

Management of water supply systems in the Kano district of Nigeria: problems and possibilities

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ABSTRACT

Poor water supply practices directly affect the social and economic conditions of each and every community. Since actions on water supply systems are usually at the local level, this is an area where individual citizens can become highly involved if motivated and energized with financial incentives. Community education is vitally important for sensitization and mobilization of the rural communities so as to achieve commitment and sustainability. The theme of this discussion is that water-using development projects should fulfil the real local needs for improved production, social conditions and cultural achievement. Consequently, a strategic approach for managing water resources sustainably is essential to the actual planning, development and implementation of water-related development activities.

Key words | basic needs, communal efforts, indigenous knowledge system, nucleated settlements, rural water planning, water-borne diseases

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PROBLEM STATEMENT AND OBJECTIVES

Most of the populations of developing countries live in areas that lack basic social and welfare services particularly in rural areas. This situation encourages people, particularly the younger generation, to migrate from the rural areas to the urban centres. To stem the undesirable rural–urban migrations, the provision of basic social amenities in rural areas is essential. The development of safe water supply systems for rural environments is vital in order to satisfy basic needs and, over recent years, has increasingly become an important guideline in rural development policy (Forch and Biemann 1980).

The emphasis today lies in the search for adequate sources of rural water supply and their development to acceptable standards for rural water use. Thus, water has to be transformed from its natural raw state and then transported to homes and factories to satisfy human needs because the hydrological cycle does not adapt itself to our space, time and quality requirements (Kavanagh 1967). Yet the general experience is that securing good quality water for millions of poor under-served people continues to pose immense problems everywhere in the developing world.

Consequently, rural dwellers have commonly been left to their fate of relying on water sources that are unreliable and unsafe for consumption.

For instance, during the dry season, people usually spend much time and effort to obtain untreated water from distantly located sources, which carries pathogenic organisms. The prevalence of debilitating water-borne diseases such as guinea-worm, typhoid fever, diarrhoea, cholera, intestinal disorders and schistosomiasis helminthiasis gives the alarm. This situation results in an inefficient and ineffective labour force in terms of reduction in labour hours and general debility (Acho-Chi 1980). Obviously, the improvement in the water supply situation with regard to quality, quantity, distribution and local stewardship has a key role to play in the rural development process.

The availability of sufficient potable water thus constitutes a yardstick for assessing social development in developing countries. Rural water planning can help to inform the decision maker to make more rational decisions. In this context, the objectives of the present study are to:

1. analyse the problems of rural water planning in an environment which lacks basic water and sanitation services,
2. discern the factors which may affect an improvement of the situation, and
3. determine the potential of feasible forms of action.

METHODS

The information used in this paper comes partly from field studies of some 20 village communities close to Kano City, Nigeria, and partly from published material. Three interview schedules K_1 , K_2 and K_3 were developed. Schedule K_1 addressed the perceptions of the people about local water resources development; K_2 focused on the water supply situation; and schedule K_3 dealt with the development and operational maintenance of water supply schemes in the study area. Interviews were undertaken in the local language by field assistants who were of school certificate level. Samples of equal proportion were taken from each surveyed village community. The argument is that the Kano district is an amalgamation of small, nucleated settlements with similar physical, socio-economic and cultural elements. Random systematic sampling techniques were used within each of the sampled villages in order to obtain the interviewees.

GEOGRAPHICAL AND ECOLOGICAL FACTORS

Geohydrological characteristics

The study area has three main physiographic regions, namely, the basement complex to the south, Chad formation to the north, and river alluvium along major rivers. The rocks are mostly crystalline and metamorphic. Sub-surface water is limited to pockets of discontinuous mantle of weathered rocks (local aquifers). Faniran (1975) notes that the random distribution of these aquifers is similar to those of the rural settlements. This implies that a sustainable supply of boreholes can be introduced into the

rural communities with maximum local involvement. However, the decomposed mantle is often too thin to collect and store large quantities of water. Consequently, the success ratio of borehole programmes in the surveyed area has been low.

In contrast, the Chad formation is a fresh water sedimentary sequence of Pleistocene age. Here, groundwater occurs in perched aquifers as confined or semi-confined water. So far, small aquifer systems have yielded very encouraging results. Besides, river alluvium occurs along water courses. It comprises various sediments such as coarse and fine sand, silt and clay, making available storage capacity.

