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APPRAISING PROPOSALS FOR WATER SUPPLY INVESTMENTS

By

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ABSTRACT

The main objective of this paper is to discuss the feasibility and utility of economic appraisal of community water investments. In the first section the scope of current investments are detailed. In the second section we discuss the special problems associated with the proliferation of self-help water schemes. Public and private water investments together constitute an important commitment, and we explore the problem of judging whether this investment is at an appropriate level given national goals and available resources. It is evident that this difficult question cannot be satisfactorily answered until we have a more coherent understanding of the cost-effectiveness of individual schemes.

Finally a set of criteria is suggested which may be used to obtain information about individual schemes. Application of these appraisal procedures will sharpen the judgement of decision makers making allocations within the sector. In aggregate this information will also be valuable to those concerned with resource allocations to the sector.

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1. This paper was written as a contribution to the IDS study group investigating certain economic and social aspects of the Kandara Water Scheme in Murang'a District. This study group was convened at the request of the Ministry of Finance and Planning where officials are anxious to learn more about the effects of water investments in rural areas and about the capacity of the beneficiaries to raise capital and recurrent finance to support these large schemes.

2. The writer was a Research Officer in the Planning Division of the Kenya Ministry of Agriculture during 1971/2. He was seconded from Wye College, University of London and financed by grants from the British and Kenya Governments to study economic aspects of the Kenya Water Programme. The views expressed and interpretation of facts in this paper are the responsibility of the writer and should in no way be taken to represent either of his sponsors. He would like to acknowledge the assistance of the World Health Organisation sectoral study team in this and other aspects of his study.

INTRODUCTION

Many rural Kenyans consider a modern water supply extremely important for agricultural production and personal welfare. In most cases, present facilities are viewed as inadequate, and the Government has embarked upon an ambitious investment programme in this area. However, for many people the pace of public activity is too slow, and therefore self-help water projects are being initiated. This paper examines the situation with a view to providing some analytical insights for the allocation of the limited resources available for water development.

It is worth noting that by the standards of developing countries water development in Kenya is relatively advanced. There are several countries in Europe where public supplies are not considered safe. According to the World Health Organisation, "in many developing countries the present rate of increase in urban community supplies is not even sufficient to make up for past neglect, let alone keep pace with the population increase; the present rate of progress in improving rural water supplies is so slow that it will take more than 100 years to reach a satisfactory level". (10) In Kenya, however, investment levels are high and increasing, and operation is relatively efficient. The proportion of water unaccounted for in a system is one index of management performance, and it is shown in Table 1 that according to this index Kenya compares favourably with many countries of the world.

Table 1. Unaccounted For Water in Distribution Systems.

	City	Percent of Produced Water Unaccounted
1.	Sao Paulo	36%
2.	Taipei	35%
3.	Bogota	25%
4.	Kingston, Jamaica	23%
5.	Kuala Lumpur	19%
6.	Lahore	37%
7.	Dacca	53%
8.	Manila	55%
9.	Bujumbura	30%
10.	Yaounde	20%
11.	Addis Ababa	27%
12.	Accra	31%
13.	Nairobi	15%
14.	Mombasa	9%
15.	Kakamega	10%
16.	Bondo	15%
17.	Homa Bay	2%
18.	Kericho	15%
19.	Narok	2%
20.	Fort Hall	5%
21.	Kerugoya	12%
22.	Kiambu	7%
23.	Embu	12%
24.	Meru	5%

Sources: IBRD, Water Supply and Sewerage Sector, Working Paper, October 1971, for 1 - 12. Kenya, Ministry of Agriculture, Water Development Division, operation charts, 1970-71, for 13 - 24.

SCOPE OF WATER DEVELOPMENT

In fiscal year 1970-71, about £5.3 million was budgeted by the Kenya National Government and other public authorities for water supply systems. Of this total, £1.7 million was allocated for development. Table 2 shows a breakdown of this total, taken from the 1971 Economic Survey. The Water Development Division of the Ministry of Finance has overall responsibility for water development and is directly responsible for more than half of the activity in this field. It would appear from these statistics that total water expenditures have increased by 55 per cent over the level of five years ago. However, such a conclusion requires considerable qualification.

First, the expenditures are listed at actual cost, and if corrections were made to constant (1964) costs, the 1970-71 total would be somewhat deflated. Second, the 1970-71 data are provisional estimates, and actual expenditures were considerably lower because of the influence of several factors. Approved development estimates for the Water Development Division, including supplementary estimates, were £1.30 million, but actual expenditures were only £0.78 million. For water development in rural areas, approved estimates were £0.86 million and expenditures £0.41 million.

The Water Development Division's accelerated development programme is not well balanced. There are severe staffing problems at all levels, and administrative procedures cannot cope with the increased pace of development. At present, 44 per cent of the established professional posts in the Water Development Division are vacant. According to a recent staffing report (8), the Division will need 65 additional engineers by 1980. Assuming that engineers will be graduating from the University of Dar es Salaam by 1975 as well as from the University of Nairobi, the total number of Kenyan civil engineers trained in East Africa by 1980 will be around 225. The Water Development Division will attract only a few of these graduates, for they will also find jobs with public and private construction, roads, railways, harbours, irrigation and other sectors. Staff shortages contribute greatly to deficiencies in data collecting which leads to deficiencies in planning.

Table 2. Estimated Expenditures on Community Water Development (Kf'00).

	1966 - 67		1970 - 71	
	Development	Recurrent	Development	Recurrent
Water Development Division	174	1,169	944	1,540
Mombasa Pipeline Board	111	463	45	552
Ministry of Health	26	*	33	*
Ministry of Lands and Settlement	80	*	64	*
Ministry of Cooperatives & Social Services	10	*	23	*
Local Authorities	549	821	603	1,469
Total Development Expenditures Estimated	950		1.712	

* Not available

Source: Kenya, Economic Survey, 1971.

