GLOBAL DRY TOILET ASSOCIATION OF FINLAND
TAMPERE UNIVERSITY OF APPLIED SCIENCES

A GUIDE TO SANITATION AND HYGIENE IN DEVELOPING COUNTRIES

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FOREWORD

According to estimations there are approximately 2, 6 billion people living without proper sanitation. These people have to decide on daily basis how to organize defecation without feeling ashamed, feel of fear or direct health problems due to lack of sanitation. Some relieve themselves during the night time while others hide in the bushes for defecation. Some people even defecate into plastic bags and then throw the bags as far as they can. If people don't have access to proper toilets, they need to rely on solutions that are neither good for them nor the communities they live in, or for the environment. Due to inadequate water supply, sewerage systems and lack of sanitation millions of people face death annually. Over 2 million people die annually just by diarrhoea, wherefrom most are under the age of five. Every day approximately 5000 children die to diarrhoea based diseases. According to some estimates two thirds of the costs of medical treatment are used to nurse diarrhoea related diseases.

At the same 300 million people in developed countries are using the same amount of water what many people in developing countries are entitled for a whole day by simply flushing once. According to WHO and UNICEF safeguarding access to clean water and sanitation to all people would cost approximately 9 billion USD annually from the year 2005 to 2015 (including only building cost. If you compare this cost to the cost of global armament (780 billion USD annually), to the cost of alcohol and cigarette consumption in Europe (155 billion USD annually) or even to the cost of ice-cream consumption in Europe (11 billion USD) it can be considered as rather small cost.

World's sanitation problems cannot be solved only by building water latrines and sewerage systems. The building and maintenance costs are too high and furthermore this infrastructure cannot ensure clean environment. In a case of inadequate waste water treatment even more severe health and environmental risks than the use of bushes for defecation purposes can be created. Therefore it is necessary to develop cheap, technically simple and safe sanitation alternatives, which can be adjusted to meet the needs of different cultures and environments. Dry latrines (Dry toilets, DT) are one good solution for this. It is also necessary to increase sanitation and hygiene education for understanding of the connections to human and environment health.

This sanitation guide was produced originally by Global Dry Toilet Association of Finland (GDTF) and Tampere University of Applied sciences (TAMK) project in 2005. The project received support from the Ministry of Foreign Affairs of Finland. The aim of the project was to increase the knowledge of Finnish workers in developing countries in sanitation and hygiene matters and to give them abilities to answer the local people's questions on sanitation and hygiene. The aim is that workers, organizations and companies take sanitation issues as a part of their functions.

Guide is produced by project coordinator Sari Huuhtanen (GDTF) and a student of environmental engineering Ari Laukkanen. The guidance group was formed by Raini Kiukas (GDTF), Eeva-Liisa Viskari (TAMK) and Perttu Heino (TAMK). In addition, the text was commented by Kati Hinkkanen (GDTF), Sanna-Leena Rautanen form Tampere University of Technology and Helvi Heinonen-Tanski from University of Kuopio. First English edition was produced by project coordinator Mika Korkeakoski from TAMK (2006) and second edition by Ilkka Pulkkinen and Sari Huuhtanen (2009). In addition second edition was commented by Emmanuel Mutamba (Green living movement) and Sanna Ojalammi.

Year 2008 was United Nation's Year of Sanitation which gave lots of publicity to the sanitation issues. Unfortunately, now when we are reaching to the end of the year 2009, there are still too little efforts made to improve sanitation condition throughout the World. Hopefully this guide, at least in small scale would encourage as many as possible to start think about sanitation issues and take them into consideration in their own work. Of course, there are also needed to increase investments towards sanitation by local governments in developing countries. It is also necessary to increase support to organisations that are doing sanitation projects and in all encourage local activities to improve sanitation and hygiene.

In Tampere/Finland, 21.12.2009
Sari Huuhtanen

1. INTRODUCTION

1.1. Definition of sanitation

World Health Organization (WHO) defines sanitation as group of methods to collect human excrete and urine as well as community waste waters in a hygienic way, where human and community health is not altered. Sanitation methods aim to decrease spreading of diseases by adequate waste water, excreta and other waste treatment, proper handling of water and food and by restricting the occurrence of causes of diseases. [1, 2]

Sanitation is a system to increase and maintain healthy life and environment. Its purpose is also to assure people have enough clean water for washing and drinking purposes. Typically health and hygiene education is connected to sanitation in order to make people recognize where health problems originate and how to better sanitation by their own actions. Essential parts of sanitation are building of toilet and wash up facilities, sewerage systems as well as usage and maintenance education of the facilities. [3]

In defining United Nation's Millennium Development Goals (MDG) two terms are used in sanitation: "improved sanitation" or broader concept "basic sanitation". [4]

Developed sanitation facilities are defined in WHO's and UNICEF's Joint Monitoring Program (JMP) "Progress on Drinking Water and Sanitation: Special Focus on Sanitation 2008". Following methods are considered as improved sanitation facilities: [52]

- pour-flush latrine/toilet to:
- public sewer
- septic tank
- pit latrine with slab
- ventilated improved pit latrine
- composting toilet.

Following sanitation facilities are considered as undeveloped: [52]

- service or bucket latrines (where excreta are manually removed)
- pit latrines without slab or platform
- hanging latrine
- open latrines
- excretion to environment.

Basic sanitation was defined in UN's World Summit on Sustainable Development (WSSD) in 2002.
By the definition basic sanitation consists: [4]

- development and implementation of efficient household sanitation systems
- improvement of sanitation in public institutions, especially in schools
- promotion of safe hygiene practices
- promotion of education and outreach focused on children, as agents of behavioural change
- promotion of affordable and socially and culturally acceptable technologies and practice
- development of innovative financing and partnership mechanisms
- integration of sanitation into water resources management strategies in a manner which does not have negative impact on the environment.

1.2. Ecological sanitation

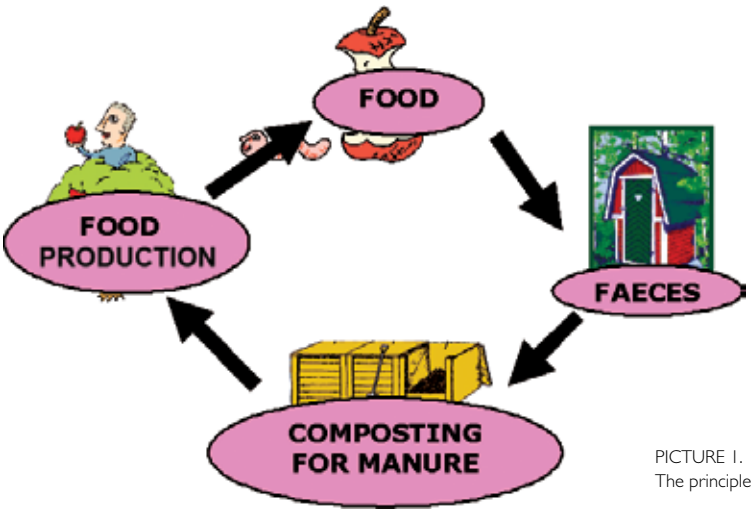
Ecological sanitation (Ecosan) is based on the nutrient cycle. In the modern centralized waste water solutions human faeces are considered more as a resource than waste. Excrement is treated in situ and the formed end product can easily be used as fertilizer in agriculture. Ecological sanitation techniques take into consideration the surrounding environment by decreasing contamination as well as keeping it clean and safe. [6]

Following characters can be found in Ecological sanitation principles and implementation: [6, 7]

- aim is to decrease contamination of the environment caused by human excretion and prevention of diseases deriving from excreta
- human urine and faeces are considered as a resource, not as waste
- recovery of nutrients from excreta and utilisation of the end product as fertilizer and soil enrichment material
- in situ or close by treatment of the excreta
- avoiding utilization of water in the transportation of excreta
- use of decentralized waste treatment methods and services (e.g. collecting, recycling and preserving)

The principle of nutrient cycle is shown in Picture 1. In the nature waste is not generated, but all the products of organisms are used as nutriment or nutrients for other organisms. Plants give directly nutrition to herbivores or indirectly as energy for the animals higher in the food chain. When animals defecate into the nature, the unused nutrients are transferred back to soil for the use of plants and decomposers.

Human nutrient cycle was also earlier a closed system and the nutrients of excrement have been utilized in cultivation. In the developed countries after the change to modern sanitation techniques, the nutrients of excreta are not used for soil enrichment anymore. Excreta is mixed with water (in industrial countries usually to drinking water) and transported to centralized water treatment plants for purification. By doing so the nutrient value of the excreta is lost and waste is produced rather than valuable soil enrichment material. This has led to situation where fields are fertilized with artificial fertilizers to ensure growth. Nutrient runoffs of these additional fertilizers are the cause of eutrophication in many lakes.



PICTURE 1.
The principle of nutrient cycle

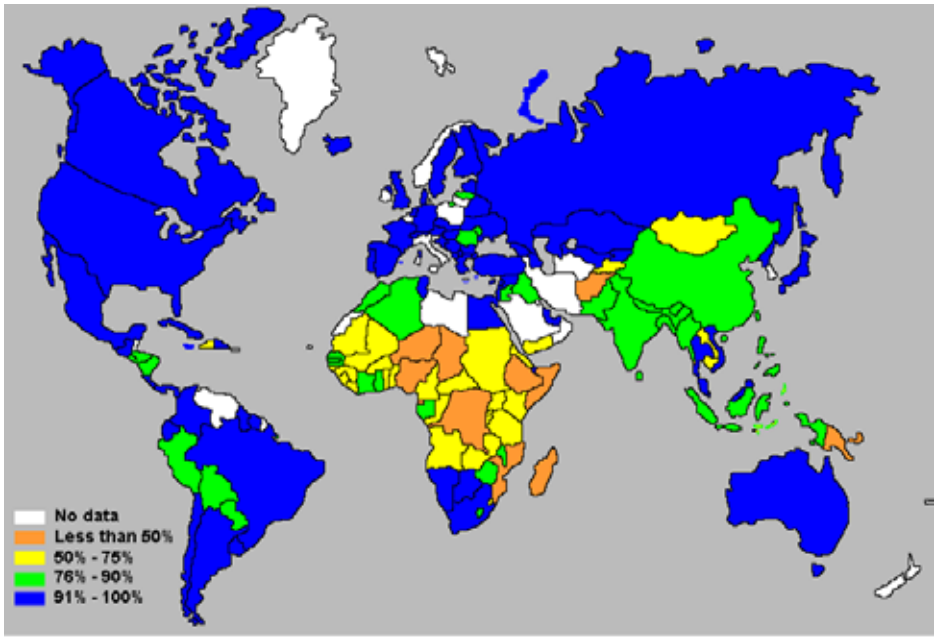
The shortage of water often causes sanitation problems. Ecological sanitation with dry latrine technology does not merely decrease health problems caused by excreta but also clings into the fundamental causes of the problem. The contamination of scarce water resources decreases, and water is saved for other purposes such as food preparation and hygiene. [6]

The nutrient quantities of human excreta are high especially in urine. (Table 7, Chapter 3.6). Furthermore the nutrients are in an easily accessible form. Better or similar plant yields than by using commercial fertilizers are harvested by using pure human urine or composted excreta as fertilizer and the use of industrial fertilizers can be decreased or even stopped. In developing areas this diminishes the economical dependence on industrial fertilisers. [6]

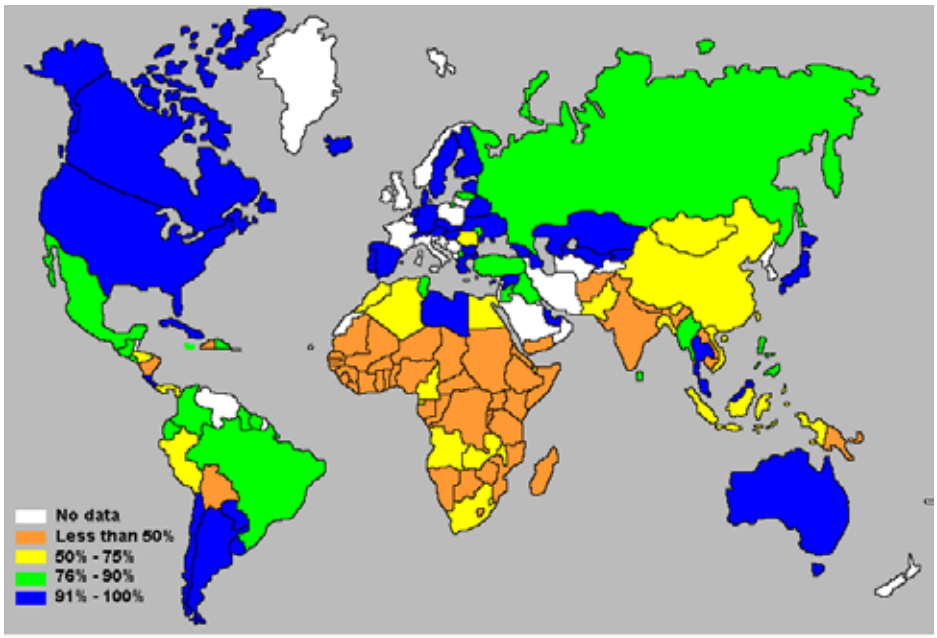
1.3. Water and sanitation situation of the world

Access to clean water can be considered as one of the basic needs and rights of a human being. The health of the people and dignified life is based on access to clean water. Clean water together with proper sanitation increases the well-being in terms of health and economy. When sanitary conditions improve people have more time to take care of livelihood and food supply. Ensuring access to clean water and basic sanitation services is the first step in eliminating poverty. [5]

According to WHO and UNICEF 87 per cent of world's population had access to an adequate water supply. The amount of proper sanitation has increased from 49 percent in year 1990 to 62 percent in year 2006. Still approximately 900 million people are lacking access to an adequate water supply and 38 per cent of the word's population (equals to 2, 5 billion people) are without access to proper sanitation services. Most of these people live in areas of Asia, where as much as half of the population lack of proper sanitation services, and in areas of Africa, where 2 out of 5 does not have access to adequate water supply. The situation is especially alarming in rural areas, where half of the people do not have access to proper sanitation and water supply services. In bigger cities the problem is intense population growth and concentration on population centres. This will burden existent services on decades to come. [5, 8, 52]



PICTURE 2
Global water supply coverage in the year 2000. The Picture shows the percentage of population that have access to adequate drinking water supply. [52]



PICTURE 3
Global coverage of improved sanitation in the year 2006. The Picture shows the percentage of people with access to proper sanitation services. [52]

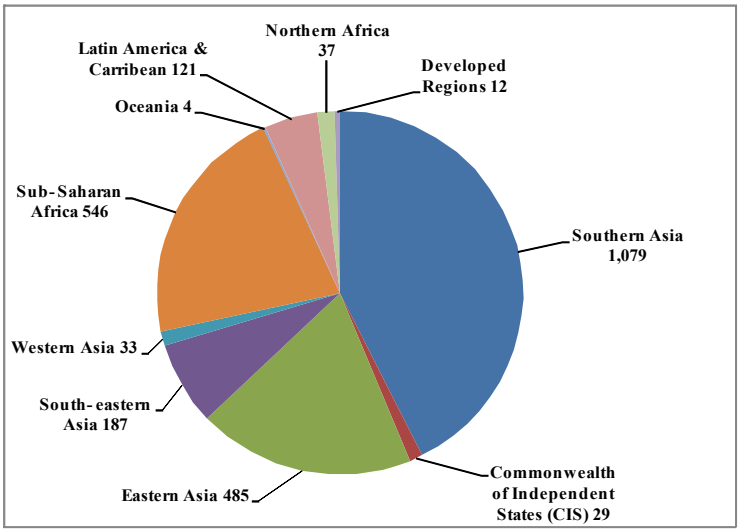


FIGURE 1
2,5 billion people without improved sanitation by regions (unit: in millions of population). [52]

The lack of access to clean drinking water and proper sanitation services create annually a significant amount of illnesses and deaths. (Table1). Societies and countries with very high degree of poverty suffer the most. A decrease in diarrhoea cases could be reached with the use of adequate water supply (21 percent decrease) and sanitation services (37, 5 percent decrease). A 35 percent decrease in diarrhoea cases could be reached simply by washing hands. [5, 10]

Table 1 Examples on consequences of lack of clean drinking water and proper sanitation services. [5, 9]

- Each year there are approximately 4 billion diarrhoea cases that cause 2.2 million deaths, mostly among children under the age of five. This means a rate of one child every fifteenth second, which is 15 percent of all of the death causes among the children under the age of 5.
- Approximately 10 percent of the population in developing countries is affected by intestinal worms. Intestinal parasitic infections can lead to malnutrition, anaemia and retarded growth.
- 6 million people are blind from trachoma. It is the most common cause of blindness in the world.
- 200 million people in the world are infected with schistosomiasis, of whom 20 million suffer severe consequences
- Over one million people die from malaria every year. Over 267 million people are infected by malaria.
- Hundreds of millions of people suffer from different types of intestinal parasites annually.

