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Dry Ecological Sanitations for Dry Land—A Review

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ABSTRACT: The objective of this paper is to make a hypothetical comparison on the environmental benefits of two sanitation techniques, viz. dry (minimum water) vs. water based, for rural areas. It is a well known fact that sanitation coverage in rural and suburban areas is poor, and these inadequacies are clearly visible in terms of declining health and illiteracy among the children (girls in particular).

Sanitation techniques can be broadly classified into those that require minimum or no water and those requiring water for the operation and maintenance. While the latter type is more convenient to use, the former type of sanitation techniques requires a greater degree of 'user discipline' and is more viable to environmental health. The performance of sanitation techniques can broadly be assessed under two criteria, viz., community and environmental health. A comparative performance would also be done for their suitability to different climatic zones of India.

Besides, with the looming threat of water scarcity, sanitation techniques might be required to be reassessed for their ability to sustain the rural/suburban community's sanitation requirements.

This paper is based on a thorough assessment of various literature pertaining to dry and wet sanitation techniques and includes a systematic analysis comparing the impact of both sanitation techniques on the health and sustainability of the community and environment. A simulation would also be developed and the results would be presented in the paper.

INTRODUCTION

Human excreta are a source of infection. Around 2.4 billion people do not have access to improved sanitation (Park, 2007). By 2030, an estimated 5 billion of the world's 8.1 billion people will live in cities. About 2 billion of them will live in slums, primarily in Africa and Asia lacking access to clean drinking water and working toilets, surrounded by desperation and crime (Evaes, 2007).

Many diseases are associated with inadequate water, sanitation and hygiene, such as typhoid and paratyphoid fever, dysenteries, diarrhoeas, cholera, hookworm diseases, viral hepatitis and similar other intestinal infections and parasitic infestations (Park, 2007; Chourasia, 1994). About 30 such diseases are of public health importance (Duncan Mara and Sandy Cairncross, 1989). Lack of access to safe water, sanitation and hygiene causes 1.6 million deaths a year, mainly due to diarrhea and mainly among children under five.

Various studies have concluded that the impact of sanitation on diarrhea is greater than that of water supply. Sanitation helps to prevent other diseases, which are unaffected by water supply, such as intestinal worms, bilharzias and certain mosquito-borne diseases like filariasis. Those without access to adequate sanitation are 1.6 times more likely to experience diarrhoeal disease. However, water supply is also necessary to promote sanitation because if a person does not wash his/her hands after using toilet, it can cause the spread of intestinal worms and at the same time, having sufficient water supply is prerequisite for hand washing. Thus, water supply and sanitation are closely inter-linked (UN-Habitat, 2006). Hence, these diseases are not only a burden on the community in terms of sickness, mortality and a low expectation of life, but a basic deterrent to social and economic progress.

The Figure 1 depicts the transmission of diseases to the new host through the fecal matter. The person carrying diseases; whose excreta may cause various diseases through various channels such as fingers/legs, food, water, flies and soil.

TECHNOLOGIES IN MARKET

In order to overcome the occurrences of these diseases, there are various latrines for different user ends. These latrines may act one of the important barriers to curb the fecal oral disease transmission. For latrine technologies the review distinguishes between systems which do not need water for functioning (dry systems) and those which do (wet systems).

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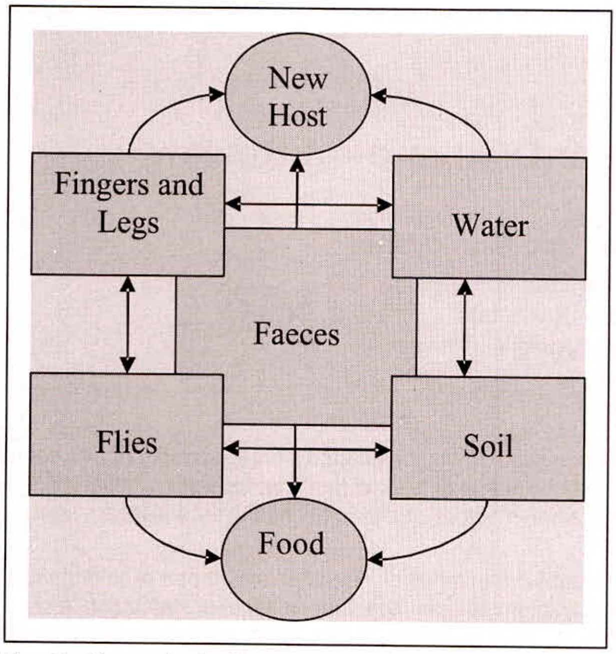

