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Irrigation improvement projects in Tanzania; scale impacts and policy implications

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Abstract

Observations in Tanzania indicate that the improvement of traditional smallholder irrigation does not necessarily result in improved water performance, greater equity and reduced conflict. The usual outcomes of such projects is a gain in water for the system being upgraded, especially if located upstream, accompanied by less ability to share water at the river basin scale. This paper concludes that these projects do not commonly understand, match and respond to the complexities of well-developed and evolving smallholder irrigation found in multi-user river basins. Without re-appraisal, the risk is that donors will be unsuccessful with smallholder irrigation and turn away from this sector, as they did with large-scale irrigation.

Keywords: Donor programmes; Improvements; Irrigation; Performance; Policy; Smallholder systems; Tanzania.

1. Introduction

The context of this paper concerns the changes in hydrology of the Ruaha River in Tanzania over the last 20 years. These changes and their context are well documented in recent papers (Baur *et al.*, 2000; Lankford & Franks, 2000; Lankford & Gillingham, 2001) stemming from analyses conducted by a project funded by the UK Department for International Development (DFID, 1998). The project “The Sustainable Management of Usangu Wetlands and their Catchments” (SMUWC), located in Southern Tanzania, started in 1998 with a three-year timeframe. The project arose from concerns arising during the 1990s over water, particularly when the Ruaha River dried up in the Ruaha National Park and hydropower-derived electricity cuts occurred in Dar es Salaam. Among a number of competing theories about the causes of the drying up of the Ruaha was the growth and changing nature of irrigation in the Usangu. The area and issues are further described in articles by Hazelwood & Livingstone (1978), Kikula *et al.* (1996) and SMUWC (2001).

With respect to this paper, the key notable feature about the Usangu Plains is that smallholder irrigation is extensive in area: from between 20,000 to 40,000 ha located on between 7–12 rivers. The area and number of rivers change because both are dependent on the seasonality of rain and river flow. Moreover, it is the cumulative effects of this scale of irrigation in terms of livelihoods, rice production, water use and conflict that makes this area so important in Tanzania. Some individual smallholder schemes are over 1000 ha, making them relatively large scale and complex.

2. Irrigation interventions

Indigenous small-scale irrigation is the dominant contributor to total irrigated area in Africa within many countries (Gowing & Tarimo, 1994). In recent times, there has been a resurgence of interest in irrigation in sub-Saharan Africa as an engine of rural development and food security, as shown by the increased activity of regional institutions working in these fields. This applies to research institutions and networks such as SWMNet (Soil and Water Management Network), SACCAR (Southern African Centre for Co-operation in Agricultural and Natural Resources Research and Training) and IWMI (International Water Management Institute). In addition, there is renewed donor support of irrigation (e.g. from the Danish Agency for Development Assistance (DANIDA), the Japanese International Cooperation Agency (JICA), the African Development Bank (AfDB) and DFID) and there is evidence of a greater number of poverty-related policies that address irrigated agriculture (e.g. Rural Development and Agricultural Development Strategy Papers linked with debt-relief programmes).

The approach taken in supporting irrigation in Tanzania (MAFS, 1999; JICA, 2001) mirrors approaches found elsewhere in sub-Saharan Africa and, on occasion, elsewhere in the world (e.g. FAO, 2001). This can be described as being a "single system, productionist model", with features that are described in this paper. The principal weakness of such an approach is that it emphasises physical improvements to an intake of a single irrigation scheme, ignoring the fact that, by connection of a river supply, multiple schemes inter-relate, forming a much larger collective. The individual-system approach greatly "empowers" some schemes over others, leading to inequality of access to water. This issue is pertinent when the flow in the river decreases, as pointed out by Ambler (1994): "during the dry season, the enhanced acquisition capabilities of the permanent weir allow it to capture more water than its traditional share, to the dismay of farmers in downstream canals".

The second weakness is that such an approach does not distinguish between irrigation systems that are at different stages of development. It instead perceives irrigation as described in many textbooks and engineering manuals; conceiving that irrigation productivity is a function of various "agronomic inputs" that need to be applied in a co-ordinated and formulaic fashion. Underpinning this approach is a belief in sound (i.e. formal) engineering science that then is "participatorally" rolled out with the users. This view is applied to both "brand new" systems and to the improvement of irrigation systems that have already been developed indigenously by users. This paper argues these two kinds of irrigation systems are at different stages of development and therefore require different approaches.

