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Implementation of South Africa's National Water Act. Catchment Management Agencies: Interests, Access and Efficiency. Inkomati Basin Pilot Study

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Implementation of the National Water Act

Catchment Management Agencies: Interests, Access and Efficiency

Inkomati Basin Pilot Study

1. Executive Summary

South Africa's National Water Act of 1998 radically changed the rules governing access to water resources. An important objective of the legislation is not only to achieve equitable access to the resource, but to ensure that its use is socially efficient: that is optimal in terms of the benefit generated for all South Africans. This recognises the scarcity of the water resource in South Africa, and implies that any re-allocation of water in favour of previously disadvantaged communities must bring about a more productive use in terms of direct and indirect economic and social benefits.

This report presents the findings of a preliminary study to identify the interest groups and the dynamics between them in the Inkomati Basin, one of 17 Water Management Areas (WMA) currently proposed for South Africa by the Department of Water Affairs and Forestry as the basis for decentralising water management activities in order to make them more responsive to needs and opportunities.

The Incomati Basin WMA falls almost entirely within Mpumalanga Province, with a small portion in Northern Province. It is principally constituted by the Komati, Crocodile and Sabie river catchments, all of which flow ultimately into the Incomati river in Mozambique. Management of the resource is subject to international agreement between South Africa, Mozambique, and Swaziland, through whose territory the Komati river flows. About 95 percent of runoff in the Inkomati Basin as a whole is generated from rainfall in South Africa and Swaziland. Within the Inkomati WMA (ie in South African territory) the principal water users are forestry and irrigated agriculture (sugar cane, tropical and sub tropical fruit orchards, vegetables), which between them account for 75 percent of water use, equivalent to 42 percent of mean annual runoff.

Water consumption by forestry is not expected to rise in the future, the existing plantations having already largely attained the maximum under international agreements. Primary consumption of water is projected to triple from current levels by the year 2010, but will still only account for 188 Mm^3/a compared to 518 Mm^3/a streamflow reduction for forestry. Current projections do not provide for any increase in consumption of water arising from changing industrial structure of the region, but the supply capability of existing infrastructure (including dams under construction) will be largely taken up by existing irrigation developments. Given that instream flow requirements are likely to increase as a result of ecological elements of the Reserve, to be established under the new legislation, and to meet international obligations for cross-border flows, it is likely that water will be scarce and improvements in efficiency of use will be needed. The greatest scarcity of water is likely to be felt in the lower Komati (Nkomazi) and lower Crocodile (Onderberg).

These areas have in past five years seen a major increase in access to irrigation for previously excluded black smallholders, particularly to grow sugarcane to supply TSB's expanded sugar mill capacity. However, an analysis of the efficiency of water use by different crops shows that irrigated sugar cane is a relatively inefficient use of water, compared to irrigated fruit orchards or vegetables, in terms of direct economic benefits (i.e. to farmers), and indirect multiplier effects through forward and backward linkages between irrigated crops and other sectors of the economy. Irrigated vegetables also generate more employment than sugar cane, which has about the same employment potential as fruit orchards. An overriding advantage of sugar cane for smallholder growers is that the sugar industry provides a guaranteed market, and has a vested interest in ensuring good standards of technical and managerial support to growers. This means that sugar cane presents much lower risks for smallholder growers than other crops.

More generally black farmers face barriers to entering irrigated farming due to confusion over the extent of water availability, both institutionally (DWAF, Irrigation Boards, and the Dept of Agriculture all avoid responsibility), and technically – not least due to lack of systematic and accurate records of water use by irrigated agriculture. The most common response to applications for irrigation permits is: 'all water has already been allocated'.