However, these problems would be less serious if their effects were not exacerbated by deficiencies in administrative procedures. These deficiencies are most evident on the financial side. Over the last three years, the development budget has increased fourfold (assisted by Swedish credit) but the recurrent budget has been limited to an increase of only 25 percent (Swedish credit not available). This would not be too serious at this time if the recurrent budget only covered operation and maintenance of existing water supplies, but according to present procedures a number of other items such as planning and transport, workshops for vehicles, petrol, drawing materials and office supplies can only come out of the recurrent budget. As a result of the shortage of recurrent funds, some of the development funds cannot be spent. There are also problems on the development side which lead to the underutilisation of available funds. For instance, urban water development has been financed by loans from the British Government since 1966-67, and 40% of these loans must be spent on imports from Britain and the remainder on local purchases. According to the World Health Organisation Sectoral Study (11), estimates of £816,820 have been approved for urban water since 1968-69, but only £377,914 spent, which may reach £463,000 in the 1971-72 fiscal year. One reason for this is that the accounting system does not yield detailed information about past imports from Britain. Furthermore, there are irregular delays in the issue of funds so that it is impossible to spend the planned amount within the fiscal year. Unspent money from one financial year is not automatically reallocated for the following year.

A third reason for viewing the data in Table 2 with caution is that there are errors of omission and classification. The most important ommission is the expenditures of Nairobi City Council. Unfortunately the municipalities operate according to the calendar year rather than the fiscal year, so straight comparisons are not possible. Increases in population and higher demand from existing population in Nairobi necessitate approximately £1.0 million a year in augmenting expenditures. As a result, Nairobi accounts for about 45 per cent of all public development expenditures on water. A further distortion of the data in Table 2 is that sewerage expenditure is included in the figure for local authorities, and this is 75 per cent of the total for that class of expenditures. The World Health Organisation Sectoral Study estimates that £2.89 million will be available for water development in 1971-2, made up as follows: Water Development Division, £1.12 million; Nairobi City Council, £1.30 million; municipalities, £0.13 million; Ministry of Health, £0.15 million; Ministry of Lands and Settlement, £0.09 million; and Ministry of Cooperatives and Social Services, £0.10 million. The best estimate which can be made of actual public expenditures on water at present is close to £6.0 million a year.

GROWTH OF SELF-HELP SCHEMES

The goal of public water development in Kenya is to provide an adequate water supply throughout the country within thirty years. This time period is realistic in terms of the large area to be covered, the complexity of the programme and the limited resources available. However, although this time period might be realistic from the planners' point of view, there are many indications that it is much too long for those awaiting the improved service. Casual interviews, research findings and the statements of political leaders all indicate that the population gives high priority to water development. Because public water development seems slow and because water schemes which pipe water directly to private homesteads rather than to communal water points are generally preferred by the population but are very expensive relative to limited public funds, large numbers of self-help water schemes are being formed around the country.

Self-help water development is not new. In 1967, 764 self-help water supplies were completed with a total value of £77,000 (78 piped supplies, 157 wells, 84 spring protections and 156 dams and catchments). (5) What is new is the scale of some of the recent projects. For example, Kandara Water Scheme in Murang'a District is a self-help project likely to cost £0.5 million. Mathira Division near Nyeri has a series of self-help water schemes under construction costing between £0.1 and £0.2 million. Plans are being made in other districts for schemes on a similar scale.

It is not fully clear why these very large and ambitious investments are being initiated by local residents. Water supply affects every member of the community, and political leaders are quick to see the opportunities for exercising leadership presented by such a widely popular cause. Quite often political boundaries follow rivers, so a scheme can easily be designed to cover a political constituency. Very large schemes may profit from economies of scale, so that the average cost per family is lowered.

Furthermore, the main objective of many self-help water associations is to lobby the Government to obtain a public scheme, and clearly, the larger the membership the more effective the lobbying. This lobbying is understandable since the average cost of developing a communal point water scheme in Kenya is at present £45 per family and recurrent costs about £5 per family per year, which means that the average annual costs are about £9 per family. Rates for public water projects are generally £2 per year, so each family receives a direct income transfer from public funds of £7 per year.

In the past, the technical coordination of large self-help schemes has often been a problem. The Mathira scheme, for example, has numerous technical deficiencies.[3] To overcome this problem the Government has agreed to provide free technical services for large schemes. If the Water Development Division cannot provide these services, they will hire engineering consultants, as at Kandara for example, but the demands for these services may soon exceed the available funds.

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3. The following safari report was written after a visit to Mathira Self-Help Water Project in October, 1971:

Half a day was spent visiting some of the self-help schemes in Mathira Division. In this area there is a very large number of self-help schemes. Each one is part of a plan to bring water to the bulk of the families in the Division. In most instances individual connections are planned. Construction is in progress in several parts of the Division. Estimated costs are between shs 2-4,000,000.

In view of the very large expenditures involved and the obvious enthusiasm of the people the following observations are extremely disturbing:

1. There were no maps, plans or drawings available and none in use at any of the construction sites. Apparently none exist.

2. No levels have been taken. As a consequence one 50,000 gallon masonry storage tank is out of command and cannot be filled.

3. An additional foot of head is being provided at the intake site to attempt to overcome this problem. Almost certainly this is inadequate.

4. Throughout the Division G.I. pipe is being used. This is generally too small a diameter for planned water consumption. Furthermore, PVC would be more than adequate at half the cost.

5. An interesting method of finding levels is now in use as a consequence of (2) above. A half-inch steel pipe is run across country and if water flows the three-inch main is then constructed.

6. One hydram installed is clearly giving inadequate discharge. No calculation was done and indeed in the absence of technical know-how the empirical approach, though wasteful, is the only alternative.

7. From one intake, for perhaps half a mile, a three-inch G.I. main has been installed on either side of the road. One four-inch PVC main would have served the same purpose at fifty per cent of the cost.

8. At a spring catchment there was a unique but expensive masonry silt removal device.

These are admittedly casual observations. However, it is clear that something is very wrong. Either technical assistance was not requested or if given it is of a very poor order. The system should be such as to prevent this type of wasted efforts. These people are not rich and the wasted effort and money is little short of tragic. For example, one engineer for a week with a few maps and a level would save many thousands of shillings. It is strongly recommended that this situation be further investigated.

