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Introduction:

Responsibility for development of water resources has shifted several times since the publishing in 1952 of the Water Ordinance in this Ordinance, together with amendments, revision, and subsidiary legislation, wide powers are vested with the Minister responsible for water resources. This has been in turn within the portfolio of the Minister for Land Settlement and Water Development, Minister for Natural Resources, Wild-Life and Tourism and since 1968, Minister for Agriculture. In the Ordinance a wide range of functions are specified including protection of and course of any body of water whether used for cattle, fishing or as a source of drinking water; flood protection and construction and maintenance of works necessary for proper use of water. As a result other ministries have responsibility for certain areas of water development and conservation. These include Ministry of Works, Ministry of Health, Ministry of Lands and Settlement, Ministry of Local Government and Ministry of Cooperatives and Social Services. Other agencies are concerned with rural water including voluntary bodies such as OXFAM, international agencies such as UNICEF and WHO and other aid bodies such as USAID. Coordination of the work of these bodies is not all it might be though efforts are now being made to coordinate through the activities of the Water Development Department.

It is useful to distinguish between the various forms of rural water development. In this paper we are concerned mainly with rural community water supplies for domestic use though in part stock water supplies and minor irrigation are discussed. Major irrigation, fisheries development and urban water supplies are outside the scope of this paper.

Water as a development input.

Current concern with the generally poor water facilities in rural areas and the failure to provide new facilities even sufficient keep up with population growth stems from the largely untested hypothesis that water is a key input in the development process. Such statements as "a piped water supply is a major promoter of health and standard of living in a community"¹

1. Diamant BZ "The Development of the WHO/UNICEF Assisted Rural Water Supply Programme in Kenya" Nairobi: 1969.

preface reports on rural water development. Starting from such a premise justification of expenditure, staff requirements and future expansion is practically a formality.

An economist may readily appreciate the utility of piped or protected water but has to question whether the benefits exceed the costs and whether ratio of benefits to costs exceed alternative investment opportunities (after taking due account of special characteristics of competing alternatives). An economist is unlikely to be impressed by statements such as "it is hoped to achieve a target of 50 per cent of the rural population of Kenya being supplied with piped safe water at the end of the (1969-74) National 5-Year Development Plan"². There is no inherent merit in 50 per cent excepting that it facilitates easy calculation. It is important to consider the evidence to support such a target.

Few empirical studies of the impact of protected water supplies on communities have been completed in East Africa. However it is possible to go some way to assessing likely impact by use of deduction reasoning and it is also possible to formulate specific hypothesis for subsequent empirical testing. It is useful to consider separately potential health and economic benefits although ultimately there must be direct and indirect economic benefits from an improvement in health.

Health benefits clearly an infected water source will lead to poor health of persons using this supply. In particular a high incidence of communicable intestinal diseases, typhoid, intestinal parasites, infantile diarrhoea and trachoma might be anticipated.

If domestic water supplies are restricted and insanitary then household cleanliness will suffer, including food hygiene, giving rise to additional risk of infection.

The link between health and economic benefits is that with improved supplies savings are possible on health expenditure,

2. Ibid. p.17

particularly staff and drugs, if preventable diseases are in fact avoided. In addition increased fitness of agricultural workers should facilitate higher labour inputs at critical periods of the agricultural calendar and a higher quality of work. It is generally appreciated that lack of labour at key periods may limit the total area cropped, the area of high value crops and also planting of all crops at an optimum time and thereby lower potential farm income. However the extent to which sickness at critical time periods (such as planting weeding and harvesting) actually reduces the time available for agricultural labour and the efficiency with which tasks are carried out has not been determined empirically in East Africa. In the longer term the debilitating effects of childhood infection are also important for these will lower potential energy output in the subsequent adult working life. Given the high incidence of diseases in rural areas it would be plausible to postulate that preventable sickness must be an important factor constraining agricultural output and economic gains are to be obtained from its elimination.