Although this paper is a critique of conventional irrigation policy found in Tanzania, there is ample evidence of innovative interventions by donors. Examples of these are given in the TIP programme (Bashagi, 1998) and in the Irrigation Section Support programme managed by DANIDA (DANIDA, 1998). DANIDA are increasingly interested in addressing wider irrigation drivers and, for example, have drawn up guidelines for the review of the legal framework surrounding irrigation. Another sign of recent attempts to critically review irrigation policy is given by the conclusions of the 1st National Irrigation Conference held in Tanzania in March 2001 (DANIDA/JICA, 2001). For example, conclusions were proposed addressing four strategic issues: planning, participatory approaches, sustainability and institutional issues.

The wider literature also shows there is a willingness to understand smallholder irrigation systems and the appropriateness of policy support. This is shown by a wide range of past and recent research (Moris & Thom, 1990; Carter, 1992; Manzungu *et al.*, 1998; Potkanski & Adams, 1998; Koopman *et al.*, 2001). Yet frequently we see such analyses concentrate on within-system problems rather than adopting a river basin perspective of smallholder irrigation. The challenge here is to design a type of support programme that matches up to the complexities of irrigation within river basins; an approach that moves away from a disciplinary, component focus with a single-system emphasis.

3. Approach used in research

The irrigation research component of the SMUWC programme (SMUWC, 2000) consisted of a total of 10 months of fieldwork and desk studies, and took place over a period of about 2.5 years. A mixture of methods was used, including analyses of secondary and historical information and reports, field observations, individual interviews with stakeholders (including engineers, extension officers and farmers) and multiple surveys with farmers and farmer groups. A considerable amount of hydrological analysis, and aerial and satellite interpretation conducted by other members of the project team also informed these studies.

The main evidence for this paper came from the Kimani Irrigation Project (WER, 1993) and from other sampled systems in Usangu (Lankford & Gillingham, 2001). From these visits, it is possible to say that some, if not all, of the impacts identified in this paper are applicable beyond the Kimani Project. These lessons probably apply to the rest of Tanzania, and to sub-Saharan Africa, where smallholder irrigation systems are seen as a vehicle of food security, livelihoods and rural and water development – and where the intervention model is one that focuses on singular irrigation systems and is explicitly “production oriented” in conception.

4. Characteristics of unimproved indigenous irrigation systems

Unimproved indigenous irrigation systems are those that have been built, and are managed, by the water users themselves. Since the 1940s, such systems have developed throughout the Usangu Catchment. In upper areas, these have been used for dry season cultivation of vegetables and maize, and in the lower areas for wet season supplementary irrigation of rice. The typical characteristics of indigenous systems in Usangu are described below.

4.1. Physical infrastructure

With indigenous systems, the weir and intake are made from locally available material such as stones, sticks, poles, sandbags and grasses. As a result, the weir is not water-tight. Water leaks through the intake structure and continues down the river channel.

The irrigation channels are earth ditches that have been dug by hand, and are usually no more than one metre wide and one metre deep (at the intake), with secondary canals no more than 50 cm wide and 30 cm deep. Within the systems, there are normally some secondary canals, but few tertiary canals. Water is diverted from the secondary canal directly into farmers' fields and flows from one farmer's fields to the next and so on, until water reaches the tail-end of the irrigated area or dries up. There are usually no concrete diversion structures and the channels are not lined. Farmers make the best use they can of any natural channel such as old river channels and gullies. There are few, if any, drainage structures but water is continually recycled as it flows from one farmer's fields to the next. Some water drains back to the main and secondary canals and is reused further down the system.

Maintenance of this physical infrastructure is labour-intensive. The intakes are not permanent and require constant maintenance throughout the rainy season. The channels are cleared once or twice a year by hand. Therefore, all of the farmers using the system need to co-operate closely to ensure the physical sustainability of the system. This co-operation forms the basis of a common property regime that tends to grow stronger over time and ensures the successful management of the irrigation system in terms of meeting the farmers' own needs within the limits of their own resources.