Recommended clean water need in a day is approximately 50 litres per person. It is divided into following categories: [11]

- drinking water 5 litres
- sanitation 20 litres
- washing up purposes 15 litres
- preparation of food 10 litres.

Especially in the driest and poorest regions the available water supply does not cover 50 litres for a person in a day. E.g. in Eritrea people have to survive by 15-30 litres per a day. In Finland the average household consumption of water varies between ca 180 litres/person/day in blocks of flats to ca 150 litres/person/day in terraced houses to ca 130 litres/person/day in one family houses. The water consumption decreases slightly if the residence has a separate measuring device. The average amount is in this case around 116 litres/person/day. Over one third of the household water consumption goes to personal hygiene and one fourth to flushing of toilet. [12, 13, 14]

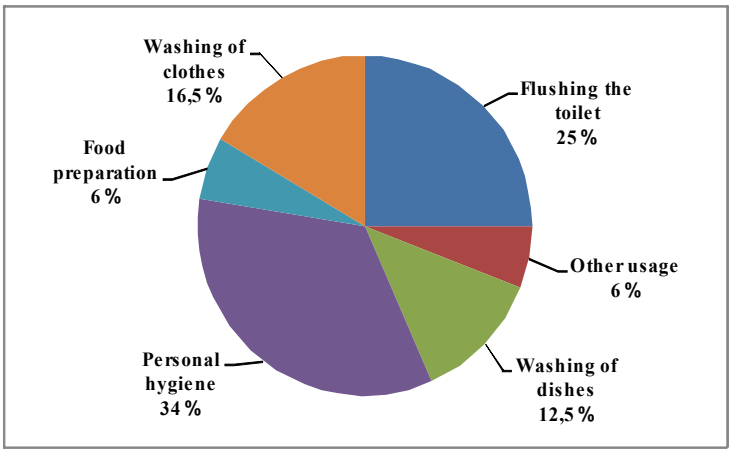


FIGURE 2 The distribution of water usage in households in Finland. [13]

1.4. United Nations' Millennium Development Goals

In the United Nations general assembly decisions were made for the Millennium Development Goals (MDG). MDG is an agreement on the rules of international cooperation signed by UN member states, UN organizations and international financial institutions. It can be considered as the basis of all international cooperation and as a goal to improve the state of developing countries accepted by all the UN member countries. [15, 16]

In the general assembly eight Millennium Development Goals were set and a decision was made to achieve these goals by the year 2015. Millennium Development Goals (MDG) are presented in Table 2. The goals are ambitious, but at least in some level attainable. [16]

Table 2 United Nations' Millennium Development Goals. (MDG) [16]

Goal 1. Eradication of extreme hunger and poverty

- Halve the proportion of people whose income is less than 1 USD between 1990 and 2015
- Halve the proportion of people who suffer from hunger between 1990 and 2015

Goal 2. Achieve universal primary education

- Ensure that all the children are entitled to primary education by 2015
- Goal 3. Promote gender equality and empower women
- Eliminate gender disparity in primary and secondary level by 2005 and in all levels by 2015

Goal 4. Reduce child mortality

- Reduction of two-thirds the under-five mortality by 2015

Goal 5. Improve maternal health

- Reduction of three-quarters in maternal mortality ratio by 2015

Goal 6. Combat HIV/AIDS, malaria and other diseases

Goal 7. Ensure environmental sustainability

- Integrate sustainable development principles into country policies and programmes and reverse the loss of environmental resources
- Halve the proportion of people suffering the lack of access to safe drinking water and basic sanitation by 2015
- Achievement of significant improvement in the lives of at least 100 million slum dwellers by 2020

Goal 8. Develop a global partnership for development

- E.g. increase aid to developing countries, creation of nondiscriminative trading and financial systems and debt reductions

The seventh goal of Millennium Development Goal is ensuring environmental sustainability. It contains a target 10 with aims to halve the proportion of people suffering the lack of access to safe drinking water and basic sanitation by 2015. [4]

In ensuring drinking water it is defined that people need to have access to safe and clean water supply and a possibility to acquire enough water for drinking, food preparation and hygiene purposes. In terms of defining sanitation two terms are used: improved sanitation or a broader concept basic sanitation. [4]

To halve the proportion of people suffering from the lack of access to proper sanitation from 1990 by 2015 the global coverage of sanitation should increase to 75 percent. Even now it seems that the targets will not be met unless a radical increase in sanitation programmes appear. In the targets of MDG 1, 9 billion people would lack proper sanitation services by 2015. With the present sanitation programmes and the predicted population growth only 2, 4 billion people level can be achieved, which means that the sanitation coverage would stay at the present level. The situation is especially troublesome in Southern and South-Eastern Asia, Sub-Saharan Africa, Eurasia and Oceania. In these regions the sanitation programmes are completely inadequate to meet the targets of MDG. It is estimated that to reach the targets of MDG by the year 2015 it would be necessary to double the sanitation projects in the world and in Africa projects should be quadrupled. [8, 17]

Despite the global slowness in the development results have been accomplished to improve sanitary conditions. In some regions the positive development has been significant. E.g. the coverage of sanitation in Eastern Asia has almost doubled since 1990. At the same time sanitation coverage has increased from 20 percent to 37 percent in Southern Asia. [5]

Water projects financed by Finland have brought clean and safe water until this day approximately to five million people. Water sector has been subsidized for almost 30 years. Support has been first and foremost on nondiscriminative and fair distribution of water supplies and sustainable maintenance on water supplies. By the year 2000 water projects have been subsidized by 370 billion euros in 15 countries. At this moment there are projects in eight countries. It is though unfortunate that according to studies the state of water management and sanitation is still poor in all of Finland's long-term target countries. [18, 19]

According to present knowledge, sanitation projects usually account to better health effects than mere water projects (depending largely on the beginning situation in the target country). However amounts of sanitation projects have not been as great as the amount of water projects. There are many reasons for this situation. Sanitation issues are often found difficult to solve especially due to strong prejudices, beliefs and other cultural matters. Water is often experienced as condition of life, what it certainly is, but sanitation is seen as inevitable burden. Sanitation solutions can be very expensive and technically hard to handle. Especially if it is considered water latrines of the developed countries with costly sewerage systems and waste water treatment plants. Therefore many projects have eventually failed to come true. The governments of the target countries usually have more important priorities than safeguarding the toilet services to the inhabitants and for that the importance of the hygiene aspects is not recognized.

Finland has committed to do its share in implementing MDG and to safeguard water supply and sewerage as well as sanitation for approximately to five million people. This would require in total ca 500 million euros investment (40 million annually) on water and sanitation projects by the year 2015. According to Ministry for Foreign Affairs of Finland accomplishing these targets would require, in addition to financial support, increase in consultant services, decrease of target countries to about five and increasing participation in multilateral projects where support has not been much persistent. [18]

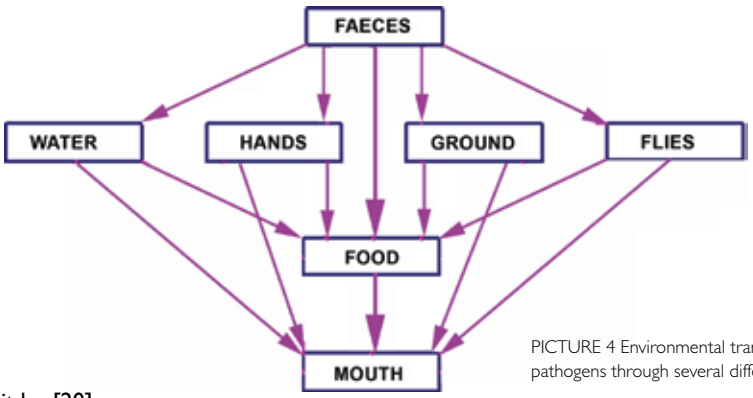
2. INFECTIOUS DISEASES

Resources of safe drinking water will decrease in the future due to factors like intense population growth, urbanization and possibly also from climate change. Strong migration to cities will increase the amounts of human excrement and other waste to a level where it is hard to handle. If no improvements take place in the resources these wastes end up untreated to the environment and water bodies. Especially in the rural areas people lack knowledge on sanitation solutions and waste treatment as well as resources to solve these problems. [20]

Sanitation and human health are closely connected to each other. Inadequate treatment or disposal of human excreta and other waste can lead to transmitting and spreading of diseases originating from excreta. Especially children are susceptible to diseases. Therefore it is very important to safeguard adequate sanitation and education to reduce the amounts of infections and access of causes of diseases to water. [20]

2.1. How do diseases spread

Pathogens transmit through several different routes (Picture 4). The cause is often inadequate sanitation and hygiene.



PICTURE 4 Environmental transmission of pathogens through several different routes.

Pathogens can transmit by: [20]

- direct contact to human excreta
- contaminated drinking water
- through flies and other insects
- through vegetables, shellfish or other food products exposed to contaminated water or soil
- accidental ingestion of contaminated water e.g. during swimming
- inhalation of contaminated dust and aerosols from waste water irrigation, scums, showers or by other means
- through water-borne pathogens
- contact with animals acting as hosts for parasites and pathogenic bacteria
- through contact with infected individuals.

The main organisms posing threat to human health are pathogenic bacteria, viruses, parasitic protozoa and helminths that can be found in large numbers from excreta of infected individuals. Usually only a small amount of infectious agents and doses is enough for infection. Therefore direct and indirect excrement load to water bodies is a significant factor in increasing the risk of infection. The direct and indirect load is caused by: [20]

- direct load from human excreta
- large quantities of water from centralised water treatment plants
- grey water

- storm water
- impact of sludge and manure run-off from cultivated land
- impact of animals' and birds' excreta.

Effects of direct load from human excreta depend mainly on the soil type and quality and location of water sources (groundwater, surface water) in respect to the source of load (e.g. toilet). Transmission of the load varies in different soil types. Pathogens also have their characteristics in terms of mobility and life span due to different soils. Transport of pathogens usually necessitates liquid. Therefore movement of liquid in the soil is crucial on mobility of pathogens. In order to prevent spread of pathogens special attention needs to be given in isolation of pathogens from surface and groundwater. [21]

2.2. Diseases spreading through water and inadequate sanitation

Shortage or lack of safe drinking water can easily cause transmission of excreta related diseases. Infections tend to have two main routes: drinking of contaminated water and inadequate hygiene due to scarcity of water. [5]

Several excreta related epidemics have occurred due to drinking of contaminated water and even today these epidemics can be found in both the developing and the developed countries. Excreta related diseases are e.g. diarrhoea, cholera, typhoid fever, hepatitis-A, dysentery and guinea-worm disease. Appendix 1 shows diseases and causes of diseases both in Finnish and in English. [5]

Unimproved hygiene and inadequate washing up usually derive from scarce water resources. These cause skin and eye infections which spread easily from direct contact to contaminated water resources or to infected individual. [5]

Diseases spreading through contaminated water and excreta

Diarrhoea is the most important excreta related diseases. It transmits easily through both main routes. Approximately 4 billion people are infected and ca 2, 2 million die annually to diarrhoea. Several bacteria and viruses cause diarrhoea. It is an acute malfunction of digestive system which causes watery excrement and continuous need for excretion. It creates rapid weakening of liquid and salt balance and the body starts to dehydrate. 10 percent loss in body fluids leads to death. Children are remarkably more vulnerable to diarrhoea than adults. Diarrhoea is the main cause of malnutrition of children. [10, 22]

Main factors in transmitting of diarrhoea are inadequate personal and food hygiene, lack of safe drinking water, high residential density and increase of bottle-feeding instead of breast-feeding. [10, 22]

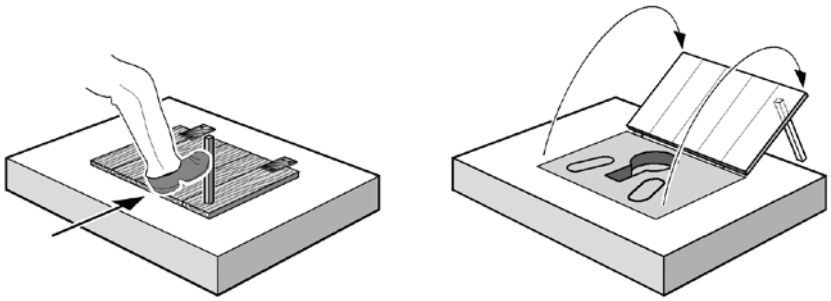
The most important means of preventing diarrhoea: [10, 22]

- improvement and increase of access to safe water and sanitation services
- the use of adequate toilet and paying attention on proper handling and disposal of excrement.
- promotion of hygiene education
- encourage of breast feeding
- vaccination against measles
- proper cooking of drinking water and food
- keeping food and water clean
- washing hands (also children's hands) before touching food
- general improvement of living conditions.