Most of the streams retain water in the alluvium throughout the year and the reserves may be large enough to constitute economically viable water supplies for the nearby communities. The only constraint is that considerable surface run-off from torrential rains assists the transfer of water out of the Kano district, since neither the sparse and scorched vegetation nor man-made barriers seem able to contain it. The result is that the physical characteristics of the local water resources are impaired by the spread of desert conditions.

Water resources

The geographical location of the Kano district of Nigeria away from the sea determines its climate, which is hot and dry most of the year. Water quality and abundance are issues in the area surveyed. The extensive and indiscriminate use of the environment accelerates run-off and decreases seepage. The local circumstances, therefore, fail to augment water resources and call for responsible rural water planning.

Table 1 indicates that replenishment of groundwater occurs between July and November when there is no water deficit. Annual rainfall variations are not large, but the contrast between a relatively short, intense wet season and a long, intense dry season is significant locally.

The agricultural communities, therefore, are poorly endowed with water resources. This is consistent with the observation that more than 50% of the available water is consumed by evapotranspiration processes. Acute water

Table 1 | The water balance for Kano (after Faniran)

Components (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P	0	0	2	9	64	110	223	301	136	16	0	0
PE	118	128	175	175	200	163	146	120	139	156	132	132
ST	0	0	0	0	0	0	77	258	255	115	24	0
AE	0	0	9	64	64	110	146	120	139	156	132	24
DEF	118	128	173	136	136	53	0	0	0	0	0	108
SUR	0	0	0	0	0	0	0	0	0	0	0	0

P=precipitation, PE=potential evapotranspiration, FC=field capacity (300 mm), ST=soil water storage, AE=actual evapotranspiration, DEF=water deficit, SUR=water surplus (all the table units are measured in mm).

shortages are common, particularly in the dry season as sources are exposed to intense net radiation and the attendant extremely high evaporation rates.

In the annual water balance, the potential rate of evapotranspiration exceeds the quantity of precipitation (Figure 1). This seriously reduces local water supplies. This usually occurs in the hot dry season marked by constant thirsty winds. Grasses wither, trees shed their leaves, while water courses dry up with the entire land-

scape appearing as a desert. Bush fires are common and dust storms blow sandy soils from the sun-baked fields. This is the season of the desiccating harmattan, which is very severe in this region. The effect is that the water table is at greater depths below the surface and the soils are much drier. Subsequently, there is no surplus water that could rapidly replenish the soil moisture of the desiccated soil profile; and the water table is liable to many fluctuations. This necessitates a radical change in traditional attitudes towards water management and the introduction of a holistic approach to water use in the Kano region.

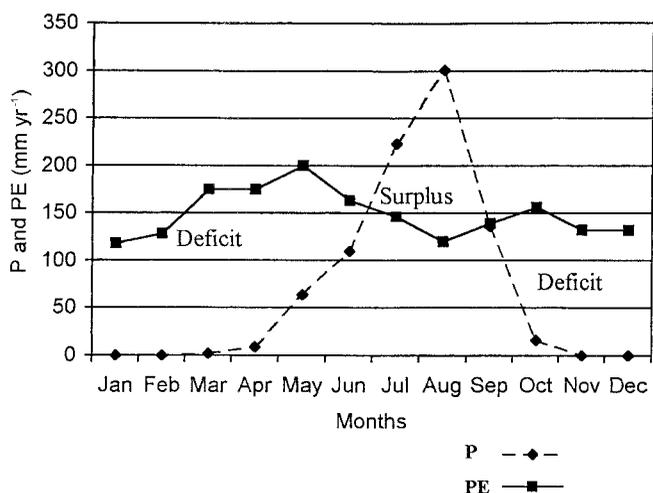


Figure 1 | Annual average precipitation (P) and precipitation effectiveness (PE) per unit area in mm per year.

Anthropogenic forcing on water resources

The Kano district comprises a set of small, nucleated settlements in about an 80-km radius around the city of Kano. Present population projections show that the area has about 5 million inhabitants. The population density and growth rate are over 435 inhabitants km⁻² and 3%, respectively. These figures are strikingly high and are governed by the spatial spread of water resources. The existence of the population is based on a low-technology tropical farming system, which yields little more than the minimum for subsistence. Population pressures today are altering this system and the deterioration of the natural environment is the result. Continual and worsening pollution of water resources through unsustainable land use

tends to diminish the amount of water that can be fed into system reservoirs for safe consumption.