GOVERNMENT POLICY ON SELF-HELP

The increased demand for water development reflected in self-help activity raises important policy questions. Of prime importance is the issue of scheme selection. At present district priorities for Government financed schemes are set by the District Development Committees according to local priorities. No guidelines are currently issued setting out criteria which might be applied to weigh alternatives. In certain instances a project considered important by a self-help association ranks low in terms of district priorities. For example the Kandara scheme was ranked fourth by the District Development Committee despite the unprecedented fund-raising efforts of the local people.[4]

This illustrates some of the difficult problems to be resolved. The local community can seldom raise sufficient capital and recurrent finance to pay for a feasibility study, detailed design, contract documents, construction, operation and maintenance. In most cases the operation at least has to be taken over by Government. Rural people understand the need for capital but seem reluctant to face operation and maintenance costs, and generally insufficient funds are raised to pay even for the initial installation. Nevertheless sufficient funds are raised to demonstrate widespread public interest which merits some form of Government support. A well organised and well supported self-help group can try to by-pass the normal procedures for setting district priorities, and if these are relatively large projects they can distort planned allocations within the water sector or even within the national plan itself.

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4. Methods of fund raising merit some study. Various degrees of coercion are employed. For example this is a copy of a circular in the possession of the writer, applicable to all staff of a County Council. Very few of the staff would benefit directly from the project.

All Heads of Departments,

X County Council.

X Harambee Water Project.

Please arrange to collect from staff within your Department towards the above important project as follows:-

Heads of Departments	20/-
Their Deputies	15/-
and the rest	5/- per person

Please let me have your contributions by Monday 4th October, 1971 for transmission to the D.C. on 5th October, 1971 without fail.

(Signed) CLERK TO COUNCIL.

SELF-HELP FOR PRIVATE CONNECTIONS

A new type of self-help water scheme has begun to be developed which also has important policy implications. Current Government projects supply a basic pipe network and communal water points spaced so that there is a point within one kilometre of the majority of the population. In the richer relatively well-watered areas this service is not a great improvement over the existing traditional sources. Many people from schemes in these areas such as Kyeni, Inoi, Gatango, Ngecha, West Karachuonyo and Tartar-Keringet are now petitioning for private on-farm connections. There are sound reasons to support this trend which will be discussed below. However, the costs for this type of system are at least double those of the present Government projects.

In some places these higher costs are being met by self-help activity. For example at Inoi a communal point network is being constructed by the Water Development Division at a cost of £75,000. The residents are petitioning for private connections through the chairman of the Self-help Water Association, and they have raised £4,000 and have a further £25,000 committed to meet this objective. Approximate estimates indicate that the additional cost of providing loop mains and hanging branch lines, plus a simple standpipe for 50 percent of the registered plots would be £100,000 to £200,000, depending on the standard of design and the method of construction.

The Government must decide whether to give in to the wishes of the people of Inoi and provide finance for the higher level of service. It might be thought that these people already are very fortunate to have the communal point system and they should be content. However, it is known that with private connections people will use more water thus obtaining important health benefits, and rate collection will also be greatly improved. These are the benefits which have to be weighed against the cost of the more expensive service.

COST-BENEFIT ASSESSMENT

Water development in both urban and rural areas is an important area for public investment activity. In urban areas it has been somewhat neglected partly because of financial problems, partly because of poor project preparation (many of the benefits unidentified) and partly because of inadequate management systems.[5] In the rural areas, neglect was relatively greater until the late 1960's

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5. Evidence of neglect is that WDD engineering estimates, 1968/9 to 1971/72, were £1.08 million. Approved estimates were £0.82 million and likely expenditures £0.46 million. IBRD in a sector review (Water Supply and Sewerage, Sector Working Paper, World Bank, Washington, October, 1971) suggest that urban areas deserve priority over rural areas because urban dwellers are less able to help themselves, population is increasing more rapidly, needs increase more rapidly than population and high population density makes inadequate and pollutes traditional sources. Conversely public health benefits will be greater and investment costs per head lower because of economies of scale and because planning and operation are simpler.

when the deficiencies were recognised and rural water development was given prominence in the rural development strategy which dominates the current (1970 - 74) Plan.

Evidence of neglect in urban areas, rapid expenditure increases in rural areas and widespread self-help activity all suggest that a continuous review of resources and objectives is necessary. There are several important questions: is the total amount spent on water development appropriate, is the balance between rural and urban expenditures optimal, will water self-help activities absorb resources which would be better utilised elsewhere? Some form of cost-effectiveness analysis is needed to answer these and related questions, but first the value of cost-benefit analysis in this area should be discussed. This is necessary because some have suggested that such analysis is unproductive. Padfield maintains that cost-benefit studies for water are "a trivial but expensive exercise" and claims that for water development in Kenya there is "implicit reliance upon cost-benefit criteria as the only operational index of performance". (6) This second statement is simply not true. Cost-benefit analysis provides a useful conceptual framework, but it is only one of many criteria for decision making and evaluation in the field of water development.

Too much emphasis should not be placed on the outcome of any cost-benefit assessments even if the project output is readily identified and easily valued, as is the case with most industrial projects and some agricultural schemes such as irrigation projects. In sectors such as transport and power, there are special appraisal problems associated with identification, enumeration, quantification and evaluation of costs and benefits. These problems are even greater for domestic water investments, for the link with the production process and readily valued output is even less distinct. Although personal and social benefits from water investments may be real and important, the translation of these gains into conventional economic units presents both conceptual and empirical problems. Furthermore, an improved domestic water system supplies only potential benefits and often a joint input is necessary for these benefits to be realised. For example, an accessible and plentiful water supply undoubtedly creates opportunities for improved dairy husbandry, but dairy cows have to be available and credit is often required before the opportunity can be used. It is therefore reasonable to question the feasibility and utility of attributing the benefits to only part of the necessary inputs.

ROLE FOR COST-BENEFIT

One extreme position would be that all types of cost-benefit analysis are worthless in areas such as water supply where the problems are complex and the analytical procedures seem inadequate. At the other extreme, one could contend that quantification is possible and the assumptions which have to be made anyway are explicit in a quantitative model so that these procedures are a sound basis for decision making. Between these extreme views, we find that meaningful analytical procedures can be utilised to improve decision making in conjunction with expert intuition and judgement.

