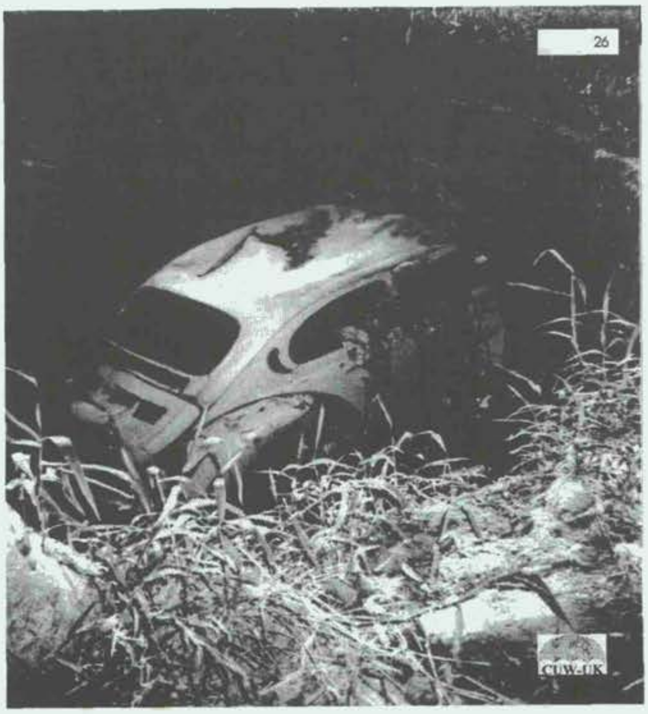

18
Uncontrolled
urbanisation
in flood plane
UNEP
CIJW-UK

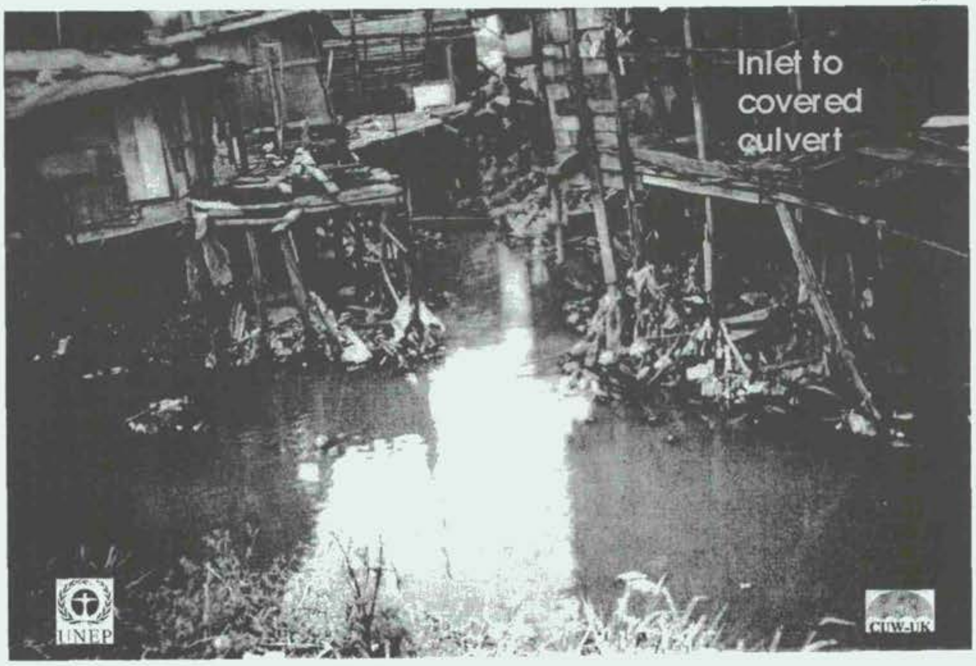

24
Removal of solid waste
from urban stream
Inlet to
the covered
urban stream
UNEP
CIJW-UK

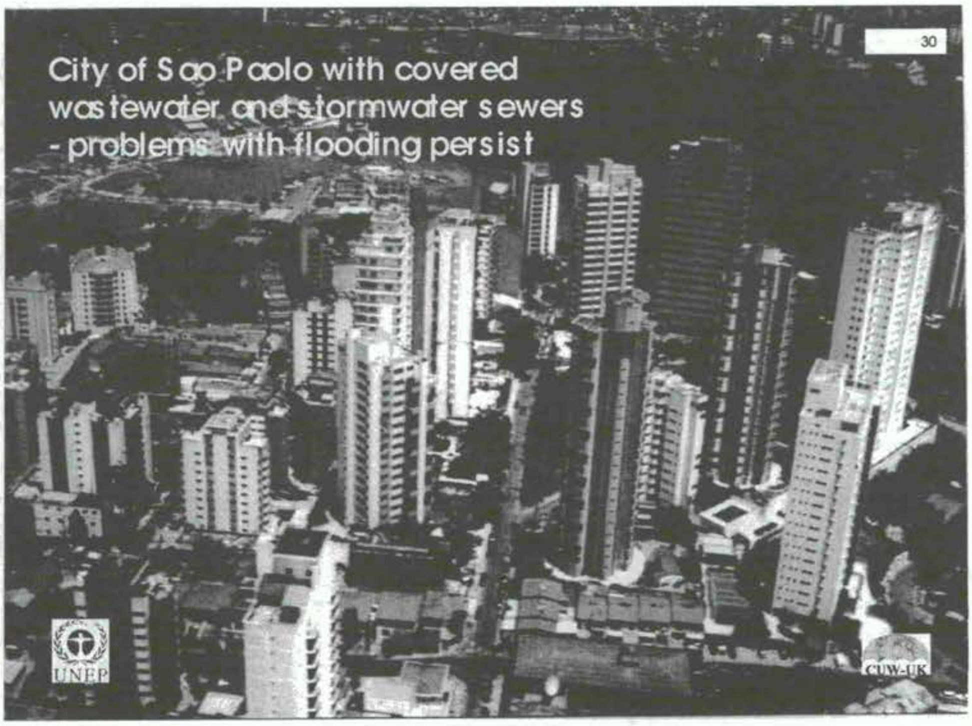
"Fusca Rolha"

Beatle Cork



Courtesy of Dr.
Canholi, S.Paulo





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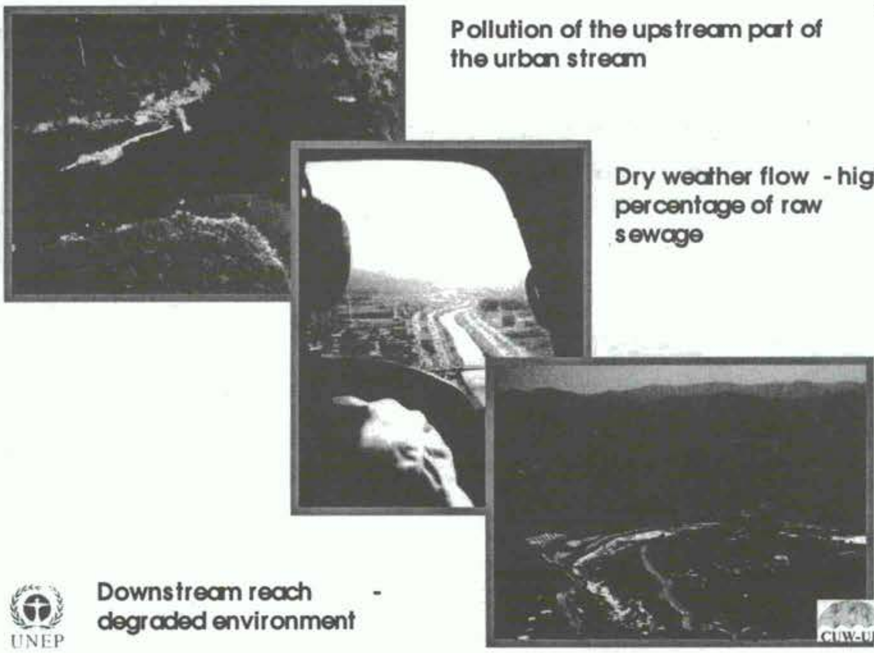
Pollution of the upstream part of the urban stream



Dry weather flow - high percentage of raw sewage

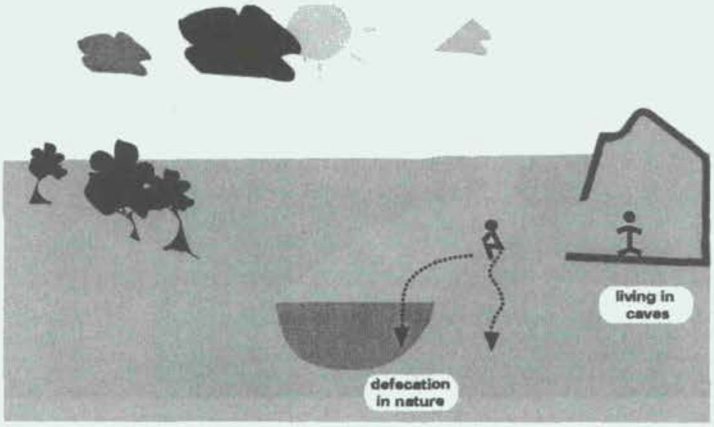
UNEP

Downstream reach - degraded environment

5

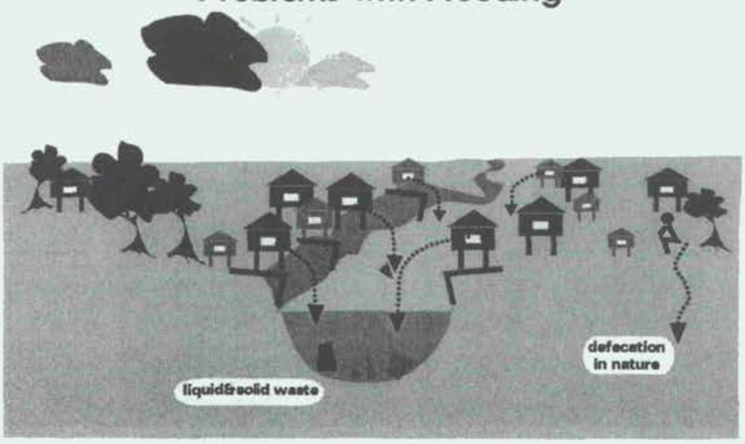
Phases in Unsustainable Urban Development

1. Early Civilization - Living in Nature - Low Level of Pollution

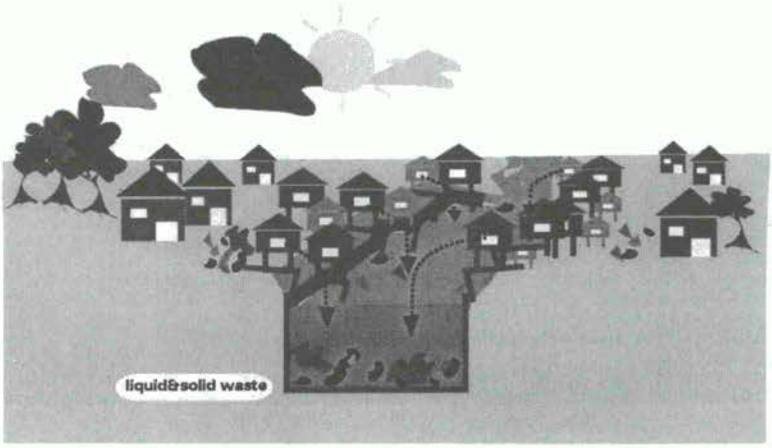


6a

3. Uncontrolled Urbanization (Occupation) of Flood Plain Streams as Recipients of Solid & Liquid Wastes Problems with Flooding

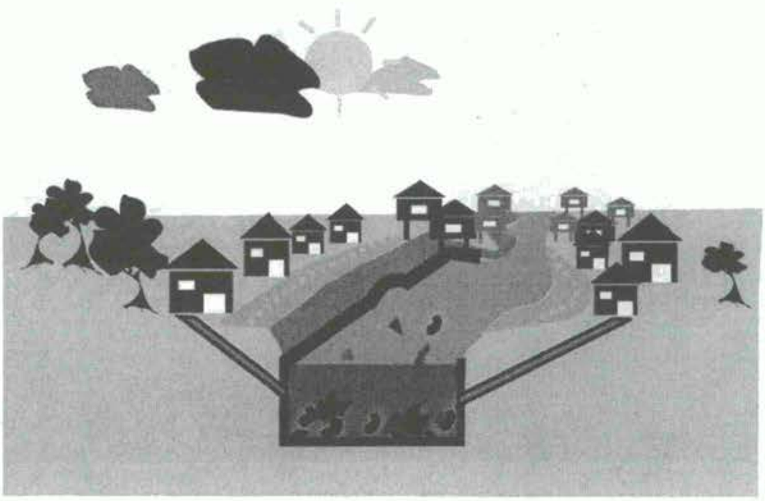


4. Channelisation of Urban Streams Recipients of Solid & Liquid Wastes - Wastes & Stormwater Problems with Flooding & Clogging 6b



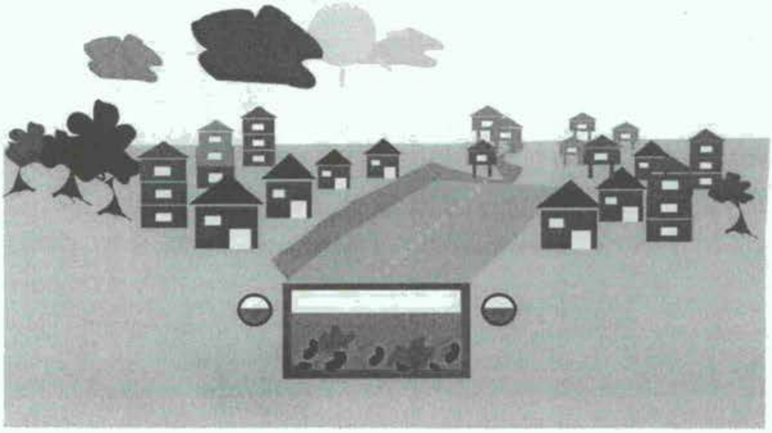
6c

5. Sewers Connected to Channelised Streams



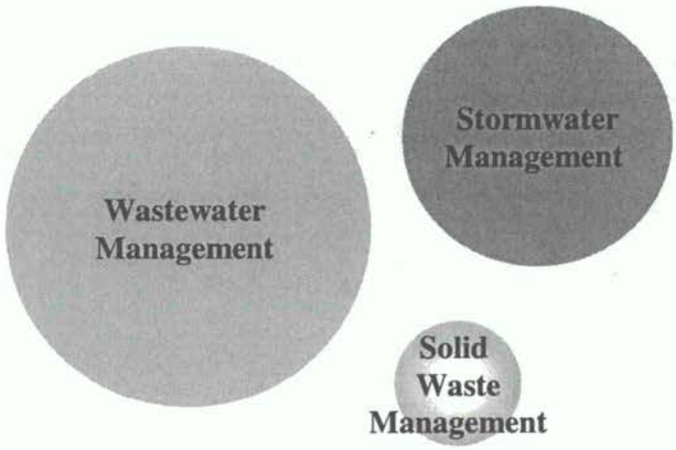
28

6. Uncontrolled Urbanisation in the Upper Parts of a Stream
Building of Separate Sewers - Problem of Inlet Clogging



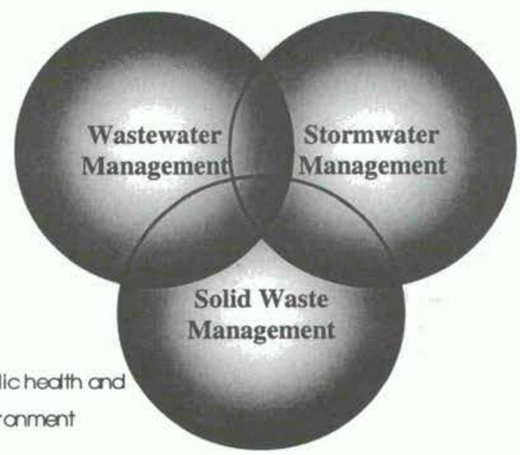
39a

Conventional Approach



39b

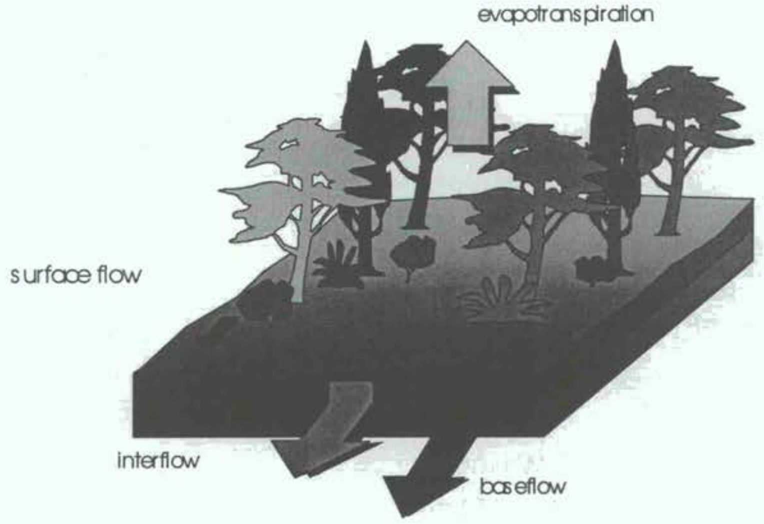
Integrated Waste Management



To improve public health and protect the environment

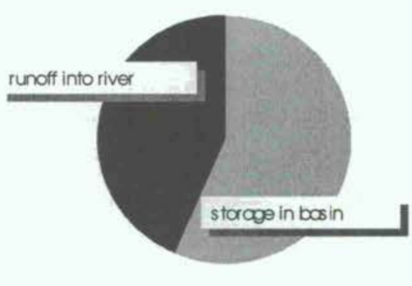
46c

Natural Catchment

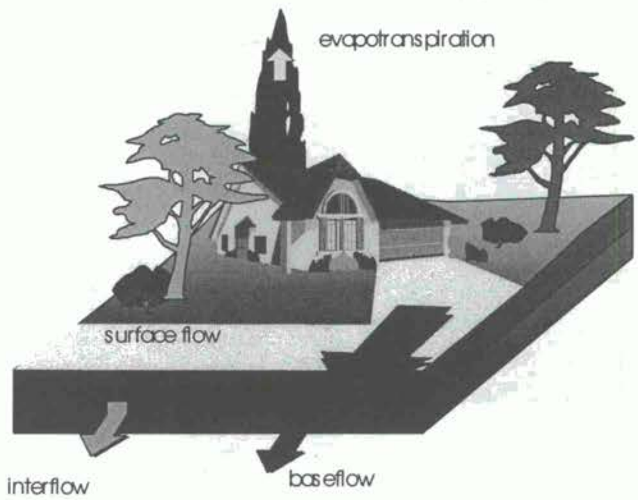


46a

Distribution of Rainfall and Hydrograph for Natural Catchment

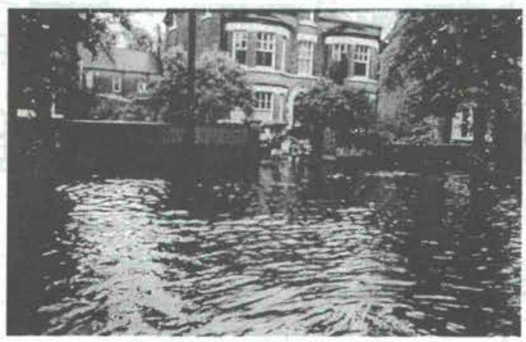


Developed Catchment



Conventional Systems - Urban Flooding Problems

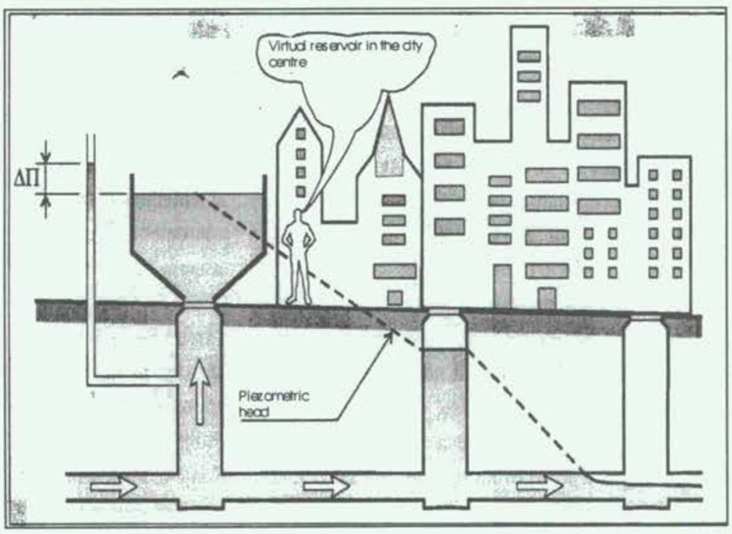
- Flooding inconvenience
- Health
- Traffic blockage
- structural damage
- Loss of property value



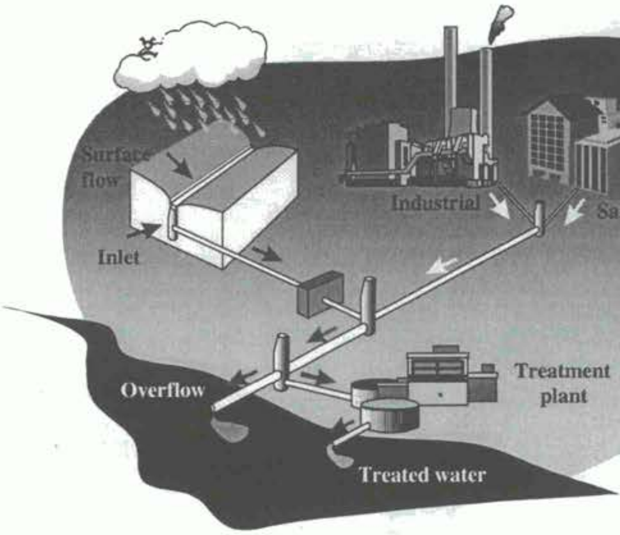
Conventional System - Quality Problems

- Polluted runoff-widespread as rain - deadly as poison - streams, lakes,...
- Intermittent overload of treatment plants
- CSO pollution of receiving water bodies

Virtual Reservoir (current concept off flood modelling)



Traditional approach to drainage and treatment

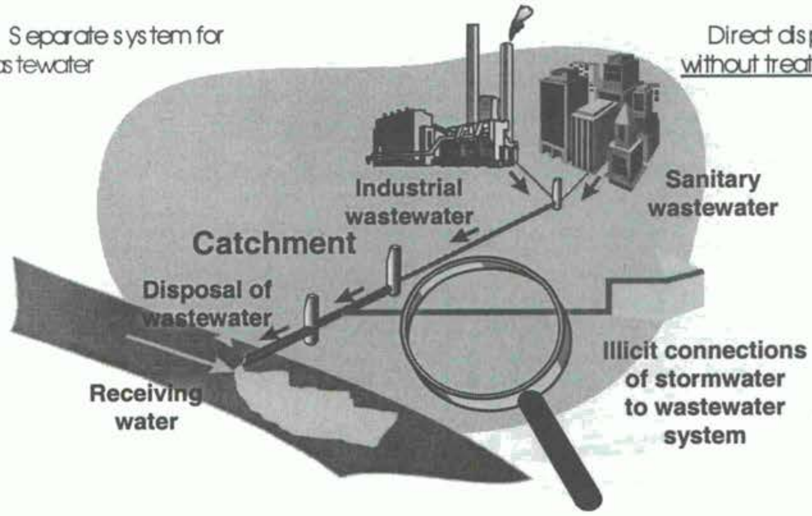


T21

Components of an Urban Drainage Catchment

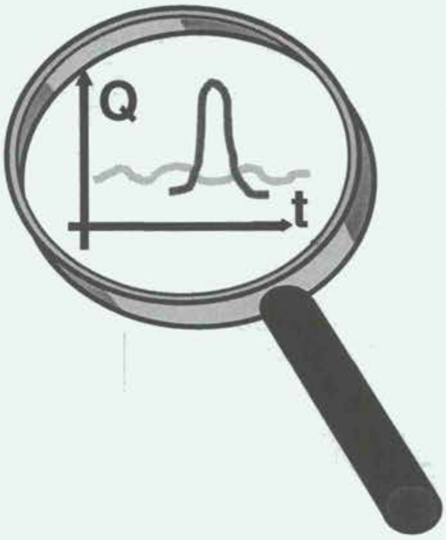
A. Separate system for wastewater

Direct disposal <u>without treatment</u>



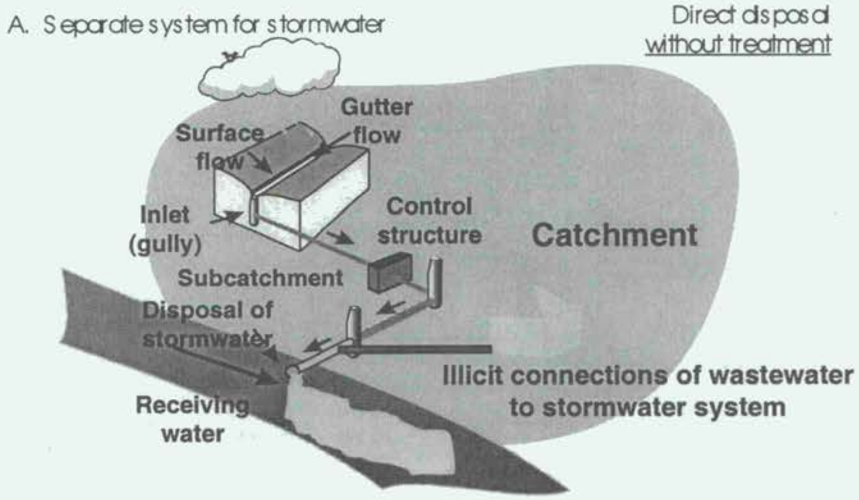
T28

Intermittent Load of Treatment Plant by Stormwater



T22

Components of an Urban Drainage Catchment

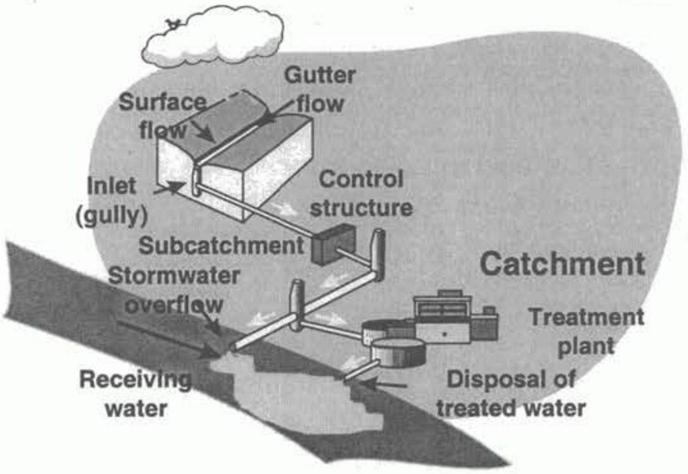


T23

Components of an Urban Drainage Catchment

A. Separate system for stormwater

With treatment

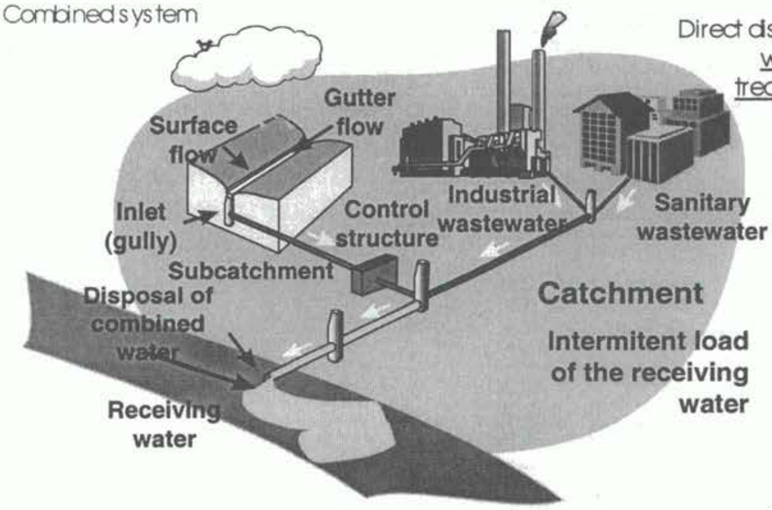


T24

Components of an Urban Drainage Catchment

B. Combined system

Direct disposal without treatment



DISCUSSIONS

Luiz Gamez (Costa Rica) - "It is important for Latin American countries not only to look at the problem from an environmental point of view, but also to look at the economic impact of not addressing the issues. We are exacerbating erosion problems by urbanizing in hillsides, inadequate places and we are also increasing runoff that is affecting our investments in infra structure. So we are therefore degrading our own infra structure of investments by not having an adequate land use policy. Besides, we are increasing sedimentation on our reservoirs, and this decreases the life use for hydroelectric projects. We are also losing fertile soil and replacing it is has a high cost. Although our countries have a lot of laws and regulations, these does not translate necessarily into a policy. So we should not only update our legislation and regulation, but also make use of the policy instruments we have at hand to address these issues. And financially speaking, we do not have many options to solve these problems. Many times this is more an administrative than a capacity problem."

Richard Middleton - "One of the problems in city administrations is that the city administration itself is not an integrated unit. You have a sewerage unit, you have an on-site sanitation unit , perhaps the Ministry of Health, you have stormwater drainage which is typically part of the transportation sector and does not talk to anybody, and you have solid waste which may be private sector. So pulling these ideas together, again I would welcome contributions on how do you get this to happen. It is a very good concept, but the fact is that the city, and particularly if it is a small city dominated by a provincial state administration one level up, they may have real problems putting these ideas together."

Arthur Archer - "What do you plan to do if wastewater go into your water supply ?"
Cedo Maksimovic - "If you are talking about the problems of interactions with the water supply, in developing countries the problem is that the water supply is often intermittent. You do not have continuous water supply. These pipes are not always under the pressure. So when you have intermittent water supply, when you have water only for a certain number of hours a day, when the pipes are under the low pressure ground water which is usually polluted, it enters in the water system and this is another source of the threats to public health. Because the polluted ground water enters the water supply system. And intermittent water supply is rather a norm than an exception in developing countries."

Arthur Archer - "So, what method would you do to reduce the pollution of the drinking water ?"
Cedo Maksimovic - "Improving the water system itself. Again, as a part of integrated solution. Because you have a lot of cities which have an adequate amount of water at the intake. But systems are so much degraded or so little care is taken of them that a high percentage of it is lost. In the developed countries, they are happy if they have a leakage of 15% - 20%. I have seen many cities in Europe, as an example, Sophia, Bulgaria, with leakage of 70%."

Lilia Casanova - "Thank you Cedo for that but I would like to remind people here that while water supply is important, we are focusing our discussions on wastewater and stormwater."

Terrol Inniss (Barbados) - " The water of São Paulo originates in the city or is this stormwater that comes from the hills into the city?"
Cedo Maksimovic - "No. Stormwater comes from the hills into the city during the rain period. What you see in the streams is mostly high percentage of raw sewage from the part of the city without a proper sanitation."

Terrol Inniss (Barbados) - "I have seen that there is another solution of cutting off that water that comes from the hills and taking it around the city and disposing off it. Are you saying that it is too expensive to be done? "
Cedo Maksimovic - "No, only that it is a viable solution and I think that water originated from suburban areas should be taken care of by some other means. I am going to talk tomorrow about some possible solutions, alternatives to just building canals. There are also other techniques, and very important: affordable and low cost techniques. "

Eugenio Barrios (Mexico) - "My concern is how to make things happen. Mexico City is quite similar to São Paulo, a huge city highly populated. It is a very dynamic city, where you cannot wait to start proposing an integrated approach when you are suffering with a lot of flooding and you have to get rid of the water as quickly as possible. So it is very difficult to handle this situation within a big city. So in your experience working in São Paulo deduces some promising future for this? "
Cedo Maksimovic -"I think there is a promising future and this is the only way to go. The problem is that many of these cities did not have any planning documents. They needed a master plan for São Paulo that did not exist or if it existed it is not updated. The city of São Paulo did not have a consistent policy of coping stormwater in the past. As I was told, this is the first time that the city is realizing that you cannot solve problems of pollution by just building new treatment plants. Stormwater has to be tackled planned: you must find out where this water comes from, how much of water you have, what is the pollution source, how much of pollution, what happens to the pollution itself. I have been told that this is the first time a stormwater master plan is done in São Paulo.
In the past, as in many other cities, stormwater as I mentioned was ignored. People dealt with it the locally: they built small canals, urban streams and so on, but there were no integrated solutions. And you can not wait for twenty years for a solution. You have to deal with the problem immediately."

Julio Torres (Panama) - "About one of your comments on of integrating different management, in Panama we have the Ministry of Health, Ministry of the Environment, the Ministry of Ecology and the institution that I am part of, the Institute of Aqueducts and Wastewater. They form the Board of Directors, through which everything that is

done in one of the institutions has to be approved. So, therefore, everybody is integrated to know what action is being taken through which institution."
Cedo Maksimovic - "This is a way to go but one of the problems is that even these administrative people, no matter how high titles they have, some of them need to be given some knowledge and information. And the role of this particular project of the IETC is to provide training material for people like them that do not have time like us to sit for the whole week. So when they get together, they will have some basic knowledge of which technologies are available."

Arthur Archer - "What is your view about water coming downstream and so on coming very dirty. In some cases you get erosion from agriculture areas, sometimes you get pesticides or other chemicals. What kind of action would you pick to make sure that the public gets clean water? "
Cedo Maksimovic - "There is no universal solution but the simplest solution is to try to tackle the problem as close to the source as possible. Do not let agriculture erosion to happen and if it happens, try not to let it cause further degradation downstream. So try to solve this problem locally and deal with the causes rather than the consequences."

Javier Mijangos (Argentina) - "I would like to comment about the regulations and the contamination control. This problem appears in countries where there is a federal system, like Argentina or Brazil, and then each state within the country has its own regulation. Many times, these state regulations are more or less demanding than the national or the other states environmental laws. As an example, sometimes in a state a particular effluent is considered toxic and in other states it is not. And in this case, we have a multi state impact. So I think this is also a problem that must be solved before facing any planning."
Cedo Maksimovic - "I agree. We will have a session on cross cutting issues. My understanding is that when UNEP and the World Bank discuss this problem as a kind of agreement, UNEP will concentrate more on the technological solutions and the World Bank will concentrate more on cross cutting regulation social economical issues. These two documents should be highly complementary to each other, hopefully. "

Cristobal Morejón (Cuba) - "You know that most of the Latin America countries, and that is not different in Cuba, the stormwater drainage is much less developed than wastewater one. We, in the tropical areas, have the problem of cyclones, that, among other consequences, bring flooding. So, with no stormwater drainage, we had to construct floodgates upstream in order to protect these areas. We know that some people, do not consider that as an environmentally adequate solution . So, taking into consideration all your experience in other countries, what is your opinion about that ? "
Cedo Maksimovic - "We were talking about wastewater and stormwater in urban areas but flooding at the catchment level is a big problem and sometimes more serious, causing loss of human life. I think that we must plan different level of solutions because there will be other problems of destruction of dams and reservoirs used not only for electricity production or water supply but also as a mean of flood control. And specially in countries that have this extreme hydrological or meteorological conditions, problems are even more severe. The only solution is to analyze the causes and find a proper solution."

ENVIRONMENTALLY SOUND TECHNOLOGIES: WHY THEY ARE IMPORTANT, AND HOW TO SELECT THEM

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I. What are environmentally sound technologies (ESTs)?

Environmentally sound technologies are technologies which perform better in relation to the environment compared with other technologies. The term 'technology' includes both hardware and software. However, there are no hard and fast definitions of what are environmentally sound technologies.

Hardware or 'hard' ESTs. These refer to equipment, machines, physical facilities and infrastructures for avoiding, reducing or controlling environmental damages which put at risk the life and welfare of humans and the natural ecosystem. They do not pollute the air, water or land nor deplete non-renewable resources. Examples: facilities for waste treatment (household, industrial, solid, liquid, chemical or gaseous waste), for pollution control; for remediating or restoring damage to the environment; for monitoring or assessing environmental quality; others.

Software or 'soft' ESTs. These refer to systems, processes, and procedures to operate and maintain 'hard' ESTs as well as those systems, processes, and procedures for environmental planning and management. Examples: environmental information systems; environmental technology assessment; environment risk assessment; management of ESTs; policies and regulatory frameworks for environmental conservation; others.

ESTs include both 'hard' and 'soft' ESTs for avoiding, reducing or controlling risks or consequences from natural environmental hazards, such as, earthquakes, typhoons, and others. Examples: natural disaster-resistant building materials technologies and construction systems.

II. Why are ESTs important?

- **They avoid/prevent or reduce risks to human life and welfare**

  – *They avoid/prevent or reduce the risks to human life, disease or other types of occupational health hazards that could arise from the application of a new technology or continued use of an existing or old technology.*

Examples of risks: Worker exposure to chemicals in industry and agriculture; pollution inside factories (synthetic materials) which have been found to cause lung cancer, TB and other pulmonary diseases.

- *They avoid/prevent or reduce the risks of disease or death to people in communities which are near or around the facility where the technology is located.*

Examples of risks:
Pollutants in drinking water. Case: Minakata disease due to mercury and other toxic wastes dumped into the Minakata river in Japan in the 1960s.

Ambient air pollutants. Cases: Donora air pollution disaster in Pennsylvania in 1948 which caused deaths from respiratory diseases; Yokkaichi asthma from industrial smog in Japan in the 1960s.

Malodorous and toxic gases. Case: Kaida Enterprises, Ltd., a Hong Kong plastic toy factory which was asked to close down after it was found responsible for the outbreak of respiratory diseases in 1982.

Nuclear radiation. Case: Chernobyl disaster in 1986 in Russia which caused several deaths, deformities and diseases and whose effects are still being continually found among residents who lived within 50 km of the site.

Acid rain. Cases: Acidification of buildings and wildlife in a number of countries with industries which emit large quantities of sulphur dioxide. (UK, Canada, Russia, Eastern European countries, China)

- *They avoid/prevent or reduce the risks to ecosystem life or health.*

Examples of risks:
Habitat alteration and destruction, species extinction or loss of biological diversity, stratospheric ozone depletion, global climate change and others which threaten ecosystem life.

Cases: (1) 13 out of 17 major ocean fisheries in the world are in trouble due to several technologies which have converged to overstress the fish supply (i.e., sonar, radar tracking, satellite navigation system, factory ships, and gigantic nets);
(2) Loss of biodiversity due to deforestation from slush and burn farming;
(3) The Aswan Dam in Egypt has upset fishing at the mouth of the Nile by altering the traditional ecological composition of the water;
(4) The Chicago environmental disaster where a metal-plating plant poured 4,000 gallons of cyanide and cadmium waste down a floor drain - delivering a toxic jolt that temporarily shutdown a branch of the city sewer system and killed 20,000 fish in the Chicago River;
(5) Eutrophication of lakes which destroy natural habitats.
(6) Global warming due to the greenhouse effect of some gases like CO_2 which will affect human health and also cause habitat alteration and destruction.

– *They avoid/prevent or reduce the probabilities of death and damages to property due to natural hazards like earthquakes, typhoons, hurricanes and other harsh climatic conditions.*

The risks to humans from natural hazards are more or less known and the likelihood of the occurrence of natural hazards are more or less predictable. While it may be said that the risks to the environment from human action are not always known and are not easy to predict.

- **They create products and processes that are environmentally beneficial or benign.**
  - *Their products or processes do not pollute the air or contaminate the soil and water bodies.*
  - *Their waste is recyclable or biodegradable.*
  - *They use less fossil fuels, i.e., gas, oil, coal which are polluting and practically non-renewable.*
  - *They use alternative energy sources which are more abundant and less polluting, such as, solar, wind, geothermal, others.*

- **They enhance cost effectiveness and improve process efficiency.**
  - *Their processes do not produce waste or have little waste. If they do produce waste, this waste is recyclable or biodegradable.*
  - *They are easy and not too costly to maintain relative to the financial ability of users and available skills.*

III. How to select ESTs

- **Systems approach in selecting ESTs: EnTA**

Choosing ESTs requires an understanding and application of a systems approach through a process called environmental technology assessment (EnTA).. This means awareness of the technology cycle and an understanding and application of the technology assessment process. Above all, it is well to note that technology choice is not an isolated decision. It has to be a part of a broader social and economic or industrial framework since the application of a technology and its timing have to come within the context of a nation's development policy and level of development.

- **Understanding the technology cycle.**

Technology assessment requires an understanding of the basic elements or phases of the technology cycle, from the time of its inception or introduction to replacement or disposal.

Elements of the technology cycle:

(1) Identification of the problem/need or opportunity and the purpose for choosing the technology;
(2) Alternative solutions;
(3) Site selection;
(4) Design and planning;
(5) Rights and permissions;
(6) Construction;
(7) Operations;
(8) Maintenance and repair;
(9) Waste disposal;
(10) Expansion or alteration;
(11) Replacement; and
(12) Disposal (abandonment).

- **Understanding and application of the technology assessment process**

Essentially, the process involves an evaluation of the technology from the time of its selection, to adoption, application, operation and management. It requires an understanding of the potential environmental risks/impacts from the technology; an awareness of the effects of the technology on social, cultural and economic/financial conditions within the locality or organization which will adopt and use the technology; and an understanding of the issues involved in the event of abandonment or the need to dispose or replace the technology.

IV. The basic steps of EnTA:

1. Analysis of the reason for selecting a technology

This is the most important stage of the EnTA process. An environmental problem, an industry need or a general public need, or an opportunity may drive the desire to acquire a new technology or replace an existing one. However, too often, this leads to one solution, usually a 'hard' technological solution which may not be the right kind or not the only solution. For example, the problem of pollution from solid waste. The usual solution to the problem is sanitary landfill or incineration or composting. While any or a combination of these methods can dispose of so much garbage, the volume of waste may still not change. Other solutions to eliminate or reduce garbage will have to be explored.

2. Gathering information on the proposed technology and alternative solutions

To avoid falling into the trap of a strong bias towards a single technological solution, there is a need to deliberately stand back and ask the question: Is this is the only possible solution? What and where are the other alternatives? Other possible alternative solutions could be 'soft' technologies - non-technological solutions - like changing people's behaviour or lifestyles, changes in social policy, legal or regulatory frameworks. This is the stage when as much information should be made available to the decision makers or when decision makers should try to have at hand as much information on ESTs as possible.

Information should be made available on the proposed technology as well as on alternative or competing technologies. The information should include: description of what the technology is for; its materials and energy requirements; capital, labor and managerial requirements; industrial and engineering processes and operations; products; byproducts, including waste and what is done with it; scale of operation; land use; distribution of output; associated transportation requirements at all phases; performance record based on a set of indicators. This should also include some estimates of probabilities of technology breakdown and to accidental or deliberate disruption.

Alternative solutions need not be new technologies but could be improvements to an existing technology.

If the technology has accessory or supporting technologies (e.g., computers, monitoring equipment, bundy clocks, etc.), information on these too must be made available since they may be already in use and may only need some adjustments to be made compatible with the new technology.

Even if alternative 'hard' and 'soft' technological solutions have been considered, this is not sufficient. There is a need to also consider other factors, such as community values, available technical and managerial skills in the organization which is adopting the technology, administrative and political structures within the larger society where it will operate, others, before a final decision can be made.

3. Making a choice among alternatives.

Making a choice among alternatives implies making a comparison of two or more technologies. However, this is not easy since to acquire information on several alternatives would be time consuming and could be discouraging. The problem is often due to the lack of adequate, reliable information on more than one kind of solution that is available and easily accessible by decision makers. And even if more information would be available or accessible, there is still the deeper problem of a tendency to rely on information being provided by a particular technology provider because of several factors.

- **Factors that can limit information search**:

(a) The natural tendency towards passive acceptance or least resistance as this is less costly in terms of time and effort;
(b) A strong influence of an aggressive technology 'champion';
(c) Technology is tied to a technical assistance promise, trade agreement or foreign debt agreement;
(d) Dominance in the country of a foreign country which produces technologies;
(e) A combination of any of these.

In view of these factors, the challenge for making a choice among alternatives falls largely upon the person/s who are tasked to make that choice. A good guideline is to remember that the best choice cannot come from complacency nor from political considerations but from the application of the principle of appropriateness and soundness of the technology because of higher considerations for the health and safety of people and their natural ecosystems, for the sake of sustainability.

However, granting that the principle is the basis for making the choice, how does one choose between two or three 'equally' technically sound and appropriate technologies? The following factors may be considered.

- **Suggested criteria for selecting between two or three equally sound and appropriate technologies:**

(a) Cost of acquisition, operation and maintenance the equipment or facility vis-a-vis the 'affordability' of the acquisitor. Considerations will include the distance of transporting from the source, cost of the entire equipment/facility and spare parts, cost of maintenance services, including cost of waste disposal.

(b) Ease of acquisition, operation and maintenance. This refers to the speed of delivery of the main equipment/facility, ease of access to spare parts, questions of whether monitoring and maintenance services will be provided as part of the package, whether the adopting organization has or will have the necessary technical and managerial skills to operate and manage the facility or whether it is user- friendly. It also refers to the question as to who owns the technology and to transfer issues. For example, will the technology place the acquisitor in a 'locked-in' position where it will be practically bound to that single technology, without elbow room or flexibility to shift to another less expensive or demanding technology should the time come to make a shift?

(c) Track record of the technology provider. This refers to the reputation of the provider whether it has a long time experience in producing and delivering environmental technologies; whether it is reputed to have good quality products with good environmental performance; whether it delivers the good on time; whether it provides technical training to staff; and whether it has good reliable maintenance services and service centers in the adopting country.

(d) The technology is not tied to any foreign trade or debt agreement. If the acquisition of the technology is part of a trade agreement or a foreign debt agreement, this could hamper or adversely influence the assessment process. Nevertheless, if the agreement should include importation of an environmental technology, it would still be advisable to subject the technology to an assessment process to ensure its environmental soundness and compatibility with other related systems.

(e) The technology is gender-friendly. This means that it would be good if the technology to be acquired can be operated by both men and women and not just by the men. For example, wastewater management facilities are usually operated and managed by men but there is no reason why these cannot be also operated and managed by women with better design and accessories, if necessary. The gender factor is important so as not to exclude an important and an increasingly sector of the population – women. To also ensure success in the adoption, application and management of the technology, it will be helpful and enriching if women are involved in the identification and selection of technology or in the EnTA process.

4. Situational analysis

This refers to an analysis of the existing social, cultural, economic and even political conditions of the locality where the technology is proposed to be introduced and of the conditions in the institution/organization which will be responsible for the initiation, application, operation and management of the technology. This requires gathering of baseline data on the current situation as well as on future trends (worst case or best case scenarios of the effect of the new technology or system) in the society at large and in the organization.

This will include considerations of community values and preferences. The technology should not be repugnant to community values or practices. For example: An incineration plant which is producing so much noise or emitting so much dioxin, fiorin and other toxic gases has become repugnant to a number of Japanese communities which do not like to be exposed to the dangers of pollution; or energy generation through biomass technology using pigs waste will not be acceptable in a Muslim community; or replacement of coconut trees with a fast growing palm specie in order to introduce cocowood technology will be opposed by people in a traditional coconut producing country; or introducing the use of treated water for drinking in a community where freshwater is still abundant and not polluted will just be laughed at. It will be a radical idea whose time has not yet come for this community.

In the case of wastewater treatment as a new technology, if the community will be charged a fee for its use, this idea should be fully explained early on, that is, before installation, to the community in terms of its long term benefits for all, otherwise it will not receive support and no one will want to use it. If the facility will be emitting foul smell and disturbing the senses of the community, its location should be also properly considered or this facility will also not be supported.

5. Identification and consultation with stakeholders

The introduction of a new technology will invite various kinds of interest as well as concern among the different groups of users in the society where the technology will be introduced and even from those who will not use it but would be affected by it in one form or another. The technology will affect almost everyone - whether directly or indirectly, negatively or positively. These individuals are represented by interest groups, i.e., governmental organizations, institutions, agencies, NGOs, academic institutions, private business groups or clubs, church organizations, and other entities who advocate for a common interest. **These interest groups are called stakeholders.** Their stake in the technology could be financial, social (health and safely), economic, political or administrative. They can be influenced by the technology or they may want to influence the technology itself.

The participation of stakeholders in the decision making process for selecting the particular technology and its accessories is therefore necessary to ensure a successful implementation of the technology. Objection to a technology from any one group could result in a total rejection of that technology by the whole society. It is therefore important to identify, again, early on in the EnTA process, the various stakeholders who should be informed or directly involved and to design a consultation mechanism as part of the technology assessment process.

There are a number of good things that can come out from a consultation with stakeholders. Some of these are:

a. Additional information
b. A better understanding of the community
c. Provide opportunity for critics to express strong, negative or hostile views
d. Encourage dialogue and discussion of possibilities
e. Improve the quality of the plan/proposal
f. Add credibility to a plan/proposal
g. Identify conflicting interests
h. Build a constituency for the new technology
i. Identify expertise which can be tapped
j. Reduce alienation
k. Promote more effective decision making
l. Create an intellectual or sophisticated level of discussion
m. Demonstrate a model of participation
n. Promote cooperation
o. Promote community power
p. Bring about changes in behavior
q. Identify with the solution

<u>There are bad things that may happen if stakeholders are ignored, even if the technology chosen would be the right one</u>. Some of these unfortunate events could be: A complaint related to the license, permit, or patent from a politician or businessman; a complaint from the neighborhood community regarding noise, odor, or other problem, even if that would be quite minor or nonexistent; worst, a demonstration rally against a facility for reasons of fear which may be unknown or unwarranted.

6. Identification of potential impacts

The new technology should be expected to impact on people, their environments and resources. These impacts would be both positive and negative, direct or indirect. Identifying potential impacts is not an easy task. Hence, persons who are tasked with technology assessments are also expected to have as much imagination and openness of mind as possible to think of all the possibilities or probabilities. However, in identifying potential impacts, it is sufficient to identify those of potential importance and with probability of happening or occurring. A more detailed search for accuracy of the occurrence of the impact will not be necessary. This will require the use of another type of management and decision tool - an environmental impact assessment (EIA) or environmental risk assessment (EnRA) - which may be done after a technology has been assessed and selected.

The search for potential impacts considers each significant phase of the technology cycle - from the initiation or introductory stage to implementation, operation, utilization and

up to abandonment or replacement of the technology. The main objective is to identify the potential impact of the technology on the health, safety and welfare of people and the natural ecosystems on one hand; and, on the other hand, to identify the probable impact of people and their environment on the effectiveness and usefulness of the technology. The search should not be also limited to the impact expected over a short term, within the planned or anticipated use of the technology. It will require a long range view, perhaps, over a period of 25-50 years.

In general, the areas where the environmental impact of a new technology may likely occur or which will have an impact on the technology itself are:

(a) *Human behavior and preferences* - including their social, cultural, economic, political, administrative, geographic, aesthetic, climatic, and general environmental conditions;

(b) *Natural ecosystems and resources* - land, air, water and their resources, animal and plant life,

(c) *Built environment* - land use and settlement patterns, physical infrastructures, amenities and facilities in urban or rural areas.

For example. If the proposed technology were an on-site community scale wastewater treatment plant, some of the questions that may be asked to determine environmental impact would be: Is the proposed wastewater treatment plant part of an existing or planned integrated wastewater management system of the city where the community belongs? Is it intended to accommodate only household wastewater or also storm water and wastewater from small restaurants, small clinics or chicken and other animal farms in the community? Is the site located within or surrounded by residential settlements? Is it located on a wetland or a watershed or near a freshwater resource, such as, a river, lake or reservoir which is likely to be polluted? Are there natural habitats in its proposed location which are likely to be dislocated or destroyed? Is it going to be managed partly or wholly by the community? Is it going to drive away present and prospective communities because of its small and create a ghost town? Or is it going to induce more infrastructure development around the facility, such as, roads and transportation networks which would change the whole character of the present area?

When a particular technology and its supporting technologies have been chosen, then the need arises for more detailed information on the impact of these technologies on the environment to guide the preparation of guidelines and safeguards for people's health and safety as well as guidelines for the efficient and safe operation of the technology itself. It is at this stage when an EnRA or EIA becomes necessary. EnRA determines the likely impact of the new or improved technology on the environment of the proposed site and its environs. It is complementary to environmental impact assessment (EIA) but simpler and less costly.

7. Policy analysis

EnTA has to be understood and applied within the context of a nation's policy on environment and development. This step may be a part of the situational analysis in EnTA.

Prior to doing an EnTA, it is necessary to make a review of a nation's or a locality's development and environment policy which may include rules and regulations for environmental protection and conservation, for instance: a strict national policy to protect wetlands, watersheds and groundwater aquifers, or a policy of separating wastewater and storm water, or a zoning policy of locating hazardous and malodorous facilities at least 1.5 km away from the population centers and which classifies wastewater treatment plants as hazardous and malodorous, should be strongly considered in designing a wastewater treatment facility.

Knowledge of the policies and regulatory requirements which will affect new technologies will save time, effort and money in the EnTA process since the selection of the technology can be largely guided by existing policies and regulations.

Other development policies that need to be analyzed other than environmental policies and land use and zoning are: labor laws, importation regulations, national/local laws on patent, taxation laws, regulations on foreign capital and business ownership, others. For instance, it may be the policy of the nation or locality to give priority to labor intensive technologies, or to limit importation of heavy equipment but give preference to small-scale technologies for community-based environment programs, or not to import from countries which do not have diplomatic relations or reciprocal trade relations or known to be cuddlers of terrorists.

8. Findings and recommendations

EnTA is not a one-off activity. It is a continuing process which follows a spiraling decision loop. It does not end where one technology has been decidedly replaced or disposed. The process continues to the point where a new decision has to be made to replace the 'debunked' technology and the decision loop begins to grind anew but this time, perhaps, under different assumptions and conditions.

Since it is a continuing process, EnTA is most effective if it is a part of an established development planning and management system, particularly, if it is being utilized as a planning and decision making tool for environmental management that is required by policy. Otherwise, if EnTA as a process does not exist, or is undertaken randomly and not required as a matter of policy, the selection of an environmental technology is likely to be influenced by a flurry of extraneous conditions usually dictated by political and other subjective considerations. In this regard, a country's aims of sustainable development may be good only on paper.

There is a need to make EnTA a part of public policy. If EnTA is not yet operational as a matter of policy, there are areas where the criteria for selecting an environmentally sound technology may be applied. These would include: EnRA or EIA which is now being implemented by many governments, the issuance of importation permits, locational clearance and permit to build, or the issuance of business permit and license to operate. There is a danger, however, that the selection process will be haphazard and ineffective when undertaken as simply an add-on to a separate requirement.

It is also important to note that undertaking EnTA requires multi-disciplinary teamwork. Ideally, the team should include an environment specialist, an urban/regional planner, a sociologist, an economist, and a lawyer. If the technology involves a specialized subject like waste water treatment, the team shall consult with a specialist in the area.

Moreover, the EnTA report will contain recommendations that will be addressed to the decision makers of the organization or locality which may adopt and use the technology.

Its recommendations may include:

(1) To adopt the technology in its entirety (i.e., its hardware and software) or only the software part; or to modify an existing technology with additions or improvements from the new technology; or to integrate the technology with other systems;

(2) To build the capacity of the staff to manage or supervise the facility by providing them with training on management or supervisory level skills and technical skills training for the staff who will operate the facility;

(3) To privatize some aspects of the system but to be monitored and supervised by the organization;

(4) To prepare safety guidelines for the community and to disseminate this information effectively;

(5) To review the performance of the technology on a regular basis and to submit reports with recommendations to decision makers also regularly.

V. The Role of IETC in ESTs

The role of IETC in ESTs is to facilitate the adoption and use of ESTs for urban environmental management and for the management of freshwater resources, such as, lakes and reservoirs and other freshwater bodies, especially in developing and transitioning countries.

IETC undertakes this mandate in three ways:

(1) *Providing information and improving access to information on ESTs drawn from global sources through various forms of media - print, visual, electronic and seminars.*

(2) *Building or enhancing the capacities of policy and decision makers to make informed choices by developing training modules and conducting pilot training activities on 'soft' ESTs for environmental planning and management.*

IETC is not a technical training institution but it undertakes pilot training activities in its special areas of concern at regional/sub-regional and global levels in partnership with capacity building institutions.

(3) *Providing technical assistance through advisory services in using certain 'soft' technologies for environmental planning and management.*

These 'soft' ESTs are: environmental technology assessment (EnTA), environmental risk assessment (EnRA), adoption, operation and management of ESTs, environmental management systems (EMS) and the management systems for specific environmental issues, such as, waste management (solid waste, waste water, storm water treatment), planning and management of lakes and reservoirs, and freshwater augmentation. Advisory services may also include policy formulation or developing regulatory frameworks in support of 'soft' technologies for environmental management.

In the selection of ESTs, IETC plays a valuable role. Being a part of a multilateral organization, it will be valued for its objectivity by having no vested interest in promoting technologies of any one country. IETC tries to ensure that decision makers are able to make an informed choice on ESTs by providing them or making accessible to them as much information as possible on the whole range of ESTs that are being promoted by various technology providers from various countries. In this regard, IETC has undertaken researches and surveys and has published results of these studies in the form of international source books and technical reports.

To further improve access to information, IETC has developed an electronically searchable directory of ESTs and an electronic tool for accessing and exchanging information on ESTs which has been called *maESTro*. *maESTro* is a software that enable users to acquire information on ESTs that are available all over the world, particularly, information on:

- Institutions working in the area of ESTs;
- Information sources on ESTs; and
- Technologies (ESTs)

With *maESTro*, IETC hopes to link information providers and technology providers on ESTs with technology users, managers and researchers.

To help managers and decision makers in the selection of ESTs, IETC has undertaken various training activities to build the capacities of managers and decision makers. Regional and global workshops on EnTA, EnRA, on the Adoption, Application and Management of ESTs, and on EMS. Workshops have been held in Southeast Asia, China, Eastern Europe, Africa and the Caribbean sub-region of Latin America. Similar workshops are planned to be held in other regions during the current biennium.

IETC does its work in cooperation and collaboration with other UN agencies and other international organizations which are involved in similar environmental work. In this regard, IETC has undertaken its capacity building activities and information services in partnership with other units within UNEP, with other UN agencies, and with other international organizations/institutions.

IETC welcomes partnerships with other organizations or institutions which share its interests in ESTs.

VI. *maESTro* and EnTA

How will *maESTro* be helpful in the EnTA process to identify and select an appropriate technology for wastewater management?

maESTro will be able to provide information on:
(a) Institutions whose work is related to wastewater management;
(b) Information systems related to wastewater management; and
(c) Technologies for wastewater management.

The information on technologies will give you details on: source/origin of the technology, costs involved, where it has been applied, and its advantages or disadvantages. More details on *maESTro* will be provided by the next speaker from IETC.

VII. Conclusion: Some food for thought

Environment and development problems being a result of human dynamics will always be a part of us. Technologies can provide solutions. But technology decisions must be made within the broader context of a nation's development policy and vision. And decision makers must be able to base their decisions on reliable, verifiable information before they make that important technology choice. UNEP-DTIE- IETC is there to help.

What are environmentally sound technologies?

There is no single or commonly accepted definition of 'environmentally sound technologies'(ESTs). However, there are generally recognized features of ESTs and an increasing recognition that these features distinguish them from other technologies.

ESTs defined ESTs are recognized as technologies that perform better for the environment or in relation to the environment than conventional technologies. In particular, these features make them environmentally sound:

- They avoid producing waste and avoid degrading the environment with their waste.
- They do not pollute or they pollute less the air, water and land. They are 'clean' technologies.
- If they cannot totally avoid waste, they reuse or recycle their waste, hence, they are quite energy-efficient.

ESTs are dynamic. Because of the evolving nature of environmental problems, the features of ESTs are dynamic - i.e., environmentally sound today, not necessarily tomorrow; environmentally sound for one country, but not so in another.

ESTs are either 'hard' or 'soft'

'Hard' ESTs - are easily recognizable and more popular. They refer to the hardware part of technologies, i.e., equipments and machines, including their accessories, for example:

(a) End-of-pipe technologies designed for the treatment of pollution
(b) Remedial technologies aimed at cleaning up damage or reclaiming resources that were formerly degraded (e.g., technologies for desalination, soil decontamination, etc.)
(c) Process technologies producing goods or services with lower resource consumption or degradation (manufacturing technologies that use lesser fossil fuels or use alternative energy sources like solar, wind or hydrogen)
(d) Product technologies involving environmental improvement through altered final or intermediary products which are less polluting and are recyclable.

'Soft' ESTs - refer to environmental management systems and procedures, including the systems and procedures of operating and maintaining the hardware part of technologies. They include environmental planning and management tools, such as, EnRA, EIA, EnTA, EMS, economic and legal instruments, other policy instruments and the whole array of concepts and principles that govern environmental management.

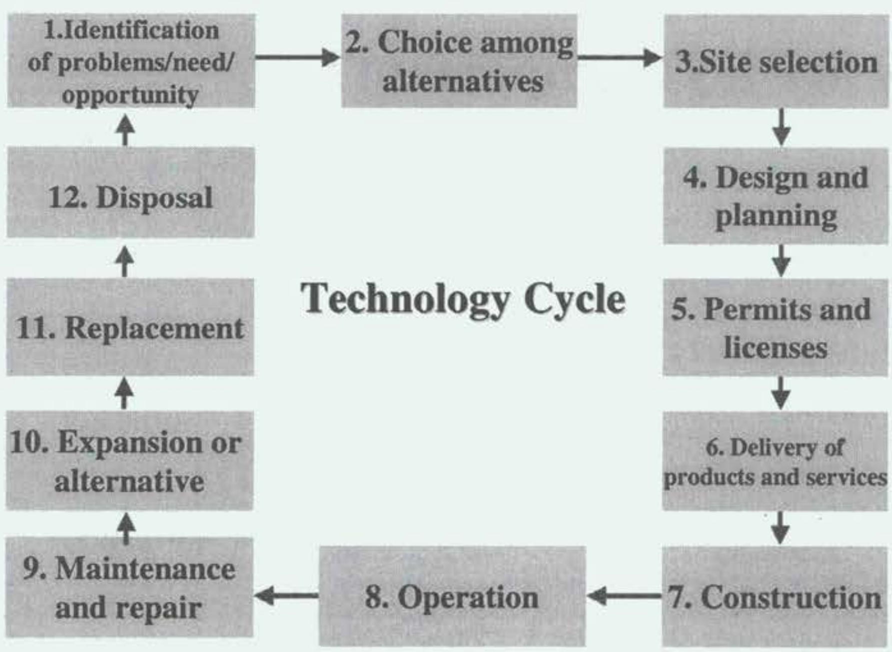
Why are ESTs important?

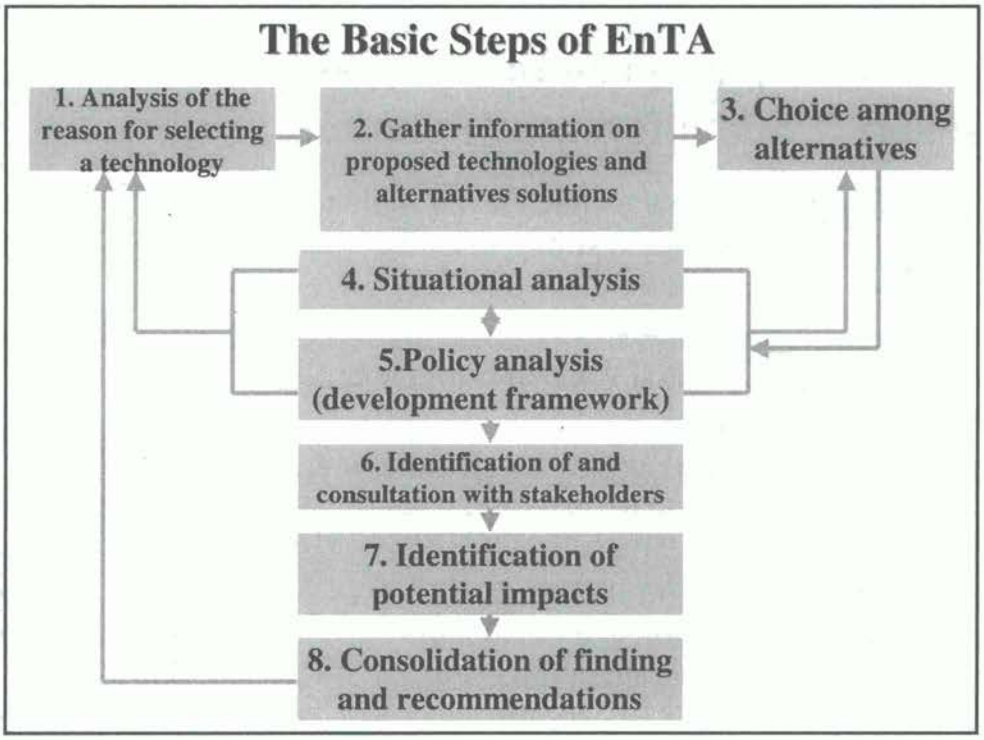
- They avoid/prevent or reduce risks to human life and welfare.
- They create products and processes that are environmentally beneficial or benign.
- They enhance cost effectiveness and improve process efficiency.