High population density and poor land use management has led to the loss of indigenous knowledge in conserving and protecting the local environment. None the less, the idea of land use based on the principle of sustainability is slowly being propagated due to its large measure of control over nature. For instance, micro-projects on agro-forestry, afforestation of water catchments, improved pastures and ecologically adapted land utilization methods will eventually reverse the degradation and regradation of natural vegetation cover in the Kano district. One of the needs for the development of vegetation is to create a moisture island and to improve the water balance of the study area so that there is a greater guarantee of safe, dependable water supplies.

Surface water abstraction from basement complex rocks

The nature of the country's rocks heavily limits the absolute quantity, specific yield and spatial distribution of underground water (Faniran 1975). The basement rocks do not effectively store large quantities of groundwater due to lack of lateral confinement of precipitation which enters them so that 'sub-surface water is restricted to pockets of discontinuous mantle of weathered rocks' (Oyawole 1972). For instance, out of 70 boreholes constructed in the basement complex, 23 (33%) were abandoned (Du Preeze and Barber 1965).

The movement of groundwater, particularly in the dry season, is very slow and variable. As the mean depth of weathering is 12.4 m, the local people cannot take a more active role in the well-sinking programmes because of their low level extraction technology. In many cases, open wells have been dug through communal efforts and found to be dry. Even so, many rural communities in the Kano district have dug wells on the basis of trial and error, which in many places have to reach 10 m deep before they provide all-year-round water. Usually no revetment is done in the wells dug in sand (soft terrain) so they always cave in. This destroys local initiative and makes the development of groundwater systems the preserve of the government.

The result of the background just presented is the relegation of groundwater sources to the formulation of water development plans, virtually all of which rely on surface water sources. Faniran (1982) notes that water engineers manifest no interest in underground sources because of the following:

- (a) The traditional view that basement complex rocks are intrinsically poor as groundwater media.
- (b) The disappointments experienced during well-sinking operations in the 1940s and 1950s which recorded not only low success rates but inferior yields compared with sedimentary rock environments.
- (c) The impressive and therefore more politically appealing nature of dams compared with boreholes.

The wrong technology or approach is a set back to the exploitation of the groundwater resources of basement complex rocks in the Kano district.

Problems of water supply and utilization

Three basic ingredients are very important in the development of water resources:

- (a) Storage, which is distribution in time.
- (b) Means of conveying water from one place to another, that is, distribution in space.
- (c) Treatment of clean water for drinking purposes. (The treatment of effluents is more relevant.) This condition will ensure the establishment of suitable patterns of water resources development.

However, the local water supply policy is haphazard and embraces a series of projects without any well-defined objectives. This state of affairs is further compounded by chronic design problems like faulty distribution systems, careless and wasteful use of water (due to high pressure), increasing capital and operating costs of expanding water supply facilities, and lack of manpower. Some of the most serious problems are examined below.

Distribution problems

Water is brought to the rural people in the outskirts of Kano in four different ways. These range from improved

Table 2 | Perception of water supply provision (N=400)

Perception	Number of respondents	Percentage
Provide pipe-borne water	300	75.0
Dig wells/boreholes with hand-pumps	26	7.5
Construction of dams	74	0.5
Total	400	100.0

wells, pipe-borne water through street standpipes, water tankers, and lately dams without distribution. There are also water-carriers in the study area. Dams take care of domestic, stock and small-scale farm water needs and are becoming particularly popular. However, dam water gives rise to numerous disease-producing organisms requiring extensive control methods in order to get rid of them.

The purpose of various community water supplies in Kano State is to ensure an adequate and improved water supply for the state's rural populations. To realize this laudable objective, private connections are discouraged through prohibitive initial installation costs. This government water policy is mistaken and unwise because the powerful Muslim mores, particularly those relating to women, weaken the desire for communal water points thereby making private water connections the ideal. Besides, the poor distribution of the standpipes means that some people still have to go quite some distance to fetch water while there is over concentration of people at certain points (Akintola *et al.* 1979). The significance of this is that an artificial scarcity of water may be created even when there is enough water for all. Also when repair works are being undertaken the taps remain closed and there may be localized shortages of water due to low pressures in some areas.

