DRAFT

ESTIMATING DAILY WATER REQUIREMENTS FOR PLANNING RURAL WATER SUPPLY PROJECTS

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WEST JAVA RURAL WATER SUPPLY PROJECT OTA - 33

OCTOBER 1982

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CONTENTS

I. SUMMARY

In reviewing the data on water communicable diseases, and considering actual water use patterns in rural (remote) communities, an analysis could be made of the potential benefits of applying certain safe water supply rates (lcd). The paper indicates how to use the lcd in designing systems, and for long term planning of water supply improvement.

However, it has to be emphasized that a rational use of lcd-values does not imply the eradication of diseases, since drinking water is only one of the factors influencing human health.

It is concluded that safe watersupply levels (lcd) should be considered as follows:

10 lcd is the minimum requirement to prevent water-borne diseases.

80 lcd is the minimum requirement to also prevent water-washed diseases.

100 lcd is the minimum requirement to also prevent water-related diseases.

120 lcd (and over) can be considered luxury supply increasing well feeling.

II. INTRODUCTION

For long, individual households took care for their own supply of safe water, and people relied on sources available in their immediate living environment, such as wells and springs.

Where the population increased, those sources became scarce, and other water had to be used requiring often some form of rough treatment prior to use.
This treatment generally aimed at improvement of the bacteriological quality by storing the water in 40 liter containers for one or two days.

In the cities, where people live close together on a relatively small area, traditional natural water sources, were insufficient to supply water for everyone. Therefore watersupply organizations were established to provide drinking water.

At the moment similar patterns are evolving in the rural areas of Java, since the rural population is increasing steadily, under influence of a higher life expectancy, high birthrates and improved living conditions. The present water sources in use, like shallow wells and deepwells, are too intensively used and consequently water quality deteriorates. As a result numerous people are compelled to obtain their drinking water from polluted sources such as rivers and irrigation canals. The contamination of these sources is caused by their function : discharge of wastes.

At present an increased attention is given to improve the water supply situation in developing countries, with strong emphasize on the rural population. This group is mostly economically weak and therefore can not afford the cost for providing water by the commonly available, sophisticated, technical solutions. This situation can only change when simple low cost water supply systems are developed and made operational.

In planning and designing water supply systems, the basic question is: "how much water should be provided?". If the quantity is too low, the population still has to use the contaminated, water sources, and will object to contribute for the newly implemented system. If the volume is too high, the financial constraints of the system will be too high, a burden and the effort to water supply improvement is deemed to fail also. In some way an optimum has to be found to escape this dilemma.

In this paper water use patterns in rural areas and the common insight on water communicable diseases are presented. By combining these two, reasonable estimates of lcd requirements of water can be derived.

III. WATER COMMUNICABLE DISEASES

Several textbooks and publications sum up the diseases affecting man. Since this information is widely available only a comprehensive review will be given here.

Some 40 diseases are known, which can be traced to have some relation with water. Many of those are caused by bacteria, virusses, protozoa and helminths.

In general four basic mechanisms of water communicable disease transmission are distinguished: water - borne, water-washed, water-based and water-related insect vectors.

A water-borne disease is one, which is transmitted, when pathogenic organisms are in water, which is drunk by a person who then becomes infected. Water-borne diseases include cholera (salmonella species) and typhoid fever (vibrio species), but also infectious hepatitus (hepatitus virus) and bacilary dysentery (shigella species). Drinking water quality is hereto a determining factor upon occurence.

The water-washed diseases can be distinguished in three subtypes.

- Infections of the intestinal tract, causing diarrhoeal diseases, but also typhoid fever and bacilary disentery.
- Infections of the body surface, as the skin and the eyes, causing bacterial skin sepsis, scabies and fungal skin infectious and
- Infections carried by insects, which result from bad personal hygiene.

Water-based diseases is one in which the pathogenic organism spends part of its life time in an intermediate aquatic host. An important example is schistosomiases and the Guinea worm.

The water-related insect vector diseases at least is spread by insects which either breed or bite near water. Malaria, yellow fever, dengue and onchocerciacis are important examples. The vectors most closely related to domestic water supply are the Aëdes mosquito vectors of dengue and yellow fever, which breed in temporary water containers used to store water in the household.

For Indonesian circumstances the occurrence of water - based diseases are of relatively minor importance.