A problem is identified, key questions are asked, relevant information is collected and evaluated and alternative actions are defined and assessed. The use of this procedure to appraise water projects will reveal insights and approximate measures of value which can only add to the intuition and judgement of experts in making the decisions which have to be made. In the past, decision makers, who are often politicians, have been abused for poor decisions, but this is unfair in some cases because they have not always had the information they needed. Hence they have had to rely heavily on intuition which often leads to error.

Kenyan officials have sponsored a number of efforts to develop appraisal methodology (9, 3, 1 and 6), but problems associated with the empirical application of these methods have become evident. This does not mean that efforts have been wasted, only that they were perhaps misdirected. In the first place, appraisal of the whole programme has been emphasised rather than of particular projects. Secondly, evaluation of the productivity of different schemes has been stressed, although it is now evident that the information gathered is not sufficiently reliable and the precise meaning of particular measures is not clear enough to allow evaluation on a traditional cost-benefit basis. Furthermore, information for alternative investments in such areas as education and health is not available (although meaningful cost-benefit appraisals have been proven possible for certain health programmes). The cost-benefit analysis of individual projects should improve those projects and provide feedback for planning other similar projects. The scale of such assessments has to be limited and only a few schemes can be thoroughly tested, but in spite of these limitations it should still be possible to improve planning and implementation.

BENEFIT REALISATION

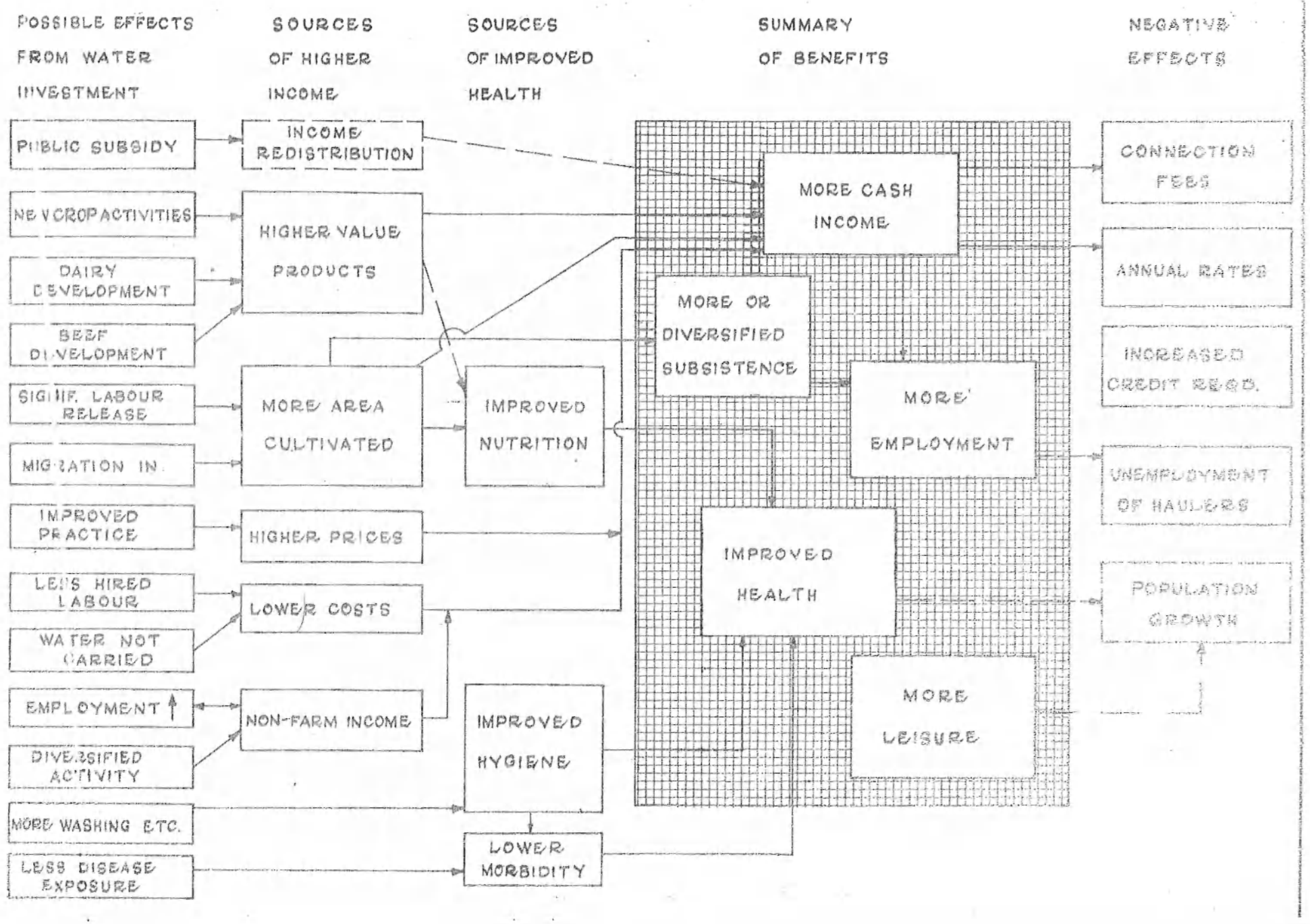
It was previously noted that the main appraisal problem is the estimation of benefits. It is known that water investments will generate opportunity for four types of benefit: higher cash income, increased and more reliable subsistence, improved health and increased leisure. Attempts to identify the components of each type of benefit are made difficult by the two problems of isolating the effects of water development and valuing benefits which are not marketed. Progress in this area is likely to be slow and unproductive, and a new way of handling the benefit question is needed.

A more productive approach is to regard water development as one important input for rapid rural development and to concentrate on assessing the overall potential and the complementary inputs required to realise this potential. An area with few complementary facilities will give a lower return to water investment than an area which has similar potential but is better endowed. In the second area there will be a higher benefit from the release of labour, improvements in health and so on. For example, the economic gains from investing in areas where tea roads (high standard roads built for the rapid transport of tea) are available will be greater than in areas with a similar ecology but where there are unimproved dirt tracks.

