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A policy framework for surface water and shallow groundwater allocation, with special reference to the Komadougou Yobe River Basin, northeast Nigeria

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SUMMARY

The Hadejia and Jama'are rivers rise on the Basement Complex of Kano and Bauchi States, and on entering the area underlain by sedimentary rocks, they lose most of their water in their passage through Jigawa, Yobe and Borno to Lake Chad. Water resource developments on the Hadejia branch are now so far advanced that effectively the entire flow is consumed before the confluence, where the river changes name to the Yobe. These developments have taken place in the absence of a coherent, integrated water management policy, either nationally, for the river basin, or at a local level. The Jama'are tributary is so far undeveloped, although this is unlikely to remain so for much longer. In this article proposals for an analytical framework for water allocation policy in the river basin are made, together with an analysis of the characteristics of the major existing water-using activities. The article argues, not for a particular water allocation policy, but for clarity and transparency in the development of such policy by the relevant authorities in Nigeria.

INTRODUCTION

The Hadejia-Jama'are-Yobe river system drains a catchment of approximately 85,000 km^2 in northeast Nigeria (Figure 1). Under natural conditions (i.e. in their unregulated state), and prior to the drought that began in the early 1960s (Hess *et al.*, 1995), the two major tributaries, the Hadejia and the Jama'are, contributed approximately 40 per cent and 50 per cent respectively of the total river flow leaving the hard rock area of the upper catchment (the remainder coming from minor tributaries of the main rivers) (Schultz, 1976). Once the rivers enter the middle and lower basin, underlain by Quaternary Chad Formation sediments, they lose water all the way to Lake Chad (NEAZDP, 1990). Since the early 1970s major water resource developments on the Hadejia branch (the Tiga dam, Kano River Project phase 1, Challawa Gorge dam, Hadejia Valley Irrigation Project, and extensive pumped farmer-managed irrigation in Kano and Jigawa States), coinciding with reduced rainfall, have sharply reduced flows in this tributary, so that now the river flow at Gashua consists almost exclusively of Jama'are water. For some years now there has been the prospect of the construction of regulatory works on the Jama'are tributary (the Kafin Zaki dam), and the possibility of the development of irrigation schemes in the Jama'are valley that would further reduce the river flows at and beyond Gashua.

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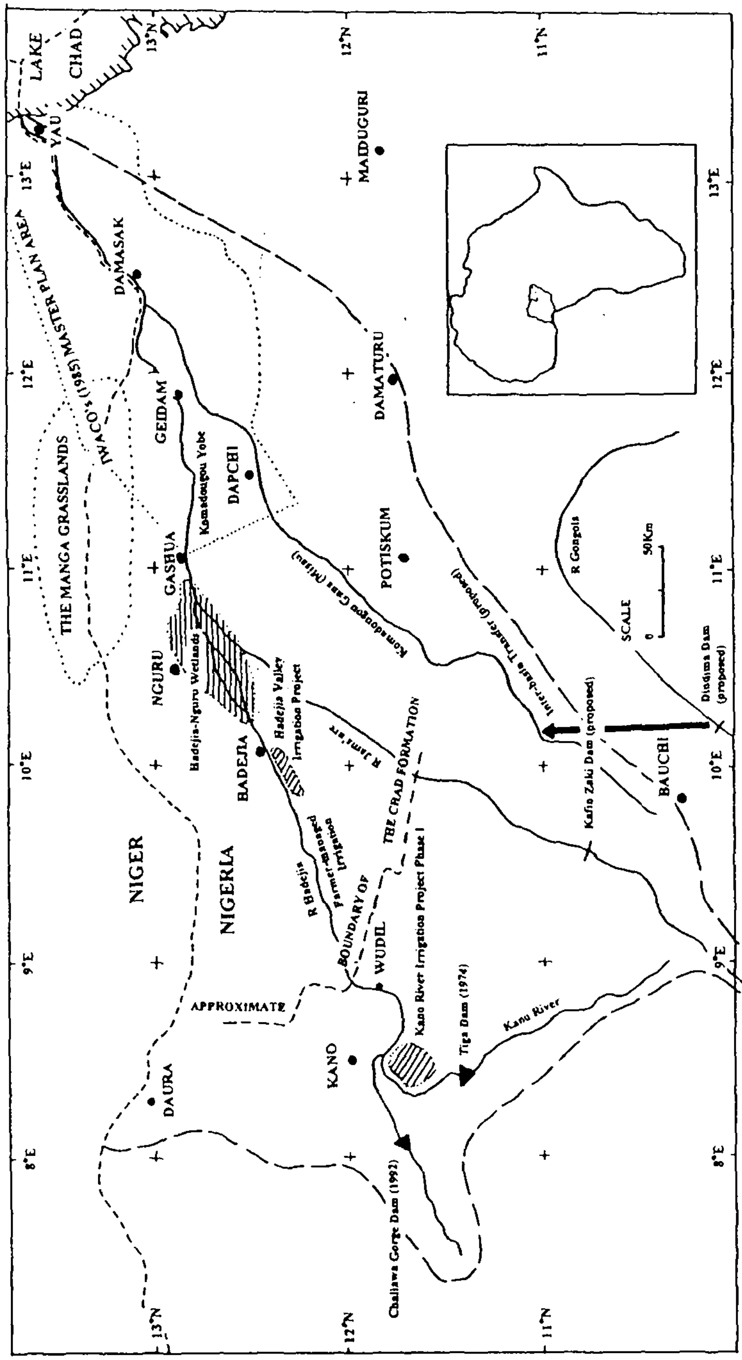

Figure 1.