The common transmission routes of the enteric diseases are:

- Cholera: man - faeces - water or food - man.
- Typhoid and para typhoid fever: man - faeces - food or water - man.
- Hepatitus infectiosa: man - faeces - food or water - man.
- Bacilary dysentery: man - faeces - flies/food or water - man.

While water-borne diseases mainly result from ingestion of contaminated water, the water-washed diseases originate from too little attention or possibilities for personal hygiene due to shortage of water. Water-related vector diseases, finally, are the result of improper environmental hygiene or improper waste water management - ment in the community.

In figure 1 the water communicable diseases are shown in relation to several aspects of water.

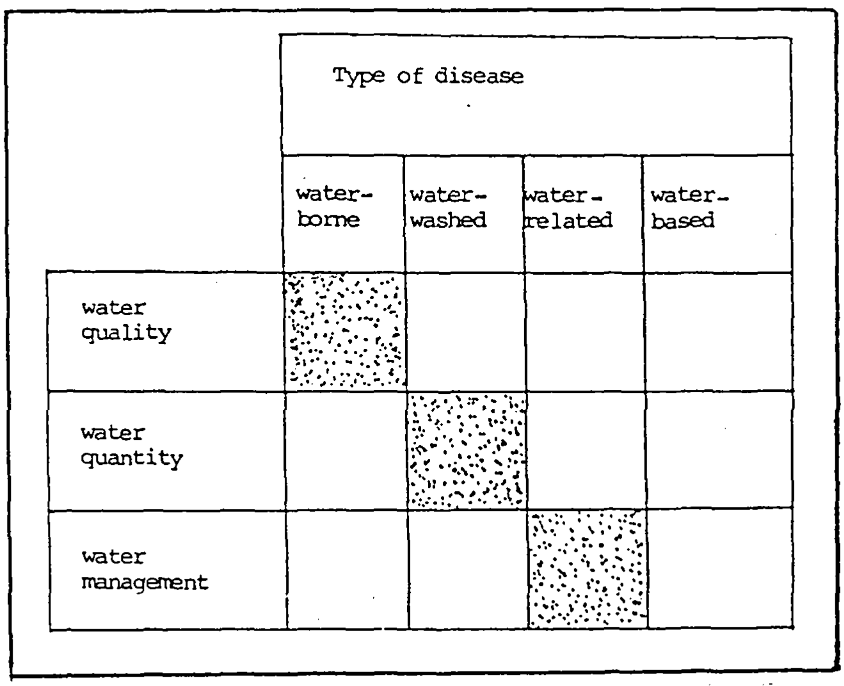

Figure 1: Water communicable diseases related to water aspect.

IV. SOME CHARACTERISTICS OF RURAL COMMUNITY

Each rural community has its own specific characteristics in terms of culture, social network, economic potential, level of development, way of communication etc. Therefore it is impossible to establish one, generally valid, statement about rural water usage. However, within certain limits, general patterns can be assumed. Hereto the experiences will be used as obtained in the community water supply project in Kutaampel, reply of Karawang as basic data.

A general characterization of the community can be derived from the following socio-economic data.

IV.1. Demographic structure

The total population of the community is 10.000. 50% of the population is younger than 19 years; 10% is older than 50 years.

The age frequency distribution is shown in figure 2.