Figure 1 illustrates schematically the major benefits of water development. This should indicate key questions which will facilitate the appraisal procedure. The water planner cannot be expected to make an integrated development plan for a whole area, but it would not be too difficult to list complementary facilities and notify the authorities responsible for missing facilities of the opportunities likely to be available. In this way the proportion of potential benefits realised should be improved. For instance in an area with dairy potential, the agricultural extension staff, credit agencies, dairy cooperatives and animal disease officers should be officially informed of the water scheme plans. Similar information should be given to the public health authorities and community development officers.

Information on the development potential of an area and the existing facilities is valuable to decision makers and planners. If decision makers aim for growth at least cost, they will choose schemes with apparent potential and existing infrastructure. However, this will result in a policy of giving more to those with existing facilities, and the neglected areas will become relatively more neglected. If the opposite policy of compensating backward areas is pursued, then the necessary complementary facilities are specified. If this procedure is adopted, planners will have more information on which to base their assessments of technical proposals. For example, there is stronger economic justification for private on-farm connections in dairy development areas.

IMPACT OF WATER INVESTMENT



OVERALL IMPACT

President Kenyatta recently stated that "the real strength and spirit of a nation lies in the contentment of the people and their knowledge that structures of development have a measurable effect on their own lives". Water supplies must rank very high in meeting this objective.

All water investments will have an important benefit unrelated to economics, public health or even leisure, and this poses the principal analytical problem. Suppose, for example, it could be shown that released time creates no new income earning opportunities, that health benefits are not significant because other diseases abound and that leisure is already available in abundance. It would not follow that no water investments should be made, yet this information would be valuable to planners in deciding the level and rate of investment and the type of service to be provided. The question of income redistribution becomes apparent, and it should be noted here that income redistribution is perhaps one of the more important criteria to be used in judging the benefits of water investments.

APPRAISAL CRITERIA

Useful criteria for judging water development proposals, whether for the national programme or for a particular scheme, are presented below:

1) What are the needs?
2) What are the goals? This involves some consideration of opportunity costs.
3) What resources are available? What share of national or local resources could realistically be called on for this project?
4) What means are proposed? This involves a consideration of the allocation of resources.
5) What alternatives were considered? A preliminary evaluation of proposals should be made.
6) What activities are involved? List the actions necessary for the execution of the plan.
7) Are the goals likely to be achieved by the proposed actions?
8) What effects will the project have? Do these justify higher investments?

This set of questions has been used to derive the appraisal procedure set out in the appendix.

The first two questions are the most important and most neglected, especially when the programme as a whole has been dealt with. The last four questions are more appropriate to the appraisal of particular schemes, but they are also necessary for the review of programme objectives. The question of needs will be taken up in more detail in the following section.

NEEDS OF THE COMMUNITY

The community needs a safe, accessible, reliable, plentiful, low-cost water service.

Safety

Provision of a safe water supply would seem to be an undisputed objective. Safe water should be hygienic and palatable, and should meet certain aesthetic standards with no discolouration or visible solid matter. There are two problems involved in the translation of this desirable objective into an operational procedure. First, safety is not an absolute standard, for water can be more or less safe, and second, considerable capital and recurrent costs must be met to provide a relatively safe water supply.

Water may be made unsafe by an excess (or deficiency) of naturally occuring or man-made chemical substances, by pathogenic micro-organisms or larger forms of life such as worms. In East Africa the most common chemical contamination is excessive sulphate salts, and the most troublesome form of chemical pollution is fluorine in borehole water. This is a particular problem in parts of Tanzania. (2) In Kenya some of the boreholes in the Rift Valley have potentially harmful levels of fluorine (i.e. above 1.5 pp. on). Although national and international standards for water quality are valuable for the purpose of surveillance, considerable judgement and flexibility is required in application. Water considered unsafe by World Health Organisation standards may nevertheless represent a marked improvement over the previous supply. In some communities no alternative water source may exist and therefore chemically unsafe water has to be consumed.

There is often no cheap and effective means of purifying water from chemical contamination. However, it is technically possible to eliminate most pathogenic organisms by treatment, and it can be argued that the costs of such treatment would be outweighed by the benefits of improved health. However, even if it is accepted that the benefits exceed the costs, it is not possible to treat all water supplies in the short run. Where a public water system is installed with a water source that has a known pollution risk, either chlorination or filtration or both are to be recommended.

There are two source for the Kyeni water scheme, one inside the Mount Kenya forest and one in farmland. Water samples have been taken on several occasions, and both sources have been classified as unfit for human

consumption because of bacteriological contamination.[6] Consequently a chlorination plant is being installed which will increase annual costs by approximately £0.25 per user. It has been estimated that for rural water schemes as a whole, the annual per capita costs of treatment (chlorination and filtration) average £0.5.

Accessibility

All human settlements have access to water, but the time people must spend reaching the supply varies enormously. With private on-farm connections this time spent is minimal. There are very few household connections in rural Kenya. At Kabare, Zaina and Kibichoi a total of nearly 50,000 people are served by on-farm 'courtyard' connections, but no connections are made to the household as is the practise in urban areas. At Zaina with its large number of water outlets (In 1970, one third of the connections were dry however.), the average time spent fetching water per day per family was only 25 minutes, and in a nearby location with communal water points 45 minutes (4), i.e. a net saving of 20 minutes per family for the Zaina residents. The saving is similar at Kibichoi and Kabare. At Kibichoi 50 per cent of the farmers before the scheme had to travel between one and two miles to the water supply (7), so the time taken to fetch water was slightly greater than in the control area near Zaina. Kabare is well watered and not too mountaineous, so that the amount of time saved by investment in private water connections would be smaller as in Zaina. These and other high potential areas are generally well watered, and it is to be expected that the amount of time saved by the installation of water connections would be relatively small, generally less than an hour a day. However, in the high potential areas one would expect the opportunity costs for labour to be high. In these areas valuable crops are grown with husbandry methods which generate peak demands for labour at certain times of the year. Consequently there are profitable opportunities for released labour, but the time saved by water investment is a relatively minor factor.