Fig. 1: Channels for the occurrence of diseases due to fecal matter

The latrine technologies include (Wet systems):

1. Basic improved traditional latrine
2. Double vault compost latrine
3. Pour-flush latrine
4. Pour-flush latrine with leaching pit

The latrine technologies include (Dry system):

1. Dry sanitation
2. Ventilated improved pit latrine (VIP)

Waterborne sanitation systems are the traditional technologies used in urban development. However these are not sustainable in water-scarce situations. Dry sanitation is defined as the disposal of human waste without the use of water as a carrier (Redlinger *et al.*, 2001). Often the product is then used as fertilizer. In developing or underdeveloped countries or to the water scare communities this kind of sanitation will be boon.

Table 1 shows the comparison of different latrines applicable at various regions based on various parameters such as region having high/low water table, cost etc.

Table 2 highlights the advantages and disadvantages of wet and dry systems. The wet system are suitable in the areas where there is plentiful of water source available. For the reason being is, the annual volume of water (almost invariably potable water) needed to flush away the 550 liters of waste produced annually per person is 15000 liters. But it may not be suitable for the water-scare community, as they cannot afford such luxury.

Table 1: Comparison of Technological Options of Sanitary Latrines in Water Logged Areas*

Technological Options	*Area of Application*	*Cost*	*Ease of Construction*	*Required Soil Condition*
Earth Stabilized Pit Latrine	Flood-prone area	Low to medium	Easy	Permeable soil
Step Latrine	Flood-prone area	Low to medium	Requires supervision	do
Aqua privy	High water table	Medium-High	Requires supervision	do
Septic Tank	High water table	High	do	Do and need dispersion trench
Eco Sanitation	Water logged rocky areas	Moderate	Needs little supervision	No special requirement

*Ponnuraj (2006), Manual on water and environmental sanitation for disaster management, WHO, India publications.

Table 2: Advantages and Disadvantages of Wet and Dry System*

Wet System		*Dry System*	
Advantages	*Disadvantages*	*Advantages*	*Disadvantages*
Low cost Control of flies and mosquitoes Absence of smell in latrine Contents of pit not visible Gives users the convenience to sewer when sewerage becomes available	A reliable (even if limited) water supply must be available Unsuitable where solid anal cleaning material is used	Low Cost Can be built by householder Needs no water for operation Easily understood Control of flies Absence of smell in latrines	Does not control mosquitoes Extra cost of providing vent pipe

*UN-Habitat (2006), Social Marketing of Sanitation, WHO, India

Dry sanitation/composting latrine may be suitable for water-scare communities. As they can be built with the easy available mud or blocks at low-cost, environmentally acceptable, hygienic and overcomes the conventional treatment option. Ecological sanitation reduces the need of pipelines- the most expensive part of traditional sewer network. According to United Nations Environment Programme (2004) the annual costs of ecological sanitation options are lower than most conventional options. As an example the ecosan toilet system in Bangalore, India has an annual cost per person of 10 USD (Jenssen *et al.*, 2004).

Among India's one billion population 72.21% live in rural areas (6.38 lakh villages) with 85% of these lacking proper sanitation. Approximately 700 million people defecate in the open. This is a problem particularly for women in rural areas as their safety and dignity are at threat. Only around 30% sanitary facilitates are made available to rural areas in India. Despite the Millennium Development Goal 3 stresses on gender equality, the sanitary and hygiene needs of women and children in particularly are grossly neglected there by resulting in significant productivity loss both in the domestic and occupational front. This gross insufficiency in access to sanitation compels women towards lesser fluid and food intake, which results in urinary infections, kidney problems and other health problems. Children, particularly, young girls feel insecure and dissuaded from attending schools due to lack of proper sanitation. Provision of proper sanitation will have a bearing on the community literacy rates. Young girls are denied their right to education because they are deterred by the lack of separate and decent sanitation facilities in schools. Only 60% of rural population is literate, with 50% dropout rates before fifth standard. Among India's 700,000 rural primary and upper primary schools, only one in six have toilets. Around 50% of all polio cased world-wide is reported in India. Jaundice and viral, gastro-enteric and cholera outbreaks are almost an annual feature in many villages and children are the most vulnerable. India loses approximately 73 million working days annually due to sickness caused by unsafe water and lack of sanitation. Women and children would most benefit with improved hygiene and sanitation.

ANALYSIS

Let us see how we can implement these technologies (Table 1) in various regions of Karnataka (India) taking as an example. As we have already understood by the previous analysis, there are various factors which would see a successful implementation of sanitation project in adequate/inadequate water regions.