4.2. Management of water

Scheduled water allocation is rarely practised in these indigenous irrigation systems. Water may be allocated to each secondary canal in turn at times of high demand and low flows, but this is only done as a last resort. Otherwise it is expected that water should flow in all secondary canals, with farmers at the top-end of the system planting their nursery fields and transplanting first. Tail-end farmers prepare nursery fields and transplant when there is sufficient water in the irrigation system to reach them. The result is that top-end farmers transplant in December or January, while tail-end farmers do not transplant until March (and in dry years may not transplant at all, or only a small proportion of their plot). There is an informal practice that once farmers at the top-end have transplanted they should not divert more water from the system until other farmers further down the system have transplanted. During this period of waiting until the water arrives in the tail-end areas, some of the farmers from these areas hire out their labour to farmers who have received water.

In a year when the rains are poor, only a "core" area at the top-end of the system is irrigated, with the tail-end left fallow. In a wet year, the whole area will be cultivated, including possibly areas not previously cultivated below the tail-end areas.

4.3. Institutions for water management

Traditional irrigation committees manage the indigenous systems. A typical committee will consist of a Chairperson, Secretary and representatives from each secondary canal. These people are chosen by elections, held every five years or so. The committee organises system maintenance and any schedules in times of scarcity. They are also responsible for enforcing by-laws that relate to irrigation and punishing those who do not adhere to the by-laws.

There is no remuneration for being a member of the irrigation committee and, given the high labour demands on all households involved in paddy irrigation, minimising the time commitment to the committee is important. Therefore, the management of these indigenous systems is minimal. The committee organises those tasks that are essential to the sustainability of the system – notably repairs to, and maintenance of, the intake structures. They will also impose fines on those who fail to contribute to this work. Any other tasks are only undertaken as and when absolutely necessary, such as organising an allocation schedule (which then needs to be enforced, adding to the labour burden of leaders).

5. Irrigation improvement projects

These indigenous systems have been the focus of several irrigation improvement programmes and are termed by many as “improved” irrigation systems. There have been four key improvement projects:

(1) The Usangu Village Irrigation Project 1985–96 (UVIP, 1993). This was funded by the FAO and aimed to upgrade six indigenous furrows. Work was completed in three of these systems.
(2) The Kapunga Rice Project, 1988–92. This project had three components: the building of a parastatal farm, the building of a smallholder irrigation scheme and improving the existing smallholder irrigation systems abstracting from four intakes on the Chimala River.
(3) The Kimani Irrigation Project (KIP), 1991–94. This project, funded by the Canadian International Development Agency (CIDA), planned to upgrade 4300 ha of irrigated agriculture in the Kimani Sub-Catchment, of which only 500 ha was completed.
(4) Smallholder Irrigation Improvement Component (SIIC), 1997–2001. This programme was part of the World Bank-funded River Basin Management and Smallholder Irrigation Improvement Programme (RBMSIIP). Under this programme up two indigenous furrows were upgraded.

All of these programmes had two combined aims: to improve agricultural productivity (by increasing yields and expanding the irrigated area) and, within the indigenous smallholder systems, to increase the efficiency of water use. The project documents implied that indigenous systems were unproductive (with average yields of 2.5 t/ha of paddy) and inefficient users of water (figures of 15–20% are quoted, although rarely defined). Typical project activities were both physical and institutional. Physical activities included building concrete intakes, realigning main and secondary canals, installing concrete diversion boxes with control gates and digging drainage channels. Some schemes (e.g. the UVIP work at Majengo Furrow) also involved land-levelling and the redistribution of land. Institutional activities included establishing a legally registered co-operative or association to manage the system, establishing a number of sub-committees, such as finance, operation and maintenance, and secondary canal committees. KIP also established a River Committee to help resolve upstream–downstream conflicts. Operation and maintenance was targeted, with new guidelines on water scheduling and cycling between farmers. In theory, the ability to control flows of water to different parts of the system, as well as from the river to the system, were to be improved. Equally, so the theory went, newly installed drainage channels were to raise the efficiency of water use because surplus water returns to the river. In addition, controllable adjustable intakes were supposed to allow irrigators to throttle back non-necessary abstractions, further reducing waste and raising efficiency.

6. Results of the improvement programmes

The impacts of these schemes were manifold and are discussed in the following subsections.