How to select ESTs

Systems approach in selecting ESTs: EnTA

- Awareness of the technology cycle
- Understanding and application of the technology assessment process
- Technology choice





1. Analysis of the reason for selecting a technology

- This is the most important stage of the EnTA process. An environmental problem, an industry need or a general public need, or an opportunity may drive the desire to acquire a new technology or replace an existing one. However, too often, this leads to one solution, usually a 'hard' technological solution which may not be the right kind or not the only solution. Other solutions to eliminate or reduce garbage will have to be explored.

2. Gather information on the proposed technology and alternative solutions

- Need to gather information as much as possible to avoid falling into the trap of a strong bias towards a single technological solution.
- Information should be made available on the proposed technology as well as on alternative or competing technologies.
- Alternative solutions need not be new technologies but could be improvements to an existing technology.
- There is a need to consider other factors, such as community values, available technical and managerial skills in the organization.

3. Making a choice among alternatives.

- Making a choice among alternatives implies making a comparison of two or more technologies. However, this is not easy since to acquire information on several alternatives would be time consuming and could be discouraging. The problem is often due to the lack of adequate, reliable information on more than one kind of solution that is available and easily accessible by decision makers.

Factors that can limit information search

a) The natural tendency towards passive acceptance or least resistance as this is less costly in terms of time and effort
b) A strong influence of an aggressive technology 'champion'
c) Technology is tied to a technical assistance promise, trade agreement or foreign debt agreement
d) Dominance in the country of a foreign country which produces technologies
e) A combination of any of these

Suggested criteria for selecting between two or three equally sound and appropriate technologies

a) Cost of acquisition, operation and maintenance the equipment or facility vis-à-vis the 'affordability' of the acquisitor.
b) Ease of acquisition, operation and maintenance.
c) Track record of the technology provider.
d) The technology is not tied to any foreign trade or debt agreement.
e) The technology is gender-friendly.

4. Situational analysis

This refers to an analysis of the existing social, cultural, economic and even political conditions of the locality where the technology is proposed to be introduced and of the conditions in the institution/organization which will be responsible for the initiation, application, operation and management of the technology.

This will include considerations of community values and preferences. The technology should not be repugnant to community values or practices.

5. Identification of and consultation with stakeholders

- The participation of stakeholders in the decision making process for selecting the particular technology and its accessories is necessary to ensure a successful implementation of the technology.
- There are a number of good things that can come out from a consultation with stakeholders.
- There are bad things that may happen if stakeholders are ignored, even if the technology chosen would be the right one.

6. Identification of potential impacts

- The use of another type of management and decision tool - an environmental impact assessment (EIA) or environmental risk assessment (EnRA) may be done after a technology has been assessed and selected.
- The main objective
  - to identify the potential impact of the technology on the health, safety and welfare of people and the natural ecosystems on one hand
  - to identify the probable impact of people and their environment on the effectiveness and usefulness of the technology.
- The search will require a long range view over a period of 25-50 years.

Areas where the environmental impact of a new technology may occur or which will have an impact on the technology itself are:

a) Human behaviour and preferences
b) Natural ecosystems and resources
c) Built environment

7. Policy analysis

- EnTA has to be understood and applied within the context of a nation's policy on environment and development.
- Knowledge of the policies and regulatory requirements which will affect new technologies will save time, effort and money in the EnTA process.
- Other development policies that need to be analyzed are:
  - labor laws
  - importation regulations
  - national/local laws on patent
  - taxation laws
  - regulations on foreign capital and business ownership

8. Findings and recommendations

- EnTA is not a one-off activity.
- EnTA is most effective if it is a part of an established development planning and management system.
- There is a need to make EnTA a part of public policy.
- It is important to note that undertaking EnTA requires multi-disciplinary teamwork.
- The EnTA report will contain recommendations that will be addressed to the decision makers of the organization or locality which may adopt and use the technology.

The Role of IETC

Promote the adoption and use of ESTs for urban environmental management and for freshwater management in developing and transitioning countries.

Various forms of media (print, visual, electronic and seminars)

Training modules and Pilot training activities

Advisory services

'Soft' ESTs

- Environmental technology assessment (EnTA)
- Environmental risk assessment (EnRA)
- Environmental management systems (EMS)
- Management systems for specific environmental issues
  - Waste management (solid waste, waste water, storm water treatment)
  - Planning and management of lakes and reservoirs and freshwater augmentation
  - Advisory services

UNEP INTERNATIONAL ENVIRONMENTAL TECHNOLOGY CENTRE

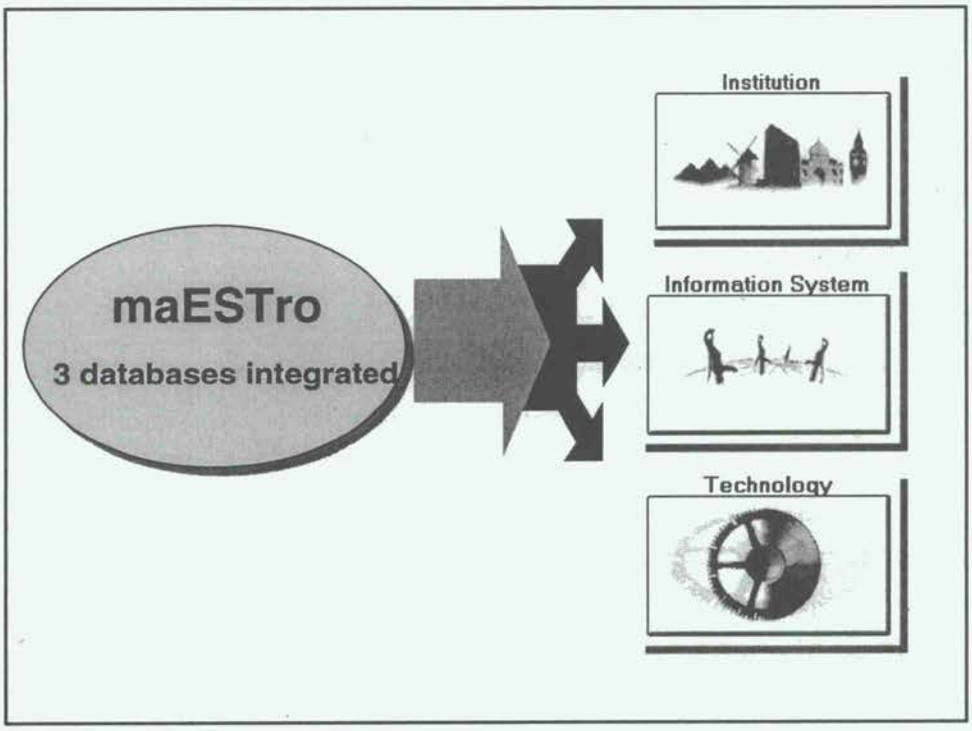
UNEP

maESTro

IMPROVING

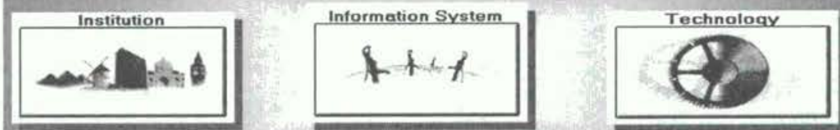
access to information on

Environmentally Sound Technologies (**ESTs**)



maESTro and EnTA

maESTro



Information on Wastewater Management

EnTA Process

Identify and select an appropriate technology for wastewater management

FOOD FOR THOUGHT

Development problems will not go away.

Technology decisions are important. But they must be made within the broader context of a nation's development policy and vision.

IETC IS HERE TO HELP.

maESTro - A COMPREHENSIVE GLOBAL DIRECTORY FOR ENVIRONMENTALLY SOUND TECHNOLOGIES

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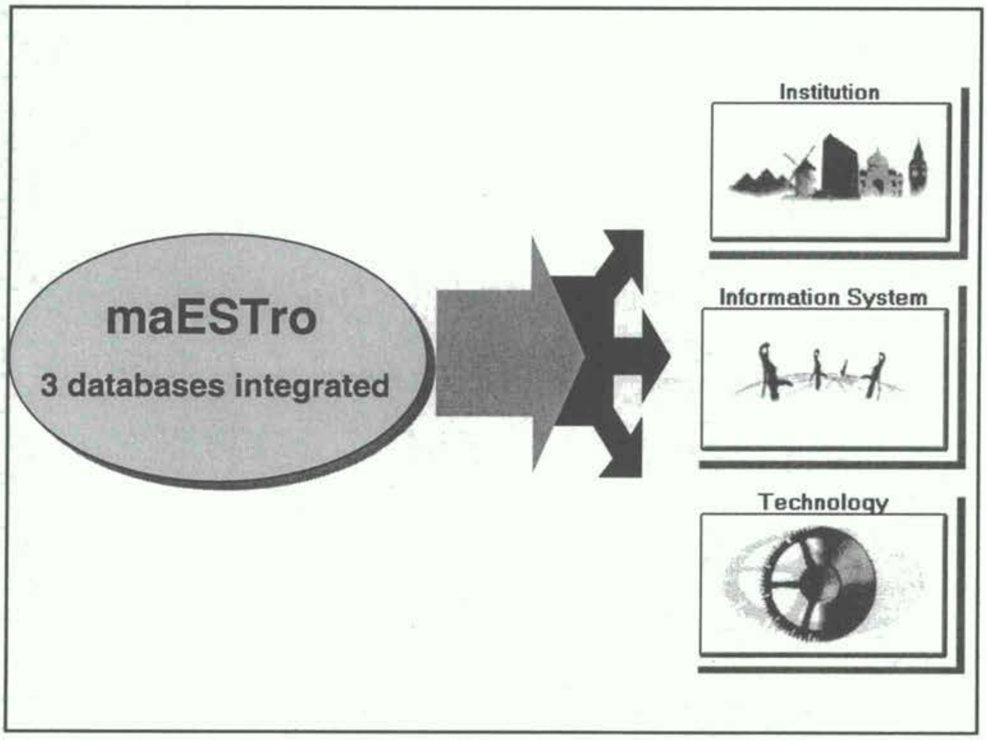

World wide collection of EST information

- Asian Institute of Technology	**Thailand**
- Asian Pacific Center for Tech. Trans.	**United Nations**
- Centre for Advanced Philippine Studies	**Philippines**
- Centre for Environmental Technologies	**Malaysia**
- EnviroNET	**Australia**
- Environment Liaison Center International	**Kenya**
- Environmental Management Secretariat	**Uruguay**
- EUREKA	**European Union**
- Foundation for Applied Research	**Hungary**
- Global Environment Center	**Japan**
- Global Environment & Technology Foundation	**US**
- Institute of Industry & Technology	**Korea**
- INTEC	**Chile**
- International Energy Foundation	**Libya**
- National Environmental Protection Agency	**China**
- OCETA	**Canada**
- University of South Valley	**Egypt**
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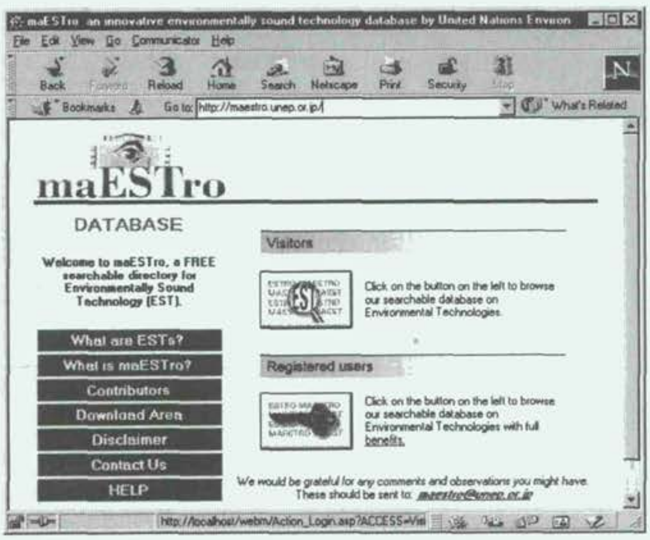
maESTro

maESTro: Accessible with Internet

- Always updated
- On-line search
- Accessible
  > Anywhere
  > Anytime
  > Any OS
(Windows, Macintosh, Linux, Unix...)

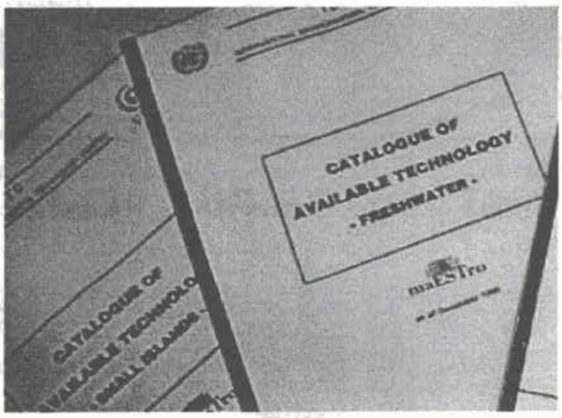


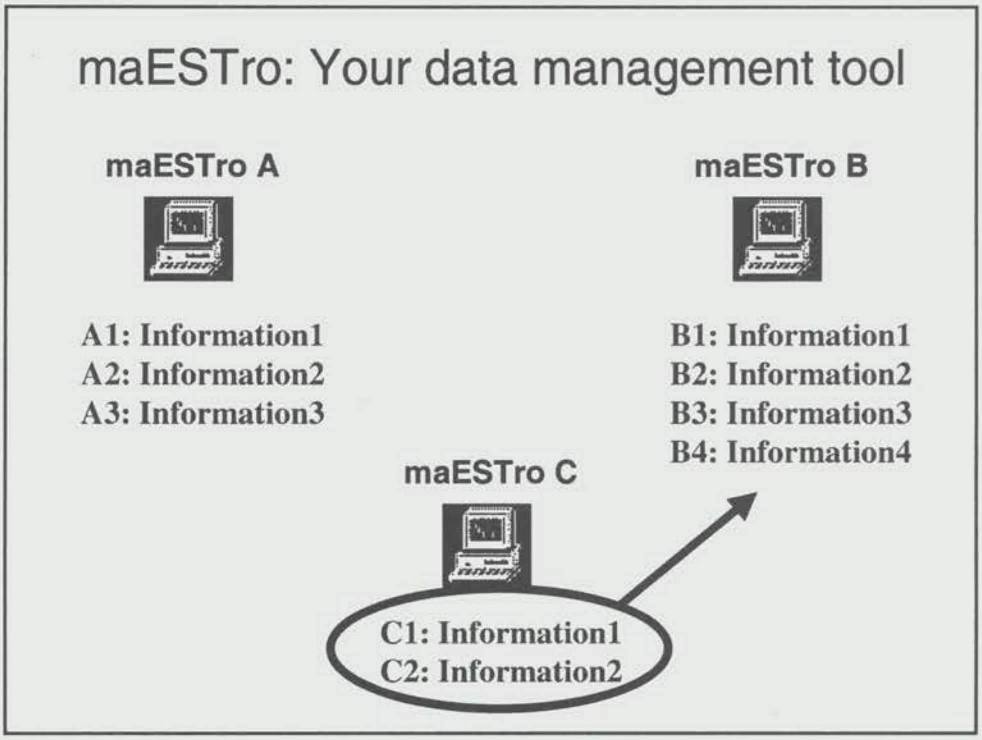
maESTro: Accessible **without** Internet

- Standalone version
- CD-ROM or floppy
- Windows OS
  (3.1, 95/98, NT)
- Updated every
  6 months
- Report function
- User friendly

maESTro: Accessible **without** computer

- Subject On Demand
- Table of contents
- Easy search
- Index by INFOTERRA
  themes and Location

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A2: Information2
A3: Information3
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B3: Information3
B4: Information4
maESTro C
C1: Information1
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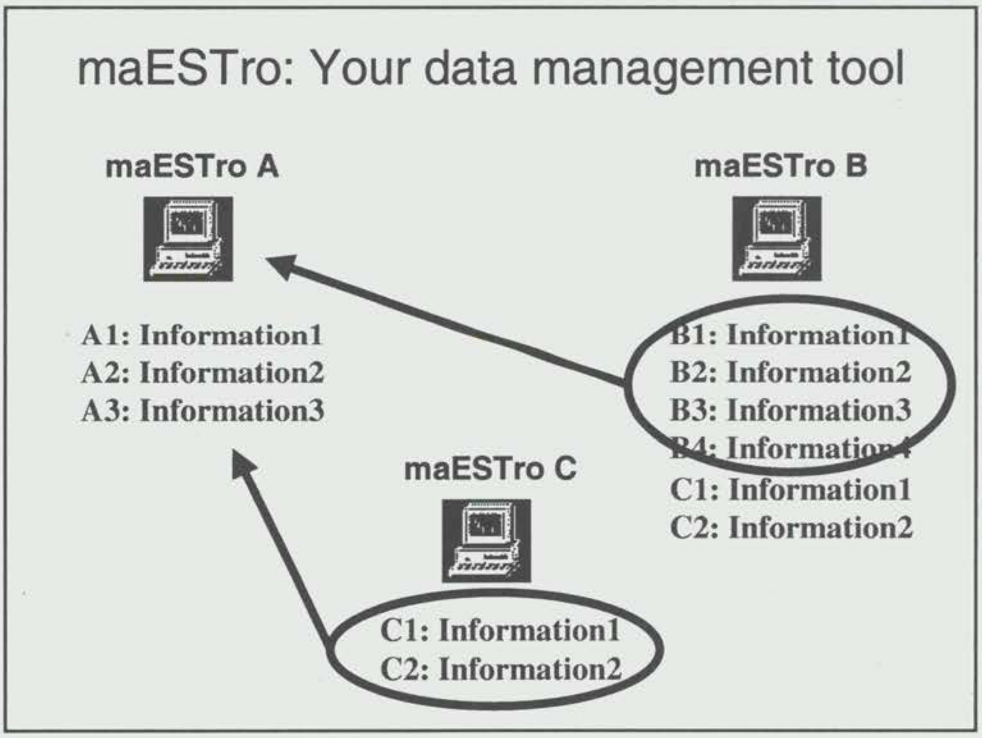
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C2: Information2

maESTro B

B1: Information1
B2: Information2
B3: Information3
B4: Information4
C1: Information1
C2: Information2

maESTro C

C1: Information1
C2: Information2

maESTro needs constant input

The more we get contribution,
the more you will get back information

SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT IN LATIN AMERICA

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To use appropriate technologies represents one of the basic elements to achieve solutions to the environmental problems that are generated by the combined processes of urbanization and industrialization, as well as for those that result from the agricultural activity and for the human establishments in the rural area.

Another essential aspect to understand and analyze the environmental problems is the one of using a holistic, intersectorial and multi-disciplinary focus, to be consequent with the principle of the indivisibility of the ecosystems, which are administered in an arbitrary way and manipulated by segments.

A third aspect to be considered in the solution of the environmental problems is the one that establishes the relationship among the ethical principles that sustain the Agenda 21, and its pragmatic application concerning the concept of sustainable development.

In attention to the three elements previously mentioned, we must act on the basis that the water resource is indivisible; it is finite and it is vital to sustain the existence in all the well-known ways of life, including the development processes designed to generate wealth, well-being and a better quality of life.

All societies, from the most primitive to the modern ones, have used and will always use the natural resources and its biodiversity to obtain food, shelter and to develop their productive activities.

The shortage and the competition for the natural resources and the biodiversity, in all the continents and in all the times in history, have generated conflicts and wars.

With the exponential increment of the demand that is stimulated by the demographic growth and the compulsive consumer marketing, it will be impossible to find the breakeven point that guarantees the sustainability of the development processes.

Investigating, promoting and developing integrated solutions to offer appropriate services of water supply, collection and treatment of wastewater and solid waste, of anthropogenics origin or generated by natural causes, represents a challenge and an unavoidable commitment for the Pan-American Health Organization and because of that with great satisfaction, we contribute with this meeting by presenting our ideas and experiences in order to help reach its objectives .

It is widely known that when it becomes possible to universalize the potable water supply services, the wastewater systems, including its treatment, and stormwater collection, the epidemic profile of Latin America will be very different from the current one.

Unfortunately there are still regions where child mortality and waterborne diseases have records that are incompatible with the advances that Science and Technology put at our disposition.

It is also observed with concern that 90% of the collected wastewater, domestic and industrial, are launched to water bodies without any treatment, creating a recurrent and accumulative contamination of these resources.

To develop the national capacities, emphasizing the necessity of combining the use of appropriate technologies, integral handling of the ecosystems and to promote the socially sustainable development of the environment, is a commitment that we all have to take to diminish the iniquities and to build a society with a bigger lasting perspective in time.

I - GENERAL ASPECTS

On behalf of the Pan American Health Organization, I extend our greetings to the organizers, IETC/UNEP and ABES-Rio, and to the delegates that have attended this meeting, where new approaches will be presented in designing, as well as experiences achieved in different points of the geography of the America, whose specific objective has been the one of achieving a sustainable administration of the systems of sewer systems that collect the wastewater and the stormwater from different populations.

That peculiar objective of achieving a sustainable administration of these systems, is just one of the elements that contribute to reach a higher objective that is the one of having health and quality of life for all the human beings.

The sustainable development in its anthropocentric and humanistic connotation, understands and enables that the man carries out his productive economic activity without causing irreversible damages to the ecosystems that sustain his activities.

It is also important to remember some information on the current situation of the demographic aspects and about the services of basic reparation, among which are the offered ones for the sewer systems, main object of the meeting.

Demographic situation

The population from Latin America is of 405 millions in the 2000. That indicates us that in the last 50 years all the utilities had to be multiplied by 3, on the average. In the rural areas (100 millions) there were no big changes in population growth, but in the urban areas, the situation is very different: we have arrived to 305 millions of people, meaning a growth of 4, 5 or more.

Potable water supply

The most recent data indicates that 90% of the urban population and 50% of the rural one have a water system. The problem is that the quality of the water is unknown and also there are no reliable information on the characteristics of the systems (pressure, continuity, losses, administration, etc.).

Nevertheless, it is clear that more than 130 millions of inhabitants of our countries still lack potable water at their homes.

The epidemic records show strong evidences on the adverse effects generated by the lack of water supply and for the insufficient disinfection of the supply services. The morbidity and the mortality caused by the cholera, the enteritis and by other pathogen agents transmitted by polluted water, generate in a recurrent way a high percentage of the expenses of the health systems in the whole continent.

Wastewater system and disposition

The figures on this aspect are very similar to those of the previous item. The added difficulty is that a population of around 200 million inhabitants, that is served by collection of wastewater, sees the sanitary sewage being thrown without treatment in the bodies of water that outskirts the urban perimeter. We are talking about more than 30 million cubic meters of daily polluted water, as much as chemically and organically, that are spread in our rivers, seas and lakes.

The challenge is to enlarge the covering and to use the different technologies to treat the wastewater, including its reuse for different productive activities.

Stormwater system

The situation of the stormwater systems is less known than the one that exists for water supply or wastewater services. As a general rule, the stormwater net is only a percentage of the sanitary net and the operation conditions and maintenance are very limited.

A popular definition establishes that strong tropical rains collaborate with the urban cleaning, by dragging the garbage gathered toward the stormwater system and then toward the bodies of water; the reality is that the obstruction of the systems increases and the streets themselves are the cause of the pluvial water, causing periodic floods in many cities.

Solid wastes

Reports indicate that around 70% of solid wastes are collected in urban areas and 50% of that total has a proper disposition system. The result is that more than 150,000 tons of daily garbage are disseminated in ravines, gulches, parks, rivers, sidewalks and in housings courtyards. That is the reason for the massive reinfestation of the *Aedes* *aegypti* and also the transmission of illnesses vectors transmitted, besides the depressing urban scenarios with tons of garbage in state of decomposition attracting more vectors.

Mortality Vs Reparation

In the Americas, some countries have a child mortality of, in average, more than 100 for each 1000 born alive. And in these and in other countries with a less depressing average, some areas have a mortality 2, 3 and 4 times bigger than that average.

When relating the covering of basic sanitation and the average of child mortality in the countries of the America one concludes that those with a limited have a higher child mortality and when the mortality is low there is a wider covering. It is obvious that other factors can impact in such behavior, but it is undeniable the historical importance that the sanitation has on the health, the well-being and the quality of the population's life.

The inequalities and iniquities in health, in which some countries of our region have an outstanding place, can be reduced by means of working on enlarging the covering and improving the quality of the services of basic sanitation.

II - TECHNOLOGY AND SUSTAINABLE MANAGEMENT

The next 8 sheets present the main elements that characterize an administration so that it has sustainability attributes in the environmental, operative and financial dimensions.

It is emphasized that the territorial basis of the sewerage systems is a hydrographic space denominated basin. And to make correct decisions it is necessary to have the best and biggest series of information related to that resource and of the factors that impact it.

The planning in that area should consider a wider participation of all elements that exist in the basin, independently of the administration pattern that is adopted, as well as of the different uses or demands that compete for the same resource. A detailed vision, added to the analysis of the different variables, using a similar methodological pattern, leads to the definition of one unique model for each basin, which has projections of wide impact among all the users.

The integrated handling of basins is not an exact mathematics formula; it is not a sophisticated engineering design; it is the appliance of ability and common sense in a space where different interests and different elements exist, each one with an important role and with different grades of interactions among themselves. Technology itself is a factor to be taken into consideration, but it necessarily should respond to the demands and cultural and financial possibilities of their users and not on the other way around.

The main attributes of the proposed outline, point toward the necessity of a multi-disciplinary and intersectorial management, promoting the strengthening of the consulting and articulation mechanisms and of articulation in every area where it applies.

consulting and articulation mechanisms and of articulation in every area where it applies.

The projects to be developed should contain objectives, goals and indicators of clear results, in which the engineering component should be supported by the application of technologies with the attributes of serving faithfully the population and their real possibilities.

The CEPIS, specialized center in this matter has in its site www.cepis.org.pe information about multiple experiences, as well as publications with valuable information gathered in different places of the world, which are in each representation of the PAHO/WHO, to facilitate you, delegate friends, in each one of its respective countries.

Appropriate Technology

1- Solves specific problems.
2- Adaptable and applicable in the social, cultural and financial areas.
3- Easy operation and maintenance.
4- Total sustainability.

Holistic Focus on Sustainability (Agenda 21)

1- Intersectorial.
2- Multidisciplinary.
3- Pragmatic.
4- Trustable information.
5- Mechanisms of articulation.

Watershed Management

1- Human settlements.
2- Basis for territorial management.
3- Balance: demands x offers.
4- Sustainable space.

Resources Management

1- Planned processes function (intelligents).
2- Monitoring database.
3- Political and social control of the market.
4- Planning with clear goals and result indicators.

Complete Design

1- More than pure Engineering.
2- Flexible norms and criteria.
3- New equipment and material.
4- External variables.
5- Continuos cycles.

Experiences

1- Use of PVC.
2- Condominial sewage.
3- Integrated watershed management.
4- Community participation.
5- APA-PAM.

Essential Elements

1- Training/Development of human resources.
2- Applied research.
3- Sustainable development management.

Vision of the Future

1- Watershed systems.
2- Water and sewage services to all.
3- Elements of a complete system.
4- Sludge, agriculture, development and sustainability.

DISCUSSIONS

Augusto Sergio Guimarães - "I guess it would be very good for us from so many countries to hear from you some sort of assessment on the progress being achieved by the sanitation coverage in this continent, Central and South America."
Ivan Estribi - "The World Health Organization together with UNICEF set up an evaluation of the water supply and wastewater coverage for all the world. They analyzed not only the coverage water situation but also the characteristics of this coverage; not only the water quality but also the continuity and the quantity per person. Let us not forget that this is the decade when cholera returned, after having been eliminated more than 150 years ago.
The situation of the water and sewage utilities was also evaluated, considering that this is the decade of privatization in mostly all countries. "

Eugenio Barrios (Mexico) - "I have a doubt about the correlation between sanitation and the death rate. In case of Cuba, we have seen that sanitation is not efficient, but in spite of that, child mortality is very low. We have all assumed that there is direct correlation between the protecting human health and wastewater treatment. Because of that, would you say that there is another way ? "
Ivan Estribi - "Yes. In Cuba about 100% of the population have access to medical care, vaccines and sanitary education. This is a complementary tool to make good use of the services. That is exactly what happens in Canada, United States, Chile, Uruguay and Costa Rica, the five countries in the Americas with the lowest child mortality rate."

ALTERNATIVE TECHNOLOGIES FOR WASTEWATER MANAGEMENT

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ABSTRACT

A range of technologies for on-site wastewater management, for collection of wastewater, its treatment, reuse and disposal is available. A number of these will be highlighted: On-site wastewater management technologies (Pit latrine, Composting toilet, Pour flush toilet, Septic tank, Improved on-site treatment units), Collection of wastewater (Deep sewerage, Simplified sewerage. Settled sewerage), Wastewater treatment, Activated sludge, Trickling filtration, Lagoons, Land-based treatment, Constructed wetland, Anaerobic treatment), Wastewater reuse (Agriculture, Aquaculture, Industry) and Sludge treatment and reuse.

Systematic decision making tools for selection of technology are available ranging from a simple flowsheet to more complex computer programs. Scenarios for sound practices of technology will be used to illustrate a range of possible applications of technology that take into account environmental, economic and other factors.

KEYWORDS

Technology options, wastewater, selection, sound practices

INTRODUCTION

In this paper technologies for collection, treatment, reuse and disposal are described in very general terms, so that options for the different local environmental, economic and social contexts can be evaluated. The description is not meant to be exhaustive, but to enable the scientific basis of the technologies to be understood. The relationship between processes in highly engineered systems and natural purification processes is presented wherever possible, so that simple engineered systems that are more akin to natural systems can be appreciated. Sludge is produced from treatment systems, and its treatment, reuse and disposal is also discussed. Natural purification processes are described in my paper 'Technology choice and sustainable wastewater management', so this paper has to be read in conjunction with it.

Sound technology practices are reviewed in the context of environmental, economic and social conditions of a community. The criteria for selection of technology are described in my paper 'Criteria for evaluation of technology for wastewater and stormwater management' This paper is also based on UNEP IETC's International Source Book on Environmentally Sound Technologies in Wastewater and Stormwater Management.

1 - WASTEWATER COLLECTION

Wastewater sewerage systems can be classified into three major types: 1. Conventional sewerage, 2. Simplified sewerage and 3. Settled sewerage

(a) Conventional sewerage

Conventional sewerage is also termed deep sewerage. This term results from the fact that in actual practice the sewerage pipes are laid deep beneath the ground. There are a number of reasons for the relatively great depth of the pipes. A minimum velocity is needed to ensure that self-cleansing conditions occur at least once daily (usually 0.75 m/s). Combined with a minimum specified diameter (usually 150 mm internal diameter), the outcome is the requirement of steep gradients for the pipes. Added to this is the specification for a minimum depth of buried pipes to avoid interference with road traffic and other services (minimum of 0.9 to 1.2 m). Main sewerage trunks are therefore generally quite deep if gravity is relied upon as the driving force for flow.

Pumping is generally required at various stages of the sewer pipe network, especially if the landscape is fairly flat. The larger the population served by the sewerage system, and the longer the planning horizon is to cope with future population increases, the larger the diameter of the final pipes becomes. The costs of the pipes, inspection manholes, pumps and pumping stations and their construction/installation are therefore high. The costs of operation and maintenance are correspondingly high.

The design procedure for conventional sewerage is well developed from its early beginnings in the provision of sewerage in the city of London and other European cities. It is now acknowledged that the design procedure for the conventional sewerage is based on very conservative assumptions.

(b) Simplified sewerage

Simplified sewerage is also known as shallow sewerage. Again the term reflects the nature of the shallower placement of the pipes in contrast to the conventional or deep sewerage. The purpose of simplified sewerage is to reduce the cost of construction and the corresponding cost of operation and maintenance. Simplified sewerage is designed based on hydraulic theory in the same manner as for conventional sewerage. Its design assumptions are, however, less conservative. Smaller diameter pipes are used when water use per person is known to be less. Minimum depth of cover of pipes can be as low as 0.2 m when there is only light traffic. Manholes can be replaced by inspection cleanouts because of the shallow pipes. Design planning horizon can be 20 instead of 30 years, because population projection may be uncertain. In a variation of the simplified sewerage the pipe layout passes through property lots (condominial) rather than on both sides of a street (conventional). Figure 1 shows a comparison between sewerage layout in conventional sewerage and in condominial sewerage, while Table 1 shows a comparison of length of pipes required. Cost of construction can be 30 to 50 % less than conventional sewerage depending on local conditions.

Figure 1 . Pipe layout for (a) conventional and (b) condominium sewerage

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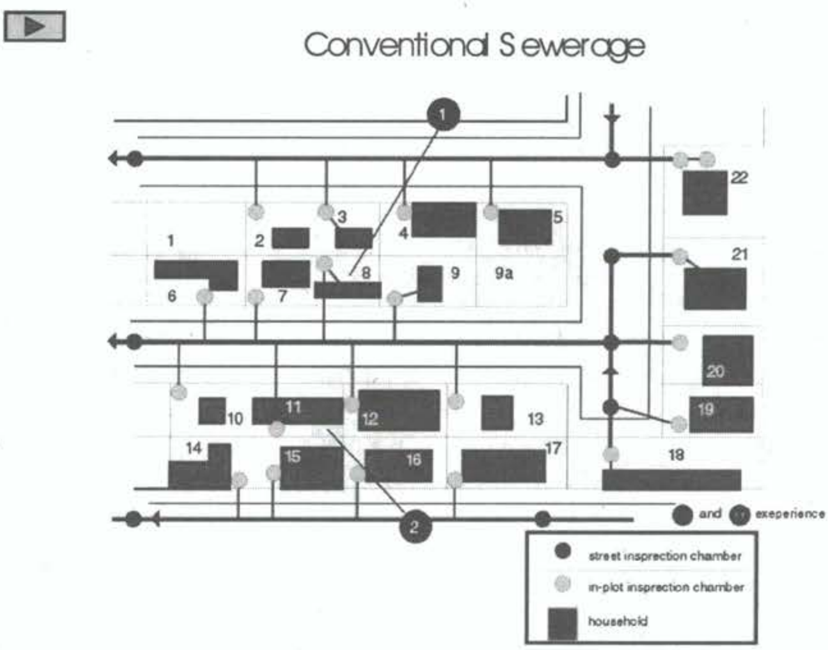

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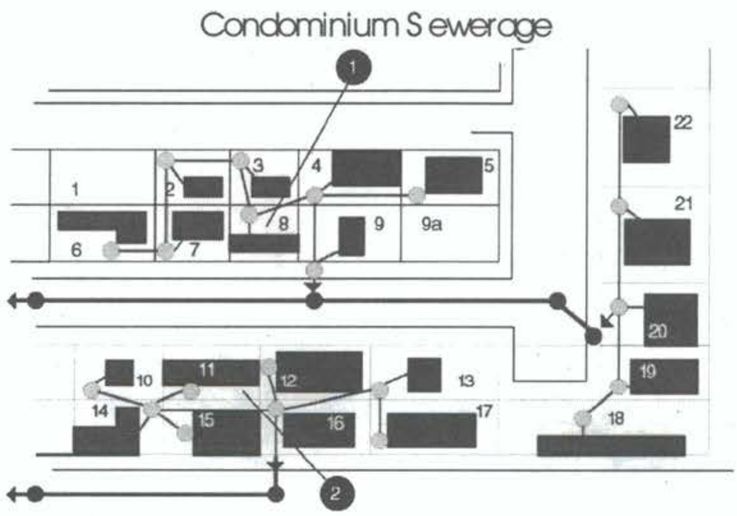

Table 1 . Comparison of length of pipes required for conventional and condominium sewerage

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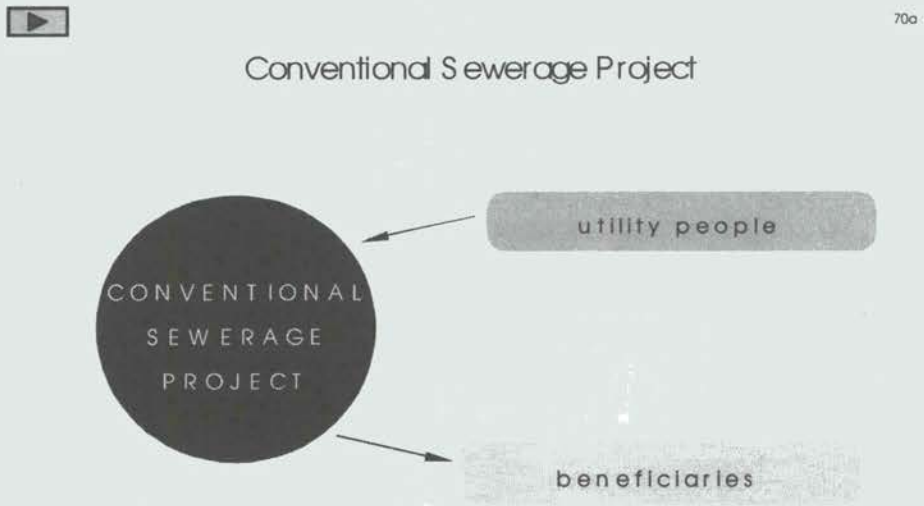
Condominium vs Conventional Sewerage System

LAYOUT	ON SITE PIPES/ HOUSEHOLD (m)	HOUSING CONNECTIONS/ HOUSEHOLD	SEWERAGE HOUSEHOLD (m)
1. Conventional	0.9	9.9	12.8
2. Condominium	2.5	10.9	6.0

Shallow sewerage is also conducive to local community participation. This is because of sewer pipes having to cross property boundaries and hence the need for the community to agree to this arrangement. This arrangement needs to be in place not only during construction, but also for maintenance (e.g. unblocking of sewer pipes). The shallow pipe, and hence the shallow trenches, also allow members of the community to participate by for example providing labour for digging the trenches. This is in contrast to conventional sewerage where specialised machinery is required for the deep trenches. Figure 2 contrasts the two approaches.

Figure 2.Contrast in community participation between conventional and condominial sewerage



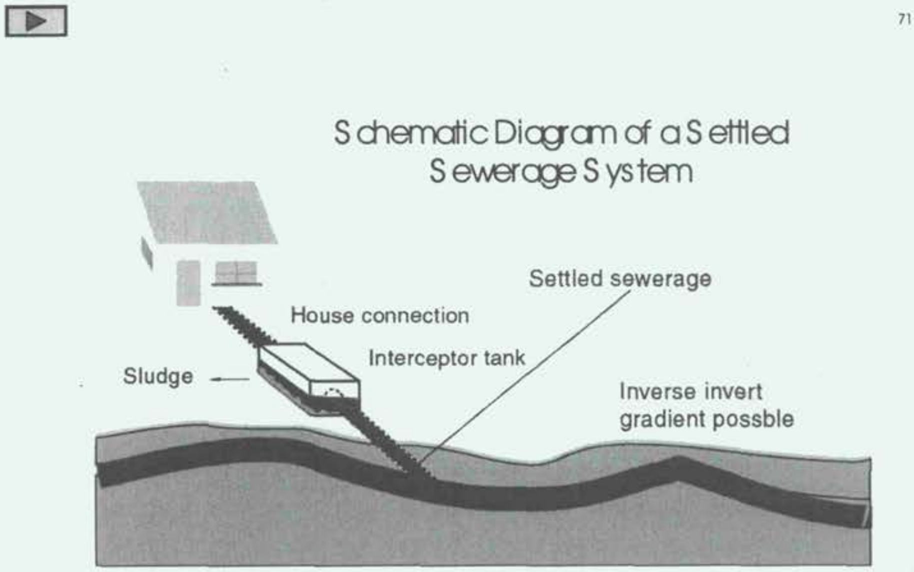
There has been considerable experience with simplified sewerage particularly South America and manuals have been produced to assist engineers with its design. Developed initially in Brazil it has been used in many parts of the world.

(c) Settled sewerage

Settled sewerage refers to sewerage for conveying wastewater that has been settled, for example in a septic tank. The origin of settled sewerage is to convey overflow from septic tanks where the soil cannot cope or absorbed the overflow. This usually occurs when the groundwater table is high, or where the soil permeability is low, or where there are rock outcrops. It can also be used when effluent from septic tanks pollutes groundwater and it is necessary to convey the effluent off-site and treat it. Because there are no solids that can potentially sediment in the sewerage pipes, there is no requirement for the self-cleansing velocity. Smaller pipes and lower gradients can be used. The cost of settled sewerage is between a third and a half of conventional sewerage. Originally developed in South Australia to overcome problems with failing septic tanks, it has been used quite widely worldwide to upgrade septic tank systems.

Where there is no existing septic tank, an interceptor box or tank can be used. It functions like a septic tank and designed in the same way (Figure 3). To reduce cost the wastewater from a group of houses can be connected to one interceptor tank. Just like in a septic tank, accumulation of sludge has to be removed regularly from an interceptor tank.

Figure 3 . Interceptor tank in settled sewerage



2 - WASTEWATER TREATMENT

Treatment of wastewater and stormwater means the removal of pollutants from the water. The first principle to bear in mind therefore is to prevent pollutants from entering the water in the first place. Separating collection of wastewater and stormwater belongs to this principle. Treatment of industrial wastewaters before discharge to the sewer is highly important in this regard.

In the case of wastewater, separating blackwater and greywater can mean less energy is required in treatment. This is because blackwater contains most of the solids, which during treatment have to be removed from the mixture. Further separating urine and faecal materials may also mean that the urine can be reused without much treatment and the faecal materials can be more simply treated. The use of water to convey toilet wastes may be questioned based on this principle, because treatment means separating these wastes from the water.

Besides preventing pollutants entering the water, water conservation means that less volume of water has to be treated. Since the size of treatment systems is primarily governed by the volume of water to be treated rather than the amount of pollutants in the water, less volume means smaller treatment plants and corresponding capital cost. Use of less water to flush toilets belongs to this principle.

A range of wastewater treatment technology options is presented below. Treatment of wastes on-site is considered first, followed by off-site treatment of the wastewater.

2.1 On-site wastewater treatment systems

On-site treatment relies on decomposition of the organic wastes in human excreta by bacteria. This can take place in a simple pit in the ground or in specially designed tanks to promote the bacterial decomposition of the wastes. Unless re-use of the wastewater is specifically intended, the overflow from the pit or tank is allowed to soak into the ground. Further bacteriological decomposition and soil filtration, adsorption and purification processes take place. Potential of groundwater pollution, however, exists with on-site treatment and disposal systems, because not all pollutants (e.g nitrate) are removed by these processes.

Pit latrine, pour flush latrine, composting toilet, septic tank and two improved on-site treatment units are described because they represent major types of on-site treatment systems.

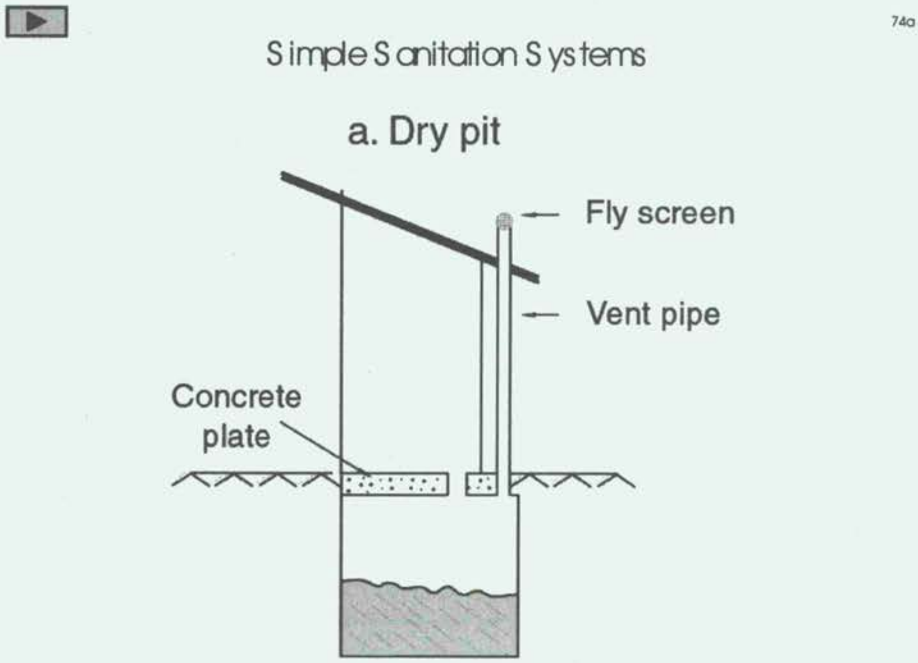
(a) Pit latrine

A pit latrine collects excreta in a pit dug in the ground beneath the toilet structure. If the soil is loose the pit needs to be lined with, for example, loose bricks to prevent the wall from collapsing. During storage in the pit decomposition of the organic substances takes place under anaerobic conditions. The anaerobic decomposition releases gases (carbon dioxide and methane) and reduces the volume of sludge.

Seepage of water into the surrounding soil takes place through the sides and bottom of the pit. During seepage further decomposition of organic matter by soil bacteria takes place reducing the BOD of the water. There will also be die-off of bacteria and viruses during storage and as the water percolates through the soil. Nutrients are generally not removed by bacteria under these conditions, so pollution of groundwater will occur.

Control of odour and insects are important with a pit latrine. This is achieved by having a vented pit that extends at least 1 m above the toilet housing (Figure 4). The vent acts to draw odour and insects into the pit and up the vent. Gases (methane and carbon dioxide) produced by the decomposition of the excreta also leave through the vent. Natural convection can be assisted by facing the vent towards the sun and painting the vent black to maximise absorption of heat from the sun. The heated air in the vent rises and draws air from the toilet. Ventilated improved pit (VIP) toilets are widely used in Africa.

Figure 4 . Ventilated Improved Pit latrine



Pit latrines pose problems when groundwater is shallow and the pit is in groundwater or close to it. There is no soil barrier to protect the water quality of the groundwater, and mosquitoes may breed inside the pit. A pit is also difficult to dig when the ground is rocky. Pit latrines should not be used in these cases.

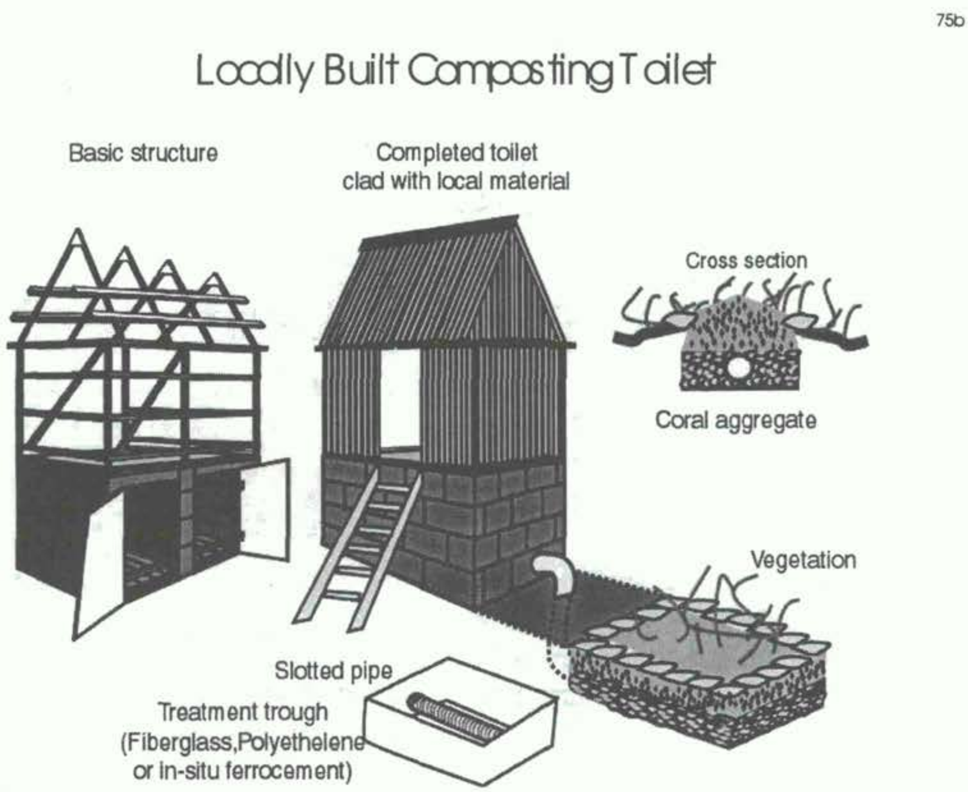
The pit will eventually fill with faecal sludge and needs to be emptied. The period between emptying depends on the size of the pit and its usage. It is desirable to design the pit to store at least one year of sludge production. Emptying requires mechanical suction of the sludge. Two adjoining pits can be used alternately. Further decomposition of sludge in a full pit takes place while the adjacent pit is in use. Its content after further decomposition can be manually removed.

An alternative way of dealing with a full pit is to dig another pit and relocate the sanitary platform and toilet housing to the new pit. The full old pit can then be covered with soil, preferably of greater than 15 cm depth to prevent disease vectors (rodents and insects) from burrowing into it.

(b) Composting toilet

Rather than decomposition of the faecal sludge under anaerobic conditions (no oxygen) in the pit of a pit latrine, decomposition under aerobic conditions (with oxygen) can be promoted in an above ground (elevated) latrine (Figure 5). Air can be introduced through an opening to pass through the sludge and exit through the vent, while excess liquid is allowed to drain for collection or evaporation. With two adjoining composting chambers or vaults used alternately, the process of composting in an already full chamber can be allowed to proceed until the chamber is to be used again, and produce mature compost for direct re-use in the garden. Other household organic wastes (e.g. food wastes) can be added to the faecal sludge, and materials such as newspaper or sawdust can be added to balance the carbon to nitrogen ratio for optimal composting. Because mature compost takes several months to produce under ambient temperatures, it is desirable for the chambers to be sized to hold at least 6 months of wastes. Worms can also be added to assist with vermi-composting.

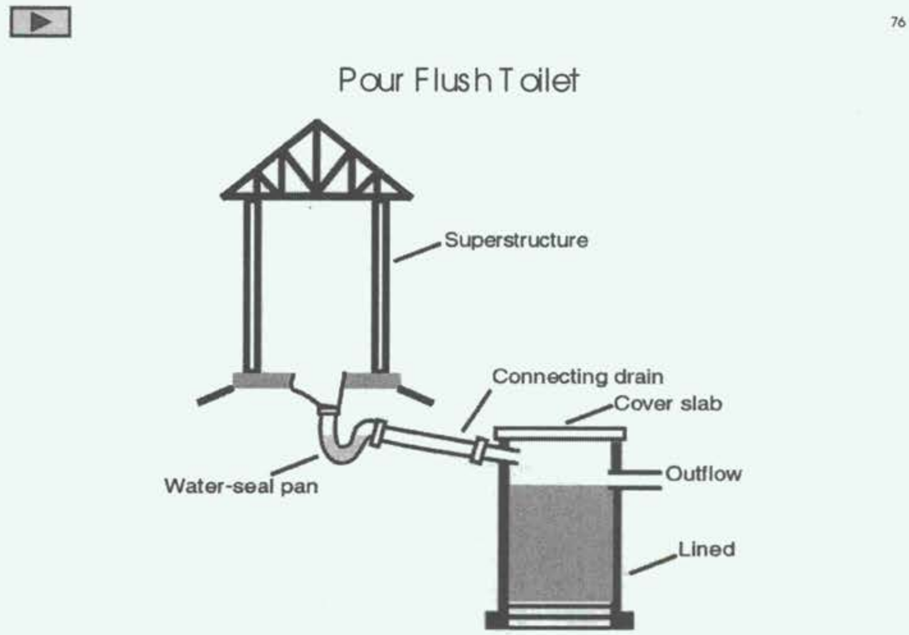
Figure 5 . Composting toilet



(c) Pour flush toilet

A pour flush toilet (Figure 6) has a water seal. The problems associated with odour and insects are avoided by having the water seal.

Figure 6 . Pour flush latrine pan



Excreta deposited in the latrine pan is flushed by pouring 2 to 3 L of water into it. The mixture is directed into a pit in the same way as for a pit latrine. The processes of biodegradation of the organic wastes in the pit are exactly the same. More water percolates through the soil surrounding the pit, and the potential for groundwater pollution is higher. A pour flush toilet with a pit is therefore not suitable when groundwater table is close to the surface.

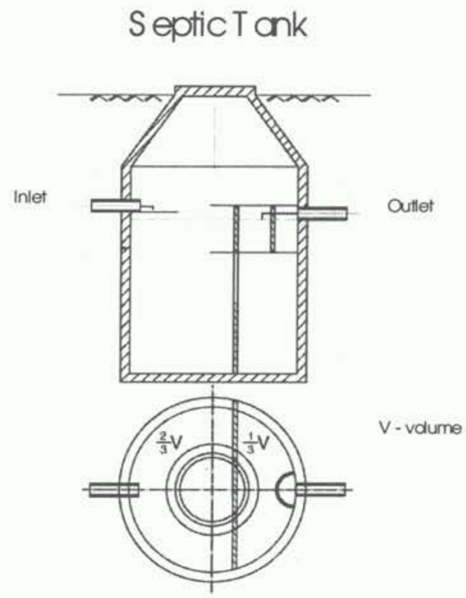
Sludge has to be regularly emptied from the pit. The use of two adjoining pits alternately enables the sludge in a full pit to undergo further decomposition while the other pit is being used, and enables manual sludge emptying after further sludge decomposition.

With the use of the pit latrine, composting toilet and pour flush latrine, greywater (sullage) has to be separately treated. Greywater can be reused directly or after treatment. Disposal of greywater on-site is by use of a leach pit or trench (See below under Septic tank). Limitations of disposal of greywater by leach pit or trench are similar to those applicable to septic tank.

(d) Septic tank

A septic tank is a water tight tank, usually located just below ground, and receives both blackwater and greywater (Figure 7). It can be used with pour flush toilets or cistern flush toilets. It functions as a storage tank for settled solids and floating materials (e.g. oils and grease). The storage time of the wastewater in the tank is usually between 2 and 4 days. About 50 % removal of BOD and Suspended Solids (SS) is usually achieved in a septic tank due to the settling of the solids during wastewater storage.

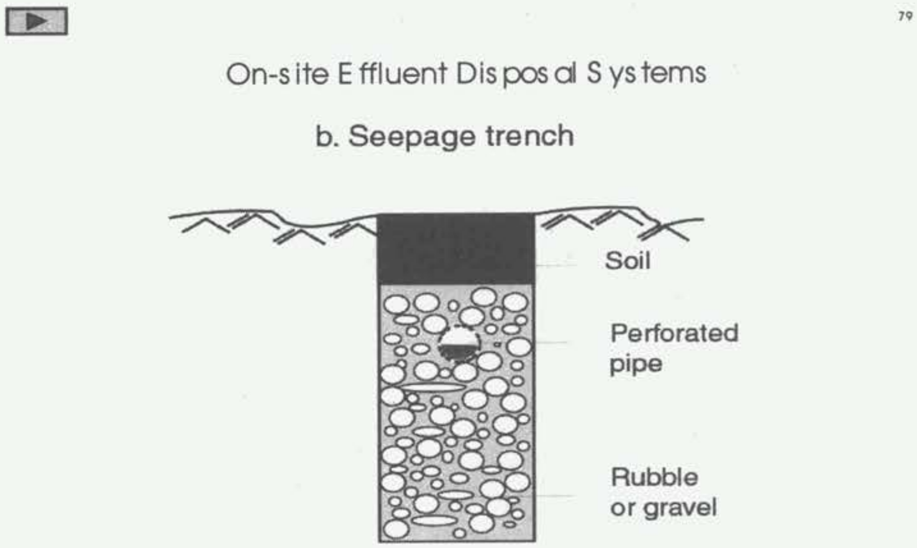
Figure 7 . Septic tank



A septic tank can be constructed of bricks and mortar and rendered, or of concrete. Its shape can be rectangular or cylindrical. A septic tank can be partitioned into two chambers to reduce flow short circuiting and improve solids removal.

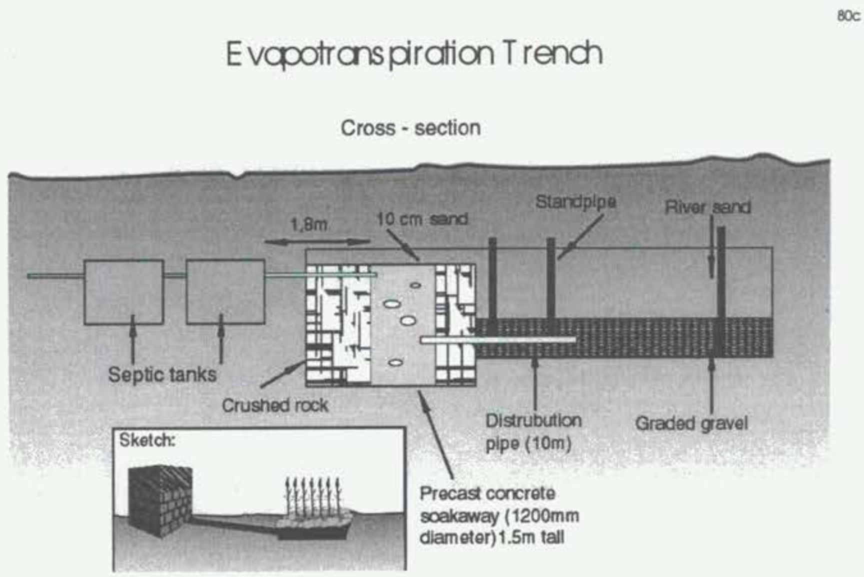
The overflow from a septic tank is directed to a leach pit or trench. A leach pit is similar to the pit of a pit latrine or pour flush latrine. The pit must be sized to allow percolation of the volume of wastewater generated. A pit works well in soils with high permeability. In soils with lower permeability a trench can provide the larger surface area of percolation (Figure 8). The trench is usually filled with gravel and a distribution pipe for the wastewater is placed in this gravel layer. Soil is then placed above this gravel layer to the ground surface.

Figure 8. Leach trench for disposal of septic tank effluent



A leach pit or trench does not work when the soil permeability is too low (e.g. clayey soil or hard rock). In regions where annual evaporation is high, trees and shrubs can be used to help pump the water into the atmosphere by evapotranspiration. An evapotranspiration trench can be designed similar to a leach trench, but a suite of suitable local vegetation species tolerant of high nutrients and water are planted above and surrounding the trench (Figure 10). The trench should be sized to store water during the rainy season or low evaporation periods.

Figure 9. Evapotranspiration trench.



A leach pit or drain does not work either when the groundwater table is close to ground surface. In this case off-site disposal is necessary using a settled sewerage system. If the groundwater table is not too close, an inverted leach drain (described below Improved On-site Units) can be used.

The organic solids in a septic tank undergoes anaerobic bacterial decomposition just as in the pit of a pit latrine. The sludge needs emptying, and the period between emptying is usually designed to be between 3 to 5 years. The sludge has to be further treated before reuse or disposal.

The septic tank overflow undergoes further bacterial decomposition as it percolates through a leach pit or trench. The decomposition is undertaken by soil bacteria, usually under aerobic conditions. The BOD of the wastewater can reach a low figure (<20 mg/L) if the distance between the bottom of the pit or trench to the groundwater table is greater than 2 m. Nutrients are not significantly removed by the bacteria and usually pollute the groundwater. Pathogenic bacteria are removed by die-off or filtration by the soil, but viruses may travel further in the soil or groundwater.

Percolation of septic tank overflow is much slower compared to rainwater percolation. This is because a layer of bacterial slime grows on the surfaces of the soil particles, restricting flow. Two leach pits or trenches used alternately, say every 6 months, are better than a single leach pit or trench of the same total area for percolation, because as one is used the other will recover its percolation rate.

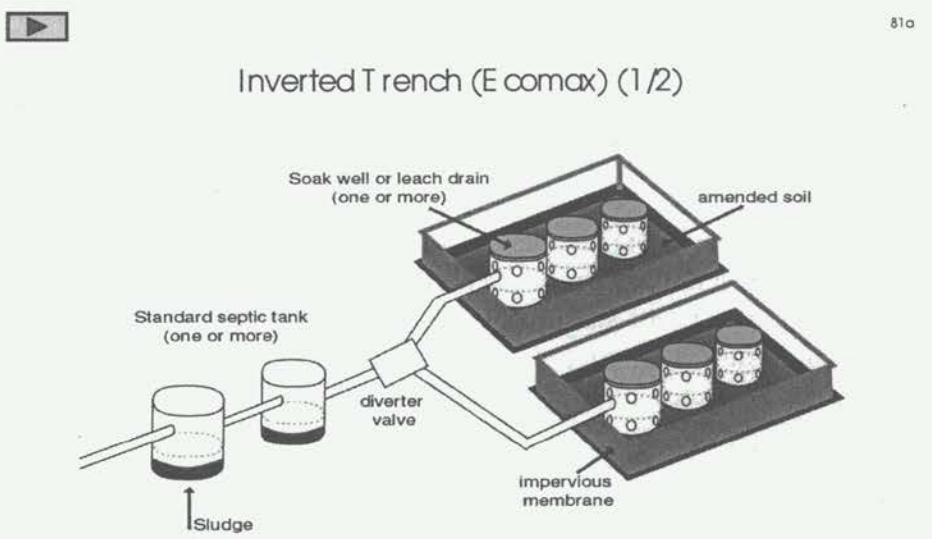
2.2 Improved on-site treatment units

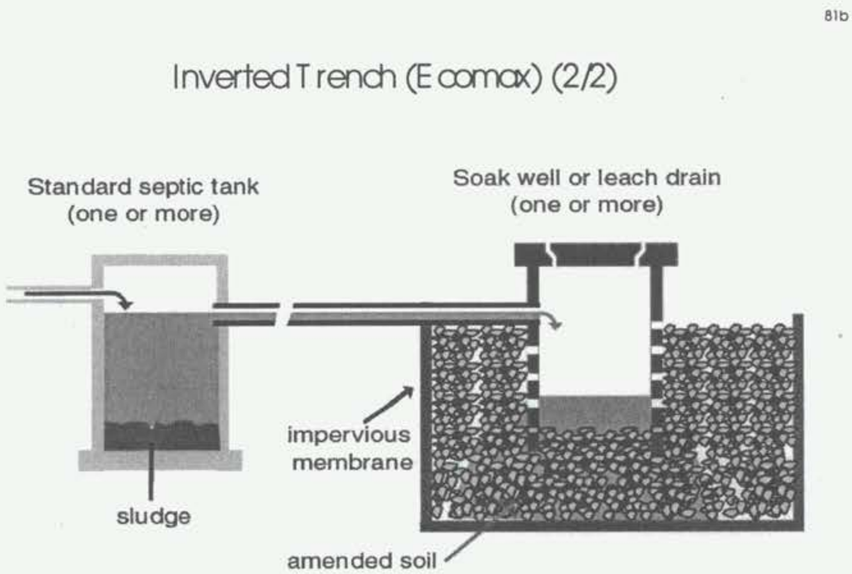
Improved on-site treatment units refer to treatment units which improve the performance of one of the above on-site systems, for reducing BOD, SS and/or nutrients. Two designs are described to illustrate the main principles used. A principal aim of the improvements is to prevent groundwater pollution or enable water reuse of the treated wastewater on-site. Many designs are available using similar principles. A number of these are described in detail in the Regional Overviews, where these units are used.

(a) Inverted trench

In the system illustrated in Figure 10 the trench of the septic tank is underlain by a plastic or impermeable liner. The liner is filled with sand or a fairly permeable soil. Overflow from the septic tank is introduced at the base of the sand layer. It flows up through the sand layer and flows over into the surrounding soil. The sand layer acts as a slow sand filter, where bacteria growing on the surfaces of the sand particles degrade the organic substances to reduce BOD. Because of the fluctuating flow of wastewater with peak flows in the morning and in the evening, the upper region of the sand layer alternates between aerobic and anaerobic conditions. Under these conditions a significant part of nitrogen in the wastewater can be removed by nitrification (bacterial conversion of ammonium in the wastewater to nitrate under aerobic conditions) and denitrification (bacterial conversion of nitrate to nitrogen gas under anaerobic conditions). In addition if materials that can remove phosphate are mixed with the sand, phosphorus in the wastewater is also removed. One material, that has been found to remove phosphate effectively with a capacity for phosphorus removal for several years, is bauxite refining residue (red mud).