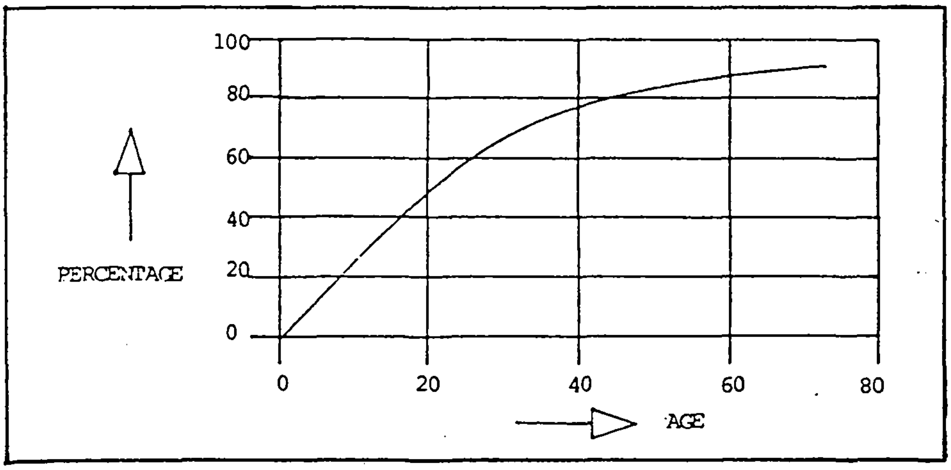

Figure 2: Age frequency distribution

IV.2. Desa economics

The total desa income amounts at 1.2 billion rupiah per year (US § 1.85 x 10^6), or a per capita economic desa income per day of Rp 330,00 (US § 0.50).

The desa economy depends for 42% on agricultural activities, for 48% on (several) trade (transport) and other commercial activities, and for 10% on bio-industry as poultry and cattle.

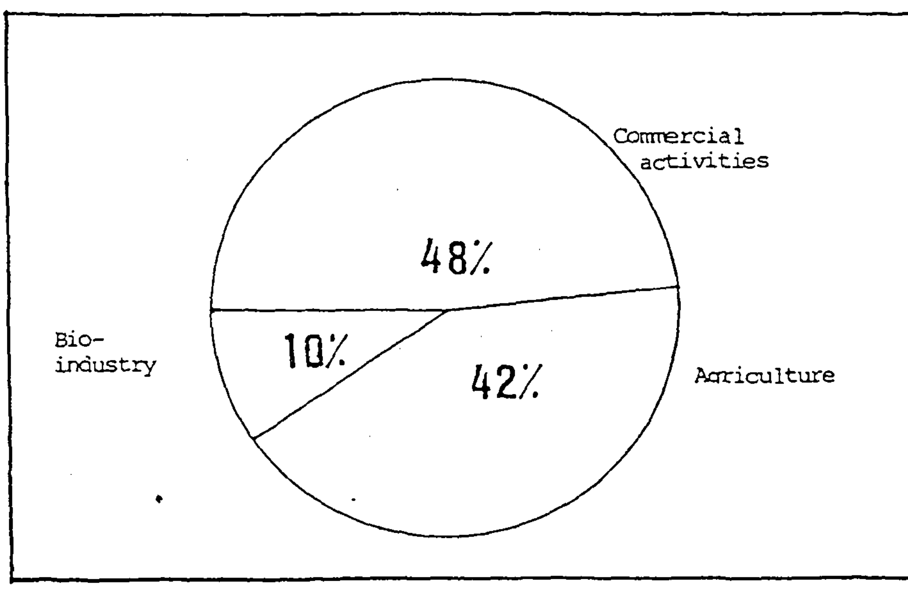

Figure 3: Economic activities

IV. 3. Education level

Given the specific demographic character of the desa, namely an expanding population, a large part of the population (60%) is either pre-school or into the school age. The other part shows an education up to primary school (24%) or no schooling at all (15%).

EDUCATION LEVEL	PRECENTAGE
Pre-school schoolage	60 %
Primary school	24 %
Advanced education	1.3 %
University	0.01%
Illiterate	15 %

Table 1: Education level

IV.4. Housing

In the desa two third of all houses is of a temporarily nature and only 17% can be considered as permanent , which means constructed from bricks and ceramic rooftees.

If a relationship is assumed between income and the type of houses which is occupied, it can be assumed from the income distribution graph and the data as above mentioned that famlies with an income of Rp 10.000,00 - Rp 30.500,00 occupy temporarily houses and families with incomes of Rp 50.000,00 per month or more do posses permanent houses.

IV.5. Income distribution

Monthly incomes in the desa range from Rp 12.000,00 to Rp 100.000,00 (US § 20.-/155,-). The mean income is Rp 35.000,00 per month complying with the 80% percentage. The modal income however, is Rp 17.500,00 complying with the 35% percentage. The average modal daily per capita income amounts at Rp 250,00 (US § 0.40). The income frequency distribution is shown in figure 4.