Karnataka is one of the eight largest states in India with 52 million population (1981 Census) out of which 28% population is in Urban, with summer: March to May (18°C to 40°C), winter: October to December (14°C to 32°C), South-West Monsoon: June to August and North-East Monsoon: October to December with minimum 500 mm to 4000 mm rainfall every year. There are many river basins such as Krishna River, Godavari River etc.

In Karnataka more than 90 per cent of habitations especially rural out of 56682 rural areas, depend upon ground water and are facing major risks of depletion of the source. Out of 56682 rural habitants (Govt. of Karnataka, 2001), over 35 per cent of the rural habitations are yet to be covered with adequate drinking water supply. The problem of inadequate drinking water supply is more acute in drought, where more than 30 per cent rural habitations lack access to adequate water supply (Table 3). The drought regions are the yellow shaded regions (expect Kolar) and few parts of light blue shaded regions (Dharwad, Bangalore Urban, Chitradurga) from the Figure 2. From the Figure 3 these regions have relatively higher density of populations compared to adequate water regions.

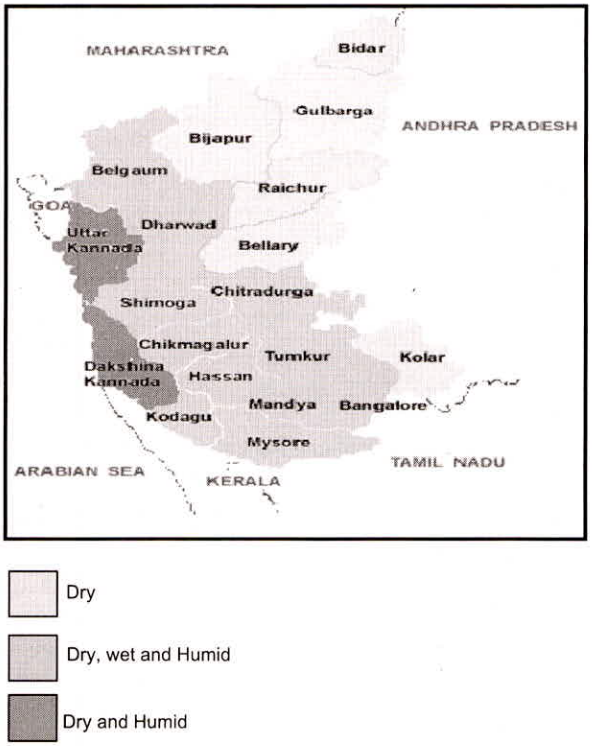

Fig. 2: Climatic variations in Karnataka

Table 3: Status of Rural Water Supply in Karnataka, 2002*

District	*No. of Habitants with lpcd < 55 lpcd*			
	No.	*% to total*	*55 lpcd and above*	*Total*
Bangalore ®	956	30.09	2221	3177
Belgaum	995	64.44	549	1544
Bellary	590	57.28	440	1030
Bidar	211	23.29	695	906
Bijapur	524	52.04	483	1007
Bagalkot	333	46.77	379	712
Chikkamagalore	705	19.79	2857	3526
Chitradurga	504	33.14	1017	1521
Davangere	391	31.94	833	1224
Dakshina Kannada	1470	47.88	1600	3070
Udupi	1402	41.38	1986	3388
Dharwad	245	54.69	203	448
Haveri	339	48.85	355	694
Gadag	128	34.04	248	376
Gulbarga	1208	62.59	722	1930
Hassan	1923	44.53	2395	4318
Kodagu	452	82.94	93	545
Kolar	705	18.29	3149	3854
Mandya	705	18.29	3149	3854
Mysore	540	26.77	1477	2017
Chamarajnagara	509	75.18	168	677
Raichur	529	37.7	874	1403
Koppal	265	33.42	528	793
Shimoga	1068	23.39	3498	4566
Tumkur	1918	37.33	3220	5138
Uttara Kannada	1298	22.74	4411	5709
Bangalore(U)	701	64.79	381	1082
Total	20495		36187	56682
% to total no of villages	36.16		63.84	100

*Rural Development and Panchayat Raj Dept. (RDPR)

For the drought regions the wet technologies would mean expensive, needs regular supply of water, maintenance and various others costs involved in the implementation of sanitation (wet) projects. This can be justified by the following discussion as follows: A survey by the Directorate of Economics and Statistics (Govt. of Karnataka, 2002) evidenced that majority of habitants had below 55 liters per capita per day (lpcd) of water supply (Table 4), an indication of lacunae in engineering plan, capacity installation and satisfaction derived by people. The Department of Mines and Geology (DMG) while studying fluctuations and depletion in ground water has concluded that the level of ground water has depleted up to 7 m in several districts.