6.1. Immediate hydraulic effects of improved intakes

The physical changes resulted in larger individual irrigation systems that were capable of abstracting greater quantities of water from the river, and that abstracted water throughout the year. These changes

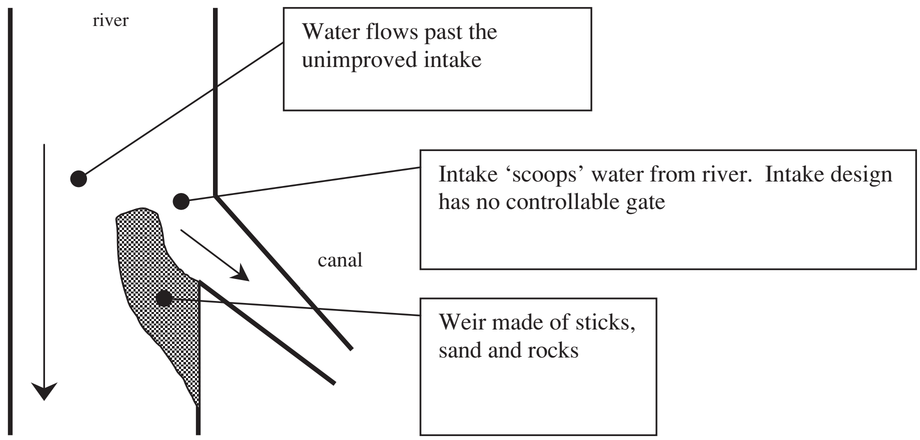

Fig. 1. Unimproved "traditional" intake.

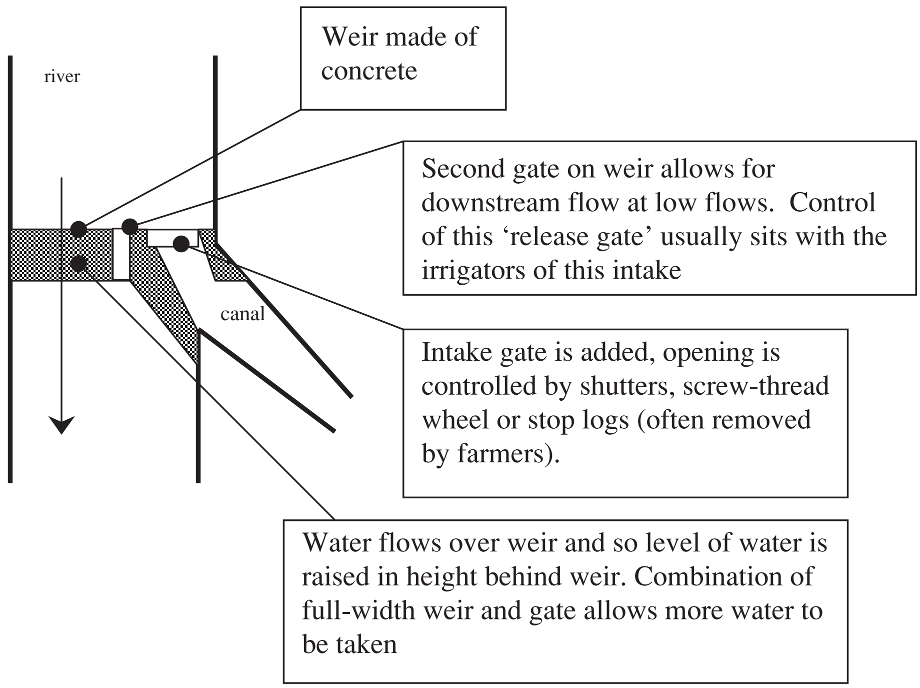

Fig. 2. Improved intake.

from traditional to improved intake are represented in Figures 1 and 2, with end-on views given in Figures 3 and 4. Previously, traditional intakes 'scooped' water from the river, allowing water to pass without necessarily raising river water levels. Without command until the levels of water rose, smallholders had to wait until December and January when the rains arrived. This allowed water to pass into their intake and canal and therefore supply downstream needs.

However, the combination of the higher-level concrete weir and the lower level of the base of the intake orifice effectively raised the level of water behind the intake. This ensures that all the water can be taken, no matter what the level of flow, and means that command of land becomes possible during low flow periods. This increased the total amount of water abstracted and lengthened the abstraction period over time. In addition the design affected the sharing of water between intakes and downstream users – themes that are discussed below.