Washing hands is a simple measure to prevent diarrhoea. Hands should be washed always after using the toilet and before food preparation and eating. Special attention should be paid that children wash their hands because of exposure to pathogens while playing with contaminated water and ground. If possible hands should be washed with soap

and running water. A simple hand-washing device can be made for washing hands. Instructions for construction and use can be found in Appendix 2.

In addition to washing hands it is worthwhile to pay attention among others to food and water preservation. Water should not be transported nor conserved in open containers since e.g. insects and pathogens can easily reproduce in them. Water containers should be washed and if possible disinfected on regular bases. E.g. toilet and water containers handles easily accumulate pathogens and therefore should be cleaned regularly. Squat-hole cover can be opened even by foot so that no use of hands is needed. (Picture 5)



PICTURE 5
Squat-hole cover. [23]

Food should be preserved without contact to contaminated water and ground. Neither should it have contact with flies or pathogenic insects. Therefore attention needs to be focused on compactness on serving dish lids and doors of food storages as well as insect nets. Especially meat and milk product preservation needs to be taken notice in regions where cold storage is not an option.

A tourist can be infected by diarrhoea due to food, drink or bad hygiene conditions. A traveller should avoid certain food types that enhance the risk of receiving pathogenic bacteria and viruses that cause diarrhoea. [24]

Foods that should be avoided: [24]

- unbottled drinks and ice cubes
- unpacked milk, cream and ice cream
- cold or insufficiently cooked meat, fish, shellfish, and egg dishes
- mayonnaise based salads
- fruits and vegetables that are unwashed or washed with tap water.

Likely safe are: [24]

- bread and other dry grain products
- soups served hot
- freshly prepared hot meat and fish dishes
- vegetables served hot
- peeled (by oneself) good quality fruit
- hot beverages (tea and coffee etc.)
- bottled, preferably carbonated drinks.

Diarrhoea is treated by offering the patient great amounts of liquids such as soups, juices, clean water, watery porridge or oral rehydration salts (ORS). ORS are available both as liquid and as dosage bags which can be diluted to water or ORS can be made. [12, 25]

To make Oral rehydration salt (ORS) you need:

- Litre of clean water
- Half a teaspoon of salt and eight teaspoons of sugar
- If no sugar is available, it can be replaced by the same amount (8 teaspoons) of ground rice, corn, durra or boiled and mashed potato. In this case water (1 l), salt (0.5 teaspoon) and ground grain is boiled by 5-7 minutes until it reminds of watery porridge. This is fed to the patient when cooled in small quantities. [26]

Patient suffering from diarrhoea can eat and drink according to his/her wants. Especially easily digestible liquid rich foods such as potato and carrot mash as well as gruel are highly recommendable. If appetite is poor also fools, cereals, rusks, crackers and crisp bread are of good alternatives when available. Milk can irritate stomach and worsen the diarrhoea. Breast-feeding, diarrhoea patient is still breast fed, should be though carried out as before. Sour milk products and lactic acid bacteria can shorten the durance of diarrhoea. [25]

Long term diarrhoea can be dangerous especially to children and the elderly. Therefore it is necessary to begin rehydration treatment immediately after diarrhoea occurs. Medical treatment is recommendable if: [25]

- the child is under the age of six months
- the patient has not eaten or drunk anything and is clearly washed out
- the symptoms are exceptionally fierce and the overall condition has clearly weakened or has not improved in couple of days.
- intense stomach aches occur
- diarrhoea lasts over five days
- patient is diabetic with uncontrollable and unacceptable blood sugar levels.

Signs of dehydration are e.g. [26]

- extreme thirst and dried out lips
- sunken eye balls and tearless eyes
- sudden weight loss
- little or no urine or dark urine
- sagging of soft spot in infants.

Simple test is to lift patient's skin between two fingers. If the skin does not fall right back to normal the patient is dehydrated. In this case immediate rehydration needs to be started and medical treatment is needed is the condition of the patient does not improve

Cholera is not as common as diarrhoea, but the infection routes are alike. Approximately 140 000 people are infected whereof 5000 die to cholera every year. It is caused by Vibrio cholerae – bacteria. Cholera epidemics spread more widely than diarrhoea which usually occurs locally. Vaccinations, quarantines and travel bans do not prevent cholera from spreading. As high as 90 percent of all cholera cases are symptom less, but the carrier of the disease can still infect others. Similar to diarrhoeal cases also cholera causes dehydration. In most of the cases rehydration helps, excluding the most severe cases where antibiotics and intravenous (IV) treatment are needed. The most important measures in preventing cholera from spreading are similar to diarrhoeal cases. Adequate drinking water and food hygiene is the primary measure to prevent cholera. It is also recommended to avoid raw fish and seafood in areas where cholera is met. At times when the risk of cholera epidemic is high, gatherings of people should not be held. [10, 22, 27]

Typhoid fever spreads through similar routes with diarrhoea and cholera. The infection is caused by Salmonella typhi or Salmonella paratyphi -bacteria. Symptoms include fever, dysphoria, headache and diarrhoea. Typhoid fever can be prevented and treated with similar measures as in diarrhoeal cases. Vaccination is recommended only if staying longer periods in a region where typhoid fever is met for it does not give complete protection against typhoid fever. [22]

Hepatitis A is caused by RNA related picorna virus. It is transmitted through food and drink in contact with: contaminated water or soil, infected individual, or excreta contaminated water, and directly from one individual to another. Insufficient amounts of drinking water and poor sanitation and hygiene conditions increase the risk of infection. Hepatitis A causes fever, exhaustion, lack of appetite and jaundice. Symptoms may vary from mild to severe. Majority of the infected are children, who after a recovery from the disease gain immunity. [22]

The most important measures to prevent hepatitis A: [10, 22]

- improvement and increase of access to safe water and sanitation services
- using adequate toilet and paying attention on proper handling and disposal of excreta.
- promoting hygiene education
- vaccinating against hepatitis A
- washing hands (also children's hands) before touching food
- general improvement of living conditions.

Leptospirosis is caused by Leptospira spp. microbe. It is found all over the world and it is transmitted both to humans and animals. Humans are transmitted by direct contact with animal urine or urine contaminated water ground or plants. It can be transmitted through digestive system, skin lesions, eyes and mucous membrane. Leptospirosis causes high fever, intense headache, muscular pain, redness of eyes, stomach aches, jaundice, skin and mucous membrane bleeding, vomiting, diarrhoea and rash. There are no figures on the amounts of the infected for the disease is not reported and it is hard to diagnose. [22]

The most important measures to prevent leptospirosis: [22]

- vaccination of animals and restricting amounts of rodents
- use of protective clothing
- avoiding contact with infected animals
- avoiding contact to contaminated water (e.g. swimming)
- clean drinking water
- vaccination of group at risk.

Schistosomiasis is the second largest infectious disease caused by helminthes. It is caused by Schistosomas haematobius, S. japonicum or S. mansoni flatworm. The larva of the flatworm swimming in the wild pierces through skin and causes infection. All untreated and natural fresh water in the infected areas can be considered as a possible source of infection. Excreta of both infected humans and animals spread the helminth to water bodies. Approximately 600 million people, whereof ca 200 million is infected, live in the infected regions. About 120 million people, whereof ca 20 million has severe symptoms, suffer from the symptoms of the disease. Symptoms are blood in urine and solid excrement, expansion of spleen and liver and on some occasions and disturbances in central nervous system. If the infection is detected early on it can be treated with medication. [22, 27]

The most important measures to prevent schistosomiasis: [22, 27]

- restraining oneself on swimming and wading in fresh water
- avoiding contact with untreated water
- using appropriate footwear
- boiling, filtering or chlorine or iodine treatment of water
- improvement and increase of access to safe water and sanitation services
- using adequate toilet and paying attention on proper handling and disposal of excreta.
- promoting hygiene education
- general improvement of living conditions.

Ascariasis is one of the most common parasitic diseases in the developing countries, but the helminth is found all over the world. It is caused by Ascaris lumbricoides roundworm. It is transmitted through uncooked food in contact with contaminated ground (by roundworm eggs). Eggs spread through human excreta. Approximately 10 percent of the population in developing countries are infected by ascariasis and every year it causes death to ca 60 000 people (mostly children). Infection can cause stomach aches, coughing, breathing difficulties or fever. Infected individuals suffer from under nourishment, anaemia and slow down in growth. [22]

The most important measures to prevent parasitic infections: [22]

- avoiding contact to ground contaminated by human excreta
- washing up hands with soap before food preparation
- peeling, washing or cooking all raw vegetables
- avoiding food contact to ground, and reheating all food that is dropped to floor
- terminating direct watering of plant with waste waters (water needs to be treated e.g. primary sedimentation pools)
- improvement and increase of access to safe water and sanitation services
- using adequate toilet and paying attention on proper handling and disposal of excrement
- promoting hygiene education.

Hookworms (E.g. Ancylostoma duodenale and Necator americanus) are common intestinal parasites especially in the tropics. In warm and moist circumstances their eggs develop into larvae that can penetrate by piercing human skin (also through healthy skin) and move via blood circulation to lungs and thereafter to digestive system and small intestine. They attach to small intestine walls and start sucking blood and by doing so causing running sores to the intestines. Matured hookworm develops in the intestines and produces thousands of eggs that spread back to the ground by excretion. Mild infection caused by hookworms is often symptomless, but continuous infections can cause especially to children e.g. anaemia, stomach aches, diarrhoea and weight loss. Chronic infection can cause children e.g. disturbances in growth and due to lack of protein and iron slow down of mental development. Hookworms are extremely dangerous to small children. [28]

Infections from hookworms can be prevented by avoiding walking barefooted and contact to human excreta contaminated ground. Use of adequate toilets and proper hygiene are of great importance in defeating the disease. [28]

Giardia intestinalis (also known as Giardia lamblia) protozoa create very durable cyst forms, which can last in the excreta even several years. Protozoa is met worldwide. Giardia can be transmitted from ground, food or water, which has been in contact with infected individuals or animal's excreta. It spreads usually through mouth and not through blood. It can cause digestional problems such as diarrhoea, stomach aches and nausea. The symptoms can lead to weight loss or dehydration. Giardia can occur also as symptom less.

The most important measures to prevent giardiasis: [28]

- restraining oneself on swimming at least two weeks after diarrhoea to prevent pathogens spreading through water
- avoiding use of uncooked food and washing all raw vegetables with clean water
- boiling, filtering or chlorine/iodine treatment of water or use of clean drinking water
- improvement and increase of access to safe water and sanitation services
- using adequate toilet and paying attention on proper handling and disposal of excrement
- adequate hand hygiene and promotion of hygiene education.

Also **Cryptosporidium** protozoa create durable cyst forms, which can even have resistance to chlorine and iodine treatment. It spreads similar to giardia and infections are found all over the world. It has similar symptoms to giardia, but can also in addition cause fever and intense vomiting. Cryptosporidium infections can be prevented like giardiasis, but since chlorine and iodine treatments are not definite water needs to be boiled to terminate it. It can also spread from swimming pools, where chlorine usually eradicates other pathogens. [28]

Diseases spreading through inadequate hygiene and due to lack of water

Trachoma is an eye infection, which, if suffered from repetitious infections, can cause blindness. It is caused by bacterium Chlamydia trachomatis. It spreads easily from contact especially amongst children, or from child to mother. Also flies transmit the disease. The infection causes bilateral keratoconjunctivitis which causes corneal scarring resulting upper eye lid to turn inward, severe weakening of eyesight and blindness. According to WHO estimates there are over six million people blinded by trachoma and 150 million people who are in the need of treatment. It is one the biggest blindness causing diseases, which is curable. [22]

The most important measures to prevent and treat trachoma: [22]

- improvement and increase of access to safe water and sanitation services
- using adequate toilet and paying attention on proper handling and disposal of excrement.
- promoting hygiene education
- restricting reproduction of flies
- facial cleanliness
- antibiotic treatment
- surgery of eyelids.

Scabies is easily infective skin disease, which spreads in e.g. crowds. It is found worldwide. It is caused by Sarcoptes scabei mite. Fertilized female mite penetrates into the skin, depositing eggs in the tunnel behind her. After the eggs are hatched, larvae migrate to the skin surface and eventually transform into the adult form mites and mate. Actual scabies is an allergic reaction to mites. Scabies can occur on hands, between the fingers, folds of the skin, penis, breasts and shoulders. Annually over 300 million scabies cases are reported. Even though scabies can be found everywhere and in all social classes its appearance is enhanced by poverty, inadequate water supply and sanitation conditions and high population density. The mite is easily spread in crowding conditions by skin contact such as in hospitals and day care centres. It spreads to some extent through bed linen and clothes and extremely well in sexual intercourse. [22]

The most important measures to prevent scabies: [22]

- adequate personal hygiene
- improvement and increase of access to safe water and sanitation services
- washing up with hot water and soap and thereafter with acaricide mite wash
- disinfection and wash of contaminated (by mites) clothes and bed linen.

Mosquito-borne diseases

Malaria is the most common infectious disease caused by parasites. It is caused by Plasmodium falciparum, P. vivax, P. ovale and P. malariae parasites and it spreads by carrier Anopheles –mosquitoes, which reproduce in standing fresh and brackish waters which can be as small as wet plastic bags or tyres. Mosquitoes are usually active (bite) at dusks and evenings. Malaria causes fever, repetitive chills, intense sweating, headache, muscular pains, tiredness, nausea, vomiting, heavy diarrhoea, anaemia and yellowish skin, but also in more severe cases seizures, coma, severe anaemia and renal failure. Without appropriate treatment malaria can spread to brains and cause death. According to WHO's estimates

there are 300- 500 million malaria infections and over one million deaths caused by malaria every year. Malaria is one of the major causes of death amongst African children under the age of five. [22, 27]

The most important measures to prevent malaria: [22, 27]

- avoiding moving outside without proper clothing especially during sunrise and sunset
- dressing in light long sleeved and legged clothing during sunrise and sunsets
- using N,N-diethyl-meta-toluamide (DEET) consisting mosquito repellent on uncovered areas of skin
- using prophylactic medication
- eradicating mosquitoes with mosquito repellent from sleeping facilities before going to bed
- promoting and using of insecticide treated bed nets
- ensuring early detection and control of malaria epidemics
- reducing mortality by early detection and prompt treatment of malaria cases with effective anti-malaria drugs
- filling up or drying reproducing water sites of mosquitoes as a part of a broad environmental programme.