The Kafin Zaki dam site was investigated at the end of the 1970s and construction began in the early 1980s. When funds ran out in 1983, construction ceased (NEAZDP, 1990), but more recently construction work was re-activated, and then cancelled again following the fall of the military President Babangida in 1993. Proponents of the dam argue that if sufficiently large outlet structures were built in, and if the dam were to be operated in an appropriate manner, an artificial, but predictable, flood could be released for rice farmers and fishermen in the lower Jama'are and Yobe rivers. It is argued that the increased predictability of the wet season flood, together with the maintenance of dry season flows that could be used for pumped irrigation, would provide benefits greater than the costs of the structure.

Most consultants who have studied the river basin have rejected the possibility of rainfed groundwater recharge, preferring the idea that the shallow alluvial aquifers adjacent to the river floodplains and the contiguous aquifers beneath the interfluves are replenished only by seasonal river flow. This argument is rejected by Carter and Alkali (1995), who point to conflicting evidence from the locality, as well as more widely in the Sahel and similar climates. Nevertheless, it is the case that present knowledge of shallow aquifer geometry, hydraulic properties, continuity and recharge is severely lacking. The development of water management policy that includes consideration of the shallow aquifers is therefore a very uncertain process.

Arguments, at times heated, have taken place about how the limited surface water and shallow groundwater of the basin should be allocated and managed. Conflicts between the requirements of Kano City and the major irrigation projects on the one hand, and those of farmers, fishermen and wildlife in the Hadejia-Nguru wetlands, on the other, have been well aired in the literature (Adams and Hollis, 1988; Barbier *et al.*, 1991; Kimmage and Adams, 1992). Because of the developments that have now taken place upstream of the wetlands, it seems that the argument for maintaining the 'natural' river flows and flooding patterns in this tributary may have already been lost. This is not yet so however in the Jama'are tributary, which is so far relatively undeveloped and subject therefore only to natural variations in river flows.

The overall objective of a water policy, according to Caponera (1992) is to 'achieve the maximisation of benefits deriving from available water resources, and their most rational management'. This statement begs two questions: to what extent are the benefits achievable from the available water resources already being enjoyed? and, what, in the particular natural, social, cultural, economic, and political environment, constitutes *rational* management?

Much of the literature reviewed below is highly critical of the past and present performance of river basin management in northern Nigeria. Most authors have argued for a particular priority in water allocation, depending on their own perceptions of existing rights or rational allocation procedures. The present article is written in a rather different vein. It is an attempt to raise the issues involved in water allocation in the river basin, and to present the options and their practical implications in a more objective manner. Ultimately it is a matter for the appropriate Nigerian authorities and consumers to arrive at a consensus on the best way to manage the limited water resources of this dry region. This author would argue, not for a particular allocation rule, but rather for transparency and clarity in the decision-making processes. Such clarity must take full account of the present state of ignorance of many aspects of the hydrology and agricultural economy of the region. Any allocation rule is likely to be controversial, but the more open and lucid the decision-making process is, the more likely is it that a workable consensus can be reached.

WATER RESOURCE DEVELOPMENTS TO DATE

The major physical control structures and abstractions in the Hadejia valley have already been mentioned: Tiga dam was completed in 1974, and was filling from then until 1976; Challawa Gorge dam was closed in 1992; parts of Kano River Project phase I (net area 22,000 ha) came into operation over the two decades following completion of Tiga; studies and designs for Kano River Project phase II (net area 40,236 ha) were completed in the 1980s, but it seems unlikely that this scheme will progress further, and Hadejia Valley Irrigation Project (net area 11,361 ha) barrage and head pond were still under construction in 1994. In addition to the growing urban demands of Kano City, and the requirements of the formal irrigation schemes, recent years have seen a massive expansion of small-scale pumped irrigation, and the volumes of water so abstracted are now substantial.

Table 1 lists the estimated water requirements of the identified major users and compares these to the available water resources. An important point to note is that natural flows in all the northern rivers, the Hadejia included, have significantly declined since the early 1960s, because of drought. Annual rainfall in the far northeast of Nigeria over the period since the early 1960s has been following a downward trend, reducing by about 8 mm per year (Hess *et al.*, 1995), and river flows have dropped

Table 1. Water resources and water demands in the Hadejia River Basin

Flow component	Volume, Mm^3/a	Source
Estimated river flows upstream of Hadejia town		
Mean Ann River Flow at Wudil, pre-Tiga (1964–73)	1865	NEAZDP (1990)
Est Mean Ann Natural flow at Wudil, post-Tiga (1974-85)	1555	NEAZDP (1990)
Mean Ann River Flow at Hadejia, pre-Tiga (1966–73)	717	Ministry of Works and Survey (1972); WRECA (1974, 1989)
Percentage 'losses' between Wudil and Hadejia	62	
Estimated available flow at Hadejia under natural conditions (1974-85)	600	
Forecast demands upstream of Hadejia		
1. Kano City Water Supply	103–203	Diyam (1986)
2. Kano River Project Phase I	247–370	Diyam (1986)
3. Hadejia Valley Irrigation Project	215-414	Diyam (1986)
4. Net Reservoir Losses (Tiga)	164	Diyam (1986)
5. Net Reservoir Losses (Challawa)	98	Diyam (1986)
6. Farmer-managed irrigation	98–283	Diyam (1986)
Total forecast demands		
Upstream of Wudil (1, 2, 4, 5)	612–835	
Downstream of Wudil (3, 6)	313–697	
Losses Wudil-Hadejia	446–584	
Net flow downstream of Hadejia	0–46	

correspondingly (NEAZDP, 1990; Table 1). The table shows that demands totalling 612–835 Mm^3/a upstream of Wudil (i.e. all the demands listed, except Hadejia Valley Irrigation Project and most of the farmer-managed irrigation) would reduce flows at Wudil to 720–943 Mm^3/a, and that the remaining demands and natural 'losses' between Wudil and Hadejia would further reduce this flow to 0–46 Mm^3/a. These estimates confirm the conclusions of Hollis *et al.* (1993), that '... in recent years the Hadejia has made a tiny contribution to the flow at Gashua'; even in 1992, when Gashua and points downstream received their largest flood for 10–20 years, Hollis *et al.* (1993) estimated that the Hadejia contributed less than 10 per cent of the river flow at Gashua.