Figure 10 . Inverted trench (Ecomax)

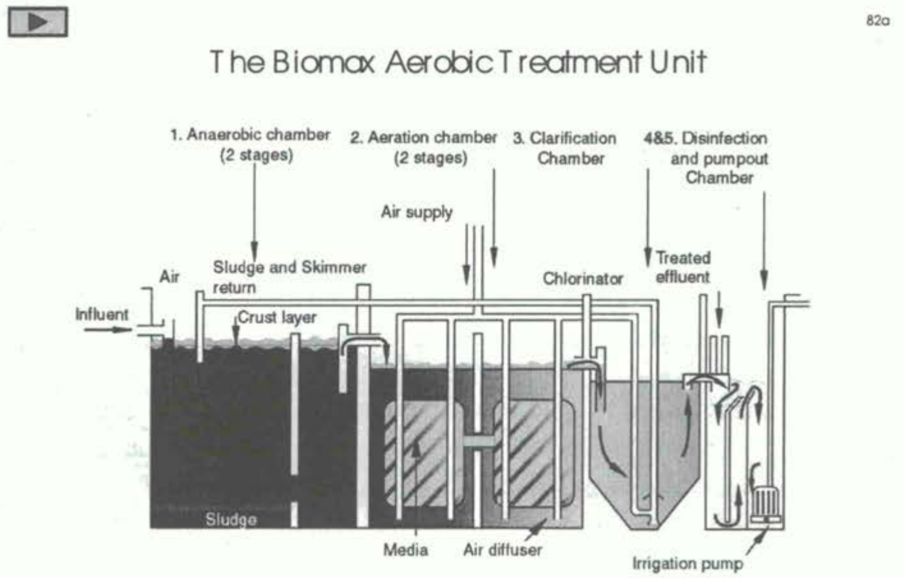




(b) Aerated treatment unit

An aerated treatment unit consists of a tank similar to a septic tank. The tank is partitioned into four compartments (Figure 11). The first compartment receives the wastewater and acts as a sedimentation tank for solids. The overflow from the first compartment goes to an aeration compartment. The aeration compartment is fitted with corrugated plastic sheets to enable bacteria to attach. The aeration supplies oxygen to the bacteria decomposing the organic matter in the wastewater thus reducing its BOD. After aeration the wastewater passes to a third compartment which acts as a second sedimentation tank. Sludge from this second sedimentation tank is pumped to the first compartment for storage. After sedimentation the wastewater overflows to a fourth compartment for storage and pumping, usually for irrigation of garden beds. If required, chlorination is applied by inserting chlorine tablets in the pipe between the third and fourth compartments. Chlorination is required when the treated wastewater is irrigated by sprinklers. Sub-surface irrigation is preferable, because it does not require chlorination.

Figure 11 . Aerated treatment unit (Biomax)



Power is required for aeration and pumping. For a system serving a household of up to 10 persons, the power supply rating needed is 100 W (2.5 kWh per day). This on-site unit is a miniature of an activated sludge treatment plant usually used for centralised treatment. One difference is that surfaces are provided in the aeration tank to retain bacteria during peak flows. The other difference is that sludge from the second sedimentation tank is returned to first tank for storage.

2.3 Off-site wastewater treatment systems

Off-site treatment is the treatment of wastewater that has been conveyed using a sewerage system. Activated sludge treatment is now considered the conventional means of large-scale off-site treatment of sewage, and is described first. Trickling filtration is an alternative that was developed earlier than the activated sludge process, and this is described next. There have traditionally been other more simple, but as effective methods of treating sewage. These include the use of ponds or lagoons, land-based treatment (sewage farming), and aquaculture. The first two are described in this section, while aquaculture is described under wastewater reuse, because wastewater is generally treated first prior to aquaculture.

Several general principles common to treatment systems will be discussed first. The main aim of treatment is to reduce biochemical oxygen demand (BOD) and suspended solids (SS) to acceptable levels. This is achieved by removing solids and aerating the wastewater to satisfy the oxygen demand of the wastewater. The different treatment systems achieve the removal of solids and in providing oxygen in different ways. It should be noted that if the systems are properly designed, constructed, operated and maintained, they should all achieve the required standard of treatment. The latter is generally a reduction of BOD to less than 20 mg/L, and SS to less than 30 mg/L.

Nutrients (nitrogen and phosphorus) may need removal if the wastewater is discharged to water environments sensitive to enrichment by nutrients. Heavy metals and other pollutants are not generally a problem unless the sewerage system receives industrial discharges. In this case treatment of industrial wastes prior to discharge to the sewerage system is the solution of this problem.

Removal of SS and BOD produces sludge, and the sludge has to be treated prior to reuse or disposal. Anaerobic treatment has recently been suggested for wastewater. The main reason for the use of an anaerobic process is the recovery of energy (in the form of methane) from the wastewater for explanation of the anaerobic process). The upflow anaerobic sludge blanket process is described at the end of this section.

(a) Activated sludge treatment

The term 'activated sludge' refers to sludge in the aeration tank of an activated sludge treatment process. It consists of flocs of bacteria, which consume the biodegradable organic substances in the wastewater. Because of its usefulness in removing organic substances from wastewater, the sludge is kept in the process by separating it from the treated wastewater and re-circulating it. A typical arrangement of an activated sludge process is schematically shown in my paper 'Criteria for evaluation of technology'.

Wastewater entering an activated sludge treatment plant is usually passed through a bar screen to remove gross materials such as napkins, rags and other materials which may damage mechanical equipment further down the treatment plant. The bar screen consists of vertical bars separated by a distance of about 1 cm. Screened solids are continually scraped off the bars. The screenings can be landfilled or incinerated.

Sand and similar heavy particles are removed next in a grit chamber. This chamber can be aerated to separate these particles from other suspended solids. The wastewater spends a relatively short period in the grit chamber (in the order of minutes). The sedimented sand and grit is usually landfilled.

The finer solids are removed in a settling or sedimentation tank, where the wastewater spends of the order of an hour to allow the solids to settle or float. The mechanical removal of solids as described above is usually called 'primary treatment', the sedimentation tank as primary sedimentation tank, the overflow from the sedimentation tank as primary-treated wastewater (primary effluent) and the sludge produced as primary sludge.

The primary-treated wastewater is then passed to an aeration chamber. Aeration provides oxygen to the activated sludge and at the same time thoroughly mixes the sludge and the wastewater. Aeration is by either bubbling air through diffusers at the bottom of the aeration tank, or by mechanically agitating the surface of the water.

In the aeration tank the bacteria in the activated sludge consume the organic substances in the wastewater. The organic substances are utilised by the bacteria for energy, growth and reproduction. The wastewater spends in the order of a few hours in the aeration chamber before entering a second sedimentation tank to separate the activated sludge from the treated wastewater. The activated sludge is returned to the aeration tank. There is an increase in the amount of activated sludge because of growth and reproduction of the bacteria. The excess sludge is wasted to maintain a desired amount of sludge in the system. This part of the treatment process is called 'secondary treatment', the sedimentation tank as secondary sedimentation tank, the overflow from the sedimentation tank as secondary-treated wastewater (secondary effluent) and the excess activated sludge as secondary sludge.

An activated sludge treatment plant is a highly mechanised plant, and is suited for automated operation. The capital cost for building such a plant is relatively high. The energy requirement, particularly for providing air to the aeration tank, is also relatively high. There is a need for regular maintenance of the mechanical equipment, which requires skilled technical personnel and suitable spare parts. The operation and maintenance costs of an activated sludge treatment plant are therefore relatively high.

An activated sludge treatment process can be operated in batches rather than continuously. One tank is allowed to fill with wastewater. It is then aerated to satisfy the oxygen demand of the wastewater, following which the activated sludge is allowed to settle. The treated wastewater is then decanted, and the tank is filled with a new batch of wastewater. At least two tanks are needed for the batch mode of operation, constituting what is called a 'sequential batch reactor (SBR)'. SBRs are suited to smaller flows, because the size of each tank is determined by the volume of wastewater produced during the treatment period in the other tank.

(b) Trickling filtration

A trickling filter is a bed of solid media for bacteria to attach on its surfaces. Wastewater is irrigated on the solid media (Figure 12). It is also called a biological filter to emphasise that the filtration process is not mechanical straining of solids, but removal of organic substances by use of bacterial action.

Figure 12. Schematic diagram of a trickling or biological filter

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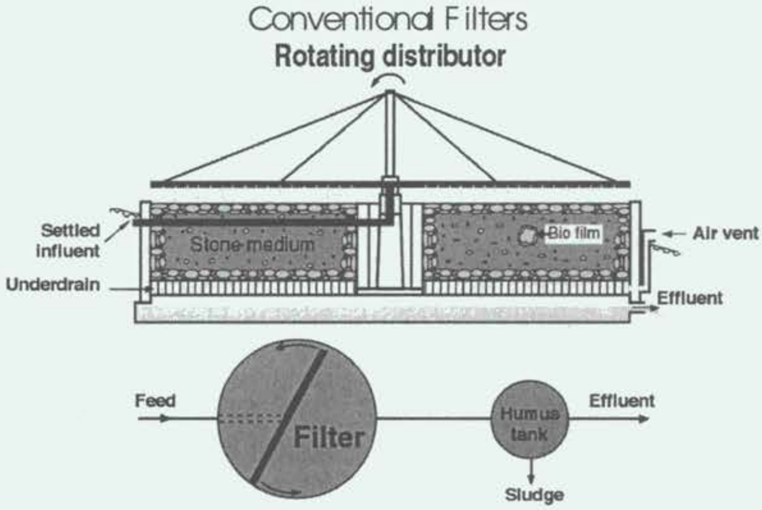


The solid media can be stones, waste coal gravel or specially manufactured plastic media. The latter can be corrugated plastic sheets or hollow plastic cylinders, with the main aim being to provide a large surface area for bacteria to attach to, while at the same time allowing free movement of air. Typically the solid media is placed in a tank on a support with openings to allow air to move up by natural convection and for treated wastewater to be collected in the under-drain.

Wastewater has to undergo primary treatment before trickling filtration, otherwise solids will block the filter. As wastewater trickles over the surfaces of the solid media organic substances are trapped in the layer of bacterial slime. The organic substances are consumed by the bacteria in the same manner as in the activated sludge process, while air diffuses into the slime layer from the air spaces in the bed of the trickling filter. Growth and reproduction of the bacteria take place and result in an increase of thickness of the slime layer, particularly at the top of the biological filter. Periodically bacterial slime sloughs off the surfaces of the filter media and leaves with the treated wastewater.

Solids derived from the sloughing off of bacterial slime are separated from the treated wastewater in a sedimentation tank. Sludge from this sedimentation tank is not returned to the trickling filter, but treated prior to reuse or disposal. Treated wastewater can however be returned to the trickling filter, if this will assist with either treating the wastewater further (second pass) or more generally for a more uniform distribution of water over the trickling filter bed. The trickling filter and associated sedimentation tank is also termed 'secondary treatment'.

The energy requirement for operating a trickling filter is less than for an activated sludge process, because oxygen supply to the bacteria is provided by natural diffusion of air. The area requirement of a biological filter is, however, larger than for an activated sludge process to achieve the same quality of treated wastewater.

(c) Lagoons

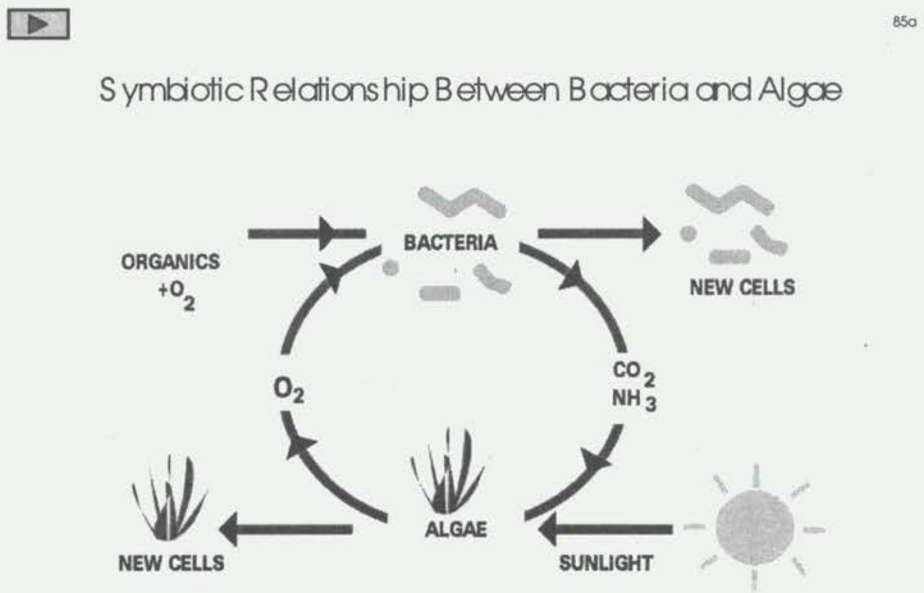
Ponding or lagooning is effective in treating wastewater and can reduce BOD and SS to the same levels as mechanical treatment plants (e.g. Activated Sludge Treatment). In addition because of the longer residence time of wastewater in the lagoon (in the order of days), removal of pathogenic bacteria and viruses by natural die-off is greater than in an activated sludge treatment plant (residence time of the order of hours). Cysts of parasites and helminth eggs are also usually removed through sedimentation in the lagoons.

A lagoon is a shallow excavation in the ground (1 to 2 m deep). It is generally unlined and percolation of wastewater into the soil and groundwater takes place. With time the percolation rate will reduce, because of formation of a sediment layer. Evaporation loss of water can be significant in arid climate regions. The soil itself is, however, not involved in the physical and biochemical wastewater treatment processes taking place in the lagoon. A lagoon can therefore be lined with a layer of clay or with an impermeable plastic membrane if protection of groundwater is desired, without affecting the performance of the lagoon. Wastewater lagoons are also called 'waste stabilisation lagoons', because the organic substances in the wastewater are converted to more stable (less degradable) forms.

The following processes take place in a lagoon. As wastewater enters a lagoon sedimentation of solids occurs. Because of the long residence time of the wastewater in the lagoon system, much of the solids in the original wastewater are removed. Aeration of the water from the atmosphere occurs by a process of diffusion aided by turbulence caused by wind movement on the surface of the water.

Oxygen is also supplied by algae in the lagoon which thrive on the nutrients (nitrogen and phosphorus) released by the decomposition of the organic wastes. The photosynthetic activity of algae, however, only takes place when there is sunlight. Thus oxygen produced by photosynthesis is only available during this period. A symbiotic relationship exists between the bacteria and the algae. Bacteria take up oxygen and release carbondioxide, while algae take up carbondioxide released by the bacteria and produce oxygen for the bacteria (Figure 13).

Figure 13. Symbiotic relationship between bacteria and algae in a wastewater lagoon.



Depending on the oxygen demand of the bacteria in the lagoon, the following conditions occur:

Anaerobic lagoon	The oxygen demand of the bacteria exceeds oxygen supply by surface aeration and algal photosynthesis. Biodegradation of the organic wastes is by anaerobic bacteria. Methane gas is a by-product. Odorous gases are produced, but impact is reduced when a layer of scum forms at the water surface.
Facultative lagoon	The oxygen demand of the bacteria is met by surface aeration and algal photosynthesis, but is not met when the latter is not active. The water environment is aerobic during the day, but turns anaerobic at night. Biodegradation of organic wastes is by facultative bacteria, which can operate under both aerobic and anaerobic conditions.
Aerobic lagoon	The oxygen demand of the bacteria is met by surface aeration and algal photosynthesis.

It is common to have a series of lagoons with the first one or two being anaerobic lagoons, the middle ones facultative lagoons and the last few aerobic lagoons. The sediment at the bottom of lagoons is anaerobic, and undergoes anaerobic bacterial decomposition. The first lagoon in a series will eventually be filled with solids. The sludge produced can be removed and treated for re-use or disposal or allowed to undergo further biodegradation in the lagoon prior to re-use. Anaerobic lagoons can be made deeper so that more sludge can be accommodated and the need to remove sludge made less frequent.

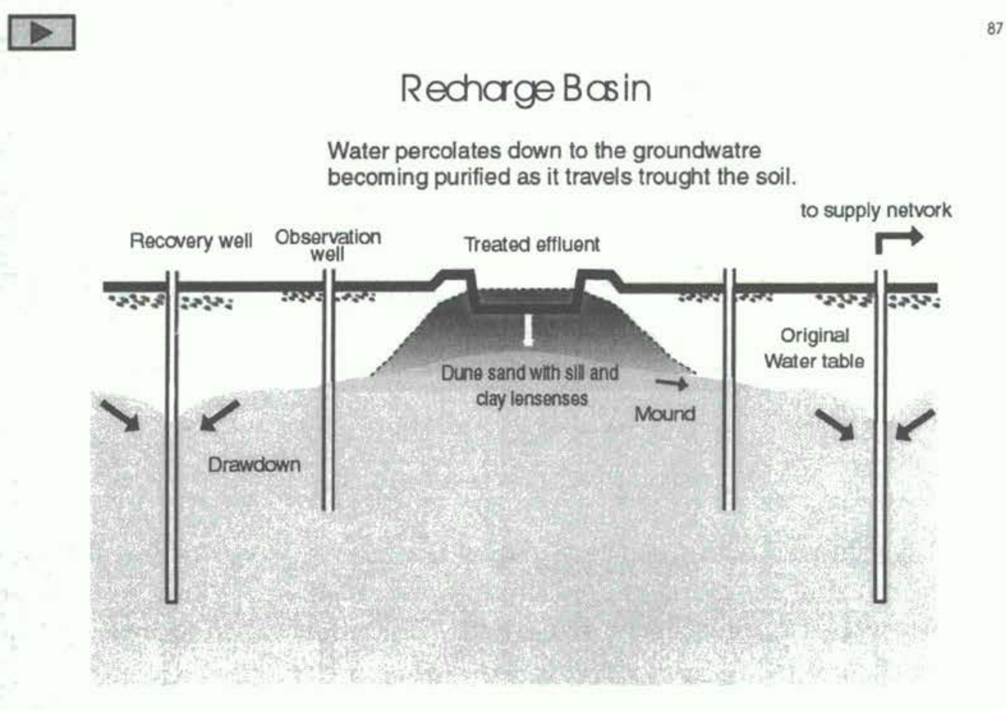
Lagoon performance is affected by temperature. At a higher ambient temperature (e.g. in the tropics) a shorter residence time of wastewater in the lagoon is required to achieve the same level of treatment compared to when the temperature is lower. Because algae are present in treatment lagoons, they leave with the treated effluent. One way of harvesting the algae is through aquaculture.

Oxygen transfer from the atmosphere into lagoons can be increased by mechanically agitating the surface of the water. This can be done by using a vertically mounted impeller, and the lagoon becomes more like the aeration tank of an activated sludge process. The agitation can also be provided using a horizontally mounted rotor. A configuration that can be used to apply this is a circular ditch, and the water is continuously circulated around the ditch so that its movement is like that in a river.

(d) Land based treatment

Land based treatment of wastewater relies on the action of soil bacteria to degrade the organic wastes in the wastewater. In what is termed 'Soil Aquifer Treatment' wastewater is applied to unlined basins in cycles of flooding and drying of approximately one week each (Figure 14). During flooding wastewater percolates through the soil beneath the basin to the unconfined groundwater aquifer. Organic substances are consumed by soil bacteria. Suspended solids are trapped at the bottom of the basin, and the percolation rate decreases. During drying the layer of solids accumulating at the bottom of the basin are degraded by bacteria and also undergo drying. The percolation capacity for wastewater is therefore rejuvenated.

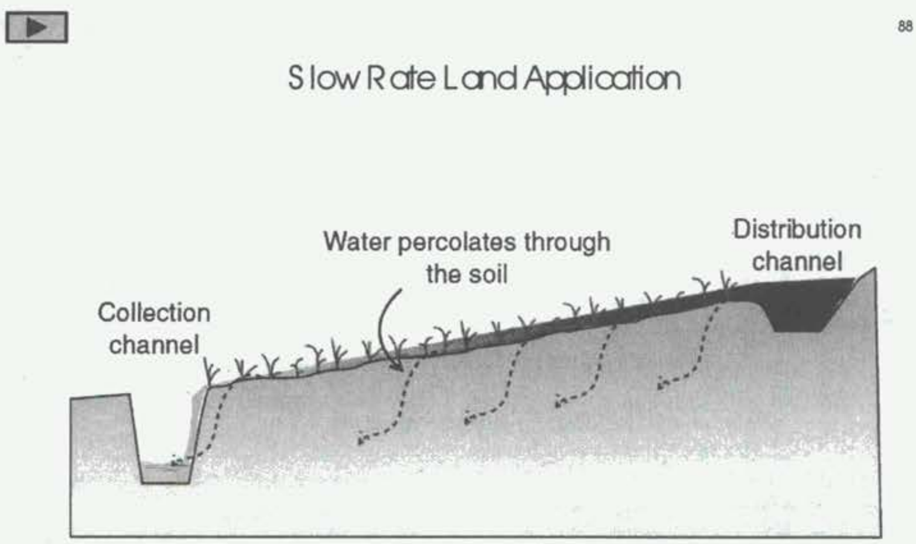
Figure 14. Soil aquifer treatment or rapid-rate land application system



Soil aquifer treatment is also known as rapid-rate land application. It works well when the soil permeability is high (> 1 m/day), and the highest groundwater table is at least 2 m below the bottom of the basin. Upon reaching the groundwater the SS and BOD of the water is generally low. Furthermore if the soil beneath the basin contains clay minerals, pollutants like heavy metals may be adsorbed by the clay minerals. The groundwater aquifer acts as a storage for the treated wastewater, which is usually withdrawn for reuse.

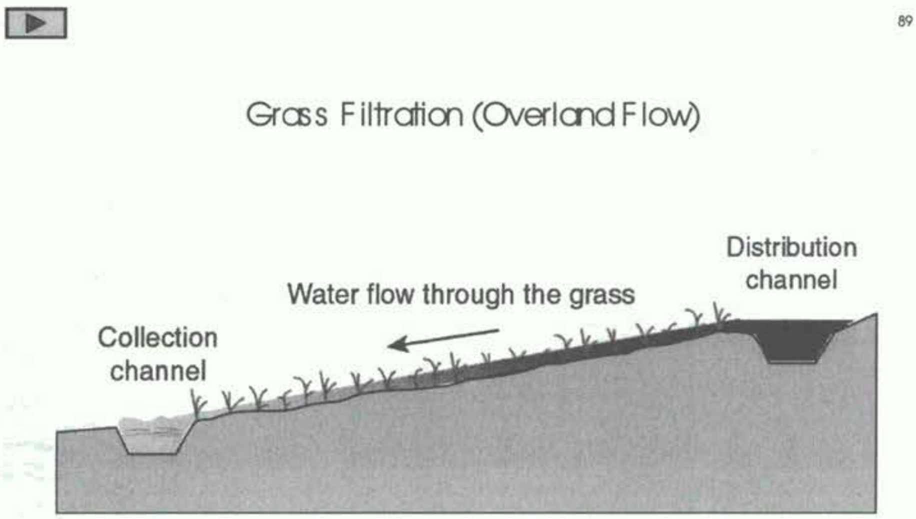
In what is termed 'slow-rate land application system' wastewater is applied to land through channels in the upper part of the gradient and treated wastewater is collected in channels in the lower part of the gradient of a slightly inclined ground (Figure 15). The application is intermittent and its rate is dependent on the permeability of the soil and the loss of water due to evaporation. The organic substances in the wastewater are biodegraded by soil bacteria at the surface of the soil and during percolation through the soil. Vegetation is usually part of the treatment process. It takes up nutrients (nitrogen and phosphorus) released from the degradation of the organic substances. The vegetation (usually grasses) is harvested by grazing animals (cattle or sheep).

Figure 15. Slow-rate land application system



When the soil is saturated with water (e.g. during the rainy season), 'overland flow' or 'grass filtration' mode of operation is used. In this case wastewater flows over the soil surface and the organic substances are removed by bacteria attached to the vegetation and soil surface (Figure 16).

Figure 16. Grass filtration

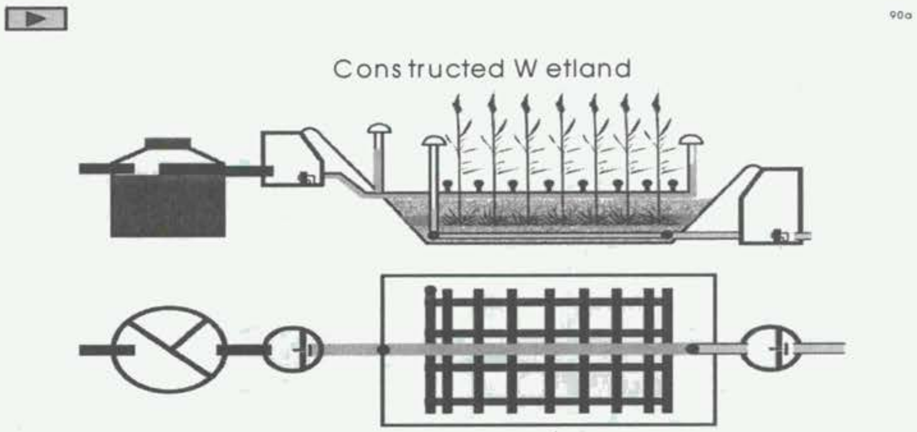


Raw wastewater can be used in any of the above land based treatment system provided that the application rate is small. Settled wastewater needs to be used for higher rates of application. Land application treatment systems work well in arid or semi-arid regions, where the soil is generally not saturated with water over much of the year, and reuse of wastewater for agriculture is attractive. Particular attention has to be given to public health requirements.

(e) Constructed wetlands

Constructed wetlands are in-between lagoons and land based treatment systems. A constructed wetland consists of a gravel bed in which wetland species, such as reeds, are planted (Figure 17). Wastewater (usually after settling of solids) passes through the gravel bed, and organic substances are degraded by bacteria attached to the surfaces of the bed and plant roots. The removal of BOD and SS in beds with and without plants does not appear to differ by very much. Wetland plants take up nutrients (nitrogen and phosphorus) when water residence time is long. Long-term nutrient removal requires harvesting of the plants. Constructed wetlands need to be designed to minimise problems with insects (mosquitoes and midges).

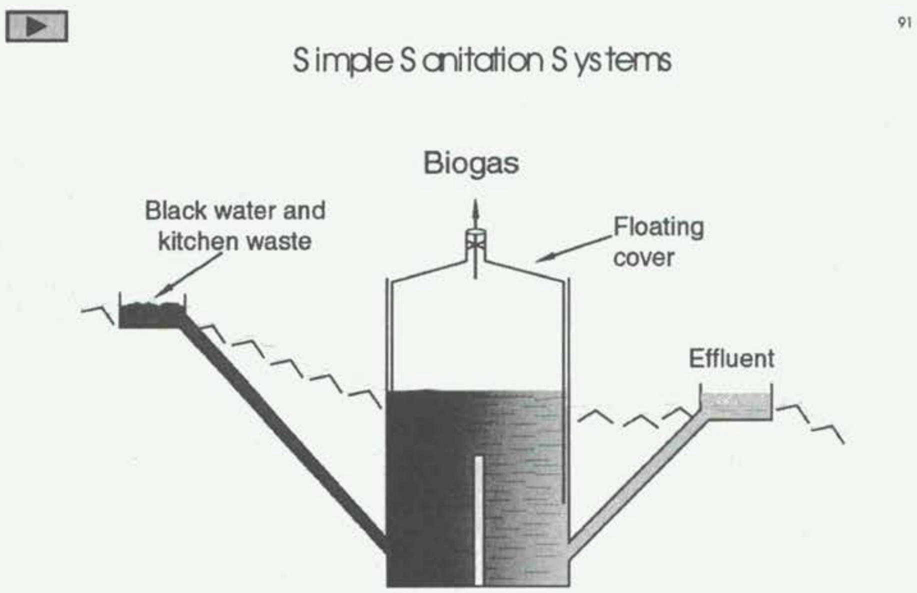
Figure.17 Constructed wetland



(f) Anaerobic treatment of wastewater

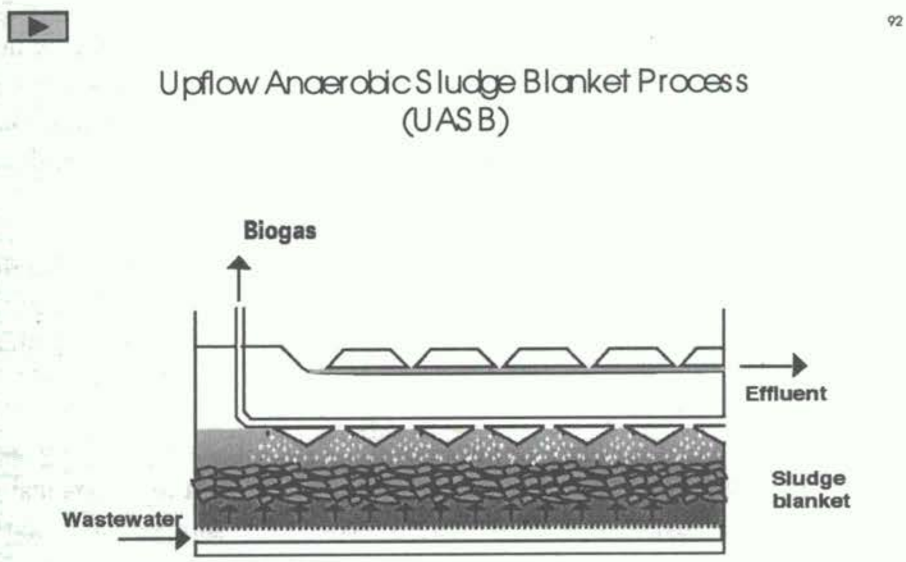
Anaerobic treatment is more suited to wastewater high in BOD. It is used to treat the sludge from an activated sludge treatment or biological filtration process. In households where there is cottage industry (such as food processing to supply restaurants or food market) the wastewater may be high in BOD. Wastewater high in BOD may also be generated when water conservation measures result in less water being used. A simple method to treat blackwater and kitchen waste is shown in Figure 18. The biogas produced can be combusted for use in cooking.

Figure 18. A simple anaerobic treatment of blackwater and kitchen waste



In the Upflow Anaerobic Sludge Blanket (UASB) process settled wastewater is passed upward through a sludge blanket. The sludge blanket consists of anaerobic bacteria, which have developed into granules. Because of the high settling velocity of the granules, the granules are not carried over in the upflowing wastewater. A high concentration of bacteria is therefore retained in the tank. The tank itself has no internal moving parts (Figure 19). If wastewater is distributed evenly at the base of the tank, mixing between the wastewater and the granules of bacteria is promoted by the carbondioxide and methane gases produced by the anaerobic treatment process and the upward moving flow of the wastewater.

Figure 19. Upflow anaerobic sludge blanket (UASB) reactor



Although the reactor itself has a simple configuration with no moving parts, pumping of the feed is still required. Methane gas is produced which needs special handling procedures to prevent leakage and explosion. Wastewater treated anaerobically requires further aerobic treatment to reduce its BOD and odour. Excess granules need to be treated prior to reuse or disposal, although currently there is a demand for the granules to start up UASB reactors. The mixture of methane and carbon dioxide (termed 'biogas') can be combusted and used for heating the content of the anaerobic reactor or for other purposes.

3 - SLUDGE TREATMENT, REUSE AND DISPOSAL

Sludge is produced from the treatment of wastewater in on-site (e.g. septic tank) and off-site (e.g. activated sludge) systems. This is inherently so because a primary aim of wastewater treatment is removing solids from the wastewater. Additionally soluble organic substances are converted to bacterial cells, and we remove the latter from the wastewater. Sludge is also produced from the treatment of stormwater, although it is likely to be less organic in nature compared to wastewater sludge.

Bucket latrine and vault latrine store faecal sludge, which needs to be collected and treated. In the former case human excreta is deposited in a bucket and the content of the bucket is emptied daily, usually at night giving the term 'night soil' to the faecal sludge. In the latter the excreta is stored in a vault for a longer period of up to two weeks before removal. The content of the vault should preferably be removed mechanically.

The characteristics of sludge vary widely from relatively fresh faecal materials generated in bucket latrines to sludge which has undergone bacterial decomposition for over a year in a double pit latrine. The treatment required is therefore dependent on the characteristics of the sludge. The former may contain large numbers of pathogens, whereas the latter will contain much less due to pathogen die-off. Sludge should, however, always be handled with care to avoid contact with pathogens.

Sludge may be contaminated with heavy metals and other pollutants, especially when industrial wastes are disposed into the sewer. Pre-treatment of industrial wastes is therefore essential before discharge to the sewer. Treatment of sludge contaminated with high concentrations of heavy metals or toxic chemicals will be more difficult and the potential re-use of the sludge will be limited.

Faecal sludge contains essential nutrients (nitrogen and phosphorus) and is potentially beneficial as fertilisers for plants. The organic carbon in the sludge, once stabilised, is also desirable as a soil conditioner, because it provides improved soil structure for plant roots.

Options for sludge treatment include stabilisation, thickening, dewatering, drying and incineration. The latter is most costly, because air pollution control requires extensive treatment of the combustion gases. It can be used when the sludge is heavily contaminated with heavy metals or other undesirable pollutants. Prevention of contamination of the sludge by industrial wastes is preferable to incineration. A conversion process to produce oil from sludge has been developed, which can be suitable for heavily contaminated sludge.

The costs of treatment of sludge are generally of the same order as the costs of removing the sludge from the wastewater.

(a) Stabilisation

Faecal sludge collected from bucket or vault latrines has a very high biochemical oxygen demand (BOD) and is generally putrid and odorous. Primary and secondary sludges from an activated sludge treatment plant also have a high BOD and may be difficult to dewater. Even sludge from a septic tank, which has undergone bacterial decomposition over at least a year, still has a high BOD. Stabilisation is the term used to denote the process of BOD reduction. The stabilisation process can be carried out under aerobic or anaerobic conditions..

Aerobic stabilisation of primary and secondary sludges can be carried out in an aeration tank in the same manner as in an activated sludge process. Because of the high oxygen requirement this process is energy intensive and costs are high. Aerobic stabilisation requires less energy when carried out as part of a composting process. For composting of sludge, its solids content should be increased to at least 15 % so that it can be handled as a solid. Thickening and dewatering (see below) of primary and secondary sludges are required to achieve the required solids content. Faecal sludge may contain high enough solids. Mixing with dry materials such as dry saw dust may assist with achieving the required solids content as well attaining the required carbon to nitrogen ratio for composting.

(b) Composting

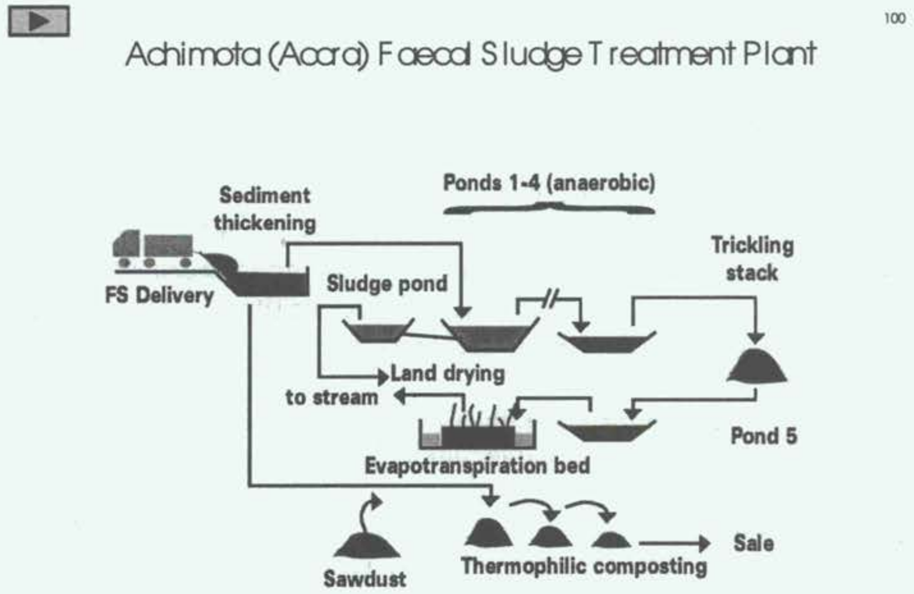
Composting is an aerobic bacterial decomposition process to stabilise organic wastes and produce humus (compost). Compost contains nutrients and organic carbon which are excellent soil conditioners. Composting takes place naturally on a forest floor where organic materials (leaf litter, animal wastes) are converted to more stable organic materials (humus) and the nutrients are released and made available for plant uptake. The process is slow on a forest floor, but can be accelerated under optimum conditions.

The optimum conditions for composting are a moisture content of about 50 %, a carbon to nitrogen ratio of about 25 to 30, and temperature of 55 °C. Because wastewater sludge is rich in nutrients its carbon to nitrogen ratio is low (5 to 10). It is also high in moisture. Addition of dry saw dust, which is very high in carbon to nitrogen ratio (500) can adjust both the moisture and carbon to nitrogen ratio. Other waste materials that can be used for this purpose are mulched garden wastes, forest wastes and shredded newspaper.

Composting can be carried in specially built composter, such as an inclined rotating cylinder, fed on one end with the raw materials, and the aerated product collected at the other end. As the materials are slowly tumbled over a period of about one week, they are mixed and aerated. Because bacterial decomposition produces heat, temperatures in the insulated composter can easily reach 55 °C. The immature compost is then windrowed for at least 12 weeks to allow the composting process to complete, with occasional turning of the windrow.

Composting can be more simply carried out in windrows (Figure 20). Regular turning of the windrows assists with mixing of the materials and more importantly supply the oxygen to the bacteria. Temperatures can reach 55 °C, because compost has a good heat insulating property. Turning of the compost also ensures that all parts of the windrow reach the required 55 °C essential for pathogen destruction. Turning is required every two to three days in the first two weeks when temperature is 55 °C or above. After this period frequent turning of the compost windrow is not required as less heat is generated and less oxygen is required while the compost undergoes maturation.

Figure 20 . Windrow composting

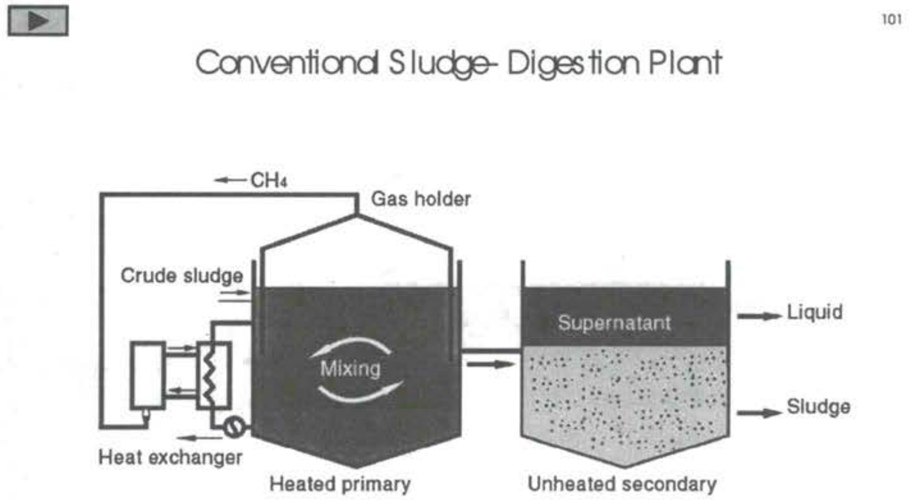


(c) Anaerobic digestion

Anaerobic digestion is a bacterial decomposition process which stabilises organic wastes and produces a mixture of methane and carbon dioxide gas (biogas). The heat value of methane is the same as natural petroleum gas, and so biogas is valuable as an energy source.

Anaerobic digestion is usually carried out in a specially built digestor, where the content is mixed and the digestor maintained at 35 °C by combusting the biogas produced. After digestion the sludge is passed to a sedimentation tank where the sludge is thickened. Biogas is collected from both the digestor and the sedimentation tank (Figure 21). The thickened sludge requires further treatment prior to reuse or disposal.

Figure 21 . Simple anaerobic digestion process



Anaerobic digestion can also be carried out at a slower rate in an unmixed tank or pond. Covering is usually by a UV resistant plastic sheet, because of the large area needed to be covered, and biogas is collected from the top of the sheet.

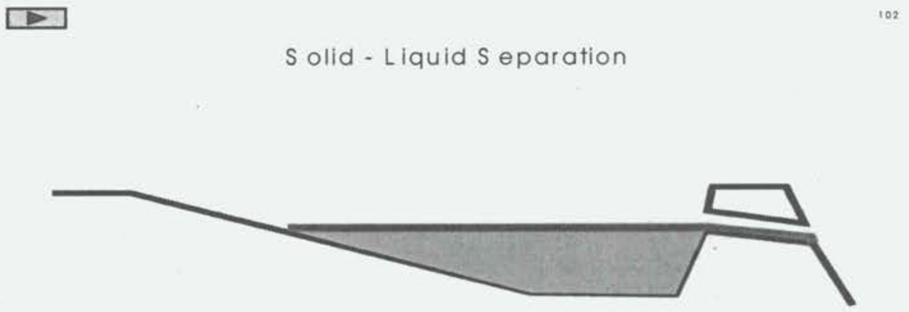
Storage of biogas can be in a cylindrical tank with a floating roof. The cylindrical roof floats on water and its position is determined by the volume of the gas stored under the pressure of the roof. Biogas can also be stored in a balloon, but only under low pressure.

(d) Thickening

Sludge contains a high concentration of solids, but its water content is still high. Combined primary and secondary sludge from an activated sludge treatment plant contains about 2 % solids and hence 98 % water. One kg of dry sludge is associated with 49 L of water. Thickening to 5 % solids means one kg of dry solids is associated with 19 L of water, thus 30 L of water has to be removed.

Thickening is carried out in a sedimentation tank or in a sedimentation pond (Figure 22). The latter is advantageous if land area is available, because the sludge can be allowed to settle over a much longer period and a higher solids content of the thickened sludge is achieved. The water removed from thickening needs treatment. It can be returned to the inlet of an off-site wastewater treatment plant, or in the case of sludge from on-site units by an aerobic treatment process such as lagooning

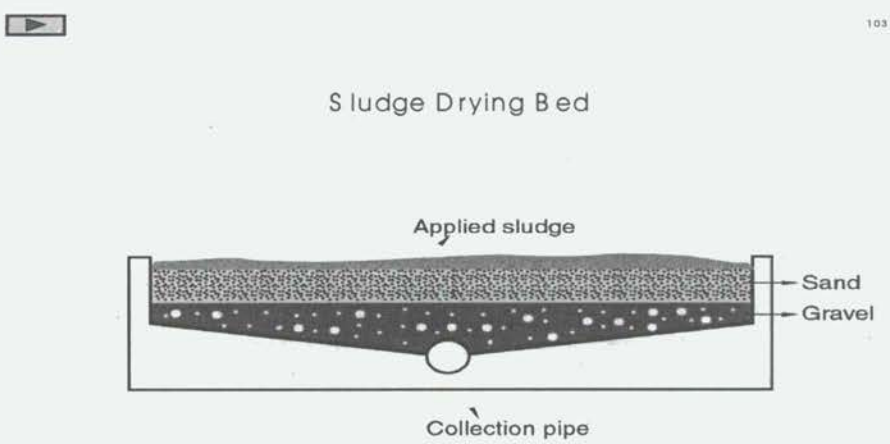
Figure 22 . Sludge thickening pond (Ghana)



(e) Dewatering and drying

Dewatering aims to reduce the water content further so that the solids content of the sludge is about 20 % (equivalent to 1 kg dry sludge with 4 L of water). The sludge can then be handled like a solid. Dewatering can be done mechanically using a filter press (employing pressure or vacuum), or a centrifuge. It can also be done using drying beds. A drying bed consists of a 30 cm bed of sand with an under-drainage (Figure 23). Sludge is applied on the sand bed and is allowed to dry by evaporation and drainage of excess water over a period of several weeks depending on climatic conditions. Bacterial decomposition of the sludge takes place during the drying process while moisture content is sufficiently high. During the rainy season the process may take a longer time to complete, and sizing the area of the drying beds should take this into account.

Figure 23 . Sludge drying bed



(f) Sludge reuse

Raw sludge from activated sludge treatment plants has been applied directly onto agricultural land particularly in the United Kingdom. This practice is considered unsatisfactory because of the presence of pathogens in the sludge in high numbers. There has been no thorough study, however, which has shown that there is an increase in the risk of acquiring illnesses associated with pathogens in the raw sludge when proper handling procedure and non-entry to the land following application is observed.

Reuse of composted sludge as a soil conditioner in agriculture and horticulture returns carbon, nitrogen, phosphorus and elements essential for plant growth back to the soil. Less chemical fertilisers are required and the organic carbon helps to improve soil structure for soil aeration, water percolation and root growth. The nitrogen and phosphorus are also released gradually for plant uptake compared to the more soluble chemical fertilisers. The potential of leaching of the nutrients to ground or surface water by rainfall run-off is much reduced. Pathogens and heavy metals can, however, limit the reuse of sludge.

Pathogens should be reduced to levels that do not pose health hazards to workers handling the sludge, potential health hazards from the spreading helminth eggs and from horticultural produce contaminated by pathogens. Composting of the sludge to attain a temperature of 55 °C for two weeks followed by windrow maturation produces sludge that meet these conditions. Stabilised sludge which has been dewatered and dried on sand beds to attain a low moisture content can meet the same conditions.

Heavy metals and toxic chemicals are difficult to remove from sludge. Preventing these chemicals from entering the wastewater or sludge should be the aim of wastewater management for sludge intended for reuse in agriculture or horticulture. Reuse may still be possible for purposes such as mine site rehabilitation, highway landscaping or for landfill cover. Sludge which has been conditioned for reuse is also called 'biosolids'

Conversion of sludge, which is heavily contaminated by heavy metals or toxic chemicals, to oil is technically feasible (Enersludge process). A full scale plant is operating in Perth, Western Australia. The conversion is by a pyrolysis process, heating dried sludge to a high temperature in the absence of oxygen or with a controlled amount of oxygen. Capital and running costs of an oil from sludge process are high.

(g) Sludge disposal

Final or ultimate disposal of sludge, which cannot be reused, is by landfilling or incineration. Since sludge for landfilling usually contains heavy metals or toxic chemicals, lining of the landfill with clay or plastic liner may be required to prevent contamination of groundwater. Incineration of sludge is by a multiple hearth furnace or fluidized bed furnace. Energy input is required to dry the sludge before combustion is self-sustaining. Combustion flue gases usually need treatment to meet air pollution control standards. Investment and operating costs are high.

4 - WASTEWATER REUSE

Human excreta and wastewater contains useful materials. These are water, organic carbon and nutrients. They should be regarded as a resource. In their natural cycles they are broken down by micro-organisms and become useful to plants and animals, thus sustaining natural ecosystems. When improperly disposed these substances can cause pollution, because the organic materials exert oxygen demand, and the nutrients promote algal growth in lakes, rivers and near-shore marine environments.

Human excreta and wastewater contain pathogens. Reuse of the wastes must ensure that public health is maintained. Planned reuse is the key to wastewater reuse. Planning for reuse ensures that public health and protection of the environment are taken into account. Reuse of treated wastewater for irrigation of crops, for example, will need to meet (i) standards for indicator pathogens, and (ii) plant requirement for water, nitrogen and phosphorus. Standards for reuse of wastewater for various purposes have been developed by WHO and many states (see Regional Overviews). Plant requirements for water and nutrients is plant-specific and site-specific (dependent on soil type and climate) and information on these requirements need to be obtained from local sources of information.

Unplanned or unintentional wastewater reuse is already taking place widely when we have human settlements along a major river (e.g. the Mississippi River). Water is withdrawn from the river by a community, treated for water supply and distributed. After its use the water is collected, treated and discharged to the river. This process is repeated many times along the river. The only documented 'intended reuse' of this nature is in Winhoek, Namimbia where treated wastewater is returned to the water reservoir supplying water to the town. This was initiated during a severe drought (See Regional Overview for Africa).

While reuse of wastewater for public water supply of drinking water quality standard is the exception, the technology exists to process wastewater to drinking water. A pilot plant at Denver demonstrated that 1 million US gallons per day (3.78 million L/day) of secondary effluent could be treated to produce water that is better in quality than water supplied to the city of Denver.

All water used for drinking purposes has in a sense been used, because in the water cycle water is continuously cycled.

4.1 Wastewater reuse from off-site treatment plants

(a) Wastewater reuse for agriculture

Treated wastewater from off-site treatment plants can be reused for irrigation of parks and gardens, agriculture and horticulture, tree plantation and aquaculture, if these exist or can be established not far from the wastewater treatment plants. For these purposes the wastewater should generally be treated to secondary wastewater standard (< 20 mg/L BOD and < 30 mg/L SS). Total coliforms should be < 1000 organisms per 100 mL for irrigation by spraying. When sub-surface irrigation is used this requirement may not be necessary. A period of non-entry to irrigated sites may need to be observed, particularly for wastewater-irrigated parks and gardens. Irrigation of vegetables for direct human consumption requires a much stricter guideline.

Because requirement of wastewater for plant growth is governed by climatic conditions, soil and plant type, there may be a need for storage of the wastewater. An alternative to storage, if land area is not available for this purpose, is to dispose of wastewater that is excess to requirement. A combination of wastewater for irrigation and aquaculture (see below) is also an option that can be considered.

Slow rate land application and grass filtration when combined with growing of grasses for grazing by sheep or cattle can properly be considered as treatment and reuse of wastewater.

(b) Wastewater reuse for aquaculture

Treated wastewater can be used to cultivate fish in ponds. The nutrients in the wastewater promote the growth of algae and aquatic plants, which in turn are grazed by the fish. Indirect reuse of the wastewater can be implemented by growing for example duck week, which is then harvested and fed the fish in a separate pond not fed with wastewater. Figure 24 shows the direct and indirect reuse of wastewater. To ensure that public health is not compromised strict guidelines should be observed (Figure 25).

Figure 24 . Direct and indirect reuse of wastewater for aquaculture.

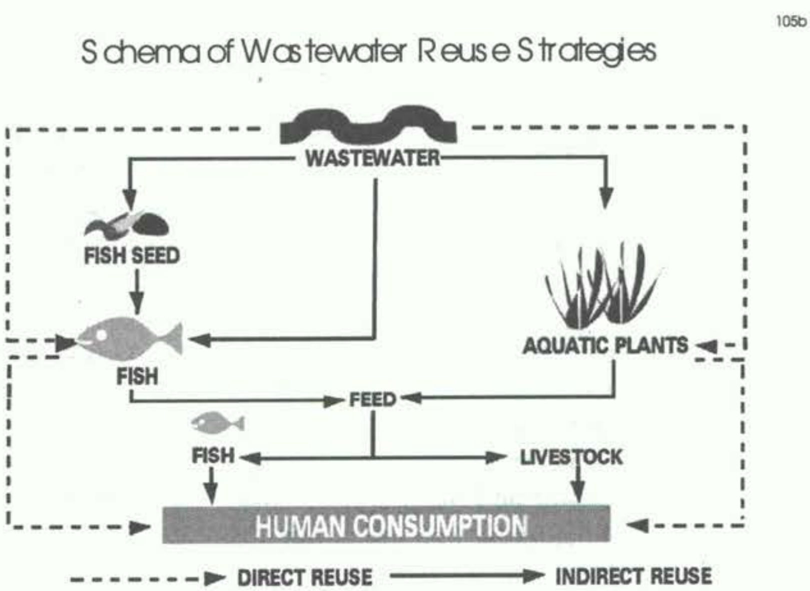


Figure 25 . Public health guidelines for wastewater fed aquaculture

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Public Health Guidelines for Wastewater-fed Aquaculture

- Minimum retention time of 8-10 days for raw wastewater
- In wastewater-fed fish pond water:
    - A tentative maximum critical density of 10^5 total bacteria/ml
    - Absence of viable trematode eggs
- Suspension of wastewater loading to the system for 2 weeks prior to fish harvest
- Hold fish for a few hours after harvest to facilitate evacuation of gut contents
- Fish muscle quality:
    - <50 total bacteria/g muscle
    - No *Salmonella*
- Good hygiene in handling and processing:
    - Gut the fish
    - Wash
    - Cook well

Because of the importance of aquaculture as a means of reusing wastewater a special section is devoted to this topic in the UNEP IETC International Source Book on Wastewater and Stormwater Management.

(c) Wastewater reuse for industry

Treated wastewater can also be used for industrial purposes, if suitable industries are not far from the treatment plants. Industry's requirement for water quality ranges widely, from very pure water for boilers of electricity generation to lower water quality for cooling towers. Treated wastewater can fulfil the lower range of this requirement, e.g. water for cooling towers. Secondary-treated wastewater after chlorination may be adequate for this purpose.

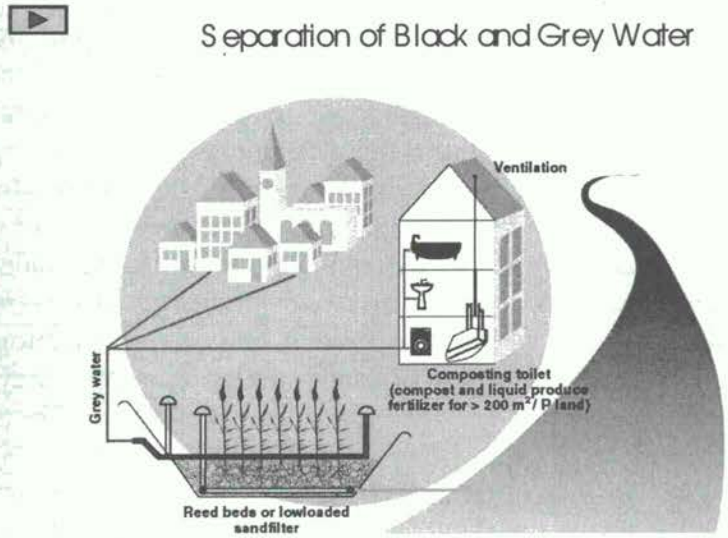
With off-site treatment plants reuse of wastewater may be limited by the need to pipe treated wastewater to where it is needed. To implement wastewater reuse in houses for toilet flushing, watering of gardens and other purposes which do not need drinking quality water, a third pipe-reticulation system is required, that is in addition to the reticulation to provide drinking water and the sewer to collect the wastewater. Care is also needed to prevent cross-connection between drinking water and treated wastewater.

'Sewer mining' is the term given to the withdrawal of wastewater from a sewer for reuse near to the point of withdrawal. This provides an opportunity for reuse without having to pipe treated wastewater from the centralised treatment plant. Wastewater needs to be treated to the standard required for the reuse, and may duplicate the function of the centralised treatment plant.

4.2 Reuse of wastewater from on-site systems

Many options are open to a householder who wishes to reuse wastes on-site. One option is separation of all wastes (Figure 26). Urine is separately collected and stored for later use as a liquid fertiliser, rich in nitrogen, phosphorus and potassium. Toilet wastes are composted and used as a soil conditioner, rich in organic carbon, nitrogen and phosphorus. Greywater is treated in a constructed wetland and used for sub-surface irrigation of the garden beds. This option may be suitable for a householder who is interested in managing wastes for beneficial uses in the garden, being a keen gardener. Sufficient garden area needs to be available for this purpose.

Figure 26 . Separation of household wastewater for on-site reuse



Another option is the use of an evapotranspiration system for growing shrubs and trees. This is a passive system, not requiring household attention on a regular basis, except requesting a desludging of the septic tank every 3 to 5 years. There is a fairly wide choice of shrubs and trees to choose from depending on local soil and climatic conditions.

5 - WASTEWATER DISPOSAL

Disposal of wastewater and stormwater should preferably be considered only when reuse options are not feasible. Ultimate disposal of wastewater is either onto land or water (river, lake, ocean).

(a) Land-based disposal of wastewater

Disposal onto land takes the form of effluent from on-site and off-site treatment systems being allowed to percolate through the ground. For a septic tank, for example, this occurs through the soakage of overflow from the septic tank in a leach drain. Disposal onto land generally pollutes groundwater, and may reach surface water when groundwater eventually discharges into surface water. The impact of BOD and nutrients in the wastewater on the surface water has been attenuated by soil processes and is therefore not as severe as direct disposal into surface water. Disposal from an off-site treatment plant for groundwater recharge to control encroachment of sea water in coastal areas is a form of reuse.

Injection of wastewater into a deep confined aquifer via a borehole is a possibility. Only treated wastewater with very low content of suspended and colloidal solids can be injected into a deep aquifer to prevent blockage of the pore spaces surrounding the borehole. The long-term effect of deep well injection is still unclear and the method is not generally recommended.

(b) Wastewater disposal to water environments

Disposal into a lake, stream or ocean needs to take into account the ability of the receiving water to assimilate wastewater. The natural purification capacity of the environment is limited. Even when wastewater is disposed to the ocean, the area surrounding the outfall can be sufficiently polluted and the pollutants (including pathogens) can be washed towards the beaches. The minimum water quality standard for disposal to a water environment is BOD < 20 mg/L and SS < 30 mg/L. This standard is generally achieved by secondary treatment processes (lagooning or activated sludge treatment). This standard was initially developed for wastewater discharge into rivers, assuming that an eight fold dilution by river water takes place. A class 1 river therefore can maintain a BOD of less than < 3 mg/L (Section 1). Such is dilution is not always achieved in arid or semi arid areas.

Nutrients (nitrogen and phosphorus) promote the growth of algae in the receiving water. In lakes and sensitive water environments the removal of nutrients may be required. Furthermore if the wastewater contains high levels of heavy metals and toxic chemicals, these may have to be removed before wastewater disposal. Over the years the requirement for disposal into water environments have become stricter as the impact of pollutants is better appreciated. It can be expected that this trend towards more stringent discharge requirements will continue (See Western Europe and North America Regional Overviews).

6 - SOUND PRACTICES

6.1 Technology choice

Environmentally sound practices in wastewater and stormwater management are practices that ensure that public health and environmental quality are protected. A range of technologies exist that can achieve this objective. A summary is shown in Table 1. Even though this table does not cover all available technologies, they represent major technologies for situations that are likely to be encountered. The Regional Overviews include technologies that are modifications or variations of the listed technologies or represent practices or advances in the regions.

Table 1. Technologies for wastewater and stormwater management (with relative costs, environmental impact and maintenance requirement)

Wastewater management technologies

Technology	Capital cost	Operation & maintenance cost	Environmental impact
On-site technology			
Pit latrine	Low	Low	Pollution of groundwater
Composting toilet	Low	Low	Reuse of nutrients
Pour flush toilet	Low	Low	Pollution of groundwater
Improved on site treatment unit	Medium to high	Low to medium	Reuse of water and nutrients
Off-site technology			
Collection technology			
Conventional sewerage	High	High	Dependent on treatment
Simplified sewerage	Medium to high	Medium	Dependent on treatment
Settled sewerage	Medium	Low	Dependent on treatment
Treatment technology			
Activated sludge	High	High	Nutrients may need removal
Trickling filtration	Medium	Medium	Nutrients may need removal
Lagoons	Low to medium (dependent on cost of land)	Low	Nutrients may need removal; aquaculture can be incorporated
Land-based treatment	Low to medium (dependent on cost of land)	Low to medium	Reuse of water and nutrients
Constructed wetland	Low to medium (dependent on cost of land)	Low	Amenity value
Anaerobic treatment	Medium	Medium	Produces biogas; further aerobic treatment needed

Common to all sound technologies is that there is a scientific basis for the physical, chemical and biological processes for the removal of pathogens and pollutants from the water. These processes are largely akin to the purification and recycling processes taking place in nature. Properly designed, constructed, maintained and operated these technologies can achieve protection of public health and the environment, and can recycle water and nutrients, which are beneficial to sustaining ecosystems and life.

Associated with each technology hardware is:

(a) a philosophical basis or approach, e.g. separation of waste components (dry conservancy), or conveying all wastes away with water (water based conveyance), minimising capital cost, minimising maintenance requirement; or maximising reuse)

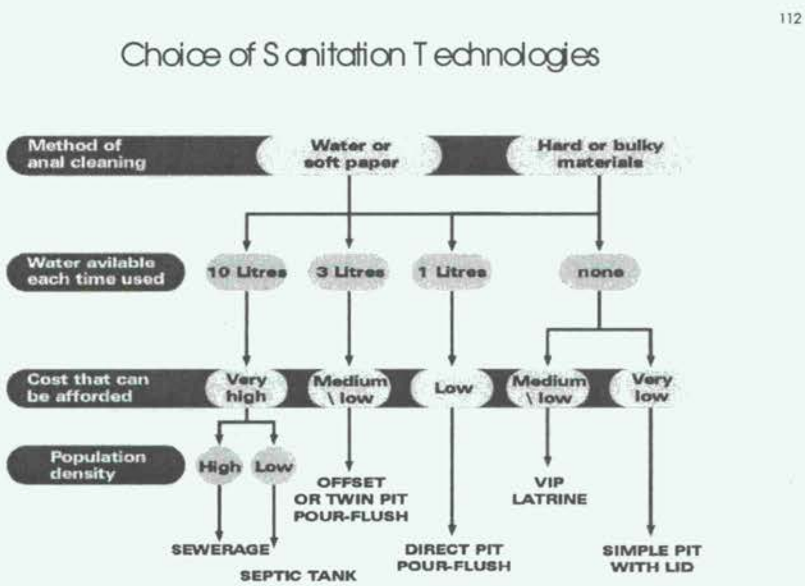
(b) maintenance and operational requirements, which are the software associated with the technological hardware, and therefore

(c) level of skills required to operate the hardware and software, and consequently training requirements for personnel

The choice of technology is determined by environmental, economic and social factors.

Procedures to consider economic and environmental factors in a systematic way have been developed. These range from a single decision-making flowsheet to a computer software package. Simple decision making flowsheet is shown in Figure 27.

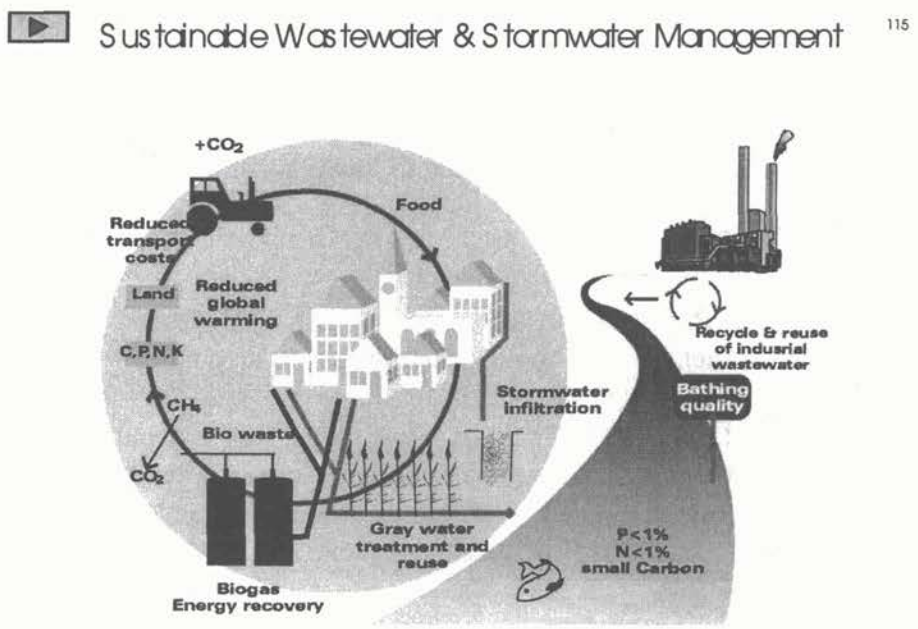
Figure 27. Simple decision making flowsheet for choosing wastewater treatment systems (Ref. Pickford)



6.2 Scenarios for Sound Practices

General scenarios can be sketched based on population density to illustrate integration of technology, environmental, economic and social factors. For a low population density and where land is available around dwellings, on-site systems with on-site reuse provide householders with options which are a function of water availability, toilet type and desired reuse of blackwater and greywater. Use of a double vault composting toilet (2 (4.1.2)) and greywater for subsurface irrigation is shown in Figure 28. Maintenance requirement will be emptying the vault (say, every 6 months), windrow-composting the content with garden waste and diverting blackwater from a full vault to the one just emptied. Irrigation system for greywater need to be checked weekly.

Figure 28. Composting toilet for blackwater and sub-surface irrigation of grey-water



A system requiring less householder maintenance is a septic tank with an inverted leach drain or evapotranspiration trench. The septic tank needs to be de-sludged every 3 to 5 years. This is done by calling a sludge contractor. This service should be available in the community for this option to operate satisfactorily.

For a high population density, community ablutions blocks with payment for use can work well. The wastewater can be conveyed to a location where land is available for land-based treatment and reuse through grazing grasses irrigated by treated wastewater. The operator of the ablutions facilities needs to ensure public health requirements for the wastewater reuse are met.

Toilet facilities in individual dwellings are an option with wastewater collected using simplified sewerage. This can condominial sewers or with street connections depending on community choice. Collected wastewater is treated using a series of lagoons, with the final lagoon employed for aquaculture. Depending on land use downstream of the lagoons, wastewater can be reused further for agriculture, horticulture or tree plantation. The requirement of planning a sewerage system within a catchment basin (to use gravity flow), the environmental requirement for reuse of wastewater nutrients (to prevent pollution), the economic requirement of balancing economy of scale of treatment and the cost of the sewer pipes, and the social requirement for community consultation point to planning for a community-scale collection, treatment and reuse of wastewater. The optimum size of the population served for a community-scale systems will depend on local conditions, which in turn are determined by local geographical (topography, climate, soil), environmental, economic and social/institutional considerations.

CONCLUSIONS

The range of technology available for wastewater management is such that there is at least one that can suit a particular local situation. Decision making tools are also available, and these range from a simple flowsheet to a sophisticated computer program. It is important, however, to understand the environmental, economic and social basis for making the decision and arriving at the most optimum choice. Sound practices to achieve sustainable development have been suggested to illustrate what can be achieved.