The National Water Act of 1998 provides for the establishment of a Catchment Management Agency (CMA) to undertake delegated water management activities within each WMA. A parallel process of consultation has been under way in the Komati and Crocodile catchments since the beginning of 1998 coordinated by the Deputy Director (Water Quality), DWAF Mpumalanga Region, in order to inform different interest groups of the provisions of the new legislation and to initiate action towards drafting a proposal for the establishment of a CMA. This process has included a number of public 'forums' with continuity and development of the process through steering committee meetings. The process was initially directed towards forming a separate CMA for each catchment, but current proposals envisage a single CMA to cover all three catchments, with 'catchment management committees' to ensure an adequate representation of interest groups from each catchment. The consultation process was extended in January 1999 to the third catchment in the WMA, the Sabie and its subcatchment the Sand.

Records of the different meetings which have taken place during the past year chart a steady growth in the number of interest groups participating and represented on the steering committees, with the most important additions having been black farmers associations. An analysis of the way in which different stakeholders are represented on issues of water use suggests four main areas where implementing a CMA may provide opportunities for strategies which seek more equitable distribution of the beneficial use of water, while also improving the efficiency of water use:

A strategy for *representation* which recognises that under previous legislation control of water became highly decentralised, in the sense that the water resource management in each catchment became dominated by a small number of forestry or irrigation interests Representation on a CMA offers an opportunity to counterbalance controlling interests in each catchment to develop experience in management through broad consensus rather

than domination of one group by another. This should also offer scope for better representation for groups such as black farmers who should be allowed representation through farmers associations, as well as through water users' associations which, despite claims to the contrary, are likely to continue to reflect irrigation boards' priorities in representing the interests of larger commercial farms. In this regard, current proposals for all agricultural interests to be given representation as a single 'sector' should be reviewed.

A strategy of *information management* recognises the need for accurate and systematic collection, recording and reporting of data on water use to be implemented by all water users, as current data is often inconsistent. While more accurate and accessible data inevitably renders the operations of irrigation boards (WUA) and individual water users more transparent to other interests in the WMA and may be resisted by some water users, this can be traded against the advantages irrigation boards and individual irrigators will gain from better efficiency in resource use, leading to improved profitability, and fewer disputes over water use. Further, a policy of transparency over water use would allow irrigation interests to obtain a clearer picture of abstraction and storage by upstream industrial users (notably Eskom on the Komati catchment) and, as a consequence, enable negotiations over possible releases of water by industrial users for irrigation during drought periods. As part of an information strategy, the dissemination of information on water availability needs to be improved in the public domain. In particular, the translation of hydrological models into estimates of water availability at different points of the WMA needs to be reviewed, with the objective of providing an agreed set of expectations of water flow (its range and probability) at different times of the year that can be compared with measured values (eg from flow gauges). Both expected and measured flow data should be published in such a form that they would be widely accessible to all water use interests in the WMA.

A strategy of *irrigation access* for black farmers recognises that developing better access to irrigation for black farmers is a matter of providing access not simply to water, but to a viable production system. For relatively inexperienced black irrigators operating in a sophisticated market economy, that means adequate technical support, appropriate managerial advice, and a product with a guaranteed market. In South Africa, this support can only be found in the commercial sector. Currently, it is only on offer from the sugar industry. It is unlikely, however, to be an optimal use of water in terms of the net return to the individual farmers or in terms of the wider social benefit. The obligation on CMAs to ensure that water use is both equitable and beneficial in the public interest suggests that the licensing of water should include incentives or conditions requiring commercial interests to form partnerships with black irrigators that develop the latter's managerial skills and experience by providing technical, managerial, and marketing support. Partnerships could be a way of making available additional water for reallocation to previously disadvantaged groups from efficiency savings in existing water use by the commercial sector. Attention needs to focus on incentive structures for such savings and for commercial partnerships in agricultural sectors other than sugar which provide black irrigators with long-term, high-quality, technical, financial, and marketing support.