The water resources of the Jama'are tributary have so far hardly been touched by large-scale developments. The Kafin Zaki dam is the major proposed regulating structure, which, even if operated to the benefit of water users in the lower valley, would still incur net water losses (evaporation plus lost runoff minus direct rainfall) of around 294 Mm^3/a (Diyam, 1986). The main danger as far as downstream users are concerned is the prospect of large-scale formal irrigation schemes being constructed in the middle Jama'are valley, using substantial quantities of the river flow even before it reaches Gashua. If the dam is ever completed, and if funds are made available, it is unlikely that the state authorities would be able to resist the temptation to proceed with these schemes, the total area of which amounts to around 84,000 ha (implying a possible water requirement of 1,000–1,500 Mm^3/a).

The other major proposed development is the inter-basin transfer of 1,000 Mm^3/a from the Gongola basin to the Misau (Komadougou Gana) (Diyam, 1986), via the Dindima dam on the Gongola river, and a gravity (tunnel) transfer across the watershed. This is not the place to enter into a discussion of the political, economic, social and environment merits of the proposed scheme; it is enough to point out the enormous political and financing hurdles such a project would have to surmount, especially when internationally the emphasis is increasingly on demand management strategies rather than supply augmentation approaches to water policy.

CONSUMPTIVE AND NON-CONSUMPTIVE WATER USES

A distinction is usually made between consumptive uses of water, i.e. those that result in evaporation or transpiration, so losing water from the catchment, and non-consumptive uses, in which water is used, usually contaminated, but returned to the system for use downstream. Irrigation involves both consumptive use, as evapotranspiration, and non-consumptive use, such as canal 'losses' that may recharge local groundwater. Domestic water uses are usually considered non-consumptive, since the majority of water used is returned to surface or groundwater as sewage and sullage flows. Whether the latter assumption is justified in the case of northeast Nigeria, where only a fraction of wastewater is piped or canalised, is questionable. It may be that the majority of rural wastewater, and a good deal of urban sullage and sewage, fails to return to watercourses or groundwater, and is lost as evaporation. As far as this article is concerned, it is assumed that little of the water used for any of the activities identified is returned to the system; all uses are assumed to be consumptive; this is clearly a conservative assumption.

INSTITUTIONS

One of the main reasons why the allocation of water within the river basin has been so problematic has been the plethora of institutions involved. When major developments began in the late 1960s and throughout the 1970s, control was already divided between two states, Kano (upstream) and Borno (downstream). In addition, the headwaters of the Jama'are river fell in Bauchi State. The creation of Nigeria's Federal River Basin Development Authorities in the 1970s did nothing to ease this situation, since responsibility for the development of the basin water resources was split between the Hadejia-Jama'are and Chad Basin Development Authorities. In 1990 two new states, Jigawa and Yobe, were carved out of the eastern part of Kano State and the western part of Borno, respectively. There are now no less than five states and two federal authorities with responsibility for developing the water resources of the basin.

There is moreover a split between the River Basin Development authorities with their traditional interest in large-scale formal irrigation schemes (such as Kano River, Hadejia Valley and South Chad), and the State Agricultural Development Programmes (ADPs), whose main interest in terms of water consumption since the early 1980s has been the promotion of fadama development or small-scale river floodplain pumped irrigation.

This is only to mention the federal or state government institutions involved. Prior to their existence, and continuing to the present, are the numerous village level decision-making and communications systems that control access of individual farmers and fishermen to land and water. These institutions, like the water uses that they regulate, have tended to be ignored by government, and, especially, by foreign donors and consultants. One suspects that their invisibility to most outsiders belies the sophistication of their organisation; perhaps detailed study of these regulatory systems would, like the Californian groundwaters studied by Blomquist (1992), reveal '... the order of local governance that lies behind the surface appearance of chaos'.

PAST CRITICISMS OF RIVER BASIN MANAGEMENT

Various authors have reviewed and criticised Nigeria's experiences of river basin management (e.g. Adams, 1983, 1985, 1991; Carter, 1981; Carter *et al.*, 1983; Salau, 1986). The main criticisms are that water resource development has concentrated almost exclusively on the construction of dams and large-scale formal irrigation schemes. Integrated, basin-wide planning has been conspicuously absent, and the large schemes have had adverse environmental and social impacts, besides being extremely costly and inefficiently managed. Moreover, the large-scale irrigation schemes have not only displaced former residents of the reservoir areas, but also ignored, and deprived of water, larger areas of existing farmed fadama (Hausa: flood-prone land, ranging from seasonally flooded depressions to major river floodplains) than the areas that have subsequently been brought under formal irrigation (Kolawole *et al.*, 1994). These schemes have benefited contractors and those involved in the award of contracts, consultants, and larger farmers, instead of, and even at the expense of, the rural poor.

Even the world Bank-funded, state-based, ADPs that have introduced small-scale, farmer-managed, irrigation have not been immune to criticism. These programmes, while making no pretence at integrated water resource development, are important in the present context because of the large and growing volumes of water that they consume. Kimmage (1991), while noting the rapid growth of this form of irrigation through the 1980s, doubts its technical and environmental sustainability, and argues that its inherent inequity makes it unsuitable for achieving 'broad-based agricultural and/or rural development'. Despite these criticisms, however, this type of water resource development is still growing rapidly, shows attractive financial performance, and is continuing to be promoted by the relevant state authorities and by the World Bank (e.g. World Bank, 1991).

CURRENT RATIONALE FOR WATER ALLOCATION

One of the major driving forces behind earlier developments has undoubtedly been a belief in the necessity of river control. The dominance of the engineering outlook has led to the construction of major dams and large-scale formal irrigation schemes designed to exercise a high degree of water control. Although significant attempts have been made to understand and quantify the hydrology of the river basin, these have been with a view to control rather than in order to adapt existing farming activities better to the natural constraints and variability of the system. This faith in the necessity of large-scale river control, combined with former irrigation schemes, persists to the present day.