Josefina Gomez (Dominican Republic) - " About the first example presented, I would like to know about the cost, when this is to be used and what are its pathogen problems and solutions."
Goen Ho - "In Australia and the United States this is used in national parks, and so there is no power supply, no water and of course it can only be used when the cleaning is made with paper. In many parts of Asia they have to use water. About cost, this is the high cost version. But there are other appropriate technologies. This is just one of them."

Terrol Inniss (Barbados) - " Where is the liquid at the bottom going?"
Goen Ho - "It is collected just like urine, it is diluted and used as liquid fertilizer. This is not suitable for every situation, but for when the house is on a stilt."

Julio Torres (Panama) - "Are there any chemicals used in that system? "
Goen Ho - "No chemicals at all. The only additives are the worms."

Carmen Olano (El Salvador) - "Is there any kind of educative programs to impose this kind of system and what is the acceptance by the population in Australia for example? "
Goen Ho - "The major application is in national parks and in remote areas when the soil is very arid. So this is just an alternative. Every new technology requires education. This is a very important point."

Robert Merino (Peru) - "We have been already using this technology in Peru and we have a problem. In spite of the fan system, there is a strong odor on the surface. Is there any chemical to extinguish these odors? In Peru they use the coal ash and also lime which is very cheap. Is there any other alternative? "
Goen Ho - " In some pit latrines, you have to add ash or lime. With this you do not have to add anything. In essence it is a composting system that is aerated. We have six months at least to stabilize the material. But these same effects are also applicable to other types of pit systems.
I would like to remind you that these technologies will not only be in the source book but also in the 'maESTro' database."

Louise Zuilen (Suriname) - "About figure number24, you said that you can cultivate fish in the pond. What kind of fish an live in those waters? "
Goen Ho - "A kind of tilapia."

ALTERNATIVE TECHNOLOGIES ON STORMWATER MANAGEMENT

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ABSTRACT

Following the first lecture on general principles of stormwater management this lecture deals with alternative solutions for handling urban drainage systems. The alternatives to conventionally applied systems are supposed to be more sustainable and provide better interaction with wastewater systems. They are designed to control flooding and pollution problems as near to the source as possible and are aimed to restore or maintain the ground and surface water flow patterns that existed before the development took place. They all attempt to mimic the natural processes involved and are variously called Sustainable Urban Drainage Systems (SUDS), Best Management Practices (BMP).

Broadly speaking SUDS starts with *good housekeeping* to prevent urban runoff from getting in contact with substances that can pollute the water and then be washed away during a storm. Furthermore, they involve techniques for *minimization of direct runoff* by *infiltration* and *storage rainwater harvesting* and its use as a resource and improvement of runoff water quality. Finally, they contribute to urban and *environmental amenities* by providing water features and creating conditions for wildlife to be restored in urban areas.

The technical applicability of these systems in both developed and developing countries is discussed.

Selected slides illustrating the application of these alternative (sustainable) techniques of storm drainage are included in the TM – Training Module that accompanies the Source Book. Parts of the TM relevant to this lecture are included in a separate Power Point presentation.

INTRODUCTION

New concepts of urban drainage based on controlling runoff that are considered to be more sustainable than conventional systems which are primarily designed to reduce local flood risk.

Urban storm water management has, until recently, been focused on solving local flooding problems by transferring large amounts of water downstream of any built-up area as quickly as possible. This inevitably increases volumes and peak discharges causing damage not only to the downstream reaches but also to the natural receiving bodies and the entire environment as well. However, it is becoming increasingly apparent that this solution is not acceptable. Everybody seems to be "downstream" and affected by the inappropriate solutions in the upstream parts of the catchment. Alternative solutions are being sought.

Conventional design criteria also require silt and solids to be washed out, rather than settling out in the drainage system. The emphasis on rapid removal of water from contaminated impermeable surfaces and ensuring sediment transport leads to pollution of receiving watercourses.

Source control is an alternative strategy attempting to emulate natural catchment conditions in order to pre-empt or reverse the negative impacts of urbanization. The general philosophy is to reduce and attenuate the storm flows before they reach the drainage network, as well as to improve water quality by allowing self-treatment processes to take place. Starting with source control, applicable at each household , followed by site and regional controls, significant reductions in flood risk and pollution potential can be achieved.

The applicability of a specific type of source control facility is dependent on a large number of physical factors such as the level and sensitivity of the groundwater table, the density of vegetation and the porosity of the soil. Socio-economic factors also are important, such as management regimes, planning controls and operation and maintenance costs. Successful and appropriate selection of source control measures is thus highly site-specific. It should be noted that this concept has been practiced in several countries (Sweden, Japan, USA, Germany, France) for many years and that its use in UK is being widely promoted (CIRIA, 2000).

The cummulative effect of all storm drainage systems contributing to the balance of surface water and pollutant flows has to be taken into account for the sub-basin upstream of the point under consideration, especially in densely populated areas. The impact of storm drainage systems on downstream municipalities and water users is critical in those cases where the drainage peak flow exceeds the capacity of the river channel as there is no capacity left for downstream runoff. In these cases, the downstream-upstream relationships have to be analyzed in order to either share the existing capacity or to share the costs of capacity enlargement or runoff reduction. The concept of polluter pays is important in allocating these costs.

more severe. Rivers carrying water from large catchments serve as receiving water bodies for both solid and dissolved pollutants, and the effect of urban runoff has to be analyzed from the point of view of its pollution effects and the contribution to the silting of downstream water courses, including reservoirs.

Urban runoff management should use a dual drainage concept where the interactions between a buried underground network of sewers and the capacity of surface elements, mainly streets, are taken into account in determining flow volumes. In addition to reducing flood risk, modern storm drainage systems have to be designed and operated in such a way that they also contribute to pollution reduction and to the improvement of urban amenity.

The level to which all three aspects can be tackled and successfully applied depends on the economic development of the country. Traditionally, this is considered to be a "rich men's business". However, the change of paradigm in which public participation is recognized in dealing with problems of this nature is required, enables all countries to exercise sustainable practices and find more appropriate solutions. The world is experiencing a spread in the acceptance of the sustainability concept, and thus examples of the successful applications of SUDS in developing countries are no more a rarity.

TECHNIQUES APPLIED IN SUDS

1) Principles

The aims of SUDS are:

- Reduction of flood risk by reducing runoff volume and peak flow rate;
- Reduction of pollution of receiving water bodies (quality management);
- Better use of resources; and
- Improvement of urban amenities and the natural environment.

Control of runoff quantity and quality is achieved throughout the entire route of the runoff by combining various techniques in parallel and in series. These include:

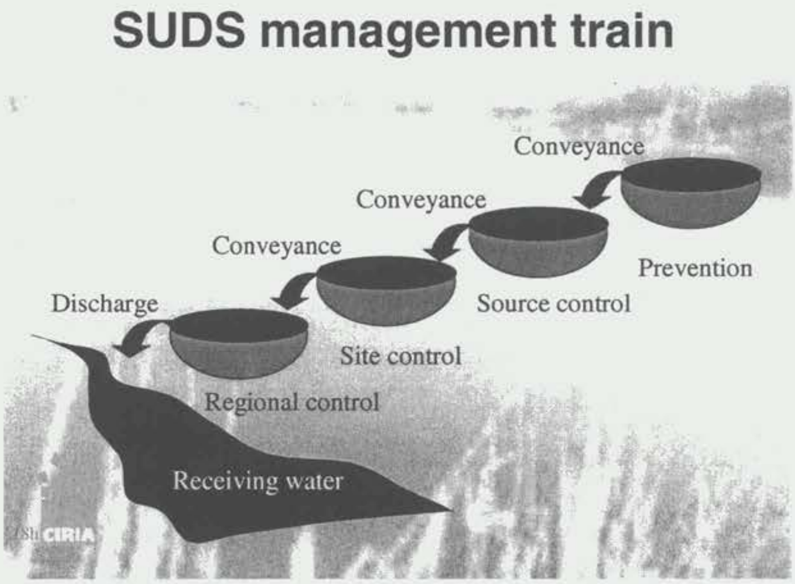
- Reducing the volume of runoff through minimizing the use of impermeable surfaces, using permeable surfaces, rainwater harvesting and drainage to soakaways;
- Good housekeeping to reduce the pollution of runoff through contamination by silt, litter and spills that should be swept up and removed from impermeable surfaces;
- Attenuating any excessive flows; and
- Reducing the amount of pollutants and by making them less toxic and less hazardous by creating a series of "natural" filters, ponds and wetlands.

All of these techniques can provide urban amenities and valuable aquatic habitats.

The process by which this is achieved is known as the *surface water management train.* Its major steps are shown in Figure 1. The train includes:

- Good housekeeping and preventive measures;
- Source control;
- Site control;
- Regional control; and
- Conveyance elements such as swales, ditches, culverts and streams linking them together.

Figure 1. Runoff control by the surface water management train (CIRIA 2000)



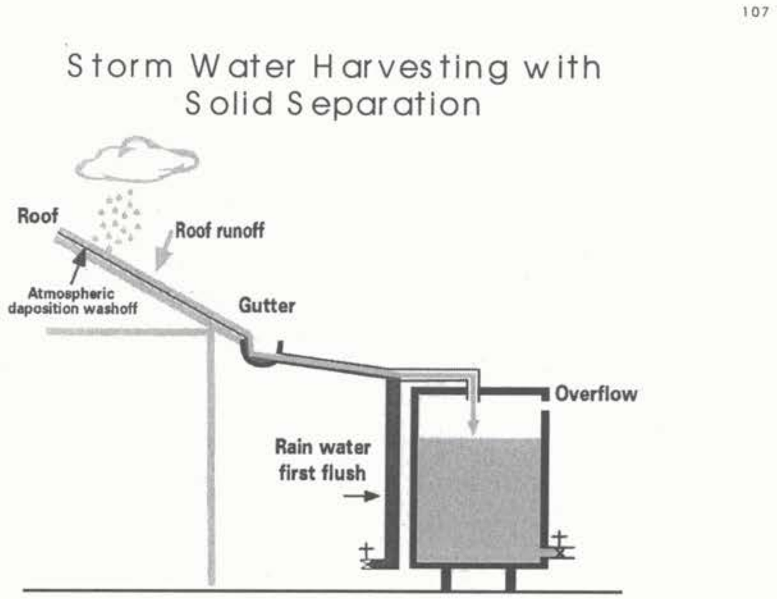
The range of measures to be applied is numerous. No single solution is universally applicable, and local conditions play a crucial role. The selection of techniques should be inspired by the natural drainage system, with preference given to source control. Surface water drains naturally through a series of stages and this model can be used to design a drainage system, with each successive stage treating or attenuating the water. The elements can be arranged in series (on-line) or in parallel with the main conveyance (off-line). The flow rate may also vary during storm conditions, with floodwaters being routed around wetlands. This will protect the aquatic environment and also dispense with a treatment stage for water that may carry proportionally less pollutants than a smaller runoff event.

2) Rainwater as a resource

Rainwater from both urban and rural areas is a precious resource. It should therefore not be allowed to become polluted or drain away without entering the local natural hydrological cycle. Impermeable surfaces and piped drainage restrict infiltration to the soil and aquifers and drainage to natural watercourses. This reduces the availability of the resource to both local populations and the environment.

Harvesting and using local rainwater at a household and community level has been used for many centuries.

Figure 2 . Roof water harvesting and trapping of the most polluted volume



The most straightforward way of rainwater harvesting is storage of roof runoff. It may be stored directly into a cistern (sump) with some simple method of diverting the most polluted portion of runoff such as shown in Figure 2. Whilst this has been continuously practiced in many developing countries, the technique is also being revisited in developing countries (Herman-Schmida 2000).

3) Flood risk reduction (runoff volume and peak reduction)

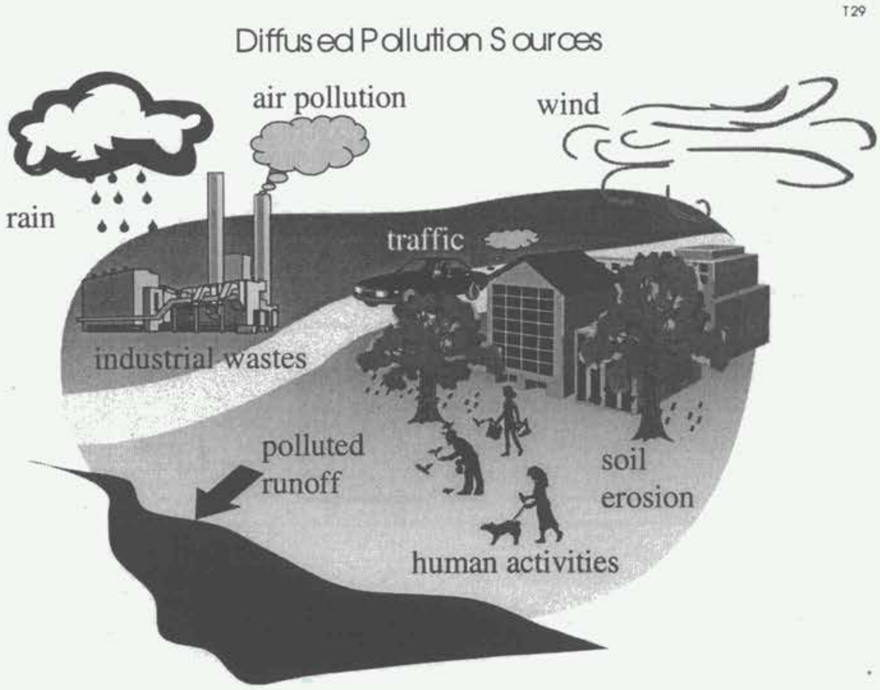
Engineers' conventional role in drainage is the reduction of local flooding. Reducing flood risk in SUDS is achieved by significantly reducing the quantity of water taking part in direct runoff and attenuating any runoff does occur. This is managed by the combination of two major techniques:

- infiltration and
- storage

4) Stormwater quality enhancement

Despite the common view that prevailed in the past, urban runoff is not clean. It erodes soil from unprotected areas, dissolves chemicals and organic material spread throughout the catchment and washes off pollutants from impermeable surfaces. Additionally, if not prevented, runoff interacts with domestic and industrial wastewater. This is especially true when combined sewerage systems are used, mixing foul sewage with runoff. The sources of pollution are spatially distributed throughout the whole catchment. If not properly managed they end up in receiving water bodies. Figure 3 depicts diffused pollution sources that lead to polluted runoff.

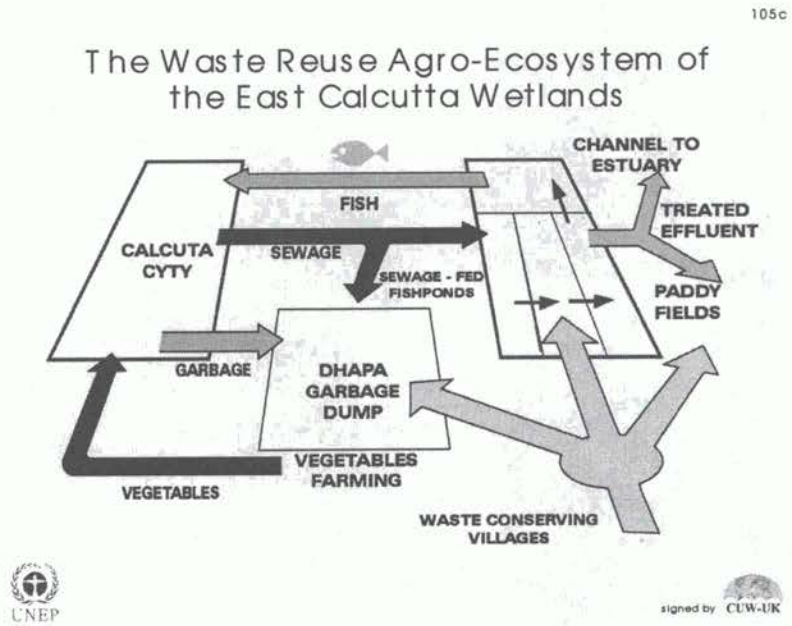
Figure 3. Diffused pollution sources in urban areas



One of the roles of SUDS is to improve urban runoff quality by dealing with it in all phases of runoff, starting from the moment when the raindrops hit the ground to its disposal into receiving water body. Treatment takes a variety of forms, but mainly falls into processes such as settling, filtration and biological action. Although not all parts of the treatment train may be present in every SUDS, all of the ones present have a role to play in the gradual quantity reduction, degrading and removal of pollutants. Although most of the pollutants stay in the catchment, there is evidence (Bond et al. 1999) that they become less toxic through various processes and interactions with vegetation, soil, pavement material, air and micro-organisms. The final result is a cleaner, less environmentally harmful runoff.

The quality of runoff should be considered as part of integrated urban water management. It does not make much sense to provide extremely sophisticated wastewater treatment plants including tertiary treatment if the diffused sources contribute significantly to surface water pollution. Additionally, it should be kept in mind that some solutions for natural treatment of domestic wastewater such as applied in Calcutta (Figure 4), can be successfully combined with storm water treatment.

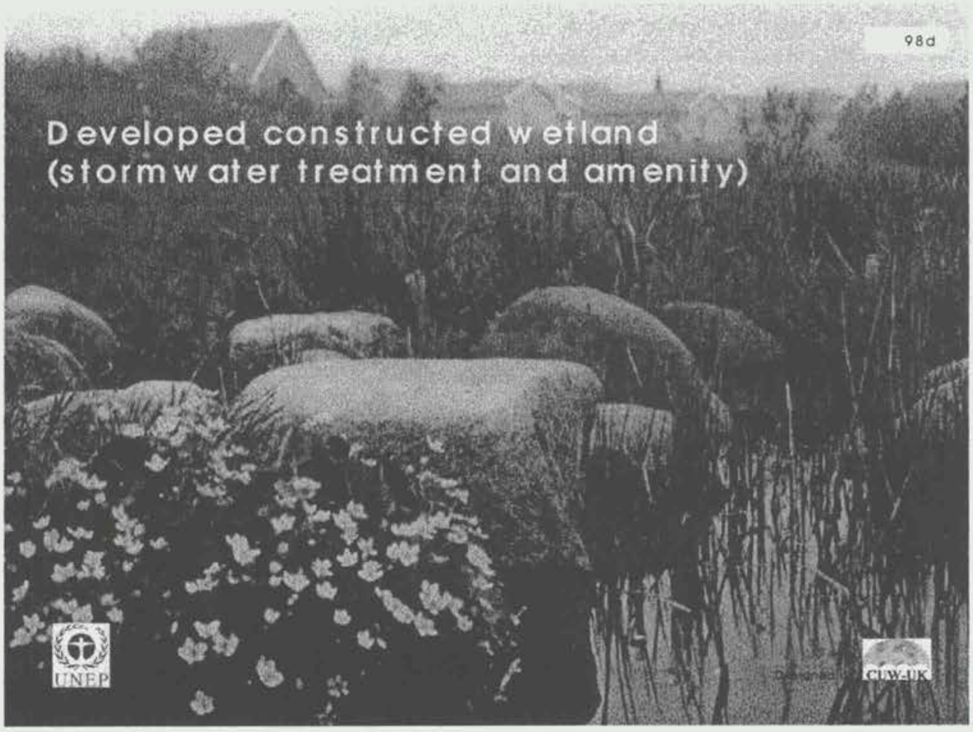
Figure 4. Integrated natural treatment of waste water, solid waste that can be combined with storm water treatment



5) Amenity values

The amenity value of a properly designed sustainable drainage system should be balanced with two other goals – to control water quality and quantity of runoff. By integrating sustainable urban drainage systems into an overall plan of land development, public areas can fulfil dual functions. Landscaping of the development will be enhanced, not just through the inclusion of water features, but also through improved soil moisture levels that result from the drainage system, reducing the need for irrigation. Developing any open water or wetland feature into a conservation area has a high level of public support. As demonstrated by Parikh (1999), the amenity component plays a very important role in the rehabilitation of slums in India. He claims that improved amenity of the rehabilitated slums was a motivation factor for individual contributions of the settlers for further upgrades. It has also been demonstrated in developed countries (Sweden for example) that an attractive wetland (Figure 5) has been "appreciated" by the neighbouring community, which was ready to pay a higher price for properties in the area.

Figure 5. Stormwater detention constructed wetland as an amenity element in an urban environment



CONTROL METHODS

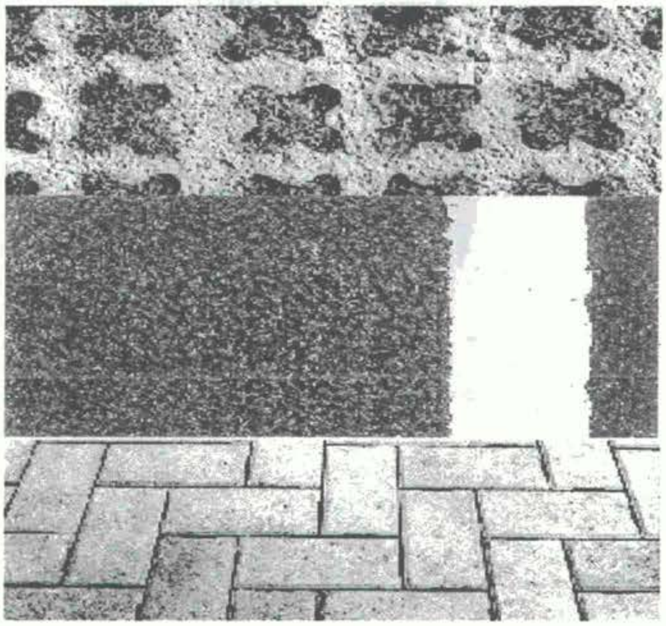
a. Permeable surfaces

Permeable surfaces, such as shown in Figure 6 are used for infiltration and temporary storage of rainwater directly falling on them or running from adjacent areas. Pavement construction acts as a reservoir, and is drained slowly. Surfaces should be as flat as possible, and thus no cross slope is needed. Rainwater captured by permeable surfaces is subject to evaporation. According to Bond et al. (1999), treatment of pollutants takes place in the bio-film created around the gravel or crushed stone used in the permeable sub-base. Although these results have yet to be proved in further research, they indicate that these structures have a certain potential for pollution reduction. These techniques are not currently nor widely accepted for applications that impose high load, but are ideal for car parks and driveways.

Permeable surfaces include gravel areas, solid and porous blocks, as well as continuous porous or permeable pavement. The selected surface has to meet certain hydraulic and structural design criteria. They can be incorporated into design both with and without infiltration. The former method consists of a permeable surface layer, bedding layer and a sub-base. Infiltration occurs to the sub-base and then to the underlying soil. An overflow route should be provided for intense storms that exceed the permeability of the

system. In the case with no infiltration, an impermeable membrane below the permeable sub-base is provided. The outflow occurs at the bottom of the permeable fill, and overflow occurs along the surface.
Long, narrow permeable surfaces can be used adjacent to impermeable areas to collect runoff. These are known as filter drains. Filter drains consist of permeable materials located below the ground surface to store the runoff. The permeable surface can be in the form of grassed or gravelled areas, paving blocks with gaps between individual units, paving blocks with vertical voids built in or porous blocks. Water is therefore collected from a large area, stored in the filter drains and allowed to infiltrate through the soil or slowly drain horizontally along the drain before discharge or further treatment. The permeable fill traps sediments and thereby cleans the runoff. Filter drains and permeable surfaces are currently used for road verges and car parks. The surfaces should be kept clear of silt and cleaned regularly in order to keep the voids clear. Weed control may be necessary.

Figure 6. Examples of porous surfaces

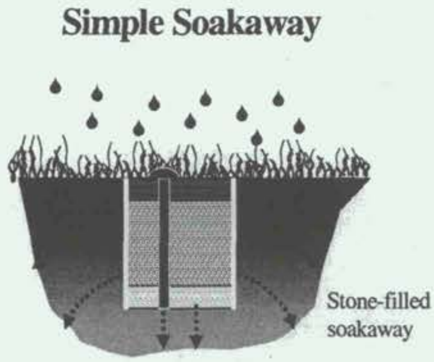


b. Infiltration

Infiltration devices drain water directly into the ground. They include infiltration strips and infiltration basins, which are located at the ground surface and soakaways, infiltration reservoirs and trenches which are located below the ground surface, and into which run-off is directed. Inflow can be in the form of sheet flow across the surface or concentrated in a pipe and then discharged into the device. They function by storing water temporarily and allowing the water to infiltrate into the ground. For a better aesthetic appearance, infiltration basins should be completely covered by grass. They work well when the soil is permeable and when the groundwater table is not close to the surface, although they can be used to a limited extent even on clay soils. Maintenance consists of regular inspection to ensure that the infiltration capacity is maintained. Areas draining to an infiltration device should be kept clear of silt, as this will get washed into the device and reduce its permeability as well as fill up space that should be used for storage. Thus in the management train, a system should be placed upstream of the infiltration facility to either prevent silt from occurring (through sweeping or erosion control) or to remove silt (by filtration or settlement). Soakaways are typically used for roof drainage from individual houses. Where the runoff is relatively clean. Drainage of polluting areas, such as construction sites, should be treated through several stages of a management train before infiltration can be permitted. They should not be applied in zones from which groundwater is used for drinking water.

Infiltration takes place not only in intentionally built areas such as soakaways (Figure 7) and infiltration trenches, but also through the sides of ponds and channels. It can be seen that many of the features constructed as part of a sustainable urban drainage system fulfil several roles.

Figure 7. Simple and chamber soakaway with inspection tube and shaft for debris



39

removal

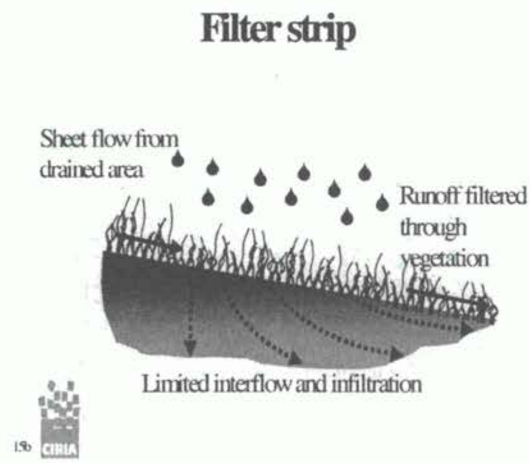
38

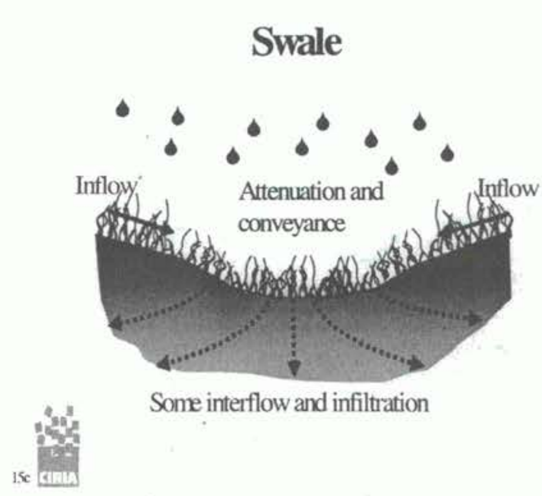
c. Filter strips and swales

Filter strips are gently sloping, vegetated areas of ground. Sheet flow from the drained area passes through the vegetation (most commonly grass) which produces a filtered runoff. They are designed to slow the flow, so silt is settled and filtered out of the runoff. There is a limited interflow and infiltration to the soil, since most of the water is transported along the surface, through the vegetation.

Filter strips are intended for low flows, as the grass interference is greater and the filtration is higher. High velocities of water can flatten the vegetation, causing much poorer filtration. A figure (Figure 8) of a filter strip is presented below:

Figure 8. Filter strip and swale





Swales are long, shallow channels with a gentle gradient. The sides of the channel act as filter strips whilst the gentle gradient of the channel and cross-section slows down the flow, storing the rainfall water within the channel. The low velocity of the flow allows the settling of solids whilst the grassed banks provide a medium for bio-filtration. The water also percolates into the soil, and is subject to physical and biochemical filtration as it naturally infiltrates. This combined effect reduces the area of land required, as compared with a system that treats and attenuates flows separately. Swales should be designed and built alongside the impervious areas they are meant to drain in order to receive sheet flow from the surface.

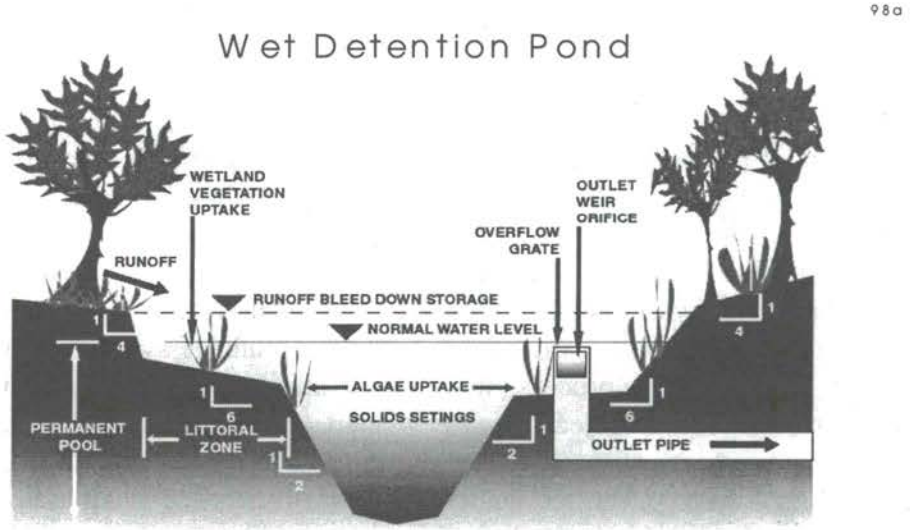
d. Storage

If high flows or pollution cannot be prevent at source, the runoff may have to be stored to attenuate storm peaks and treat contaminants. Runoff can be stored in specially constructed underground reservoirs which can be either empty or filled with gravel, or on the ground surface located in natural or constructed, *detentions basins, retention ponds* and *wetlands* (Lawrence and Breen 1998). They store water temporarily (a basin) or permanently (a pond). Detention basins have normally dry beds, provide flood storage which attenuates flows and permits settlement of coarse silts *Retention ponds* are permanently wet, retaining a minimum amount of water over dry periods. They are inhabited by aquatic vegetation around the edge and provide longer hydraulic retention times, allowing greater levels of treatment. Wetlands are shallow ponds and marshlands covered almost entirely in aquatic vegetation, providing even more treatment potential. Run-off water quality is improved upon storage in basins or ponds because of sedimentation of solids, bacterial action and nutrient uptake by vegetation.

Flows downstream of the basins or ponds can be controlled. Basins and ponds also act as infiltration devices, and are usually used at the end of the stormwater treatment train, providing an additional step if source control does not have an adequate capacity to control run-off and pollution. The detention time can vary from a matter of hours (detention) to up to three weeks (retention). Both basins and ponds can be vegetated, so a range of features can be created, which have amenity values for passive recreation or wildlife habitat. Water stored in ponds can also be used for irrigation of parks and gardens or for fire-fighting and other purposes. Basins and ponds need to be maintained in order to control vegetation and removal of accumulated silt.

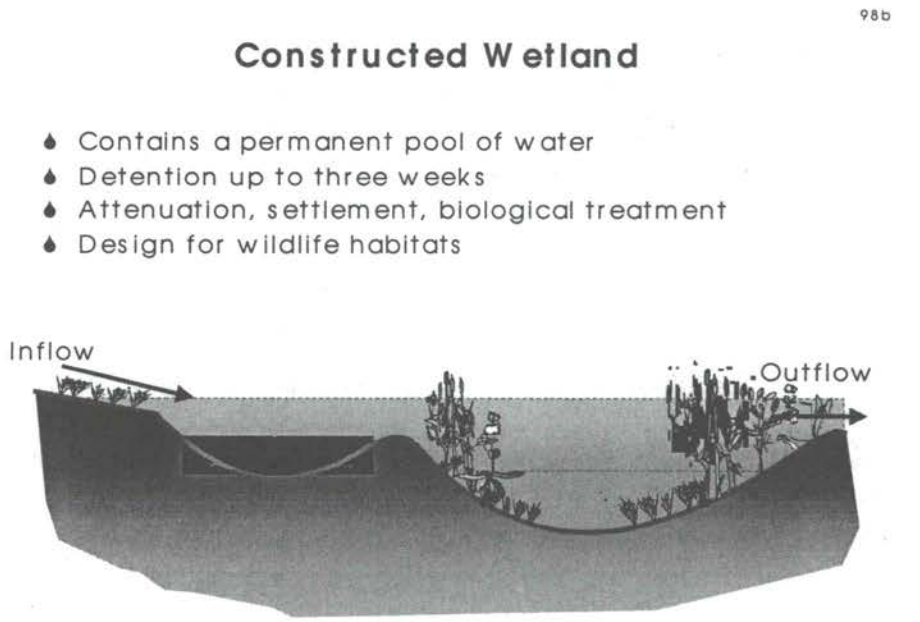
A sufficient base flow must be ensured in order to keep the wetland in operation during dry weather periods. Appropriate vegetation should be selected to suit the local soil, climate, wildlife and water regime. A detention pond with permanent pool of water is depicted in Figure 9.

Figure 9 . Wet detention pond with permanent pool of water



A cross section through a constructed wetland is shown in Figure 10. It should be noted that it contains two parts, the upstream one in which settling of sediment and treatment takes place and the permanent pool, which should be at least three times greater in volume.

Figure 10. Constructed wetland



MULTIPLE FUNCTIONS

The fact that various techniques perform several functions is not limited to technical matters. The water features can form an integral part of the landscaping during land development. Thus visual and conservation considerations also have an impact on the design of sustainable drainage systems. They can attract wildlife and create a pleasant environment. In places where basins or channels are dry for most of the time, the areas can serve a dual purpose. Paths, car parking lots or sports fields can all be allowed to flood and thus provide cost-effective water storage. If designed properly, these areas can rapidly recover from inundation and serve their primary purpose for most of the year. This idea can also be used with permeable pavements, where rainwater is retained within the paving layer and then drained at a natural flow rate. However, these advantages only accrue if all parties involved in the drainage system are involved at an early stage of the design process, in order to allow ideas and opportunities to be discussed and the wider project objectives shared. The design and operation should involve a wider range of professionals, including landscape architects, ecologists, engineers, hydrologists and water quality scientists. The public should also be involved, as the drainage methods selected have to meet their demands in terms of amenity, operation and perceived safety.

These techniques are affordable in developing countries, requiring simple construction and maintenance techniques and little or now imported materials and plant.

Information support
Successful application of SUDS will depend on the quality of information used in planning, analysis, design, construction and operational management. General purpose tools such as data bases, design and graphics packages are very useful. Spatial distribution of catchment characteristics, diffused pollution sources and of the source control and other SUDS elements require that the appropriate tools, including GIS based programmes, be used in any analysis. This is a challenge for the near future. However, in terms of software for SUDS analysis, a comprehensive model that treats this technology integrally, incorporates it into a conceptual integrated urban drainage model and provides interactions with other subsystems of integrated urban water management, does not yet seem to exist. Adding in the "soft" side of the process, in terms of consultation and aesthetic considerations demonstrated that modelling alone cannot provide an adequate design tool.

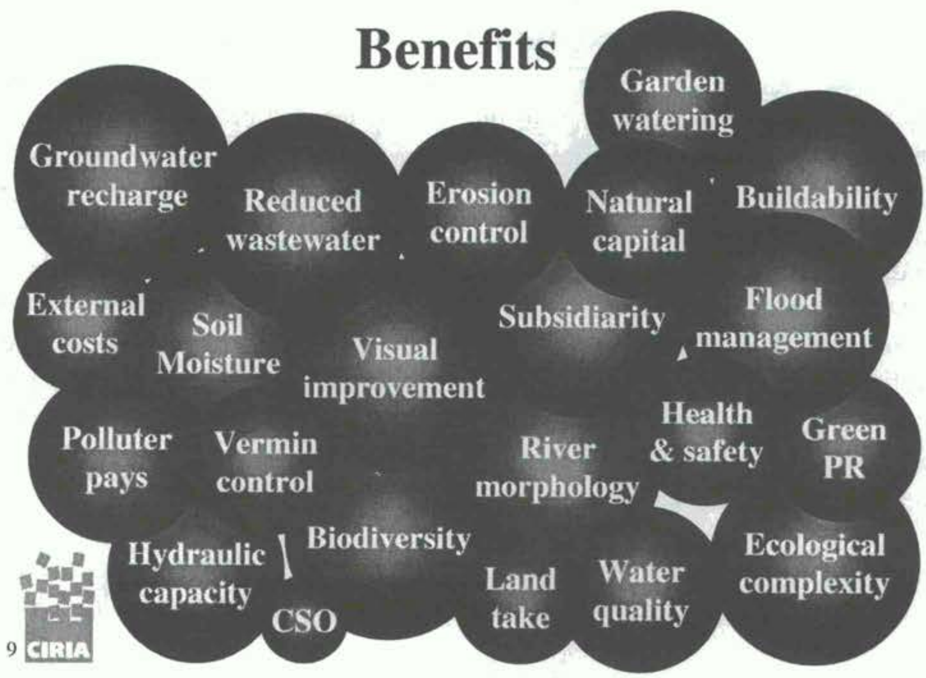
Benefits for using SUDS
SUDS are not universally applicable. They have to be carefully planned and maintained. Examples of successful applications as well as failures can be found in many countries. According to CIRIA (2000), the benefits are numerous (Fig. 11) and each of them should be evaluated against possible drawbacks that SUDS can generate. However, they should also be compared to the conventional alternatives and evaluated across all of the relevant disciplines (e.g. flooding, pollution, environment, operation, aesthetics) rather than the narrow criteria used in conventional design.

Barriers for wider use

Although the theory of sustainable urban drainage is accepted in some areas, it has not gained wide acceptance in developed countries. A great barrier is the low availability of information, both in general terms of the options available and in specific areas such as technical design and maintenance. The initial problem is the lack of awareness of the problems and the solutions currently available.

The proposed concepts require an integrated approach to design so they need to be addressed early in the design process. Developers need to be aware of the opportunities that can be used to their advantage. The lack of existing examples of such schemes leads both developers and planners to hesitate in selecting or approving these innovative techniques. Even if the idea is accepted, engineers and architects have only limited experience in the design of the features and the technical literature is not readily accessible, being both scattered through various sources or based on overseas experience. This in turn does not promote integrated design or the selection of the most suitable techniques. There are no specific problems in building most of the proposed features, even though some features, such as permeable pavements are only a recent development. However, contractors will have to develop experience in this area to refine the designs and gain confidence in these techniques.

Figure 11. Benefits of using SUDS



The operation, maintenance and ownership of drainage schemes also present issues that have to be resolved. The developers of a project normally hand over the responsibility of the drainage to either a local authority or the owners of the land. The very features that make sustainable drainage attractive have to be considered in the division of management responsibilities. There are very few single function features. As ponds serve multiple roles (a visual feature, conservation area and a drainage resource), the question of who is best suited to maintain the area has to be addressed early in the design and selection process.

In the past, pipes could have been identified in providing urban drainage and the responsibility assigned to the relevant body. A swale, basin or flood plain that is fully integrated into the landscaping should be maintained as such, but attention must be paid to some specific points. These include the disposal of settled solids from the runoff, the maintenance of infiltration features to ensure their continued effectiveness and the monitoring of the scheme to ensure it is functioning correctly.

This UNEP-ITS project, in addition to tackling the problems from various angles, is introducing new elements: comprehensive literature, regional overviews and a training manual. It is hoped that they will remove some of the barriers, for the benefits of the communities in which SUDS are to be applied.

ACKNOWLEDGEMENTS

The authors of this article are indebted to the colleagues and co-workers who provided photographs and slides and who assisted in the preparation of the training module, as well as providing useful suggestions for its improvement.

Thanks are due to: Miss I. Maksimovic and Miss M. Vidakovic for art work, design and professional processing of the slides, Miss Z. Todorovic and Mr. Z. Tamburic for their assistance in the final processing of the Power Point presentation, Mr. D. Andjelkovic who assisted in composing the final text and in preparation of the role game for running training courses. The consent of CIRIA (Construction Industry Research and Information Association-London UK) for making use of some of the SUDS training material is also acknowledged.

Thanks are due to the participants of the present Workshop held in Rio de Janeiro and Ms. C. Arnt for their valuable comment and feedback on the pilot version of TM .

Finally, the professional co-operation and support of Ms. L. Casanova and Mr. S. Matsumoto of IETC-UNEP enabled this product to be developed, tested and made widely available.

The satisfaction of the future users of the training manual as well as an overall international awareness raising will be a reward for their enthusiasm and professional assistance and support.

REFERENCES

1. Herman, T., Schmida, U,.(2000) Rainwater utilisation in Germany: Efficiency, dimensioning, hydraulic and environmental aspects. Urban Water, Vol. 1. Issue 3.
2. Bond P.C., Pratt, C.J., Newman, A.P. (1999) A review of stormwater quantity and quality performance of permeable pavement in the UK, Proc. 8ICUSD, Sydney.
3. Lawrence, I. and Breen, P. (1998). Design guidelines: Stormwater pollution control ponds and wetlands, CRC for Freshwater Ecology, WSAA, ISSN 1441-0656.
4. Parikh, H., (1999) Private communication.
5. Ho, G. and C. Maksimovic, (2000). International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC -UNEP, Technical Publication.
6. Maksimovic, C. and Ho, G. (2000) Training Module for the IETC -UNEP.
7. Group of authors: Regional overviews for the International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC.
8. CIRIA (2000) Sustainable urban drainage systems – best practice C523, London.
9. CIRIA (2000) Sustainable urban drainage systems – design manual for England and Wales, C522 London.
10. CIRIA (2000) Sustainable urban drainage systems (SUDS) - Training Material.
11. IETC- UNEP (2000) Manual for running training course (Role game).
12. Maksimovic, C., Butler, D., Graham, N., (1999). Emerging technologies in water industry, in Water Industry Systems: modelling and optimization applications, Edited by D. Savic and G. Walters, Research Studies Press , 39-64.
13. Macropoulos, C., D. Butler, C. Maksimovic (1999) GIS suported evaluation of source control applicability in urban areas, Water Science and Technology, Vol.39, Number 9 ISSN 0273-, p. 209-216.
14. Marsalek, J., C. Maksimovic, E. Zeman and R. Price (1998). Hydroinformatics in Planning, Design, Operation and Rehabilitation of Sewer Systems, ASI Series, Edited by, Published by Kluwer.

2b

Overview of Presentation

The concept of Sustainable Stormwater Management

- The concept of sustainability
- Aims, Management Train Benefits
- Hole life costing

Intetaed Source Control Solutions

- Concept for the future
- Stormwater collection under source control and treatment,

- Barriers to broader application
- Technology choice
- Sustainable scenarios

Principles of Modelling and Design

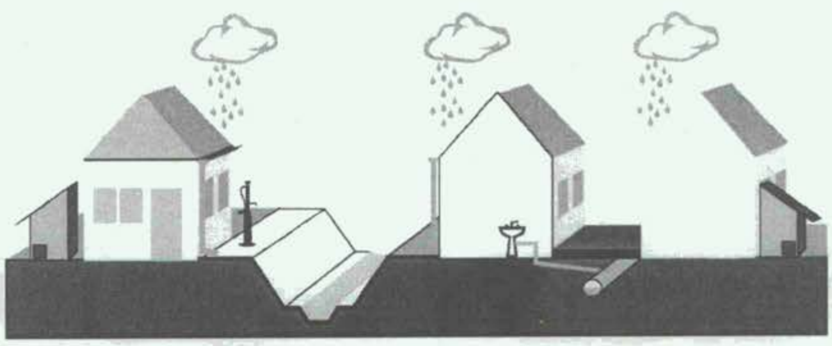
- basic approaches

T1

a. Natural Stream

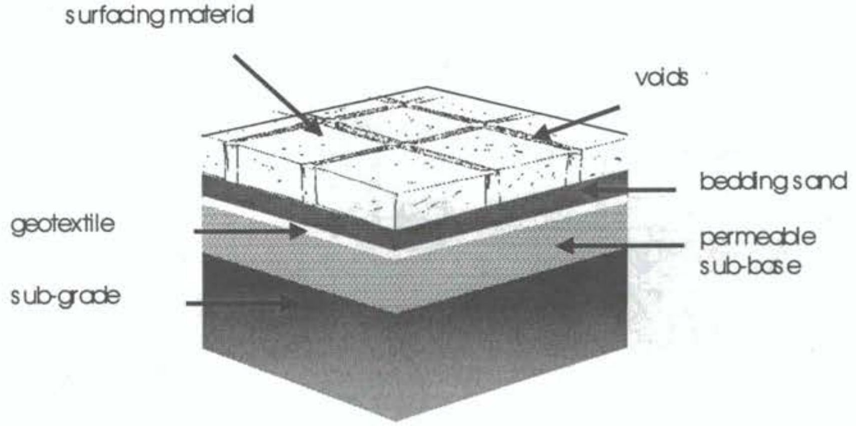
T2

b. Lined Channel



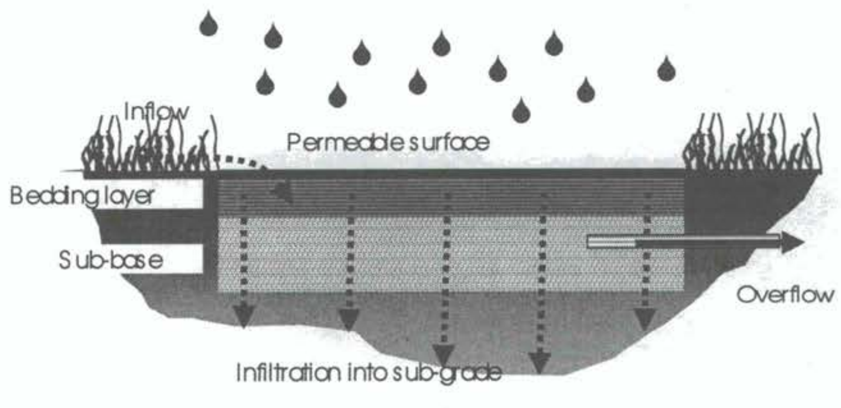
96a

Permeable Pavements



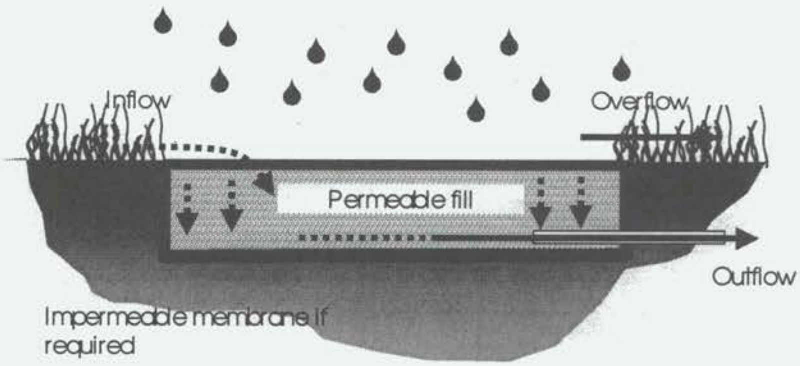
96b

Permeable Pavements with Infiltration



96c

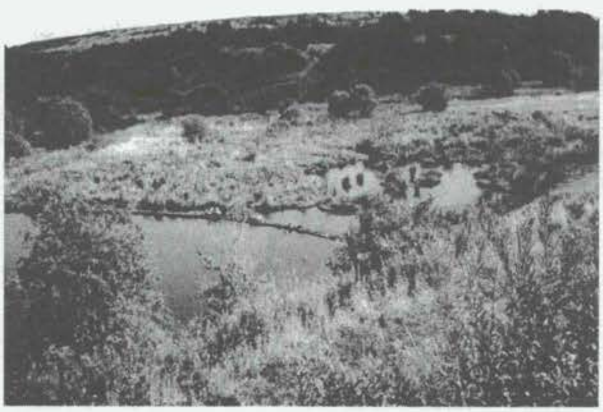
Permeable Pavements without Infiltration



98c

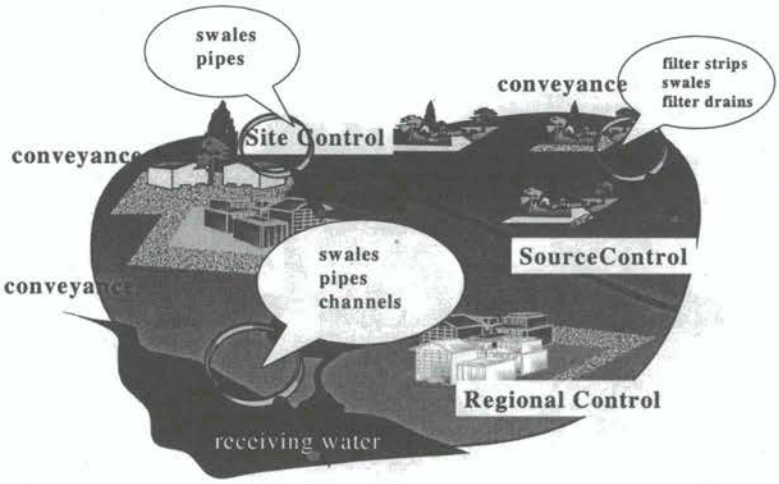
Basins and Ponds

- Detention basins
- Retention ponds
- Wetlands

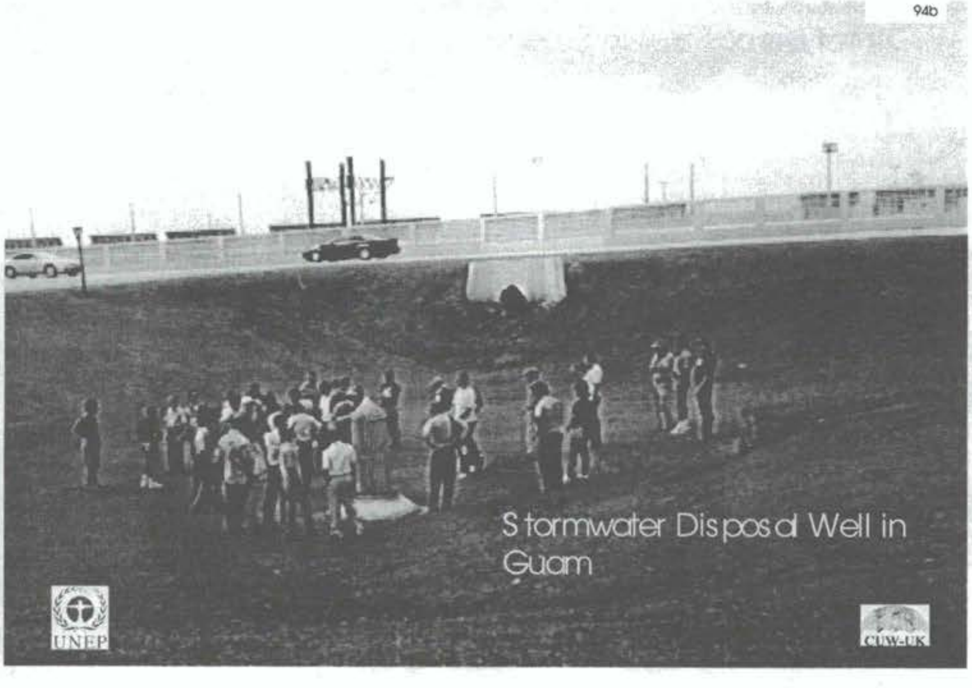


An Integrated System

T30

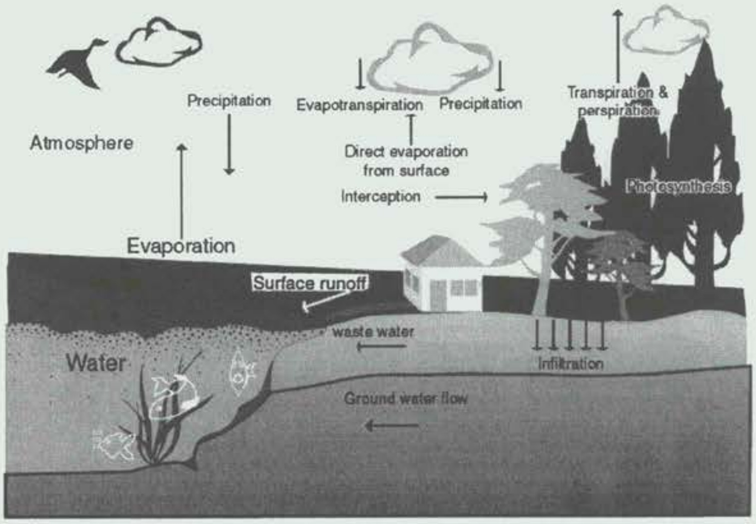


94b



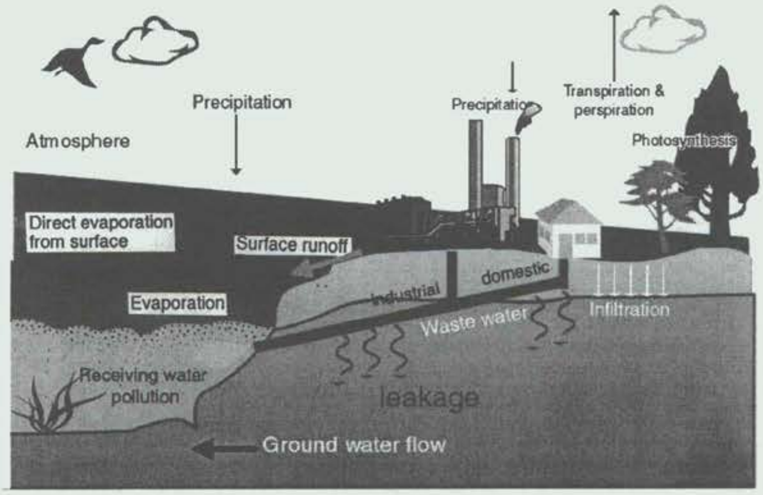
61b

Water Cycle in Developed Ecosystem



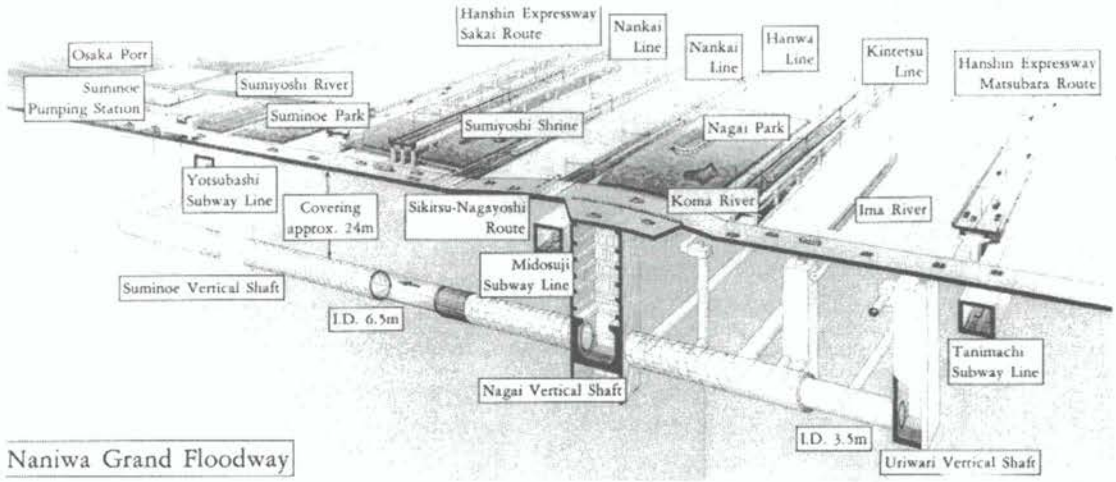
61c

Water Cycle in Urban Ecosystem; Direct Disposal - No Treatment



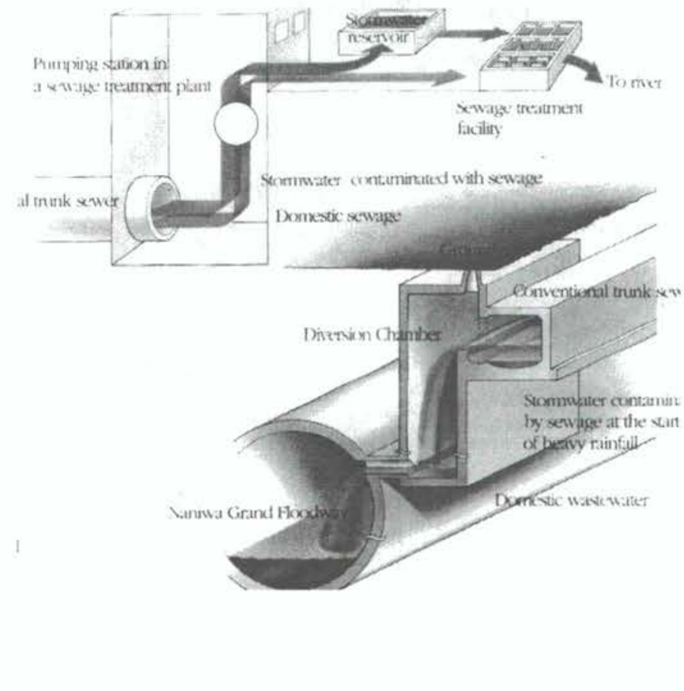
67c

Deep Underground Storage, Osaka, Japan

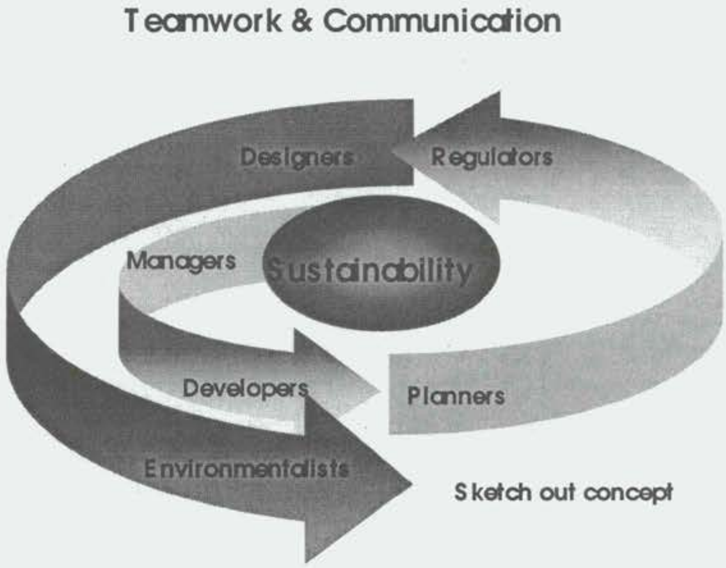


67b

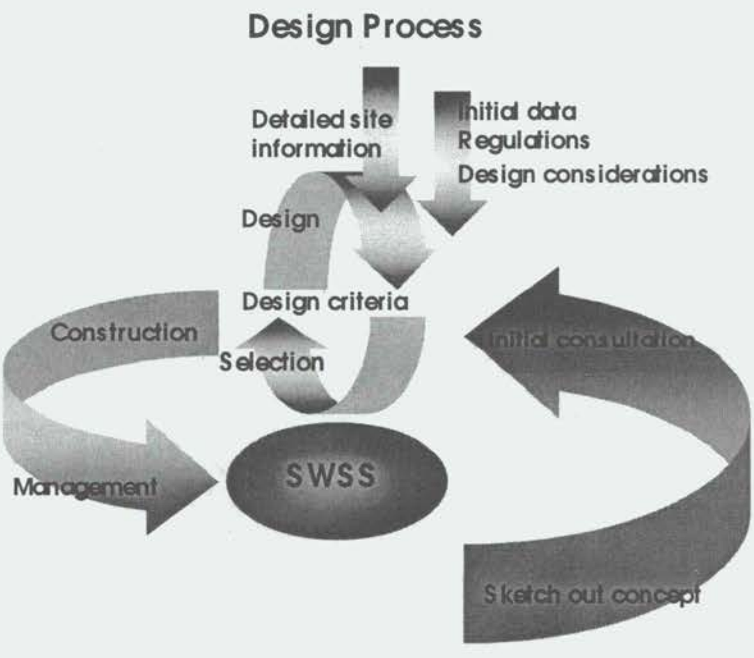
Concepts of Inflow and Outflow from the Deep Storage, Osaka, Japan

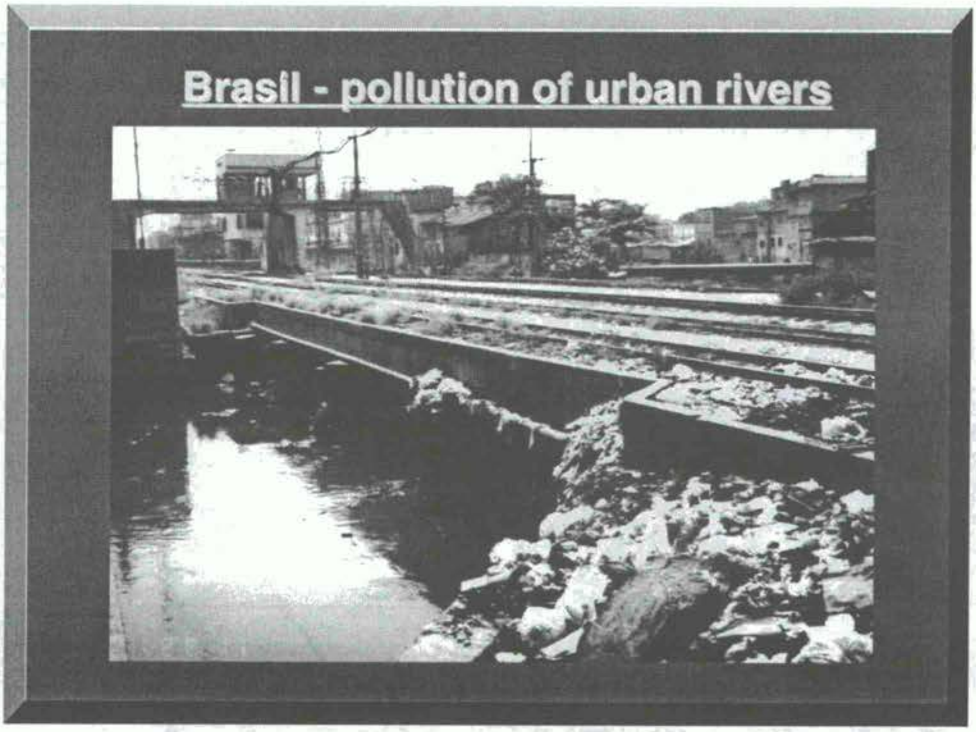


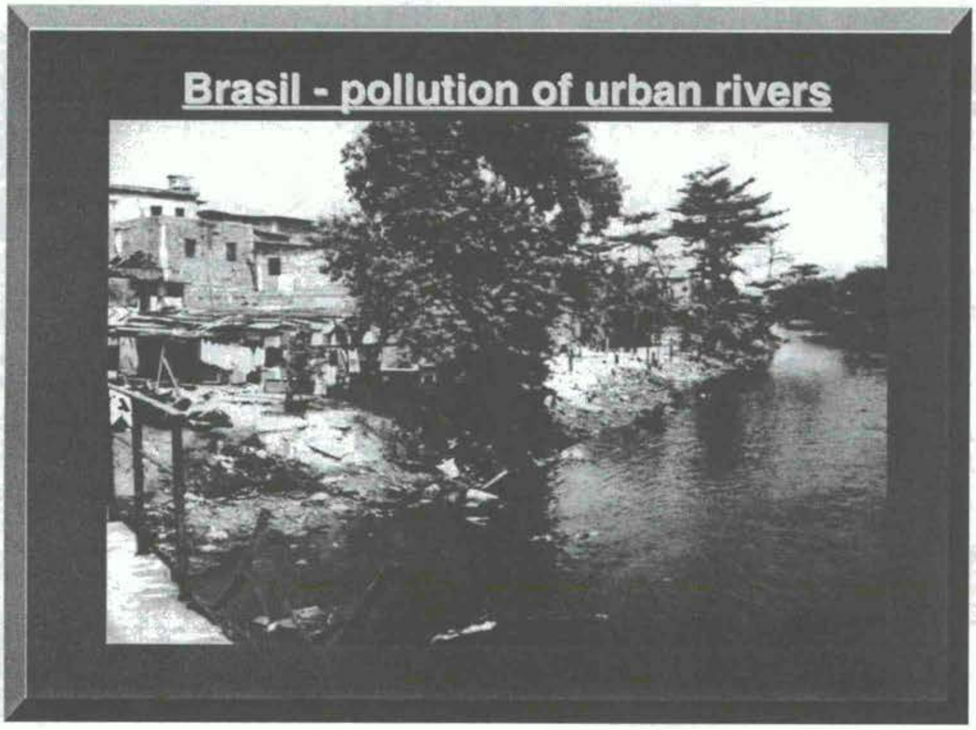
T33

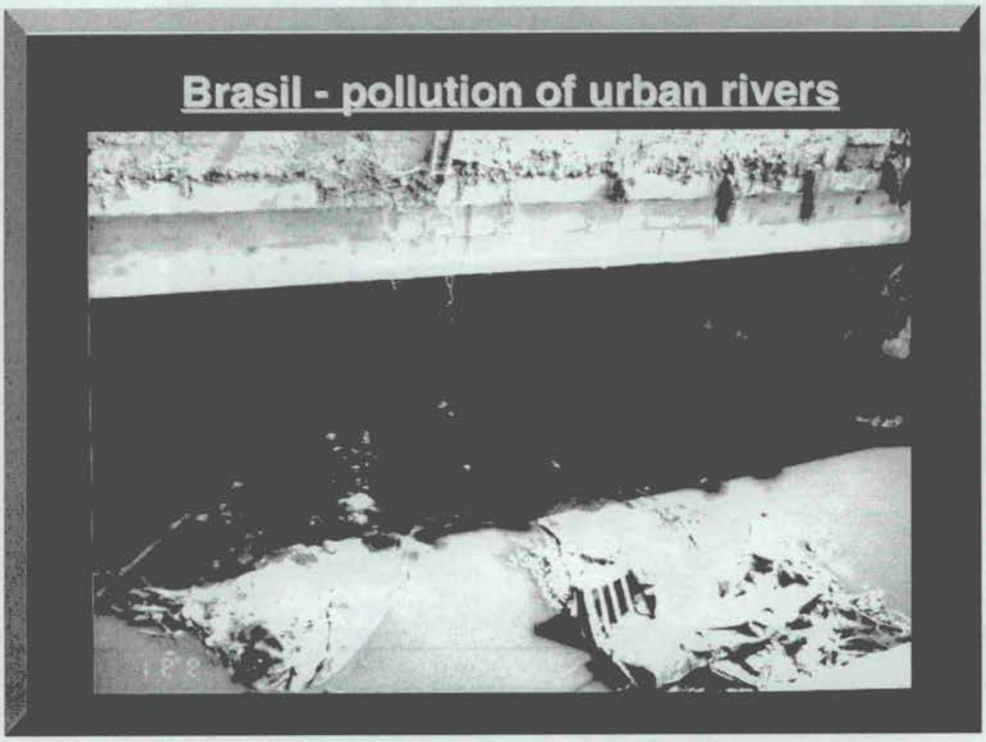

Teamwork & Communication
Designers
Regulators
Managers
Sustainability
Developers
Planners
Environmentalists
Sketch out concept