There is a dearth of data on the extent of preventable diseases in rural areas. One notable exception is for the Zaina area of Nyeri District which has a well documented study that is both longitudinal (before and after rural water investment) and horizontal (with and without piped water, investigated at a single point in time)⁵ Although there are a number of methodological inadequacies, probably inevitable in the circumstances, nevertheless the data is certainly the best currently available for East Africa. The Zaina scheme has supplied piped chlorinated water to nearly 6,000 people since 1961. The area was subjected to a health and general living condition survey in 1961 before the water was available together with a nearby area- Thegenge, which was considered to be similar in all respects with the exception of piped water. Four year after piped water became available to Zaina both areas were resurveyed and it was found that the general

5. Fenwick KEM "A Progress Report on the Zaina Environmental Sanitation Scheme - A Pilot Project in Rural Africa" MOH, NYERI Kenya Mimec(1965?)

level of health had improved dramatically in Zaina among children but declined slightly among adults. In the control area the general level of adults and children had declined. Details are shown in Table I

Table I Morbidity in Zaina and Thegonge
(days illness per person March to September)

Age	1961		1965		65 as per cent of 61	
	Zaina	Thegonge	Zaina	Thegonge	Zaina	Thegonge
1 Year	16.09	9.11	4.34	8.12	27	89
1 - 2 years	13.01	7.17	7.50	10.14	58	141
3 - 6 years	11.10	9.96	5.10	9.50	46	95
7- 12 years	5.44	2.51	3.13	3.98	58	159
Children all ages	4	6.2	4.7	7.5	50	118
Adults	3.28	2.70	3.71	3.15	113	117

One of the most interesting facts derived from this table is that an adult is sick for less than half a day a month and that piped water has made no improvement. Therefore on the basis of this data the hypothesis that large potential gains in labour output are to be obtained from a general improvement in health cannot be substantiated and indeed even if piped water removed all sickness, the gain to the labour force would be less than half a man day per month - perhaps 1.5 days per holding per month.

The improvement in the general health of children in Zaina between 1961 and 1965 is striking and this contrasts with the slight deterioration in Thegonge. The author of the study attributes this to piped water inputs and predicts that the improvement in Zaina and the difference between the two areas will widen as time passes. It is hoped that a follow up study will be carried out in 1970 or 1971. (Indeed given the proposed level of investment on rural water this would appear to be reasonable.) It is not simply piped water that has changed life in Zaina. The presence for extensive periods of doctors, health assistants, nurses and others preoccupied with health hygiene and general environmental improvement must have had an effect. It is not surprising that there was an improvement in other indices of a healthy environment such as improved roofing, larger houses, better ventilation and lower presence of vectors such as fleas, bedbugs, rats, mice and cockroaches. However similar teams were present in the control area and although some improvement was noted in most aspects this was considerably less than in Zaina. It is interesting to note that the control investigation has possibly resulted in local action for Thegonge is now scheduled for a similar reticulated water scheme within the next two years.

Academically this has its drawback because this will end the control for future appraisals.

One problem in ascribing high benefits to health improvement is that investment in piped water with the objective of elimination of infective diseases associated with water supply may not in fact improve general health conditions dramatically. This could occur because other diseases such as respiratory diseases continue to cause high morbidity or because even with the piped supply water associated disease continues. This could occur because the population is still exposed to infection (e.g. infected from purchased vegetables, infected whilst on visits to friends, infected by mosquitoes breeding in waste water areas, infected by sleeping sickness from tsetse flies whilst walking through swamps to market produce, infected because other aspects of hygiene neglected, infected because 'say' for shortage of funds, water is not chlorinated). This is really a depressing view point for it means that to be successful an extremely large area has to be supplied with protected water and all necessary aspects of health and hygiene education satisfied. The main implication is that it is not possible to claim that the benefits from protected water will equal the total savings in health expenditure and saved working time because certainly water related illness will continue to be a social cost.

For some of the water associated diseases it is possible to use alternative methods of control. Typhoid could be prevented by TAB vaccination and yellow fever by appropriate vaccination. Malaria can be prevented by chemoprophylaxis and ascariasis yaws etc. by regular mass treatment. Perhaps the most simple method of improving hygiene is to boil all water used for drinking, cooking and washing utensils. This latter proposal has proved difficult to implement in some countries though not apparently in Uganda. There are however several drawbacks to alternatives including the cost of the services, severe practical objections and there are a number of infections that it is not feasible to treat with alternative means.