In the arid low potential areas we have the opposite situation. Here the rural economic system is based on livestock with relatively low labour requirements. Furthermore, there is a clearer division of labour between men and women in the livestock herding areas. In this situation water is generally much further from the household, and several hours a day may be spent fetching water. However, settlements are sometimes temporary and generally scattered so that costs of water development per family are higher than in high potential areas.

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6. For example, samples taken on 4/3/1971.
Presumptive Coliform Test

	Thuchi Intake	Siangomo Intake
Coliforms:	180/100ml. water	160/100ml. water
E. Coli.	180/100ml. water	90/100ml. water

It is in the medium potential areas that the highest productive labour savings from water development might be anticipated. Here production is based on crops and livestock, and peak demands for labour occur during the rainy seasons. Surface water sources are often limited, unreliable and at some distance from the households. This often, but not always, makes development of these sources more expensive than in high potential areas. On the other hand, the gravity scheme at Kyeni runs from the high potential zone to the medium potential zone, so that extension and better service can be achieved in the medium potential area at a relatively low marginal cost. The medium potential areas below the high potential areas should be regarded as expansion areas for the relief of population pressures in the high potential areas. This type of expansion will become more attractive as developments in agricultural technology make cultivation possible in the drier areas, and settlement in these areas will be greatly encouraged by water development.

Reliability

If a water source is unreliable, very little can be done to improve the situation. Storage can increase reliability, but it is expensive. The best way to assure reliability is to select a good initial source, and the additional cost of reaching a more distant but more reliable source[7] is often justified.

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7. For example this report from the WHO sectorial study files:

SAFARI REPORT

MARTINYANI WATER SUPPLY

The source of water consisted of three wells adjacent to a swampy area. Originally only one well was built but two extra were added in an attempt to increase the allowable draw-off. A 2,000 gallon/hour pump pumps the water to the school complex about a mile away. There is one tap about three quarters of the way up the pumping main. The water is delivered to a steel elevated tank about 15,000 gallon capacity. There had been no water reaching the tank for over a week at the time, due to lack of water at the source. The strata in which the wells have been sunk is not sufficiently permeable to warrant such a supply from it. When pumping commences the water very soon drops in level down to suction inlet and the operator must wait some hours for it to recover.

The school has been built in anticipation of a reliable water supply with a large shower block and several residential quarters. Water was being brought in by vehicle for the teaching staff but it was not known how to cope with the boarders when school was commenced in the next week.

The headmaster stated that a permanent stream existed about three miles away. This was not checked but if so, it would certainly give a better supply than that now in use.

The scheme is in Phase 6, 1968/69 of the WHO/UNICEF programme.

Reliability of the system as a whole is a function of good design, good materials and careful supervision during construction and operation. Certain types of systems are more likely to be unreliable than others. For example, according to the World Health Organisation, 51 per cent of all the WHO/UNICEF schemes are working, but only 37 per cent of the pump schemes. (11) Pump schemes are more difficult to design, require careful maintenance and have relatively large recurrent costs.

Reliability is an even more important criterion in urban areas than in the countryside because in urban areas alternate water sources are generally inadequate or polluted.

Quantity Supplied

It has often been stressed that a water system must produce large quantities of water if important health benefits are to be realised. The marginal cost of increasing pipe capacities is relatively small (A four-inch pipe has twice the carrying capacity of a three-inch pipe but costs only fifteen per cent more.), so it would appear that there are only minor obstacles to the provision of large quantities of water. However, the situation is more complicated because a good deal of empirical evidence suggests that without household connections people will not use more than twenty litres of water a day per person. If water has to be carried more than a few yards, daily consumption per person falls below twenty litres. Although little is known for certain, this level of consumption is considered insufficient to protect against disease, especially from the group of infections which have been classed as water-washed diseases - dysentary, yaws, scabies, etc.

The capital costs of water systems with private on-farm connections are very high, as shown by the preliminary estimates of the additional costs of supplying homes in Kyeni, Inoi and Gatango. At Kyeni, the cost of supplying a storage tank alone was 120 per cent greater than the cost of the communal point network already installed. At Inoi, the estimates of the cost of private connections for only 50 per cent of the farms (the estimated effective demand) excluding on-plot facilities but including storage increased the total cost of the project over 100 per cent. At Gatango, additional cost estimates are almost as high. We have no statistics on the magnitude of benefits from individual connections with which to compare these additional costs. It is known that only 65 per cent of the population use the communal points at Kyeni, that only fifteen litres per head are consumed daily and that the rate of revenue collection is very low (six per cent of levy).

COST OF DEVELOPMENT

Water development uses large amounts of capital and skilled labour, both of which are in limited supply. For this reason, most students of the subject agree that a full development programme will take twenty or thirty years. Even in the rich countries of Western Europe piped water supplies have been in general use for less than seventy years, and remote and isolated communities still rely upon wells or springs. A recent study of rural water development in England concluded "that the costs of maintaining the existing settlement patterns would exceed those incurred in providing similar facilities by relocation". In other words it would be cheaper to move the communities than to pipe water to them. Almost certainly this will be true in all but the high potential areas of Kenya. Indeed, in Tanzania one of the justifications for the Ujamaa Village settlements is that the per capita costs of services such as water will be made lower.

Cost estimates for water schemes vary widely because of the influence of several factors such as topography, ground conditions, location of source, location of scheme, population density and design standards. Despite this wide variation, average or model cost estimates are useful guides when assessing the likely magnitude of national programmes and the relative costliness of a particular scheme.

The following cost estimates are suggested in the World Health Organisation sectoral study, based on the experience of Tanzania and Uganda (11):

Table 2. Modal Per Capita Costs of Water Development (K£).

Service	Treatment	Rural	Urban
Individual connections	Yes	£5.50	£10.00[a]
Communal points with pipe capacity for i.c.	Yes	£4.50	
Communal points with full reticulation[b]	Yes	£5.50	
Communal points[b]	Yes	£2.75	
Communal points[b]	No	£2.50	

[a]These costs are higher because the per capita water requirements in Mombasa and Nairobi are about three times the rural levels, and the marginal costs are £16 and £25 per capita respectively.

[b]All communal points estimates assume 100 per cent usage.