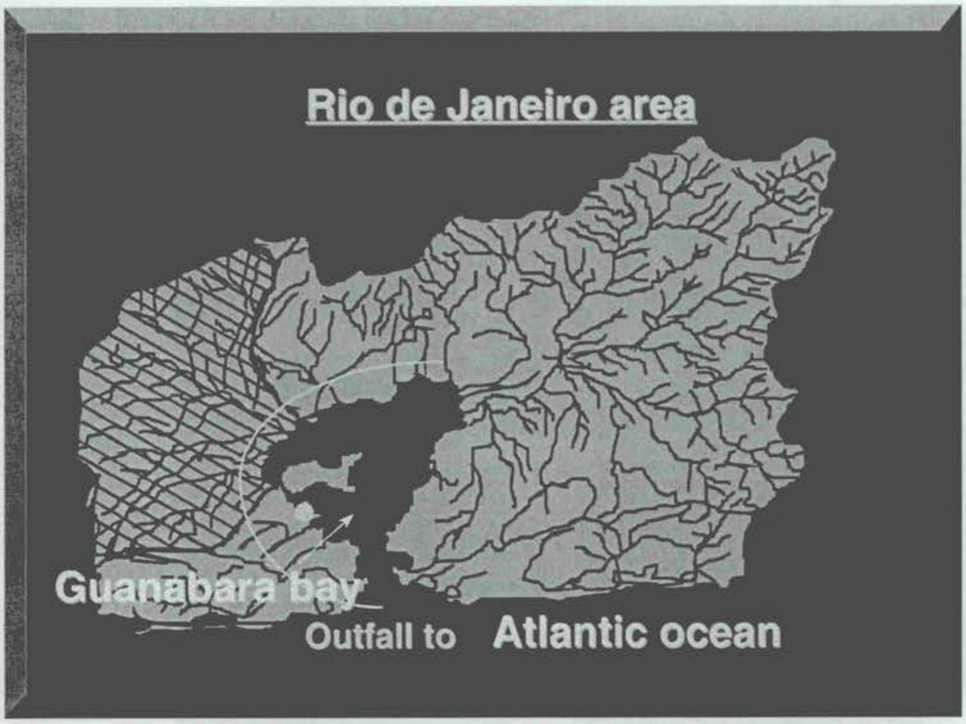
T34

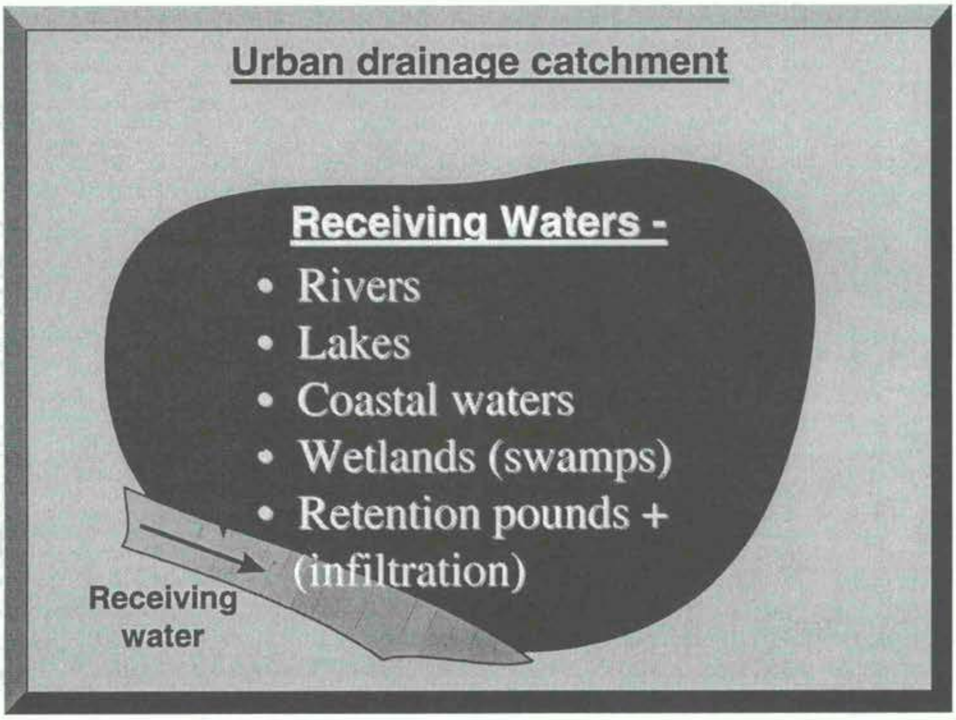

Design Process
Detailed site information
Initial data
Regulations
Design considerations
Design
Design criteria
Construction
Selection
Initial consultation
Management
SWSS
Sketch out concept

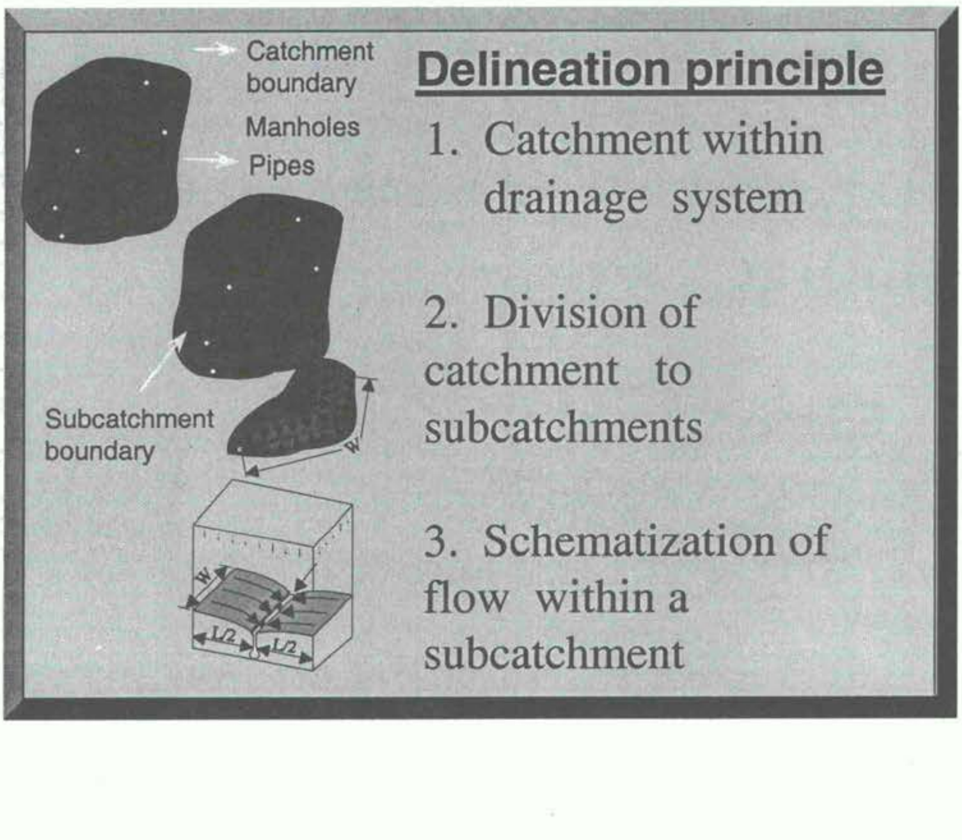

Brasil - pollution of urban rivers


Brasil - pollution of urban rivers


Brasil - pollution of urban rivers

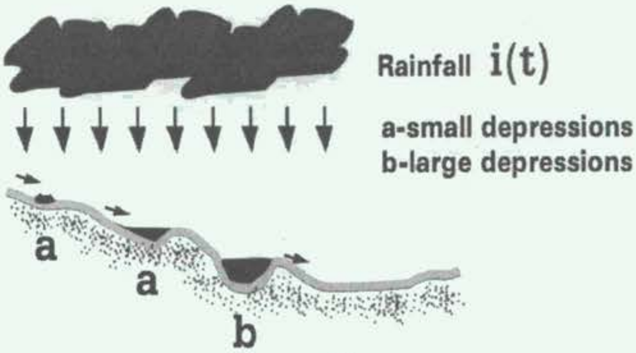

Rio de Janeiro area
Guanabara bay
Outfall to
Atlantic ocean


Urban drainage catchment
Receiving Waters -
• Rivers
• Lakes
• Coastal waters
• Wetlands (swamps)
• Retention pounds + (infiltration)
Receiving water


Catchment boundary
Manholes
Pipes
Subcatchment boundary
Delineation principle
1. Catchment within drainage system
2. Division of catchment to subcatchments
3. Schematization of flow within a subcatchment

T37a

Surface Retention



$i_{e1}(t)=i(t)(1-S/S_d)$

S -accumulated rainfall excess

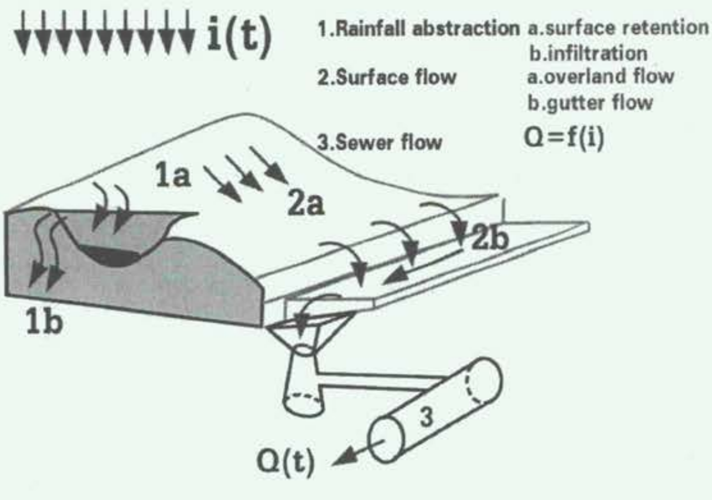
S_d-depression storage capacity

smooth impervious surfaces 0,5-0,7mm

soil with vegetation 2,5-4mm

T37b

Flow Processes in Urban Drainage System

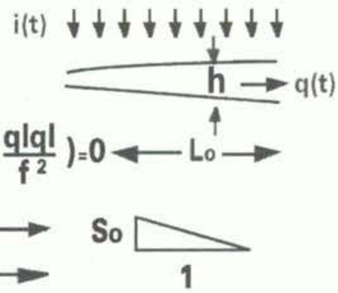


Overland Flow

$$\frac{\partial h}{\partial t} + \frac{\partial q}{\partial x} = i_e$$

mass conservation:

$$\frac{q}{\partial t} + \frac{\partial q^2/h}{\partial x^2} + gh\left(\frac{\partial h}{\partial x} - S_o + \frac{q|q|}{f^2}\right) = 0$$



← full dynamic →

← noninertial →

← kinematic →

$$f = \sqrt{\frac{2g}{c_\tau}}\, h^{2/3}$$

Sewer Pipe Flow

basic equations

mass conservation:

$$B\frac{\partial h}{\partial t} + \frac{\partial Q}{\partial x} = 0$$

momentum conservation:

$$\frac{\partial Q}{\partial t} + \frac{\partial Q^2/A}{\partial x} + gA\left(\frac{\partial h}{\partial x} - S_o + S_e\right) = 0$$

← full dynamic →

← non inertial →

T37e

Solution of the Equations of Kinematics Submodel

$$\frac{\partial y}{\partial t} + \frac{\partial q}{\partial x} = ie \qquad q = \alpha y^{\beta}$$

a) locally distributed (with discretisation of subcatchment width)

b) locally lumped(without discretisation of subcatchment width)

a) four point implicit method of Preissman,explicit methods...

b) Chowdnury-Pell method

simple single element=nonlinear reservoir

DISCUSSIONS

Cristobal Morejón (Cuba) - "About wet plants for controlling stormwater and wastewater, can you elaborate a little more on that? Are there examples where this can be applied? "

Cedo Maksimovic - "As I mentioned this is not a new technology. Open ditches systems have been applied all over the world and gradually have been replaced by pipes. This is only a turn back to nature. These systems are mandatory in Sweden for many years. Sweden has a regulation about what has to be done on source control at a household level and municipal level.

I have mentioned the example of Florida, because almost fifteen years ago they had undergone systematic, retrofitting of the concrete retention basis and replace them by soft grass aquatic culture, microphytes.

I have seen an example of a factory that built a tennis court with concrete walls and it was used as storage for stormwater during the rain period. When the rain was over, it was emptied through a kind of a small pipe, cleaned and then use again as a tennis court. This s in a city in Japan that has been completely designed under source control principles.

This technique is being used for many years. It is now becoming mandatory in many countries. Germany, UK, France are changing regulations. Western Europe is waiting for these solutions right away. In the United States it has been applied in some states, maybe not so strictly enforced but more or less volunteered. I think the city of Los Angeles is planning to spend billions of dollars on stormwater cleaning."

Terrol Inniss (Barbados) - "Legislation in Barbados is being fought from all angles by some engineers. Right now we have total retention of stormwater on-site for industrial and commercial buildings.
Is it possible that any of the two agencies, either IETC or UNEP, issue their views on legislation with access to those who are trying to champion the same cause of sustainable stormwater, wastewater and even solid waste management? Can you issue your endorsement to legislation that would put this sort of things in place? "
Cedo Maksimovic - "I see two persons who can answer this question better than me, Richard Middleton and Lilia Casanova."
Lilia Casanova - "That is a function of UNEP, not IETC. We have a division called Division of Implementation and Law. What I can do is submit a recommendation to this division saying that this is a request from participants from a workshop that we conducted. And then we will see how they will react to the recommendation."
Richard Middleton - "I come from a country that has about 5000 stormwater management ponds in suburban Washington, all of which are community managed. So, I am extremely interested to hear this very good approach to both reducing stormwater flows and treating monumental problems of polluted runoff, in our case lawn fertilizers, salt from snow removal and so on.
Swales are excellent but not all the 'favelas' in Brazil have these nice grassy areas so you can have overland flow. In South Asia they are doing research on road storage because the road plus its curbs on each side represent a considerable storage which can be used on peak season.
There is also a very old technology in this part of the world. It came from India and it is a grass called *'vetiva'* introduced in the West Indies to stabilize roads and sugar cane plantations. It is a small grass that produces perfume and whose roots go down into the soil three meters at least. So if you are trying to stabilize the water flow, you can plant what we call a 'green dam'. It really stops the water then it extracts and stops the silt. I would strongly recommend looking at things like that."

Viviana Rocco (Uruguay) - "I agree with Richard about the importance of these designs and I would emphasize for our countries the maintenance. I consider it essential; not only the solid waste but also maintenance."

Augusto Sergio Guimarães - "I might add one aspect regarding what we call here in Brazil 'drainage without rains'. When you consider the low-income areas, placed in the upper areas of a basin, to some of these areas we may provide adequate drainage services by just using the grade of the streets rather than installing the conventional drainage system. Another aspect is to provide a practical example that might go in parallel to the very learning sequence of activities you proposed us. So if we could add one practical example from an specific city might, it would be very helpful."

HIGHLIGHTS FROM THE SANITATION OVERVIEW OF SOUTH AND CENTRAL AMERICA

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22210-080 Rio de Janeiro - RJ
Brazil
asprovita@alternex.com.br

ABSTRACT

The presentation starts by discussing Regional population , population distribution and sanitation coverage, stressing from the outset the unreliability of some of the information gathered. Actually the author will insist with the request for a qualitative analysis to be performed by experienced consultancy so as to confirm (or not) available data, especially when for work on unofficial forums. Country-wide internal variations will also be explored by the author as for some countries average figures may reflect high levels of services coverage in capitals and other large cities and thus hide difficult situations encountered in villages and small cities.

Regional wastewater characteristics will be shown and discussed, with the author once again emphasizing that wide standard variations makes average figures questionable, which is quite different from what happens as rule in developed societies.

The author will express his pessimistic view on the service coverage trends especially regarding the present and increasing financial difficulties being experienced by the Regional sanitation sector.

The author then analyses conventional sewers and how they have been used in the Region without engineering codes being duly adapted, which has been as important money wastage factor. Alternative sewer systems are taken into consideration especially the Brazilian condominium sewerage and the Colombian solids free sewerage.

On-site sanitation is also discussed, with the author remarking that despite efforts made by agencies the Region's sanitary engineering sector still regards it as a second class solution. Nevertheless new technology achievements on the design and construction of precast , fiberglass septic tanks and soakaways are reviewed.

Region-wide sewage treatment procedures and coverage are also described, with sound alternatives presented. Sewage reuse practices and why it is not so spread in the Region is assessed, too.

South and Central America

Country	Population (in 1000's)		
	Total	Urban	Rural
Argentina	34,587	30,152	4,434
Bolivia	7,061	4,320	2,741
Brazil	161,790	126,190	35,594
Chile	13,951	11,823	2,128
Colombia	35,886	26,491	9,395
Costa Rica	3,330	1,441	1,859
Ecuador	11,460	6,944	4,516
El Salvador	5,310	2,685	2,625
Guatemala	10,621	4,108	6,513
Honduras	5,462	2,425	3,037
Nicaragua	4,139	2,138	2,001
Panama	2,630	1,412	1,218
Paraguay	4,564	2,297	2,267
Peru	23,468	16,445	7,021
Suriname	410	263	147
Uruguay	3,129	2,820	309
Venezuela	21,844	18,656	3,168
Total	349,642	260.610	88.973

Sanitation Service Coverage

Population Served (1995)

- Below 40%
- 41-70%
- 71-100%

Wastewater Characteristics

Central America (also valid for South America)

SEWERED AREAS

communities which present homes and businesses piped water and sewers

Total Suspended Solids (TSS)	200-300 mg/L
5-day Biochemical Oxidation Demand (BOD)	200-250 mg/L
Chemical Oxidation Demand (COD)	350-450 mg/L
Total Nitrogen as N	25-60 mg/L
Total Phosphorus as P	5-10 mg/L
Oil and Grease	80-120 mg/L

Wastewater Characteristics

Central America (also valid for South America)

SEWERED AREAS

communities which present homes and businesses piped water and sewers

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Total Phosphorus as P	5-10 mg/L
Oil and Grease	80-120 mg/L

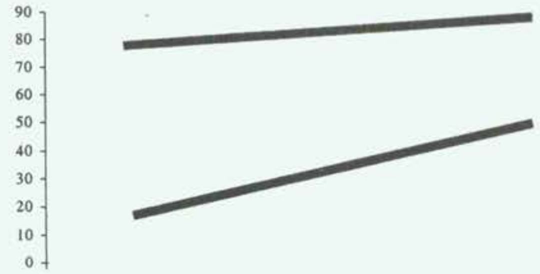
UNSEWERED AREAS

but served by septic tanks

TSS	10,000-25,000 mg/L
5-day BOD	3,000-5,000 mg/L
COD	25,000-40,000 mg/L
Total Nitrogen as N	200-700 mg/L
Total Phosphorus as P	00-300 mg/L
Oil and Grease	2500-7500 mg/L

Sewage Collection (%)

	1980	1988	1995
Urban	78	80	80
Rural	22	32	40
Total	59	66	69



Population Served With Sanitation Services Data for 1995 (Population in Thousands)										
Country	Population			Sewage and Excreta Disposal						
				Total Population Served		Urban Population				
	Total	Urban	Rural	Population	%	House Connection	%	Others	Total	%
Argentina	34,587	30,152	4,434	26,104	75	11,686	39	12,565	24,252	80
Bolivia	7,061	4,320	2,741	4,376	62	1,784	41	1,324	3,308	77
Brazil	161,790	126,190	35,594	109,075	67	44,036	35	49,563	93,599	74
Chile	13,951	11,823	2,128	11,231	81	9,340	79	1,891	11,231	95
Colombia	35,886	26,491	9,395	21,081	59	17,219	65	1,325	18,544	70
Costa Rica	3,330	1,441	1,859	3,198	97	768	55	653	1,441	100
Ecuador	11,460	6,944	4,516	6,073	53	4,262	61	627	4,889	70
El Salvador	5,310	2,685	2,625	4,091	77	1,615	60	773	2,388	89
Guatemala	10,621	4,108	6,513	7,141	67	2,868	70	998	3,867	94
Honduras	5,462	2,425	3,037	4,453	82	1,216	50	1,078	2,294	94
Nicaragua	4,139	2,138	2,001	2,437	59	730	34	1,147	1,877	88
Panama	2,630	1,412	1,218	2,381	90	899	64	500	1,399	99
Paraguay	4,564	2,297	2,267	1,465	32	466	20	N/A	466	20
Peru	23,468	16,445	7,021	14,431	61	9,654	59	3,141	12,795	78
Suriname	410	263	147	303	74	7	2	244	251	95
Uruguay	3,129	2,820	309	1,593	61	1,593	56	N/A	1,593	56
Venezuela	21,844	18,656	3,168	15,767	72	11,562	62	2,295	13,857	74
Total	349,642	260,61	88,973	235,2	69	120,398	52	78,124	198,051	80

Sewage and Excreta Coverage Comparison

Country	1995 Coverage	1988 Coverage	Variation
Argentina	75	89	-14
Bolivia	62	34	+28
Brazil	67	78	-11
Chile	81	83	-2
Colombia	59	65	-6
Costa Rica	97	97	0
Ecuador	53	56	-3
El Salvador	77	61	+16
Guatemala	67	57	+10
Honduras	82	62	+20
Nicaragua	59	19	+40
Panama	90	84	+6
Paraguay	32	58	-26
Peru	61	42	+19
Suriname	74	56	+18
Uruguay	51	60	-9
Venezuela	72	92	-20

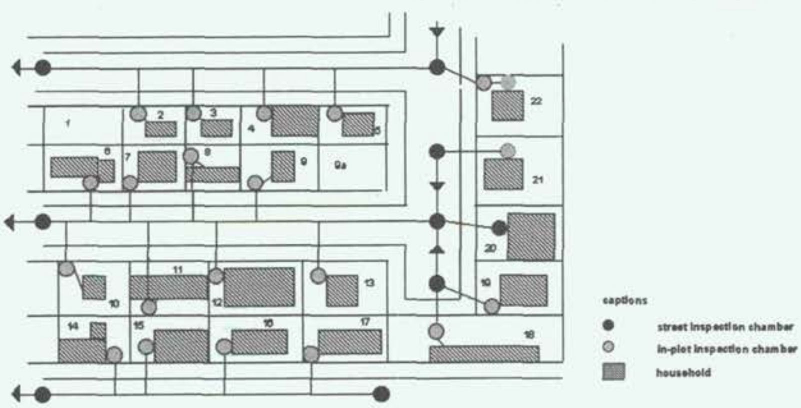
Regional Experience

- To copy American sewerage design codes <u>without adaptation</u>

- Overdesigned and overflats pipes
  - final flow as the only design flow
  - 200 mm diameter for minimum pipe

Regional Experience

conventional sewerage

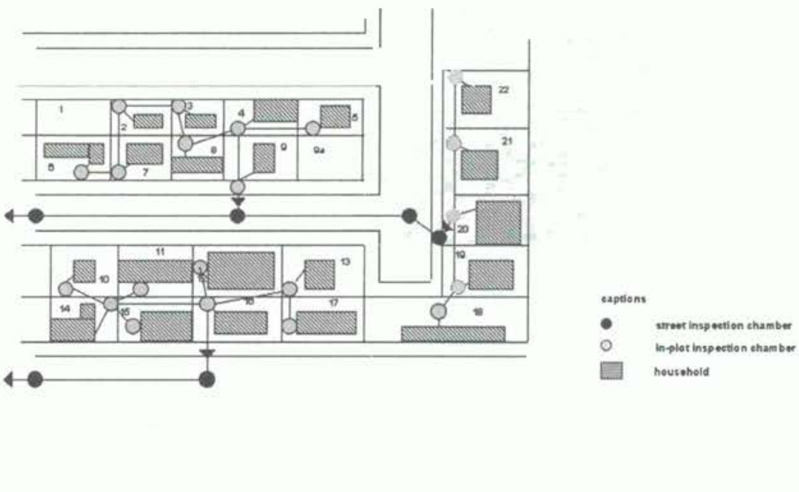


Brazilian Experience

- self- cleansing velocity concept
- use of minimum tractive force
- use of 100mm as the minimum sewerage pipe

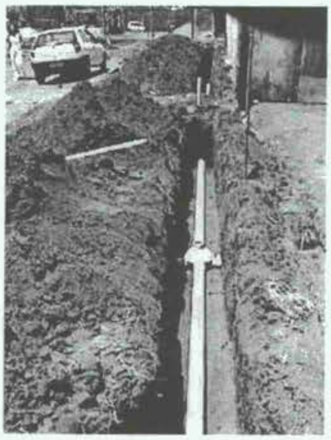
Brazilian Experience

condominium sewerage



Brazilian Experience

condominium sewerage

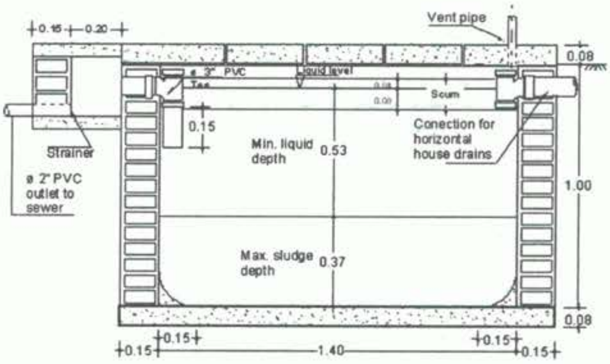


Brazilian Experience

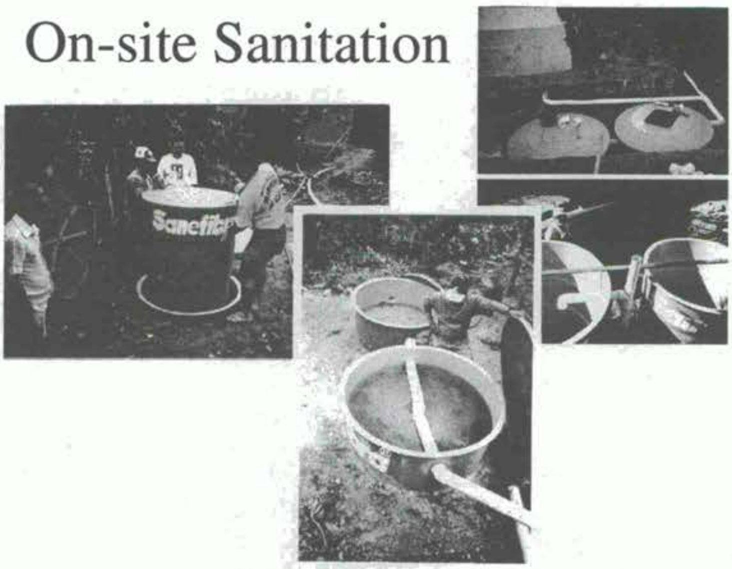
condominium sewerage

Colombian Technology

Solids-free Sewerage (ASAS)



On-site Sanitation



Precast, fiber-glass septic tank and soakaway

Sewage Treatment

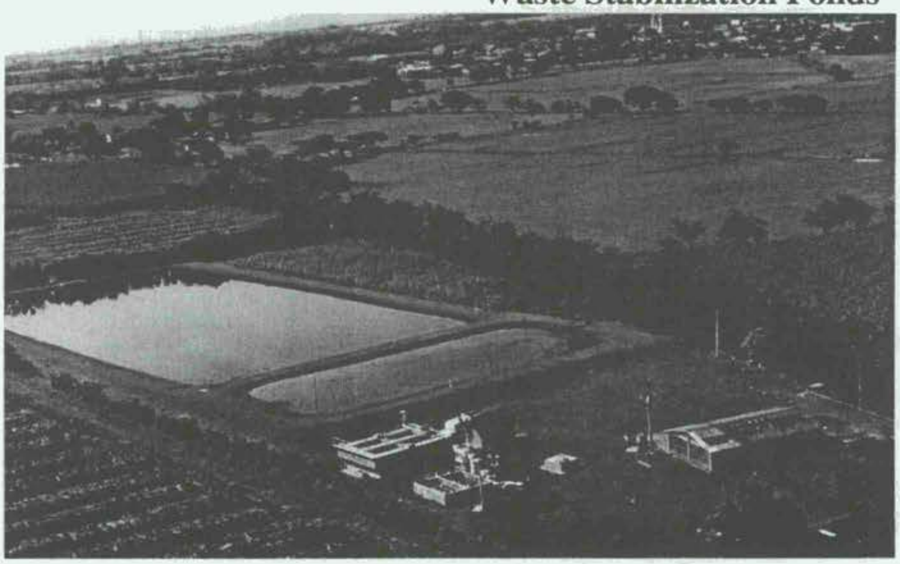
Percentage of Sewage Treated Before Discharge							
Country	Proportion of Urban Sewage Treated Before Discharge	Proportion of Treated Waste by Level			Proportion of Waste Discharge in Rivers, Lakes and Sea		
		P	S	O	R	L	S
Argentina	10	0	100	0	-	-	-
Bolivia	30	33	67	-	8-	20	-
Brazil	20	10	68	22	-	-	-
Colombia	5	-	100	-	-	-	-
Costa Rica	3	33	67	-	98	-	2-
Ecuador	-	-	-	-	80	1	-
El Salvador	1	-	-	-	-	-	-
Guatemala	9	46	54	-	-	-	60
Nicaragua	21	46	54	-	19	80	-
Paraguay	1	-	100	-	100	-	-
Peru	-	-	-	-	-	-	-
Suriname	1	-	100	-	-	-	-
Uruguay	15	50	28	22	90	8	2
Venezuela	-	-	-	-	66	24	10

* P = Primary Treatment
S = Secondary Treatment
O=Others

** R = River
L = Lake
S = Sea

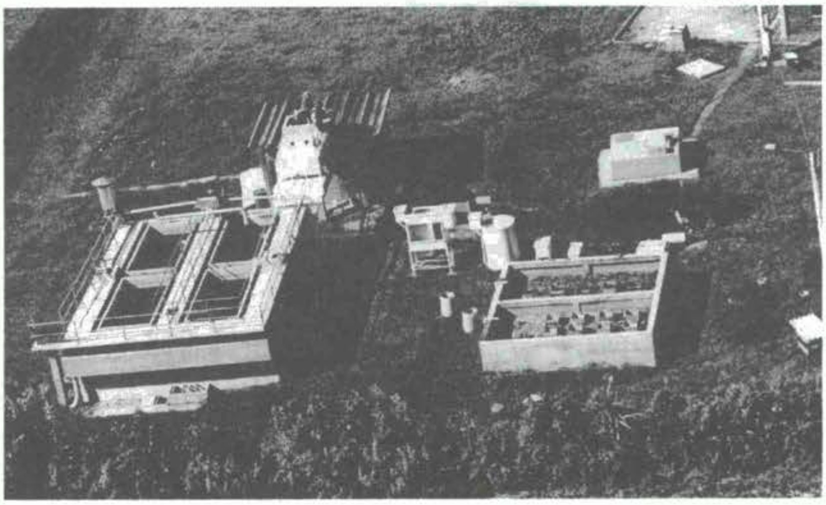
Sewage Treatment

Waste Stabilization Ponds



Sewage Treatment

UASB



Sewage Reuse

- Reuse practices poorly disseminated regionally
  - Cultural bias
  - Historically, low needs for reuse
  - Technology still to be absorbed

Sewage Reuse
San Juan Ponds, Lima, Peru

DISCUSSIONS

Viviana Rocco (Uruguay) - "In Uruguay we have been using Brazilian codes for quite a long time, which has helped us very much in saving money, but concerning final flood design for the pipes system, we must keep that final flow design because we have been building networks for a long time. We have our network functioning for more than a century. Concerning the minimum diameter issue, one limitation we do have is the maintenance equipment. So we cannot go below 00 or 150 mm because our equipment cannot go into the pipe.

About solids free sewerage, you mentioned the Colombian experience and we also have had good experiences with the 'Prof. Azevedo Neto's system' that has been working quite well in Uruguay with strong community participation. We have a double septic tank, so we stabilize solids in one for a year or two, while we use the other one."

Augusto Sergio Guimarães - "In the question of the final flow, it is something that does not preclude the use of the initial flow, so we call for using the initial flow so as to design the grade but use the final flow to design diameters. When you use only final flow, by all reasons you will be over designing the sewerage's."

Richard Middleton - " I used to manage a combined World Bank / W.H.O. unit where we tried to get information on design sectors to support policies. These numbers are very difficult to get in most countries. What really frightens me is when you put a team into a country and ask what are you doing, what is the situation here and nobody knows.

How can you make decisions on investments, priorities or anything else if you do not know what is going on in your own country.
W.H.O. produced a very good minimum evaluation procedure and it asks basically three questions: What is there? Does it work? Is it being used? If you cannot answer all of those three questions, you actually are not providing services."

Carmen Arevalo - "I want to reaffirm in a way Richard's statement because the experience we have is that there is no reliable information on the sector. It is clear that each institution has a different set of data. Only in Nicaragua have I seen one little system working for rural areas. It is a very friendly and easy to work information system and they have reliable data on rural services.
Another point is on the code and it is related to the experience we are now implementing in La Paz. Based on the Brazilian condominium sewage experience we are implementing a pilot project there and it would be interesting to comment on the adaptations and specially the adoption of alternative codes and how the establishment and the institutions are very reluctant to accept changes in that."

Augusto Sergio Guimarães - "I'll go back to Viviana's comment, when we decided to reduce the minimum diameter of the pipes. Sometimes a specific task seems impossible, but technically speaking it is possible. Some engineers developed in Brasilia a beautifully designed small equipment to clean and to unblock the pipes used for condominium sewerage. So I think that there we have reached one second step. First step is to say and to show that this condominium sewerage may be feasible in some particular situation. Second, is how to operate and keep the pipes cleaned. This is very important, otherwise, it would be damaging the whole concept which I think is great in some particular aspects."

Eugenio Barrios (Mexico) -"About report, I think it is a very good opportunity to raise political awareness among the decision takers. For example, I think it would be very useful to have a better indicator of sanitation, instead of just referring to coverage. Maybe it would be helpful to include other kind of information and try to put a whole indicator of the country or different regions of the country. Wastewater characteristics around the world are all about the same, but the contents of pathogens are quite different. We have found that in Mexico the contents of helminth eggs are completely different from developed countries and this is a very important element when you talk about the levels of treatment you want to provide. "

Julio Torres (Panama) - "What happens when you change the pipes from six to four inches? What about expansion or multiple floor buildings that may grow up in that area? "
Augusto Sergio Guimarães - "Engineering is something to do in the field and also we should find the trends of the area. If this is to change from individual houses to multi-stories buildings, obviously this sort of development has got to be included as part of the overall project. We have to take that in consideration specially when we are dealing with low income settlements."

DEVELOPMENT AND OTHER ASPECTS OF THE CARIBBEAN REGION

Ing.Arthur Archer
Regional Consultant of IETC
172, Regency Park
Christ Church, Barbados

The Caribbean Region is located from the southern area of Florida (USA) to the Northern area of South America, with some Central American Countries to the East. The Caribbean Region has many Small Island Developing States (SIDS) which were British and French colonies, with most of them acquiring Independence and are now seeking true development, in many cases seeking financial and technical assistance from International Agencies and development countries. The countries/Islands with their geographical locations include :

Northern

Cuba, Haiti and Santo Domingo, Puerto Rico, British Virgin Islands, Turks and Caicos, Jamaica, Bahamas, Tortola.

Leeward Islands

Anguilla(UK), St. Kitts-Nevis, Antigua and Barbuda, Montserrat, Dominica, Guadeloupe.

Windward Islands

St. Lucia, St. Vincent and the Grenadines, Grenada, Martinique, Barbados.

Southern

Trinidad and Tobago.

The larger and more developed countries in the Region include Cuba, Puerto Rico, Martinique and Guadeloupe, with Haiti and Santo Domingo in further need for development, with Trinidad and Tobago on the way to country development. Some of the smaller Islands, also some larger Islands which are now developing, include Anguilla, Antigua and Barbuda, Bahamas Islands. Barbados, Grenada, Jamaica, British Virgin Islands (Tortola being the largest and most populated) St. Kitts-Nevis, Montserrat, St. Lucia, St. Vincent and the Grenadines, Turks and Caicos Islands (UK Colonies).

Climatically, the Islands are generally warm, with some cooler conditions during winter, also with diverse occasions of rainfall. The region has experienced hurricanes with damage to some proprieties and flooding in some areas.

Due to the small Islands with nearby coastal and marine areas, the countries/Islands have become major areas for Tourism visits from Europe, USA, Canada and some Caribbean Islands, with attractions for sea-bathing, diving and views of marine ecosystems, and in some areas attractions for fishing.

TERRESTRIAL CONDITIONS

Some of the countries/islands are hilly and mountainous, with rivers, streams, watercourses and ghuts, which, in some cases contribute to the flooding of lower terrestrial areas during heavy persistent rains. Some of the Islands have limited hilly and mountainous terrain, with less flooding and damage to proprieties, generally with flows in drains, culverts also with pollution of rivers and also the marine areas.

There are many rivers in the hilly and mountainous countries/Island which contribute to flooding : Dominica with over 300 rivers; Grenada, Jamaica, St. Kitts-Nevis, Tortola with hilly mountainous terrain frequently cause flooding in the lower flatter areas during persistent heavy rains. It is also reported that Haiti and Santo Domingo, Cuba and Martinique and Guadeloupe experience flooding during heavy persistent rains. In the Caribbean Region due to limited financial resources and growing technologies, also with climatic conditions, and limited technologies, there is need for development of utilities and management of facilities.

EXISTING AND DEVELOPMENT OF SYSTEMS AND TECHNOLOGIES

Water supplies are limited in some Caribbean Islands – mainly flat Islands – with the potential threat of pollution of some ground water, generally in rural areas, where many wells/soakaways provide water for potable purposes. There is also pollution of rivers and the marine area from pollution during heavy rains, with threats to health. Property connections of potable water from water supply plants is mainly in urban and sub-urban areas, with in some cases rural areas, water collection is at stand pipes and in some cases water is collected from rivers for domestic use, at times without boiling. There is the need for potable water supplied in all regions.

Water supply catchments are built in many areas/islands for the collection and retention of potable water. There are also reservoirs built to retain water, with filtering and chlorination before disposal into the country's (areas') distribution system. In some Regional countries/Islands, there is need for assistance by International Agencies and developed countries, also to have local personnel effectively trained for operation and control of water supply stations. However, there has been a heavy reduction of Typhoid and other gastro-intestinal disease with the improvement of water supply management.

WASTEWATER AND STORMWATER

However in the Caribbean Region, due to limited finance, and untrained personnel, the major areas which require international financial assistance, also trained (engineering) personnel, is the control of wastewater (sewerage) and stormwater. Pollution of rivers and the marine environment poses threats to aquatic and marine ecosystems, as well as human health; and there are measures to reduce the flooding of roads, proprieties and agricultural areas by improvements to drains, culverts, watercourses, rivers which impose heavy financial requirements. Stormwater also poses a threat to health, and there is need for statutory provisions for improvements.

Wastewater

In the Caribbean Region there has been some improvement in the disposal of wastewater (sewage) in some countries/Islands. But in most of the Small Island Developing States (SIDS), there are still serious problems with the collection , treatment and disposal of sewage. There are cities and urban areas with large populations where sewage collection (pipework) has been constructed, generally without effective treatment, and disposal of sewage and effluents not effectively and located not determined. However in most Caribbean countries/islands, the septic tank is the major source of sewage collection, with disposal of effluents into soakaways and wells, and in some Islands, effluents are disposed in drains and culverts. The impact on the river and marine areas will heavy pollution which impacts on marine ecosystems, and could be a threat to human health. There is also the need to control the disposal of septic tank effluent into soil conditions, as there is in some cases the need to protect groundwater. Filtration and chlorination of effluents are needed. Also the zoning of areas on the disposal of effluent in the sub-surface is required.

There are still however, the need for environmental and health protection to reduce damage to coastal areas (erosion) and destruction of ecosystem. There are three (3) Islands which during the 1940s, as colonies, sewage collection systems were constructed in the heavily populated urban (St. Lucia, Grenada, Dominica) without sewage treatment plants (except some filtration), with marine outfalls. During the Hurricane "Jane" (1955) marine outfall pipelines were broken in the Islands with no replacements, with heavy pollution by nutrients and faeces on ecosystems, and with some erosion of beaches there has currently no sewage treatment plants. Dominica is currently reconstructing the sewage system with a treatment plant and new marine outfall. In Kingston, St. Vincent, there is a sewerage collection system in two main streets with some lanes between the main streets, with a filter on the coast and marine outfall (400 meters long), which, due to leaks in the outfall, the Kingstown Harbour is heavily polluted.

Other Islands, except in Tortola, Barbados, Jamaica, Trinidad and Tobago, and the Bahamas have sewerage collection systems with some treatment facilities except in Tortola.

There are also numerous sewage package plants, mainly in coastal areas, where in several facilities there is treatment of effluents by chlorination. There are also some which discharge effluents to the sea and rivers without disinfection. There is thus need for statutory monitoring to insist on disinfection of effluents. Coastal areas are however attractive to tourists in the Caribbean Region, and is a major contribution to economies and financial contributions. However, in the region there is need for international financing agencies to assist the Islands in improving the collection, treatment and disposal of sewage, especially disposal of effluents. International agencies which have assisted the Islands with wastewater control include the World Bank, the Inter-American Development Bank (IADB) , USAID, PAHO, UNEP and the British Government.

Stormwater

Due to hilly and mountainous terrain of many of countries/Islands in the Caribbean, there is flooding downhill, with damage to proprieties; and occasionally, due to rapid and heavy flow from stormwater during heavy and persistent rains, soil slippage occurs with danger to properties and persons.

But there is the need for governments in the region to construct and provide drains, culverts, channels of adequate depth and width to cope with the flowing stormwater. Currently is most regional countries/Islands, drains, culverts and channels are too shallow to cope with the heavy persistent flows of stormwater. Another problem with stormwater in the region is the blockage of drains, culverts and watercourses by garbage, and other wastes, also the failure of governments and local governments to clear drains and culverts of garbage, silt/soil and other disposed articles.

There is also another problem with stormwater. That is pollution of coastal marine waters and also on beaches, also erosion of soil with pollutants from agricultural areas, also the smothering of marine ecosystems from ghuts, also from other hills. Another stormwater problem is the impact of pollution on rivers and streams, also with heavy pollution of the marine areas by pesticides and agricultural chemicals.

However, due to flooding of urban, sub-urban and coastal areas, action needs to be taken to improve the depth and width of drains and culverts where there is heavy flow of stormwater from hills and mountains. Also there needs to be a statutory requirement to restrict and prevent the disposal of faecal matter into rivers, streams and watercourses which are sloped to the marine environment which impact on marine ecosystems, fisheries, also with erosion of beaches.

SPECIFIC PROBLEMS IN ISLANDS

(a) Marine pollution in Islands and coastal areas are experienced in Grenada, St. Lucia, Tortola, Dominica, St. Vincent, mainly due to the broken outfall pipelines of the sewerage systems; the pollution generally occurs in harbours, with the polluted waters which could be a health threat. In Grenada, Dominica, St. Lucia and St. Vincent there are measures being taken to improve and extend sewerage systems, with improved treatment and marine disposal. During 1998 to 1999, a British Consulting firm was preparing designs and plans for improvement of sewerage systems in Grenada and St. Vincent.

(b) Pollution of rivers and streams is a major problem in some Caribbean Islands. In Dominica the Caribs in the North and Northeast are major contributors to the disposal of sewage and other faecal wastes into rivers. St. Lucia, St. Kiits-Nevis, St. Vincent, Jamaica and Trinidad also experience pollution of rivers, watercourses, due to the disposal of garbage, and also the build-up sand and rocks which contribute flooding;

(c) In rural areas there are problems with the pollution of groundwater due to the infiltration of effluents from septic tanks, pit latrines, and in some cases inland Package sewage treatment plants. The use of standpipes are generally placed in rural areas. Some personnel often obtain a limited amount of water from standpipes for cooking, bathing, washing and other uses.

(d) Laundries are generally located in urban and sub-urban areas, where the disposal of used water contribute to flow into drains and culverts , often reaching the marine environment with impacts (some deteriorative) on ecosystems - coral reefs, sea grasses and fisheries.

(e) In the Caribbean Countries/Islands there is need for international assistance to improve the collection, storage and distribution of potable water, also the construction of sewerage system in heavily populated areas (City and Coastal) with adequate studies, designs and decision on the disposal of sewage effluents – also with marine studies (oceanographic) to determine the location and length of outfalls. There is also to the need, oceanographically, to determine the direction of currents, also the effective depths of areas for the end of the outfall for effluent disposal, which will not impact on ecosystems.

(f) Solid waste is major problem in the region. There is need for statutory measures for the collection, storage and disposal of garbage and other solid wastes. Also statutory measures to restrict and prevent disposal of garbage and other wastes in drains, culverts and watercourses to restrict flooding of roads and properties.

OVERVIEW OF COUNTRIES/ISLANDS IN THE CARIBBEAN REGION

Anguilla

The small Island is 27.5 square miles, and is a colony of Great Britain. The Island is generally flat, with the highest point 250 feet above sea-level. Due to the flat terrain, ground water in terrain is saline, but there are two (2) desalination plants which supply potable water to most of the population. In the capital, "The Valley" the aquifer supplies 250,00 gallons of water/day. There are eight (8) natural ponds which retain water and is useful for agriculture. Stormwater is not a serious problem, with the main flooding occurs in the "St. Elizabeth Drive" in the Valley. There are plants to sink wells in the area to reduce flooding.

It has been recommended for a sewerage system to be built in the Valley and adjacent areas. The Islands has however become a tourism area, where there are nice beaches, and there are thirty-seven (37) package sewage treatment plants, most of them in the coastal areas, with some plants at schools and public buildings.

Antigua

The Island has an area of 108 square miles with a population of 64,500. The City "St. John's" is located on clay soil in most of the Island. There are problems in St. John's with wastewater as due to the clay soil, effluents from septic tanks and Package sewage treatment plants flow into drains and eventually flow into St. John's Harbour which is highly polluted. A recommendation is made for a sewerage system in St. John's.

There are over 25 package sewage treatment plants, mainly in the coast, with a few inland. There are also other locations where sewage effluent is disposed to wells, and in some cases to the marine area via rivers. At English Harbour, there are several boats, and there is a SBR sewage treatment plant for the area. The Holberton Hospital also has a small package plant where effluent flows to the Fitchers Creek and into the Bay.

Reports of the APUA is that there are 4 MGD of water supply to the public, with 80 percent (80%) supplied by the desalination plant at Crabbs – 11% is supplied by groundwater, with 9% supplied by surface water dams. The brine from the Crabbs desalination plant has destroyed marine ecosystems in the coastal area.

Stormwater is also a problem in the country. The Airport Road is flooded by the Holberton Hospital drains; All Saints Road and Liberta Village and flooded by overflown culverts. Stormwater also flows from the Bendals area, Martins Village, Attas and Independence Drive, which coverage at Bridge near Marker Street and flows into St. John's Harbour.

NB: Flooding of roads and properties is a major problem in Antigua, especially in St. John's.

The country will need international financial assistance to build a sewerage system in St.John's . There is also the need to increase the volumes of drains and culverts; also the strategy requirement to restrict the disposal in drains, watercourses and culverts which contribute to the flooding of roads and properties.

Barbados

Barbados is an Island with area 166 square miles with population of 263,000. Earlier there has been some pollution of nearshore marine areas, due to wastewater disposal, and occasionally some aquifers may have experienced pollution. The Island is 82% limestone.

There had been in recent times more attention to wastewater (sewage), as during the period March 1979 to June 1982 a sewerage system was constructed in the City of Bridgetown and adjacent areas. The result has been the removal of faecal pollutants with the building of beaches, due to removal of excess algae on coral reefs. Currently there is the construction of a sewerage system on the South Coast, also with plans for a system on the West Coast. The West Coast has been experiencing some beach erosion due to the infiltration of nutrients from soakaways on the coast, with smothering of coral reefs by algae. The Bridgetown Sewerage system costed US$ 14 million, and the current South coast project is due to cost over US$ 30 million. The coastal areas need to be protected as there are major areas for tourism, which supports the Islands economy.

On the coast and inland, package sewage plants are used mainly at hotels. There are seventeen (17) plants with sixteen (16) on the coast, with one Rotating Biological Contactor (RBC) at an inland Hospital. As a statutory measure, all package plants are monitored, and must chlorinate effluents before disposal to the marine area.

There are five (5) zones for protection of groundwater, the main source of potable water on the Island. In Zone 1 there are restrictions on disposal of effluents from septic tanks and Package plants. In Zone 2 septic tanks are required for wastewater. Septic tanks are also used in parishes off the coast and in Zones 4 and 5, soakaways are used.

Stormwater causes flooding from hilly areas in the East of the Island, also there is flooding in St. Lucy, St. Peter and St. James where there is need for well designed drains, culverts and channels. There has also been blockage in small shallow drains, with flooding of adjacent roads and properties. In St. Michael on the South some flooding occurs, but there is less flooding of properties. On the East where there is clay soil, some slippage of soil occurs during heavy rainfall.

Wastewater and stormwater is receiving attention by Government, with increased tourism in the coastal areas. Bridgetown is a major tourism area, but there is still need for improvement of drains, culverts, channels and watercourses.

Dominica

This country is the largest in the Leeward (SIDS) with an area of 288 squares miles, with a population of 75,000. The highest mountain is 4,747 feet above sea level. The country has many poor people with minimal housing and poor wastewater and faecal disposal facilities.

Wastewater management is reaching improvement in Roseau, the capital. The existing sewerage area in Roseau has a population of 17,350. But there have been serious problems with wastewater. The sewerage system in Roseau was built in the 1940's with no treatment plant, and nine (9) marine outfalls installed, mainly on the West. During the hurricane "Janet" in 1955, the outfall pipelines were broken, with no replacement, and in some areas on the coast, sewage and effluents in some areas flow over the beaches, with pollution which is dangerous to persons.

There is currently a reconstruction design and plans for the sewerage system where the broken outfalls will be redirected to the new pipelines, with sewage flowing to a treatment plant at "Baytown" on the West a marine outfall 1000 feet offshore. The proposed plant will be adjacent to Pottersville, a heavily populated area, with several commercial facilities.

With the island having over 300 rivers, many faecal wastes are discharged into rivers. In the "Carib Area" in the North, Northeast and Northwest it is a practice of disposing faeces into rivers. The Roseau River is highly polluted, but this will be reduced with the reconstruction of the sewerage system. Currently there is massive disposal of septic tank effluents in the Roseau River. Proposal treatment at the plant is by bar screens (filters) with removal of oil and grease in collecting tanks. Squatter houses with limited faecal disposal facilities in Baytown, will be relocated to the Stock Farm Area.

During 1999 there were no package sewage treatment plants, but septic tanks are the major facilities for sewage treatment, often with effluents discharged to rivers.

Stormwater :
Due to Dominica's mountainous terrain and the many rivers, flooding occurs in the lower areas. Flooding occurs in Roseau, due to the existence of small drains and culverts, coupled with the blockage of drains by garbage and other disposed articles. Other areas where flooding occurs include Portsmouth in the Northwest generally with stormwater from the North River and South Beach River. The St. Joseph Coastal Development, Mahaut Coastal Development, the La Plain area, the Carib Reserve, Calibiche, and Marigot are some areas which experience flooding. It is reported that due to flooding in many areas off rivers, the sides of rivers, streams should be walled, also the bases.

The Portsmouth area in the North is the second most populated area after Rosea, and due to problems of septic tank effluents in drains, and the heavy development of housing, the area is recommended for a sewerage system.

The country with its high terrain, and problems with wastewater and faecal disposal there is need for international assistance for the island. Currently, the country is receiving financial and technical assistance for the reconstruction of the Roseau sewerage system from the Caribbean Development Bank, CIDA of Canada, Kuwati, with assistance of the Government of Dominica.

Grenada

The island of Grenada has population of 94,000. It is quite hilly in terrain, even in the capital city of St. George's.

There is wastewater sewerage system to which (In St. George's) 1,900 people, domestic and commercial, are users. The system has no treatment facility, and like other islands, the marine outfall was broken during "Hurricane Janet". It is reported that 14,000 persons are served by the sewerage system which includes Tanteen and other parts of St. George's.

In the sewage collection system, there have been several manholes which overflow during peak periods – morning and evening. There has been heavy pollution of the careenage by flow of sewage, where there has been many yachts and ships entering. But in the early nineties a new marine outfall was installed off the Green Bridge on the West, with some reduction of overflowing manholes. However, there is need for the reconstruction of the sewerage system as many pipelines have small diameters which contribute to flooding of manholes. There is also the need for a sewage treatment plant to reduce pollution of the marine area, also with a marine outfall after oceanographic study.

The area of Grand Anse, which is a tourism area, was receiving wastewater pollution, with damage to coral reefs and some erosion of beaches, during the 1980's and early 1990's. But during the year 1994, a sewage collection system was constructed with a drainage filter, also with a marine outfall which has contributed to the reduction (almost total) of faecal pollutants on the beach and nearshore areas.

Grenville, the second largest populated and commercial town in Grenada has a comparatively flat area near the coast which is below sea level. Due to this condition where is heavy commercial and domestic populace there are areas where there is blockage and stagnant wastewater in drains and culverts, with pollution problems and mosquitoes. Wastewater is mainly (in that area) in septic tanks. There has been a recommendation to build a sewerage system, which will relieve much of the pollution in commercial and domestic areas.

Currently there are sewerage designs made to improve wastewater collection and disposal in St. George's. Tanteen and Belmont areas are included in the St. George's sewerage extension. The firm Howard Humphrey's of the UK included the financial provision for a sewerage system in Grenville which is likely to be US$ 13,000,000 with sewage treatment and marine outfall.

There is, however, many septic tanks in the islands for sewage treatment, with disposal into soakaways, and in some areas, to rivers and the marine area.

Stormwater :
As expected, due to the hilly terrain of the island, several areas experienced some flooding during rains. The Tanteen area experiences flooding from Richmond and Marest Hills; Edward Street in the city experiences flooding from hills in small drains; Charlotte and Little Rivers flow to the town of Gouyave and enters Milet Bay with wastewater pollution. In St. George's near the Careenage on the West of the markets, flooding occurs during heavy rains. Grand Brass and Great Rivers flow from hills at 200 feet elevation. Storm water passes through Paradise under Paradise Bridge and enters Great River Bay, North of Grenville.

The Grenville flat area is subject to flooding from the surrounding hills and at times reaches 2 to 3 feet in the coastal area. Some damage occurs during flooding and water generally remains stagnant in concrete and earth drains, occasionally with mosquito breeding and odours. There are numerous drains which contribute to flooding, but it is reported that anti-malaria drains pass through St. Andreas, Telescope, Subise and Marquise – they flow without stagnation.

It is reported that there is no combination with stormwater and wastewater. The island is making improvement in wastewater and stormwater with the assistance of developed countries and international agencies.

Jamaica

This is the largest country compared to other SIDS. It has a population of 2,200,000 with many rivers, streams and watercourses.

Wastewater has been a problem in Kingston due to sewage disposal which flows into the harbour. But it has been reported that there has been an improvement in sewage treatment with a reduction of pollution in the Kingston Harbour, even due to the treatment of food processing, slaughtering and nutrients. There are also sewage treatment plants in Montego and Ocho Rios from which effluents flow to the sea via rivers.

In the sub-urban and some urban areas, package sewage treatment plants are used – usually at hotels, condominiums and apartments. There are also septic tanks with effluents –some chlorinated – which discharges effluents to soakaways, also to rivers. Pit latrines are mainly located in rural areas where faecal matter is buried.

Stormwater :
This reportedly causes some flooding in several areas – housing and commercial facilities – of the country. There is reportedly the need for the increase in the depth of drains, culverts and channels, and also the need, statutorily, for restriction of the disposal of garbage and other wastes which contribute to flooding of drains, culverts and other channels.

NB: Further information will require consultancies.

St. Lucia

The island has many flat areas, with Castries, the capital, generally flat, but with some hills to the East. It is an island with increasing development – domestic, commercial and industrial.

Wastewater like in some Caribbean islands have environmental problems. In the city there is a sewage collection system, without a treatment plant, but with a small facility with a filter, from which sewage flows into the adjacent harbour at the edge of the land. The harbour is very heavily polluted. Besides the sewage from the city of Castries, other areas uphill have wastewater and effluents flowing to the harbour.

The Victoria Hospital located near to the harbour has thirteen (13) septic tanks from which, in soakaways, there is filtration of pollutants to the harbour. There is also in the compound a septic tank from which effluent flows to the harbour by a drain.

Other facilities where wastewater (sewage) effluents impact on the marine areas and in some cases tertiary treatment provide treated wastewater for gardens, and agriculture include:

(a) Club St. Lucia Hotel at Cap Estate which functions 100,000 gallons of sewage during tourism periods. There is a stabilization pond where there is tertiary treatment and chlorination. During rains the effluent flows to the sea at Grand Anse.

(b) Carib Blue is a hotel with 102 rooms. Wastewater is pumped uphill to three (3) ground cells – effluent flows to a tank, which is used for irrigation.

(c) At Sandals La Toc Hotel, there are five (5) treatment tanks. There are two (2) tanks from which the effluent, with chlorination, is used for irrigation – some of the effluent is flowed to the sea.

(d) At Dennery, there is a hospital with 21 beds, and two (2) septic tanks. Some effluent flow to the sea. There is also in the area where squatters use pails for excreta, and dispose the waste into the Bay.

(e) Of major importance is the Leeward and Windward Brewery where there are five (5) ponds to receive wastewater. There is a septic tank in the Brewery, where effluent flows to a pond. Some of the ponds are treated with surface aeration, and effluent flows to Black Bay. There is also the St. Judes Hospital which also disposes sewage by an existing pipeline to a septic tank on the beach. Wastes from the Brewery, Hospital and other plants are supposed to flow to the septic tank, but the volume is restricted. The effluent from the septic tank flows into the sea by a coastal flow.

At Rodney Bay, which is a tourism area, a sewerage system was constructed and completed early 1997, with treatment of the sewage by five (5) ponds. It was reported that most of the hotels and other buildings are connected to the system. Some of the ponds have surface aeration, and the effluent is chlorinated before disposal to the sea, in a swamp. The system has improved the disposal of wastewater, with improvement of marine bathing areas.

Stormwater :

This poses a problem by flooding. The Castries area and Anse la Raye experience flooding from the hills during heavy persistent rains. Drains, culverts and watercourses generally contribute to flooding due to the accumulation of garbage, also eroded soil from uphill areas. In Chausee Street flooding occurs due to the filling of drains by soil. Around the city market, adjacent to the harbour, flooding occurs due to a blocked drain from upstream. Large flooding occurs around the city market.

In Anse la Raye heavy flooding of roads and homes occur due to the blockage of pipelines under the road. Stormwater from the hills also floods areas adjacent to the airport and flows to the sea. Castries River also has a badly sited channel, with eroded soil and other pollutants flowing through the river to the Castries Harbour. A Canadian firm, "R. V. Associated Limited" is working to reduce damage by storm water, especially in Castries, Anse la Raye and Vieux Fort.

There is need for the reconstruction of the Castries Sewerage System, for in addition, there is need for a sewage treatment plant, with a marine outfall having its location and length determined by an oceanographic study.

St. Kitts-Nevis

The island, St. Kitts, is hilly, with Basseterre the capital being the flattest area of the island. The population is approximately 34,000, with Basseterre a population of 16,000, nearly half of the population. The highest (extinct) volcano Mt. Liamugia rises to the height of 3,792 feet. Wastewater is a problem in the island, as septic tanks in Basseterre have the effluents flowing into street drains, which finally flows on the beach off Basseterre Bay and into the sea. Uphill at St. Peter there is a heavy flow of storm water with heavy pollutants (effluents) flowing to the sea.

Basseterre Harbour and Lime Kiln Bay are heavily polluted by wastewater with the Harbour reportedly having loss of most marine ecosystems. During late 1998, storm water from the hills at St. Peter with pollutants from septic tanks flow through the watercourses which lead to the drains at College and Westbourne Streets with flooding of the coastal buildings. The pollution of the Bay was expensive due to the flow of septic tank effluents contributing pollution to the drains.

At Lime Kiln Bay there were also high faecal coliforms and faecal streptococci. The package sewage treatment plant at JNF Hospital is in poor condition with minimal removal of pollutants. At the opposite Brewery there is also a package sewage plant which discharges effluent with the hospital in a drain on the beach - the bay is highly polluted.

Frigate Bay is the tourism area with hotels, and the coastal area is less polluted as effluents from package plants and septic tanks are chlorinated. Package plants are at Horizon Villas, Frigate Bay Beach Hotel and the Jack Tar Hotel with a large treatment plant. There are septic tanks beside in Basseterre city at coastal restaurants, apartment buildings in the Frigate Bay area, also at the Timothy Beach Resort (3 septic tanks); Island Paradise Resort (3 septic tanks); Bird Rock Hotel (4 septic tanks). There are numerous other septic tanks on the coast from which nutrients from effluents impact on coral reefs with excessive algae.

<u>Stormwater :</u>
The St. Peter uphill area has been a major source of flooding of the coastal area via watercourses ahead of College and Westbourne Streets. The stormwater from the hills carried out massive erosion of the soil in the watercourses with flooding of the coast adjacent to Basseterre Harbour, also the flooding of the adjacent New Town area. During the flooding (1998) 83 vehicles were stalled, with the drowning of a man. In the Canyon area on the east, flooding also occurred from the Canyon River. Nicola Town also received flooding from through the Barkers ghut.

The West Farm Area on the Southwest also received some flooding, and at Cold Road Town on the West flooding occurred from two (2) ghuts, also from East River and Winfield River.

At Bloody Point on the Southwest there is a large ghut through which stormwater flows to the sea. The ghut is the area, where reportedly, Caribs commited suicide jumping into the ghut with its large stones.

COMMENT : There is definitely the need for a sewerage system in Basseterre to reduce the destruction of marine ecosystems in Basseterre Harbour, also to reduce the potential health threat by effluents flowing into drains.

A major matter to reduce flooding in Basseterre is the building of concrete watercourses downhill from St. Peter and above the drains and culverts at College and Westbourne streets. There is also the need to inform residents to avoid buildings houses adjacent to watercourses and ghuts, such as exists in Cayon.

Nevis

This is small island with a population of 12,000. Septic tanks are the major wastewater treatment in the city and suburbs. But at "Four Seasons Hotel" there is a sewage treatment plant which produces tertiary treatment of effluent, with irrigation of the golf course. Pit latrines are mostly used in the rural areas.

Stormwater poses a problem in Charlestown, the capital, as stormwater flows through ghuts to the city and into the marine area. Some flooding occurs, but there is the deepening of drains to receive stormwater and restrict flooding. The Caribbean Cove Area, Stony Grove and Farms are also experience flooding. There is a plan to wall the sides of ghuts to reduce flooding of adjacent area with housing. There is also a recommendation to build bridges over ghuts where flooding of roads occurs out of the city.