Direct economic benefits.

It is claimed that an ample supply of clean water is essential if the densely settled high altitude areas are to successfully adopt high quality livestock enterprises, particularly grade cattle. Ample water at the homestead is necessary firstly because this obviates the energy absorbing walk down the ridges through tick infested vegetation to water animals. Secondly it enables high standards of cleanliness in housing and dairy. Cattle may be kept on fenced paddocks or a zero grazing system can be adopted.

At Zaina between 1961 and 1965 the number of grade cattle increased from 3,640 to 6025, an increase of 66 per cent. In the control area the increase was from 3115 to 4250 or 36 per cent. In consequence Milk Sales to the dairy cooperative have also increased. A similar increase has occurred in the numbers of pigs in Zaina. Data for livestock numbers are presented in the following table:

Table 2 Livestock development in Zaina

		1961	1962	1963	1964	1965
Grade cattle	Zaina	3640	-	-	-	6,025
	Control	3115	-	-	-	4,250
Milk sales to cooperative (gallons)	Zaina	-	54,800	109,700	133,500	110,600
	Control	-	23,400	40,400	56,200	44,600
Pig sales	Zaina	88	235	347	564	1,258
	Control	22	53	60	13	173

Source: Zaina Report

An economic survey of a similar scheme at Kabare in Kyrinyag District was conducted in July and August this year. This is also a piped water scheme installed in 1961. Although the data has yet to be analysed in detail it appears that very few grade cattle have been bought in this area and virtually no pigs. The reasons for this failure to reap economic advantage are not clear but it is probably a complex including lack of credit for purchase of stock, lack of land for fodder without uprooting coffee or having less staples such as maize - a high risk strategy, lack of marketing and processing facilities and less local initiative than in Zaina. Thus the benefits of piped water in the form of returns from intensive livestock husbandry are only potential benefits and a number of complementary inputs are required before these benefits are realised.

Perhaps the most important benefits are achieved by relieving the women and children from their customary task of carrying water from the source to the homestead. This activity is in many cases extremely arduous with heavy loads being carried long distances or up steep slopes. The amount of time involved varies widely as distance from homestead to source utilised has a wide range. In most cases the usual source is within half a mile but in the more arid areas a walk of six miles in each direction is not unknown. In rare periods of drought even greater distances may be covered. Warner⁴ found a round trip ranged from 1.0 to 5.6 miles taking between 40 minutes and 3½ hours. With more than one trip per household per day the total time absorbed in this activity ranged from 3 to 7 hours per day. Provision of a convenient supply would make available significant amounts of labour for agricultural and domestic activities.

4. Warner, Dennis "Rural Water Supply and Development or a Comparison of Nine Villages in Tanzania" E.A. Agricultural Econ. Conference Nairobi: June 1969.

The effort required to carry water is such as to reduce the amount of water consumed in the home to the bare minimum to maintain the household. At Zaina before the scheme was introduced average consumption was only 1.65 gallons per head per day; at Thegonge only 1.29 gallons in 1961 and 1.96 gallons per head per day in 1965. Warner found at nine sites in Tanzania consumption ranging from 0.9 to 3.3 gallons per head per day. With a piped supply at Zaina it is estimated that consumption is now 14.7 gallons per head per day though this is a very rough approximation.

Piped water at the homestead enables supplementary supplies to be given to high value crops at periods of extreme water stress. It is also possible to maintain seed beds in the dry season for crops such as onion or chillies that are transplanted at the beginning of the rainy season. However with most designs the discharge is too limited for extensive irrigation. Perhaps because of lack of awareness or motivation water that is spare is seldom used in this way.

Other benefits which could accrue given an assured safe water supply is permanent settlement in the drier areas where seasonal rainfall makes catch cropping possible. In livestock areas it is impossible to distinguish between communal water supplies and range water supplies. In some areas the number of cattle are determined more by water availability in dry periods than by fodder availability. Increase in water supply will increase cattle numbers and potential off-take^x.