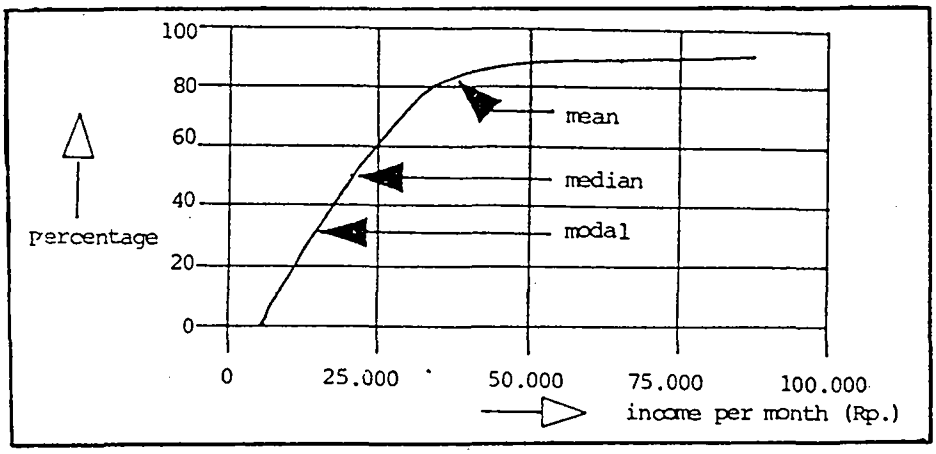

Figure 4: Income (Rp.) per month frequency distribution

IV.6. Water supply situation in a rural community

In this paragraph the water supply situation is briefly reviewed. The water sources people rely on are, shallow groundwater, irrigation canal water and water from the river Citarum.

IV.6.1. Use of water sources

30% of the population is using exclusively wells for water supply purposes, while 25% exclusively relies on surface water. 35% is using both surface water and well water. 10% is using other, mainly highly suspect sources, such as the farm and drains.

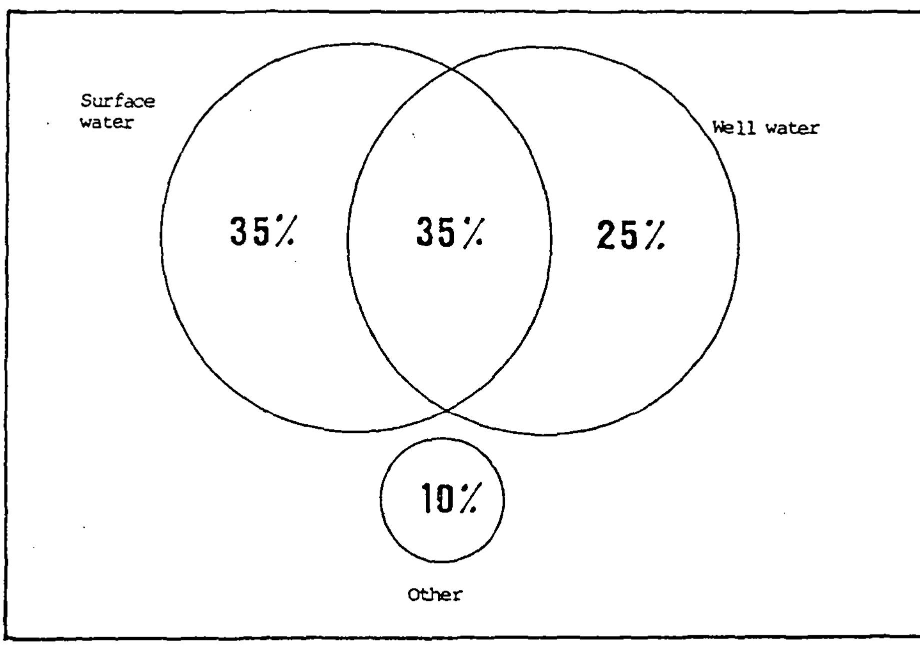

Figure 5: Source for water supply in a rural kampung

The total number of wells is 380, thus for an average 26 people per well. However, from a survey it could be calculated that 50% of all wells are used by up to 20 people, while 13% of the wells provided water for up to 80 people per well.