A second influence on the type of development adopted in the past, and, to a lesser degree, to date, has been the political and financial benefits to be won through the judicious award of consultancy and construction contracts. It is well known, if inadequately recognised in print, that the lucrative contracts that characterised the oil-boom years of the 1970s and since, helped to achieve the political and financial advancement of many of those involved in decision making. That this is less so today is due only to the reduced volume of public money available for such contracts.

The third major factor implicit in the development of water resources in the Hadejia Valley has been the opportunism and power of the upstream authorities. The fact that dams could be constructed most advantageously in the upper, hard rock catchment, and the potential that that conferred on the areas near to and commanded by these dams, inevitably fostered a 'use-it-or-lose-it' mentality. The concept of a fair deal for (downstream) Borno State, although lobbied for, apparently fell on deaf ears.

THE BAGAUDA LAKE AGREEMENT

Following the study by Schultz International (1976), a meeting at the Bagauda Lake Hotel (Kano State) in 1977 ratified the major recommendations of the Schultz report. The meeting, which was attended by the major relevant state and federal authorities, agreed, among other things, that Kano State should release sufficient water from the Tiga dam to maintain an annual flow of 1,380 Mm^3 at Gashua. It is generally acknowledged now, with the benefit of hindsight, that this figure was unrealistically high. Since the drought, the natural flow at Gashua would probably have been 20–25 per cent less than this (Diyam, 1986; Adams and Hollis, 1988). The point here, however, is that a clear, apparently fair operating rule for the then only major upstream control structure on the river system was agreed by all—and then never implemented.

POLICY DEVELOPMENT: AN ANALYTICAL FRAMEWORK

A recent policy paper of the World Bank (1993) emphasises the need for a clear analytical framework as a basis for water management policy. The shape of such a framework is not, however, detailed by the authors of this report. A proposal is therefore made here as to the possible shape of such a policy framework. The application of such an analysis to the Hadejia-Jama'are-Yobe river basin is also made.

The first component (Figure 2, box 1) consists of an *analysis of the failure of the existing system*. In the present case, the fragmented and inadequate way in which water resources, present uses, and future demands have been evaluated, and the ad hoc way in which projects have been implemented, have been highlighted above. Box 1 of Figure 2 lists other system weaknesses. Weaknesses in the system of water provision or allocation are likely to become more prominent as competition for an increasingly scarce resource grows.

The second component (Figure 2, box 2) consists of an *assessment of present knowledge*. There is never sufficient knowledge on which to base water policy, since, however well known the present conditions may be, the future is impossible to forecast with certainty. Nevertheless, three key areas of the knowledge base need to be examined. The first of these is knowledge of the water resources, i.e. the hydrology and hydrogeology of the basin. In the Yobe basin data collection has been undertaken over several decades (although attention to this has declined in the last ten years or so), and several teams of consultants have been commissioned to carry out studies. Notwithstanding the sometimes questionable conclusions of consultants, it cannot be said that the Yobe basin is devoid of hydrological and hydrogeological knowledge. The second area of knowledge is that of past and present water use. In principle this knowledge is no less accessible than that of the resource itself, however, in reality there are frequently significant blindspots on the part of government. In particular, uses of water by small farmers and by rural populations in general are often ignored in government statistics. The 'invisibility' of these 'informal' water uses can be a major cause of conflict when development proceeds without acknowledgement of existing rights to water. In the Yobe basin the productivity of existing water use in the threatened Hadejia-Nguru wetlands has been well documented (Barbier *et al.*, 1991) and contrasted with the highly capital intensive and relatively poorly performing Kano River Project upstream. The third area of knowledge is that of future demands. This would be difficult in any environment, but in a climate that is inherently variable, and where the first two aspects of the knowledge base are weak, it is especially so (see, for example Carter *et al.*,'s 1986 review of irrigation growth forecasts in Nigeria).

The third component of the analysis (Figure 2, box 3) consists of a clear *statement of the pre-suppositions, value judgments, and paradigms* that are to be taken as the foundation for further policy development. Even today, much writing on water policy fails to make these aspects explicit. Currently accepted dogma is presented as if it were fully proven best practice, when in reality it may only represent a reaction against approaches that have failed in the past. The current dogma presented in the literature can be summarised as follows:

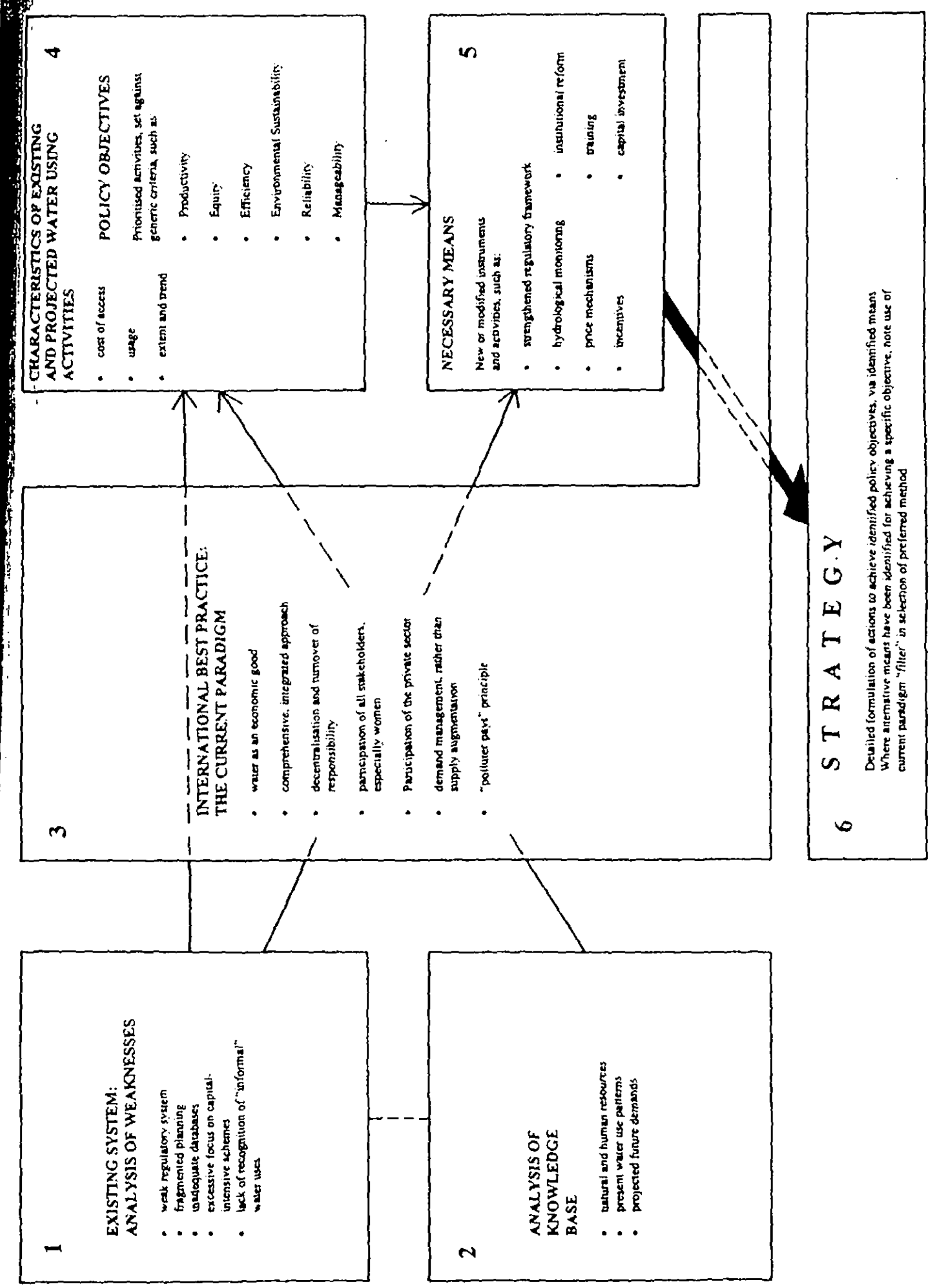

Figure 2.

(i) water should be treated as an economic good (World Bank, 1993; Winpenny, 1994);
(ii) an integrated, comprehensive, or holistic approach to water policy is needed (Adams, 1985; World Bank, 1993);
(iii) decentralisation and turnover of responsibility is necessary and desirable (World Bank, 1993);
(iv) greater participation of stakeholders, especially women, is needed (World Bank, 1993);
(v) increased participation of the private sector is desirable (World Bank, 1993);
(vi) demand management, rather than supply augmentation, is the correct way forward (Winpenny, 1994);
(vii) in relation to water quality, the 'polluter pays' principle should be implemented (Winpenny, 1994).

Proponents of these issues would generally argue their merits on pragmatic and/or theoretical grounds, although more than one contain aspects of ethics or political correctness that may not be shared by all, especially by developing country governments. This is especially so in the case of those issues that imply a need for greater democratic empowerment. The point here is not to defend or take issue with any of these aspects of the currently received wisdom, but simply to make transparent the foundations upon which further aspects of policy analysis are to be built. The whole set of principles listed here and in box 3 can be seen as a 'filter' through which policy objectives and instruments are developed, and detailed strategy built up.

The fourth, and central, component of policy analysis (Figure 2, box 4) is the *identification and prioritisation of goals and objectives*, following an analysis of the key characteristics of existing and projected water-using activities (cost of access to water, amount used, and present and projected extent of each use). It is possible to identify (Chambers, 1976; Winpenny, 1994) at least six broad objectives or generic criteria for water allocation that could form the basis for water management policy, either singly or in some prioritised combination. These are: productivity (or economic efficiency), equity and respect for existing water rights, efficiency of resource use (i.e. minimisation of unproductive losses), environmental stability or sustainability, reliability or predictability of supply, and manageability or institutional sustainability. Inevitably there is some overlap between these objectives, but they are sufficiently distinct to justify separate treatment. They are discussed at greater length in relation to the Yobe catchment below.

The fifth and final aspect of the proposed analytical framework is the *means of successful and sustainable implementation*. This includes the legal and institutional systems and other necessary conditions for an expressed policy to be made to work over the long term. Strong legal and regulatory frameworks, effective pricing and cost recovery mechanisms, comprehensive databases, strong analytical capabilities, financial accountability, and a substantial voice on the part of the stakeholders are all recognised as necessary (World Bank, 1993; Winpenny, 1994). In the absence of some or all of these factors it can be extremely difficult to develop viable policy.

The six identified policy objectives just mentioned are now examined in greater detail, with reference to Table 2.