A strategy of interdepartmental collaboration on *land tenure for irrigation* recognises the removal and resettlement of many African communities under homeland administrations has left a legacy of overlapping land rights in ex-homeland areas which may lead to conflict between competing claimants seeking to develop irrigation. Equally, occupation of an irrigated plot offers an African smallholder an opportunity to 'upgrade' his or her tenure to that of individual title. In effect, therefore, the expansion of irrigation for African smallholders precipitates the need to redefine land tenure under 'tribal' authority and may accelerate the shift of irrigated land to individual, rather than tribal, title. In this way the allocation of water is inextricably linked to the resolution of land rights in ex-homeland areas. If a CMA is to be able to manage this potentially conflictual situation, DWAF needs to engage with other government departments in laying the groundwork for an institutional framework for allocating land and water in ex-homeland areas. Firstly, DWAF needs to remove the anomaly whereby water allocation is made to black farmers by the Department of Agriculture. Future permits for water use by black farmers should be based on a review of water availability on the rivers concerned (see 2, above). Secondly, DWAF needs to engage the Department of Land Affairs, the Department of Agriculture, relevant TLCs, LRDCs, and Tribal Authorities, in order to review systematically the tenure status of land where irrigation expansion is proposed with a view to identifying areas of conflict, clarifying the terms under which water permits are issued, and seeking equitable allocations for those with legitimate claims.

Background

South Africa's National Water Act of 1998 radically changed the rules governing access to water resources. An important objective of the legislation is not only to achieve equitable access to the resource, but to ensure that its use is socially efficient: that is optimal in terms of the benefit generated for all South Africans. This recognises the scarcity of the water resource in South Africa, and implies that any re-allocation of water in favour of previously disadvantaged communities must bring about a more productive use in terms of direct and indirect economic and social benefits.

To achieve this, redistribution of water will need to be guided by two factors: an assessment of the social efficiency of alternative, and possibly competing, demands for water; and an awareness of changing demand for water as previously excluded social groups take up new opportunities.

A key question is how best to approach this institutionally and organisationally. The new policy and legislation provide for many water management activities to be delegated to a catchment or regional level, in order to make management more responsive to local needs and opportunities. However, this approach carries the risk that the management process could be captured by some locally influential interest groups to the exclusion of others. Despite widespread optimism to the contrary, experience suggests that this risk is not diminished by decentralisation (Manor, 1995; Carney, 1995; Carney and Farrington, 1998). In the South African context particular attention needs to be given to the way access to water is negotiated by poor communities who, by virtue of their historic exclusion from land ownership, currently enjoy only limited access to water resources, and who may be ill-equipped to take advantage of the provisions of the new legislation.

At the request of the South African Department of Water Affairs and Forestry (DWAF), the UK government's Department for International Development (DFID) agreed to fund a preliminary study to identify the interest groups and the dynamics between them in one of the catchments in South Africa selected as a pilot for implementation of the National Water Act, and to make recommendations for strategies to adopt in the establishment of catchment management agencies.

This report presents the findings of a study undertaken by the authors over a period of three weeks in January and February 1999 in the Inkomati Basin, which is one of 17 Water Management Areas (WMA) which would together cover the territory of South Africa, under proposals put forward for public consultation by DWAF in October 1998. The study was based on documentary sources made available by DWAF in Pretoria and Nelspruit, and on a series of interviews conducted with stakeholders. Those consulted are listed in appendix 2. The analysis of efficiencies of alternative uses of water makes extensive use of recent published and unpublished research by one of the authors, Professor Rashid Hassan, of the Department of Agricultural Economics at the University of Pretoria. The present report is a revision of an initial draft which formed the basis for a series of workshops organised by DWAF in Pretoria and Nelspruit in April 1999. Workshop participants included officials from government departments at national and

provincial level, and stakeholders in the Inkomati Basin WMA. The workshop discussions, together with written comments, notably those from Charles Sellick, have had an important input to this revised report.