Dengue fever and dengue haemorrhagic fever (DHF) has become one of the most severe infectious diseases carried by mosquitoes. Infection is caused by arbo virus, which spreads through Aedes
mosquitoes also at daytime. Dengue fever causes fever, headache, muscle pain, pain behind the eyes, muscle and joint pains and rash. Dengue haemorrhagic fever causes high fever, bleeding, enlargement of liver and in the most severe cases disturbances in blood circulation and death. It is estimated that there are 50-100 million dengue infections and 500 000 dengue haemorrhagic fever cases annually. There is no vaccination or prophylactic medication against dengue fever. [22, 27]

The most important measures to prevent dengue fever infections are mainly similar to malaria's, but protection from mosquito bites is also needed during the daytime and there are no prophylactic medication. [22, 27]

3. SANITATION SOLUTIONS

There are several technical solutions and variations for treatment of human urine and solid excrement depending on the existing culture and building possibilities. Most of these solutions, when properly planned, built, used and maintained, ensure safe and adequate sanitation and provide significant health benefits. In order to attain all health benefits mere technical solutions are not enough, but sanitation and hygiene education is also needed. [20]

In order to enhance human health with latrines, following issues should be taken into account: [20]

- user of the latrine should be isolated from (their) excreta
- prevention of community exposure to excreta through e.g. contaminated water
- prevent possibility of flies and other harmful animals to be in contact with excreta and prevent transmission of pathogens to humans
- excreta must be covered and/or pathogens made harmless.

Human excreta (mainly solid excrement) contains pathogens. Many diseases can spread through excreta, if treatment has not been handled adequately and safe. Diseases such as diarrhoea, cholera and typhoid fever spread easily from excreta to hands and thereafter to mouth causing infection. Adequate excreta handling methods (collection, storing, and treatment procedure) enhance human health. Therefore sanitation programmes can be of great importance in providing good human health. [29]

If excreta handling is not carried out properly there remains a risk of pathogens spreading to surface waters along the rainwater. In a case of prolonged inadequate excreta handling groundwater contamination may also appear. Excreta attract flies, rats and other harmful animals, which can further spread diseases and worsen the health conditions of humans. [29]

3.1. Selecting the sanitation solution

Minimum requirements can be set to the amount and the quality of latrines according to conditions: immediate solutions (emergency solutions e.g. in cases of natural disasters and wars), short-term solutions or long-term solutions (Table 3).

Table 3 The minimum requirements of the quality and amount of latrines. [23]

	Immediate/ Emergency solutions	**Short-term solutions**	**Long-term solutions**
Quality	Technically simple solutions, barely socially and culturally acceptable, basic health protection measures against diseases, technology sustainable for one month.	Technically appropriate solutions, socially and culturally acceptable, minimal health hazards, technology sustainable for six months.	Technically very appropriate solutions, socially and culturally very acceptable, no health hazards, technology sustainable for three years.
Quantity	1 latrine/100 users , schools 1/50 girl and 1/100 boy, hospitals 1/50 patients, maximum walking distance: 70 m/one way	1 latrine/50 users , schools 1/30 girl and 1/60 boy, hospitals 1/20 patients, maximum walking distance: 50 m/one way	1 latrine/20 users , schools 1/15 girl and 1/30 boy, hospitals 1/10 patients, maximum walking distance: 25 m/one way
Usage	At least 50 percent of population have access to domestic facilities on regular basis.	At least 75 percent of population have access to domestic facilities on regular basis.	At least 95 percent of population have access to domestic facilities on regular basis.

Immediate solutions need to be mobilized to affected area usually very rapidly. Therefore the technical solutions need to be basic, easily built, used, and maintained. In this case social and cultural factors connected to usage of the latrines (e.g. religion, differences between sexes, need of privacy) cannot be considered thoroughly. Health protection measures can neither be as good as in long-term solutions, but even they are better than operating without latrines [23].

Sanitation solutions can be divided according waste treatment type to on-site sanitation (the excreta in treated on the site) and off-site sanitation (the excreta is treated elsewhere). In the developed countries traditional waste treatment type is off-site sanitation. For the users it is easy and safe to use, for the excreta is treated elsewhere. It does not necessitate much space and it can be utilized very well in high density populated areas. For the needed building and maintenance costs as well as due to large quantities of water it necessitates traditional water latrine culture is not the solution for problems in developing countries. Therefore it is only possible to utilize on-site solutions or small scale off-site solutions where the waste water treatment is carried out village specifically. [30]

There are many factors contributing to selection of sanitation solution. In making the selection it is important to map cultural, technical, social and economical factors. Sanitation methods should be chosen to motivate users for usage and maintenance of the facilities. To meet the needs of users, participation from the users' side in sanitation planning is very important. Sanitation solutions dictated by outsiders are usually not long-lasting and in the long run inappropriate solutions culturally will not be used by the local population. [29]

Examples on which information should be considered in planning sanitation solutions:

- background information on users e.g. population profile, age and gender distribution, cultural background
- availability of water and wish to use it on sanitation (culture/ religion)
- availability of sewerage system; is waste water treatment organized; routes and waste water pools of possible sewerage systems
- ground analysis (soil type, hardness, permeability); is it hard to dig the ground; availability of digging workers and equipment; is there a need for supporting structure for pits (e.g. sandy soils)
- deepness of ground water and bedrock
- closeness to wells and/ or surface water sources, water storages and water supply sites
- climate; are there a lot of rains in the area and occurrence of extensive surface water runoffs
- the quality and distances to existing sanitation facilities, other sites for excretion
- refuse tips for solid wastes
- availability of economical resources for improvement of sanitation, who is reliable for building and maintenance, are there regulations on sanitation, if yes, what kind
- availability of knowledge to build latrines and improve hygiene
- culture of handling latrine waste
- is latrine waste experienced as dangerous or in other ways hard to handle
- possibilities to separation and usage of urine
- soil type of cultivated land; availability of artificial fertilizers
- way of defecation (squat, sitting); usage of separate urinal; availability of separative seat and possibilities to manufacture seats locally.

Population distribution and its' possible changes are important to define to be able to quantify needed facilities. In addition, population profiles such as age and gender distribution has to be clarified since needs of the different groups vary. Physical characteristics of the region such as climate, soil types, ground water, existing water and sanitation sites should be documented accurately and marked into maps to identify all significant features considering the project. [23]

Soil quality can be one of the most influencing characters in the region's sanitation projects. Hardness of the ground can prevent or considerably complicate digging by hand, where sandy soils can give way when dug. Clayey ground can prevent totally or hinder significantly permeability of the soil.

Closeness of groundwater is also one of the considerable factors. In areas where groundwater is close to the surface of the ground traditional pit latrines cannot be used. Also seasonal changes in the surface level of groundwater should be taken into account. It is also necessary to pay attention to locations of water sources in relation to latrines. (Chapter 3.3)

Climate has influence especially on the amounts of rains and runoffs as well as on treatment and utilisation of latrine wastes. Condition and utilization of existing sanitation sites should be thoroughly surveyed before building new latrines in the area. Economical factors and especially the know-how of the local people influence on the actual construction work. [23]

Handling of the latrine waste and other cultural background information should be clarified properly to be able to choose the right sanitation solutions for the prevailing culture. Through education it is possible to try to affect the culture, but it needs to be noticed that usually the changes happen slowly and gradually.

It should also be found out if there are other organisations working in the same region and establish contacts with the key persons. By doing so, gathering and sharing of the existing information is enabled, overlapping is avoided and unnecessary tension is decreased between the organizations. [23]

Influencing factors and usability of latrine types are presented as flowcharts in Figure 3. The model is suggestive and it needs to be noticed that the selection of latrine type and structural solutions has to be made case-specifically considering surrounding conditions, cultural and other aspects. Pros and cons of different latrine types are presented in figure 3 and table 4, which can be of help in selection the right solution for the area.

FIGURE 3 Factors influencing on selection of latrine type.

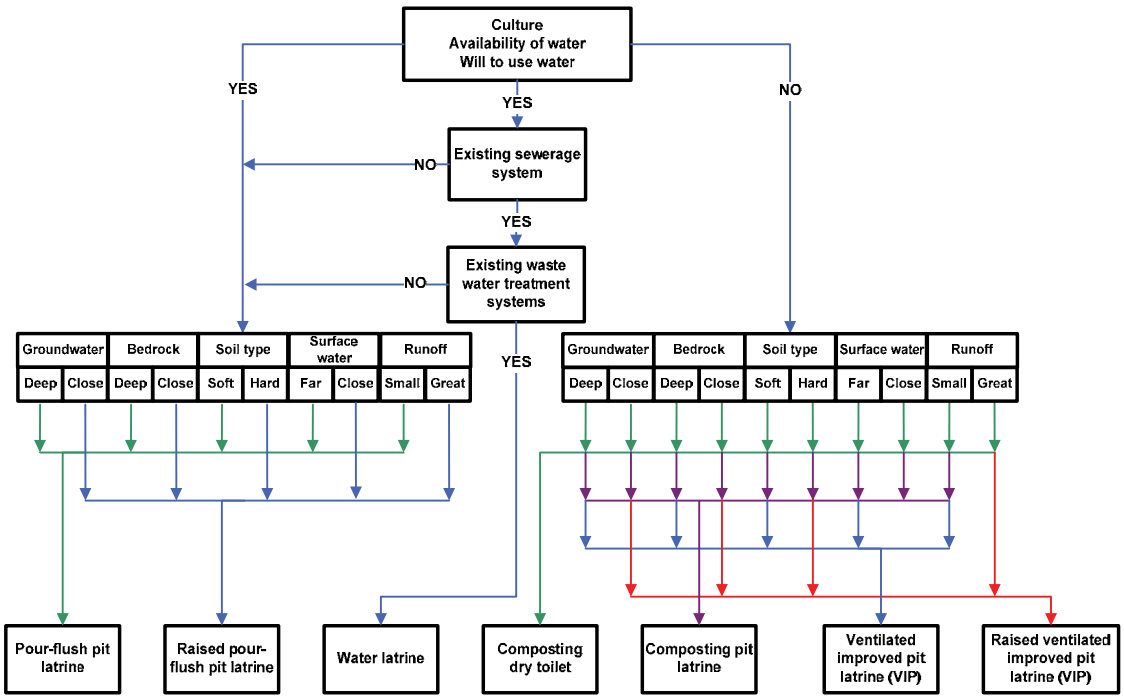


Table 4 Pros and cons of different sanitation solutions. [30]

Sanitation methods	Need of water	Pros	Cons
On-site -methods			
Pit latrine	no	Cheap, easy to build, does not demand much expertise	Noticeable fly and odour problems, hygiene and health problems, nutrient and pathogen runoffs to ground and groundwater
Ventilated improved pit latrine (VIP)	No	Decrease of fly and odour problems, cheaper to build than water latrines, does not demand much expertise	Higher costs than simple pit latrines, location must be selected carefully, gloom may disturb usage, nutrient and pathogen runoffs to ground and groundwater
Pour-flush latrine	Little	Can be utilized in cultures where water is needed for toiletry washing purposes, minor fly and odour problem	Higher costs than in the above-mentioned, need of water for utilization, cannot be utilized if large materials are used for wiping purposes, nutrient and pathogen runoffs to ground and groundwater
Composting latrine	No	Soil enrichment material and fertiliser is produced, can be used in areas where groundwater is close to ground surface or it is hard to dig a pit, minor runoffs	Latrine waste needs to be added litter, waste treatment requires time and education, prejudices in handling latrine waste may emerge due to cultural and other factors
Composting dry latrine with urine separation	No	Soil enrichment material and fertiliser is gotten, also urine can be used separately as a fertiliser, can be used in areas where groundwater is close to ground surface or it is hard to dig a pit, minor runoffs, latrine does not have odour	Latrine waste needs to be added litter, waste treatment requires time and education, prejudices in handling latrine waste and urine may emerge due to cultural and other factors, handling and storage of urine require space
Septic tanks	Yes, big	Easy to use, no fly or odour problem	Expensive, requires water pipe and lot of space, requires regular sludge removal and treatment, soil type must be permeable, nutrient and pathogen runoffs to ground and groundwater
Off-site- methods			
Village specific sewerage system (small scale)	Yes, to some extent	Easy to use, can be maintained village specifically, sewerage does not require much space, costs decrease in densely populated areas, cheaper than large scale sewerage system	Requires solid containers and regular emptying, requires space for centralised, necessitates reasonable amount of users for sewerage operation, requires waste water treatment, directing untreated waters to water bodies is health and hygiene risk
Water latrines and sewerage system	Yes, big	Easy to use, no fly or odour problem, Waste is transported easily.	Very expensive to construct and maintain, requires a lot of water and know-how, leaks are common, needs a waste water treatment facilities, directing untreated waters to water bodies is health and hygiene risk.

3.2. Specification of different latrine types

Composting latrines

Various types of composting latrines can be found around the world. Common feature of them is that latrine waste and sometimes also organic food is composted and the end product can be used as fertilizer and soil enrichment material. Dry litter (bulking material) e.g. ground, grass, leaves, sawdust needs to be added (to excrement) after every usage. This speeds up decomposing process and prevents odour problems. Decomposing process is discussed in Chapter 3.6. The models vary between simple composting pit latrines to urine separating dry latrines. Depending on the existing toilet culture (E.g. defecation sitting or squatting) and availability of local raw materials different types of interior solutions can be made. It is very important to educate users to safe and efficient maintenance of the latrine to ensure human health and effective decomposing process. [26, 29]

Composting pit latrines

In the most simple composting pit latrine models a pit with depth of ca one meter is dug and a lid (e.g. concrete) is constructed. The pit needs to be low enough to prevent water entering the pit and leaching to ground waters. Composting latrine can also be built above the ground surface on top of a small hill. [26, 29]

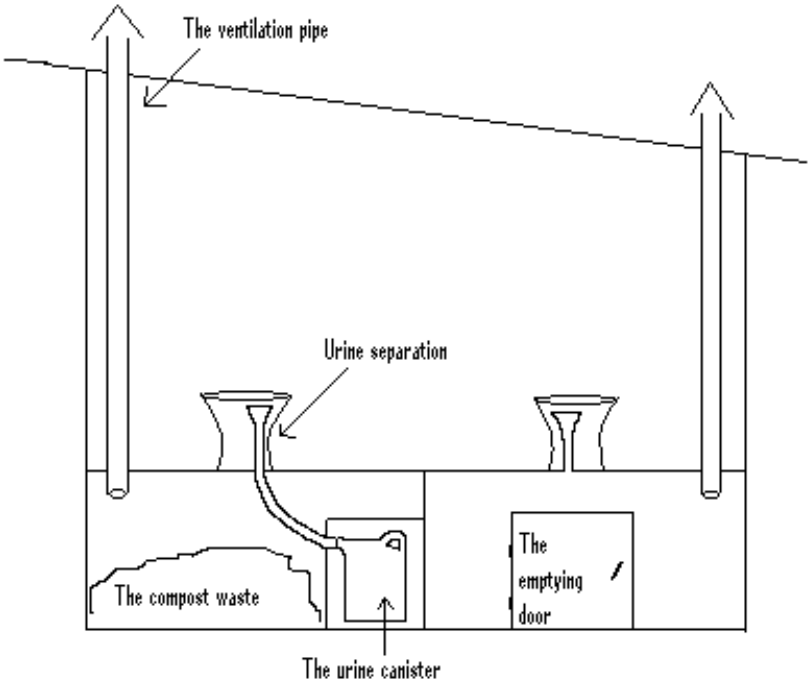
The simplest way is to construct a light protection from e.g. grass or bamboo around the pit that can be moved after the pit is full. Filled pit is then covered with ca 30 cm of ground and left to decompose. The decomposed material can be dug up after approximately one year and utilised as fertiliser. Thereafter the pit can be used again. Latrines can also be constructed with two pits. A couple of months after the pits have filled nutrients can be utilised for example by planting fruit trees or tomato saplings on top of the pits. (Picture 6) [26]