Table 2. A framework for analysis of water-using activities

Water-using activity	Cost of water	Usage	Returns per M^3 of water	Equity and existing rights	Efficiency	Env. impact	Reliability	Ease of management	Priority
Rainfed farming	Low: farm labour only	High: ca 250mm/a	Low, as with most crop production, low yields	Access equitable, given access to land	Low losses: some unproductive evaporation	Very low	Highly risky, subject to recurring droughts	No outside agencies involved: totally farmer-managed	Fundamental subsistence requirment of majority of population
Residual moisture farming	Low: farm labour only	High: ca 250mm/a	Low financial returns, low yields	Subject to access to suitable fadama land; subject to annual flood	Efficient use of resource	Very low	Subject to suitable flood conditions	No outside agencies involved: totally farmer-managed	Efficient, low-cost use of resource: important to conserve this activity
Flood rice cultivation	Low: farm labour only; cost of increased reliability very high	High: ca 500mm/a	Low financial returns: low yields	Subject to access to suitable fadama land	Thirsty crop, but appropriate to natural conditions	Very low	Highly subject to flood conditions	No outside agencies involved: totally farmer-managed	Effective exploitation of natural conditions which cannot easily be put into alternative use
Farmer-managed small-scale irrigation	Medium: cost of shallow tubewells and pumps can be repaid in one season	High: ca 400mm/a	Medium, by adoption of high value crops	Access limited to relatively wealthy or credit-worthy farmers: at present no major water conflicts (but some over land)	Low, due to over-irrigation (although some returns to groundwater probably)	Risk of deterioration of water quality	Potentially high, but subject to fuel/spare part availability	Minor but important role of outside agencies, mainly farmer-managed	Attractive option where water resource can be shown to be replenished
Formal large-scale irrigation	Extremely high: per ha development costs up to $20,000	High: ca 1,000mm/a	Low to medium, depending on crop selection	Conflicts with informal water uses in river floodplains	Low, due to over-irrigation and canal losses	Risks of waterlogging and salinity in upland schemes	Potentially high, but limited by performance of managing agency	Complex and costly in both financial and human resource terms	Costly, inefficient, and derogating from existing effective water uses: should take low priority
Traditional fishing	Low: use of natural river reaches and pools	Requires open water from which evaporation loss is significant	Low in absolute financial terms, but significant part of local economy and nutrition	Access determined by local community; no conflict with other users	Low	Very low	Subject to river flood conditions	No external agencies involved: totally managed by fishing community	Effective, low impact use of natural conditions, should be preserved
Traditional livestock production	Low: traditional and improved hand-dug wells and seasonal water bodies	Low: <1mm/a	High: livestock a central part of the rural economy	Some conflicts between dry season floodplain grazing and other fadama activities (eg SSI)	High	Potentially damaging if stocking densities become high	Relatively high: low consumption use of shallow groundwater	No external agencies involved: totally managed by pastoralists and farmers	Will have to remain a central part of the rural economy in such a semi-arid environment
Industrial uses	High: pumping, treatment, and reticulation	Low to medium	High	No major problems of access (given capital), nor of conflict	Medium to high, depending on losses incurred	High pollution risks from certain industries	Potentially high, but subject to quality of management, and fuel supply	Difficulties of spare parts, chemicals, and energy supply, but under private sector control	High priority in terms of cost effectiveness, subject to pollution controls
Urban domestic	High: pumping, treatment and reticulation	Medium: ca 15mm/a	No direct financial returns	Minor access problems; no major conflicts with other uses	High losses from reticulation	Problems of sullage and sewage disposal	Low under existing management	Difficulties of spares, chemicals, and energy supply under public sector management	Very high, in terms of need
Rural domestic	Low: mainly shallow groundwater use	Low: <1mm/a	No direct financial returns	No access problems, no conflicts	Low losses	Very low	High, except in periods of extended drought	No external agencies involved: community managed	Very high, in terms of need

PRODUCTIVITY (ECONOMIC EFFICIENCY)

The first possible objective of a water allocation policy is that of economic efficiency. This would seek to maximise or optimise the financial and/or economic returns on investments made within the river basin. It would take account of both costs and benefits to the national economy as well as investment costs and returns to individual consumers and water-consuming enterprises.

Table 2 lists the major water-using activities in the Yobe basin with indications of their costs of access to water, usage and financial returns. A number of enterprises, such as rainfed farming, residual moisture farming, rice cultivation, fishing, and livestock production involve nil or low monetary costs (although labour clearly represents an opportunity cost), whereas the others require significant capital and recurrent investment. Formal (large-scale) irrigation, in particular, is highly capital intensive in this region.

Agricultural uses of water are particularly greedy in comparison with other non-farming uses, and for this reason are increasingly criticised nowadays (e.g. ODA, 1992). Such criticisms need to be carefully considered, however, against the feasibility and desirability of developing alternative enterprises. It is difficult to conceive of anything other than a predominantly rural, agricultural economy being feasible in northeast Nigeria for the foreseeable future. Equally, the costs of developing alternative uses of rainfall and flood water on anything other than a very small scale are likely to be prohibitive.

The fourth column in Table 2 indicates the relative financial returns, or added value, corresponding to each activity. Farming, with the exception of livestock production, yields relatively low returns per cubic metre of water, while industrial uses are inherently more productive. It is argued (e.g. Winpenny, 1994) that consumers of urban and rural domestic water should pay the real cost of water supply, the time and energy presently expended on water collection being diverted into economically productive activities. In an ideal world where the poorest sections of the community, as well as the wealthier, had ready access to financially gainful employment, this argument might be defensible; in the economy and culture of northeast Nigeria, it is hard to see this concept taking root.

In the case of irrigation, where the greatest usage and greatest conflicts over water take place, the experience of the last few decades has demonstrated the better economic and financial performance of small-scale farmer-managed irrigation than that of large-scale formal irrigation schemes (World Bank, 1979; Carter, 1981; Carter *et al.*, 1983; Adams, 1991; Brown and Nooter, 1992). Farmer-managed irrigation has involved smaller capital investments, both by government agencies and by individual farmers (although farmers have borne a larger share of the investment costs), and returns have been high. This contrasts with the performance of the large-scale schemes, the investment costs of which have been extremely high, and borne almost entirely by government, and the returns of which have been disappointing. The productivity objective, therefore, would demand a water management strategy that improves access to water by small farmers. This would have to be backed up by adequate incentives and support services to farmers, including credit, input supply and access to markets.

Based on the experience of the last few decades, the case for placing farmer-managed irrigation and water management practices at a higher priority than large-scale formal irrigation, seems irrefutable. If the large-scale irrigation schemes continue to take a

prominent place in the development plans of the region, then the reason for this is not to be found in economic arguments.