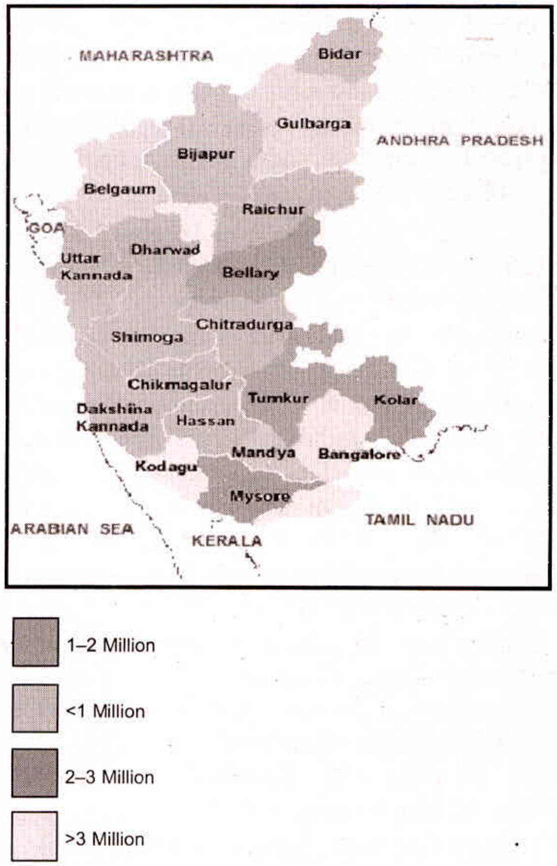

Fig. 3: Human settlement density

Table 4: Actual Level of Drinking Water Supply in Rural Areas (sample survey 2001)*

Bore-well with hand pumps	91.7% of 470 rural habitations had less than 55 lpcd
Mini water supply schemes	Out of 646 schemes surveyed 91.48% reported less than 55 lpcd
Piped water supply schemes	86.07% of 977 rural habitations had adequate water supply less than 55 lpcd

*Puttasamaiah S, 2005.

Many rural habitations in Karnataka are facing health problems due to inadequate water use and fecal oral transmission. For instance, people in few villages of Jagalur taluk in Davanagere district reported skin diseases after they stopped bathing due to shortage of water (Deccan Herald, March 12, 2003). Gastroenteritis is the major disease with nearly 24 thousands of incidences and about 200 deaths in 2001. It should be noted that viral hepatitis is increasing rapidly in the state from 1714 cases in 1997 to 5438 in 2001.

Apart from health effects, inadequate water supply increases hardship on women and children, compelling them to spend more time and energy in collecting water.

Other one of the important discussion on land (soil) and its suitability for the implementation of sanitation project (Farley and Kilbey, 1999). Pit latrine or pour flush latrines require continual dosing with enzymes to aid the decomposition process and to try and eradicate odors. On certain sites, e.g. rocky ground, in flood areas, above ground water source etc., pits cannot be dug at all (Mangalore, for example). The South African Water Research Commission (WRC) notes that 46 per cent of ground water resources are contaminated above the internationally acceptable level. For double vault compost latrine large vaults are needed to store the faeces for at least a year, to ensure they become pathogen-free. As these latrine works on anaerobic composting concept, understanding of anaerobic composting is lacking and the contents become wet and malodorous (Farley and Kilbey, 1999).

VIP's are costlier than pour-flush and less costly than septic tank latrines. This kind of latrines is costly in comparison to other pit and pours-flush latrines and requires greater care in changing over the use of pits. Bore hole latrine involves low cost of construction, short time usage and suits the poor community. But this kind of latrines releases foul smell by breeding of flies and insects, possible contamination of ground water if the water table is high and requires shifting of superstructure once the hole is filled (Chourasia, 1994). However, in densely populated areas, the limits are obvious: Digging a new pit when the old one is full often leads to the question; where to build new one? Most of the above said wet technologies are based on the premise that excreta are waste and that waste is only suitable for disposal. These wet technologies allow mixing comparatively small quantities of potentially harmful substances with large amounts of water and the magnitude of the problem is multiplied. Even in developed countries, these conventional systems are directly cross subsidized and the chances to ever become financially sustainable are low (Langergraber and Muellegger, 2005).

Apart from the water availability, cost, region suitable etc. there are few more factors which may be very important part of sanitation projects. Such as community acceptance and culture, after the analysis, if the decision maker opts for dry system in drought prone areas. Then the culture and community acceptance seek is an important to see that the project is implemented.