In certain areas such as Amboseli key to rationalising competing uses of land hinge around water supply. The Masai herdsmen and their stock traditionally use the lake in the Amboseli game viewing area as a dry season water source. Their herds have increased in size as a result of improved veterinary attention and now the game is threatened by competition. This in turn threatens the high foreign exchange earnings from tourism. Alternation water sources away from the game viewing area are a pre-condition to solving the social and economic problems presented.

One final potential benefit, largely a social one, exists in the arid areas such as Turkana where the hardships of the inhabitants are increased by inadequate and unreliable water sources. Provision of water to these areas would bring some measure of relief and might effect some savings in famine relief.

Investment Plans

Although the benefits from improved water are more apparent than proven the conviction in Kenya is that such a basic necessity should be provided to a minimum defined standard in order to obtain national objectives particularly

^xCare must be taken because an increase in cattle numbers may denude cover, increase run off thus lowering production of pasture which is limited by rainfall infiltration. Erosion is a secondary though important hazard.

"Social Justice, human dignity and equal opportunity". In the past investment in urban areas has been running at nearly three times investment in rural areas despite the large predominance of rural inhabitants. Government has now decided to greatly increase the current investment of £300,000 per year (recently increased from £100,000 per year) in rural areas for even at this level the proportion of rural population served by protected water is falling. As a preliminary target, to be modified in the light of experience, a basic communal supply (not individual connections) will be brought to the whole country within twenty years. Although there is no firm commitment as yet by Treasury it is known that if this target is to be hit investment will have to build up to £2 million per year within the space of a few years. In order to design, implement and operate the increased programme the Water Development Division of the Ministry of Agriculture is being strengthened and steps have been taken to obtain aid finance to meet capital requirements.

Technical Problem Areas

Before investing in a programme approaching £2 million per year Government needs some indication that the technical capacity exists. Not all areas are suitable for piped water schemes and consideration has to be given to boreholes, wells, dams, hafirs (pans), weirs, sub-surface dams, jabias (rain-water storage tank), rock catchments and protected springs thus considerable initiative and flexibility as to design has to be left to field personell. There are staff vacancies at all levels in the Water Development Division but as this is recognised to be a constraint steps are being taken to rectify the position by training more Kenya nationals and by obtaining assistance from overseas. Past policy has placed the onus for development and operation of rural water schemes upon the local authorities but this has proved in many instances to be a failure due to technical and financial limitations. In some instances pay for staff such as school teachers has been difficult to obtain so it is not suprising that development or even repair work has been found wanting. Recent policy proposals put the responsibility back with Central Government which has the finance, skilled manpower and organisation ability to develop water resources.

In civil engineering terms rural water projects are small jobs. Although a case can be made for the technically more efficient capital intensive construction technique the issue is less clear cut if shadow prices are used for key inputs of unskilled labour and foreign exchange. In social terms it would be a sound policy to insist that wherever practicable labour intensive construction techniques should be used.

ECONOMIC, FINANCIAL AND SOCIAL CRITERIA.

In two areas of policy, namely selection of schemes and pricing of water, there is conflict between economic, financial and social objectives. It would be fair to state that Kenya has chosen to pursue its national objectives from a base of high national income. A high and growing national income is seen as a necessary pre-requisite to the majority of social objectives however landable they might be. Thus the logical strategy given this standpoint is to invest in those schemes which promise to give high returns to national income. Failing this schemes should promise high financial returns so that the stock of public investment funds is maintained. What can be termed social investment or pure charity schemes should receive low priority at this stage unless other considerations predominate (such as political consideration).

One important criterion for selection of schemes is the priority accorded to improved water by the community to be served as exemplified by their self-help contribution be it in cash, materials or labour. It is possible that interest in improved water supply is a consequence and not a cause of development. If this is the case and self-help was the sole or major criterion for selection, the result would be to reinforce trends in regional growth disparity. In practice therefore it is likely that selection will be based upon local initiative, assessed need and forecast benefit in relation to cost subject to a satisfactory spatial distribution throughout the country.