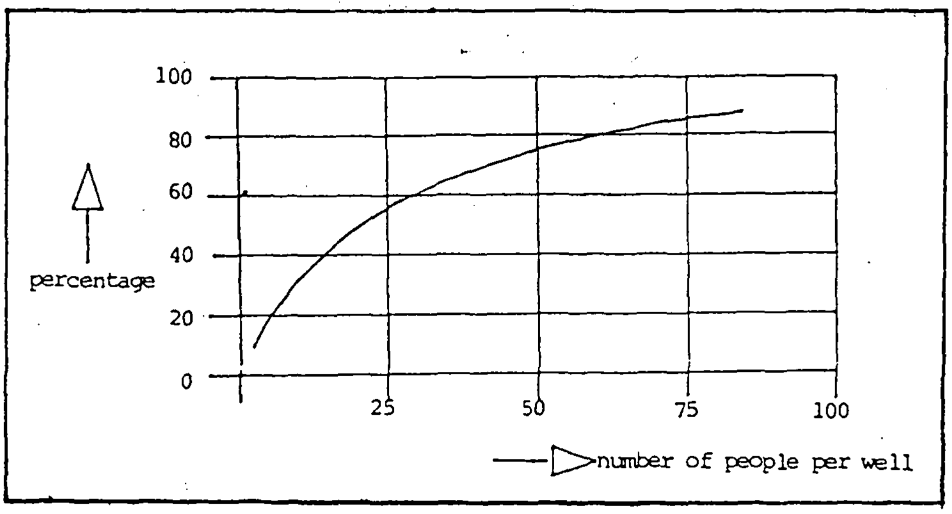

Figure 6 : Frequency distribution of number of users per well

The wells are generally located at distance of 4-20 m from the house.

IV.6.2. Qualitative characteristics of the wells

The wells are evaluated on their water quality, based on taste as experienced by the population.
A survey produced the data as showned in table 2.

WATER TASTE	W E L L S :	
	DRY MONSOON	WET MONSOON
"salty"	35	63
"brackish"	44	79
"fresh"	150	178
not specified	3	61
TOTAL AVAILABLE	232	381

Table 2: Well water quality

The table shows that the number of available ground - water sources drops down (to 61%) during the dry monsoon as the quantity of fresh wells amounts to only 40% of the total potential in the wet monsoon. Not mentioned is the hygienic condition of the water. However it can readily be assumed that the well conditions do not favour human health.

IV.6.3. Quantitative water use.

The quantity of water used was analysed in relation to two parameters, the family income and the family seize. The income level did not show a significant relation with the water use. The family seize had a slight , however significant influence. (figure 6)

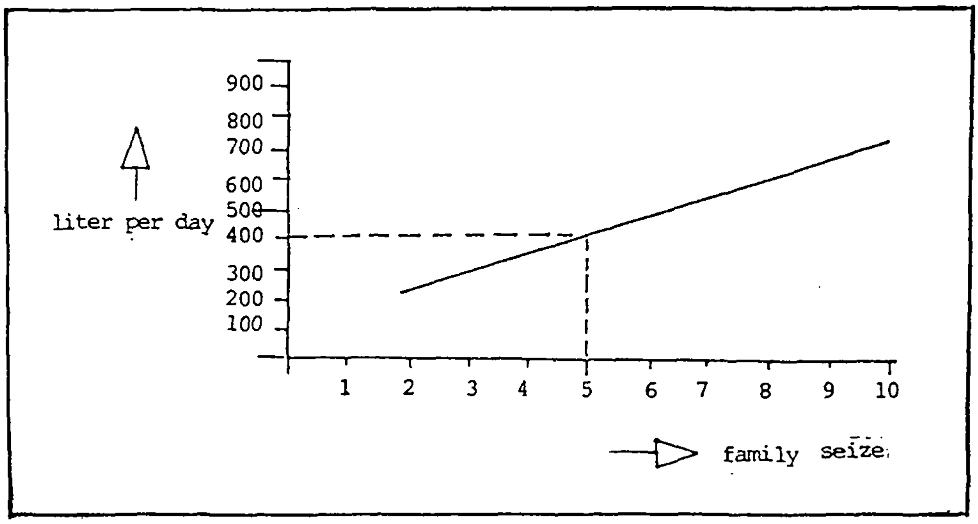

Figure 7: Water use per family

From this observation is shown that a general formula can be derived:

$$Q = n * 62 + 100 \text{ l} \quad (1)$$

$$(n \geq 2)$$

in which Q : The total quantity of water used per family per day.

n : number of people per family.

For drinking water purposes the following equation could be established:

$$Q_{DW} = 3.2 * n + 2.7 \text{ l} \quad (2)$$

in which Q_{DW}: The quantity of drinking water used per family.