In addition, concrete weirs were not being washed away during floods. Unfortunate though it is, if the traditional intake is washed away this erosion in effect reduces the amount of water abstracted. A traditional construction contains within its design a "natural" flow-release valve.

The only time the modernised intake and release gates were adjusted to reduce intake flows occurred when the rainfall or river flows were too great for the demands of the irrigators or when downstream users were able to negotiate some division of flows. Even so, this delayed response associated with the new design increased the total abstraction volume over the old design.

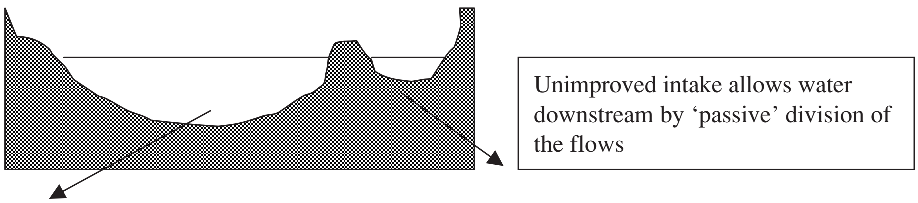

Fig. 3. Unimproved intake – end view.

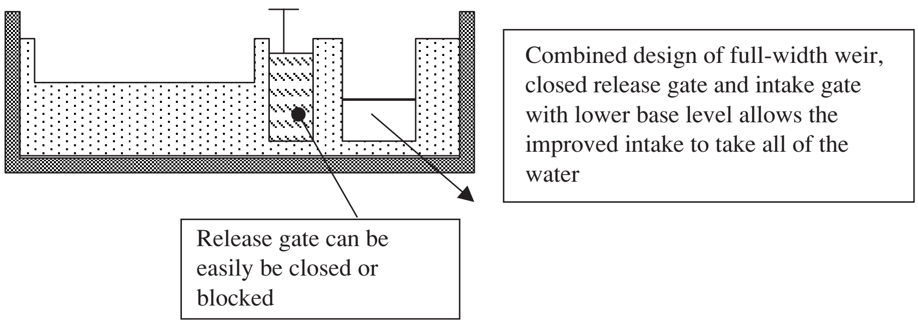

Fig. 4 . Improved intake – end view.

6.2. Environmental impact

The new weir designs had serious effects on downstream users during the dry season. This is because the first concrete intake (on a river with a sequence of intakes) abstracted most, and occasionally all, of the water. The reason the intake abstracted all the water is because the weir cill level is above the intake cill level and because the release gate was often fully closed by the upstream irrigators (see Figure 4).

These rates of flow during the dry season in some of the perennial rivers are as low as 50 l/s and are probably at the "Q95" flow rate, i.e. they are exceeded 95% of the time. In the UK and elsewhere in Europe these flow rates are normally deemed "minimum acceptable environmental flows" and only under unusual circumstances are they allowed to be tapped. In Usangu such flow rates could be argued as being for environmental needs, for downstream livestock users and for providing water for in-stream domestic use. Thus the design, although operating well at certain flow rates, pre-disposed the intake to impact negatively on the environment during the dry season.

6.3. Maintenance and operation

Farmers reported that maintenance requirements and skills had changed. Significantly, the labour requirement for maintaining the intake was reduced. From a farmer's perspective, this was the most positive impact of the projects. However, there was less incentive for farmers to co-operate together to ensure the long-term maintenance of the system, arising from three factors: firstly, farmers were reluctant to pay money to cover the cost of maintenance or water guards; secondly, farmers stated that they felt that the leaders would embezzle the money, and thirdly, farmers felt that, since the government/donor built the new intake and channels, the government should be responsible for maintaining the system.

The management institutions set up by the programmes were not readily adopted. The new tasks were seen to be onerous and there was some resistance from farmers to many of the tasks (e.g. water scheduling, collection of payments). Water schedules (cycling of water) were not followed since farmers "like to see water flowing through their fields", arguing that the scheduling was, in fact, rationing. It was interesting to note that many of the control gates within the system were removed or spoiled.