Source: 11.

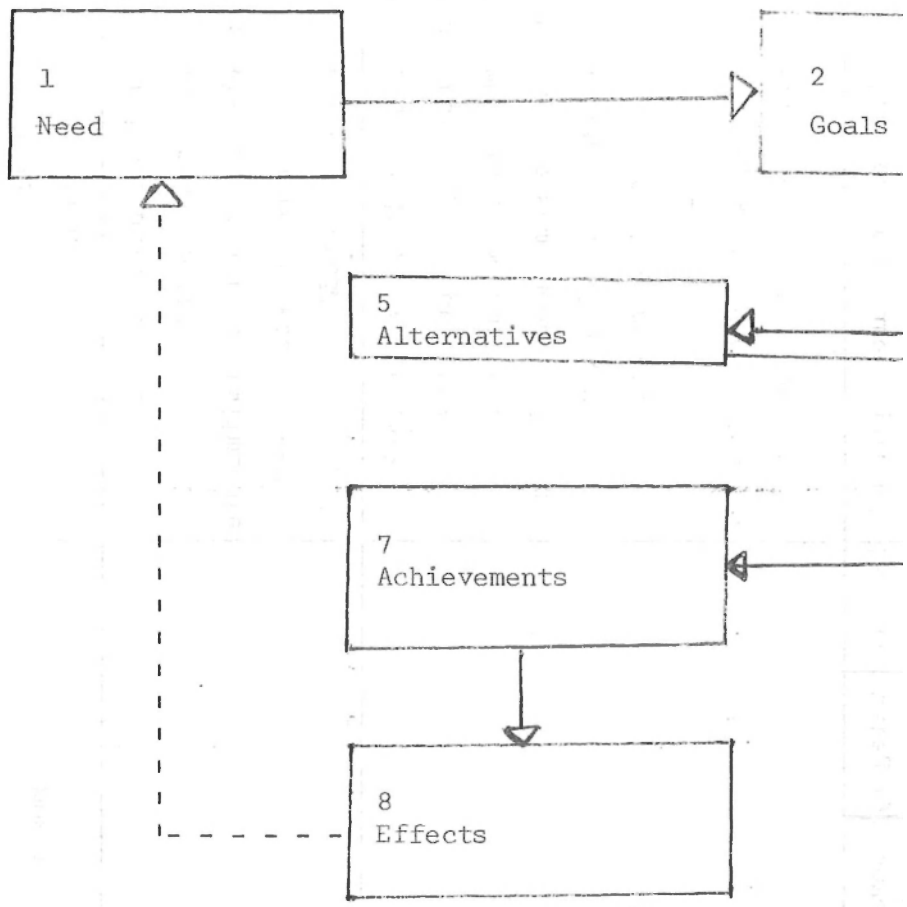
Annual recurrent costs for individual schemes (1971) range from shs 3.50 per capita in Isiolo to shs 115 per capita in Kwale, which is more than double the cost of the next most expensive scheme. The average for all Water Development Division schemes is shs 14 per year, somewhat higher than is technically possible because capital rationing has inflationary effects on operating costs and old or over-extended schemes generate high recurrent costs.

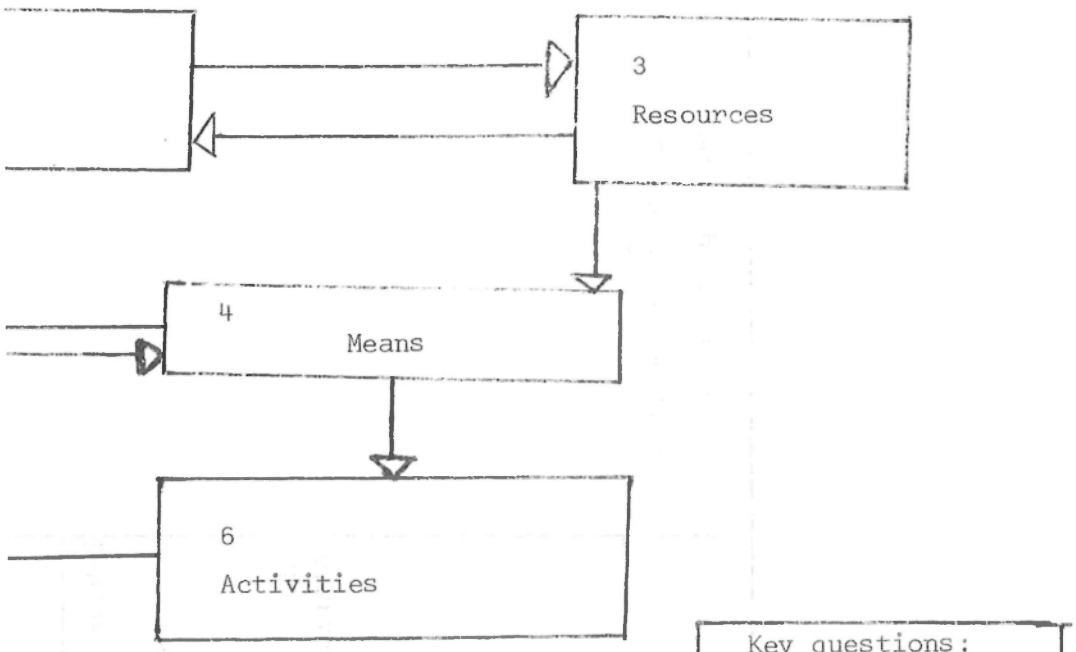
These cost estimates show that the annual cost of a piped-water rural scheme is about £1.1 per capita per year or £10 per family, in other words about one-fourth of average cash income. A rate of £2 a year is usually charged, or about five percent of cash income. Thus private costs are only twenty percent of direct public costs, so that significant income transfers are being made from the general public to the water scheme users, all the more so if the users are not paying the rates.

CONCLUSION

This is not a comprehensive review of rural water development, but a few topics have been discussed which are hopefully relevant to the problems of evaluation and decision making. In particular, discussion has centered on the issues raised by the large self-help water schemes.

APPENDIX. PROCEDURE FOR APPRAISAL.