EQUITY AND RESPECT FOR EXISTING WATER RIGHTS

The objective of some form of equitable allocation of water would have to take account of the water demands of farmers and fishermen all the way from the head-waters of the major tributaries to the river outfall at Lake Chad. The major difficulty with such a policy is the present state of ignorance of precisely what these current (let alone future) demands are. This ignorance, combined with past attitudes that have marginalised traditional water users (see, for example Adams, 1983) militates against the adoption of a policy primarily based on equity.

Nevertheless, in water management terms two possible approaches exist, were equity to be a major objective of policy. The first would be to maintain the natural state of unpredictability of river flows, on the basis that all users would then remain equally subject to the vagaries of nature; this would require a positive decision not to proceed with further control structures such as Kafin Zaki.

The second, and more interventionist, strategy would involve the construction of dams and their management in accordance with operational rules designed to maintain certain minimum flows (or proportions of the available runoff) at defined points down the river system. Reference has already been made to the Bagauda Lake Agreement, one part of which attempted precisely this.

A policy that gives priority to the rights of existing ('traditional') water users as opposed to newcomers (and, in contrast, to priority being given to new upstream users) requires detailed recognition and knowledge of these abstractions. The point has already been made that such recognition has been lacking, and the necessary research has not been done to any significant extent in northern Nigeria.

Such a policy would also require legislation and control to a degree that is almost entirely lacking at the present time in Nigeria (although other African countries, such as Zimbabwe, have shown that the necessary instruments can be effective, given the willingness and the organisation).

The fifth column of Table 2 is an attempt to summarise the inherent difficulties involved with each of the water-using activities in allocating water equitably, and/or respecting existing (unwritten) water rights. Once again the main difficulty arises when larger-scale formal irrigation development deprives 'informal' water users of their traditional rights.

EFFICIENCY OF RESOURCE USE

This third objective would treat as high priority the need to minimise unproductive flows of water. Much has been written in the past about 'losses' of water from the river system after it has entered the area underlain by the Chad Formation (e.g. Schultz, 1976; IWACO, 1985). These losses to the river are divided between shallow groundwater recharge (the smaller part) and evapotranspiration (the larger part). As an indication of the relative magnitude of these two flows, Schultz (1976) estimated for the middle basin (from the edge of the Base Complex to Gashua) that the recharge element and the evapotranspiration 'loss' made up 12 per cent and 88 per cent of the total river flow losses respectively. It is likely that the proportion of the losses going to recharge decreases downstream.

The concept of 'losses' needs close examination. Groundwater recharge can hardly represent an undesirable loss, since it is a means of storing water beyond the reach of evaporation. Transpiration flows may take place through crops or economically valuable natural vegetation (e.g. grasses and other forage, and trees used for medicinal purposes) on the one hand, or unproductively through unused vegetation (although even if vegetation is not used by man or livestock, it clearly still may have value to the natural ecology). Only open water and bare soil evaporation, in general, constitute undesirable losses, and their minimisation may be a valuable goal. It is therefore important to determine the actual volumes of productive or potentially useful water fluxes, as well as the unproductive flows. These are not known at present.

If it were to be established that a significant part of the water 'lost' to the river system has no productive or ecological value, then there would be an argument for concentrating development in the upper and middle parts of the river basin in order to minimise such losses. This would run precisely contrary to any objective of spatial equity or top-end/tail-end parity. No special engineering measures would be called for, although a higher degree of control over river flows would assist in the minimisation of unproductive losses.

The sixth column of Table 2 summarises the unproductive losses inherent in the water-using practices listed.

ENVIRONMENTAL STABILITY OR SUSTAINABILITY

The objective of environmental sustainability could range from pure environmental conservation, at one extreme, to that of a totally managed environment, involving complete control of water, land, and vegetation resources, but avoiding degradation, at the other. Given the costs involved in the latter, it is likely that a situation close to the former will be more realistic for the foreseeable future. The major anthropogenic impact on the stability of the environment is the development of large dams and irrigation projects. These have already resulted in undesirable local impacts such as waterlogging and water-related disease, as well as numerous downstream impacts in terms of altered river flows. It must be borne in mind, however, that the natural environment of the Yobe basin is semi-arid, and highly variable; natural climatic change may affect soils, land cover and water resources at least as much as, if not more than, man-made interference.

Sustainability, in an environmental sense, must therefore allow for the high degree of variability, both spatial and temporal, inherent in the climate, together with the growing demands on the natural resources of the region. Rather than the rather static concept inherent in much discussion of sustainability, a highly dynamic concept must be adopted. In such an environment, and especially given the economic difficulties of the country, policy and strategy based on *control* of water are less appropriate than those based on *adaptation* to the inherent variability.

RELIABILITY/PREDICTABILITY

The fifth objective of a water management policy is that of reliability of water supply. There is a strong argument from many parts of the world that improving reliability of supply can significantly contribute to the encouragement of self-help development of irrigation and improved performance of existing schemes. In northeast Nigeria one of the strongest arguments for the continued construction of large dams such as Kafin Zaki is the increased predictability that would be achieved through control.

There is, however, a much cheaper option that would go some way towards the objective of predictability, while foregoing the degree of control that would permit a major reduction in year-to-year variability of flows. It can be shown (e.g. IWACO, 1985; Carter, 1995) that if river flows were gauged accurately where the major rivers leave the crystalline rock upper catchment (Wudil in the case of the Hadejia, and Bunga Bridge in the case of the Jama'are) and the results were made available promptly, then floods in the lower valley could be forecast with reasonable accuracy with 2–3 months warning. At the present time this is not possible because of the effective cessation of reliable river gauging in recent years (NEAZDP, 1990).