PICTURE 6 Fruit trees are planted to pits after they have filled with excreta and the latrine (structure) is moved to new pit location. [26]

Composting dry latrines (or dry toilet, DT)

Dry latrines are built on top of the ground and therefore can be utilised in regions where ground waters are close to surface or where there are runoffs to surface water. Dry latrines are also useful when the ground is hard or in other ways difficult to dig. Unlike to pit latrine dry latrine has the advantage functioning always on the same location, close to the user. Efficient and safe use of composting dry latrine requires education for the users and commitment in latrine waste handling and utilisation for soil enrichment material. [26, 29]

In Picture 7 a model of dry latrine is presented. A base is constructed out of concrete bricks or other water proof material. Construction of two chambers is recommended to let the waste to decompose at least for a year while the other chamber is used. If urine is separated, separative toilet bowls or benches in sitting models (can be built from local materials) or jugs and buckets in squat models can be used. Latrine can also be equipped with a separate urinal for men. Separately collected urine can be used as fertilizer. Use of urine is presented in Chapter 3.6. [26]



PICTURE 7 Composting dry latrine with two chambers (vaults). [57]

A hole for vent pipe to upper part and small doors for emptying purposes on the lower part are made to the chambers. The emptying of the chamber is carried out from the rear of the latrine through the small doors. The latrine is built of available local raw materials if possible. The best colouring to the insides of the latrine is blue since it does no attract flies. [26, 32]

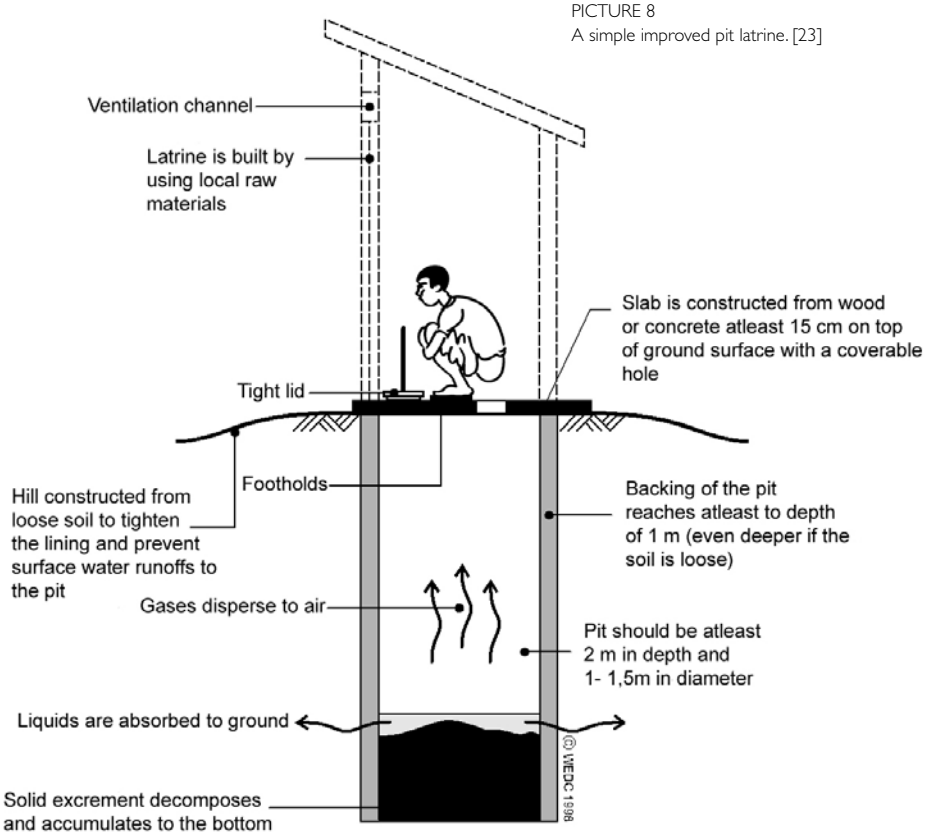
Table 5 Instructions for use of dry latrine.

Add dry matter after each usage. Make sure no water gets in the toilet chamber if the contents of the toilet get wet, add more dry matter.	It is best to let the faeces decompose for a full year before emptying the chamber. Check the level of decomposition and further compost when needed.
If the toilet smells bad or flies are entering the latrine, add more dry matter, and make sure the vent pipe is clear .	Do not put garbage to the waste (E.g. diapers, sanitary pads or other plastics).
If the pile builds up too high, use a stick or manure fork to push it back down.	Clean the latrine on regular basis and make sure that everything is functioning.
Keep small water container in the latrine for urine separation hole and urinal flushing.	Remember to use gloves and shoes and wash your hands when handling latrine waste.
When the urine pot is full, empty it and make fertilizer (instructions chapter 3.6).	Keep instructions for use of latrine for everyone to see e.g. on the latrine wall.
When the first chamber is full, use the other chamber. Be sure to cover the first chamber and it's content properly.	Provide a place for washing hands.

Pit latrines

A pit dug to ground remains as one of the most simple and used latrine type in the world until today. There are tens of different types of pit latrine solutions from a very simple to a rather developed model. Picture 8 demonstrates a model of a pit latrine. [29, 31]

PICTURE 8
A simple improved pit latrine. [23]



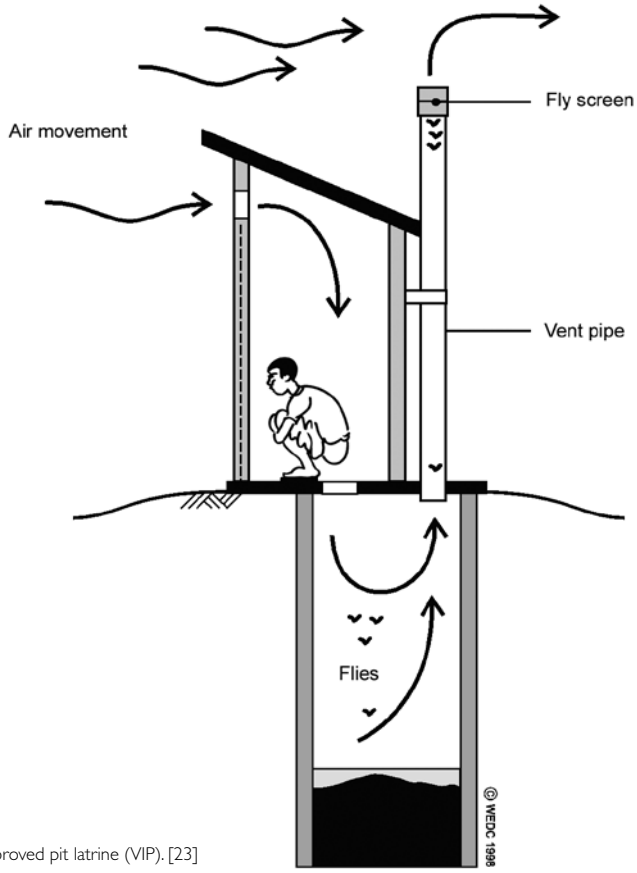
At least two meters deep and ca 1 meter in diameter pit is dug for the construction of pit latrine. A lid is constructed from concrete or local materials e.g. from wood. A hole is made to the lid, where both solid excrement and urine drops to the pit. The pit is used until it fills where after a new pit is dug.

Ventilated Improved Pit latrine (VIP)

Usually two to three meters deep and ca 1 meter in diameter pit is dug and covered with a for the construction of ventilated pit latrine concrete lid (Picture 9). A hole (ca 20x30 cm) is made to the lid, where both solid excrement and urine drops to the pit. To prevent pathogens leaking to groundwater from excreta the pit should be constructed at least two meters above groundwater surface. If the ground is hard or ground water is close to the surface, the pit can be constructed on a hill (raised VIP). [29]

There is a hole in the concrete lid for vent pipe, which prevents the odour and fly problems. Air circulates through drop hole to pit and thereafter through vent pipe to outdoors, which keeps the latrine odourless. Vent pipe diameter should be at least 100mm and the top of the pipe half a meter above the roof to ensure proper air movement. [29]

On the top end of the vent pipe is fly screen that prevents flies to enter the latrine. Latrine should be dim (recommended colour e.g. dark blue) to direct the entered flies (from drop hole) towards the light of the vent pipe. Fly screen prevent flies to exit and they will die eventually. [29]



PICTURE 9
Ventilated improved pit latrine (VIP). [23]

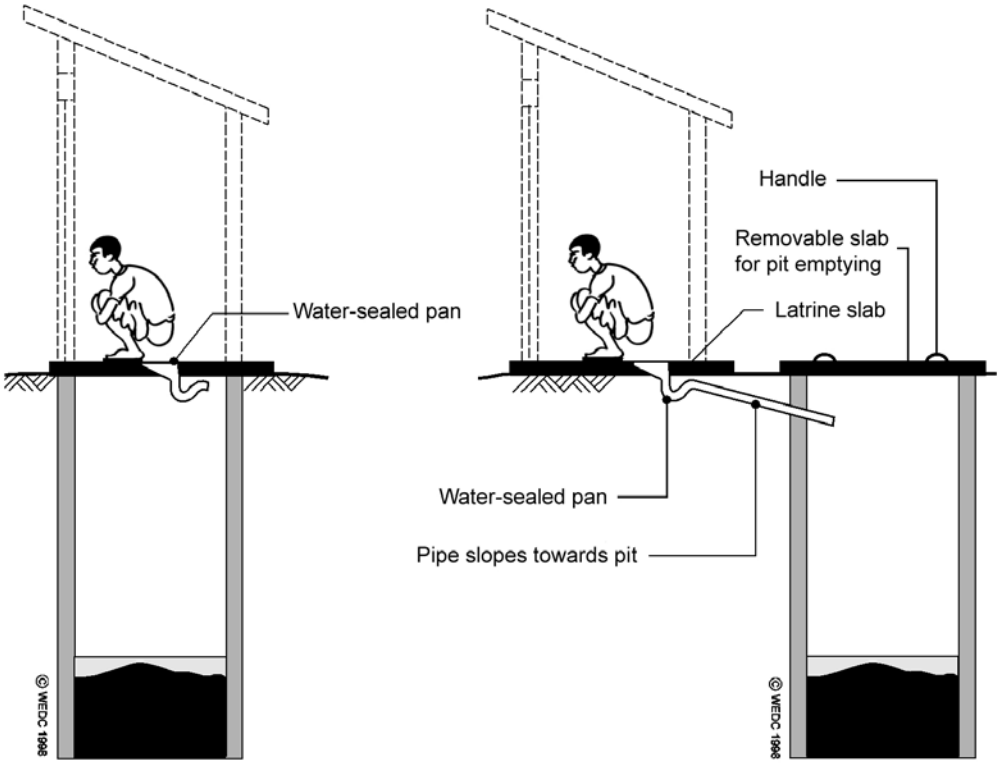
If the ground water is in depth and there are no water sources nearby that are in contamination risk due to rainy season runoffs ventilated improved pit latrine can be used. Problems in utilisation of VIP can be caused by flies and diseases spreading through flies. Therefore it is important to pay attention to the colouring of the latrine and remember to close the lid when latrine is not used. To prevent odour and fly problems the condition of vent pipe and fly screen should be checked on regular basis. In terms of hygiene it is important to pay attention to cleanliness of the latrine daily. [26]

Pour-flush latrine

The structure of pour-flush latrine (Picture 10) correspond in principle ventilated improved pit latrine. In pour-flush latrine there is a U-formed water seal, which prevents flies to enter and odours to form. The latrine is flushed with a

couple of litres of water after every use. Pour-flush latrine can be used when water is needed for cleaning purposes, enough water is available, ground is permeable and climate does not alter water seal to freeze. [29]

If only one pit is used in the latrine, it can be utilised until the pit is full. Thereafter a new pit has to be dug or empty the pit before usage can continue. Latrine can be constructed initially with two pits, when the excreta can be directed to the second pit with the help of a valve after the first pit is full. Then the excreta left in the first pit can be covered and left to decompose while the second pit fills. [26] However, in the pour-flush pit latrines the decomposing process is usually incomplete and thus pathogens can still be found from the latrine waste. If the latrine waste is planned to use as fertilizer it should be further composted to ensure safe use of the end product.



PICTURE 10
Pour-flush latrine, two models, where the latter can be constructed as two pit latrine. [23]

3.3. Location of the latrine

Selecting location for latrine is very important in terms of usage. Following factors can influence the selection of location:

- human influence on the region e.g. housing distribution and density, shared areas, industry, roads and institutions
- amount of users and their distribution in the area
- population centralisation and population growth areas
- geomorphology of the area e.g. mountains, forests, vegetation, swamps, and water resources
- if latrine is wanted inside or outside
- ground factors; is it hard to dig; is the soil type permeable
- how deep is the surface of ground water
- how deep is bedrock
- are there wells and/or surface water sources nearby
- quality and distance to existing sanitation facilities, other defecation sites
- refuse tips of solid wastes
- places for disposal
- how latrine waste is utilised.