3
Resources
4
Means
6
Activities
Key questions:
What
Why
How
When
Where
Who

<table>
<tr><th>Criteria</th><th>Critical Question</th><th>Comment</th></tr>
<tr><td>1. NEEDS</td><td>1.1 What are needs of area?
1.2 Why these needs?
1.3 What alternatives? (Eliminate need, more or less of need, different need.)</td><td></td></tr>
<tr><td>2. GOALS</td><td>2.1 What needs are to be met?
2.2 What is given priority?
2.3 What is to be omitted?
2.4 Why are some needs deferred? (Classify as vital, very important, important, desirable.)
2.5 How are goals to be achieved? (Give very general answer.)</td><td></td></tr>
<tr><td>3. RESOURCES</td><td>3.1 What resources are required?

3.2 Any self-help? - specify.
3.3 Do goals appear realistic?</td><td>
<table>
<tr><th>Resource</th><th>Category</th><th colspan="2">Development</th><th colspan="2">Operation</th></tr>
<tr><th></th><th></th><th>Unit</th><th>Level</th><th>Unit</th><th>Level</th></tr>
<tr><td>Labour</td><td>Unskilled
Skilled
Highly - Skilled</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Land
Materials</td><td>Construc-tion
Fuel & Power
Transport
Overheads</td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

Criteria	Critical Question	Comment
4. MEANS	4.1 What technical means proposed? 4.2 Why this system? 4.3 How is it to be implemented? (What materials, equipment, procedures?) 4.4 When is it to be implemented? (What is sequence of events, when do they start, what is the duration?) 4.5 Where is it located? (Why were the limits so decided. Why not larger or smaller?) 4.6 Who is responsible for initiative, design, construction, operation, finance?	
5.ALTERNATIVES	5.1 What initial studies were conducted? 5.2 Were alternative layouts and preliminary estimates prepared? 5.3 What procedure was used to select final design? 5.4 Was the timing of costs, in alternatives, accounted for by a discounting procedure?	
6. ACTIVITIES	6.1 Was this sequence adopted: predevelopment study, design, purchasing, construction, operation? 6.2 Demand assessment 6.2.1 Is per capita consumption in line with guidelines (Appendix EI 20-25 CWP, 50 LPD)? Private connections? 6.2.2 Is livestock accounted for (75 lpd grade cattle, 25 lpd others, 5 lpd small stock)? 6.2.3 Are institutions provided for (Administration, offices, hospitals dispensaries, schools, hotels, bars shops, overall industries, etc. See guidelines for demand estimates.)?	

Criteria	Critical Question	Comment
	6.2.4 Is irrigation permitted? What would be additional cost of providing, say,400 lpd? 6.2.5 How is pattern of demand over time determined? 6.2.6 What provision is made for phasing supply to match increasing demand? 6.3 Intake design - is source sufficient to feed intake 24 hours with ultimate demand? 6.3.1 How is intake capacity related to ultimate demand? 6.4 Treatment - is water source tested biologically, chemically? 6.4.1 Is full, partial or zero treatment proposed? 6.4.2 Are treatment plans phased with demand? 6.5 Pump Installations - is it gravity or pumped? 6.5.1 What is standard capacity? Is this reasonable in view of alternative sources, scheme storage, etc? 6.5.2 Do proposed pumps match attitude, demands etc? 6.5.3 Is there 12 hours storage at end of rising main? If more, is it justified? 6.6.4 What is length, design, etc. of rising main? 6.6 Main lines - are these plastic, asbestos-cement or metal? Why? 6.6.1 Was there a detailed survey? 6.6.2 How is capacity related to present and future demand?	

Criteria	Critical Question	Comment
	6.6.3 What is maximum pressure (1 100 m)?	
	6.6.4 Is there on-line storage, is it associated with break-pressure tanks?	
	6.6.5 How is on-like storage justified?	
	6.6.6 Branch and distribution lines - is density sufficient to supply communal points and/ or all farms?	
	6.6.7 What peaking and minimum pressures are assumed?	
	6.7 Distribution System - communal points, licensed retailers, private connections. List.	
	6.7.1 What changes over time are expected?	
	6.7.2 Are communal points simple or otherwise? What is distance between them? How are they located?	
	6.7.3 Is there storage at water point? Is peak demand such that it is utilised?	
	6.7.4 What is the marginal cost for private connection?	
	6.8 Purchasing - is the scheme dependent upon cost regulations regarding purchasing?	
	6.8.1 Is there an alternative procedure?	
	6.8.2 Are there stores to hold materials?	
	6.8.3 Who prepared material schedule, bill of quantities, cost estimates, drawings?	
	6.8.4 Who is to prepare contract documents and evaluate tenders?	
	6.8.4 Is water permit obtained?	
	6.8.5 Is all necessary land purchased?	
	6.8.6 Is project to be gazetted?	
	6.9 Construction - who is to construct?	

Criteria	Critical Question	Comment
	6.9.1 Is contractor on WDD-approved list for job of this size? 6.9.2 Are there bar diagrams/critical path for construction stages? 6.9.3 Is consideration given to capital/ labour substitution? 6.10 Operation - is there an operating manual? 6.10.1 Is provision made for taking over existing schemes? 6.10.2 Is there a trained operator? 6.10.3 What are the costs of operation? 6.10.4 What organisation is responsible for operation, maintenance and augmentation? 6.11 Finance - what is the source of finance for capital and recurrent items? 6.11.1 What are the terms for finance? 6.11.2 What is the payment system proposed and rates scheme? 6.11.3 What are estimated collection costs? 6.11.4 By what means were the people informed? 6.11.5 Who is to collect and account for revenue? 6.12 Benefits - Use figure 1 to describe overall development potential, complementary facilities existing and required. Write critical assessment. 6.12.1 How was scheme selected? 6.12.2 Is there evidence that scheme is accorded high priority by people?	
7. ACHIEVEMENTS	7.1 What will be achieved (e.g. water delivered to X people by CWP, or by private connections etc.)?	

Criteria	Critical Question	Comment
8. EFFECTS	8.1 Do the achievements meet the objectives stated under 2? This includes what is achieved, why, how,when, where and by whom.	

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