St. Vincent

The area of the island is 133 square miles, with a population of 115,000; Kingstown, the capital, has a population of 15,500. The city and both sides of the Kingstown Harbour are surrounded by precipitous hills rising to over 300 meters. Kingstown Harbour is large, about 2 kilometers wide and 1 kilometer deep.

Wastewater (Sewage) :
A sewerage system is built in the commercial area, in the main streets of Halifax and Bay Streets, with some lanes and streets between the two (2) main streets. Sewage flows from the system to a small facility with a filter and a pump from which the filtered wastewater is pumped 400 meters around the southern side of Kingstown Bay. Currently, there are leaks in the marine outfall pipeline, with heavy pollution of the harbour and adjacent marine areas. Due to the limited collection of sewage in the system, they are plans for the extension

of the system which is being designed and planned by the British consulting firm of Howard Humphrey's and Partners.

The South coast is also a highly sewage polluted area as restaurants, hotels and other buildings on the South coast with septic tanks and a few package sewage treatment plants, also a large septic tank on the adjacent Young Island, along with pollution from two (2) Calliaqua drains, makes the sea between the two islands heavily polluted. But the beaches are major tourism bathing areas. The South coast is being planned for a sewerage system, being designed by Howard Humphrey's and Partners, to stretch from Arnos Vale area, through Indian Bay area to the Calliqua Bay area, while passing through a surface water ditch on the land.

Industrial wastewater also contributes pollutants and is damaging to human health. Agencies from which pollutants occur and generally pollute marine areas include: Bottlers plant at Camden Park, also a brewery from which wastes are discharges to Lomans Bay; liquid wastes from the distillery in Georgetown from which wastes are disposed into a coastal river and enters the sea on the Georgetown Eastern coast. Some crushing occurs on the West from which dust is washed into a river and flows into Colonaire Bay with the smothering of coral reefs and sea-grass beds, with loss of fisheries; also the East Caribbean Metal Industries Ltd., from which heavy metals (zinc, iron, lead) reaches the marine area, with damage to ecosystems. The flow occurs mainly during heavy and persistent rains.

Agriculture is a major industry in St. Vincent, including bananas from which some pollutants reach the coastal and marine areas, which include eroded soil with pesticides and fertiliser residue. There are also plants in Kingstown city from which pesticides (Furadan, Vydate and Premicid) are mixed in loamy soil and impact on the Bay.

There is definitely need for statutory measures (laws) and management to restrict wastewater and other pollutants from impacting on human beings, as well as on marine ecosystems.

Stormwater is a problem in St. Vincent. Rivers and watercourses receiving pollutants generally flow to the marine area with destructive impacts on marine ecosystems (coral reefs, sea-grasses) , with damage to fisheries, and in some cases, beach erosion.

The Chateaubelair River transport soil during rains to the sea by erosion. Some rivers are also used for washing clothes. On the whole, in flat areas, and in some areas with heavy development, drains, watercourse and streams cause flooding during rains. Layou River occasionally overflows and goes to the sea with some sewage pollution from homes.

Georgetown River flows from Perseverance, through Mt. Bentinch and flows through Georgetown to the sea. It receives pollution from septic tanks, garbage and other pollutants through O'Briens Chili and Caratal Villages, and flows to the sea. Many squatting poverty homes on the beach experience flooding during heavy persistent rains and high tides.

The Tourama River flows through Overland Village to the sea. Flooding occurs during heavy persistent rains; Kingstown North River flows to the Kingstown Harbour and receives large quantities of sullage and garbage which pollutes the Harbour.

Bequia

Septic tanks are the main facility used for wastewater. Effluents from septic tanks generally flows into Port Elizabeth (capital city) Harbour with nutrients impacting on coral reefs, sea-grasses and fisheries. In the Friendship area septic tank effluents and sullage flow into public drains, flow to Friendship Bay, polluting sea-bathing areas. Fringing reefs near the coast are impacted by nutrients with some erosion.

Stormwater flows from uphill, collecting leachate from a landfill into the sea at Anselle Cotte where stormwater with wastes impact on coral reefs on the coast near Adams Bay.

Most of the island is not occupied especially in the North and Eastern areas. Storm water mainly transmit eroded soil and nutrients to the coast.

Union Island

At Union Island, Clifton Harbour is heavily polluted by sewage and solid wastes. Yachts contribute to the degradation of coral reefs and sea-grass beds from yachts.

There are thick mangroves on the island, located adjacent to Ashton Harbour. There is a fifty (50) acre lagoon swamp, and is a nursery for fish life, but is polluted during heavy persistent rains.

COMMENT :In St. Vincent there is definitely need for expansion of the Kingstown sewerage system, also at the construction of the sewerage system on the South coast. The reported estimated cost for the two sewerage construction is EC$ 36,752,450.

Tortola

The area of the island is 21.5 square miles. It is hilly and mountainous with the highest peak 1,780 feet above sea level at Mount Sage. The population is approximately 16,000 with the capital, "Road Town" having a population of 4,000. The hills and mountains slope to near the coast – Road Town, Long Took, East End, Baughers and Wickham being the widest areas from the sloping hills and the coast. Due to the most of the impermeable subsoil in the island, most potable water is supplied by desalination.

Wastewater :
There is a wastewater (sewerage) collection in Road Town, where there are 550 property connections. There is no sewage treatment plant from which, at a collection facility, the sewage is pumped from the center of Road Town into the marine area on the East, 600 feet

offshore at a depth of 60 feet off the Slaney coastal area. It has been reported that sewage disposal has been damaging coral reefs, sea-grasses and fisheries, with some erosion of beaches on the coasts by smothering of coral reefs.

Some visits were made to package sewage treatment plants. There is need for some better management of some plants:

(a) At the Prospect Reef Hotel in Road Town, there was considerable sludge on the surface of a package plant in the settling chamber. Reportedly chlorination is applied and the effluent used for irrigation of gardens. However, some of the effluent flows to the sea, with some pollution.

(b) The Nanny Cay Yachting compound had over 100 yachts other vessels, but the package plant was in a bad non-controlled condition. There was a thick surface cover with sludge, also with extensive weed on the sludge and the plant. The effluent is not clear and is not chlorinated, and is disposed into the Nanny Cay Marina. There is need for statutory action to control the plant. It is a major source of pollution and a health threat.

(c) At the Long Bay Hotel, with 115 rooms, wastewater is collected and is discharged into two (2) Klargester sewage package plants. The effluents is chlorinated and is used for irrigation for gardens and lawns.

(d) At Long Look and East End many houses in the area are in hilly terrain, with septic tanks, where, due to the impervious sub-soil, the septic tank effluents flow on the surface and into roads and drains. Due to potential threat to health, there is need for the construction of a sewerage system in the area to reduce pollution and threats to health.

(e) At Cane Garden on the West, there is a cromoglass sewage treatment plant with a capacity of 45,000 gallons. It has three (3) aeration section, a settling chamber, with two (2) chlorination chambers from with the effluent is piped 700 feet offshore, away from bathing areas. There is currently fifty one (51) connections to the plant which is well maintained. The area is well visited by tourists who enjoy the marine sea-bathing.

Stormwater :
This generally flows from the hills and mountains with impact on the flatter areas. The Road Town, there are widespread deep concrete channels which receive stormwater and discharges the stormwater to the sea without flooding. There are, however, other areas where flooding occurs. There is Jack Ass Ghut to the east of Road Town where stormwater flows into the Wickhams Cay area, with some flooding. The Humtums and Long Bush Ghuts collect stormwater, which flows into the Roads Town channels and into the sea. The Long Bush Ghut discharges stormwater at the Waterfront and Fish Look roads, while storm water flows and impact on Pickering Road, Botanic and Sand Box Drives. There, however, is the need for the removal of garbage and other wastes in drains leading to the main channel in Road Town.

There is definitely the need for a sewage treatment facility in Road Town. However, measures are being taken for the walling of ghuts which will reduce flooding in some areas, also the smothering of marine ecosystems, with facilities for removing soil.

As a British colony, there is need for a British assistance, also some international financing assistance.

Turks and Caicos Islands

NB: Information obtained of the Islands.
The total population of the islands is approximately 14,000. The following populations are recorded – Grand Turk, the capital, 3,761; Providenciales, the major tourism island, 5,586; South Caicos, 1,400; Middle Caicos, 400; North Caicos, 2,000; Salt Cay, 300.

Wastewater in the islands is generally treated by septic tanks, also by pit latrines. The sewage facilities in the islands are 807; septic tanks, 460; pit latrines, 341; six (6) properties with no facilities. In Providenciales there are more septic tanks and extended aeration plants. It is reported that there are in Providenciales, at Ramada Inn, a 100,000 gallon sewage treatment plant. At Turtle Cove there are septik tanks at the hotel and other buildings; at Club Med, wastewater is treated by four (4) cell lagoons, which treat 1,585,200 US gallons of wastewater some effluents are flowed to the sea. There is a desalination plant in the Great Bay area which produces 600,000 gallons/day of potable water.

At South Caicos, there is the facility which produces large quantities of fisheries, some of which are exported, but it also serves the islands.

There is some pollution of the coastal and marine areas as building with septic tanks, mainly on the coasts, discharge effluents to the sea by drains and channels. There is a solid waste disposal area on the coast which imposed pollutants in the nearshore and on fisheries areas. There are many ponds in the area where garbage and other wastes are disposed.

Trinidad and Tobago

In Trinidad, the population is reportedly 1,230,000. It is a large island with many facilities and products – oil and petrol are major facilities.

Wastewater is a system where, reportedly, in Port of Spain and San Fernando, there are sewerage systems, with effluents discharges to the sea. In Port of Spain it is reported that effluents from sewage pollutes the Gulf of Paria between Trinidad and Venezuela. There are many areas in Trinidad with package plants where effluents are discharged to rivers, with flow from rivers to the sea. However, in the Caroni swamp, it is a tourist attraction with boat trips for bird watching and fishing. There are also a few activated sludge treatment plants from which the effluents flow through rivers and swamps to the sea.

There are many package sewage treatment plants in Trinidad from which effluents are tertiary treated and used for irrigation, and some are also disposed into rivers and the marine areas. Septic tanks are also numerous with effluents disposed into soakaways, and in some periods and locations piped to rivers, streams and the sea.

Storm water is well produced, as water from hills flows into catchments, then piped to reservoirs where potable water is retained for distribution in the supply system.

The areas of storm water catchments were not obtained, neither the actual locations of reservoirs. In rural areas, there are standpipes which are used mainly by poverty-stricken persons. But as required in the region, there is need for distribution water supply systems in rural areas.

NB: Trinidad is also known as the main supplier of oil and petrol in the Caribbean region. Some areas out of the region also obtain oil and petrol from Trinidad. In recent years there are many marine pumping facilities in Trinidad.

Tobago

This is an island with a population of 42,000. Wastewater is collected and treated in a few conventional treatment plants, with effluents discharged to the massive environment, including the marine area. In part of the island there has been a relocation of sewage discharges away from the largest coral reefs. There was recently preparation for a sewerage system for the country. Tourism has increased with good bathing areas and clean beaches.

POLICY, ECONOMY AND FINANCING IN THE CARIBBEAN REGION

In the regional countries/islands, policies are generally from governments, also in some countries local governments are established to manage conditions in different areas of the country/island. However, the final decisions on policies, actions and financial decisions are the responsibility of Government.

In major works for the proposal for agriculture, road works, housing, commercial and industrial developments, approvals and monitoring require decisions and approval by Government.

The construction/installation of water supply, sewerage facilities and storm water facilities must be approved by Government, so also housing estates, commercial, industrial and agricultural facilities. The local Governments are afforded with the monitoring of functions in their respective areas and boundaries, also collection and approval of the number of working personnel, also the quality of facilities and actions, which must be reported to Government as a policy matter.

But of more major importance is the policy of management by Government. Also the country's economy, health and environmental conditions, construction and management structures, services and having contact and cooperation with international agencies. There are also statutory requirements for services, also control by the police and military services. Policy in the region needs to be effective in improving and protecting environmental and health services, as well as acquiring functions to improve economy and functional services.

ECONOMY

Caribbean countries are making efforts to control and maintain their economies. Tourism is a major contribution to most Caribbean countries/islands. Contribution to economics also include the export of goods – mainly bananas and sugar – also fruit, vegetables, oil and fuel, cement, bauxite and lumber. The cost of goods, exports of fruit and other vegetables play an additional role in the economy of many regional islands.

Governments are also receiving some financial assistance from developed countries (mainly small colonies) , also from international financial agencies which assist in protecting economies of countries, also assisting in facilities of poor persons, and also underdeveloped areas. It is important by a good economy to protect existing facilities/services, e.g. water supply, sewerage, agriculture and industrial facilities/services, and also to have provided financial facilities to improve "tourism" also environmental and health conditions which will support "tourism" (a major contribution to economics) as well as to maintain good quality of facilities, food, services, and other provisions.

FINANCING

In the Caribbean region, many countries/islands are receiving and producing exports and development of agriculture, services, also businesses, with the experience of improved and good livelihood in some of the regional countries. But in many regional countries, shortage of funds limits the experience of good livelihood. In the regional countries, many products are sold to regional countries, as well as to developed countries – products exported include sugar, bananas, fruits and vegetables. The banana agricultural industry has been supportive to some of the regional countries by exportation to European countries, Canada and the USA. Some of the regional countries which export bananas include Dominica, Grenada, St. Vincent, St. Kitts and Jamaica. The export of sugar to the USA and European countries is generally from Barbados, St. Kitts and other regional countries.

But the major provision of finance in the region is by "Tourism", which is due to the excellent existence of coastal areas, with good clean beaches for sea-bathing, diving to view the marine ecosystems (coral reefs, sea grasses, fisheries), also the availability of boats for sailing and also viewing the sea and sea-bed. Tourism contributes major financial intake to Caribbean regional countries, which include Barbados, Antigua, Jamaica, St. Lucia, Grenada, Tortola and St. Kitts. But to sustain the attractiveness of the countries/islands, there needs to be the consistence of a high standard of environmental conditions. In coastal areas, marine and island areas, with the protection of health, there must be good quality water supply, also good management and operation of wastewater and stormwater, also the control and disposal of garbage.

Wastewater (sewage) with the increase of water supply, and also cases of faecal waste is being attended and disposal to maintain good environmental qualities. As a result of the need for environmental improvement in some areas and Islands, financial assistance is generally sought from international agencies, which include the Interamerican Development Bank (IDB), PAHO, USAID and UNEP. Trinidad is one of the countries requiring lesser financial assistance, as the country has the largest "oil production" in the Region, from which finance is obtained by export of oil and petrol. The British Virgin Islands (mainly Tortola and Virgin Gorda) and Turks and Caicos Islands receive financial assistance from British Government. To assist with maintaining the high quality of health and environmental conditions, projects which are being financially assisted by International agencies and developed countries by loans and gifts in some Regional countries/Islands include:

(a) The reconstruction of the Roseau sewerage system in Dominica. The project will include the removal of the nine (9) broken outfalls. There will be a sewage treatment plant at Baytown with a marine outfall 1000 feet offshore. The reported cost is over US$ 13 million;

(b) In Barbados after construction of the Bridgetown Sewerage System, there is currently the construction of the South Coast Sewerage System. The IDB costed the project as 25.4 million, but it is expected it will be over US$ 30 million.

(c) There are also designs and plans for sewerage projects in Grenada and St. Vincent.

    (i) In Grenada the cost of the project is estimated as US$ 15,045,500 and will include extension of the St. George's sewerage system also construction in St. John's area; also sewerage construction at Grenville.

    (ii) In St. Vincent, there is planned the extension of the Kingstown Sewerage System, also a new system on the South Coast, the cost is EC$ 22,590,540. Three pumping stations and marine outfalls are estimated as EC$ 14,162,000.

NB – In Road Town, Tortola there is need for a sewerage treatment plant.

- In St. Lucia and Grenada there is need for sewage treatment plants. There is need for oceanographic studies to determine the location and length of outfalls;

- In Anguilla, there is need for a sewerage system in the Capital, "The Valley", as there is need to reduce pollution of groundwater;

- In St. John's, capital of Antigua, there is need for a sewerage system to reduce pollution of the Harbour and other marine areas. The soil is clay, with no absorption of sewerage effluents.

Financial assistance is being needed for the corrections, and improvement of the above facilities, and improvement of environment and Public Health. There is also financial assistance from international agencies and developed countries to assist the countries/Islands with the Caribbean Region, with improvement in health and development facilities and protection of health.

To finance the improvement of facilities, and obtaining health and management facilities, and also provision of services, water, wastewater, stormwater, there is need for international agencies assistance.

DISCUSSIONS

Josefina Gomez (Dominican Republic) - "I would kindly request Mr. Archer to update his data. First of all, there is no such a country called Santo Domingo, it is Dominican Republic, and of course this is not one of the less developed countries in the area but a developed one.
In my point of view, this report does not reflect the greater Caribbean area situation. I would like to request you to include the data from my own country which I can provide and maybe also for another country. Thank you very much."
Arthur Archer - "As far as it regards Martinica and Guadeloupe , there is very little information on them."

Glen Laville (Bahamas) - "I would also like to mention that in the Bahamas there is no submarine outfall presently. Also one thing that was not mentioned as far as treatment of sludge either from septic tanks or from normal extended aeration treatment plants was sludge drying beds and also further treatment by anaerobic lagoon and also facultative lagoon. So, that is something that should be added."
Arthur Archer - "I was in the Bahamas in 1980's and there was no facility treatment. Most of the wastewater was disposed into some rivers in Nassau. But I understand that you have some kind of treatment now in Bahamas, is that so ? "
Glen Laville (Bahamas) - "Well, that is only in the downtown area. There are treatment plants in other parts of the island."

THREE WATER AND SANITATION PROGRAMS ACTIVITIES IN DISSEMINATING INFORMATION ON URBAN ENVIRONMENTAL SANITATION

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I want to describe, very briefly, three Water and Sanitation Program (WSP) activities in Urban Environmental Sanitation that are closely connected to the topic of this workshop. First, let me recapitulate three lessons that I think we have drawn from the experiences of this workshop.

The first is that sanitation has received far less attention than water supply. And we all know the consequences: in developing countries there are massive deficiencies in service, causing appalling living conditions, severe environmental degradation, increased sickness, and early death. The poor suffer most, but the overall economic development of an entire country may be harmed, if its people cannot live healthy and productive lives.

The second lesson is that it is not much good dealing with one sector at a time:

- increasing water use leads to increased wastewater generation;
- providing sanitary sewers to deal with this wastewater only solves part of the real problem, if the house is liable to be flooded because the storm drains are inadequate;
- providing bigger storm drains doesn't work if they are always blocked with solid wastes;
- and so on.

Part of this lesson is that whatever we propose as <u>technical</u> solutions need to be acceptable and affordable to the users; the community or its appointed institutions needs to be able to operate and maintain the technical solutions; and communities should not be allowed to "export" their problems to some unfortunate downstream community or to the environment in general. Therefore we need to take a <u>holistic</u> approach, considering all these factors and trying to come up with the solution that best fits the circumstances.

The third lesson is that usually it is not always only the <u>technical</u> aspects that give trouble. Failures are usually due to poor policies, lack of political commitment, institutional deficiencies and poor financial performance, and other non-technical factors (including imposing some centrally-conceived solution which is not matched to the socio-cultural environment where it will be applied.

So it was good news that IETC was following up its earlier source book on solid wastes management by developing its technical source book and training materials on wastewater and stormwater management. The Water and Sanitation Program agreed with IETC to complement IETC's work, at a global level, and focus on these non-technical issues.

The three activities that WSP is engaged in are:

- The UES Resource Guide - a book in Urban Environmental Sanitation
- a Gaps Study
- the creation of an Urban Environmental Sanitation Network - UESNET .

Each of these three activities is intended to help people concerned with this sector to obtain reliable information on how to solve environmental sanitation problems in urban areas. WSP's mandate is to assist the poor, and so these activities pay special attention to the problems of providing affordable and sustainable services to low-income groups in peri-urban squatter areas.

THE UES RESOURCE GUIDE

It is important to clarify that UES - Urban Environmental Sanitation includes sanitation, wastewater management, stormwater drainage, and solid waste management. It does not include water, except looking at water/wastewater interactions, and it does not include aspects such as vectro control or air pollution.

The guide was originally conceived as a technical source book on urban environmental sanitation, covering on- and off-site human waste disposal, municipal solid waste and storm water management. However, when the WSP learned about IETC's work, the two organizations agreed that their efforts should be complementary and avoid duplication. So IETC added on-site technologies to its review, while the Program changed the focus of its efforts to cross-cutting, institutional, economic and financial issues.

The Resource Guide, in discussing these non-technical issues, tries to take a holistic approach, and, where possible, directs readers to selected, readily-available texts which will provide guidance on the matter in question. We say "where possible" because we have found it surprisingly difficult to locate suitable texts. There seems to be a great gap between what is promoted in international rhetoric and what is available to guide practitioners - most publications still deal with <u>one</u> aspect of <u>one</u> sector at a time. So, for example, one can read about willingness-to-pay studies being used to guide the choice of sanitation solutions, but there is not much guidance on how to find out what people can afford when they have to consider several different UES improvements, perhaps each with several possible levels of service, at the same time - and still have enough money left over to meet basic household necessities such as food, shelter, clothing, and education for their children.

There is a possibility that this failure to consider the real choices that people have to make, about how to survive on a few dollars a day, may help to explain why so many well-intentioned people promote environmental services projects which only too often are found not to be sustainable. It is worrying to see scarce national resources being spent on elaborate sewerage and sewage treatment projects, when there is little chance that they will ever pay their way, or even continue operating properly. One very positive outcome of IETC's work will be to show decision-makers how many options there are for providing satisfactory service which is also sustainable, such as the pioneering sewer systems developed here in Brazil.

THE GAPS STUDY

In the course of our investigations, we found ourselves identifying as many gaps as solutions. This left us with some problems in preparing the Resource Guide, but contributed directly to the second activity : the Gaps Study. This will identify gaps in UES knowledge, and to suggest what needs to be done to fill these gaps.

The present status of these two activities is that a first draft of the Resource Guide was distributed in mid -1999 and extensively reviewed; publication of the revised document is planned for later this year. A preliminary report on the Gaps Study was also circulated in 1999, and it is expected that a final list of key topics will be produced at the same time as the Resource Guide, or shortly afterwards. I think one can reasonably sum up the present situation by saying that, while we don't know all the answers yet, we can be sure that "business as usual" will not work, and we do have enough information to allow sector professionals to try out new approaches. By sharing our experiences, both good and bad, we have a much better chance of making significant improvements in the way people live and the ways in which our cities function.

THE URBAN ENVIRONMENTAL SANITATION NETWORK - THE UESNET

While the other two activities were both short-termed, the establishment of an Internet-based Urban Environmental Sanitation Network (UESNET) is a long termed perspective activity . This was first suggested by the Technical Advisory Committee of the Global Water Partnership in late 1997. WSP volunteered to develop the UESNET and to manage it initially. The purpose of UESNET is to help municipal officials and others responsible for UES services to overcome the past neglect of these services. UESNET will do this by:

- developing and disseminating knowledge on how to improve service delivery;
- changing the attitudes of municipal decision-makers and service providers, so that they give higher priority to these services;
- building institutional capacity to deliver service; and
- encouraging the participation of the user community in the development, implementation and management of services.

The UESNET intends to establish global and regional Help Desks to assist in information dissemination and to provide advice on UES issues. It will enlist existing organizations to host its activities. For example, it is expected that the first regional network will be managed by an early participant, the Andean Association of Enterprises and Institutions providing Water Supply and Sanitation Services (ANDESAPA). ANDESAPA will administer UESNET activities in its region, and will host a regional Help Desk. Agreements are being negotiated to establish the first country network, in India, which will also be managed by a local institution. Both the ANDESAPA and the India networks should be operational by July 2000.

It is anticipated that UESNET will initially have to be supported by donors, but it is intended that it will eventually become self-sustaining, through membership fees, contributions and fees for special services.

All this was developed in total ignorance if what IETC is doing with maESTro. We now have to think how we can best integrate the two efforts, because clearly maESTro is very well-designed and has tremendous potential.

In planning UESNET, we proposed special efforts to ensure that not only engineering professionals but also municipal administrators and community organizations can get access to the information being provided through UESNET. In many countries that will mean using means <u>other than</u> the Internet, because access to the Internet is limited or too expensive. The regional and sub-regional units will disseminate information and build capacity through national member organizations, but both the content of the messages and the means of transmission will have to be tailored to local conditions.

For example, a central university may have good access to the UESNET site on the Internet, while a municipal engineer's office may want information to be on CDs developed by the national office, and community organizations may want good printed materials, such as posters and information sheets, in the local language. This activity, particularly its attempt to reach out to local communities and NGOs, seems to us to have tremendous potential, and may be the best way in which WSP and IETC can complement each other's efforts. Further information on the development of UESNET may be found at the website http://www.uesnet.org .

<u>URBAN ENVIRONMENTAL SANITATION</u>
RESOURCE GUIDE: What we think we know
GAPS STUDY: What we need to know
UESNET: Information dissemination

THE WORLD BANK'S WATER AND SANITATION PROGRAM: RELATED REGIONAL AND GLOBAL ACTIVITIES

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ABSTRACT

The Water and Sanitation Program-Andean Region is one of five regional groups of the Water and Sanitation Program of the World Bank. The Program team in Bolivia, Ecuador and Peru plays a central role in the development of innovative public-private partnerships, in scaling up pilot projects and in implementing approaches that enable low-income population in rural and urban areas to have access to sustainable services. In all three of its focus countries WSP has significantly contributed to sector policy designs including the preparation of reforms to sector laws.

The Andean team's peri-urban activities revolve around studies, diagnostics, identification of non-traditional project implementation models, and the documentation of successful cases. Its innovative pilot project in El Alto and La Paz, Bolivia, is a leading global model of a public-private partnership and has drawn significant attention worldwide. The condominial sewerage technology and integral community participation have been keys to the project's success. Cost savings have been substantial. Plans to scale up the implementation model are being prepared in Bolivia and Peru.

At a global level the Program is presently engaged in three initiatives that are closely related to IETC's wastewater and stormwater management source book. These are a Resource Guide in Urban Environmental Sanitation (UES), a UES Gaps Study; and the Urban Environmental Sanitation Network (UESNET).

The Program originally conceived the **Resource Guide** as a technical source book on urban environmental sanitation, including on- and off-site human waste disposal, and municipal solid waste and storm water management. On learning that IETC had already published a source book on solid waste and was preparing a source book on wastewater and stormwater management, the Program agreed with IETC that the two efforts should be complementary and avoid a duplication. IETC therefore agreed to include on site technologies in its review, while the Program changed the focus of its efforts to cross-cutting, institutional and economic/financial issues. A first draft of the Resource Guide has been extensively reviewed; publication of the revised document is planned for later this year. The **Gaps Study** is closely related to the Resource Guide. Its purpose is to identify gaps in knowledge in the three sub-sectors, and to suggest actions to be taken to fill these gaps. It is expected that the Gaps Study will be published together with the Resource Guide, or shortly thereafter. Establishment of the **Urban Environmental Sanitation Network** (UESNET) was first suggested by the Technical Advisory Committee (TAC) of the Global Water Partnership (GWP) in late 1997. The purpose of

UESNET is to disseminate information to help municipal officials and others responsible to overcome the serious backlog in providing urban environmental services in developing countries. The UESNET will establish a global and regional helpdesks to assist in information dissemination and to provide advice on UES issues. Agreements have been reached to establish the first country (India) and regional (Andean Countries) networks by July of this year. Information on the further development of UESNET can be found on a new website: http://www.uesnet.org.

Rio de Janeiro, Brazil Marzo 2000

The Water and Sanitation Program in the Andean Region

Carmen Arevalo

Water and Sanitation Program (WSP)

An international partnership to help the poor gain sustained access to improved water supply and sanitation services

Water and Sanitation Program

Mission statement

The WSP helps poor people gain sustained acces to improved water and sanitation services

Water and Sanitation Program

WSP - Global

- 5 Regional Offices in Africa, Asia and Latin America
- Since 1972 WSP has influenced the design and implementation of projects for $2.5 billion, reaching 5.5 million people
- Financed by over 15 agencies and administered by the World Bank

Water and Sanitation Program

Principles

- Supports a people-centered demand-responsive approach
- Water has an economic as well as a social value
- Development efforts must be participatory; water should be managed at the lowest appropriate level
- Women must play a central role in water projects

Water and Sanitation Program

Objectives

- Generate and communicate know-ledge acquired in the field
- Strengthen sector policies
- Improve the effectiveness of invest-ments

Water and Sanitation Program

WSP - Andean Region

- WSP Program Offices in: Bolivia, Peru and Ecuador
- The Regional Office was opened in 1996 and in 1999 was transferred from La Paz to Lima

Water and Sanitation Program

Learning Agenda

- **Rural agenda** - Supports the design of institutional mechanisms for service delivery and sustainability (PROSABAR in Bolivia, PRAGUAS in Ecuador, PRONASAR in Peru)
- **Urban agenda** - Designing strategies and mechanisms for reaching the poor (*El Alto* Project in Bolivia)
- **Small Towns agenda** - Definition of learning agenda / identification of sustainable models

Water and Sanitation Program

Carmen Arévalo Río de Janeiro, March 2000

El Alto Pilot Project

Difficulties in Accessing Sanitation Services

- Cost
- Technical Paradigm
- Cultural Paradigm

Challenges

- The urban population's quick growth.
- The high percentage of urban population that live in the suburbs without the appropriate services.
- Urban poverty.
- Necessity of big investiments.
- Lack of replicable and sustainable models.

Basic Principles

- Community and institutional participation;
- Appropriate and low cost technology;
- To reduce the cost of the services;
- To respond to the demand;
- Preservation of the environment;
- Existence of intra-houses facilities;
- Effective use of services;
- Recovery of investiments;
- To monitorate and evaluate the results.

Objectives of the project

To develop technological options, methods of social intervention and financial options of investiments recovery that can be replicable in other urban areas.

To identify and test innovative solutions for the sanitation services in the poorer urban areas.

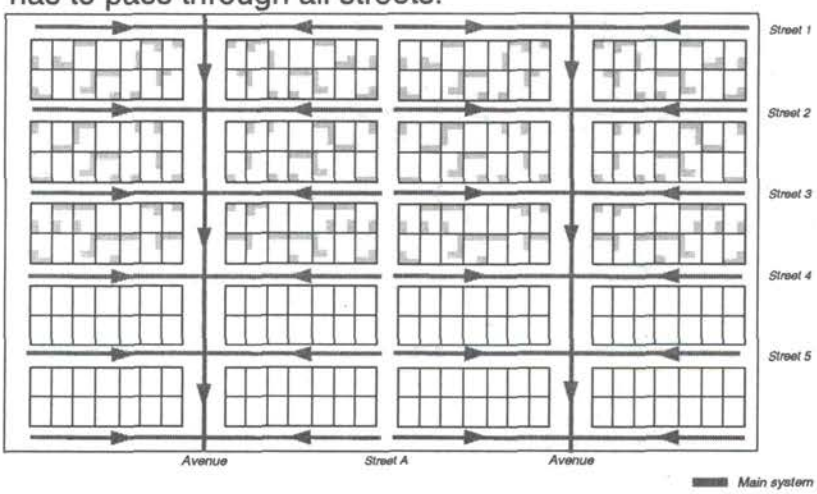
To install intra-houses water and sewerage systems to 10.000 families of scarce resources in La Paz and El Alto.

Conventional System

- The system belong to the concessionaire;
- Each problem on the system affects the system as a whole;
- More inspection cameras;
- More difficult and deeper access for maintenance;
- Heavier and more expensive equipments.

The Conventional System

Each lot is considered as an user and the main system has to pass through all streets.

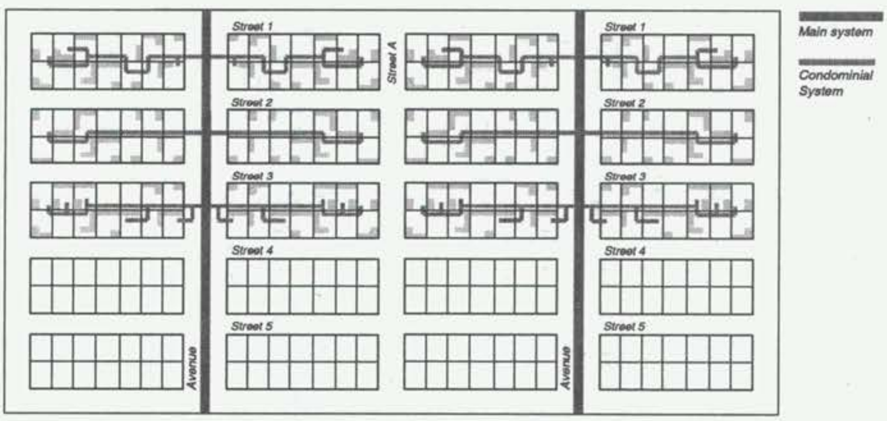


Condominial System

- Higher participation percentage of the condominial ramifications;
- Ramifications as independent sub-systems;
- The problems in the ramifications do not affect the system;
- Smaller quantity of inspection cameras;
- Smaler depths with easier access;
- Simpler and more economic equipments.

The Condominial System

All the sub-basin is considered now as an user , which is connected by one single point to the main system.



Administration Model

Areas of action of the condominiums:

- acess control and cleaning of the condominial ramifications;
- internal control of consumption and charges.

Areas of action of the concessionaires:

- quality control of wastewater of the condominiums;
- wastewater transport, treatment and adequate disposition.

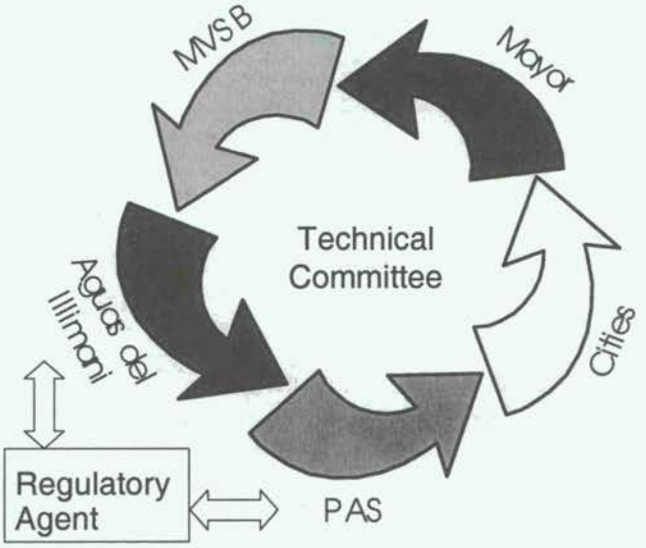
Methodology

The whole system is considered as an educational process for the community.

The pedagogic process is based on a system where all involved elements reflect about their reality and how to solve their problems.

It uses an interdisciplinary focus, with equipments able to perform actions in an integrated way in the different areas related to the environment.

Institutional Participation



- **Objective:** to include a wide range of institutions in the planning and in the project implementation to assure its replicability.

Stages of Installation

First: Identification of the elements involved characterization of the areas and design of preliminary projects;

Second: Negotiation of the final projects, signature of agreements and formalization of the condominiums;

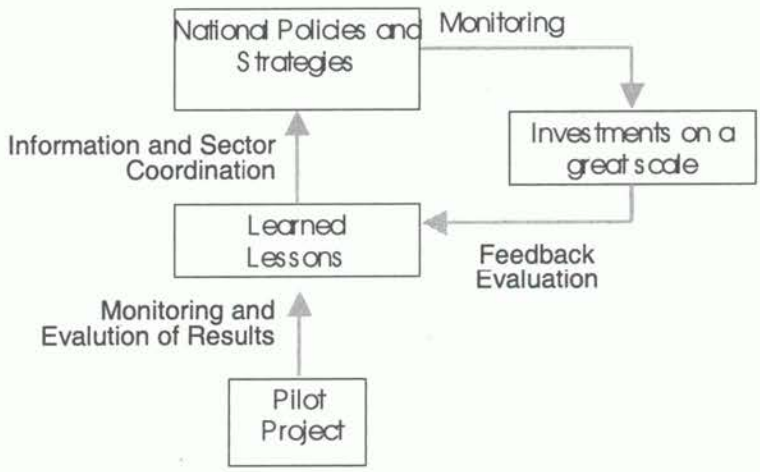
Third: Training of community groups;

Fourth: Works and administration training;

Fifth: Consolidation of the system;

Sixth: Systematizing and final evaluation.

Replicable Model



Impact

- Aguas del Illimani S.A . (the private concessionaire for the water and sewage service) has decided to use the condominial system for the new facilities in La Paz and El Alto.

- The Bolivia´s Viceministry of Basic Services is implementing through PROSABAR and under the technical support of the El Alto Project coordination team, a condominial project.

Impact (cont.)

- The Basic Services Vice-Ministery and the Bolivia Reparation Superintendence know, accept and use the condominial technology.
- A draft to reform the norms and policies of the sector is being studied.

Impact (cont.)

- An initiative to implement a pilot project using the condominial technology at Santa Cruz has begun.It is a combined operation between most of the water and sewage system cooperatives, the International Financing Corporation and the Aguas del Illimani.
- The project has connected 1522 lots to water supply system and 1946 lots to sewage system.

Impact (cont.)

- 795 new sanitary modules have been built, which represent 77% of all the connected lots to the sewage systems built by the Project .

Impact (cont.)

- The Aguas del Illimani billing system monitoring has demonstrated that the consumption of water has increased in 50% in the first two months after the intervention of the Project. After the third month, the consumption level tends to estabilize with a growth of 20% in the areas where the Project has been installed.

Appropriate Costs

Neighborhood	For condominial lot (US $)	For conventional lot (US $)	Difference %
Caja Ferroviaria*			
Implementation	99	205	48
Social Work	10	5	-
Total	109	210	52

**The installation costs include the treatment system*

Appropriate Costs

Neighborhood	For condominial lot (US $)	For conventional lot (US $)	Difference (%)
Oro Negro			
Implementation	116	264	44
Social Work	10	5	-
Total	126	269	47

Early Lessons

The System

- It has to be adapted to local conditions and to the peoples' requirements.
- Installation is cheaper than the conventional system, which should be reflected in lower conexion fees.
- It allows community participation in
  - Planning
  - Construction
  - Maintenance (lower tarifs)

Early Lessons (cont.)

The Community

- It is possible to introduce cultural changes and approaches to sanitation and hygiene, but it requires additional efforts and strong social intervention components.
- Its behavior is not homogenious. Could be willing or not to participate in project implementation and maintenance or in training, capacity bilding and educational programs.
- It is willing to pay for an improved system and is also willing to improve their sanitary conditions.

Early Lessons (cont.)

The Private Utility Company

- It is interested in adopting lower cost technologies particularly to reach low income families when tied to coverage target by the consession contracts.
- Is willing to spend on a project social intervention but up to a certain limit.

Early Lessons (cont.)

The Government Institutions

- It takes time and efforts for the new technology/system promotors to induce them to accept them and to produce the new norms and standards required for its replication at a larger scale.

DISCUSSIONS

Francisco Cuba Terán (Bolivia) - "About Carmen's presentation, I begin with a little explanation about Bolivia government policy about basic services. In the beginning we were trying to give basic services to poor rural areas. As we could not do that so fast, rural poor people began escaping from the poor small cities and they began accumulating a settling in cities like El Alto and big cities in Bolivia. So El Alto city began growing very fast, almost 9% a year. Just for you to compare, La Paz grows 1.9% a year.

To cope with the sanitation situation there we count on a program like the one at El Alto city. We have to make a final evaluation of results, which are very good, and then we have to determine new standards for sewerage systems in Bolivia, including condominium sewerage systems.

Answering a question that was asked, in El Alto the social cultural issues are very particular. The climate is very dry and it is also very cold. The population is not accustomed to sewerage systems and for you to convince them that they have to pay to use something they never used, is very difficult. So, that is also one of the reasons why the dotation of water is so low. In this project, wastewater treatment is not included."

Javier Mijangos (Argentina) - "I would like to know how to deal with the industrial connections and if there is in Bolivia an industrial credit line to invest in treatment plants."

Carmen Arevalo - "In the case of El Alto, there are no industries there, just basically residences . Maybe Francisco can answer the second one."

Francisco Cuba Terán (Bolivia) - "In Bolivia industrial activity is very low. The credit plans for industries do not exist because the industries there are not treating their effluent. I think the concessionaires are going to oblige them to have a wastewater plant treatment before discharging in the Choqueyapu *river* or in the on-sewers."

Louise Zuilen (Suriname) - "In Suriname we tried to implement the same system as the one in El Alto, but it did not work, because the government tried a pilot project and it started in a poor area. Since they did not have to clean their septic tanks, because everything was going to a general system, they threw sanitary napkins and all that kind of stuff into the toilet and started blocking the whole system. Even people who used it properly had problems and whole community of that area started complaining.

So the government stopped the project and they abandoned the system and now everybody in that area has its own septic tank again. Engineers and environmentalists were disappointed, upset because it was not the system that didn´t work, it was the people, the community that wasn´t trained.

So, my question is how did the system work in El Alto, where people were just as like non accustomed to that kind of system?"

Carmen Arevalo - "The point you are stressing is very important. The efforts that are being made within the community are stressing the importance of the systems, how it works, how to use it and how to take care of it. I think Augusto could give more examples because this system has been used a lot in Brazil with very good results. But it is clear that the project is not only to lay the pipes, but it also requires a very strong social interaction in order to avoid this type of problem pointed out."

Augusto Sergio Guimarães - " Regarding condominium sewerage, it was interesting to realize that Carmen spent possibly five percent of her presentation on the question of engineering codes and perhaps all the rest discussing social aspects related to the implementation of the project.
When dealing with this kind of problem, the administrators have to be prepared to take care of a project with dozens of social assistants and software guys, several group discussions that possibly make the overall decision a bit more complicated, but with a stronger guarantee of being successful.
Another question to discuss regards to the two different areas to be benefited there in Bolivia, because in El Alto with the aerated climate possibly the stormwater is not going to be a problem, but in Santa Cruz it could be a problem. Here in Brazil we have had some problems with the handling of condominium sewerage in areas where the precipitation is a bit high, because people on one hand have to be educated not to direct stormwater into the tiny condominium pipelines. On the other hand, public utilities have to install a storm drainage, otherwise the overall system may collapse."

Luiz Gamez (Costa Rica) - "Have you used your study on´ willingness to pay` to adjust the tariff?"
Carmen Arevalo - "The people are willing to pay. This is already a question between the public utility and the regulatory agency. Because what is expected is that a tariff will be lower in those cases where the population participates in the management of the system. We are dealing with cost of this and this cost has to be an input to this negotiation and final decision. This willingness to participate or not should be reflected in a tariff difference."

Terrol Inniss (Barbados) -"You said that the population consumes about ten liters of water a day. Where do these people get that potable water from and what is their present disposal system if any and if there is any effect of the temperature because of the altitude? "
Carmen Arevalo - "The water comes from the public utility company. They have treatment plants and they have pipes supplying this area. Some areas did have neither water nor sewerage, and they bring water from nearby sources or water trunks or whatever.
Regarding the disposal system, they use the river nearby. This is a rural habit and it is probably not a big problem in a rural area, because it is a huge territory. However, in urban areas the conditions were really bad. Gray water was disposed in the streets. So it was a big problem regarding health.
About temperature we had no problems."

Lilia Casanova - "Related to Louise´s comments, about the communities need of knowing about the new technologies and more information and training. How did you do this in the communities in Bolivia, in Peru and in Ecuador where they would be equally also not knowledgeable about the new technology? Who did you use to introduce the new technology particularly in maintenance? "

Carmen Arevalo - "We have large field teams, consisting of engineers and social professionals from Bolivia. We imported from Brazil the two main technicians and the social specialist. They do the social and technical integration. We have to train these teams first and then they go to the community."

Lilia Casanova - "This is a lesson I would like to share with everybody. Sometimes, when new technologies are being introduced, there is need for external expertise, because it might not be available locally. In the case of El Alto, the external expertise came from a country within the same continent, because more or less people within the same continent will understand each other social cultural common aspects.
We are talking about technology transfer here. It is not technological solutions that work but the non-technological solutions. I think this is a lesson that I hope will be remembered."

TRAINING TOOL ON SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT - THE TRAINING MODULE UNEP/IETC

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ABSTRACT

The Source Book on Sustainable Wastewater and Stormwater Management (SWW&SWM) is accompanied by a Training Module (TM), aimed at assisting IETC and other institutions involved in training of water and environmental professionals. It consists of a set of artistically designed slides and auxiliary material. The TM has been primarily developed to assist the lecturers in running the training program for water and environmental specialists. However, in addition to this main target group (Target Group 2), two other selected parts of the module will be used for addressing the other two target groups of users of the module, namely: target group 1: top level decision makers and target group 2: general public.

The Training Module was first presented and feedback from the participants sought in the Rio Workshop. The pilot version of the TM that was presented to the participants of the Rio Workshop has generated feedback from them. The TM has been updated and the final version is enclosed to this book. The comments given have been used in the development of the upgrades and its application for future training programmes. The TM is not a closed system, on the contrary, the organizers of the future training courses can easily add relevant local material and enable the trainees to do the same. The initial version of the TM is also linked with two sample hypothetical cases for wastewater and stormwater systems respectively, thus enabling a "role game" to be played during training sessions. A sample text and basic elements of the role game are appended to this article.

GENERAL CONCEPT OF THE TM

The module consists of three types of slides:
A - individual, simple slides and graphs,
B - animated slides consisting of several sequential images and
C - plain text slides which are used to provide additional explanations on the slides A and B.

The slides are fully complementary to the text in the Source Book and are also used to illustrate the book. A core group of slides is selected so that it covers the major topics and enables fast learning of the essential concepts presented in the book. For those interested in additional details, there is a group of supplementary slides (placed into a separate folder and are called ATS – Additional Technical Slides) The ATS enable users with a broader spectrum of interest to have a better access to the optional material. Furthermore, regional overviews are also accompanied by several slides, respectively. The slides are designed so that they emphasize the principles rather than details. The principles of modern graphics design are used, and the slides are meant to be easy to understand to master their essence.

The concept of the module is presented in Figure 1.

These are links between slides and relevant parts of the Source Book, i.e. users of the training materials are provided with the links that enable access to parts of the Source Book and vice-versa. The readers of the Source Book (in electronic form) will be able to access the relevant slides and illustrations.

The primary use of the Training Module is to provide assistance in the training of water and environmental planners in mastering the basics of sustainable stormwater and wastewater systems. The materials are selected so that they can serve both young specialists that are entering this profession and the senior specialists who have been used to the conventional systems in the past, and who would benefit from experiencing the essence of the "new philosophy "of sustainable solutions.

As mentioned, there are also two other groups of slides meant to be used in briefing the professionals from the Target group 1 (top level decision makers), and in running public awareness sessions for the Target group 2 (general public).

The Training Module was developed by Professor Cedo Maksimovic and Professor Goen Ho, along with two professional graphic designers, two technicians and a water resources engineer.

TARGET AUDIENCE

The Training Module is specifically designed for three above mentioned target audiences, each with different levels of interest and technical knowledge. The presentations consist of a series of slides with concise accompanying notes, as the audience is assumed to have a general understanding of the particular project and subject area, but the present material should clarify the conceptual differences between the conventional (tends to be unsustainable) and more sustainable solutions.

The presentations were designed for the following three target groups - audiences:

a. **Target group 1: Top level decision makers** such as: governmental officials working with environmental issues, top executives, mayors or their deputies in charge of the environment, and alike. This audience is in principle responsible for a broader spectrum of problems at the governmental, regional and local (municipal) level and thus does not necessarily have an insight into modern concepts and technologies in wastewater and stormwater management. Since this group is not assumed to have a deep technical knowledge on the subject, the TM is supposed to provide to them a brief, concise overview of the modern concepts of sustainable solutions, available technologies and basic criteria for technology selection depending on the local conditions. However, this group relies on the advise and support of the second target group. Technical specialists are meant to propose the options for the final considerations and possible criteria for technology selections. The typical duration of briefing sessions for this group is between half a day and one day. A short evaluation session should be held at the end of the briefing session.

b. **Target group 2: Water and environmental planners, developers and designers.** This audience has a high level of technical knowledge and inter alia is interested in the technical aspects of the planning, operation and maintenance of Sustainable Wastewater and Stormwater Systems. This major target group has a very important role to play in spatial planning, coordination of plans among various specialists, advising the key decision makers on technology choice and in cooperating with experts in technology, design, analysis and operational management. However, it should be mentioned that even this group is not supposed to make a detailed design of the systems, which still remains to be done by the other specialists in analysis, design, construction, and operational management . To provide vocational training for this group of specialists is beyond the scope of the present book and TM.

c. **Target group 3: General audience (general public, teachers, journalists, school children, NGOs).** This audience has very little or no technical knowledge and no experience with either planning or implementation of the systems. They belong to the broader category of the users of these systems and should be made aware of the general concept of sustainability and on its implementation in wastewater and stormwater systems. This target group plays a major role in public hearings, and if not properly made aware on the basics, could potentially be misled by various groups for their own goals. This group can make the system work or fail. They should be consulted in the planning process, and thus should be properly informed. The TM can be used for presentation to this target audience but can also be used for development of the other training material.

The slides are organised in three separate folders serving each of the three target groups.

STRUCTURE AND POSSIBILITIES FOR FURTHER UPGRADE OF THE SYSTEM

The training module consists of two major portions – core material and add-on modules. The core material consists of a cluster of selected files from the Source Book enabling the following units to be exercised during the training sessions: basic historical development that preceded the current situation, problem statements, basics of available principles and problem solving procedures, selection and evaluation criteria, possible solutions, and finally, evaluations. It is linked with other sources of training material as well as various add-on modules. The add-on modules are based on adequate level of general and the technical knowledge of the audience and are accordingly prepared.

Each higher level of the presentation builds on the previous one, and is open to further changes (insertion of additional slides in the folder - *Additional Technical Slides*). Slides based on specific examples may also be inserted by the user in the same folder.

An initial version of the Training Module has been developed so that further updates and upgrades can be made easily . Separate modules can be specifically designed for various regions, written in the appropriate language and adaptable to the local culture. Detailed examples and case studies can also be included. This has been designed so that it should be easy to link it with the UNDP World Bank Water and Sanitation Program publication (Resource Guide in Urban Environmental Sanitation) on crosscutting issues. Its translation into various languages would make it available to an even wider audience, and should enhance the process of creating additional local modules.

Internet-based versions of the TM could be made available to those with Internet access. This new form of distribution would greatly increase the Training Module's popularity, as it would be user-friendlier, providing interactive links between the slides / figures and the text.

The future local trainers should send their individual comments and suggestions, which then can be included in upcoming versions of the TM.

CONCLUSION

The TM is a concise document which adequately assists lecturers in running three basic forms of knowledge transfer and awareness raising:

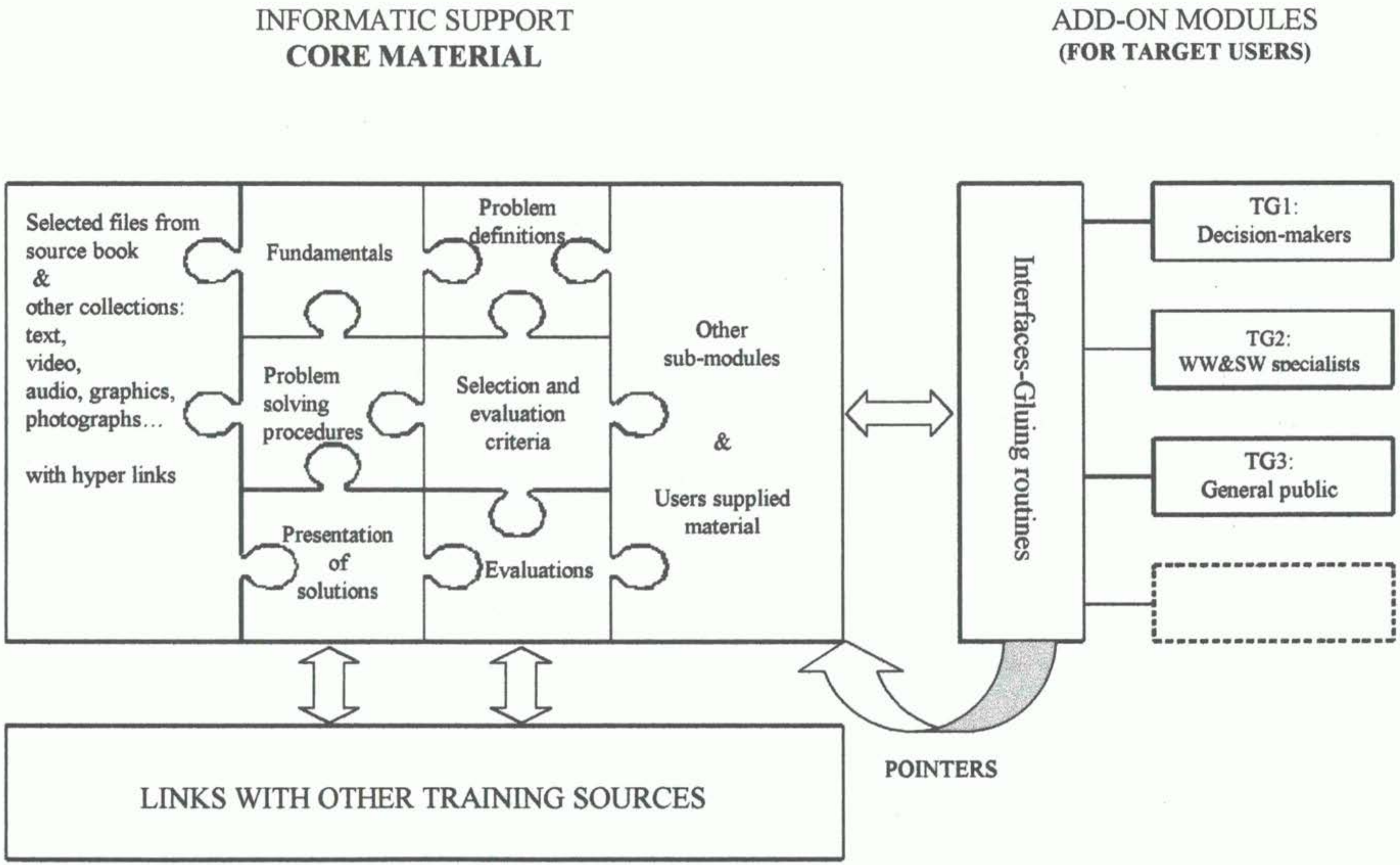
a. briefing sessions for top level decision makers
b. training programs for water and environmental planners specialists and
c. public awareness exercises for general public.

The slides and text are relatively simple to follow, and carefully designed to suit the specific target audiences. They are particularly suited for translation into other languages and for adaptations and adoptions for the global use in both developed and developing countries. It can serve as an excellent foundation for the development of future material for other IETC projects and publications.

REFERENCES

1. G. Ho, and C. Maksimovic, (2000). International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC -UNEP, Technical Publication.
2. C. Maksimovic, and G. Ho (2000) Training Module for the International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC .
3. Group of authors: Regional Overviews for the International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management, IETC.
4. Sustainable Urban Drainage Systems – Best Practice Manual for England, Scotland, Wales and Northern Ireland, CIRIA Report 523, London (2000).
5. Sustainable Urban Drainage Systems – Design Manual for England and Wales, CIRIA (C522).
6. Sustainable Urban Drainage Systems SUDS - Training Material (CD), CIRIA.

Figure 1: The Concept of the Training Module (T / M)



AIMS OF THE TRAINING MODULE :

•Complementary to the Source Book

•Briefing of top level decision makers

•Training of water and environmental specialists

•Information to general public

• Support to all 3 Target Users

CONCEPT :

•To be open for further update and local contributions

•To be adaptable for local needs (language, culture,..)

•To be open for interactions

POSSIBLE UPGRADE IN THE FUTURE :

•Translation into other languages

•Link with World Bank publication (Resource guide) on cross-cutting issues (or a separate module)

•Add-on modules on local- regional aspects

•Development of distant learning potential (Internet based)

•Basis for development of similar material for other IETC projects and publications

•Upgrade for new technologies

DISCUSSIONS

Josefina Gomes (Dominican Republic) - "It is a pity we do not have time enough to go through some specific implementation , because we only saw the slides , which I consider to be very well done. They are very clear and the information seems to be very well used. And the figures have a very good explanation of what it is. But I would like to know to whom the slides are meant for and how the training will be. Do the slides come together with some sort of a guide on how to use them ? Do they have other information besides those points on the figures ? I wish we had gone deeper in this subject."

Cedo Maksimovic - "The slides are meant to be used in a one week training program. Maybe one or two experts then will use these slides source book and additional material from your local sources to run the training course for specialists in your country, because in this workshop we have only one person from one country. Each country may have hundreds of other specialists who have to be exposed to this kind of material. It is not something dramatic to use these slides. They are most like ideas which always existed and I just put in a systematic kind of framework, illustrated in a an easy to understand manner , so that the messages are clear and the people comprehend this change of philosophy.

But Richard knows that in the past, these stormwater and wastewater systems were completely separated and people were building wastewater systems without stormwater, and vice and versa. So, the idea of a need for integration is kind of a new message, new philosophy, new concept. And this message has to be exposed to experts who have to understand, to accept and to readjust their practice design in maintenance, management according to this kind of systematic or relatively new approach.

So the answer to your question is that the users are these three target groups, the trainers, probably you or people like you who will be given or who will acquire the book and model. We will probably organize more smaller events similar to this one at the country level or small group of country where transportation cost could be lower. Then we can bring more people and train more people."

Manoherlal Kerof (Trinidad & Tobago) - " The slides really impressed me and they can be a good training tool. These systems can be used in two different scenarios. One is the existing situation and the other where you are planing to build a new house or industry with a developed water system like this.

And that is when you need some criteria to select the appropriate technologies or appropriate systems : selecting between the conventional system, on large system or local sanitation, or even integrating these three systems. The choice of the right technology should be related to the population density. "

Goen Ho - "I think they are all valid points that should be covered, specially from the point of view of planning, because with various types of population density you can not install on site systems. Therefore, I think it is right. I mentioned that we have presented at least four different ways described in the source book."

Luiz Gamez (Costa Rica) - "I believe that the material presented is very well organized and it makes good emphasis on the technical aspects. Conceptually, they should be a very good base material and the implementation of this should be our contribution. However, my only suggestion to this material would be to look at other possibilities, to

However, my only suggestion to this material would be to look at other possibilities, to include some case studies, hopefully with general numbers and results that might help as policy tools, because we should not be forgetting the policy side in all these aspects."
Goen Ho - "Yes, I forgot to mention that there are case studies from all the regions, so we can look at the source book for the detailed case studies containing figures. I think, though, that there should be only two or three case studies from each region."

Julio Torres (Panama)- "I believe that was a very good presentation. My question is how do we get hold of all that information? Is it in 'maESTro'?"
Goen Ho - "Well, at the source book, that we are going to finalize hopefully by the end of this year. Also the book and all its technologies will be at 'maESTro'."

Francisco Cuba Terán (Bolivia) - "I am concerned about the audience of the training course you have shown. I wonder which is the level it is supposed to have. Because depending on the audience, eventually you would have to change some of the contents, maybe the language and also its length. Will there be a Spanish version?"
Cedo Maksimovic - "In terms of audience level, we can start by separating around 20 slides that could be presented to an audience composed of Ministries, assistants, mayors, and decision makers. The slides would have a general content with a clear picture of what is integrated management and so on. I think the slides do not need any modifications, maybe just language translation and need a local expert who understand local people´s situation.
The second kind of audience would be composed of people with your background, specialists, engineers, environmentalists, biologists, chemists, water analysts and so on. I think for them the whole set is relevant. It doesn´t even need a local flavor, because it has been prepared to serve the whole world, and not specifically one region or another.
Finally the third group, NGO´s or housewives or community leaders, would be presented to slides with a local flavor, a flavor of that particular country or that region.
About the translation, I think this is something we will have to discuss with IETC, but we are very enthusiastic about this and we will be discussing these issues soon."

Lilia Casanova - " IETC intends to pursue other regional workshops. This is not going to be the first or the last. But, what I would like to see is a workshop with the methodology of making participants think and work. Maybe dividing the participants into two or three groups, including a problem-solving section and also providing case studies.You do not identify the name of the town, the municipality or the community, but you provide all the basic information and you do not provide how the community solved the problem. Like for example the case study presented by Viviana or by Carmen.
Then give the case study to the groups, where they would play roles, like one is the Mayor, one is a NGO leader, one is a banker, etc. And then see how they solve the problem."

Augusto Sergio Guimarães - "We have come to the conclusion that engineering is part of the solution for low cost sewerage sanitation facilities. So, maybe we might add

to this module, some non-technical examples, non-engineering aspects that might well contribute to the success or in the lack of it, to the failure of some of the initiatives that have been so well covered in the modules.
So, perhaps inside the technical module, we might include discussions over the team to support good engineering practices, and also more aspects including software activities rather than only hardware activities."

Eugenio Barrios (Mexico) - "My suggestion is on the technical aspects you are presenting. I just took a very quick look at North America design parameters, which not always can be applied to any circumstances.
In Mexico we have been developing our own parameters or our own rules but it has cost a lot of time to realize that has to be done in that way. So, I think it will be very helpful if you can take care of this present content, framework or the technology supply on which the circumstantial factor can be useful.
Another important point is having the book translated to other languages."
Goen Ho - "The text book is to apply to North America, so we are trying to present other cases, other material, not originated in North America. We are already discussing over translations."

Richard Middleton - "I would love to go back home and use this. But I do not know how to design pavements, I do not know how to design drainage swales with grass of a particular height and a particular rigidity in such a way to slowing a storm, etc. I am not saying it is not there, I am just saying from what we have seen, I do not know the link between the series of pictures and what I need to know to take home. Things like me saying to another country this is what you should do, because I can show that it will save you money. I have not got that information out of the training module. If it is there we missed because of lack of time, and if it is not there I think it needs to be.
About translation to other languages, it is very important. But also important is the translation into words that make sense to the people you have got to teach. This is a different sort of vocabulary and is also a different source of visual vocabulary. Depending on the country you are talking to, the person you show on a slide, who is wearing particular clothing, could be completely unacceptable to other people.
So we need to work with neutral images or we are promoting the wrong sort of people and destroying our efforts. The shape you show them, the color you choose for the drawings and these sort of things are very complicated, it is not just language. And there are people who have done lots of low-level training courses who can advise on that.
And third and final point, I am worried that we need to go through some of the slides with a microscope, because for example I can tell you none of the item 'pit latrines' on the slides will work because the fan pipe is one meter too short and its diameter is too small. I can tell you that flush will not work because the trap is not hydraulically efficient. It should be a 19mm trap and it is about five centimeters."
Cedo Maksimovic - "About the design guidelines, I think that concerning the wastewater and treatment processes, Ho is more qualified on commenting that. Concerning source control, unfortunately there was no good design manuals available worldwide. There is one being produced by 'Syria', a construction industry in U.K., from which part of the slides I showed were extracted from. Maybe it is the only one existing

in Europe. I know that there are many guidelines in the United States but this seems to be bit more consistent and relatively short. "

Goen Ho - " In terms of wastewater technologies, first of all, we don't want to produce a text book. There are many textbooks, but unfortunately they are based on the North American experience. But in terms of the new technologies that we are trying to promote, there are just emerging text books on simplified sewerage for example; about operation and performance of composting toilets, the pathogens in the compost, and how to handle the compost, there is a definitely lack of good researches. So this is something I would like to contribute to the U.E.S. Gap study that Richard mentioned. "

Carlos Landin (Ecuador) - "I think that it is very important to take into account The target group of the module, that I think is people like us. In my opinion it should be aimed at a more wider target group. I suggest to fill the training module with lots of pictures, because in order to convince people like we, you don't need big efforts. But to convince politicians and the community it is very hard. You should include many pictures and data about economics for example.

About eventual complications of the technology, that will be very useful in order for each of us to adapt the material to their own necessities. For example, the case of Calcuta. It is very interesting but you do not understand anything if you see only two pictures. You may need 10 or 20 case studies, each one with 20 pictures. Some case studies are very useful for Ecuador for example. The training module rarely elaborates an abstract idea and that is not a good idea. It is better to give people a very wide choice of possibilities. Each could choose the best for each case."

Cedo Maksimovic - " The point is positive and we will try to add more pictures."

Terrol Inniss (Barbados) - "I agree, the pictures and icons that tell you what is going on, because many times you do not have the time to do a lot of reading and picking up certain things to go and check. It would be very helpful if you see the picture of what you are looking for, and then you click on that and then get the relevant data."

Part III

FIELD VISIT

SITE VISIT TO PARACAMBI

On March 29, 2000, as part of the IETC Seminar to be held in Rio de Janeiro, the participants were invited to visit the Municipal District of Paracambi, populated by nearly 50,000 people, which is placed around 80 km from downtown Rio, though it still belongs to the Rio de Janeiro Metropolitan Region. In Paracambi a series of infrastructure investments is underway, particularly in the water and sanitation sectors, all of them with the support provided by the Mayor, Mr. Rogerio Ferreira, locally born, who is also professionally a cardiologist physician, a fact that makes him even closer to the people in his day-to-day activities at the Municipality.