From Table 2 (eighth column) it is evident that those activities that rely on direct rainfall or on the flood of the Yobe river are those that are most risky, whereas groundwater-based activities enjoy a somewhat more reliable water supply. Even with the drought-prone activities it is nevertheless arguable whether the inherent variability of the climate should be addressed by attempting to achieve greater *control* over natural resources, or by attempting to achieve more effective *adaptation* to the environment. The latter approach may be forced on the region, if only because of the financial and institutional weaknesses that emerge when the former strategy is followed.

MANAGEABILITY OR INSTITUTIONAL SUSTAINABILITY

In the economic, social, and cultural environment of northeast Nigeria, the sustainability of any water-using activity depends on the relative roles of the individual, the community, the private sector and the government. Each of these stakeholders operates under different constraints, and all operate within a variable and unpredictable natural, economic and political environment. The greater the dominance of the individual, the community, or the private sector, the greater seems to be the ability to overcome the obstacles imposed by the environment, such as fuel and spare parts shortages, price fluctuations, access to markets or drought. The ninth column in Table 2 therefore comments on the degree to which the farmer, the community, or the consumer is independent of government management.

POLICY DEFINITION AND STRATEGY FORMULATION

In this article, 'policy' is taken to be a higher order category than 'strategy'. In other words, 'policy' embodies the general principles, while 'strategy' incorporates the specific actions and instruments necessary to implement policy.

Table 2 is proposed as a tool to assist in the definition of policy. It allows each water-using activity to be analysed in terms of its major characteristics, and evaluated from the point of view of six generic policy objectives or performance criteria. In principle, this table could be further developed by the use of a scoring system, which together with an agreed weighting of the six policy objectives, could be used to prioritise the various water-using activities. Such an approach can easily become too mechanistic, however, ignoring important political objectives (not included in this general table) that might relate to particular water uses.

Policy should be defined in terms of a number of general statements. These should describe the principles upon which decisions will be made concerning water allocation, especially where situations of shortage or competition arise. These principles should set out: (a) a general priority order of overall water allocation objectives; (b) priorities concerning particular water uses; and (c) priorities in relation to particular water sources.

For example, in the case of northeast Nigeria, and (a), it might be agreed that all the six generic objectives are desirable goals; however, should conflict between objectives arise (as, for example, when large irrigation projects displace informal water users), it might be stated that existing water rights should take precedence over other perceived aims of such irrigation projects. Alternatively, if large-scale irrigation is perceived to be the most advantageous means of achieving the wider goal of food self-sufficiency, then it may be determined that existing water rights will have to take lower priority. In the case of (b), it is likely that domestic water uses would take precedence over all others, with competing agricultural uses being prioritised on the basis of their relative productivity, efficiency or other criteria. Particular water sources are already tied to particular activities: for example, shallow groundwater to rural domestic and livestock uses, alluvial shallow groundwater to small-scale irrigation, and floodwater to rice cultivation, fishing and residual moisture farming. Such links could be further re-inforced in policy statements, or, if appropriate, be weakened.

Strategy should be developed from general policy statements, by an identification of necessary means and instruments, and through further consideration of those mechanisms deemed appropriate by international consensus (Figure 2).

Nothing has been said so far about the mechanisms by which policy and strategy should be determined, nor about what should be involved in these processes. The international consensus increasingly points to the value of wide participation, while traditionally the approach has been far more autocratic. Regardless of the processes involved, one aim of good policy making must be to anticipate and minimise conflict. In water-scarce situations, the introduction of new, water-greedy activities (such as large-scale irrigation), or the initiation of rapid changes (as, for example, with farmer-managed irrigation in northeast Nigeria) are likely to ignite, rather than avoid, conflict.

CONCLUSIONS

Conflict over water resources has developed in the Hadejia-Jama'are-Yobe river basin since the completion of Tiga Dam in the mid-1970s. Suspicion has grown between downstream users of flood waters and the new users of impounded supplies in the headwaters of the main tributaries. Accusations have not always been well founded, since the completion of Tiga Dam coincided with the early stages of a persistent drought in the region. It has therefore been difficult to separate the impact of the dam and irrigation schemes from the impact of reducing rainfall. Nevertheless, an important reason for the suspicion and conflict that have grown has been the lack of a clearly stated policy for water allocation in the river basin.

A framework for policy analysis has been described (Figure 2), showing how analyses of the existing system, and of the knowledge base, can lead, via an explicit critique of current international thinking, to a description of the characteristics of each water-using activity, and their performance in relation to a set of six generic policy objectives (Table 2). The expression of policy objectives and the analysis of each water-using activity in relation to these objectives, logically lead to the identification of the means by which such objectives can be put into practice; in developing specific strategy, the current international practice must be reconsidered. These tools allow a clear and open expression of policy objectives and of the strategic activities that follow from the objectives. It is towards such clear analysis and communication that the authorities responsible for water management in northeast Nigeria should aim.

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Policy research in sub-Saharan Africa: an exploration

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SUMMARY

This article argues that a major problem with contemporary policy analysis is that it has difficulty coming to terms with complex economic change. This in turn is probably influenced by a view of socioeconomic systems that still harks back to the classical mechanics of the nineteenth century and a relatively stable world in which social action could reasonably be informed by disinterested scientific research of a traditional kind. By means of a review of some recent policy analysis literature and by focusing on issues relating to development issues in contemporary Africa, the article maintains that a more realistic approach would recognize the evolutionary nature of modern socioeconomic systems and base policy interventions accordingly. In particular, there is a need to see 'policy' as a process of complex change requiring innovative institutional contexts and novel managerial capabilities.

INTRODUCTION

Recent political and socioeconomic changes in Africa have brought into sharp focus the role of policy reform in creating a suitable environment for change since it is becoming clear that the implementation of sustainable development programmes will depend on the degree to which African countries reform their policies to facilitate social innovation. As Chapter 8 of Agenda 21 states:

> 'Prevailing systems for decision-making in many countries tend to separate economic, social and environmental factors at the policy, planning and management levels. This influences the actions of all groups in society, including Governments, industry and individuals, and has important im-

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