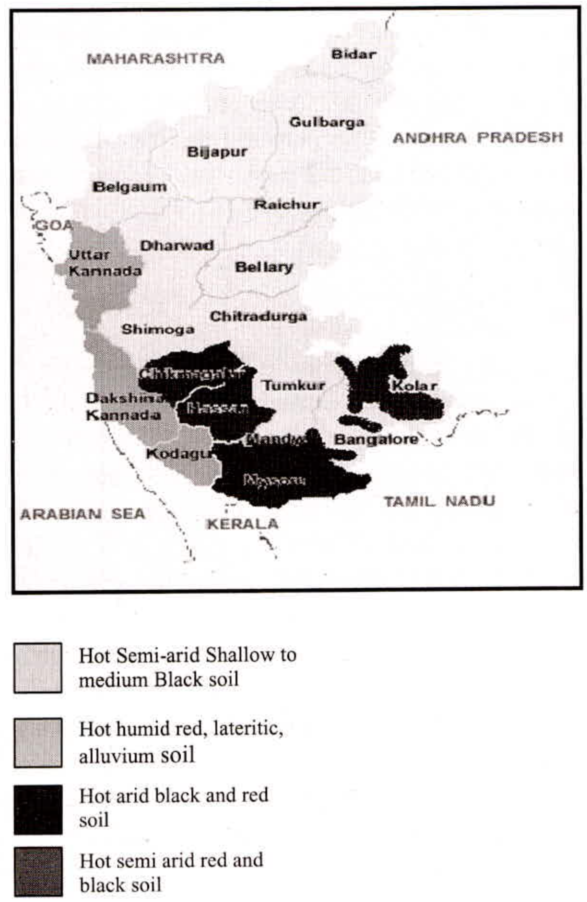

Fig. 4: Soil distribution

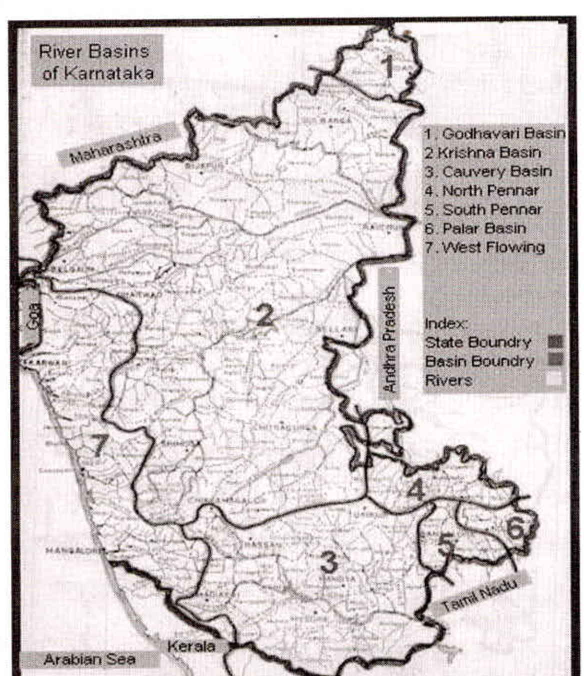

Fig. 5: Rivers of Karnataka

Community Acceptance

Dry sanitation consists of urine diversion, for urine diversion to work; men must sit to urinate, which is often unpopular. In cultures where water is used for anal cleaning, separate arrangements are required to maintain the chamber dry. The constant addition of ash, earth or lime and the periodic mixing of the pile may be considered onerous tasks by the user. User must acquire certain habits, which is only possible over a long period of time.

Culture

Religions vary considerably in addressing excreta; culture influences our attitudes towards handling excreta. In the Bible, the act of elimination is mentioned only once, and it does not address the subject using excreta for agricultural purposes. The Koran, however, prescribes strict procedures to limit contact with faecal material, including its use in agriculture, because excrement is considered impure. The principal Hindu text that details the code of conducts for rituals, the Artha Veda, clearly specifics the use of water for personal hygiene. But nowhere do we find excrement included more in a religious context than in Buddhism. An integral dimension of Buddhism is reincarnation, which promotes the harmonious concept of recycling life's treasures; it is therefore not surprising that Buddhist cultures treat earthly resources similarly.

Hence a vital information gathering before the implementation of any sanitation project would be a key point to the success.

CONCLUSIONS

With the wide variety of technologies available at door step, it would be wise for the decision maker to take various factors into account before the implementation of sanitation project. To see the success of implementation of dry sanitation, community acceptance and cultural hindrance has to be taken into consideration.

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