6.4. Seasonality of rice production

The development of improved intakes enabled late-season rice irrigation and dry season cropping and brought forward the preparation of fields for rice nurseries and transplanting as farmers sought to take advantage of the higher prices for early-planted rice. Thus, demand for water for rice cultivation has now moved from being within the January to May window, observed by Hazelwood & Livingstone (1978), to stretching to between October and June. This has lead to the greater use of water, but not a proportional increase in production because of reduced crop growth in the cooler part of the year. In addition, this more relaxed planting schedule also had effects in the upper reaches of the systems, giving rise to a mosaic of planted and unplanted fields. Here some farmers were absent at the beginning of the season, knowing they could wait till later. The downside was that their uncultivated plots were still receiving (and therefore evaporating) water either by seepage or by being part of the transference system of plot-to-plot irrigation, leading to lower water productivity.

6.5. Effects on rice production

Total rice production did not appear to have increased. In middle and tail-end reaches, yields remained at 1.5–3 t/ha and did not increase to 4–5 t/ha, as hoped for in the project plans. This was primarily because gains in water control were not observed further downstream and could not have been given sole reliance on improvements to the upper part of the main canal system. Top-end yields increased to about 2.5–4.5 t/ha because of earlier planting and optimal water conditions. Interestingly, these farmers were using farmyard manure to raise production even further, clearly reflecting the low degree of risk associated with rice cultivation in these plots. The critical point here is that projections of yields of 4–5 t/ha were unrealistic and should not have been used to initially justify the interventions.

6.6. Equity of water distribution within systems

Replacing a multi-intake, cascade and re-use system with a single intake, hierarchical canal system resulted in changes to the equity of water distribution within an individual system and more water at the top-end of the irrigation system. There are various explanations for this alteration. Firstly, new intakes were able to divert more water. This predisposed the upper system to receive more water. In theory, this water should flow down to tail-end farmers. However, this water did not reach tail-end fields because the installed formal drainage network put water back into the river (in contrast to the recycling found in indigenous systems).

Secondly, a hierarchical network of canals from one intake forces tail-end farmers to be more reliant on water from an intake that is several kilometres away rather than abstract from an intake within their vicinity – which was commonly the case in the unimproved situation. Tail-enders became more reliant on top-end farmers following the scheduling of water designed to make this more structured system work and therefore hostage to the drainage network mentioned above.

The improvement of the Kimani system by CIDA involved changing the plot-to-plot cascading of irrigation to one of channelled distribution. The latter entailed raising canal levels above the surface of the land, introducing secondary and tertiary canals and installing concrete undershot orifice gates. Together, these increased the water level difference between that in the distributing canals and that in the fields. This allowed upstream farmers to abstract more water than before and to maintain higher levels of water in their fields. Although manual intervention to control water usage was agreed as a possibility, it was unlikely and so the upstream system became pre-disposed to use more water. With the new set-up, dry tail-enders got their water later but appeared to be less patient than before as they walked back to their villages past top-end fields that were standing in deeper water than necessary. Previously tail-enders knew the top-end farmers could not store much water and that the system would "automatically" spill water to them.

Another unforeseen factor benefiting top-end farmers was that the network of new canals remained unfinished. Due to cost over-runs, CIDA funded far less of the total Kimani area than they intended. This has been observed at other schemes in Tanzania (e.g. at the Kilosa Irrigation Project) and is associated with the expense of this work. The incomplete network did not therefore provide the key arterial secondary canals to give water to tail-end farmers that previously took their water from intakes on the river – the latter acting as the 'artery'.

The last effect stems from farmers not wishing to move to a formalised cycling or scheduling manner of moving water between areas and plots (nevertheless, farmers did employ this when water was short). Under interview, such practices were said to be a sign of drought and farmers believed it resulted in water shortages sufficient to harm crop growth. The mismatch between the adoption of bifurcating canals and the non-adoption of cycling water resulted in tail-end farmers being denied water earlier than potentially feasible.

6.7. Cumulative catchment and upstream/downstream effects

Importantly, a series of improved intakes on a river raised the overall total abstraction capacity, increasing the potential to reduce downstream compensation flows. Thirty-three furrows, accounting for almost half of the Usangu rice area, were found to be emanating from upgraded concrete intakes. Moreover, 19 of these were built in the last decade. It is worth noting that 16 of the 33 improved intakes were found in the Mkoji catchment, supplying 4600 ha, which was approximately half of the total irrigated area in the sub-catchment.