2. Existing and Projected Future Water Use in the Inkomati Basin

2.1 General characteristics of the Inkomati Basin WMA

The Inkomati Basin drains eastwards from the Transvaal Plateau and South African Highveld (>2000m altitude) into the Indian Ocean via the South African Lowveld (150-800m altitude) and the Mozambique Coastal Plain (<150m altitude). This eastwards drainage traverses the Great Escarpment of the Transvaal Drakensberg, separating the highveld and lowveld, and the Lebombo hills, separating the lowveld from the coastal plain. The Basin is constituted by three principle catchments in South Africa, the Komati, Crocodile, and Sabie, which all eventually flow into the Inkomati river in Mozambique. The entire Basin falls within the summer rainfall region, with mean annual gross Class A-pan evaporation of about 1900mm. Runoff is generated principally in the western part of the Basin: from the higher rainfall of the Highveld (annual average 700-1000 mm) and the mountainous Escarpment (1000-2000mm) which separates it from the Lowveld (500-700mm). As a consequence, although 61% of the total area (46 800 km^2) covered by the Basin, is within the territory of South Africa, with 5% and 32% within Swaziland and Mozambique, respectively (JIBS, 1995:7), a disproportional amount (95%) of the total Mean Annual Runoff (MAR) in the Basin is generated within South Africa and Swaziland.

Administratively, the Inkomati Basin WMA lies within Mpumalanga Province, except the upper Sand river sub-catchment (Sabie catchment), which lies within Northern Province.

Although the proposed Inkomati Basin WMA includes small areas of South African territory which fall within two further catchments of the Inkomati Basin, the Massintonto and Uanetze, it is the Komati, Crocodile, Sabie, and Sand catchments which constitute the significant elements of the WMA, and only these are considered in this report. Although strictly a sub-catchment of the Sabie, the Sand river has a different pattern of resource development, and is therefore considered as a distinct fourth element of the WMA. Data on water use in these catchments has been drawn from two principal sources (JIBS, 1995; DWAF, 1995) supplemented by more recent estimates (MBB, 1998a, 1998b; Pollard et al.1998, NOWAC, 1999) and additional information gathered from interviews during the course of the study. Presentation of data follows the catchment subdivisions used in these sources.

Land and water use are summarised in Tables 1 and 3 respectively. These show that water use in the Inkomati Basin WMA is dominated by irrigation and forestry, which account for 27% and 15% of MAR overall, while primary and industrial use are

equivalent to only 6% of MAR currently, and projected to reach 10% of MAR by 2010. Locally, this picture varies, as detailed in the following sections.

2.2 Existing and projected future water use

Primary and Industrial use

Primary use of water reflects population distribution (table 2) in the Inkomati Basin WMA, which is heavily concentrated in the areas of ex-homelands, particularly Kangwane, Lebowa and Gazankulu. In terms of the subcatchments of the WMA, the chief areas of population concentration are the lower Komati , lower Lomati, with 12% and 8% of total population, respectively, and the lower Crocodile, Sand, and Sabie, each with 17% of total population. In all these subcatchments population densities are above 50 people/ km^2 (above 100 people/ km^2 in the Sand, lower Lomati and lower Komati subcatchments). Elsewhere in the WMA population density is less than 35 people/ km^2 , while in the subcatchments in Swaziland the population density is betweem 42 and 52 people/ km^2 .

Projections of population growth suggest that by 2010 densities will exceed 100 people/ km^2 in the Sabie, lower Komati, and lower Crocodile subcatchments, and will be greater than 200 people/ km^2 in the Sand and lower Lomati subcatchments. Overall the population of the WMA is projected to reach 2.5 million by the year 2010 – a million more than in the mid-1990s. As a consequence, water requirements for primary use are projected to triple from 67 Mm^3/a to 188 Mm^3/a. This may be greatly increased in certain locations by the growth of tourist accomodation, particularly on the approaches to the Kruger Park. Hazyview in the Sabie catchment, for example, reportedly accommodated 71 000 tourists in October 1998. Much of the supply for this increase in primary water requirements will be secured by the additional storage capacity currently under construction, principally the Injaka and Maguga dams. The Injaka dam (120 Mm^3 net capacity), under construction in the Sabie catchment, is intended to supply the water requirements of population in the Sand and Sabie catchments as well as an estimated additional 87 000 (rising to 170 000 in 2010) people living outside, mostly in the Nsikasi area of the central Crocodile subcatchment. Similarly, the Maguga dam, under construction in Swaziland, on the Komati river, is located close to the Nkomazi area (lower Lomati and lower Komati), where projections indicate half a million people will be living by the year 2010.