Latrine can be built inside the house, outside connected to the house, on the yard, further from the house or in lack of space on the roof. For the utilization purposes it is important to determine the location from the house beforehand. Too long distance to latrine makes the utilisation inconvenient, especially for the diseased persons. If the latrine on the other hand is located too close to the house possible health, fly and odour problems can increase. [29, 34]

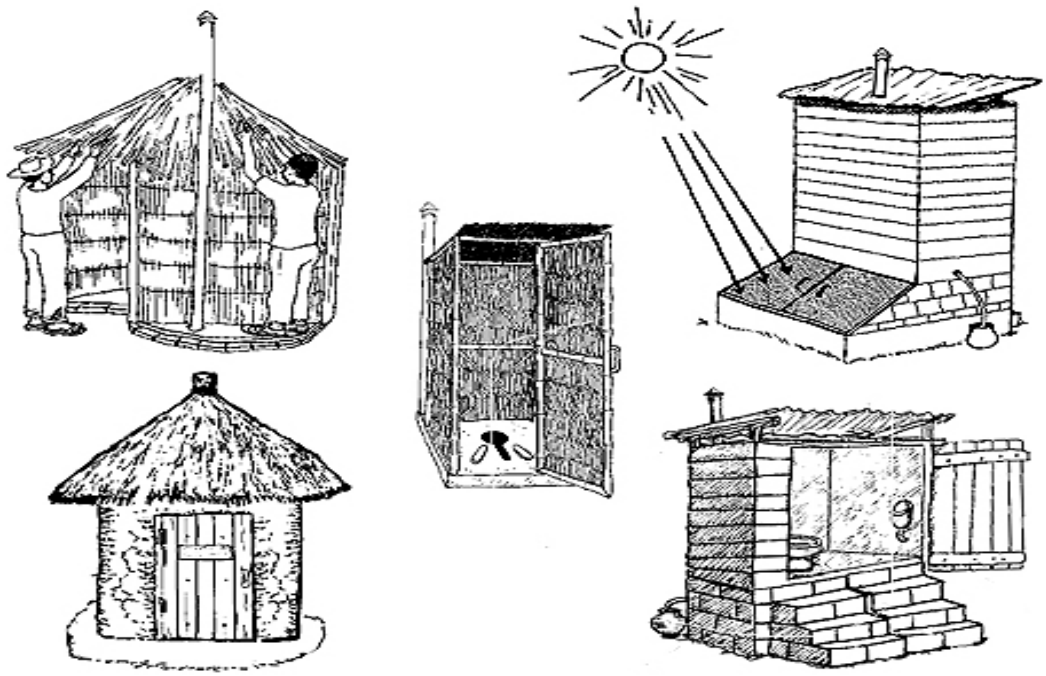
Especially when constructing pit latrine, location of the pit should be determined keeping in mind e.g. location of bedrock and ground water and the structure of the soil. The bottom of the pit should locate at least preferably even two meters higher than surface of ground water at its peak. A special attention in selecting the location for the pit is needed in regions where cracks in bedrock or limestone are found. Pathogens spread easily though cracks to ground water. [29]

Latrines should be located at least 30 meters from wells, rivers and lakes and it should not be located in region upper to water source, where runoff waters can carry pathogens to water sources. If latrines though have to be built in proximity (e.g. lack of space) to water sources, they can be located 10 to 15 meters below the water source. [29]

The structure of soil type influences essentially to construction of pit. If the soil is loose, the pit should be lined with bricks or masoned. If water is used for flushing and closeness of ground water is not in issue holes can be left between bricks to enable leaching of liquids to ground. [29]

When selecting location for latrine, environment and existing building stock should be considered. In preventing odours and flies direction and strength of wind are essential factors (E.g. effects of tree stands and buildings to wind) and therefore should be considered. [29]

A protection or a building that can be made of local raw materials, surrounding the latrine should be made. Selection of materials depends on the local know-how, availability of money and soil type. Protection can be made from e.g. bricks, concrete, wood, branches, grass, stones etc. Examples of structural solutions are given in Picture 11. [31]



PICTURE 11 Different structures of latrines. [26]

3.4. Costs of different sanitation solutions

The costs of sanitation solutions increase in proportion to advance/complicity in techniques. Usually construction costs are less in rural areas because simple solutions can be applied instead of sewerage and water treatment systems. Table 6 demonstrates estimated costs for different sanitation solutions implementation. Figures include, in addition to construction costs, variable costs (15 percent) and utilisation and maintenance costs. [33]

Table 6 Estimated costs of sanitation solutions [33]

Sanitation solution	Cost/per person USD
Purification of waste water and after treatment of water	800
Sewerage system and waste water treatment	450
Joining to sewerage system	300
Joining to sewerage system (use of local labour)	175
Water latrine connected to septic tank	160
Pour-flush pit latrine	70
VIP	65
Simple pit latrine	45
Improved local practice	10

3.5. Maintenance of latrines

Different latrine types have different tending and maintenance instructions according to utilisation and possible waste handling of the latrine. Importance of cleanliness is though a common factor for all latrine types. No one wants to use a dirty latrine and furthermore it attracts flies and other harmful animals to enter the latrine. Therefore latrine needs to be clean on daily basis. Floor and defecation hole can be either brushed or washed clean with a broom specifically meant for this purpose only. In dry latrines it is important to prevent too great of amounts of water entering the pit. Floor of the latrine can also be brushed with ash, which has a disinfecting affect.

Fly screen should be checked every month and if holes appear changed immediately. Spider webs and dead flies are rinsed off by pouring a few litres of water through vent pipe. Condition of latrine facilities is to be checked on regular basis and possible problems fixed immediately. If the latrine facilities do not function properly and fixing problems is postponed, possible hygiene problems increase remarkably. [26, 29, 35]

It is very important for parents to teach their offspring adequate utilization and maintenance of cleanliness of latrines. A special attention is to be paid on hand hygiene. Possibility to wash hands after use should be organised.

One or two responsible attendants have to be chosen for securing tending and maintenance of public latrines.

3.6. Utilisation of latrine waste

Many factors influence utilisation of urine and solid excrement. Local climate conditions create basis on which latrine waste treatment methods can be utilised successfully. There are differences in cultures on how the handling of latrine waste is experienced and approved. In some cultures latrine waste has been utilized for years (e.g. China and rural and peri-urban areas in Europe up to 1950s) and in others even discussing about possible utilization can be inappropriate. Along with the previously mentioned factors e.g. people's know-how, economical factors, health issues and legislation have an effect on the utilization of latrine waste. [37].

Annual amount of urine and solid excrement of one person consist equal amount of nutrients than what is needed to grow grain for one person's annual food requirements.

Table 7 The nutrient amounts of solid excrement and urine (person/year) of western diet. [36]

The most important nutrients	Urine (500 l)	Solid excrement (50 l)	Total	Nutrients acquired to produce 250 kg of grain
Nitrogen (N)	5,6 kg	0,09 kg	5,7 kg	5,6 kg
Phosphorus(P)	0,4 kg	0,19 kg	0,6 kg	0,7 kg
Potassium (K)	1,0 kg	0,17 kg	1,2 kg	1,2 kg
Total	7,0 kg	0,45 kg	7,5 kg	7,5 kg

Urine contains most of the nutrients (Table 7 and Figure 4) and is normally bacteria less. It has to be though noticed that e.g. cystitis, typhoid fever, schistosomiasis or leptospirosis diseased can have pathogens in urine. Following micro-organisms have been found in urine: Leptospira interrogans, Mycobacterium tuberculosis, Salmonella typhi, Salmonella paratyphi and Schistosoma haematobium. If microorganisms are found from urine they usually die rather quickly and do not pose any threat to further utilisation of urine if it is applied into the soil. Withdrawal periods should be followed especially if it is known that diseased people have utilised the latrine. Usually the problem is not urine itself but solid excrement that has accidentally mixed with urine. [36, 37, 54, 55]

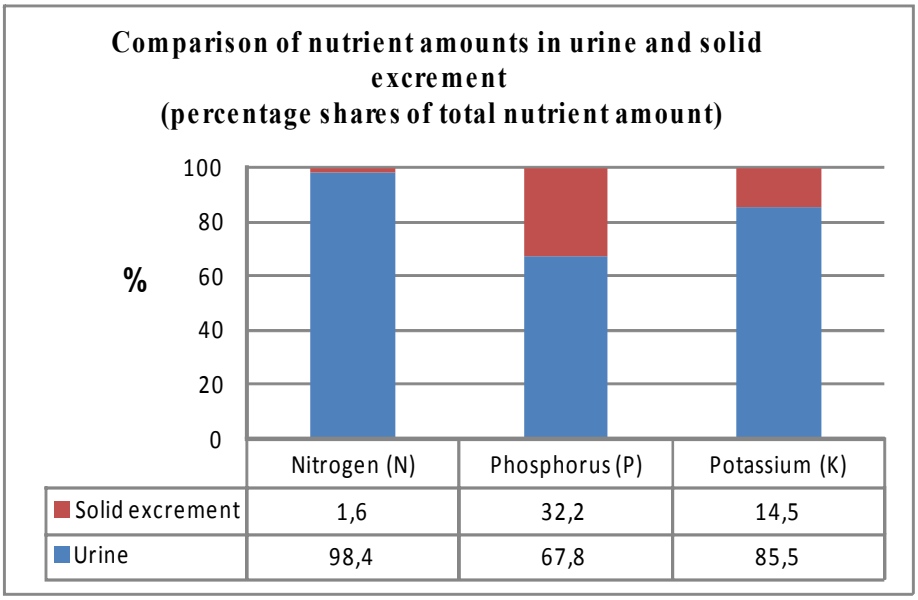


FIGURE 4
Comparison of nutrient amounts in urine and solid excrement.

The composition of solid excrement depends greatly on quality of the nutrition. It consists mainly of indigestible vegetable fibres and decomposing bacteria. Also many kinds of viruses and worm eggs may be found. A gramme of fresh excrement contains ca 100 million bacteria where among the most common are Escheria coli and faecal streptococci (Streptococcus faecalis etc.), Shigella-, Salmonella-, Clostridium- and Campylo-species and especially in the developing countries Vibrio cholera (causes cholera). In addition e.g. protozoa and helminths can spread through excreta. [36, 37]

Majority of bacteria are intolerable to oxygen, which means that they either die or stop producing when coming in contact with oxygen. Some of them may on the other hand form durable rest forms that can, in right conditions, cause an infection. If bacteria are spread to ground and water bodies, they can from there transmit to humans. From the protozoa and helminthes especially Giardia, Ascaris and Tania form extremely durable forms that can stay in the excreta for very long periods of time, even years without disinfection e.g. with wood ash. [37, 38]

Composting and the use of end product as fertiliser

Composting is a biological process where microbe community (containing many species) decomposes organic material in humid, aerobic and warm enough conditions. In addition to mould (soil containing 20-40% organic material) water vapour, inorganic salts, carbon dioxide (CO_2) and nutrient rich liquid forms in the process. A lot of heat energy is also formed, which (temperature rise) in a functional process is of essential character. In composting process the waste compacts and dries in the process remarkably so that the volume of compost mould is ca 10-20 percent of original volume. [38]

By composting latrine waste the nutrients it contains return back to nature's cycle. Utilisation of these nutrients is of significant financial benefit especially to people in developing countries who cannot afford to buy artificial fertilizers. Composted latrine waste can be utilised as soil enrichment material e.g. for planting trees and by doing so decrease increasing erosion in arid areas.

Composting latrine waste works the same way as composting other organic matter. Bacteria and fungi are the most important decomposers of latrine waste. Also protozoa, worms and arthropods work as decomposers. Oxygen is needed all around the mass, because it is necessary for the work of microbes. Mixing material and turning the compost ensure

needed lightness. Required moisture is 50-70 percent of the fresh weight. When waste is compressed no liquid should drip. Moisture can be controlled by drying, adding dry litter (bulking material), ventilation and precipitation. Temperature has great importance in the speed of the composting process. Optimal temperature is + 45–55 ^{0}C. [36]

Composting can be carried out in cold or hot composting equipment. Cold composting or cold decomposition takes place slowly under the temperature of 37 ^{0}C. In most of the latrines with no waste waters decomposing takes place in this way. [39]

In hot composting thermophilic micro organisms destroy all pathogens. The temperature should rise up to 55–60 ^{0}C for a couple of days to inactivate all pathogens. Mould formed with this method is in principle safe also for food production. In small scale compost facilities thermophilic temperatures are difficult to achieve, which needs to be taken into consideration in the utilisation of latrine waste. Absolutely safe hygienic product cannot be achieved only by composting. Composting is though best biological waste treatment method in terms of hygiene and it is easy apply to conditions where financially there are no possibilities to use other methods. [37, 38, 40, 41]

A good carbon - nitrogen ratio for composting of latrine waste is between 1:20 and 35:1. Ratio for carbon- nitrogen is 5:1 in human excrement. To balance the ratio carbonic mixing material e.g. kitchen waste, woodchip or leaf litter or pure soil if nothing else is available must be added. Carbonic material binds also excess moisture and therefore compost stays light. [36, 40]

Three stages can be defined in composting: [42]

- Active composting: the compost or latrine is being filled with food and/or latrine waste
- Resting stage: compost is not being added new waste but it is let once turned to decompose in the container covered with dry litter.
- Further composting: the compost is let to develop and mature outside in a stack or in composting equipment protected from the rain.

The emptying of the latrine should take place after the waste has been decomposing for at least a year when no further composting is needed. Fresh waste should not be then mixed with the old waste. If emptying takes place more than once a year can the not fully decomposed waste be after composted for 6-10 months. Further composting and curing can be carried out in stacks or in separate composting equipment. Curing is recommended if there are doubts of pathogen survival in the latrine waste. Completed compost is dark, relatively dry, light and smells like soil. Even though no pathogens are assumed to be in the compost it should be handled carefully (e.g. use of gloves, washing hands and two months withdrawal period between spreading the compost and harvest). Children should be kept away from composting sites, because pathogens in the compost can spread easily through their (children's) hands and clothes to others. [37, 38]

The quickness of latrine waste composting process varies due to different conditions. E.g. in cold and dry conditions of mountainous regions composting process takes much more time than in hot and moist circumstances. Especially climatic conditions affect greatly on the survival of pathogens in the compost. Therefore when composting is started information sources of compost process functionality in the area should be looked for. If there is no previous information available, small scale composting experiments can be carried out before starting large-scale composting functions. In this case effectiveness of different dry litter materials to the end product can be experimented. Possible pathogens should be determined in both from the compost and the plants that have been fertilised with compost soil. This way information of possible pathogen transfer from compost soil to plants can be gathered. When the experiment is made it needs to be noticed that the results cannot be directly applied to coming composts for amounts of pathogens can vary greatly depending on the initial condition.