For this formula it can concluded that per person there is a basic drinking water requirement and a "social factor".

No clear relations were found for body bathing, washing (Q_B) and for personel hygine (Q_H). Those figure averaged.

$$Q_B = 45 \text{ to } 50 \text{ lcd, and}$$

$$Q_H = 15 \text{ to } 20 \text{ lcd} \quad (3)$$

For clothes washing a relation was found

$$Q_C = n * 9.5 + 5 \text{ l} \quad (4)$$

These outcomes, can be used to estimate the influence of the family seize on body bathing washing (Q_B) and personel hygiene (Q_H):

$$Q_B + Q_H = 50 * n + 95 \quad l \qquad (5)$$

Knowing that the average family seize is 5, it can be calculated that the average ($Q_B + Q_H$) has to amount at 69 lcd. This indeed complies with the information from the field survey (60 - 70 lcd).

The average water usage data can be calculated from the formulas as given. For an average family seize of 5, the average lcd water use can be specified as follows:

Drinking water use	:	19
Bathing	:	250
Clothes washing	:	53
Personal hygiene	:	95
		417 : 5 = 83 lcd

Apart from this water is used outside the house for religious purposes, estimated at 20 l. per person per day. The total water use requirement can be estimated to be 100 liter per capita per day; specified as 80 liter for personal use and 20 liter for general use as an average.

IV.6.4. Conclusion

- The desa Kutaampel belongs to a group of West Javanese villages, classified as class IV. This class is associated with the average per capita daily net income, which is Rp 250,00 in this desa.

- Water use patterns are related to family seize. For a "modal" family the water needs adds up to 100 liters per capita per day. This volume is subdivided is 4 lcd for drinking, 45 lcd for bathing, 10 lcd for washing, 15 lcs for personal hygiene, 20 lcd for religious purposes, and 5 lcd for losses.

- Available water sources in the villages are shallow wells, canal water, and river water. There are 381 wells in the village, however of divers quality re - quirements to taste. Only 40% of the wells provide fresh water, and the reminder is either brackish or salty. The monsoon influence is substantial, reducing the available wells from 381 to 232. The average number of people per well is about 25. However, wells are not equally shared; the better wells are possesed by a small number families while the lesser qualities are to be shared by the others. Irrigation water, and in some cases also river water is used for washing clothes and bathing, as well as for hygienic purposes by (large) part of village population.

V. WATER SUPPLY IMPROVEMENT

Decision on improving the water supply situation may be based on a variety of considerations, amongst which an improvement of the health situation (or) to create a barrier against outbreaks of epidemics. However, also economic aspects may be the reason for improvement especially if the area in concern is important for the nutrition of the country. Whatever the reason may be, planners, designers and economists do need a realistic figure on the quantity of water to be provided, when new systems are planned for implementation.

Before choosing a "lcd-standard" or lcd, the objectives which are to be met, are to be established. Hereby attention should be given to the present water supply provision, since water is available as people are inhabiting the place. One should bear in mind that by implementing a new system for water supply an additional water source is created.

The lcd-standard, therefore, can never be a predetermined figure: only guidelines can be given for a policy for development of water supply in rural areas. Thus, the basic be given principle as adopted by the authors is: "in rural areas the implementation of a water supply system should be only the provision of a high quality water source, topping the existing sources. With this principle lcd, estimates can be made with relevance for the community.

The water use by the people and the occurence of the several diseases can be compared. (figure 8)