Industrial water use is most marked in the upper Komati subcatchment, where Eskom transfers 131 Mm^3/a (20% of subcatchment MAR) from the Nooitgedacht and Vygeboom dams to its Komati, Hendrina, Arnot, and Duvha power stations in the Oliphants catchment. Industrial consumption in the WMA is generally attributed to three principal users: Eskom, for power plant cooling, in the upper Komati, SAPPI for the Ngodwana paper mill in the Elands subcatchment, and TSB for the Malelane sugar mill (lower Crocodile). A second sugar mill, on the lower Komati, is not regarded as a net water user (MBB, 1998a). Mining and quarrying activities are also significant water users in the Crocodile catchment. JIBS (1995) states that the restricted distribution of known mineral deposits makes it unlikely that mining activity in the WMA will expand significantly in the future. The same study also concluded that no major factory development was planned outside existing urban areas, and, consequently, it projected future industrial

water use within a combined estimate of domestic, municipal, and industrial water consumption. This was calculated on the basis of projected population growth and a per capita water use of 40-85l/c/a for populations with 'basic services' and 250-400l/c/a for the 15% of the population with 'full services'. One implication of this method of projecting water consumption is that the existing industrial structure of the WMA is not expected to change. As indicated in section 3.3, there may be grounds to reconsider this assumption.

Forestry

Forestry plantations on the Escarpment are particularly heavy users of water, in the sense of streamflow reduction as defined under the 1998 National Water Act, in the Sabie, Elands, Kaap, and central Crocodile subcatchments, where they account for, respectively, 19%, 21%, 22% and 26% of subcatchment MAR. Forestry is also a significant industrial water user in the form of the SAPPI paper mill in the Elands subcatchment. Estimates of streamflow reduction are for the "maximum permitted areas" of forestry, including those specified in agreements between the Republic of South Africa and Swaziland. These plantation areas had been substantially attained by the mid 1990s, and it seems unlikely that they will be increased further. In catchments where significant areas of forest plantation are state-owned, such as the Sand river, it seems likely that the area under forest plantation will be reduced in future.

Irrigation

Irrigation is the principal user of water in the Inkomati WMA, currently accounting for 50 percent of all water use, equivalent to 27 percent of MAR in the WMA. Current patterns of irrigation reflect its development during the apartheid period almost exclusively in white farming areas. In these, three basic irrigation zones can be discerned.

1. In the Highveld subcatchments of the upper Komati and upper Crocodile, where rainfall is higher, irrigation focuses on supplemental watering of fodder and vegetable crops, soya, paprika, and some citrus.
2. In the 'middleveld' foothills of the Escarpment (Sabie and central Crocodile subcatchments), irrigation is principally for tropical and subtropical fruit (bananas, citrus, papaya, mangoes, litchis, avocado, pecan and macadamia nuts).
3. In lowveld subcatchments (the Swazi Lomati and Komati, lower Lomati and Komati, and lower Crocodile) sugarcane predominates, although citrus and tropical fruit (particularly bananas and mangoes) also remain important.

In ex-homeland areas irrigation opportunities have been far more restricted. Where irrigation development took place under 'homeland' administrations, it was often managed as a commercial plantation (eg Lisbon citrus estate in Gazankulu, and the coffee plantations at Bushbuckridge and Schoemansdal). Five categories of irrigation activity by African farmers can be identified, however.