Compost soil can be utilised for fertiliser, soil enrichment and filling material. It can be utilized on both ornamental and edible plants. If compost soil is used as substrate or for potted plants it needs to be well matured and it is good to add some mineral soil in it. Good substrate can be made by mixing compost with sand and clay in the ratio 1:1:1. Latrine compost can also be used for soil enrichment material for vegetable cultivation. One month withdrawal time after compost spreading is recommended for vegetables consumed raw. [41, 43]

Different amounts of compost soil should be apportioned to different plants, and it needs to be noticed that not all plants prefer compost soil which can have high pH value. Compost soil is good for pumpkins, tomatoes, cabbages, corn, fruit trees and currants, cherry and lilacs. E.g. for potato compost soil is too alkaline. [42]

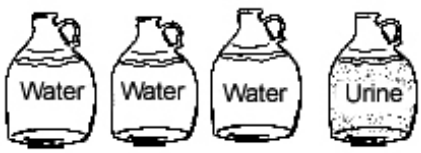
Separate collection and utilisation of urine

Many factors favour separate collection of urine. Separation of urine from the solid excrement makes handling of excrement easier and reduces the load derived from excreta by e.g. reducing the volume of excreta, reducing the odour problems and decreasing the runoffs of pathogens and nutrients (e.g. nitrates) to soil, ground water and surface waters. Solid excrement is easier to handle if it is dry and pathogens can die rapidly than in wet mixture of urine and solid excrement. Urine can be considered as almost perfect nutrient solution: nitrogen is mainly in urea, phosphorous as superperphosphate and potassium in ionic form that is useful to plants. In addition urine contains micronutrients in a well-balanced way. In separate collection nutritional value of urine is directly recovered. If urine is not separated its nutritional value is partly lost due to runoffs and evaporation and furthermore the nutrients can end up in water bodies. [36, 37, 44]

To eradicate possible pathogens from urine it needs to be stored in closed containers before utilisation. If urine is used in household's own purposes e.g. in garden or additive for the compost it can be utilised already after a couple of days of storage. If urine is not utilized in own household, the storage should be at least one month when used for food and fodder plants that are not consumed untreated and even six months when used for all plants. In storing urine a special attention needs to be paid on the tightness of the containers for the nitrogen in urine is volatile and due to evaporation valuable nutrients are lost. [37, 44]

Urine can be utilised either undiluted or diluted depending on the target. Both spreading ways have their advantages and disadvantages. [45]

1. Utilisation of undiluted urine



Urine can be spread undiluted to soil following immediate watering of the plant by its need of water. Advantage is that nutrient loss is small for the dilution increases evaporation of nitrogen. In garden use the urine can be e.g. poured with watering can to soil as fertiliser and thereafter the soil is watered with clean water. Watering ensures the absorption of nitrogen to soil, decreases evaporation and at the same time needed water amounts to different plants can be apportioned. Also the work load decreases, which can have an effect if the latrine is utilised throughout the year and the amounts of urine great. [45]

Disadvantage of utilisation of undiluted urine is that risk of over fertilisation grows, which can lead to death of the plant. To avoid the risk urine can be diluted before utilisation. [45]

2. Utilisation of diluted urine

If urine is utilised diluted, separate watering after spreading is not needed. Used dilutions are e.g. 3:1 (three litres of water to one litre of urine) or 10:1 (one litre of urine to ten litres of water). Diluting prevents the risk of over fertiliza-

tion but increases evaporation of nitrogen and work load (diluting and more spreading occasions). Noticeable is that possible pathogens survive longer in diluted urine than in undiluted urine. In addition spreading of possible pathogens from unclean diluting water needs to be recognised. [37, 45]

Urine is mostly nitrogen fertiliser. It is suitable especially to plants with high nitrogen demand such as grain, grass crops and oil plants. Other plant of high nitrogen demand is e.g. spinach, cauliflower, corn, lentils, red beans and soy beans. Urine is utilized as fertilizer according to its nitrogen value. Usually one litre of stored urine contains ca 3–7 grams of nitrogen. Guidelines for utilization can be urea, ammonium, or nitrate fertilizer instructions or extracted nitrogen amounts of different useful plants in cultivation. If specific instructions are not available all plants can be fertilized as follows: urine produced by one person in a day (ca 1-1, 5 litres) fertilizes one square meter per growing season. Therefore fertilisation with urine produced by one person in a year equals to ca 300-400 square meters per growing season. Over fertilization of most plants would require fourfold amount of urine. [45, 46, 47]

Urine contains some amounts of chlorine and therefore it is not recommended in commercial cultivation for chlorine sensitive plants such as potato, onion, tomato, cucumber and rhododendron. Over dose of chlorine can disturb crop yields of some plants. On the other hand good qualities of urine may compensate possible harms of chlorine. E.g. cucumber is said to produce lower quality yields if there is excessive chlorine. Experiments carried out in Finland though suggest that fertilisation with urine offers clear benefits in cultivation of outdoor cucumber. Furthermore in the experiment's hygienic investigation (somatic coliphage, RNA coliphage, faecal coliforms, enterococci and faecal clostridia) the amounts of intestinal bacteria in the cucumber samples turned out lower than detection limits. [45, 47, 48]

Advice on collecting and utilisation of urine: [37, 44, 45, 46, 47]

- Separately collected urine should not get into contact with excrement. Urinals are good alternatives in separate collection of urine.
- Urine collection, handling and transportation equipment should be kept clean and isolated from excrement.
- If urine is stored, it should be executed in closed containers so that evaporation of urine is as low as possible and urine does not come into contact with harmful animals.
- Pouring of urine from one container to another should be avoided for it enhances evaporation
- Gloves are to be worn when handling urine and hands are washed after spreading the urine.
- Urine is to be spread early in the morning or in the evening for sunshine evaporates nitrogen and creates odours.
- Urine can be spread either on one or more occasions depending e.g. duration of the growing season. Initial spreading should take place in the beginning of the growing season e.g. on planting stage. Plants with small roots e.g. carrot, onions and lettuce can benefit from many spreading occasions. At least a month should be waited between spreading and harvest.
- For prevention of runoffs exclusion area (preferably 20 meters) is left to wells and water sources.
- Urine is apportioned directly to the soil, not on the leaves of the plant. The ground is covered or watered afterwards to reduce evaporation. To reduce evaporation bedding material e.g. shredded grass or compost can also be applied on the ground
- If large quantities of undiluted or diluted urine accidentally come in to contact with leaves of the plant, it is recommended to rinse it off with clean water.
- If possible, urine is not to be spread directly to the roots of the plants. Large bushes and trees have nutrient taking root hairs on the same level as their outermost branches from trunk and therefore the fertilizer needs to be applied there. With vegetables and perennials the spreading distance is approximately 10-20 cm from the shoot.
- Urine, due to its nitrogenous character, is excellent additive to garden and latrine waste. It can be poured as such on top of the compost to accelerate composting process. Proportioning depends on the moisture and size of the compost. In most cases proportions are not crucial but it is enough if the compost does not get soaked.

4. Sanitation culture

Social and cultural views have to be considered when travelling to developing countries and especially when planning different projects for the area. Successful and sustainable projects cannot be carried out without thorough background of environmental and social studies and even good projects can fail due to lack of background studies. Local culture should be respected and paid attention to in all decision making.

Projects must derive from the needs of the inhabitants and they are to be carried out considering the cultural issues. It is necessary to understand that outsiders cannot determine what needs to be done and how. Instead of commanding, outsiders can provide means and alternatives on how to reach wanted goals. A lot of good methods can be learned from local behaviour, which outsiders would not have thought of. At their best the projects work as mutual learning processes where each party can broaden their views on methods and cultures. It is to be remembered that there are no right or wrong attitudes or methods but these are formed according to ones culture.

Sanitation culture is affected e.g. by following matters:

- psychological factors
- religion
- gender related factors
- economical factors
- social and institutional factors.

Sanitation cultures vary remarkably according to countries, but big differences e.g. in religious habits, poverty and gender related factors can be also found inside a country. Cultural attitudes can occur towards sanitation but practical methods can be of different character of what the attitudes may suggest. Even though area is affected by certain religion local practical methods can be of different than methods required by the religion. Therefore cultural assumptions of local sanitation are not to be made merely by looking into attitudes and values but find out local methods in practice.

4.1. Psychological factors

In sanitation culture psychological factors determine the attitude towards latrine wastes and their handling, and how this attitude affects to practical methods. Attitudes are formed from experiences and can change in time. Especially different occupational groups have different opinions of latrine waste handling depending on whether the person has interest or contact through work to sanitation and hygiene issues. Common is that the further the person is from the issue the less positive is the attitude towards the issue. In most cases attitudes though change when the issue is brought nearer to the people. E.g. In the implementation of composting latrines a lot of prejudices are present mainly due to handling of the waste. If people are on the other hand presented with functioning systems in practice and their benefits in cultivation attitudes usually change in to more positive. [49, 50]

4.2. Religion

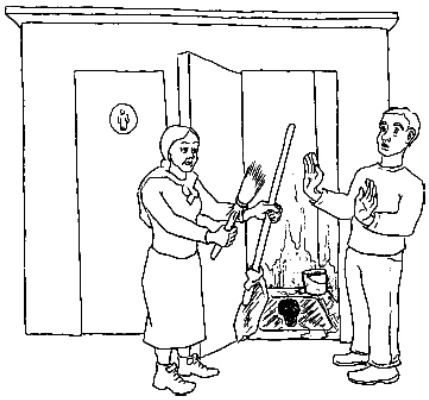
Religion affects remarkably to formation of sanitation culture since many religious habits and rituals have a connection to sanitation. Definitions of good and bad, polluted and clean can be found in many religions. This affects to utilized latrine types and attitudes towards latrines, latrine waste handling and use of the waste. [49]

In different religious groups inside Christianity water is used for many rituals (e.g. in baptism). Christianity does not though define the use of water in latrines or utilisation of latrine waste. But then again Islam determines specific rules on how to handle with excreta. Only left can be used for washing purposes after defecation (right hand is used for eating purposes) and water is used for washing. Therefore in Islamic countries it is very hard to justify use of dry latrines and in some cases dry latrines are forbidden by law. In some Islamic countries such as Yemen dry latrines are used and in this case washing can be carried out in washing places in contact with latrines. [49]

Hinduism is the main religion in India. Certain rituals, which are followed by at least a part of the traditional religion practicing people, are defined in the religion. Defecation is carried out hiding in a place where no water bodies, roads or temples are near. Defecation is something not to be talked of. Water is used for washing feet before defecation and for washing purposes after defecation. Ritual is finished by flushing the defecation hole eight times with water. Nowadays these rituals are not broadly followed but followers can be still found especially in the higher casts. This can be seen in water consumption for the people in higher casts' use more water for sanitation than the people belonging to lower casts. Cast system can still be seen in attitudes towards utilization of latrine waste. It is hard to rationalise the use of dry latrines to higher casts for unwillingness of touching latrine waste and in most cases it is not to be discussed of. The lower casts usually take care of handling and utilization of latrine waste. [49]

In addition to main religions there are several different religions and sects whose behaviour has an influence on used sanitation methods. In most cases it is hard to determine whether behavioural actions derive from the religion, learned habits or other cultural factors. In many places e.g. burying of excreta is used to prevent evil spirits, certain groups are organised their own latrine facilities or only certain people can handle the latrine waste. [49]

4.3. Gender relatedness in sanitation culture



Gender affects to sanitation culture already by physical differences. Women have to use latrines more often than men due to various reasons (pregnancy, period, child care etc.) and their visits to latrines consume more time than men's. On global scale there are though fewer latrines for women than men. In some countries there are no public latrines for women at all. [49]

In sanitation, behaviour of young children does not vary significantly between the sexes. It is common in developing countries that when girls reach puberty they are faced with more limitations than boys and they have to e.g.: [20]

- use more remote places and further from the settlements for defecation
- defecate in groups and in most cases even after sun set
- defecate in their homes and help their mothers to take out the excreta and solid waste
- even quit school for lack of sanitation facilities.

Sanitation possibilities in schools and homes enhance equality between the sexes. Girls become equal to boys for they do not have to walk far to defecate or quit school because of absence of sanitation facilities. Improvements can though create new inequalities of the sexes. E.g. getting flushing and washing water and cleaning of the latrines can end up for girls' and women's responsibility. Many times these works are not distributed fairly between men and women even though they both use the sanitation facilities. [20]

When planning for sanitation programs gender related factors need to be considered. This way projects become more efficient, fair and sustainable. Efficient sanitation facility is maintained and utilized. Different user groups' needs have to be answered to ensure utilisation of the latrine facilities. It is then not about merely answering the needs of men and women, but answers to e.g. different social/ethnic and religious groups' demands on sanitation. [20]

Sanitation needs and demands vary between genders. Women and girls demand more efforts in decreasing the work load, increase in privacy, safety and improvement of hygiene than men and boys. Women are in most cases more motivated to improve sanitation than men. Men have fewer demands considering personal and economical matters in improved sanitation. They are though motivated by the facts that safety issues improve for their daughters and wives, and

value of the property increases. Both sexes appreciate improved social status which derives from improved sanitation condition. [20]

Because men and women have their own tasks, both sexes have their special skills and knowledge on sanitation. Women usually know better about suitable location and type for latrine to meet the needs of children and women and on which models are best for hygiene. They also know better how to mix and grout concrete for they have roughcast buildings. Men usually know more about cost, quality and purchase of local materials. When projects are carried out as cooperation with knowledge provided by both sexes results are better than with only one of the groups. [20]

Even though women are more eager to improve sanitation than men they have fewer resources. Therefore it is very important to convince men of the importance of improved sanitation. The improvements have to be available also to single parent families since they have in most cases less money and resources than in families with both parents. [20]

Both men and women have to be taken into account in distribution of information and decision making. Specific gendered strategies, informational channels and organisational arrangements are needed in many countries to ensure participation of both sexes in the decision making and selection processes. It has to be acknowledged that women are usually addressed and seen as actors but mostly within small scale. Projects should take power relations into consideration and aim to equalize those at all levels. Communication strategies have to consider that men and women do not differ merely on interests but also on literacy, knowledge of language and in terms of mobility. [20]

5. Sanitation and hygiene training

5.1. Background research

When planning sanitation and hygiene one needs to gain an understanding of the target audience's level of knowledge and factors affecting the level. It is important to document all the background information that can either directly or indirectly influence the outcome of the training and project. This information includes e.g. population data, age and gender distribution, level of education, and knowledge of previous training attendance and its results.

Training needs to be based always on local demand and the interests of the residents. The best approach to improve sanitation is to consider the needs of the community and to involve the community residents in both planning and execution of training. The community needs to understand how improvements in hygiene and sanitation can be beneficial for them. They need to be supported and encouraged to find their own solutions, regardless of the technology needed to realise them.

Although the project and training would be administered from a higher level or just the field coordinator, leadership within the target community itself is important in creating change. The impacts of pressure by neighbours and the behavioural dynamics of the community need to be acknowledged and community participation in the process encouraged. [51]

5.2. Influence of culture

Several studies have found out that people do not change their attitudes towards water, hygiene, and sanitation based merely on health education. People themselves have to believe on the standard of living and health benefits and advances brought by improvements in hygiene and sanitation. Old cultural beliefs also act as a break for change but higher status, comfort, or privacy is a source of motivation for altering people's habits. [7]

It is important to find out, what the local beliefs are, especially regarding the causes of diseases. Many of them can converge with occidental medical science. Although people have their traditional beliefs, it does not rule out their possibilities for learning new habits. When promoted properly improving health conditions can be important motivating factors for a new sanitation and hygiene behaviour. [7]

It has been pointed out that during the last century training and knowledge on the importance of sanitation and hygiene have significantly improved conditions. Thus, there is no reason to believe others could not see the causality relationships and change their behaviour. Taking into account traditional beliefs and local culture while introducing new beliefs and models of behaviour, helps people change their habits. Without people's confidence in cause-and-effect relations and the meaning of things the change is only temporary. In order to achieve this all community members - young and old, women and men, as well as different social classes - need to be incorporated in the activities. When everyone is involved in all phases starting from the beginning, from mapping current situation and individual data, to finding alternatives, clearing obstacles, and planning and execution of the activities, the changes can be expected to be of permanent nature. [7]

5.3. Participatory methods

Community participation can be described as participation of the inhabitants to communal projects, which are aimed to solve problems in the community. People cannot be forced to participate but they need to be provided with a chance to participate. It is their right and one of the basic principles of democracy. The community can participate in the project in its all stages: [23]

- mapping the needs
- planning
- encouraging people
- education
- implementation
- control and follow-up.