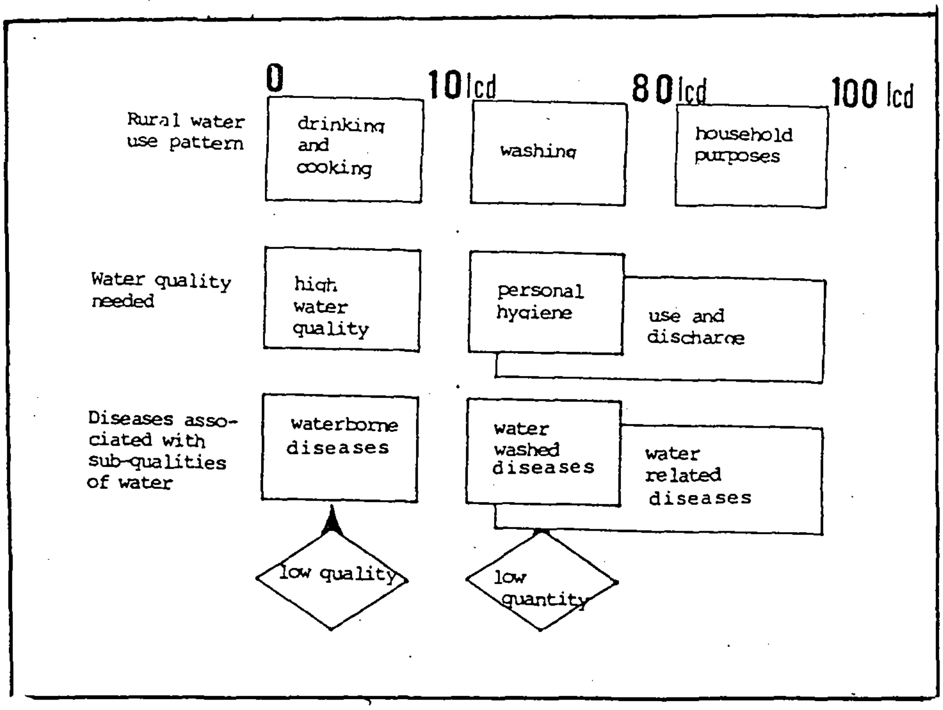

Figure 8: Comparison water use and diseases associated with water

From the figure immediately the required lcd for a certain case can be derived, if there is no water source available for any of the uses, the full lcd should be provided. If the sources in the environment are abundantly available but the quality is beyond standard, the minimal amount to be suplied shall be of 10 lcd.
If the available quantity is only sufficient for general household purposes, at least 80 lcd should be made available. From the existing situation an estimate of the required, additional water supply, can be made.

However, this is a first step in arriving at a proper solution. The economic potential of the population, and or the potentials of local and national goverment to subsidize, next to other factors affecting the health, should be taken into account. Also the range of technical solutions, as available and appropriate for and complying with the skills of the population, will be part of the decision process.

VI. TECHNICAL ASPECTS

Technically, besides shallow ground water, it is possible to use rain water, surface water and water from deep wells as source water supply. The ranges in water quantities each of the sources can cover, are shown in figure 9.

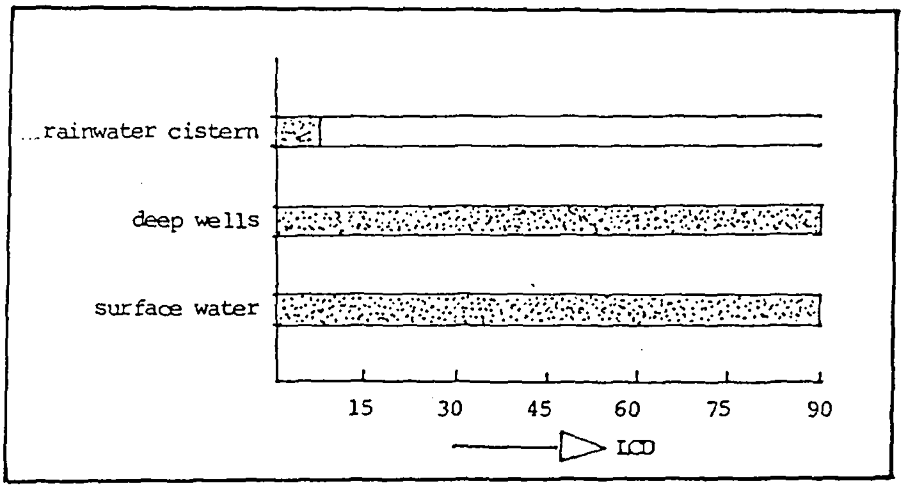

Figure 9: LCD values for selected technical solutions

Rain water cistern systems can only be considered to cover emergency situations, i.e. in case financial funds are limited and no high quality sources are available, since only water for drinking can be provided. The selection of a rain water system is based upon their low cost of construction, operation and maintenance and because they can be constructed by the villagers.

Deepwells and surface water systems can cover the same range of lcd requirements.
Summarized from technical point of view the following can be concluded.