1. Smallholder sugarcane: 9500ha developed in a series of schemes of 100 – 800 ha each under the Nkomazi Irrigation Expansion Programme (NIEP) on the lower Komati and lower Lomati since 1994. Individual holdings are generally in the range of 5 to 15 ha.

2. Smallholder irrigation of maize and vegetables on formal schemes built by homeland administrations. These total 1612 ha on the Sand river (Pollard et al), 650ha at Mkuhlu, on the Sabie (Woodhouse, 1995), 400ha at Tonga, on the lower Komati, and an unquantified area in the Mswati region (upper Komati catchment).
3. Non-formal smallholder irrigation for commercial vegetable production scattered in small areas throughout ex-homeland areas.
4. 'Community gardens' microplots irrigated by buckets or by gravity from tanks supplied by pumps from a stream or borehole in a streambed.
5. 'Backyard irrigation' using water from reticulated supplies. In certain areas this may exceed the supply capacity and cause water shortages in primary water supply systems.

The quantitative data for water use by irrigation are subject to some uncertainty, due to variations between sources for estimates of areas, and schedules of water applied. The figures quoted in tables 1 and 3 are those for 'developed' irrigation given in JIBS (1995), to which have been added schemes in advanced stages of planning or construction, such as those under the Nkomazi Irrigation Expansion Programme (NIEP) in the lower Lomati and lower Komati subcatchments. Elsewhere in table 3, the data may underestimate water use by irrigation. In the upper Komati, for example, calculated water use assumes only 3523ha, or 56% of the developed irrigation area, are currently being irrigated (JIBS, 1995). This is disputed by the Farmers Union representatives in Badplaas, who claim there are currently 120 farmers irrigating 7780ha in the area of Badplaas, Wonderfontein, Belfast and Machadodorp.

The data for the Crocodile catchment should also be viewed with caution. The figure given by JIBS (1995) for irrigation water use in the Crocodile catchment (297.7 Mm^3/a) is lower than the 307 Mm^3/a estimated by MBB (1998b: table 10), which, in turn, is lower than the annual volume of 424 Mm^3/a scheduled by irrigation boards in the Crocodile catchment (MBB, 1998b: table 8). Olbrich (1998:19) quotes DWAF estimates of a total of 78 000 ha of irrigated crops in the Crocodile catchment, which is almost double the figure in JIBS (1995), and would put water use by irrigation at about 461 Mm^3/a in the Crocodile catchment. The large discrepancy is mostly accounted for by a three-fold increase in the area of orchards compared to the JIBS (1995) data. It is beyond the scope of this study to undertake the detailed work needed to resolve these discrepancies, but, in signalling them, we wish to emphasise the priority which needs to be given to establishing an agreed set of figures for water use by irrigation.

While bearing in mind these uncertainties, the data nonetheless make clear the high intensity of water use by irrigation in certain subcatchments, notably the lower Komati and the lower Crocodile, where irrigation consumes more than the subcatchment MAR and is thus dependent on supply from subcatchments upstream. JIBS (1995) concludes that assurance of supply for present irrigation is inadequate, with consequent serious shortages, along the upper and lower Komati, the Lower Lomati, the lower Kaap river, the White river, some of the Sabie river tributaries, and the Sand river. In this respect, the recent completion of the Driekoppies Dam (lower Lomati) and the Maguga Dam (Swazi Komati) will play a significant part in assuring supply to this irrigation. The 1992 Treaty

on the Development and Utilisation of the Water Resources of the Komati River Basin agreed the following water allocations:
High Assurance supply: 15.1 Mm^3/a and 157.8 Mm^3/a for Swaziland and South Africa, respectively.
Low assurance supply: 260.2 Mm^3/a and 381 Mm^3/a for Swaziland and South Africa, respectively.

Game and livestock
By comparison with other demands on the water resource, those estimated for game and livestock in the Inkomati Basin WMA are negligible, totalling only 0.6% of overall water use (table 3).