Table 2 clearly shows a very strong desire for public pipe-borne water. Also, the construction of dams appeals to the local populations since the dam water serves as an impetus for informal, small-scale irrigation schemes in the area investigated. Certainly, the water resource and the sustainable demands, including those for irrigation should

be broad enough to incorporate both the economic and non-economic dimensions of the welfare of the community. There is thus an urgent need to assess the local water resources, including surface and underground sources.

Given the fact that the initial capital investment of piped water schemes and the subsequent running costs are high, the responses of the local people may reveal two things. The first is a deep awareness by the rural people of the utter failures of the various governments in the state to develop groundwater resources. Second, there is the impression that the development of water supply systems is largely an administrative problem. This situation also provides some indication of the little or no community interest in water supply programmes. In other words, self-help activities in water supply projects only occur on a very small scale. Perhaps this is a clarion call for the encouragement of community-based initiatives and participation of the rural people in the planning, design and management of their water resources according to local conditions and needs.

In general, good communication (meetings and standard forms) ensures sustainable and reliable water supplies. The flow of ideas between the Water Resources Engineering Construction Agency (WRECA) and the public and within the rural localities themselves develop effective networking strategies among the stakeholders so as to encourage collaborative activities in water resources management. The people need to understand the plans for the development of their localities (and their country); and they have to participate in the progressive changes for the success of development programmes. Appropriate, effective measures are necessary to intensify community education in most rural localities and the contents of such programmes should emphasize local problems and ways to solve them.

Cost effectiveness analysis

In the developed countries, water undertakings are often designed to yield a profit (Smith 1972). However, like in most developing countries, this situation is probably unattainable in Nigeria due to the social implications and the low level of personal incomes of its citizens. As a

result, water supply is regarded as a social overhead investment and charges either are disallowed or heavily subsidized by the government. Thus private water connections with water meters (for individual control) are as rare as the equally essential tariff system (Forch & Biemann 1980). This means two things for the water supply industry: wasteful and ineffective use of water when it is available; and the lack of funds to cover initial installation and subsequent costs to create a viable water supply industry. This imposes financial burdens on local authorities.

Nevertheless, a flat rate of 3 naira and 5 naira (<US\$1.00) is charged in the low and high density areas, respectively. Institutions, voluntary agencies and industries are metered and charged according to consumption. The installation of meters to control the consumption behaviour of the population will considerably raise systems costs. The fixed initial installation costs are too high and depend on the diameter of the pipes. This has meant a very low level of demand for private water connection, particularly as the rural people live in abject conditions. Water is regarded as a free or cheap commodity that no one should tax. There is an obvious desire to educate the people that water, far from being free or cheap, is expensive and must be used sustainably.

As already indicated, government policy still treats the provision of improved water sources as a social, non-financial service. But one may be compelled to question the rationale behind this policy in view of the rapidly increasing water costs and the weakening ability of many governments to supply the necessary funds. For instance, depending on the location and geological formation, the cost of providing an agricultural area with a new borehole varies from US\$8,500 to US\$51,000. If the rural people are to enjoy the benefits of safe, reliable, potable water, which is readily available at their doorsteps, then they must be made to pay at least a token amount for it. The classic economic solution to the problem of wasteful consumption is to raise the price of water.

It is appropriate to point out that general sanitary conditions in rural Nigeria favour the transmission of communicable diseases such as diarrhoea, malaria and cholera. Putting an economic value on health improvements is usually difficult. However, desired changes in health status may have indirect economic consequences,

for example, an increase in labour productivity. This may be very important if the main morbidity associated with defective water supplies occurs at periods of peak labour demand in agriculture. These indicate the importance of provision of adequate sanitation and pollution prevention in overall management of resources.

Without doubt, to curb wasteful and ineffective use and to achieve full operation and maintenance cost recovery, relatively high water taxes are required. The willingness of rural people to pay these taxes will remove the uncertainties of cost recovery which leads to reluctance to plan for the high expenditure necessary to provide reliable supplies (Jones and Hollier 1997). A major education programme using pilot projects coupled with financial incentives perform a vital role in the management system of rural water supply programmes (Tuncalp and Yavas 1983).