1. Rain water collectors: only for drinking water, they can cover a dry period, are cheap to construct, can be made, operated and maintained with local skills.

2. Deep wells: capacity of the wells is dependent upon the depth of the water and its volume present, needs deep drilling skills for construction, deep well pumps for water extraction, and are relatively expensive.

3. Surface water systems: surface water has to be available, special equipment is required, while for its construction the required skills are not a priority present within the community. Per liter water produced relatively cheap and when designed and constructed properly, to be maintained locally apart from the electro-mechanical equipment.

VII. THE LCD IN A TIME PROSPECT

Accepting the principle that implementing a water supply system in a rural community is creating an additional water supply system, the following considerations can be made. Any choice of a lcd to be supplied, over the present water use, is a step in the process towards a controlled water supply system. Communities will be less dependent upon seasonal influences and will, ultimately, have full access to high quality resources, as customary in Western society. Therefore the choice of a lcd quantity shall focus upon the existing situation, taking into account the development expectations of the community and the region.

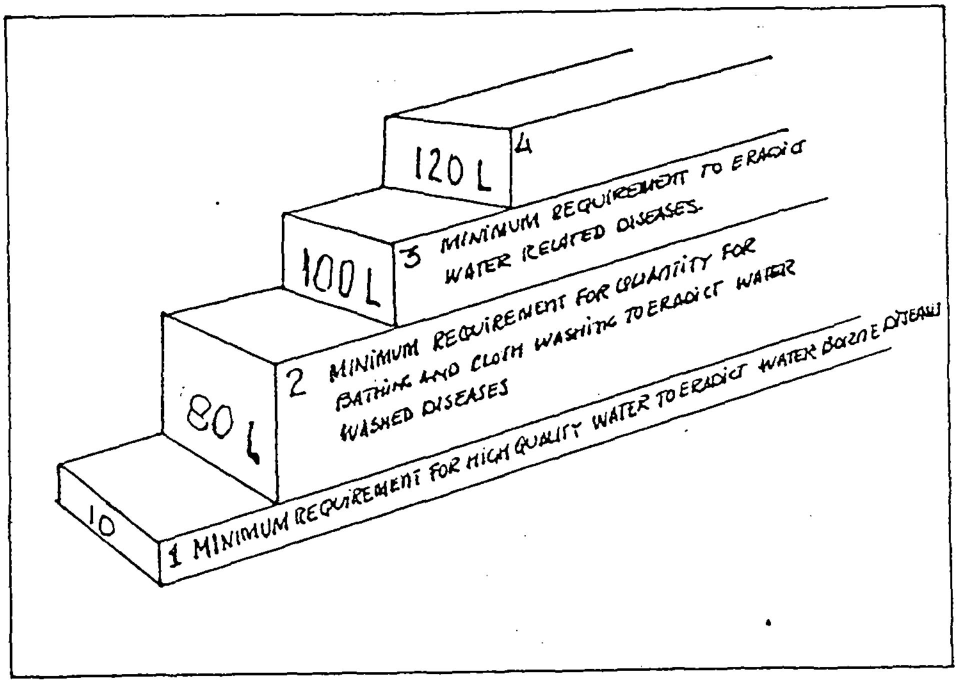

Figure 10: Lcd as a tool in water supply development

For practical purposes, taking into account limited funds and time, needed to develop skills and organizations, the water supply systems to be planned for village water supply are to be selected on their flexibility prospect as well.
Over time, every village will develop and subsequently its requirements of water will change, both in quantity and quality. Thus, for improving village water supply, only those systems can be considered that can be adapted for the provision of more water of a higher quality, to match the social and economic progress back by the community.

VIII. CONCLUSION

A simple truth is: where people live, is water. The available water, however, can be limited in quality, and/or quality, and seasonal variations might also occur. Another simple truth is: the quality of life , in terms of health, depends to a large extend on the quantity and quality of the water available.

Since one objective in development is to increase the quality of life, it is relevant to improve the water supply situation which has an impact on health.
The principle adopted by the authors is: water supply systems are to be seen as additional, high quality water sources, topping the available sources. In several steps the health condition can be improved, first by providing drinking water to eradicate water-borne diseases, second to provide bathing and washing water to eradicate water-washed diseases.

Depending on the emegency and the available funds then, or planning for, improving the water supply conditions of rural areas can be made.