Instream Flow Requirements (IFR)
Instream flow requirements (IFR) refer to the water volumes required to meet the need for minimum flow rates in stream channels. These requirements may arise from ecological considerations, as in the case of the Sabie and Sand rivers which flow through important conservation areas: the Sabi Sand Game Reserve and the Kruger National Park (KNP). Since the severe drought of 1992-3 the KNP authorities have instituted an agreement with other users of water on the Sabie, that a minimum flow of 0.6 m^3/s will be maintained in the Sabie as it enters the KNP. In addition to this absolute minimum flow, the instream flow requirement also stipulates that seasonal increases in flow should reflect natural flood regimes. In practice, the lowest annual flow recorded on the Sabie (62 Mm^3/a in 1982) is taken as a minimum annual requirement (JIBS, 1995). Current proposals for use of the Injaka dam include provision of a transfer pipeline to the Sand catchment which, in addition to providing water for primary use, will also supply 4 Mm^3/a at high assurance to augment the dry season flow in the Sand river (DWAF, 1995). Olbrich (1998) notes that reduced flow in the Crocodile river has permitted the establishment of dense patches of reeds in the river channel, further restricting flow and increasing evaporative losses. A 'tentative estimate' (MBB, 1998a) of base flow requirements for the Crocodile and Komati rivers just above their confluence at Komatipoort has been put at 63 Mm^3/a and 42 Mm^3/a respectively. These figures are also mentioned by JIBS (1995:13), as an annual minimum that may represent a seasonally variable flow.

Another reason for IFR is the need to meet international agreements on cross-border flows. This affects Crocodile and Komati, the principal tributaries of the Inkomati upstream of the frontier with Mozambique at Komatipoort. No final agreement has been reached on what the minimum flow rate should be. MBB (1998a) state the IFR to be 60 Mm^3/a, which agrees with a minimum of 2 m^3/s cross border flow included as part of the Pigg's Peak agreement in 1991 between South Africa, Swaziland, and Mozambique on the construction of the Driekoppies and Maguga dams (Armstrong and Ashby, 1995). It may be concluded that part of this cross-border flow requirement will be satisfied by the ecological IFR of the Crocodile and Komati rivers. However, since these are comprised of seasonally-variable flows, they may not satisfy the 2 m^3/s cross border flow requirement throughout the year. Either way, it is important to recognise the interim nature of current cross-border flow agreements pending formal agreement between South

Africa, Swaziland, and Mozambique on the utilization of the waters of the Inkomati basin.

3.3 Projected Water Supply in Relation to Demand

Table 4 summarises predicted water supply, based on hydrological modelling of the Komati, Crocodile and Sabie catchments following the construction of the Driekoppies, Injaka, and Maguga dams. Despite differences arising from variations in the geographical base used for modelling supply and demand, the estimates from different sources suggest similar conclusions. These are that only in the Sabie catchment will the supply capability of current infrastructure investment exceed projected demand, indicating some scope for further expansion of water use. In the Komati catchment, current investments in the Driekoppies and Maguga dams will be able to supply the requirements of existing irrigation expansion (eg the NIEP), but this capability will be stretched by increasing primary demand in the next decade. In the Crocodile catchment, supply capability already fails to meet demand, and this will deteriorate further.

It is important to emphasise that estimates for water supply capability are derived from hydrological models, which depend on assumptions made about a number of factors, such as evaporation from dams, transmission losses in rivers, and water consumption by exotic riparian vegetation. Estimates of the latter have been put at 70 and 80 Mm^3/a for the Komati and Crocodile catchments respectively (MBB, 1998a, b), suggesting significant quantities of utilisable water might released by controlling exotic species in riparian zones. MBB (1998b) have also suggested that, for the Crocodile catchment in particular, significant potential exists for increasing supply capability through construction of off-channel storage on farms. These points emphasise that estimates of the precise amounts of utilisable water depend on assumptions that may need to be revised, allowing a re-calibrated hydrological model to provide more accurate predictions of the yield of water from the system.