Inhabitants of the project regions have several reasons to participate in community-helping humanitarian projects. Community participation motivates inhabitants to work together, because it creates togetherness and gives recognition to their work. When it is noticed that through projects it is possible to better their own and community life conditions genuine participation grows. In many cases society, religion or traditions oblige people to help others. Furthermore the financial or other rewards can attract people to participate in the projects. [23]

On the other hand there are reasons for why people or communities do not want to participate in communal projects. Inhabitants may fear that the work tasks and/or benefits are distributed unfairly between the community members. This applies especially to individual-centred communities with no spirit of togetherness. People have also expectations for the government to organise issues in question and therefore own contribution is not necessarily given. The problem can also lie in the treatment of the people by organisations. If people are treated as incompetent they are most certainly going to act in a similar way. [23]

Usually people are willing to participate in communal projects. By treating the inhabitants with respect, listening and learning from them the project can be carried on successfully. This approach also saves time and money in the long run and makes the project more sustainable. [23]

When aiming to a behavioural change in sanitation practices two facts should be taken into consideration: [51]

- To create awareness within the community on how much health problems due to inadequate sanitation and hygiene could be decreased by collective action

- Empower community in making and maintaining required behaviour changes. The community needs to be assisted and educated in internalizing the fact that each household should adapt improved sanitation and hygiene actions and to realize how their actions can have an influence on the whole community.

WHO, UNDP and World Bank have a common water and sanitation program, PHAST =Participatory Hygiene and Sanitation Transformation, which tries to consider broadly community aspects and people participation. The program contains following community development health aspects and principles: [7]

- Communities can and have to define their priorities in preventing diseases.
- People of the community hold remarkably broad view and experience in health issues. Most of the communities in developing countries possess broad knowledge of both traditional and modern medicine.
- Communities can reach unanimity in sanitation and hygiene behaviour that is the most suitable for their ecological environment and culture.
- When realising own benefits from improved sanitation, actions are taken to improve sanitation.

Regardless of educational background, all people are capable to realise that excreta can contain harmful pathogens and the routes where pathogens are transmitted are in their own environment.
- In order to prevent diseases barriers can be created to decrease the amounts of infections. Communities can themselves recognize the barriers that are based on their views and local resources.

PHAST contains also principles on how improved sanitation can be promoted more efficiently: [7]

- Sustainable development in sanitation and hygiene is based on knowledge of behavioural and technical elements' interdependency.
- Best way to achieve sustainable development is gradual change. Community's initial situation is changed with small changes, step by step.
- Improved hygiene has positive effects on health situation, but mere improvement in sanitation facilities does not as such enhance the condition. Therefore hygiene education must be put more and more effort. Best alternative is to develop both issues simultaneously.

PHAST is based on SARAR - principle (Self-esteem, Associative strengths, Resourcefulness, Action-planning and Responsibility). Its basic principle is to detect and recognise people's own abilities and help them to use these. Basic rule is that people are most capable of solving problems in participatory group process and that when the group possesses enough information and experience it is able to solve their problems. SARAR consists also a few other principles, which should be noticed when planning projects. These are learning, decision making, exchanging of information and discovering principle. [7]

Principles of learning state that sustainable learning takes place best in groups. Group working provides opportunities in changing existing rules and in the end helps in changing the communities' behavioural habits permanently. Suitable learning environment and concept based learning is very important for the learning process. A base for normative change is created by combining new concepts, which will work as model for future behaviour.

Principles of decision- making refers that people who are closest to the problem understand their situation best and are most capable of finding solutions to improve existing situation. People who create solutions are usually committed to follow them through by creating sustainability. Community participation creates more efficiency and sustainability than solutions from outside. The more the locals invest their money and resources to the change the greater is their commitment in following it through. [7]

According to **Principles on mechanisms for information exchange and discovery**, information exchange and discovery increase individuals' and communities' self-confidence. When people realize that they are responsible themselves for finding solutions they start to demand information. These kinds of demands open ways for information exchange and discussion. With the help of creative learning based on active information searching individuals can evaluate and change their own behaviour. Communities can decide their own model for development and initiate required actions. Technical information is to be provided only for the needs the community has detected as a result of their own development in recognizing and analyzing problems. Outside intervention and offering of technical guidance at a too early stage disturbs this process and usually have only negative effects. [7]

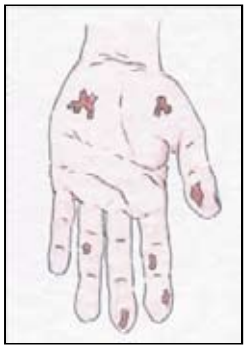
SARAR is growth oriented approach which aims through individual learning process on bringing out people's personal capacity and motivation and to benefit the group. For ensuring best possible results these principles need to be applied on all society levels evenly. If this does not take place, progress lessens, follow-through hardens and the process itself is vitiated. [7]

5.4. Improvement of hygiene

Hygiene behaviour has great influence to the risk of infections. It can be detected most distinctively in excreta related diseases and diarrhoea infections. Proper hygiene behaviour on the other hand can decrease spread of diseases from ground and insects as well as skin diseases. Adequate sanitation is the first mean to prevent spreading of excreta related diseases and spreading of pathogens in the residential environment. The second mean is washing hands which prevents pathogen transmission to food and water and further on to other people. [23]

Most important means in improving hygiene are: [23]

- adequate use and maintenance of sanitation facilities
- proper handling and disposal of solid excrement and urine
- washing hands after defecation (also children's' hands) and before touching food and water
- adequate storage and usage of clean water
- adequate storage and usage of food
- controlling amounts of vectors.



Hygiene projects can be carried out separately or together with other sanitation and water projects. It is though recommended to keep these projects separate but interdependent with their own goals. [23]

Some fables related to improvement of hygiene that should be avoided: [23]

- people are empty vases that can be just filled with new ideas
- many sectors can be changed simultaneously in hygiene improvement projects
- hygiene improvement program can reach the whole community
- new ideas replace the old
- knowing is doing.

The biggest mistake is to automatically assume that the project can take into account everything and it will automatically change behavioural models. [23]

In hygiene improvement programs following facts need to be considered: [23]

- planning, implementing, following through and evaluating the program with care
- improvements are to be directed only to unfavourable behaviour models
- target audience should be selected with care
- motives leading to behavioural changes should be identified
- hygiene information should be positive
- choosing most efficient communication channels
- keeping cost-benefit relation in mind when selecting communication channels.

Hygiene improvement programs should be directed to whole community but only in very seldom cases this can be achieved. Women and girls are generally the target group for programs for they do house works and are responsible for children. If women are provided information and education they are most likely to affect on the behaviour of the whole family. Men are generally taken the smallest target group for they are not considered for some reason as suitable target audience either for an outside or own reason. It needs to be noticed though that if men are left outside the program it can create problems in other areas. Men have great influence on changes in hygiene and sanitation, especially in planning and implementing stages. [23]

Children's hygiene education can be carried out the most successfully in context with other education. Education is especially efficient when it is attached to normal school education. Handicapped community members should be taken into account as a separate group for their special needs. [23]

In execution of hygiene improvement program problems should be identified and solved. Best method for this is participation of the community. When utilised already existing information, better results are achieved than by merely bringing new ideas to programmes. Community should be encouraged to participate in all stages of implementation of sanitation and hygiene program. [23]

The most difficult is to identify targets where change is important. When problem targets are identified means have to be found to motivate the change. Mere information does not necessarily encourage into change in behavioural models. E.g. group discussions are practical and meaningful ways to change people's views. Selection of effective communication channels is of importance. Suitable sites for guidance are market places, schools, medical treatment sites, water supply sites and area close to sanitation services. [23]

Following are to be noticed in hygiene improvement programs: [23]

- most important hygiene problems are identified in planning and implementation
- needs and wants of all groups are paid attention according to possibilities
- all community members are able to use provided facilities and services
- hygiene improvement program commit on the most important (target) problems
- contents of the program needs to be understandable and approved by the community
- users have to be responsible for services and maintenance.

5.5. Practical methods to improve hygiene and sanitation customs

Several different methods can be used for hygiene education depending on the initial conditions. Usually participatory methods are more effective than e.g. direct lecture type meetings. In this case local people participate in the educational meetings and practical matters that could not be considered by outsiders may emerge. Drawing, music and various performances (e.g. plays, theatre, and dance) are natural means to make people participate and at the same time understand the importance of hygiene and sanitation.

In the following are a few practical examples on how to start hygiene education in village communities. When planning for the education only imagination sets the limits!

Example1. How diarrhoea spreads [26]

This group work is meant for determination of transmission routes of pathogens to humans. A narration of spreading of diarrhoea is created by combining Picture drawn in groups. Small and big paper, colouring pens, sticky tape and example drawings are needed for this group work.

First the people are divided into 5-8 people groups. Each person draws one sketch on how he/she thinks diarrhoea spreads. If the person has difficulties drawing he/she can write a word that describes spreading of diarrhoea. Other group members can assist one another when needed. Example drawings can be presented to help the group in the beginning.

Each person in the group shows their drawing and the others tell what they see in the Picture. The Pictures are arranged to form a narration on how pathogens spread. If the group notices missing parts in their narration parts can be

added to the narration. When the narrative is finished the drawings are taped to a bigger piece of paper. Arrows can be drawn between the drawings to present transmission routes

Each group presents their narration to other groups and the thoughts aroused by drawings are discussed together. Narrations of different groups can be compared and possible transmission routes that are missing discussed.

Example 2. How to prevent diarrhoea from spreading [26]

After the first example another group work can be made with a help of already existing drawings on how diarrhoea spreads. The Pictures are shown in the previously formed groups. Group now discusses on how the transmission route can be eradicated (e.g. by washing hands, use of latrines, and protection of food and water etc.). The group decides which the best means to eradicate transmission routes are. Thereafter each member of the group draws another drawing where the mean to prevent transmission is shown.

The group discusses on how the previous narration changes now when there has been actions to prevent the transmission route. The group considers whether presented method is enough for preventing diseases or if further action is still needed. The groups present their new narrations to others following a discussion on thoughts aroused by the Pictures. Further thinking can be e.g. what methods are currently used in public, which methods could be taken in use and what kind of obstacles are for the use of these methods.

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Drawing references:
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SYRJÄNEN SALLA AND KLEMELÄ RIIKKA, 2009 (page 27)

APPENDIX 1. Diseases and causes of diseases both in English and Finnish

AIDS (acquired immune deficiency syndrome)	AIDS
Malnutrition	Aliravitsemus
Amoebiasis, ameobic dysentery	Amebapunatauti, amebiaasi
Schistosomiasis	Bilhartsia, skistosomiaasi
Dengue fever	Dengue-kuume
Dengue haemorrhagic fever, DHF	Dengue-verenvuotokuume-shokkioireyhtymä
Ebola haemorragic fever, EHF	Ebola-viruksen aiheuttama verenvuotokuume
Giardiasis	Giardiaasi
Guinea-worm disease, dracunculiasis	Guineamatotartunta
Hantavirus pulmonary syndrome, HPS	Hantavirusinfektio
Hepatitis-A, -B, -C, -D, -E	Hepatiitti-A, -B, -C, -D, -E
HIV	HIV (human immunodeficiency virus)
Influenza	Influenssa
Smallpox	Isorokko
Japanese encephalitis	Japanin aivotulehdus
Tetanus	Jäykkäkouristus
Onchocerciasis, river blindnes	Jokisokeus
Yellow fever	Keltakuume
Pinworm	Kihomato
Chlamydia	Klamydia
Cholera	Kolera
Hookworm disease, Ancylostoma	Koukkumatotauti,ankylostomiaasi
Syphilis	Kuppa
Diphtheria	Kurkkumätä
Typhoid fever	Lavantauti
Legionellosis	Legionelloosi
Leptospirosis	Leptospiroosi
Avian influenza	Lintuinfluenssa
Helminth	Loismato
Lyme desease	Lymen tauti
Malaria	Malaria
Marburg haemorragic fever	Marburg-viruksen aiheuttama verenvuotokuume
Meningococcal meningitis	Meningokokkitaudit
Methaemoglobinaemia	Metahemoglobinemia
Dehydration	Nestehukka
Anthrax	Pernarutto
Myelitis, infantile paralysis, polio	Polio
Dysenthery, schigellosis	Punatauti, shigelloosi
Tick-borne encephalitis, TBE	Puutiaisaivotulehdus
Rift Valley fever	Rift Valley -kuumevirusepidemia
Diarrhoea	Ripuli
Rotavirus	Rotavirus
Plague	Rutto
SARS (severe acute respiratory syndrome)	SARS
Dysenthery, schigellosis	Shigelloosi, punatauti
Conjunctivitis	Sidekalvotulehdus
Ringworm, tinea	Silsa
Ascariasis	Suolinkaistauti
Scabies	Syyhy
Tick-borne encephalitis, TBE	TBE-virusinfektio
Trachoma	Trakooma
Trichuriasis	Trikiniaasi
Tuberculosis, TB	Tuberkuloosi
Measles	Tuhkarokko
Rabies	Vesikauhu
West Nile virus, WNV, West Nile encephalitis	West Nile –virus
Lassa fever	Lassa kuume
Protozoa	Alkueläin

How to make a simple bottle portioning device, tippy-tap [26]

To make tippy-tap you need:
1) plastic bottle with a screw-on cap (e.g. soda bottle)
2) Stiff and hollow tube(e.g. inside tube of a ball-point pen)

1. Clean the bottle
2. Make a small hole in the lower part of the bottle by using a heated piece of wire.
3. Remove and clean the inside tube from ball-point pen. Cut it to 45 degree angle and push it through the hole of the bottle. The tube should fit tightly

4. Fill the bottle with water and close the cap. When the cap is tight no water is coming out through the tube. When the cap is loose the water runs through the tube as continuous stream. When tippy-tap works it can be hung from a place where people can use it for washing hands. Place soap nearby the tippy-tap or tie a bar of soap with a string to the bottle
5. To use the tippy tap: Loosen the cap so that the water runs through the tube. Wet your hands, add soap and rub them under the water as long as they are clean.

6. Dry your hands to a clean towel or shake them until dry. This is a hygienic alternative if there is not a clean towel available Do not use a dirty towel because it can spread pathogens to your hands

How to make a simple hand washing device

For construction of simple hand-washing device following equipment is needed:

1) a bottle(glass/plastic), with screw-on cap (preferably metallic)
2) a sharp pointed knife

1. Clean the bottle and the cap carefully (e.g. by boiling)
2. Make holes to the cap with clean knife
3. Fill up the bottle with clean water before using the latrine facility
4. Use up all the water from the bottle for washing hands and wash the bottle ready for next use
5. Keep the bottle clean and dry

APPENDIX 3. Additional information

Introduction

- Closing the Loop on Sanitation, EcoSanRes. http://www.ecosanres.org
- Global Water Supply and Sanitation Assessment 2000 Report. WHO, UNICEF. http://www.who.int/docstore/water_sanitation_health/Globassessment/GlobalTOC.htm
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