Three were the projects discussed in Paracambi, as follows:

- The water system of Ponte Coberta

Ponte Coberta is a low-income, small village, comprising 110 families, placed detached from Paracambi (10 minute drive), but even so it is still part of the municipal district. The water supply of the whole area of Paracambi is to be provisioned by the State Water Company (CEDAE), but very little priority has been given to the city core's system, Ponte Coberta. Actually shallow and highly contaminated wells served Ponte Coberta before the implementation of the project.

With funds provided by the National Health Foundation (FUNASA), from the Health Ministry, a community-supported water system comprising two deep wells, a 50 m^3 reservoir, distribution network and water meters has been built. The system as a whole is still under test procedures, especially in what regards the tariff scheme to be applied to the community, who has been successfully responsible for the system's maintenance and small repairs. It is interesting to realize that part of the community has demonstrated strong interest towards the charge of tariffs as a matter of saving the available water, especially because over 20 mini pools (each possessing around 500 l) have been bought and installed by dwellers right after the new water system has proven to be reliable. A local Television Network , on a program regarding water availability and uses, has used the Ponte Coberta project as a model for community-supported small water systems.

- The sewerage system of Ponte Coberta

As quite often happens to Brazilian urban communities, regardless of their income standard, the community itself has solved its sewage problem at the household level, however creating an environmental problem downstream. In practical terms, community-made drainage pipes (300-400mm) have been laid down so as to convey all household wastewaters (storm water and sanitary sewage) downstream up to the closest "official" main or even straight to the nearby creek.

The normal procedure, by the way almost never taken given financial unfeasibility, is to destroy the community-made system and in turn laid down parallel pipe systems, one for stormwater and the other for sanitary sewage, the latter discharging into a never-operated/maintained/repaired sewage treatment station. In Ponte Coberta it is under construction also with funds from FUNASA an innovative system based upon (i) the permanence of the existing system with repairs/reconstruction wherever necessary; (ii) the construction of a hydraulically-geared gate by using an induced hydraulic critical flow inside the major drainage pipe so as to divert the dry weather (sewage) flow to a community septic tank/anaerobic filter system – during the heavy rain weather the functioning of the gate will preclude the intake of storm water to the treatment system, but the gate will automatically turn to the original position as soon as the water level gets down.

It is expected that the combination of the three factors, i.e, use of (a) the existing drainage system, (b) the hydraulically-geared gate and (c) the simplified sewage treatment unit will propitiate another strong tool to make urban sewerage feasible even to low-income communities. In addition it must be emphasized that the headaches caused by the operation and maintenance of conventional sewage treatment unities will be replaced with the adoption of the septic tank/anaerobic filter systems by the following procedures: sediment removal to be made by the community, right upstream the gate when the heavy rain is finished; sludge removal, on a yearly basis, to be made by a vacuum truck hired by the Municipality; replacement by Municipality crew and disposal on farms of the filtering media (regular gravel) every 4-5 years.

- <u>Urban Core Sewerage Project</u>

Also with funds provided by FUNASA it is under initial stage the design of the sewerage system for the main urban core of Paracambi. Similarly to what happens in Ponte Coberta wastewaters from the whole urban area have been more than reasonably sewered to existing main canals and/or to the Monkeys' River (Rio dos Macacos), which is, nevertheless, in a very poor situation environmentally speaking.

This project will be a scale up of what is underway in Ponte Coberta. In a basin-to-basin approach all existing points of discharge will be screened and located on a field map so as to plot the existing collecting system and also for the necessary repairs; pre-cast concrete canals will be designed to be built inside existing canals for dry-weather flows: and suitable public areas for building flow diversion gates and community septic tanks/anaerobic filters will be chosen so as to change them legally in *non-aedificandi* sites. All in all, it is expected that the implementation of the new system (i) does not cause but minor urban diseconomies by traffic inconveniences as very little is proposed to be built in public ways; (ii) rearrange the city's sewage collecting network; (iii) improve dramatically the environmental conditions of the Rio dos Macacos' basin, being noteworthy mentioning that this basin is a tributary to the Guandu water system, which offers over 45 m^3/s of potable water to the Greater Rio de Janeiro.

Finally, the project is making use of digitized city mapping system as a cartographic basis in substitution to the costly and conventional topographic survey. As a matter of comparison, the whole project will cost about US$ 80,000 whereas the conventional topographic survey's budget was over US$ 1 million.

Participants of the Workshop have been received by the Mayor of Paracambi, Mr. Rogerio Ferreira, and had a direct contact with the members of his team and community participation leaders. They visited the sites at Ponte Coberta for wastewater treatment, pumping wells, distribution reservoir, current wastewater disposal and had a lengthy discussion with the local community members, social workers and with the project implementation professionals.

After the visit an evaluation meeting was held at the Paracambi school. The following conclusions have been drawn:

1. The project has been evaluated as a good model on how the similar small scale project should be managed in the future and in the other places in the world. In that respect IETC reiterated its commitment to support the production of a video that would promote the concept and the experience gained on the sustainability issues, community participation, small scale appropriate conditions and other aspects that can be used to demonstrate the role of integrated solutions at small scale. IETC provided additional information on what is expected to be the final contents of the video.

2. The role of the Mayor in accepting the initiative of the local community, providing his enthusiastic support and providing the support of the other teams and services of the local government has been recognized, acknowledged and praised. The project is an excellent example of how environmental 'champions' can make a difference in a community. These 'champions' include: (1) the community leaders who contributed their time and expertise to provide the necessary social and technical support; (2) the external experts who provided technical, management and coordination expertise to conceptualize, develop and implement the project; and (3) the political leaders who used their political will to mobilize resources to finance the project and harness the community's potentials to manage the project.

3. The role of the local community in initiating the project, in securing external funding and its own continuing in-kind contribution, in securing the durability (sustainability) of the project has been acknowledged and praised.

4. As a project that utilizes a traditional technology for treating wastewater, which has been modified to suit the present conditions and available resources in the community, it is also a good example of an endogenous environmentally sound technology.

5. It has been underlined that the selection of the technology for the small scale treatment, automatic separation of stormwater during rainfall events has been assessed as appropriate. The role of the expert team in providing the appropriate solution and in supervising the execution of the project has been recognized. The need for securing the long term continuity in maintaining the operation of the scheme has been underlined. The local community confirmed its commitment to this concept of securing funding for the maintenance and management of the scheme.

6. Providing drinking water and matching the scheme with improvement of the sanitation and receiving water protection as an integrated solution has been acknowledged. However, several aspects seem to not have been given the proper

care so far. Soil erosion protection, securing the structural stability of the stormwater open channel are in the urgent need of taking care of. Failure to secure this aspect might result in the structural damage which can compromise the whole project.

As a form of reminder, it is important to note that the sustainability of the project cannot depend on the contribution and support of external 'champions' who are likely to leave after the completion of the project. For reasons of sustainability, the expertise of the external champions shall have to be transferred to local managers who should then have to be trained on the job to prepare them for this eventuality of them taking on this higher level responsibility on a continuing basis.

Part IV

A B S T R A C T S

<u>ARGENTINA</u>

SEWERAGE SYSTEM BREAKDOWN - THIRD MAIN PIPE WASTEWATER CONTROL PLAN

Javier Mijangos

ABSTRACT

This report summarizes cost and performances data for a wastewater control application at the sewerage system. The system, located in the City of Buenos Aires, Argentina, is conformed by three main pipes. On January of 1998 a section of the 3rd main pipe was broken and the wastewater was turn off through the stormwater and discharge without treatment into the water course, (Riachuelo basin). The Pollution Control Division of the National Institute for Water and Environment (Instituto Nacional del Agua y del Ambiente, INA), was in charge to carry out a Control Plan to avoid a negative environment impact at the course during the restoration of the section. This plan was focused mainly at the industrial wastewater control. From January 1998 to April 1998 were taken samples over both, the three discharge points and the industries. The wastewater was contaminated primarily with cyanide, phenol, arsenic and chromium.

Maximum concentration measured in water was: cyanide 0,015 mg/l; phenol 0,022 mg/l; arsenic 0,5 mg/l; chromium 0,046 mg/l; In other hand the maximum BOD was 199 mg/l and the maximum QOD was 560 mg/l.

Maximum concentration measured in samples taken from industries were: cyanide 0,38 mg/l; phenols 0,185 mg/l; chromium 25,59 mg/l and BOD 5152 mg/l.

To take the samples on the water course, was used an automatic sampler, which were taken from the inspection well, situated approximately 100 meters before the discharge. The samples at the industries were taken from a "sample well" in a manually form.

This application was the first full scale of pollution control carry out by the Pollution Control Division to avoid a negative impact on the water course.

Actual costs for the pollution control plan application were approximately US$ 70.000.

DISCUSSION - ARGENTINA

Presenter: Javier Mijangos

Francisco Cuba Terán (Bolivia) - "In La Paz the sanitation services are privatized and the company that operates there is the same one that operates in Buenos Aires. How did the concessionaire react to the main sewerage system accident?"
Javier Mijangos - "The concessionaire was responsible for the repairing and also collaborated with the industrial contamination control assuming all the expenses that were included in the maintenance contract."

Francisco Cuba Terán (Bolivia) - "About the concession contract, is the stormwater system included in its expansion and maintenance? "
Javier Mijangos -"No, the contract includes only water supply and sewerage system. The stormwater system is managed by the Buenos Aires municipality."

Eugenio Barrios (Mexico) - "Was the cause of the collector damage the fact that there was no companies inspection?"
Javier Mijangos - "We have 5.000 registered establishments to control, and many of those discharge into the stormwater system or directly into the rivers or into the wastewater system. The concessionaire must control the quality of industries disposal also. When an industry does not follow the quality parameters, the concessionaire denounces that to the national authorities. As that was something that was not foreseen in the concession contract, the authorities implemented a contamination control plan for the sewerage system."

Viviana Rocco (Uruguay) - "You said you have a submarine outfall in Argentina. Is there any pre-treatment or diffusers? "
Javier Mijangos - "It is only a submarine pipe joined to four main sewerage systems in a specific point and through a conduct 2.500 meters from the coast that discharges about $26m^3$ per second during the peak times. The conduct has a diameter of 7 meters."

Francisco Cuba Terán (Bolivia) - "Is the treatment included in the concession contract? "
Javier Mijangos - "At first the treatment was included until 2015. Now they shortened the term. It must have some treatment at the disposal part until 2003. There are already two treatments and the collector net is divided into three basins. The North basin is treated with activated sludge and the Southeast one through percolators riverbeds."

TOWARDS SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT. PRACTICES IN THE BAHAMAS

Glen F. Laville
Philip S. Weech
John A. Bowleg II

ABSTRACT

The Commonwealth of the Bahamas is an archipelago of approximately 700 islands and cays covering nearly 100,000 square miles of the Atlantic Ocean lying just 50 miles east of Florida (U.S.A.) and extending 840 miles South eastward to within 50 miles of Haiti and Cuba. The Bahamas Islands lie between latitudes 20 and 27 degrees north and longitude 72 and 79 degrees west. Insulated from the North American Continent by the Florida Channel and yet cooled in the summer by the Northeast Trades, the Bahamas suffers neither extreme of heat or of cold. There are 29 islands, 661 cays and 2,387 rocks. The total land area is approximately 5,382 square miles, about the size of Wales, or about two-thirds the size of Massachusetts. The largest of the islands is Andros, which is 2,300 square miles in area. Twenty-two of the islands are inhabited among which, there are great contrasts, some having several thousand inhabitants, others a mere handful. Figure 1 above shows the relative location of the Bahamas to its neighbors.

The Bahamas population is currently growing at an annual rate of 1.9 percent per annum. The preliminary census report for 1990 indicated a population for the Bahamas of 254,685. As Table 1 below illustrates, that on New Providence Island, approximately 80 square miles in area with 67% of the total population had a population density of 2,144 per square mile in 1990. Grand Bahamas, approximately 530 square miles in area, with about 16% of the total population had a population density of 77 per square mile, while the remaining inhabited islands are sparsely populated. The urban sector in The Bahamas comprises the major population centers of New Providence and Grand Bahamas totaling some 85% of the population. The rural describes all the other population centers across the Commonwealth.

The Commonwealth of the Bahamas is famous for its outstanding pink coral sand and white sand beaches and crystal clear seawater. The climate is equable throughout the year allowing establishment of a viable year round tourist industry.

DISCUSSION - BAHAMAS

Presenter : Glen Laville

Eugenio Barrios (Mexico) - "Do you have problems with over extraction? In the peninsula of Yucatan, we have the same configuration as Bahamas it is a limestone aquifer and due to over extraction the deep injection has contaminated the surface water."
Glen Laville - "At the water utility, we have not had any problems because basically abstraction point in Providence is in the western part of the island. In addition to that, what we have gone to is a sort of gravity system which is based on normal gravity system for sewerage infra structure. We basically have a series of manholes, pipes and then we have trenches coming into the manholes. What that ensure is that rather than having a single point source that you have with the wells that can cause a pouring of a seawater you obstruct over a large area, therefore you have even more obstruction and you spread that over large areas. But typically we don't have many problems with a pouring of sea water, not in the sewage areas because we do not obstruct those sewage areas."

Eugenio Barrios (Mexico) - "How are you monitoring that water quality all around the aquifer?"
Glen Laville - "On a daily basis. Most of the wells are in the South zone, 40 or 50% of water in Providence comes from another island and we also use desalinated water but it is not because of any pollution due to deep injection well. It is really because of over extraction, because of the population also grew so far and so much and there is not enough water resources on island to take care of it."

Arthur Archer - "Do you treat water by clarifying through the primary treatment before disposal?"
Glen Laville - "Yes, we do. In the downtown area we have primary treatment. Before disposal it is basically primary clarified. We have solids removed, and we also have removals of floatable. In the other sewage areas we also have secondary treatment, which is activated sludge in remote areas where we have subdivisions. And we also have disinfecting before disposal in all of the wastewater treatment plants."

Javier Mijangos (Argentina) -"Do you have many problems with industrial wastewater in your country? "
Glen Laville - "Actually, the good thing for us is that we do not have a very large industry anywhere in Bahamas. Only one in the island of Grand Bahamas. In Nassau in particularly there is no heavy industry and we do not have to deal with any industrial effluent. Basically any industry that comes along we would require them to put into their own treatment system and we would give them guidance."

Viviana Rocco (Uruguay) -"What do people with no sewerage system do with the waste?"
Glen Laville - "Actually, this is one of the problems we were talking about earlier because where there is no sewerage system, the people use septic tanks. What we have found is that in the whole area of Providence that is very populated, some people cannot afford to be connected to the water supplied, so they use ground water. It depends on what area you are living, whether or not ground water contamination is a problem. If that is your only means of water supply, then you start talking about pit latrines and septic tanks, it becomes a terrible situation. So one thing that you can do is insist that in those areas people connect to the affordable water supply."

Lilia Casanova - "In your model refinement you have mentioned encompass reuse of wastewater. How do you intend to do this? "
Glen Laville - " We have found that reuse of wastewater is economical when you deal with a tourist area. We have things like transport or you can use it for irrigation. On part of the island we have a tourist center, where they reuse it for flushing toilet and that sort of thing. As far as the water and the sewerage cooperation we have not found a really economic feasible location to try to reuse the wastewater and basically that is why we have not done it yet. There is only one potential area that we have where we use a hard bracket water system for flushing toilets. What we are thinking about doing now is once we get out our treatment plants rehabilitated enough, we will shut down the bracket water system and possibly reuse the wastewater for flushing toilets."

Luiz Gamez (Costa Rica) - "Your island has very limited fresh water resources and probably the tourism sector is by far the largest consumer of this fresh water resources. When you talk about the options, about reusing that water, is there a role for the tourism sector or the private sector to help maximize or reach an efficient use of this fresh water resources? "
Glen Laville - "Actually, they are planning a role right now because the limited water resources, we have given permission to several hotels to set their own desalination plant or wastewater treatment plant. The Ministry of Health monitors them. So several of the hotels have installed their own treatment system, and they also treat at the tertiary level and they reuse their water even for irrigation of golf courses or for flushing their toilets."

Goen Ho - "Do you have to pump the wastewater or does the wastewater flow down by gravity? "
Glen Laville -"You need to pump it. When you drill these wells, every forty feet that you go down, there is about a foot or head that you have to overcome. So, basically depending on how deep you go down it will determine what sort of pressure you will need to use."

BARBADOS

HARNESSING AND HARVESTING A NATURAL RESOURCE

Terrol Tyson Inniss

ABSTRACT

Sustainable Stormwater and Wastewater Management is an issue that should always be in the forwards of our mind. To attain this within the limits of our own social and economic development it is necessary to practice sustainability in the light of a common world market and liberalized trade. It is effective Management of available resources that has the potential to achieve the forgoing.

Barbados is the most easterly of the Caribbean island situated at 13° North longitudes and 56° West latitude. It is a coral island and is approximately 430 square kilometers (166 square miles).

Although Barbados was a colony of England the Portuguese first discovered it in the sixteen century, until it became an independent nation in 1966.

Some small island population and housing needs are developing quickly, but the economic development is sometimes not as quick, because real economic development must be sustainable.

It is against this back ground that the Barbados Government found it necessary to implement a Drainage Unit to exclusively deal with Stormwater Drainage issues.

DISCUSSION - BARBADOS

Presenter : Terrol Tyson Inniss

Louise Zuilen (Suriname) - "If the ponds are only for stormwater, what happens to the wastewater? "
Terrol Inniss - "We do not have a big problem with wastewater as yet in Barbados. We have one facility, that is the treatment plant we have in Bridgetown and we are building another one on the West coast."

Cedo Maksimovic - "But those are going to be treated? "
Terrol Inniss - "Yes, all treatment plants. It will be of secondary treatment. We are not looking to discharge anything into the sea."

Luiz Gamez (Costa Rica)- "Small islands and states like yours should be particularly concerned about climate change and phenomena like 'el Niño, la Niña'. How effective should be all these investments you have shown to us in managing that vulnerability, in managing all that natural disaster risk? "
Terrol Inniss - "About the large retention ponds, one has only been tested. And so far, it has passed."

BOLIVIA

IN SEARCH FOR A SOLUTION FOR CHOQUEYAPU RIVER CONTAMINATION

Francisco Javier Cuba Terán

ABSTRACT

Situation of Choqueyapu river has been analyzed from an integrated wastewater stormwater sustainability point of view. Some of the several social, economical and environmental problems were satisfied by alternative proposed but high costs consequent of interceptor pipes and wastewater treatment plants were inevitable.

The City of La Paz is the political capital of Bolivia with a population of about 1.2 million. The city is situated in several valleys about 3600 meters above sea level. Choqueyapu river with tributaries runs through La Paz receiving in it's curse discharge of countless points of wastewater discharge form municipal, industrial, hazardous and commercial sources. In the old center of the city with mixed stormwater and wastewater sewer system, contribution of pluvial water also occurs. 150 meters in 30 kilometers fall permits high levels of reoxigenation and nitrification are assumed to take place. These biological processes are thought to lead to a certain degree of natural wastewater treatment. The river water is used for various domestic purposes and further downstream the farmers use the water for irrigation.

Common waterborne diseases in the area are diarrhea, typhoid, dysentery and hepatitis. Along the river Choqueyapu there are also problems with odor, color, accumulation of garbage, poor water quality for irrigation etc. The main reason for these problems is that domestic and industrial wastewater is let out into the river without treatment.

The water problems have caused both ecological, economical and health problems for the population around Choqueyapu. An example is the farmers downstream who have had to change from cultivating vegetables to less profitable crops because of high concentrations of coliforms in the irrigation water. It is necessary to recognize the importance of clean water for a sustainable development in the area.

Investigations of the river's degree of pollution and its natural water treatment is obtained by measurements of several different parameters such as coliforms, ammonium and COD, but to get a clear and complete view it is desirable to collect all the parameters in a water quality index. The parameter values are multiplied with weighting factors and then added to produce one value – the water quality index. This index is an excellent tool when it comes to studying changes in quality in a specific river over time or comparing different rivers. The water quality index can also be a useful tool in localizing major sources of pollution.

Choqueyapu river contamination problem have to be solved with an integrated solution including stormwater collection and final disposal, wastewater collection and treatment, sustainability guarantee so that all systems can be affordable and operable in next years.

DISCUSSION - BOLIVIA

Presenter : Francisco Javier Cuba Terán

Glen Laville (Bahamas) - "Are you treating the entire river?"
Francisco Cuba Terán - "We area treating the entire river in the old center of the city, where we can not separate stormwater from wastewater. But we have tributaries along the emissary, the interceptor. So we have the entire river plus the tributaries."

Glen Laville (Bahamas) - " When you are talking about high consumption of energy, are you talking about the treatment that you plan to do now? "
Francisco Cuba Terán - " Yes, because of the temperature in La Paz, the water temperature is below 10° C in most of the year, so you can only think about aerobic treatments."

<u>BRAZIL</u>

PRESENTATION OF MANAGEMENT POLICIES AND CONTROL OF THE STORMWATER EFFECTS IN URBAN AREAS IMPLEMENTATION OF TWO PROJECTS AT THE CITY OF RIO DE JANEIRO

Carlos Pereira Dias
Edson de Barros Mendonça

ABSTRACT

The flooding problem in the city of Rio de Janeiro has historical reasons due to the geographical boundary conditions. It has become worse as a consequence of excessive urban growth, changing the existing draining condition. The original city area between the mountains and the shore line had to be expanded to attend the urban population growth. However, some areas had an irregular occupation, such as slums, usually located in very steep slopes and in several riversides.

This process caused an increase in flood areas and in flood's frequency, urging the government mobilization to create mechanisms to protect and recover the environment. In order to implement the process of recovering the environment, the municipality has created "Fundação Rio Águas" to manage sewerage and urban drainage system through the design and implementing of a Master Plan.

The Master Plan main goal is to implement a new concept of strategic managerial of drainage engineering, changing from the old concept of rapid water flow in large channel's sections to the concept of retaining and adjusting discharges transported through the urban areas.

In order to analyze and compare both approaches, the pilot project of "Bacia do Canal do Mangue" was chosen due to its diversity and complexity besides of its several features, typical in most hydraulic basins in the city of Rio de Janeiro.

This article presents and discuss the results of the two design methodologies applied in the pilot project.

DISCUSSION - BRAZIL

Presenter : Edson de Barros Mendonça

Augusto Sergio Guimarães - " What is your opinion and technical evaluation about the 'flow out tunnel' project, which was conceived back in the 70's, but not concluded and the 'rain retaining boxes', lately planned?"
Edson Mendonça - " When we intend to study a new plan, we are supposed to check and to catalog all the previously developed studies. And this is the one with the biggest impact in the water drainage till the Mangue's channel. Hydraulically speaking, this works very well. However, there are aspects such as environmental impact and cost that are impeding the beginning of the project. We must never discard a project because the conditions may change, but we recognize that the city conditions have severely changed since then."

Terrol Inniss (Barbados) - " What method are you using to attenuate the water that passes from the acqualands into the city, to reduce the peak flow? "
Edson Mendonça - " In the urban perimeter it is difficult, but what we are doing is to concentrate accumulation areas in parts of the city a non intense public use. So, an area in which there is a lake or a propitious water accumulation, we are going to change that area so that it might have a larger accumulation capacity during the peak rain period. After that period, that area must be cleaned because rainwater brings a lot of solid wastes. Naturally there will be grids for solid wastes removal before accumulation. So, basically what we do is take advantage of the natural characteristics of the area that is going to be used. Finding a free available area in an urban center such as Rio de Janeiro is very difficult. However we have found out twenty available sites to do this kind of project."

Arthur Archer - " Do the floodings occur because of the upstream runoff?"
Edson Mendonça - " The way the urbanization occurred in the city, it was rarely given importance to the rivers. They have hydraulic characteristics typical from a tropical country. We have intense rains only in summer. So anyone who passes close to that river in the winter, imagines that river only needs one small channel section. However, during the rain season, that one section is not enough. And because there are a lot of housings too close to the rivers, to widen the rivers extension is very difficult."

COSTA RICA

THE AGROECONOMIC ACTIVITIES AT THE WATERSHEDS OF THE NICOYA GOLF : AN ECONOMICAL APPROACH OF SOIL DEPRECIATION AND WATER RESOURCES DEGRADATION

Luiz Gamez
Edmundo Castro

ABSTRACT

Costa Rica has experienced recently significant changes in its economic, political, social and technological, which have represented increased welfare. However, this accelerated population growth, combined with the developing industry expansion, have resulted in a increased waste production. The uncontrolled used of resources has produced two major threats: irreversibility and environmental impact.

The Tarcoles, Tempisque and Barranca macro-watersheds, represent major sources for drinking water supply, irrigation and hydroelectricity. Despite, water resources are chronically affected by the different human activities located in this watershed, basically soil and water pollution caused by residential, industrial and agricultural wastewater discharge and solid waste dumping.

Traditionally, the major challenge with solid waste has been its adequate disposal, provided that the externalities associated with its proximity are quite obvious and unpleasant than other waste. A common response of society toward this problem, has been to attack its visual impact by discarding garbage into water ways, burning or burying it underground (A. Cantanhade, 1997).

The change in pattern of the problems not only consists of the exponential volumes, but the change in composition to increasing complex, non-degradable and toxic materials and substances. The concentration of commerce, industry and residence in urban spaces has significantly affected efficient clean-up and management of waste.

The limiting factors, such as, the demographic explosion; the increasing amount of trash generation; its complex composition, added to the institutional weakness; insufficient waste collection fees; poor sanitation and education, and absence of community participation, have resulted in a chaotic management of solid waste (A. Cantanhade,1997).

The goal of the present study is to develop an evaluation, at a local level, to quantify in terms of cost, the management of waste generated by household sector. The response of the household in terms of real costs, and willingness-to-pay to improve the quality of water resources and the conditions of each watershed under study, were identified. For this purpose, market and WTP techniques were applied, considering these are appropriate methodological tools to support policy recommendations oriented towards strengthening the decision-making process to reduce water resource degradation in this particular watersheds and consequently the impact to the Gulf of Nicoya caused by inland pollution.

DISCUSSION - COSTA RICA

Presenter : Luiz Gamez

Javier Mijangos (Argentina) - "How do you treat the solid waste collected and do you have any regulation for this area?"
Luiz Gamez - "Solid waste is a very new challenge in Costa Rica and our legislation is not very well developed in this area. Historically the most common treatment has been disposal and covering it with land. Very recently management companies, mainly from the U.S. and Canada, have built disposal sites with adequate management. But this is limited to the central part of four major cities. By far we still have many problems in this area."

Glen Laville (Bahamas) - "As far as the watershed areas, is there any sort of restriction on agriculture use in that area?"
Luiz Gamez - "Our policy regarding land use tends to be lax because it only recommends but doesn´t abide, legally speaking. But regarding the information obtained from the erosion studies, the policy instrument being promoted by the government to revert the effect of previous forest conversion is to rent environmental services from farmers. If you have a farm land with a forest cover or if you are leaving your land to succession, you can engage into a contract with the government that can pay you for keeping that type of use."

Arthur Archer - "What are the types of wastewater treatment you actually execute? "
Luiz Gamez - "Sludge treatment is one of them."

CUBA

INTERRELATIONSHIP SANITATION, ENVIRONMENT AND SUSTAINABLE MANAGEMENT OF WASTEWATERS

Cristóbal Félix Diaz Morejón

ABSTRACT

The work mainly introduces the problem of the wastewater management, reflecting a brief panorama of the country's situation, as much in the reception as in its conduction and final disposition.

A principal case of study: the application of solution schemes of simplified sewer system or of low cost, to the local conditions; and are presented too, two also related cases: the creation of a National Center of Appropriate Technologies for Sanitation (SANITEC) that lead to the country in the search of economic solutions that protect the environment and with high social acceptance; and the particular application of stabilization ponds for the wastewater treatment coming from tourist hotels built in two keys.

The main case possesses the following characteristics:

- Support of UNICEF and the local governments.
- Work of a multidisciplinary team in all phases: planning, project and construction.
- Wide participation of the town inhabitants, from the conception of the idea and project, until their construction and maintenance (that reduces the operational costs significantly). Systematic consults with the formal and not formal leaders, and in general with the residents.
- Application of more sustainable and economical technology, with alternatives adapted to the local conditions.
- Solution to critical environmental problems in the community that provoke dangers to the human health and cause strong contamination in the river Guaso, where wastewater spilled without control.
- Solution to the floods caused by the rainwater.

The second case constitutes a simple presentation, with the objective to offer to the participants in the Workshop the possibility to share in a future the knowledge that SANITEC accumulates.

The third case constitutes a casuistic solution to the treatment of residual liquids in small islands with high development of the tourism, through the employment of stabilization ponds that at the moment have had good values of efficiency, and whose treated waters are used in the irrigation of the hotels gardens (reuse of the waters), like part of a complete cycle dedicated to avoid the contamination of the coastal and marine ecosystems, that have invaluable values for the tourist activity. Their reading may be of interest for the participants.

DISCUSSION - CUBA

Presenter : Cristóbal Felix Diaz Morejón

Goen Ho - "What are the issues and problems that you have encountered as you applied environmentally sound technologies in your country?"
Cristobal Morejón - "At first, the elimination of the environmental problems. Because of the disposal of wastewater directly without treatment into the Iguazu river created a big problem in other towns on the lower part of the river, as the people uses the water for drinking. Second, the participation of population is very important. The participation in the construction, maintenance and other things related to the operation of city."

DOMINICAN REPUBLIC

SANITATION OF HOYA DEL CAIMITO, NORTHEAST SANTIAGO CITY

Josefina Gómez

ABSTRACT

The Dominican Republic is located on the Hispaniola Island, part of the Greater Antilles Archipelago. Population was estimated in 7,293,390 inhabitants, with 56.1% living in urban areas and an annual growth rate of 2.3 % in 1993.

Sanitation services covers 89.1 % of population, and only 20.1 % are connected to a sewer system. Wastewater treatment is performed only in 48.7 % of the collected waters, but the treatment is not necessarily up to the approved standards. Stormwaters are not treated. Santiago has one of the best sanitary conditions, although due to its high rate urbanization this condition is diminishing.

Many neighborhoods are located on brooks and surrounding areas, polluting the rivers. Hoya del Caimito is in the northeast of Santiago, with a population of 8,132, of which 2,000 live close to a brook, producing 190,000 gal/day of wastewater and 1.8 t/day of solid wastes. Besides that part of the population lives without potable water.

A program to improve this situation was conducted by CEUR, sponsored by a tobacco company and with the help of several authorities and institutions from Santiago. Connections to sewer facilities, sewer pipe, drainage pipe, potable water facilities, solid waste program were implemented with the participation of the community.

DISCUSSION - DOMINICAN REPUBLIC

Presenter : Josefina Concepción Gomez Mena

Glen Laville (Bahamas) - "Why is there only 846 persons on potable water yet and 2860 on sewerage, or is that the number of connections?"
Josefina Gomez - "Because those were the persons who were connected through the project. There used to be more, before the project. "

Glen Laville (Bahamas) - "What was the purpose of covering the brook, if it is not being used now? The tobacco company still not discharges there? "
Josefina Gomez - "People still throw things although they have been receiving a lot of information and education. So some people came up with the idea of covering the brook."

Terrol Inniss (Barbados) - "What about stormwater? The brook does not have its flowing increased when there is more stormwater and how is it coping now that is covered?"
Josefina Gomez - "They built a channel beside the big brook and it takes the water directly to the river. It was the only way of having some improvement in these people lives, otherwise they were still using the brook as they used to do it."

ECUADOR

GUIDELINES FOR WASTEWATER MANAGEMENT IN QUITO, CAPITAL OF AN ANDEAN COUNTRY IN CRISIS

Carlos Landín
Katerine Endara

ABSTRACT

Frequently, the traditional strategies of river sanitation demand great investments, unaffordable for non-rich societies. In such cases, it is particularly important a careful definition of priorities, objectives and goals, which must be concrete solutions for some specific needs of the community.

A good illustration is the case of Quito. The sanitation proposal looks very different if the factual river usages (demanded quality) are taken into account, but not only the quality conditions of the water in the the rivers (offered quality).

Compatibility values were represented in a color map, which helps to visualize the problems, their type and location. This approach was used in reviewing the sanitation proposal of the Master Plan, doing it cheaper and more effective. The conclusions are:

- The Treatment Plants proposed in the Master Plan would not be effective, since the plants should be located out of the city, because they need big area. Consequently, they could not solve the main problems, which are located inside of the city. Moreover, the conditions of the lower part of the rivers would not be improved noticeably, because in the discharging point, the river water has better quality than the probable effluent of the future plants.
- The river has a huge autodepuration capability, which would be too costly to emulate with a Treatment Plant. It could be considered as an aerobic piston type reactor, perfectly able for processing the domestic effluent of the city.
- It is mandatory a good control of the industrial wastewater, because the treatment capacity of the rivers depend on the organisms living in it. Consequently, it is vulnerable to the toxic discharges (although less than a treatment plant).

Finally, in regard to stormwater problems, it was found that run-off coefficients in the urban area is 4 time higher than the natural land of the Andean Paramo. Such raise of the storm flows is too much for the sewer system of the city: not only the water comes up by the sinks during heavy rains, in some parts of the city, but from time to time alluvions come down, obstruct the entrance to the sewer system, and throw themselves over the streets through the city, causing material and even human lives losses.

Perhaps the time for cities covered by cement and asphalt is over. The rivers and the ground are not only part of the landscape of our cities, not only are reminders of the environment, to which our existence has adapted during thousands of years, but also would solve many of our problems, if we let them do so.

DISCUSSION - ECUADOR

Presenter : Carlos Landin Paredes

Luiz Gamez (Costa Rica) - "As a further step, are you developing a cost-benefit analysis?"
Carlos Landin - " No, we are not there yet. We are on a struggle against the Master Plan. The environmental area says that one has to invest in the environment according to the possibilities of our country. Unfortunately, the Master Plan elaborators follow the recommendation from the international credit agencies that consider that there must be a treatment plant. So at this point, I believe that this workshop can be useful in order to influence on the politics changing."

Eugenio Barrios (Mexico) - "On the evaluation of the assimilation capacity, everything is related to organic material. That is a kind of contamination that cannot be seen, and many times this is the most dangerous kind of contamination. So, can the lost of bio-diversity or any kind of evaluation like this biological tool indicate us that the river supports the contamination? "
Carlos Landin - "Of course the most affected part of the river is the part that runs through the city, but the area immediately besides the urbanization also has low oxygen and because of that there is few organic life. At around 30 km from the city area you start to identify small groups of people live from fisheries. So we proposed that those areas were interdicted until it becomes better. That is all we can afford to do now.
According to the law, the environment authority in the municipality is in charge of the industrial control."

EL SALVADOR

SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT. THE EL SALVADOR EXPERIENCE

Carmen María Olano Díaz

ABSTRACT

The present document contains a brief description of the status of the water resources of El Salvador.

In order to understand the present environmental problem of the country, it is necessary to get acquainted with the environment-related laws and institutions which have proven to be inefficient. Adequate regulations that control the wastewater discharges which have contaminated 90% of our rivers do not exist.

In view of this situation, actions aimed at correcting this problem have came up. In El Salvador, water treatment plants have been installed since 1980, however, due to the lack of regulatory and monitoring instruments most of them are not in operation or are in poor condition.

By the mid 90's, a different type of treatment plants called "Activated Sludges Systems" was installed. Due to its design and operation, this type of plant is convenient to achieve a sustainable wastewater management with its consequent reutilization. As are result, environmental degradation is prevented.

In conclusion, wastewater and stormwater management at urban level is unsustainable. Notwithstanding in the past two decades a conservationist awareness has been generated, a true sustainable implementation of the hydric resource management does not exist. Water resources are used irrationally and the future generations are in jeopardy.

However, it is expected that with the approval of the new Environment Regulations this situation will be gradually reverted with the support of the society and related institutions.

DISCUSSION - EL SALVADOR

Presenter : Carmen Maria Olano Diaz

Javier Mijangos (Argentina) - "At present, the government has established disposal standards. How do you know when someone is polluting ? What decisions do they take against the companies who are polluting ? "
Carmen Olano - " At the moment there is no regulation yet. Although the Ministry of Environment has control over the industries, there is not any kind of sanction, especially because there is no regulation. In spite of that, all industries are developing environmental studies now. According to the environmental law, created in 1998, they had two years to provide the results and the deadline ends on May 2000. So now, all the industries are supposed to have their diagnosis. I was told at the Ministry that about 20% of the industries have presented their documents. There isn't any kind of sanction at the moment."

Luiz Gamez (Costa Rica) - " Because of the problems caused by recent natural disasters, there is a vulnerability in the economic and social areas of the Central American countries. So there is a considerable effort for the reconstruction in countries like El Salvador and Honduras. Is the international help also helping in stormwater management ? "
Carmen Olano - " The Mitch hurricane affected mainly the coastal areas. Actually, what I know is that the international help is basically for reforestation, soil control, houses reconstruction and also health problems."

Eugenio Barrios (Mexico) - " The fact that you have a regulation does not necessarily mean that you are going to have contamination control. The governments are the major operator of treatment plants in our countries. So, would it be necessary to have a regulation on the contamination control ? "
Carmen Olano - " This is because the industries have to treat their own wastewater. So that would depend on how to control the effluents. For example, if an industry does not treat properly its waste, it will be discharged into a river and the river would be highly polluted. It would be very expensive to clean the river later."

Terrol Inniss (Barbados)- "You mentioned that the stormwater was not taken into consideration, and right now you have your wastewater system being flooded by the stormwater system. So are not you having contamination also from your solid waste being picked up by this stormwater and dumping into your existing wastewater system and into your rivers ? Is that also a big problem ? "
Carmen Olano - " Yes, that is a very big problem because , as somebody mentioned already, this solid waste also interferes with the hydroelectric plants."

Terrol Inniss (Barbados) - "So, what are you doing about that ? "
Carmen Olano - "Right now, nothing."

OPERATION AND MAINTENANCE : A REFLECTION. GUATEMALA EXPERIENCE

Adan Ernesto Pocasangre Collazos

ABSTRACT

The lack of operation and maintenance in water and wastewater systems is the main problem that countries in the process of development have to face, adding to this the lack of a "*formula*" that give us the best option of the appropriate technology.

This work tries to give the solution to this problem trying to apply the answers to a special case in Guatemala.

This case study is a project of sanitary and the Wastewater Treatment Plant in Boca del Monte, Villacanales, Guatemala.

With the agreement of opinion and trying to get together all the participants to obtain best results, this project succeed and guaranteed the operation and maintenance of the wastewater treatment plant.

To reach the main purpose of this project we began from the proposition that it is necessary the participation of all sectors involved in the wastewater treatment. This process had the participation of the Instituto de Fomento Municipal (INFOM) as the institution of the government that has the responsibility to be the advisor in this issues through the municipalities and as the entity that made the planning of the project (design, supervise, and the operation and maintenance manual); the Central Government of Guatemala giving part of de funds for the project; the Municipality of Villa Canales, that is responsible for the rest of the funds to make it possible; People from de Community of Boca del Monte, who knew and considered themselves as part of the project, they will have to pay part of the rates established to get the funds; and the Private Company who donated the land to build the wastewater treatment plant and will guarantee the operation and maintenance.

It was made the selection by choosing Stabilization Ponds in series and parallel (anaerobic-facultative) as treatment, assessing the conditionings for this to be sustainable and economic viable.

Key words

Operation, Maintenance, Stabilization Ponds, Selection of Appropriate Technology, Sustainable, Wastewater, Wastewater Treatment Plant (PTAR).

DISCUSSION - GUATEMALA

Presenter : Adan Ernesto Pocasangre Collazos

Francisco Cuba Terán (Bolivia) - " Have you thought about having the private companies participating in the basic water services in Guatemala ? "
Adan Pocasangre - " Yes, there are many companies interested in participating. The problem is political, however, not a technical problem .They have recently invested US$ 400 - 500 millions in the transport sector, but nothing in the wastewater business."

MEXICO

HOW TO DEAL WITH WASTEWATER IN DEVELOPING COUNTRIES. SOME EXPERIENCES FROM MEXICO

Jorge Eugenio Barrios O.

ABSTRACT

Through this paper, some of the current issues involved in WW management in Mexico are presented. Some of them point out unsustainable situations, others have showed some way to reach sustainability.

Wastewater (WW) is an everyday problem in developing countries. It can be found everywhere causing a lot of diseases and environmental damage. Through the years, a lot of money has been invested in sanitation programs, however few results can be observed. The traditional sanitation strategies focused on full coverage must be reviewed.

Even though Mexico does not have a formal wastewater management programs, some empirical approaches have been applied. Currently, wastewater from 55 cities is directly used in agricultural irrigation, but only at 14 some type of treatment is provided. The Metropolitan Zone of the Valle of México is the zone in the country where the most serious water management problems are found and where a new approach is extremely needed.

Wastewater reuse within the city is quite small, although now it is considered an important water resource. Currently, most of the wastewater is reused without any kind of formal treatment in agricultural irrigation in the Valley of Mezquital. This Valley has played the role of a big wastewater treatment plant. In order to meet water quality requirements, and advance primary treatment has been proposed. This technology removes pathogens, but leaving most of the organic matter and nutrients, at a lower cost than conventional secondary treatments.

Based on Mexican experience, in 1995 wastewater discharge regulations were modified considering the reality of the country. Wastewater must be managed through a comprehensive approach, that can be better viewed as a water quality management program, strongly supported by pollution prevention techniques, focused to satisfy all type of demands within an environmental system through local participation procedures.

DISCUSSION - MEXICO

Presenter : Jorge Eugenio Barrios Ordonez

Carmen Rojas (Paraguay) - "You told us you use the water from the aquifer. Is there any problem protecting the aquifer from the wastewater ? "
Eugenio Barrios - "In Mexico city, the aquifer is the main potable water source and there is a lot of problems because it's overexploited. They extract around 40 mm^3 per second daily from the aquifer, and there are some signs of pollution right now, nitrates and coliforms."

Carmen Rojas (Paraguay) - "But do you have a program to protect the environment ?"
Eugenio Barrios - "Yes, but it is very difficult because you can find wells all around the city and it is a problem of water management. The water administration has to control the extractions."

Manoherlal Kerof (Trinidad & Tobago) - "You are heading to primary treatment, then disinfection, and then irrigation. What do you mean by primary advanced treatment and is there any scheme implemented which is actually working ? "
Eugenio Barrios - "What we mean by primary treatment includes flocculation and coagulation. The primary advanced treatment or enhance primary treatment is just a sedimentation based in chemicals (wastewater treatment). In Mexico a lot of studies have been made to apply this technology with very good results."

Arthur Archer - "What do you do with the sludge from the activated sludge ? "
Eugenio Barrios - "Very few cities have activated sludge and in most of them the sludge is dumped in the sewerage system again or put in a landfill. It is not used for agricultural purposes either. There are no good sludge management practices around the country."

<u>PANAMA</u>

PANAMANIAN BAY POLLUTION AND THE EFFECTS OF THE STORMWATERS IN THE PLUVIAL SYSTEM AND THE DANGER THIS BRINGS TO THE POPULATION

Julio Torres

ABSTRACT

This study was prepared from articles from government reference, observations made by journalists about the tropics and published in the main newspapers of the country, internal writings of the Institution and personal approaches.

From it, widespread and basic arguments for a better understanding. The historical and experimental investigative data, and the credibility of these observations, allows a general vision of the government's actions and their effects.

The investigation for the realization of this study begins 1968, and every day there is an interest for the authorities to solve these problems.

Panama formed an Administrative Commission called Autoridad Nacional del Ambiente (ANAM) , a governmental organization to control the ecology and the environment. Finding solutions has resulted in projects in stages where all the institutions of the Government are involved.

DISCUSSION - PANAMA

Presenter : Julio Torres

Augusto Sergio Guimarães - " When you refer to the aerobic system, I can imagine it is some sort of bio-reduction, as a result of the operation of the system. But what about the pathogen reduction, is this some sort of preoccupation of the officials for the Panamanian water sewerage company, about that effluent being discharged into the bay?"
Julio Torres - " No, because they say they can come to 60% purity and that ought to be good enough to go into the bay. As a matter of fact, it is good enough to go into the rivers."

Glen Laville (Bahamas) - "After the problem started with the sewage in the bay and the fact that you were not getting the circulation that you used to, was any thought given to removing the break water and at least trying to alleviate the problem temporarily ? "
Julio Torres - " No because they built a marina there and it became a financial and political problem that we could not overcome . "

Terrol Inniss (Barbados)- " You mentioned taking the wastewater deep down into the ground, treating it and then dumping it into a river or bay, for example. What about the cost of dumping the wastewater into the river or a bay, is not that a lot more costly ? "
Julio Torres - " According to the figures, this system costs half as much as a conventional plant, specially when the plant is about 8 km distant. "

Arthur Archer - " I get the impression that your treatment facility is built below the ground. Is this a common thing ? "
Julio Torres - " No, this is a new system . In Colon city they built a brand new city for tourism and they are building a plant there right now to take care of the area that consists of a small city and a hotel with 800 rooms. The size of the plant depends on the quantity od wastewater that it has to take care of."

Viviana Rocco (Uruguay) - "Which are the main uses of the Pacific Coasts in that area: bathing, recreations, sailing ? "
Julio Torres - " We do not have much sailing there. The recreation beaches are outside the Panama Bay. "

Viviana Rocco - " So, was a submarine outfall (a discharge pipe that goes under the sea and has diffusers for discharging into the sea) an option ? "
Julio Torres - "Well, they have that in a base but it was built by the Americans. The Panama's technology is very obsolete compared to what the Americans are doing in their zone."

PARAGUAY

ENVIRONMENTAL SYSTEM PROJECT FOR THE ORIENTAL REGION OF PARAGUAY

Carmen Diana Rojas Giménez

ABSTRACT

Uncontrolled deforestation, loss of soils for agricultural use and the growing risk of water pollution, requires urgently the creation of a national plan for the appropriate use and exploitation of the natural resources. Such a plan needs reliable and up-to-date information and data. To meet this aim the SARO-project (Environmental System in the East of Paraguay) was founded (1997-2001).

A multidisciplinary team consisting of: Experts of the Dirección de Ordenamiento Ambiental (DOA) of the Ministry for Agriculture (MAG) of Paraguay, and experts of the Federal Institute for Geosciences and Natural Resources (BGR) of Germany.

The BGR (Bundesanstalt für Geowissenschaften und Rohstoffe) is the Federal Institute for Geosciences and Natural Resources of the Federal Government of Germany with its headquarters in Hannover, Germany. Since the German reunification the BGR has a subsidiary in Berlin .

The DOA (Dirección de Ordenamiento Ambiental) is a Department of the State Secretary for Natural Resources and Environment, a branch of the Ministry for Agriculture (MAG).

The SARO project consists of a multidisciplinary team of experts that investigate in situ the soils science, the geology, the hydrology, hydrogeology and the flora and fauna as well as socio-economic aspects in three watersheds that serve as pilot areas, with 966735 ha. (see annex). These investigations serve to understand the interactions of the different components of the ecological system and the effects caused by humans. This knowledge is necessary to enable the experts to provide proper recommendations for the exploitation and protection of the natural resources.

General objective

Inventory, evaluation and recommendations for the protection of natural resources looking for a territorial organization in three watersheds areas.

DISCUSSION - PARAGUAY

Presenter : Carmen Diana Rojas Giménez

Luiz Gamez (Costa Rica) - "As you do not have water management laws, what instruments do you use to handle all the water management aspects?"
Carmen Rojas- "We only have some institutions that have some water regulation. In my Department we deal with the territorial planning and we use some other countries examples to take the necessary decisions in the different scope of the natural resources."

Terrol Inniss (Barbados) - " Are you trying now to establish land use policies so you can determine what should be done and where?"
Carmen Rojas - " Yes, but only in three pilot areas. We try to make the planning land use and territorial planning."

Terrol Innis (Barbados) - "And what is the geology of Paraguay?"
Carmen Rojas - "We have sediments and sandstones."

PERU

CUSCO, UNDER A "PARTICIPATIVE PLANIFICATION" MANAGE THEIR WASTEWATER AND STORMWATER IN A SUSTAINED FORM

Robert Milton Merino Yépez
David Angel Valenzuela Chirinos

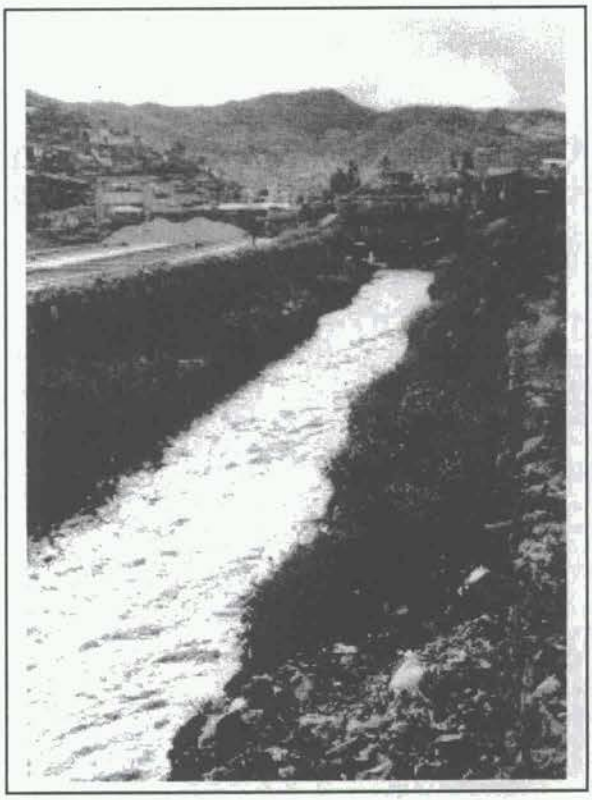
ABSTRACT

The city of Cusco, with archaeological characteristics, is of intangible nature and protected by the UNESCO, it has an inadequate gathering system of residual waters (wastewater), their unitary system dates of 40 years and it is insufficient for the conduction of the pluvial waters and wastewaters.

It is alarming to observe that the main river of the city, the Huatanay became the receiving body of 100% of the residual waters, it is the result of the growth of the city without planning.

As for the pluvial waters it is appreciated that also exists a total disorder, and it only works due to the favorable topography, in such way, during eight months (dry season) the Huatanay river serves as a throw-place of garbage and during four months (rainy season) the avenues clean the bed.

We need to collect, to drive, to try and to prepare the residual waters appropriately and consequently recover the rivers integrated to an appropriate handling of the rain waters and the solid waste. This way we will be fulfilling to recover our atmosphere strengthening the quality of life of our community.



The Huatanay river (dead for human utility). It serves as collector of 100% of the residual waters and pluvial waters of Cusco, with the multi institutional intervention and a shared planning it comes working to revert this problem in a sustained form.

DISCUSSIONS - PERU

Presenter : Robert Milton Merino Yepez

Carmen Rojas (Paraguay) - " Does the basins management committee work ? Because as I know, there are several institutions on this committee. So, please tell me exactly how it actually works."
Robert Merino – " Cusco is formed for several micro-basins. For each basin there is a committee that is in charge of checking all cases related to the environment: wastewater, stormwater, urbanization, solid wastes, etc, but always focusing that specific basin."

Terrol Inniss (Barbados) - " The contamination of the water which passes through Cusco, originates in Cusco or before you get to the city ? "
Robert Merino - " It originates in the city."

Julio Torres (Panama) - " Do all systems in Peru use gravity instead of pumps ? "
Robert Merino -" There are pumps in the coastal areas, which are flat areas."

<u>**SURINAME**</u>

SUSTAINABLE WASTEWATER AND STORMWATER MANAGEMENT IN SURINAME

Louise Francis Zuilen

ABSTRACT

Wastewater and stormwater are the main source of water pollution of open waters in Groot Paramaribo, the capital city of Suriname where most of the economical activities occur and population lives. In this urban and coastal area urban runoff (stormwater) and wastewater discharges causes dramatic changes in hydrology and water quality that result in a variety of problems.

The main causes of these problems are the increased volume, rate of runoff from impervious surfaces and the concentration of pollutants in the runoff and wastewater due to the fact that the receiving water from the combined sewer system is transported untreated to open waters. Despite the efforts of the government the impacts are still visible and palpable.

This case study provide convincing strategies how to prevent and control deterioration of the water quality and can be integrated at all levels of the society: decision makers and citizens. The strategies serve as an excellent guidance and form a solid sustainable foundation for successful water management programs.

Key words

Stormwater, wastewater, causes & consequences, effective management programs.

DISCUSSION - SURINAME

Presenter : Louise Francis Zuilen

Glen Laville (Bahamas) - "You said that you depend on fishing and tourism. How does wastewater affect your tourism industry ? "
Louise Zuilen - " It affects tourism terribly. When the area is flooded, especially in the center, the tourists have to walk in that dirty water and they won't accept it."

Manoherlal Kerof (Trinidad & Tobago) - " You said implementation is a problem. Do you have a budget for that or is there no allocation ? "
Louise Zuilen- "The environment has a low priority in our country. The government will finance social projects like housing or building bridges. IDB gave us a loan of U$200 million to finance environmental systems , but I do not know what the money was used for."

Luiz Gamez (Costa Rica) - "About public health issues. What is your current situation regarding water related diseases and is that used as an indicator to promote policy for changing the current situation ? "
Louise Zuilen - " Well, there are all kinds of diseases after floods. Some babies have diarrhea and after some time the situation becomes calm again. That is why the government does not pay so much attention to that.
We use only groundwater for drinking water and it comes from outside of the Paramaribo area, where you do not have industries, just a few people living there, so it is not contaminated. And I think that is the reason why the government does not make any effort in doing something.
Another reason is that wastewater is thrown in the Paramaribo river and there is dilution, so why bother? "

TRINIDAD & TOBAGO

WASTEWATER SECTOR IN TRINIDAD & TOBAGO WAY FORWARD FOR SUSTAINABLE DEVELOPMENT

Manoherlal Kerof

ABSTRACT

This paper aims to review the present status of the wastewater sector in Trinidad and Tobago and to address concerns regarding the sector's development after years of neglect. Over 87% of the 1.3 million population of Trinidad and Tobago enjoy a potable water supply whilst only 30% of the population is served by centralized public and private wastewater systems. The total water production (surface and ground) amounts to 780 Mld (172 mgd) while the total volume of wastewater generated equals to 702 (155 mgd). However, the total volume of wastewater collected and treated by centralized wastewater systems averages approximately 150 Mld (33 mgd) or 21.2% of the total wastewater generated. Approximately 100 Mld (22 mgd) of wastewater is collected and treated by WASA through its 12 public wastewater systems and the remaining 50 Mld (11mgd) of wastewater being collected and treated via 148 privately owned and operated (non-WASA) systems. In general, the performance of 90% of all the wastewater plants/systems can be described as poor. This is a source of concern, as at present there exists no effective monitoring and control system for the majority of the privately owned wastewater systems.

The wastewater systems, which are owned by WASA, are operated and maintained by a staff of 5% of the total WASA staff. The potable water operations engage approximately 51% of the total staff while the remaining 44% members of staff are engaged in areas like Capital Investment, Logistics, MIS, HR, Water Resources Agency, Finance and Legal Support Services. Currently two (2) persons per 1,000 population are working in ensuring potable water services, while only one (1) person per 1,000 population is working in ensuring satisfactory wastewater services.

Similarly, the investment within the wastewater sector has been historically low with an average of 7% of the total consolidated water and wastewater operational expenditure being spent on wastewater operations. Thus, despite the low sewerage rate (i.e. 50% of the water rate) the wastewater sector over the years has been operating at a profit at the cost of deterioration of its assets.

The approximate capital investment between 1987 and 1999 on the wastewater sector was less than 5% of the total investment in the water and wastewater sector. The extremely low level of capital investment clubbed with a lower allocation of operating budget have resulted in slow growth and deterioration of the wastewater systems.

However this trend is changing dramatically as in 1999 capital projects amounting to approximately $279 million for the refurbishment / upgrade of the existing wastewater systems were approved by the Government of Trinidad & Tobago. These schemes are aimed towards the improvement in effluent quality in order to meet the standards set out at TTS 417:1993.

DISCUSSION - TRINIDAD & TOBAGO

Presenter : Manoherlal Kerof

Terrol Inniss (Barbados) - "After treating that particular effluent, how did you dispose it?"
Manoherlal Kerof - "It goes to the river and through nearby stream is used for irrigation."

Arthur Archer - "Is there a sewerage system functioning ?"
Manoherlal Kerof - "Yes, and the efficiency is from 30 to 50%."

Arthur Archer - "Is there any other part of Trinidad you have sewerage systems ?"
Manoherlal Kerof - "Yes, we have four main cities with a sewerage system."

URUGUAY

MONITORING OF INDUSTRIAL WASTEWATERS AND URBAN RECEIVING WATERS IN MONTEVIDEO, URUGUAY

Viviana Rocco

ABSTRACT

Developing countries public services usually lack of available resources to assure sound environmental control and management programs. Thus, local measures are usually taken to alleviate acute problems without ever reaching the general planning stage. It is necessary to make a big financial effort to develop and put into practice a Master Plan that provides long term approach of all related issues and at the same time is environmentally friendly, financially viable and with public support.

Montevideo city has been working in its Sanitation Master Plan for the last decade, preparing what is known as its Urban Sanitation Plan (PSU). As a result, a very important investment in new sewerage works will supply adequate sanitation for the city through the next thirty years. The sustainability of such a Plan strongly depends on the implementation and taking care of several aspects, such as land use planning, institutional strengthening, financial feasibility, standards and regulations, monitoring & control programs and public education.

Efficient allocation of resources also demands that contaminated loads from all urban activities disposed into the receiving environment must be carefully assessed and quantified. This paper presents a description of how these aspects have been considered in Montevideo´s Urban Sanitation Plan and details the design and implementation of the Industrial Wastewaters and Receiving Waters Monitoring Program as a main planning tool.

Key words

Wastewater, sewerage, sustainability, monitoring.

DISCUSSION - URUGUAY

Presenter : Viviana Rocco

Luiz Gamez (Costa Rica) - " You have mentioned you use toxicity tests. Do you have any results and what is your experience with this technology? "
Viviana Rocco - " Toxicity tests were not included in the project, so we have just made the first series of tests, and I did not bring with me the results. We do not have actually toxics. Our industries development is very low, so it is not the same problem that you probably have. We only have tanneries, as generators of toxic residues. The IDB is controlling our industries contamination and we have had a very big reduction because some industries wêre shutdown. And the main industries have a good treatment system. So toxics, as an overview, are not a main issue."

Julio Torres (Panama) - " How big are the tides over there and don't they bring in the waste from the submarine outfall? "
Viviana Rocco - " We have made currents and wind studies and we do not have big tides only with about 1,5 meter. But our currency studies at the point where the outfall discharges, show that the current flows parallel to the coast, so the contamination does not go to the beach. But we have wastewater discharges, so the garbage still goes into the beach."

Augusto Sergio Guimarães - " How much of sewage has been channeled through the storm drainage without entering the submarine outfall at the "La Plata" river? "
Viviana Rocco - " In wet weather, 70%. In dry weather, nothing. In the southern and eastern parts of the city, that are served by the outfall, all the wet weather goes into the outfall."

Manoherlal Kerof (Trinidad & Tobago) - " Did you identify the small industries responsible for 80% of industrial pollution? You mentioned you would monitor these 80% but for the other 20% you would play the role of a controller. What do you mean by controlling? Have you started your public education program? What are the results? "
Viviana Rocco - " The 20 industries that contribute with 80% of the organic contamination are responsible for 95% of the toxics. So have those twenty industries monitored is our goal. About controlling, the municipality does not have money, so we cannot control all the industries in town. We must have a very strong team capable of that. We are studying for those main industrial activities in the city, which are only six, which processes they use, how do they treat their waste and how they should treat it. So with those figures we expect that we can know if what the industry is informing us is right or not. And we are going to have some monitoring stations in the receiving points. Finally, the education program is starting this year. We prepared two versions of it: a basic program costing U$ 50,000.00 and a full program with TV that will cost U$ 2 millions. So, we're is launching the basic program and looking up ways to get the money for the rest."

Carmen Arevalo - "Who is in charge of the design of this monitoring program: the municipality or a private consultant company? And about the finance, is this part of IDB loan? Where does the money come from for the implementation of the program? And how do you control these illegal settlements versus what you have very nicely planned? "

Viviana Rocco - " The sewerage master plan, prepared in 1992, identified monitoring needs and institutional strengthening for the municipality role. When the IDB lent us the money, they asked for the design of this monitoring program and institutional strengthening which was done by a private company. For the long-term implementation of the monitoring program, we are obliged to spend the least money possible, so the municipality can afford it. That is our job: to find a monitoring program that can give good results without spending money.

The institutional strengthening is the issue of finding taxes to pay for it, so it is supposed that we will have the money in some time and the educational program is also included in this master plan loan.

The IDB has loaned us U$ 100 million to incorporate those irregular settlements into the regular urbanized areas in the country. We are designing infrastructure works: roads, sewerage, water supply, etc. But we need a very big social work which is going to take two or three years for each settlement."

Part V

SESSION REPORTS

SESSION REPORT

Session number : 1
Title : Lectures "Criteria for Evaluation of Technology for Sustainable Wastewater and Stormwater Management" and "Technology Choice and Sustainable Development in Wastewater"
Date : 27 March 2000
Presenter : Goen Ho
Moderator : Satoru Matsumoto

Lecture : "Criteria for Evaluation of Technology for Sustainable Wastewater and Stormwater Management"

Summary :

1. Pro. Ho started the lecture by confirming that there is a choice for technology by taking three conventional technologies, "chamber pot", "SanPlat" and "Activated sludge process" as examples.

2. Then he described the criteria for evaluation of technology and explained in detail on each criterion. Further he talked on cross cutting issues which include "Settlement planning", "Community participation and Hygiene Promotion", and "Financing and Cost recovery". He emphasized the importance of community participation and suggested to give more information to community to invite more participation.

3. He also showed a framework for integrated wastewater and stormwater management" which will involve policy makers/managers, investors, and users.

Comments:

1. Prof. Duncan Mara of University of Leeds, who happened to be in Rio, commented that we should not knock on-site technology simply because of its polluting the ground contamination. Professor Ho agreed with his comment and pointed out that the Source Book presents a range of technologies from on-site to centralized.

2. The choice of technology should take into account local factors and would be discussed in subsequent lectures.

3. The presentation was educational and well organized.

Lecture : "Technology Choice and Sustainable Development in Wastewater"

Summary :

1. He described problems facing communities without adequate sanitation by giving some examples using slides from the Source Book and Training Module.

2. He pointed out the necessity of integrated management of wastewater, stormwater,

and solid waste, not dealing with them separately as in conventional approach. He explained the basics of integrated waste management.

3. He showed how natural process purifies the waste by taking carbon, nitrogen, and phosphorus cycles as example, and proposed that we should "imitate" nature in integrated waste management.

4. He demonstrated one of the models of sustainable wastewater & stormwater management.

Comments :

1. Prof. Mara stressed that human health should come as first priority in the integrated management rather than environmental consideration. The conclusion was that we should consider both factors, that is, it is not a matter of which comes first or not.

2. There was a comment that we should also consider "pathogen cycle".

SESSION REPORT

Session number : 2
Title : Lecture "Technology Choice and Sustainable Development in Stormwater Management"
Date : 27 March 2000
Presenter : Cedo Maksimovic
Moderator : Lilia Casanova

Summary:

1. Prof. Maksimovic presented principals of Stormwater Management using diagrams/photos included in the (draft) training module. Some of them included examples from the host country – Brazil.

2. He emphasized the paradigm shift in Stormwater Management . It is not just for solving flood problems, but should be considered as part of integrated water management.

3. He guided the participants that modern drainage systems have to be designed so as to contribute to pollution reduction and to improvement of urban amenity.

Comments:

1. Participants are pleased with his presentation, but seemed a little hurried.

2. Prof. Maksimovic added to welcome feedback from the participants on the training module.

SESSION REPORT

Session Number : 3	
Title : Lectures "EnTA: Environmental Technology Assessment" and "maESTro : a Comprehensive Global Directory for Environmentally Sound Technologies"	
Date : 27 March 2000	
Presenters : Lilia Casanova and Robert Rodriguez	
Moderator : Satoru Matsumoto	

Lecture : "EnTA: Environmental Technology Assessment"

Summary:

1. The presenter gave an operational definition of ESTs and explained that ESTs include "Hard technologies" and "Soft technologies". She emphasized the importance of "Soft technologies" to support "Hard technologies".

2. She introduced "EnTA" as one of "Soft technologies" to assess technologies from environmental perspectives and described why "EnTA" is necessary and how EnTA is done.

3. She also referred other environmental management tools such as "EnTA" and "EMS".

4. She summarized IETC's role and activities.

Comments:

1. The presentation, though the time was not enough to make a complete presentation, has incorporated importance of "Soft technologies".

Lecture : "maESTro : a Comprehensive Global Directory for Environmentally Sound Technologies"

Summary :

1. The presenter gave an overview of "maESTro" as global and comprehensive EST directory, which included;
   - What it includes
   - How it works
   - How different from other data base
   - What benefit users can get from "maESTro", etc.