With regards to the cumulative effect on the hydrological changes of the Ruaha, the introduction of improved irrigation intakes may be a far more critical factor in reducing downstream water availability than the commonly held view that low irrigation efficiency is to blame (ironically, the reason intakes were improved in the first place). April through to September is the period when recession flows from the upper catchment would normally have supplied and maintained the Usangu Wetland and Ruaha River. The improved intakes help abstract a greater proportion of these flows, thus reducing the amount reaching the wetland. It is important to note that this dry season water abstraction pattern is not the sole factor behind the complex tale of hydrological changes in Usangu, but the cumulative abstraction resulting from upgrading programmes does appears to be contributing towards reduced downstream flows during the dry season (Baur *et al*., 2000).

7. Mixed fortunes at different scales

The substantive issue is that the current approach to irrigation improvements in Tanzania affected water distribution at three different scales: locally within the irrigation system; nearby within the subcatchment; and wider within the river basin. At the local scale, within irrigation systems, the interventions tended to promote water inequities between top-end irrigators and tail-end irrigators. This was an artefact of reducing the number of intakes, adding drains and of introducing canals that do not reach the tail-end areas.

At the subcatchment scale, between intakes on a single river, improved intakes enhanced water security for the system being improved, especially if located upstream. However, the "normal" designing of irrigation intakes was done with little recognition of, or reconciliation with, downstream needs arising from neighbouring irrigation systems and in-stream environmental uses during the dry season.

At the basin scale, cumulative inequities mean that such improvement programmes do not compare well against river basin and intersectoral perspectives. The collective effect of so many improved intakes was arguably one major contributing factor to the decreasing downstream flows affecting the Usangu wetland and its discharge into the Ruaha River flowing through the Ruaha National Park.

Arguably, under these improvement projects, only one improvement was identified – the reduction of the amount of labour required to maintain the intake. Otherwise the improved projects have perhaps caused more problems than they solved: increasing top-end/tail-end conflicts over access to water, reducing the level of maintenance of the main and secondary canals, reducing the productivity of water use (because more water is used during low growth periods) and increasing the abstraction of water in the dry season. Can these projects be referred to as "improvement" projects without questioning the extent of the improvement, and for whom the project has improved water availability and predictability?

8. Policy analysis: wrong starting point or incorrect process of deployment?

The evidence suggests that the external modification of smallholder irrigation under the rationale of performance improvement was a risky and complex endeavour. The question is, though, was the policy incorrectly conceived or, alternatively, correctly designed at the outset but deployed without sufficient flexibility? In addition, why, after two decades of irrigation improvements in the Usangu area, a better-informed and more sensitive approach has not now evolved – in other words, why were such programmes drawn up in the latter half of the 1990s? It is difficult to answer this, but perhaps there are three critical issues in policy design and deployment.

8.1. High irrigation

There was no evidence to suggest that these programmes reflected a lack of staff, skills and resources found in Tanzania, as many of them were conducted under high profile, well-staffed, big budget aid programmes. For example, under RBMSIIP the total number of design checks and cross-checks was five, including final drawings by a major international engineering firm based in Kenya. On the contrary, it was this high profile and rather glamorous approach that contained its own biases, internal momentum and coherence. A review of documentation surrounding the improvement programmes showed that the design work was formalised – tending to default to costly, substantial structures reflecting a "strong" or "high" civil engineering flavour. There was no evidence to suggest that the specialists involved drew upon the significant body of experience and literature on *locally appropriate smallholder design* stemming from 15 years of work conducted mainly in Asia and also in Africa (Moris & Thom, 1990; Ubels & Horst, 1993; Yoder, 1994). This work centred on theoretical and empirical analysis regarding the form and function of types of irrigation structures, pointing out that indigenous structures embodied considerable understanding and agreement about water distribution and control (Diemer & Huibers, 1996). More locally, Gowing & Tarimo (1994) drew attention to the deficiencies of the improvement approach in Usangu in 1994 – pointing to weaknesses in the way in which research findings are drawn into policy. Arguably, this is a clear example of alternative, but nonetheless mainstream, views being ignored by designers and donors.