In the past the development of rural water has been hampered by a rigid structure of finance based mainly upon £1 for £1 grants from Government for small schemes and loans for longer ones⁵. Considerable emphasis was placed upon repayment of loans (20 years at 6½ per cent per annum). Government is at present developing a more progressive financial policy which will pay more attention to the potential benefits from the scheme than has been the case. It seems likely that level of initial local contribution will be a more flexible condition related to the needs and means of the direct beneficiaries. Although improved water supplies will not be made available at zero cost, the level of charges get above the necessary minimum will also be flexible and related to the forecast benefits, the means of the beneficiaries and the level of their initial self-help contribution. In the first schemes to be installed with this new approach various methods of collection will be attempted. At present most faith is placed in a proposed system of user groups, who give written agreement to pay a basic sum of perhaps Sh. 5.00 per family per month, more if the costs are greater and substantial benefits are anticipated. Enforcement will be by legal means plus the simple but never used expedient of cutting off supplies.

Owing to the scattered nature of most rural dwellings costs of water supplies are high. As is shown in Table 3 capital costs for gravity fed piped schemes, mostly on the lower slopes of Mount Kenya and the Aberdare Range,

5. Government of Kenya "A Statement of the Policy Regarding the Finance of Rural Water Schemes" WAT/POL/9/62 Oct 1966.

range between £20 and £40 per family or, £0.2 to £0.4 per 1000 gallons per day capacity. Tezo Roka is in Coast Province and here costs are higher. In Western Kenya it is necessary to pump to a hill before gravity feeding. Because of the high population densities cost per family is low (£16 to 18) though cost per thousand gallons daily capacity is high (£0.28 to £0.54). These schemes are scheduled to be constructed within the next two years and their selection in part reflects favourable conditions. In the future it is to be expected that costs will average near the top of the present range. Other forms of development are generally more expensive in the proposed scheme for Manda

Table 3. Capital and Annual Cost of Some Existing and Proposed Water Schemes

Scheme	District	Capital cost (£) per family per 1000 gallons daily capacity		Annual cost (8% 20yrs) (£1 family)
Gravity Schemes				
Zaina 1961	Nyeri	33.7	0.25	7.92
Kabare 1961	Kirinyaga	36.8	0.37	5.61
Kyeni Proposed	Embu	21.4	0.21	2.74
Kahuti "	Muranga	28.9	0.23	3.90
Thegenge "	Nyeri	29.0	0.22	3.67
Inoi "	Kirinyaga	34.6	0.28	4.67
Ngandori "	Embu	29.0	0.20	7.95
Tezo Roka Settlement"	Kiliti	38.6	1.20	4.90
Pumped Schemes				
Nyabondo "	C.Nyanza	18.0	0.54	4.33
Uyoma "	C.Nyanza	18.0	0.45	4.23
West Kara- chuonyo "	S.Nyanza	16.0	0.28	4.78
Tabia-Manda	Lamu	20.4	1.36	2.50

Island low costs are possible because of a fairly dense population with low usage rates. The gravity piped schemes are generally based on requirement of 100 gallons per day per family whereas the Manda scheme is based upon on 15 gallons per day.

Table 2 also shows that if families were to pay full costs (capital repaid over 20 years bearing 8 per cent interest plus estimated operation and maintenance costs) charges between Shs 50 and Shs 160 per year would have to be recovered. In certain areas such as Zaina and Kabare this is in principle possible because incomes are high and such charges would be only 5 - 10 per cent of total family income. In other less wealthy areas these

Although in principle these charges are often collectable repayments in practice are poor. At Zaina and Kabare collections have never exceeded 50 per cent of a Shs 60 per family rate. The main reasons for this are deficiencies in collection procedures and lack of will or legal authority to prosecute and cut off supplies to defaulters. Prospects for collection do not appear too hopeful though Treasury is likely to be very much influenced by this aspect when releasing funds for the proposed enlarged programme.

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