2. He emphasized that "maESTro" can be useful as "Personal Management Tool".

3. Participants made a lot of questions to the presenter from the details to advantages of "maESTro". Everyone was pleased to get a CD-ROM version of "maESTro".

Comments :

1. Hands-on demonstration was very useful to give participants an insight into "maESTro".

2. Participants appreciated "maESTro" and his presentations. Among them, WSP representatives were very much impressed with "maESTro" and asked for further collaboration with IETC.

SESSION REPORT

Session number: 4-A

Title: Presentation by participants

Date: 27 and 28 March 2000

Moderator: Cedo Maksimovic

Summary & Comments:

This session consisted of 4 parts in which the presentations were grouped according to the language English or Spanish or according to the geographical region.

The following presentations were given :

Session 4-A (1) 27th March (Presentation in English)

1. Mr. Glen Laville, **Bahamas** : Towards Sustainable Wastewater and Stormwater Management Practices in the Bahamas.
2. Mr. Terrol Inniss, **Barbados**: Harnessing and Harvesting a Natural Resource.
3. Mr. Cristobal Felix Diaz Morejon, **Cuba**: Interrelationship Sanitation, Environment and Sustainable Management of Wastewaters.
4. Mrs. Josefina Gomez, **Dominican Republic**: Sanitation of Hoya del Camito: Northeast Santiago City.
5. Mr. Manoherlal Kerof, **Trinidad and Tobago**: Wastewater Sector in Trinidad and Tobago - Way Forward for Sustainable Development.

Session 4-A (2) 28th March (Presentation in English)

1. Mr. Luis Gamez, **Costa Rica**: The Agroeconomic Activities at the Watersheds of the Nicoya Golf : An Economical Approach of Soil Depreciation and Water Resources Degradation .
2. Mr. Jorge Eugenio Barrios Ordoñez, **Mexico**: How to Deal with Wastewater in Developing Countries. Some Experiences from Mexico.
3. Mr. Julio C. Torres, **Panama**: Panamanian Bay Pollution and the Effects of Stormwaters in the Pluvial System and the Danger this brings to the Population.

Session 4-A (3) 28th March (Presentation in English)

1. Mr. Francisco Javier Cuba Terán, **Bolivia**: In Search for a Solution for Choqueyapu River Contamination .
2. Ms. Carmen Rojas, **Paraguay**: Environmental System Project for the Oriental Region of Paraguay .
3. Ms. Louise Francis Zuilen, **Suriname**: Sustainable Wastewater and Stormwater Management in Suriname.
4. Ms. Viviana M. Rocco, **Uruguay**: Monitoring of Industrial Wastewaters and Urban Receiving Waters in Montevideo, Uruguay .
5. Ms. Carmen Maria Olano Diaz, **El Salvador**: Sustainable Wastewater and Stormwater Management. The El Salvador Experience.

Session 4-A (4) 28th March (Presentation in English)

1. Mr. Adan Pocasangre, **Guatemala**: Operation and Maintenance: A Reflection. Guatemala Experience.
2. Mr. Javier Mijangos, **Argentina**: Sewerage System Breakdown - Third Main Pipe Wastewater Control Plan.
3. Mr. Carlos Landin Paredes, **Ecuador**: Guidelines for Wastewater Management in Quito, Capital of an Andean Country in Crisis .
4. Mr. Robert Milton Merino Yepez, **Peru**: Cusco, under a "Participative Planification" Manage their Wastewater and Stormwater in a Sustained Form.
5. Mr. Carlos Pereira Dias, **Brazil**: Presentation of Management Policies and Control of the Stormwater Effects in Urban Areas Implementation of two Projects at the City of Rio de Janeiro (Presentation in Portuguese).

It has been noted that participants, coming form various backgrounds, made a significant effort in collecting the initial material, submitting written contributions and in preparing their presentations. Most of the participants used Power Point as a presentation media, that will be made available as a Workshop's deliverable. Some of the selected slides will be used for composition of a separate folder, ad-on to the training material.

Although a separate session was devoted to a detailed analysis of the presentations of the participants there was a short time for discussion on each individual paper. The types of questions varied from the fundamental understanding of sustainability principles to details on concrete solutions and problems solving methods applied.

It is interesting to notice that the presenters had initially different perceptions of what they considered to be the sustainability concept, integrated analysis of wastewater and stormwater, and that the approaches in coping with the environmental issues, varied depending on whether the participants had experience in handling coastal (small islands) or "continental" problems.

The initial differences in comprehension of the sustainability had to be addressed during the rest of the Workshop in order to try to establish a common ground of mutual understanding the basics and in order for the participants to be able to serve as "messengers" of the paradigm presented and discussed during the Workshop. It was stressed that the presentations were not only meant to be the "national reports" – list of problems and potential solutions but also to serve as examples in which the strengths and weaknesses of the participants to serve in future dissemination of the results of the Workshop.

It was also noted that further re-training of the participants at national or sub-regional basis would be useful as a part of preparation for running the follow-up training and dissemination programs.

SESSION REPORT

Session number : 4-B	
Title : Sustainable Wastewater and Stormwater Management in Latin America - PAHO Presentation	
Date : 28 March 2000	
Presenter : Ivan Estribi	
Moderator : Goen Ho	

Summary :

Mr Ivan Estribi is a representative from the Pan American Health Organization (PAHO) where he is Coordinator of the Environmental Health Area and is based in Brasilia, Brazil. His presentation was in Spanish and entitled 'Tecnologias para Lograr una Gestión Sostenible de los Sistemas de Alcantarillados Sanitario y Pluvial'.

1. Mr Estribi began by showing statistics collected by PAHO on health and provision of water and sanitation services in Latin America. The information shows the relationship between the availability of good quality drinking water and improvements in public health. Coverage of sanitation in Latin America is inadequate, and the importance of increasing coverage in a sustainable way is emphasized.

2. The use of appropriate technologies is advocated. This is a solution which considers social, cultural and financial factors besides simply engineering ones, and technology used must be simple to operate and maintain.

3. Sustainability is to be achieved using the method suggested by UNEP Agenda 21 (An approach which is intersectorial, multidisciplinary, pragmatic, uses reliable information and is well communicated).

4. Management of resources should be based on proper planning, use of reliable data base, with clear goals and performance indicators that can be measured. An example of management of drainage was given. An interesting point is a suggested political and social control of the consumer market (demand supply of drainage services) and of the area/population served.

5. Practical considerations suggested include: More flexible engineering codes, use of new materials (e.g. PVC pipe and condominial sewerage), and development of skills in the community, including skills in management of sustainable development.

6. Mr. Estribi concluded by providing a vision of total coverage of all sanitation services (water, wastewater, stormwater and solid waste) in an integrated way coupled with sustainable agriculture (soils and fertilizer management).

Comments :

1. Mr Estribi's presentation attracted considerable discussion from participants because of their common experiences in South and Central America. His proposition for sustainability was well received, but many questions were raised regarding its implementation.

2. Mr Estribi provided brochures on resources available from PAHO (books, pamphlets, internet address), which were considered to be very useful by the participants.

SESSION REPORT

Session number : 4-C

Title : Discussion on participants' presentations

Date : 28 March 2000

Moderator : Cedo Maksimovic

Summary and Comments :

This was a (brainstorming) session in the sense that the participants had a chance to compare the emphasis that they placed to the sustainability concept in their own presentations with the ones given in the presentations of the others. In order to facilitate the discussion the following principal issues (bullet points) have been indicated:

- **A - What is your understanding of sustainability of wastewater and stormwater systems**
- **B - Awareness /consciousness on interactions of wastewater, stormwater and solid waste**
- **C - Good examples of sustainable solutions**
- **D - Course of action to make the systems more sustainable**

The discussion revealed that there is not yet a generally accepted understanding of what the concept of sustainability should comprise and how to convert the general principles into concrete problem solving procedure. However, after the discussion the following items have been accepted in principle:

A. Understanding of sustainability of wastewater and stormwater systems

- Understanding the interactions not only of wastewater and stormwater elements but also interactions with water supply, solid waste management, soil erosion, receiving waters (rivers, coastal water, lakes and groundwater)
- Sustainability as an aim to better solutions
- Spending too much resources on curing the problem (treatment) and very little in prevention is seen as a source of unsustainability
- Mining of resources – unsustainable
- Minimization of the negative long term effects
- Integrated management of water cycle

B. Awareness /consciousness on interactions of wastewater, stormwater and solid waste

- Low attention paid to this aspect in the past
- Providing information (educating) clients as a key to broader acceptance
- Valorization of resources
- Appropriate means of dissemination of information (local language, local culture, local solution)
- Awareness on damaging effects on local habitats and amenities (coral reefs, rare flora and fauna, etc.)
- Understanding conflicts of interests
- Integrated solutions in the planning phase

C. Good examples of sustainable solutions

- Mexico (reuse of treated wastewater as a resource – improvement of environmental and economical conditions of the local population
- Bolivia (awareness of interactions of wastewater with stormwater system)
- Cuba (variety of solutions in providing low cost sanitation with strong local participation
- Uruguay – Montevideo (activation of the local human capacity and its systematic upgrade, application of the locally appropriate solutions)
- Trinidad and Tobago (attention to maintenance)
- Barbados – Stormwater (resource) harvesting as a part of integrated solution
- Dominican Republic (partnership with local industry)
- El Salvador (interactions with city planners), integrated solutions

D. Course of action to make the systems more sustainable

- do not wait, act immediately, apply "wise man's solutions",
- Integrate planning, management and community participation
- stronger international support to selected "affordable" solutions that do not jeopardize environment and human health
- imaginative ways of attracting additional funding (activation of participants – users of the systems)
- development of partnership for cost share (community participation) in order to achieve the financial sustainability
- strengthen the legislation and enforcement component
- empowerment of the participants – users and better co-ordination and integration with water authorities
- integration at governmental level (avoid the situation: shared responsibility – no responsibility)
- maintain the momentum gained in Rio: organize local, national, sub-regional events

SESSION REPORT

Session Number : 5
Title : Lectures "Alternative Technologies for Wastewater Management" and "Alternative Technologies for Stormwater Management"
Date : 30 March 2000
Presenters : Goen Ho and Cedo Maksimovic
Moderator : Lilia Casanova

Lecture : "Alternative Technologies for Wastewater Management"

Summary:

1. Prof. Ho presented information (with photographs and diagrams) of alternative technologies for wastewater management that are available both in developed and developing countries. The alternative community-scaletechnologies found or being applied in developed countries would also be appropriate for developing countries. Some examples of these alternative technologies are :
   Dowmus composting toilet (from North American Regional Overview),
   Inverted trench (Ecomax) and On-site activated sludge process Biomax)
   from Source Book.

2. He then presented the full range of information on technology from the Source book and Training Module. Of necessity this had to be brief because of the limited time available for presentation.

3. He emphasized that understanding and use of guidelines for sanitation and health are important and should be considered prior to the application of the technologies.

4. He explained that all the information presented, including the guidelines on health, and contained in the Source Book, will be also incorporated in IETC's maESTro.

Comments:

1. Participants commented that information should include conditions where the alternative technologies are applicable and the cost of using these technologies. Response from the resource person is that these bits of information are included in the Source Book.

2. In general, participants are interested in the technologies presented.

3. The presentation was clear and well done.

Lecture : "Alternative Technologies for Stormwater Management"

Summary :

1. Based on his first lecture, Prof. Cedo Maksimovic provided information on alternative technologies for stormwater management from the draft Training Modules.

2. He presented the technologies which involve to mimic natural processes. The idea is to restore the ground and surface water flow patterns that existed before the development took place.

3. He emphasized the amenity value of a properly designed drainage system, balanced with control of water quality and quantity of run-off.

4. He referred to the applicability of the alternative technologies in developing countries.

Comments:

1. The presentation was well organized to keep interest of the participants.

2. The animated slides are beautiful.

SESSION REPORT

Session number: 6

Title: "Highlights from the Sanitation Overview of South and Central America" and "Development and Other Aspects of the Caribbean Region"

Date: 30 March 2000

Presenters : Augusto Sergio Guimarães and Arthur Archer

Moderator: Cedo Maksimovic

Summary & Comments:

This session consisted of two parts – two lectures:

- Highlights from the Sanitation Overview of South and Central America
  by Mr. Augusto Sergio Guimarães

- Development and other Aspects of the Caribbean Region
  By Mr. Arthur Archer

Both Mr. Guimarães and Mr. Arthur served in the capacity of "resource persons" i.e. they presented regional overviews, the text of which will be published as an annex to the Source book.

The lecture delivered by Mr. Guimarães covered the region of South and Central America (for the reasons of misunderstanding Mexico was not included but will be added). He pointed out the major problems in the region which is characterized by a big variety of geographical, climate, economical, cultural and development conditions.

With São Paulo and Mexico City this region is also characterized by the presence of the "megalopolis syndrome" i.e. large scale environmental problems caused by the lack of timely planning, construction and proper management of an appropriate sanitation which results in a high percentage of low income population living without proper sanitation or without any sanitation at all. Although there are examples of successful trial applications of the sustainable solutions in both on-line and off-line sanitation, the general features are as follows:

- Lack of technical regulations, environmental regulations and concern,
- Lack of implementation and enforcement of the existing regulations,
- Systematic planning, funding and quality control are unsatisfactory,
- Inadequacy of international funding mechanisms and their failure to properly utilize the available financial and other resources.

However he also presented the results of an organized systematic implementation of the sustainable solutions of low cost sanitation (condominial sewage), with strong local participation, relatively satisfactory record on the systems' maintenance etc. which were developed in Brazil and which are being applied successfully in the low income settlements in the other neighboring countries.

As a conclusion he supports the present project and invites the participants of the Workshop to organize their own follow-up actions.

In the discussion, participants asked questions on technical details of the condominial sewage method, and questioned its long term sustainability. Additionally the problems of the regions with specific harsh climate condition (high altitude places in the Andean region for example) have been addressed and the issues of the appropriate solutions discussed.

The lecture delivered by Mr. Arthur Archer covered specific problems of the Caribbean region. Because it contains many small island (developing countries) with particular climate and economical conditions, the range of problems and sustainable solutions might differ from the continental part of L&CA. He addressed the problems of frequent flooding by stormwater and its interactions with poorly developed and inadequate wastewater systems. Additionally he addressed the area specific problem of severe damages made to the existing systems by other natural disasters (hurricanes) and severe river pollution by sanitary sewerage. When addressing the area specific problems he also points out the problem of low infiltration potential of the top layer of soil which, combined with the poor maintenance results in overflowing of septic tanks and poses a continuos threat to human health.

In the discussion, the participants pointed out the following:

- Appreciation to Mr. Archer's devotion to coping with local sanitation problems throughout many years but also noticed that:
- many data used in the lecture are "outdated" and need to be refreshed
- solutions applied in some countries in the recent years not mentioned
- inadequacy of some countries' names (Dominica instead of Dominican Republic)
- lack of emphasis on the possible sustainable solutions in the future.

For the sake of compatibility with the other written material and need to be electronically published, Mr. Archer has been asked to produce an electronic version of his presentation after updating some parts of his report.

SESSION REPORT

Session number : 7	
Title : "Three Water and Sanitation Program Activities in Disseminating Information on Urban Environmental Sanitation" and "The World Bank's Water and Sanitation Program (WSP): Related regional and global activities"	
Date : 30 March 2000	
Presenters : Richard Middleton and Carmen Arevalo-Correa	
Moderator : Goen Ho	

The two presentations in this session were :

(1) Mr Middleton on the World Bank's WSP's initiative in producing a Resource Guide in Urban Environmental Sanitation (UES), Gaps study to identify gaps in knowledge in UES and establishment of a UES network (UESNET) and

(2) Ms Carmen Arevalo-Correa on the WSP's program in the Andean region.

Summary:

Mr Middleton's presentation (in English):

1. The Resource Guide covers the cross-cutting, institutional and economic/financial issues, it is complementary to the UNEP IETC Source Book, a first draft has been extensively reviewed, and will be published later in the year.

2. The Gaps study will identify gaps in knowledge in solid waste, wastewater and stormwater management and will suggest actions to be taken to fill the gaps.

3. The purpose of UESNET is to disseminate information to help decision makers to overcome the serious backlog in providing UES. It will be piloted in WSP's South Asia and the Andean region. Its similarity to UNEP IETC's maESTro was commented on.

Ms Carmen Arevalo-Correa presented (in Spanish) :

4. An overview of the WSP's program in the Andean region. The program team in Bolivia, Ecuador and Peru promotes public-private partnerships so that low-income population can have access to adequate sanitation services. Pilot projects in El Alto and La Paz, Bolivia are innovative and are being considered for scale-up and application worldwide.

5. Detailed description of the El Alto case study's innovative approach in implementing condominial sewerage in low income population. The importance of the involvement of 'social workers' was emphasized. It was considered that this aspect was as important as the choice of the technology (low cost sewerage), and includes hygiene promotion, community participation in decision making, and community contribution in providing resources. The public-private partnership was considered an essential element.

Comments:

The El Alto project generated considerable discussion. The teamwork between technical experts and social workers was considered to be an important factor for the success of the project, and lessons based on the El Alto project needed to be disseminated. A comment was made as to whether a longer time period was needed to asses the success of the case study. Participants in general agreed that the case study could have immediate application in their countries.

Questions were asked about the resources that the World Bank could provide in implementing projects.

SESSION REPORT

Session number: 8
Title: Training Tool on Sustainable Wastewater and Stormwater Management - The Training Module
Date: 30 March 2000
Presenter: Cedo Maksimovic

Summary & Comments:

After the most relevant parts of the training module have been presented in the earlier lectures of Prof. G. Ho and C. Maksimovic, this lecture was supposed to present a holistic overview of the concept and contents of the training module -TM.

The TM concept is conceived in such a way that it serves in the future workshops and target oriented training sessions as an integrated part of the set consisting of :

Part developed by UNEP-IETC :

- Source book,
- Regional overviews,
- UNEP-IETC training module TM1,
- Contribution by the organizers of the future local events LC1

To be complemented by the World Bank's set (to be confirmed) preferably consisting of :

- Resource guide
- WB training module TM2 and
- Contribution by the organizers of the future local events LC2

Within the given framework the present TM1 consists of:

- Basic module (over 200 slides - to be separated into three sub-modules to be used for training of three major target groups) with
- Hyperlinks to the relevant parts of the Source book text
- Additional set of about 60 slides (technical slides)
- Folder with the slides contributed by the participants of the Rio Workshop

All slides of the basic module were swiftly presented and the concept of the interactions with source book commented.

In the discussion, the participants commented the contents, and inquired about the future availability of the module. The concept of the TM has been overwhelmingly supported and approved to serve as an official IETC document. Participants have agreed that the slides presented by themselves during the Workshop, be used for creation of the "participants' folder". Some useful comments have been provided suggesting better clarification of some slides. IETC and WB representatives have made suggestion on the final wrap-up of the module and its matching with 2- 3 prepared case studies which can be used in running the future training courses. The possibility of using TM in running a "role playing sessions" has been mentioned.

SESSION REPORT

Session number: 9	
Date: 31 March 2000	
Title of the session: Group Discussions	
Moderator: Cedo Maksimovic	

Summary and Comments:
The participants were divided in 3 groups with two resources persons serving as moderators. Each group had several selected topics to discuss:

GROUP 1: TECHNOLOGIES FOR WASTEWATER AND STORMWATER MANAGEMENT

with the following topics:
(i) Existing Technologies,
(ii) Problems and Issues and
(iii) Future Possibilities / Options / Solutions

Participants:
Bahamas: Glen Laville
Guatemala: Adan Pocasangre
Panama: Julio Torres
Paraguay: Carmen Rojas
El Salvador: Carmen Olano
Moderators : Prof. Goen Ho and Mr. Augusto Sérgio Guimarães
Rapporteurs : Prof.Goen Ho and Mr.Arthur Archer

The purpose of the discussion group was to identify technologies in wastewater and stormwater management that were currently used in the countries represented by participants from South and Central America, the issues and problems associated with technologies and to consider possible solutions based on materials that were covered during the workshop.

Existing Technologies

The following technologies were identified based on an exhaustive round table sharing of knowledge of participants:

- Sewerage
  - Conventional Sewerage
  - Simplified Sewerage
  - Combined Sewerage
  - Vacuum Sewerage
- Sewage Treatment
  - Activated Sludge
  - Aerobic Treatment (In Underground, e.g. in Panama)
  - Anaerobic Lagoon (For septage/sludge)
  - Stabilisation Ponds

- Aerated Ponds
- Tertiary Treatment (Chemical coagulation Clz-Panama)
- Deep Well Injection (Bahamas)
- Septic Tank + Anaerobic Filter

- Trickling Filter
    - Pumping Station
    - Septic Tank
    - UASB - (Up flow Anaerobic Sludge Blanket)
    - Pit Latrine
    - Activated Sludge -> Package Sewage Treatment Plant
    - Chamber Pot
    - RBC -> Rotating Biological Contractors
- ♦ Disposal
    - Marine Disposal
    - Into Rivers
    - With and without Chlorination
    - Removal of Sludge
    - Drying
    - Ground Disposal
- ♦ Stormwater
    - Rainwater Harvesting (House, Community)
    - Groundwater Recharge from Rainwater

<u>Problems and Issues</u>

The following issues and problems were identified. These were not associated with any technology in particular, and could be broadly classified into environmental, financial, institutional and factors associated with technology (lack of maintenance, spare parts, knowledge of technology options)

- ♦ Health impact of wastewater
- ♦ Odours and flies (in some cases)
- ♦ Getting finance, insufficient funding sources
- ♦ Cost (too high construction and maintenance)
- ♦ Illegal disposal of wastes (e.g. sludge disposal to stream)
- ♦ Culturally not appropriate
- ♦ Acceptance of re-use
- ♦ Standards are not appropriate. (e.g. combined sewerage)
- ♦ Needed space for some cases of technologies.
- ♦ Deterioration of system (Beyond Design Time)
- ♦ Technologies are not appropriate for all situations. (not for high density)
- ♦ Replacement parts for foreign technologies (availability + cost)
- ♦ Lack of :
    - Technologies support and code (e.g. pit latrine)
    - Technologies options
    - Regulation opportunities for each region
    - Interest by authorities (political will)
    - Sanitary education

- Monitoring re-use and public health (sewage on vegetables)
- Maintenance for new technologies
- Training for operation (manpower)

Future Possibilities/Options/Solutions

The following were suggested during discussion period and they were by no means exhaustive because of limited time available for discussion.

- Technical support + education + appropriate technology (options for local situation) + Low Cost
- Good legislation and regulations
- Training of operators
- Hygiene monitoring
- New technologies (improving existing system)
- Give incentive to communities and factories or industries for good ideas
- Monitoring of systems by communities
- Training of community members
- Replicate good examples using good models (in other communities)
- Promote public – private partnership
- Private systems

Action Plan

Participants were asked whether they could take action in their respective positions to implement sustainable wastewater and stormwater management. There was little time available to discuss this topic, but the following were proffered.

- Diagnosis of current situation
- Policy
- Education of policy makers
- Education of population
- Get funding
- Planning
- Implementation
- Integrated solutions
- Use of Source book, Training Module and maESTro

GROUP 2: CROSS-CUTTING ISSUES

with the following topics :

(i) Planning,
(ii) Guidance and technical regulations,
(iii) Institutional framework and
(iv) Financial aspects

Participants:

Mexico: Eugenio Barrios
Cuba: Cristobal Morejón
Costa Rica: Luis Gamez
Trinidad & Tobago : Manoherlal Kerof
Dominican Republic : Josefina Gomez
Suriname : Louise Zuilen

Moderators: Lilia Casanova and Richard Middleton
Rapporteur : Richard Middleton

Since the group only met for a very brief session, and since its assigned topics were not those that had been explored in any depth during the workshop, it was not able to have a thorough discussion of the many issues involved. The following were some of the main points made during the group's discussions:

General Principles for Sustainable Environmental Services

All solutions have to be carefully developed to suit the particular problems to be addressed, in a particular social and institutional context. To put it briefly:

- Think globally, act locally (general principles need to be adapted to the realities of the immediate situation)
- There is no unique solution (solutions are situation-specific; centrally-determined or predetermined solutions are usually wrong)
- Everything is a learning process (solutions as originally conceived are rarely perfect; they need to be tested and modified as necessary through careful monitoring and evaluation)

Planning and Policy / Regulatory Framework

All countries need a plan for providing services. This should not be the classic "master plan" - typically a massive document that takes large resources to prepare, is not implemented, and never updated - but a strategic vision of what the country wants to achieve. This vision will help guide the future allocation of resources, setting of priorities, and identification of possibilities to be explored.

This vision then needs to be supported by policies and regulations, and translated into actual interventions and support. In developing policies governments need to understand the high economic costs of doing nothing (for example, promoting industrial growth while neglecting health and environmental issues). Better appreciation of these hidden costs should lead to much needed increases in funds allocated to neglected sectors such as health, environmental protection, and primary education and public awareness of health and environmental issues. These costs also justify the use of targeted, transparent subsidies, where needed, to extend services.

Regulations are frequently too cumbersome to be enforceable: there are too many different sets of regulations governing even simple activities, responsibility is divided between too many ministries or other agencies, standards are unrealistic, and budgets for monitoring and enforcement are minimal. Ideally, regulations should be consolidated and simplified (for example, Mexico combined 44 different sets of regulations into just 1!). The emphasis should be on improvements that are

incremental, cost-effective, and balanced; it is unrealistic to aim for perfection in one sector while neglecting others (for example, Germany has found that even total compliance with regulations governing discharge of treated municipal sewage into rivers will not restore river quality unless industrial wastes are more effectively controlled).
Because of current neglect and abuse, at present there is often no respect for regulations. Therefore a culture of compliance and environmental respect needs to be gradually developed. This must be presented in a positive sense.

Project Development

Proponents of a plan or project must satisfy themselves that all key actors have been involved in a consultative process during project development. This should be a precondition of financing.

Inter-disciplinary teams, with both "hardware" and "software" specialists, must be involved in project development. This will require technical agencies to use specialists in "soft" disciplines with which they may (at present) be unfamiliar (equally, non-technical organizations such as NGOs often may need to seek "hard" technical support). These staffing needs should be properly reflected in project development budgets.

Planning and management skills need to be created at all levels, through participation in the process. This implies a serious two-way commitment to capacity-building: local personnel must be made available to participate, and consultants must be prepared to work closely with them. Initially, as with all training processes, this will increase costs, not reduce them, and so has be budgeted for. The long-term objective should be creation of national and local capacity, and reduction of reliance on external expertise.

Financing

There is too much "donor dependency", which leads to inordinate delays waiting for external agencies to make up their minds whether or not to provide support, high costs for project development, use of foreign consultants who may not be familiar with real conditions and problems, and neglect of local resources and talent. Instead, countries could do a great deal to improve present conditions by maximizing the use of local resources, for example, by:

- Making use of existing willingness-to-pay for services, which is often surprisingly high (for example, payments to water vendors; household investments in latrine construction)
- Developing local financing mechanisms, such as "Grameen Bank" operations[1], or NGO-administered revolving funds, enabling households or communities to gain access to funds to improve their local conditions
- Supporting local entrepreneurs, who appear to be the ideal means for constructing, operating and maintaining local systems, but who often have great difficulty in winning contracts, securing working capital, importing

[1] The Grameen Bank concept originated in Bangladesh, where the founder made small loans to small groups of non-credit-worthy women to enable them to start income-generating enterprises. The term has now become common for any type of micro-credit outside the formal banking system.

spare parts, or obtaining prompt payment.

Finding Catalysts

The backlog in environmental services is so large that it is more than ever evident that "business as usual" not a solution. The necessary changes are unlikely to emerge from bureaucracies - all the well-known successes in this field are associated with particular charismatic leaders. More effort needs to be put into finding such "change agents" (who may be active in fields quite different from environmental sanitation), enlisting them, and giving them the necessary support.

GROUP 3: TRAINING NEEDS

With the following topics :

(i) Building-up awareness on new paradigm in stormwater and wastewater ,
(ii) Problems and issues ,
(iii) Local awareness and training needs ,
(iv) Possible local contribution and
(v) Customization and follow-up

Participants:

Uruguay - Viviana Rocco
Ecuador - Carlos Landin
Barbados - Terroll Inniss
Argentina - Javier Mijangos
Bolivia - Francisco Cuba Terán
Peru - Robert Merino

Moderators : Cedo Maksimovic and Satoru Matsumoto
Rapporteur : Viviana Rocco

Building-Up Awareness on New Paradigm in Stormwater and Wastewater

Concerning this item the group members agreed that in order to achieve the best results in disseminating the there is a big need to undertake not only training of professionals but also the "message" i.e. public awareness raising should be exercised with the other "target groups" such as top level decision makers, local communities, pupils, and students, general public. To achieve this it is necessary that, in addition to the special modules of the training package developed within the present project for the three main target groups, the local "trainers" use the local examples and address the problems of the local cultural, economic and other conditions.
In brief the main conclusions on these items are as follows:

i.1. Target oriented training ,
i.2. Reaching the right public at all levels: politicians, professionals, public opinion, local communities

Problems and Issues

Under this item the group has identified the following major shortcomings of the present methodology of handling wastewater and stormwater:

ii.1. Lack of integrated approach, including industrial sector ,

ii.2. Lack of integrated management in the water sector ,

ii.3. Need to develop public awareness & community participation through social workers training ,

ii.4. Need of mechanisms for creating O&M funds ,

ii.5. Matching funding institutions requirements with local needs in a sustainable way.

The lack of integrated approach (for example building a wastewater system and ignoring stormwater) has resulted in failure of many international projects.

Local Awareness and Training Needs

Again the problem of reaching the individual target groups has been addressed form the point of view of developing the skills and awareness of the particular "trainers" not only in mastering the major "philosophy of the SWW&SWM but also in recognizing the key issues in the particular country, region, community etc. The role of professional organizations and press has been emphasized.
Thus the major bullet points in this issue are:

iii.1 Social workers training to reach public ,

iii.2 Briefing high level authorities: IADB, WB, Regional Summit meetings ,

iii.3 Reaching professionals through universities ,

iii.4 Professional associations (AIDIS Congress), national/ municipal institutions ,

iii.5 Reaching the press ,

iii.6 Finding an adequate channel in each country .

Possible Local Contribution

In order to give the local "flavour" to the training courses – workshops in the particular countries, regions, communities, the following recommendations have been adopted:

iv.1. Adapt general framework to local reality through regional inputs to the TM: Caribbean, Andean Region and Southern Latin America ,

iv.2. Produce Case studies, Technical papers ,

iv.3. Provide links to local communities .

Customization and Follow-Up

In order to keep the momentum gained within the Rio Workshop the group recommends that the participants should keep in contact with each other and share the experience gained. Since it is likely that IETC funding of the future training programmes in the LA, CA and Caribbean will be very modest the local sources of funding will have to be identified and attracted.

v.1. Finding new sponsors for future regional events

v.2. Keep in touch among regional participants

SESSION REPORT

Session number: Field Visit
Title: Site Visit to Paracambi
Date: 29 March 2000
Coordinator: Augusto Sergio Guimarães

On March 29, 2000, as part of the IETC/ABES Seminar held in Rio de Janeiro, Brazil, the participants visited the Municipal District of Paracambi, placed 80 km from the City of Rio the Janeiro, but still officially part of Rio de Janeiro Metropolitan Region. The major aspects of the visit may be summarized as follows:

Introductory welcome speeches were given by both Mr. Rogerio Ferreira, the City Mayor, and Mrs. Eliane Barbosa, who is simultaneously the State of Rio de Janeiro Water, Sanitation and Hydric Resources Undersecretary and President of the ABES[2] State Chapter, being the latter the IETC counterpart agency for said Seminar.

Mr. Ferreira started off his speech by stressing his personal and institutional satisfaction for the visit of such a large number of distinguished professionals to Paracambi, which was a clear demonstration of approval by Mrs. Lilia Casanova after her previous site visit at the end of the year 1999 of what is going on there regarding environmental sanitation projects. He also pointed out the fact that as a matter of policy Paracambi will keep working on low-cost, replicable, environmentally sound sanitation and drainage measures with a view over the achievement of total urban coverage in a foreseeable future.

Mrs. Barbosa, right after thanking IETC Deputy Director, Mrs. Casanova, for that invaluable opportunity, gave the audience, in short, State sanitation coverage figures, and highlighted the fact that the ongoing example of Paracambi is a feasible model for other Brazilian communities and likely to be used, if duly adapted, to most of the countries represented in that meeting.

An overview of the City's planning process related to drainage and sewerage works was given by Mr. Renato Ferreira, the City's Planning Secretary. Furthermore he expressed his satisfaction with the fact that the ongoing low-cost, environmentally City's friendly approach for sanitation and drainage works is making him believe that the increase of the coverage will outpass the population growth towards in the coming years.

Mr. Augusto Sergio Guimaraes, IETC Consultant in charge of the Paracambi's sanitation measures from the outset apologized for the fact that some delay in the channeling of Federal Government investment funds made the Project be behind schedule, a fact that will undoubtedly reduce the impact of the visit. Nevertheless he formally promised the audience that all aspects of the works underway will be covered not only in technical papers to be prepared but also in the IETC-funded videofilm whose contract was under final negotiations with a local NGO.

[2] Brazilian Society for Sanitary and Environment Engineering

General description of the Sewerage Project for the Urban Center of Paracambi was given by the Consultant, with emphasis made (i) to the use of digitized maps as a matter of replacing the costly topographic surveys; and (ii) to the fact that improving, but taking into consideration the endogenous system, was part of the technical approach, not only to the Urban Center but also to Ponte Coberta, a small village (120 families) whose sanitation project is underway. Moreover it was stressed the enormous economies resulting from accepting the endogenous system, with further treatment and not destroying it as recommended by engineering codes.

The Consultant also introduced to the audience the Project's technical team, which comprises Mr. Amarilio Pereira de Souza, Senior Sanitary Engineer, Mr. Manuel Lamartine, Architect, plus social assistants and the film makers who will shoot the Project's videofilm.

Mr. Amarilio Pereira de Souza described with the support of overhead transparencies the technical aspects related to the use of a hydraulically-geared gate that is the key for the success of the Ponte Coberta Drainage and Sewerage project, underway, and future works in the urban center of Paracambi. In short, said gate is to allow to the treatment set (community septic tank plus anaerobic filter) the dry-weather flow. As soon as the rain off comes down the pipe a buoy connected to a hydraulic control sector will float and shut down the treatment entrance, thus precluding the wash-out of the treatment set's sludge; and when the rain off reduces so as to make the buoy go down, the gate reopens and the flow is once again allowed to the treatment set.

In the field visit to Ponte Coberta the Project team, with the help of community leaders, the former responsible for sewage and water systems' operation and maintenance, showed the Seminar's participants (i) the upper treatment set which is already under construction, (ii) the water works comprising deep wells, elevated 50 cum. reservoir, distribution network and household meters and (iii) the creek, presently very much polluted, which is the community's receiving water.

It was mentioned by the technical team the need for completing the water system before initiating the drainage/sewerage system as a matter not only of community's aspiration but also as an action technically correct. Even more, the construction of the water system, which was expected to come through since the early 50's, gave the dwellers an indisputable sign of the Municipality's decision in favor of the delivery of sanitation services.

Later, after lunch, policy, institutional, financial, social, and technical questions on the Paracambi Project were posed by the visitors to Messrs. Amarílio and Augusto Sergio. Afterwards, Mrs. Casanova expressed positive views on the site visited urged the completion of the works and the shooting of the IETC-funded film and finally declared that Seminar's session as finished.

Part VI

EVALUATIONS

Workshop Evaluation Results

1. The following scoring has been applied :

1= poor   2 = passable   3 = good   4 = very good   5 = excellent

1.1. General Evaluation of the Workshop

Overall benefits of the programme	3,98
Relevance to your job	3,81
Quality of the training	3,81
Venue and facilities	3,75
Support by the organizers before the Workshop	4,38
Secretarial / administrative support during the Workshop	3,81

1.2. Sessions' Evaluation

Session	Item	Relevance to your job	Quality of the presentation
1	Criteria for Evaluation of Technology by **Prof. Goen Ho**	3,56	3,83
	Technology Choice & Sustainable Development in Wastewater Management by **Prof. Goen Ho**	3,72	4
2	Technology Choice & Sustainable Development in Stormwater Management by **Prof. Cedo Maksimovic**	4,17	4,06
3	maESTro presentation by **Mr. Robert Rodriguez**	4,12	4
	EnTA: Environmental Technology Assessment by **Mrs. Lilia Casanova**	4,13	3,59
4-B	Sustainable Wastewater and Stormwater Management in Latin America - PAHO Presentation by **Mr. Ivan Estribi**	3,47	3
Special Session	Hands-on demonstration of maESTro	4,1	4
Field Trip	Field Trip	4,06	2,76
5	Alternative Technologies for Wastewater Management by **Prof. Goen Ho**	3,61	3,88
	Alternative Technologies for Stormwater Management by **Prof. Cedo Maksimovic**	4,66	4,29
6	Highlights from the Sanitation Overview of South and Central America by **Mr. Augusto Sergio Guimaraes**	3,25	3,18
	Development and Other Aspects of the Caribbean Region by **Mr. Arthur Archer**	2,75	2,12

7	Presentation of The World Bank's Water Programs : 3 WSP Activities on UES and the WSP -Regional and Global Activities by **Mr. Richard Middleton** and **Ms. Carmen Arevalo-Correa**	3,72	3,56
8	Training Tool on Sustainable Wastewater and Stormwater Management - Training Module by **Prof. Cedo Maksimovic**	4,31	4,06

2. Please give more detailed comments/opinions on the following:

2.1. The value of the Workshop to you

• This learning opportunity is quite substantial to support the development of integrated management of water and stormwater; an area seldom included in our policy goals.
• For me the value of the workshop is high, because it permits us to exchange criteria and opinions, and to know how the world is moving in this branch.
• Very good.
• Awareness of practices/problems in other countries. • Importance of integrated approach to sewage and solid waste.
• Very good. The diversity helps to maintain the attention in the workshop.
• During the workshop I could exchange the experience/knowledge with other participants about problems and solutions about stormwater and wastewater management. It is more and more clear that implementation and maintenance and enforcement is becoming more important. • I will use the information also for education purposes.
• Very educational. I could very well change my thoughts for a better and more valuable decision after returning to work.
• Because of the kind of the job I do, this workshop has given me a lot of new ideas of the technologies that can be introduced to the rural areas with less cost.
• I consider that the workshop would be better if we analyzed each case study, and everybody knows how to improve the cases in each country.
• Quite good. Especially for regional networking and get in touch with UNEP/IETC.
• It opened me to new ideas on : • Cooperative and co-working means with other agencies • Sustainable technologies • Holistic approach
• It was important to know that all the countries have the same problems and the same difficulties to solve them.
• Wider level of shared learning. Focus and better approach on sustainable wastewater, stormwater and solid waste.
• Stress on management issues in our countries is essential, so the workshop has been very valuable to me.
• It is very good to increase my background and to have new ideas and solutions for the problems we have in the field I work.

• Interaction with regional delegates and exchange of practices. • Educational – New technologies – Computer software – Printed data (SW, WW sourcebook) • Personal development – Championing cause and harnessing others to assist.
• Opportunity of updating the information, discussing some criteria, and establishing links with people working in this issue.

2.2. The duration of the Workshop

• For the first meeting, five days is necessary to cover thoroughly the objectives. The next or follow up activities can be shorter and more specific. Two-day is an adequate time frame.
• Maybe the duration is long. In my opinion, it is good in three days to emphasize the presentation and discussion of experiences of the different countries.
• Adequate * OK * About right * Reasonable
• Good. The time is a little bit short for going deeper in some points.
• Very good though out timing. Longer sessions would have weakened the effects of the workshop because of tiring and monotones repetitions.
• It was O.K., but some of the sessions needed to have time because of their subjects.
• Five days is O.K. However, everyday sessions were too long.
• Short. It was too intense, too much information. Maybe the case studies should have been less.
• We received a lot of good information, so it was O.K. If it had been shorter, it would not have been 'digestible'.
• I think it is in the exact time it needed to be.
• Short * Sessions too short * Overall day too long.

2.3. Was there something really important missing?

• No, other than common organization differences. The workshop addressed appropriately the challenges set.
• I think that it would be very appropriate to have the participation of representatives of donor's at representative decision-making level, for example GEF/UNDP, International Bank of Development, other agencies of the United Nations System.
• Non-technical aspects should be included in the training modules. More engineering accuracy is required in some slides.
• I received good ideas.
• All aspects were covered: especially in the case studies.
• We could have had a session on water availability because without water, you cannot have wastewater.
• I think it would have been important to have some dynamic sessions and have group discussions. Also it would have been nice to have one day with all the participants to go to a tourist place in Rio.
• More time for personal contacts and questions.

• The discussion and the enrichment of the solutions approved by each Latin American participant.
• Key strategies to bring up "sustainability" on respective government priority list or their agenda.
• Don't think so.

2.4. What further course development would you like better?

• Follow-up activities can substantially capitalize what was learned in this workshop, and assist in monitoring pragmatically results from decision making. Selected case studies that add new ways of using this information can be undertaken.
• Treatment of wastewater and its final disposition. • Advanced Technologies. • Appropriate technology for sanitation. • Advances in the drinking water branch. • Integrated management of water. • Evaluation of applied technologies to wastewater and stormwater.
• Regionally adapted design module.
• Systems of non-conventional water catchment.
• Organize in participating countries an environmental management course for policy/decision makers and other government departments involved in environmental issues. Other institutions of course need to be involved.
• I would like to see a workshop that included the following management issues: - Environmental watershed - Potable water - Stormwater and wastewater since they depend on each other. They are integrated.
• A course related with urbanism or landscaping and the environment. • Environmental Impact Assessments.
• Discussions about the country cases, if we know which are the issues most important about the concept of 'sustainable'.
• Environment Technology Assessment. • Environment Management System.
• Country seminars on general and specific topics • Regional seminars
• More specific/detailed • More developing country focus • More sustainability
• Environmental education
• Interaction with relevant organizations and governments in various countries especially in the participating ones.
• Any improvement I think might be done in stressing key-issues.
• Legislation related to SW, WW and solid waste management (legal aspects). • Field trips to view stormwater and wastewater structures in use. (The use of video would assist when distance is a constraint.)
• More time for discussions on concrete situations.

3. Please give more detailed comments/opinions on each session:

SESSION 1: Criteria for Evaluation of Technologies
Prof. Goen Ho

• Appropriate review. The excessive observance of presentation time chronically restricted the discussion issue to technical over emphasis rather than policy issues of major relevance to participants.
• We need a copy of the presentation because they are useful for our countries. Maybe the explanation of process for evaluation of technologies would be clearer.
• Weak presentation; too much emphasis on first world alternatives.
• Useful guidelines.
• A simple case was presented, but good to see.
• Policy (Public/community participation) and legislation plays a very important role.
• I thought it was right to the point. It could have been a little more explanatory.
• All of the criteria presented were very interesting.
• It was okay.
• Needed more details so that they could be applied.
• Country specific needs to be included as another item.
(I will be pointing what I think were key issues in each presentation) • Separate people from waste • Wastewater resources of water + nutrients. • Affordable technologies • Key decision makers + community participation + hygiene promotion
• I think it was a little bit short.
• Presentation was very informative and presenter was quite knowledgeable on the topic – his presentation lacked zest. It was also too short.
• Too general

SESSION 1 : Technology Choice & Sustainable Development in Wastewater Management
Prof. Goen Ho

• Appropriate review. Requires more time to substantially present issues more thoroughly.
• We need a copy of the presentation because it is very interesting and we will need it for the work in our countries. Maybe the explanation on process for technologies choice should be more wide and clear.
• Good presentation.
• Institutional strengthening of departments etc. which are involved with the integration process (coordination).
• I thought this was much better. Good text.
• Very interesting session
• It was okay.

• Sustainability is not technical (see session 4) so only covered part of the question.
• Effluent standard for specific location should be the objective / goal for sustainability. What you can achieve due to economic and technical constraints is difficult.
• Interesting. It is useful to see other kind of technologies, to compare and apply to the reality of our countries.
• Presentation was very informative and presenter was quite knowledgeable on the topic – his presentation lacked zest. It was also too short.
• Too general.

SESSION 2: Technologies Choice & Sustainable Development in Stormwater Management
Prof. Cedo Maksimovic

• Major topic of importance. Presentation requires much more time to cover key issues. More time for discussion was needed due to the importance of topic for region.
• Good information but general. I think the information would be diverted to technologies applied or that may be applied in the conditions of our countries.
• Good presentation - relevant theme
• It was possible to see the experience of the professor.
• Impacts risk assessment of (unsustainable) stormwater can be dealt with more in detail. To open especially politician's eyes for problems of mismanagement of stormwater and wastewater.
• Educative enough for a grade '4'. Needs a clearer definition of sustainable development.
• Very interesting session. Very relevant for the work that I am involved in.
• I think so, that can include the rain water use for drink water.
• More general and much less stimulating than Session 5-2, which was much more energetic and interesting.
• Very good courage of issue involved.
• Integrated management for Wastewater + Stormwater + Solid Waste
• Another informative presentation, although relevant. The presentation was hurried to meet the time 'restrictions'.

SESSION 3 : EnTA - Environmental Technology Assessment
maESTro
IETC

• The presentation addressed the need for our organization for reliable information tool and access to information abroad.
• MaESTro covers a good exchange of information about the existing technologies in the world. That maybe useful to implement an experience in our country. The principal problem is to extend this experience if it is positive because of the lack of financial resources and the possibility of appropriate know-how.
• Very good presentation – relevant theme.

• Useful tool and principles. * Very useful tool * Will be a useful tool * Very good tool to obtain information * Will be an excellent tool to have other papers, ideas etc.
• I think it will help the aim of IETC.
• I thought that Mr. Robert Rodriguez´s introduction of maESTro was excellent. Grade '5'. IETC has certainly selected the ideal person to perform its assigned duties, which he does exceptionally well.
• It would have been helpful to have a PC on-line to play around with maESTro.
• The evening session was the most useful.
• Other information to be loaded in maESTro must be the environmental legislation of the different countries.
• Excellent idea! It is crucial to give it the most possible diffusion! It is important to include case studies, local development experiences + investigation on papers section.
• If information is not tested usefulness, (its value) could be low. Good. Take into action.

SESSION 4 -A : Presentation by participants

• Follow-up countries in the future can assist to update information and inform on process/state.
• In general sense they were very interesting and containing good experiences of the countries. The lack of abstracts wasn't good.
• Good presentations; relevant subjects.
• It was a good demonstration of the level of participants.
• Is good. I learned a lot. I wanted more technical information, but the time was limited.
• Some were not so good, some were pretty fair & some were excellent. However, I think everybody tried hard. Besides being intelligent, it takes talent to give a good presentation.
• It was very interesting to know all different cases and situations that all Latin Americans and the Caribbeans are living.
• The time was too short.
• Translation could have been used in a better way. I feel Spanish would have made discussions more fluent and a better communication could have been reached. I refer to Spanish because it was the majority language.
• Often lost focus on sustainability + solutions. Too many general descriptions of country characters. But good way of getting to know people / problems.
• Some of the presentations were very good. Better appreciation of issues involved. Time constraints prevented good discussions.
• I found interesting experiences from Ecuador, Peru, Mexico, Costa Rica and Uruguay. The Cuban presentation is good but their experience is only for their political reality.
• 1). Very varied. 2). Not all showed sustainable practices but were relevant. 3). Informative – Challenging.
• Heterogeneous, but interesting.

SESSION 4 - B : Overview of Sustainable Wastewater and Stormwater Management in Latin America
Mr. Ivan Estribi

• Good presentation; Relevant. * The presentation was good
• I found it very interesting. The figures he showed are quite impressive and a clear indication of all that need to be done in this part of the globe. It also denotes the need of actualized information that we have, which was one of the topics considered relevant in the Workshop.
• I will give him a grade 4.
• His data was good, but his presentation was poor because it looked as if prepared in the last minute.
• Quite good and very profitable. I was able to confirm my theories about the status in Latin America regarding the handling of water.
• The information was very interesting. He emphasized the need for us to seriously address wastewater management. Also the estimated effect of the provision of potable water on mortality rates was very significant.

SESSION 5 : Alternative Technologies for Wastewater Management
Prof. Goen Ho

• This requires more time for adequate level of review. The information is well-presented and organized.
• We need to have a copy of the presentation before the speaker presents it.
• The time of presentation was too short.
• The cost to implement these technologies is also important because in these rural areas money plays an important role (not only for investments, but also for maintenance).
• These alternative technologies can serve the rural & urban environments without economic resources. Prof. Ho has performed an excellent job of explaining the operation of these.
• Need to be more adapted to developing countries reality.
• Very interesting.
• It was okay.
• Highly researchable.
• Rather hesitant. Perhaps because starting with a "high-tech" latrine raised doubts and made the audience worried?
• More focus to be given to low cost sanitation.
• In the aqua-culture experiences what could be done when the hygiene recommendations can not be fulfilled (e.g. existence of Salmonella)? I think that handling of the fish even for indirect use is risky.
• Interesting but not enough time to question alternatives. Less emphasis on volume, more on structures.
• Could be more focused on our countries and include not only general information.

SESSION 5 : Alternative Technologies in Stormwater Management
Prof. Cedo Maksimovic

• Well articulated. A potential area for follow-up and future activities to capitalize on current natural disaster problems in Central America & Caribbean.
• We need the presentations to be more adapted to our countries not too general, with examples taken from the developed work in our countries.
• Good presentation, relevant theme. More accuracy is required so as to facilitate technical designs.
• It will be nice to have the alternative technologies.
• References too much developed countries. * The same like Session 5-1. In the tropics you have other kinds of problems to solve with ponds, esp. Mosquitoes; how to deal with that. (Fishes only are not enough).
• These alternatives are a little more sophisticated & Prof. Maksimovic has motivated the economical uses of these in a very effective way.
• It will pass some years before we can think in those technologies in our countries.
• Consider use the rainwater for drink.
• Very interesting. – Could start a revolution in SSWM. * Interesting.
• Good presentation. Useful for planning and selection of alternatives.
• It is important to stress the maintenance aspect of vegetation channels and more emphasis on feasible option for heavily urbanized areas in developing countries.
• Directly relevant and interesting but somewhat swift presentation.

SESSION 6 : Highlights from the Regional Overview for Central and South America
Mr. Augusto Sergio Guimaraes

• Future follow-up actually can assist to develop an updated information base.
• The presentation was good and interesting, but it is necessary to distribute for the participants at least a copy of the presentation, like the cases of Prof. Maksimovic. It is more useful to realize this general information in the first session.
• Good presentation with important points selected.
• The time was so short to present a big point.
• Updating of the figures is necessary (evaluating) but at least we have guidance.
• Good, but lack of control of the English language has hindered somewhat the effect of understanding.
• It was interesting to see and compare all Latin American sanitation situations.
• Very focused information.
• This report is a good opportunity to raise political awareness about sanitation. I feel information could be presented in a better way to clearly reflect the situation. For instance, it is more convenient to focus on uncovered people i.e., 100 million people rather than 69% overall coverage. A sanitation indicator to show the situation could be useful. Also to refer to specific information for LA countries such as pathogens content in WW, type of systems showing successful operation, disposal techniques such as ocean outfalls, agricultural wastewater irrigation, etc…
• Good explanation of why we need to be careful about "statistics". Good review of need for

technology change - but nothing on SSWM.
• It is important to stress the need of reliable and sound information and indicators. Brazilian design of conventional sewers is very good, not only condominium. Regional experience in solids free sewage in good, too.
• Not directly applicable. Presentation too slow.
• Good. Could be better with more time or better organization.

SESSION 6 : Development and other Aspects of the Caribbean Region
Mr. Arthur Archer

• A strap report by members of Caribbean nations can assist to enrich regional perspective. Regional (Central and South area) consultations can be of key assistance, as well.
• It is necessary to use audio-visual means for the presentation, because only reading is a boring session. It is necessary to take into account the situation of the Caribbean, not only the situation of English speaking countries in particular sense. It is more useful to realize this general information in the first session.
• Weak presentation with obsolete data.
• The report needs to be updated (from 3 participants).
• Mr. Archer misses some information.
• Examples of applied sustainable technologies would be better, good operating sewage plant maintenance, how problem were solved. We can use this example and apply with adaptation in our countries. Information very obsolete.
• Very informative of geographic & historical water, stormwater & wastewater conditions of the Caribbean islands.
• It would be better if he had used some support materials to make his presentation more interested and to get the attention of the audience
• It needs more information, I know that they have information exactly about that region in papers of UNEP.
• A reading presentation is not easy to follow.
• A better description could have been made.
• Badly structured and presented – very few lessons for the workshop.
• Grossly outdated!! Interesting subject but "unsustainable" presentation! (Gave me time to complete this evaluation.) I think we needed this spare time anyway!

SESSION 7 : The World Bank's Water and Sanitation Programme
Ms. Carmen Arevalo-Correa and Mr. Richard Middleton

• Positive study case. Follow-up is recommended to monitor development.
• The principal task that we need and we want hear is how this activity can help us to solve the heavy problems in our countries. It is necessary to invite decision-makers in this activity.
• Good presentation. * It was okay. * Interesting case.
• Showed good alternative, but in a short term time we can't measure the results ; it will take five years.
• Possibilities for "small" projects in rural areas and towns.

• What are the factors or why implemented projects cannot work?
• Good training for help that could be needed for information from the World Bank. Good to the point information.
• It was a case study of my own country, it was very appropriate for the developing countries.
• It was very interesting to see clearly how a small community can be organized to improve their waste water systems.
• Should have been separated. 1) WSP 2) El Alto
• Information given was useful
• Information dissemination is crucial and vital holistic approach: Tech. + People + Politics + Financial + Options generation – Very interesting experience in El Alto: Technical + Social Team working together.
• Very interesting and help to us to open our ideas and try final opportunities for projects.
• Awareness session
• A bit fragmented

SESSION 8 : Training Module
Prof. Cedo Maksimovic

• The material projected is fundamental to support capability-building activities. Case studies can be incorporated to illustrate specific aspects and problems and approaches.
• The presentation was excellent, but the time was short for deeper questions. The presentation of accomplish study cases may enrich the contents.
• Good material, but non-technical information; Technical accuracy is required in the slides.
• Was so good but too fast.
• Was good. Overview of the training module. It is very useful for our countries. * More question and discussions about applications.
• Much more effective explanation. A more educative presentation without repetition. Grade '5'.
• Need to be translated and adopted to the audiences we have.
• Presented a very interesting option to different sectors of our society using very good and clear material.
• It was okay.
• The source book should avoid setting up paradigms!
• No time to review Source Book, and details of training tool – will it enable us to <u>do</u> something? <u>Impossible to evaluate</u> a stream of pictures – this is <u>not</u> a training tool.
• Appear to be user friendly and useful. A more close review after completion of document will only be able to provide practical feed back useful for revision /update.
• The overview was perhaps too quick to provide an assessment on the TM. I think it needs more emphasis on the sustainable issues discussed in this workshop and especially in the topics highlighted in this evaluation.
• Nice comments and advice to implement concepts, rehabilitation, etc. to improve the living standards.
• Comprehensive. It appears to be an excellent guide & tool in WW & SW Management.
• Too fast to assimilate. Repetitive in part.

Hands-on demonstration of maESTro
Mr. Robert Rodriguez.

• Precise presentation of hands-on useful information tool.
• Was developed very clean for the speaker.
• Very good presentation – Relevant theme. * Excellent * Needless to say Mr. Rodriguez is a very intelligent person. Needless to say he is a '5' • Excellent – We were left with the expectation of a real use of the Internet version. • Was enough to understand. Is a good tool for our job.
• Good. Taken into account * Very good. Useful tool to access information needed • Very interesting * Clear usage of it uses
• Extremely good, but the timing of this session was not correctly registered.
• Good training for a new user.
• We receive only a sheet of paper, but the explanation with the computer was very good. I sure will visit maESTro on Internet, to get more information about sanitation technology and offer information. Must be extensively promoted.
• We have to try personally how it works.

Field trip
Mr. Augusto Sergio Guimaraes

• Time extensive. A stormwater management site is quite necessary to exemplify.
• I think that the first part of explanation may be shorter to explain the concept in the field and to save for the final session. The explanation about community participation and their own experiences should be reinforced by the key persons involved with the project. An interview with key community persons should have happened.
• Good information provided to the audience in particular solutions. • Good example of appropriate technology.
• Very interesting to see how all the society sectors were involved to solve a community major problem.
• Was very interesting → Small-scale sewage treatment is an example for us.
• Very clever adaptation to local situation + community participation. Remarkable involvement of political authorities. Congratulations!
• Applying the tactics for completing the cycle from planning their designing, decisions, financing and community environment. This shows you can even achieve success without total political interference very good even though I feel that the project was over promoted, losing some of its value.
• Beautiful and nice people, but it is not so great as it sounds.
• I think it was an interesting field trip, but not so well prepared. Some step loosing. Technical people always need an explanation about the work, planning etc. and after the visit, etc.
• Good. However, it could have been completed in half a day. Issues were repeated over and over. Hospitality & excitement was great and appreciable.
• The field trip was interesting, but took too much time.
• Very interesting, but too much sitting for long talk sessions (introduction should have been in Rio.); Not enough time in the field actually looking at installations.

• Not so many important topics just social participation and municipal participation.
• Too tiring, too much talking.
• It is possible to get the same aim, with a half an hour video.
• Too much time talking in classroom not enough time spent on site.

4. Please feel free to give any comments / opinions on the Workshop

• We can contribute to support information + case studies that might be of use to enhance IETC on-going programs. I would certainly feel interested in a more active contribution as a partner institution from my country if this can assist to satisfy the IETC goals.
• I think that it is necessary to invite more representatives from small islands of the Caribbean, for example Santa Lucia, Saint Vincent and the Grenadines, Jamaica, Antigua and Barbados and others to this kind of meetings, because their problems in these fields are particularly special with the accelerated development of the tourism. • It is necessary to repeat this kind of meeting, for example, one time or two times in the year, permitting to exchanges successes and difficulties of different countries. • When a workshop is held in Latin American and the Caribbean, the majority of participants are Spanish speakers. I think it is better to hold the whole workshop in Spanish, the language of the majority.
• As a matter of principle, the nature of the modules would be able to design the installations shown.
• More time required at end of presentations for questions/discussions. This is where most ideas / solutions can be found.
• I think the workshop was very satisfactory for all the participants. • It would be better if the participants had all the presentations before.

• The workshop was good. I learned a lot about WWM & SWM.
• It was clear that awareness of consciousness of the government needs to be enhanced & promoted.
• In most of our countries there is
    • No treatment of sewage
    • Treatment of sewage but does not operate at all in adequate conditions
    • Partly treatment of sewage
• Clearly also there is need for:
    • Money (for investment & maintenance)
    • Legislation
• This workshop can be organized in one of the participants' countries: because more people who are involved in this sector can attend such a workshop and learn more about it.
• Papers of speakers must be up to date.

• I would like to suggest a future management workshop on :
    • Environmental Watershed
    • Potable Water
    • Stormwater & Wastewater
• In Panama, the manipulation of water is possibly greater than anywhere else in the world plus the fact that is central to most countries. We could get help from our institution (IDAAN) & the Smithsonian Institute which has been stationed in canal zone of Panama for 30 years in which it has been doing yearly studies on water, wastewater & environmental effects. You can count on me & (IDAAN) for whatever support.

• For another future workshops it would be better if you would also include more dynamic sessions because just listening (even if the expositions are very interesting) all day can be very tiring.
• I think that the information and experience, that we brought here, will be useful for our activities in the countries.
• I am quite interested in participating with IETC as a Mexican Center for information gathering these to maESTro and also in developing Env. Management system procedures. In fact, I am working in Mexico at the university on these issues, under the term "Water Quality Management".
• The workshop should deal with industrial pollution as well. There were not comments about that. All the projects presented by the organizations were related only to domestic wastewater and sewage problems.

• A feedback letter should be sent to each participant´s country indicating the following:
    • Role-played and contribution made by the representative/participant of the country.
    • Final recommendation of workshop.
    • Expected action and/or suggestion to achieve sustainable water environment. A message to create a sense of urgency on the issue and to include WW, SW & Solid Waste as priority issues & action plan of the country.
(A copy of this letter should be also be sent to the participant who attended this workshop for follow up action with their agency & government.)
 	
• Workshops of this nature should include sightseeing, social & cultural events for one day & one night.
• Dinners should not be in the same hotel. An appropriate allowance per day is normally given or should be arranged at other venue for break.

• The translation services provided were very helpful because language barriers are still very important. Most participants are Spanish speaking and yet the Workshop language was English! I feel that Spanish and Portuguese presentations would not be fully appreciated by IETC + WB English speakers – This workshop is very helpful to realize that <u>we all need a lot of support in</u>: Regulations, Management, Education, Enforcement, Public participation, Cost recovery, Political Involvement, as well as the technology aspect. I don't know if IETC, WB, WHO, etc can help us more in these areas. The organization was excellent. Thanks to the Brazilian hosts too!
• I think it is so important to make a group of five or three people and develop a case study, like the last activity to apply technology, as practice.
• The availability of Internet access and hardware of greater efficiency. • Personal time for participants who wanted to work on relevant issues of the Workshop. • A "Cleaning the Brain" session so that assimilation could occur. • Whole or part shopping day or points of interest tour.
• Time for discussions was not practical. General issues were unnecessary to repeat. Useful if it continues in a country scale. Thank you.

Special Comments on Session 8

The Training Module

(1) General impressions

* Clearly presentations are OK. Content is good for general public with some or more education, perhaps for decision-makers lacks some sort of "bait", and for sanitary engineers it is too simple in the technical aspects and perhaps too vague in management.

* Issues discussed in the Workshop thoroughly:

Technology (Adopted and locally feasible)
+
People participation
+
Politics support
+
Financial feasibility
+
Options

(2) Suggestions for grouping to three target users

A strategy option could be training first the specialists and then go after both targets (decision-makers + public opinion) with the output of the specialist training stage including adaptation to the local situation or regional.

(3) Follow-up sections for improvement

This kind of workshop should provide some input that can be usable (I think) especially since they represent regional conditions – The translation is essential in Latin America.

(4) My contribution

I can contribute with some successful experiences in my country in several topics (low cost technologies) such as:

- Solids free sewage
- Dissolved air flotation treatment
- Monitoring & control program
- Institutional strengthening

* I suggest that Brazilian technical literature should be taken into account.

* Also operation and maintenance "tips" are important beside some detailed designs.

Part VII

LIST OF COUNTRY DELEGATES AND PRESENTERS

COUNTRY DELEGATES

Country: **ARGENTINA**
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Part VIII

COPY OF CERTIFICATE

ABES RIO

Associação Brasileira de Engenharia Sanitária e Ambiental
Seção Rio de Janeiro

UNEP
Division of Technology,
Industry and Economics

The International Environmental Technology Center (IETC)
and
Brazilian Society for Sanitary and Environmental Engineering
in Rio de Janeiro (ABES-Rio), Brazil

Hereby award this

Certificate

to

Javier MIJANGOS

For serving as Participant in
the Regional Workshop
on Sustainable Wastewater and Stormwater Management
in Rio de Janeiro, Brazil
27 March – 31 March 2000

Eliane Barbosa
President
ABES-Rio

S. H. Halls

Steve Halls
Director
UNEP-DTIE-IETC

The UNEP International Environmental Technology Centre (IETC)

Established in April 1994, the International Environmental Technology Centre (IETC) is an integral part of the Division of Technology, Industry and Economics (DTIE) of the United Nations Environment Programme (UNEP). It has offices at two locations in Japan - Osaka City and Kusatsu, Shiga Prefecture.

The Centre's main function is to promote the application of Environmentally Sound Technologies (ESTs) in developing countries and countries with economies in transition. IETC pays specific attention to urban problems, such as sewage, air pollution, solid waste, noise, and to the management of freshwater basins.

IETC is supported in its operations by two Japanese foundations: The Global Environment Centre Foundation (GEC), which is based in Osaka and handles urban environmental problems; and the International Lake Environment Committee Foundation (ILEC), which is located in Shiga Prefecture and contributes accumulated knowledge on sustainable management of freshwater resources.

IETC's mandate is based on Agenda 21, which came out of the UNCED process. Consequently IETC pursues a result-oriented work plan revolving around three issues, namely: (1) Improving access to information on ESTs; (2) Fostering technology cooperation, partnerships, adoption and use; and (3) Building endogenous capacity.

IETC has secured specific results that have established it as a Centre of Excellence in its areas of speciality. Its products include: an overview on existing information sources for ESTs; a database of information on ESTs; a regular newsletter, a technical publication and report series and other media materials creating public awareness and disseminating information on ESTs; Local Agenda 21 documents developed for selected cities in collaboration with the UNCHS (Habitat)/UNEP Sustainable Cities Programme (SCP); advisory services; Action Plans for sustainable management of selected lake/reservoir basins; training needs assessment surveys in the field of decision-making on technology transfer and management of ESTs; design and implementation of pilot training programs for adoption, application and operation of ESTs; training materials for technology management of large cities and freshwater basins; and others.

The Centre coordinates its activities with substantive organisations within the UN system. IETC also seeks partnerships with international and bilateral finance institutions, technical assistance organisations, the private, academic and non-governmental sectors, foundations and corporations.

UNEP

UNITED NATIONS ENVIRONMENT PROGRAMME

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