Water supply and pollution

There is an acute shortage of land in the Kano closed-settled zone. This has resulted in the desertion of traditional techniques of peasant agriculture for permanent cultivation. Also introduced is the manure produced by domestic animals combined with household refuse. The supply of the manure is insufficient and has been supplemented with chemical fertilizers and pesticides and other water pollutants, which may filter into groundwater, streams and lakes. In particular, some rural people engage in fishing activities and directly apply Gammalin 20 and other poisonous concoctions of herbs into the local water sources in order to catch the fish. The result is that the raw water systems bear toxins and diseases. Further, soil losses create large sediment loads in the available surface water sources which burdens the treatment process.

In most cases, dwelling units in the study area lack waste disposal systems. Consequently, the rural people have the tendency to defecate in back yards. There are numerous open wells in the area surveyed which are improperly protected. Such wells and surface water sources are polluted as all surface drainage, which carries with it pathogen-laden human and animal wastes, drains into them. Hence, the local water sources are usually degraded and they become foul pits and breeding places

for all sorts of water-borne diseases, particularly guinea worm, hook-worm, diarrhoea, malaria, cholera, typhoid fever and meningitis.

As rural populations grow and large, permanent rural villages become the norm, a lot of toxic chemical wastes are generated and usually disposed of indiscriminately in open surfaces, stream channels and gutters with gross disrespect for environmental sanitation. Implicit in this is a high concentration of organic pollution during the dry season and detritus during the rainy season. The health of the local people, their societies and the land itself is, thus, being undermined by water-borne diseases. Indeed, the level of village pollution, a major component of water supply, is a matter of serious concern to the various local governments in Kano State just like in the rest of rural Nigeria.

Operation and management of water resources

Basic information on water quantity, quality and their variability are of great importance in helping effective water resources management. It has become evident that the provision of adequate water supplies of suitable quality in rural areas of Nigeria has completely missed a realistic view of the problems involved. Consequently, the progress achieved so far is insignificant. This underscores the imperative to develop functional rural water supply systems.

By far the most common teething problems are lack of financial resources and structural problems like the inefficiency of the State Water Board and an inadequate legal basis. The largely insufficient funds are contributory to the acute dearth of various categories of technical manpower skills required for achieving efficient operation of equipment and systems installations. Furthermore, the situation is actually exacerbated by the lack of confidence often shown by the administrators towards the expertise of indigenous management skills. The decision-making process is of an odd and inexplicable character. Thus, the execution, operation and maintenance of sustainable water supply systems remain elusive.

Efforts to develop water resources projects

Admittedly, the various governments (local, state, federal) have achieved immeasurable progress in their strong zeal

to provide the rural masses with a well distributed and constant supply of water to meet their needs for domestic uses, watering the livestock and irrigating the crops. Nevertheless, there is yet no effective solution to the problem of water shortage, particularly in the dry season because of the following important aspects:

- (a) Most of the water supply systems cannot carry over long into the dry season owing to the increasing interseasonal and interannual irregularity of rainfall and the wasteful diversion projects which disrupt rivers and exacerbate water shortages.
- (b) The inaccessibility of the rural communities and the inadequacy of government finance, material and technical support are crucial problems. The low or no rates charged for water consumed encourages wastage and deprives the State Water Board of a vital source of revenue that could have helped solve some of the financial problems. Money is especially needed for operational maintenance and extension of existing watering places, water supply systems, and the opening up of new water resources.
- (c) There is also the problem of lack of core technical staff resulting in the non-provision of the full range of services needed.
- (d) The small sizes of the rural communities mean that supplying them raises various difficulties: the costs are high, while participation of the local population is limited.

Due to the above shortcomings, plans are already under way to improve existing public water supply systems through the setting up of new treatment plants and distribution systems to cope with future water demands in the Kano district. The water supply situation at the moment is more than 108 million litres per day distributed as follows: 90 million litres per day to the city of Kano, and 18 million litres per day to the rural agricultural communities. The intrinsic problems and constraints which hamper water resources planning in the study area could be minimized by the construction of a great number of small earth dams and reservoirs, drilling boreholes, and building open wells and rain catchment systems which will allow water users to obtain an increased and reliable source of water. The development of water supply schemes in this way raises

many health hazards requiring a systems approach in their operational management. To check the high evaporation rates and infilling by detritus, the dam sites should be maintained under a permanent vegetation cover. Furthermore, the system of artificial recharge in the valleys of the Kano-Challawa-Wudil and Duburum-Gaya-Katagum systems should be attempted so as to halt any effluence of water from the study area.