8.2. Fault-lines in participation

Despite all these projects using participatory approaches, now *de rigueur* in irrigation for many years and which are supposed to deliver locally appropriate provisions (cf Yoder & Thurston, 1990; Koopman *et al*., 2001), why were these designs finalized? Firstly, farmer participation was passive during the problem identification and project planning phases. This meant that farmers were informed of what was happening but not actively involved in meaningful decision-making. If farmers had been involved in problem identification and project planning, the project might have identified associated constraints, such as labour inputs into the paddy crop, land tenure issues, access to markets and availability of credit. In the later stages participation was contributory rather than pro-active. This meant that farmers participated by contributing labour for the building of the scheme's structures and canals but were not pro-active on altering the layout of the scheme nor responsible for the management of project implementation.

Secondly, the improvement projects tended to introduce new institutions for managing the system rather than learning from, and building on, pre-existing practices and institutions for irrigation management. This contributed to breaking down rather than supporting the development of common-property regimes, which promote longer-term management of the system.

Thirdly, it was participation responding to verbalisations of farmers' immediate concerns, such as labour, rather than to more complex and subtle but highly significant "water-control" factors, such as canal alignment, turnout density, network hierarchy, farmer group cell size, turnout operability and division transparency. Certainly, the water control problems with indigenous unstructured informal distribution would have led to localised flooding and dry spots and therefore been a real incentive to making "improvements". However, the problem was that the improvements then took place according to highly formalised engineering formats, resulting in a practically new system. Farmers probably saw this as a step forward and did not oppose the changes. However, such designs tended to stop at the "first approximation" – the design that the engineers saw fit. This was a particular problem at the Kimani Scheme, where water users then had to adjust the infrastructure themselves in order to get water to their fields. District and regional engineers then saw such adjustments as inappropriate and illegal.

8.3. Institutional design

A more serious "omission" is highlighted by the design of the intakes under the latest improvement programme, the Smallholder Irrigation Improvement Component. SIIC is the sister project of the combined World Bank project RBMSIIP, the other half being River Basin Management (RBM). Intakes designed to favour upstream irrigators specifically undermine the catchment-wide common-property objective that is conventionally the remit of river basin management. In other words, planning should have involved all water users within the catchment where the intakes were to be installed. The fact that these two projects sit under one umbrella project reflects poorly on the institutional framework of that project, not least on its inability to review and transcend its theoretical underpinning. Even a basic examination of *de facto* evidence would have been cause for a major programme review.

Policy gaps relevant to irrigation are also exemplified by the Draft Water Policy (MWLD, 2001) where scant attention is paid to the irrigation sector, the greatest user of freshwater in the country. This points to the fragmented management of water resources amongst ministries responsible for water, an observation commonly made of water governance (Sharma *et al.*, 1996; DANIDA/JICA, 2001). However, the draft policy document does highlight that "very little research [on integrated water resources management] is done due to lack of resources" (MWLD, 2001).

9. Conclusions

This paper reviewed irrigation improvement programmes in the Usangu Plains, Tanzania, arguing that they were designed as "formal fixes". They generally focused on a few infrastructural assets in individual schemes, were shored up by incomplete analyses of traditional irrigation, tended not to utilise participation in a transforming manner and were completed within too short a timeframe, normally one or two years. Substantively, all of these dimensions reflect "normal", formal, single-system and first-approximation irrigation thinking that can, at best, be excused as approaches that tackle new irrigation systems in basins where irrigation development is minor in extent. However, such approaches are less defensible in situations such as found in Usangu, where pre-existing, evolving, composite and competing irrigation systems and other water users were found within a dynamic river basin and livelihood context.

The outcomes in this paper reflect poorly on how theory and evidence associated with irrigation improvements are used by governments and donors without close reflective examination. Inevitably, when such institutions utilise river basin management theory to draw up relatively rudimentary interventions for "improvements", they can give rise to a new set of "unforeseen" problems which, if not specifically accommodated by a longer project cycle, then require a painfully long post-project hiatus before their effects can be tackled. Indeed, the findings in this paper beg the question: "what mechanisms are there within Tanzania to begin a major review of past intake construction, particularly of the recent past, so that their imbalanced impacts may be actively addressed"? Yet, the consequences of inaction may even be more serious than this: without lesson-learning, the danger is that donor agencies in East Africa may simply pull out of the sector wholesale, as occurred with large-scale irrigation during the 1980s and 1990s.

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