The study area is underlain by basement complex rocks which are not very promising in terms of groundwater reserves. But it may be possible to get enough reserves of water in large fractured zones and deeply weathered layers. The low success ratio and disappointment that continue to impair well-sinking efforts have been adduced to insufficiency of baseline studies, inadequate pumping aquifer tests, unsuitable screening and subsequent silting. It is thus hoped that prospecting for underground water in the study area as elsewhere in Nigeria will involve the determination of the following:

- (a) The lateral and vertical limits of the diastrophic factors such as faults, fractures, joints and shears.
- (b) The areal extent and thickness of the weathered mantle.
- (c) The hydraulic characteristics (water-bearing properties) of rock samples in the laboratory.
- (d) Where and under what conditions water enters and leaves the local aquifers.

This can best be carried out through modern geophysical methods such as resistivity, seismic refraction and gravity methods. With such scientific studies, the groundwater hydrology of the Kano district can be established. Quantitative parameters needed for long-term efficient exploitation of groundwater systems and future prediction of the economic yields of the boreholes for the purpose for which they are required will be necessary prerequisites for staging and drilling boreholes with accurate results.

The lifting of water from deep wells and boreholes requires a lot of physical energy. To make its abstraction less tedious, the rural people have resorted to the use of tyre tubes, leather bags and paint tins, which are more convenient but are usually contaminated. This calls for the provision of hand-pumps that can tap the abundant water

resources of the region. In order to achieve this welcome goal, research has to be stepped up on existing traditional techniques of storage, distribution and treatment of water.

This means designing new technologies, where feasible gearing them towards cultural needs, and creating channels for translating the research findings of technologies to local needs and conditions. Water quality monitoring and assessment programmes will also be essential. This must be backed up by the encouragement of active interest and involvement of the rural communities in the thinking, planning, design and allocation of available water resources to competing needs.

Local people should be educated and trained on low-cost techniques for water resources development and on how to use water wisely and to reduce to the barest minimum the present wasteful and reckless treatment of the environment which has adverse effects on the hydrological stability of the Kano district. In this context, the rural dwellers should be grouped into multipurpose water-user co-operatives so as to have their full adhesion to the execution of small-scale water works. Quantification of present water requirements and projections of their utilization, fixing priorities on a long-term basis, will ensure sustained water resources management. This is inextricably linked to the general rural development sequence.

DISCUSSION AND CONCLUSION

Climatic variability can be equated with rainfall variability. In the Kano district, rainfall is insufficient, ill distributed, unreliable and varies greatly from year to year and in its monthly distribution within the wet season. This means that both the surface and sub-surface water resources are often in short supply. Thus groundwater recharge rates are meagre. Even so, there is high water-loss through leakage, wastage and evaporation. Further, the support and provision systems are prone to disruption and hardly in tune with deviations in supply and demand. The water supply situation today is thus beset with difficulties such as the lack of technical and managerial know-how to run and maintain the systems and the grossly

inadequate funds, which make international co-operation inevitable.

The need to train local staff in the Kano district to design, build and operate small water supply systems cannot be over-emphasized. Since water deficiency is a chief limiting factor on human activities, management of water resources should ensure that adequate supplies of suitable quality water are readily available. This can be realized through basic water resources programmes including water protection areas, simple water reserve techniques (depressions, ponds, pools), harvesting rain water, construction of earth dams, and preparation of river or lake-basin plans in which renewable water resource is the central aim (Bruce 1992). Viewed in this manner, improved water supply elements such as operational maintenance and extension, enough funds to cover subsequent costs, and technical assistance must all be available to guarantee the local people access to usable water resources.

Water resources have always fulfilled a variety of functions, but the necessity for comprehensive management and multipurpose use has never been greater. The lack of water is gaining acceptability as a basic cultural and environmental deficit in the sense that water has become an economic problem, a human rights issue and, of course, an environmental issue (Platt 1996). Securing drinking water for the population of the Kano district is obviously essential to the integrated rural development process. The failure to recognize water resources as a prerequisite infrastructural development has led to partial or complete failure of economic plans.

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