However, there seems no guarantee that more accurate predictions will 'supply' more water, rather than less. Moreover, significant further claims on water are likely to come from additional irrigation development: in Swaziland, which, according to table 3, only takes 67% of its 260 Mm^3/a low assurance allocation under the existing (1992) Treaty between South Africa and Swaziland; and from Mozambique, which is expected to recuperate some 21000 ha of irrigated sugar plantations currently lying fallow and, in time, to expand the area under irrigation in the coastal plain. One estimate puts Mozambique's water requirement from the Inkomati basin at 780 Mm^3/a - 23% of MAR for the WMA - by 2015 (JIBS, 1995)

Finally, although significant increases in primary demand (noted above) have been projected based on population growth, these are based on assumptions that future levels of industrial development, relative to population, will be the same as those existing today. Given that the Mpumalanga economy has been growing at about 7% for the past two decades, and that the Maputo Development corridor runs directly through the Inkomati basin WMA, this assumption needs to be questioned. To the extent that the Maputo

Development Corridor achieves a change in industrial structure in the region, this will need to be reflected in adjustments to projections of future water use. Future industrialisation – that is, changes to the structure and intensity of manufacturing and service sector activity, in the region – will affect water use not only directly, in terms of the consumption of water by these sectors, but also indirectly, from the point of view of employment creation.

Unemployment is a critical issue throughout South Africa, and has been estimated at 40% of economically active population in the Nkomazi area (NOWAC, 1999). Failure to generate employment through industrial or service sector development will increase pressure to expand income opportunities in agriculture. The 1000 or so black smallholder sugar growers in the NIEP are estimated to each make about R50 000 net per year from a 9-10ha holding. This is widely seen as an attractive proposition and has generated demands for further expansion of irrigated sugarcane schemes in the Nkomazi area (totalling over 5000 ha on some estimates) and beyond. Commercial farming and irrigation interests estimate that there are at least 13500ha of irrigable soils available for development in the Onderberg/Nkomazi (lower Crocodile, Lomati, and Komati subcatchments) region alone. Much of this could be allocated to black farmers, but, as indicated above, availability of water is likely to be a constraint for irrigation expansion of this magnitude.

In some areas, such as Nsikasi (central Crocodile subcatchment) and Mswati (upper Komati subcatchment) irrigation development sought by black farmers is relatively small-scale or may involve repair of existing infrastructure (see section 7 below). However, precluding for the time being any further development of large storage capacity after the completion of the Maguga dam, any major proposals for further irrigation development in the Inkomati Basin WMA will confront the limits of the system's capability to deliver more water and therefore must necessarily be linked with improvements in the efficiency of water use by the dominant existing water users, forestry plantations and irrigated agriculture. The efficiencies of water use by these sectors is reviewed in the next section.

4. Assessment of Economic Efficiency of Water Use

4.1 Introduction

According to the new water bill in SA, allocation of water among uses other than for basic needs (human and environmental) is to be guided by social equity and economic efficiency goals. The major task set by equity objectives is to create a broader social base for sharing benefits from water use by altering the unjust mechanisms and rules followed in the past to allocate access to water resources in the country. Economic efficiency goals on the other hand, address the future course of water resource allocation for a bigger economic benefit, regardless of how the realised benefits are distributed. While the two objectives may appear conflicting, they can both contribute to increased social and economic welfare in the long run if properly managed. Economic efficiency requires directing water resources to its best use (which generates the highest returns) leading to

greater output from the same water volume. Achieving larger economic benefits per unit water used improves economic welfare (bigger cake). On the other hand, excluding the majority of the members of the target community from sharing the realised gains is by no means socially desirable or optimal. Increased poverty and concomitant serious negative environmental consequences from high pressures on marginal resources were the outcome of such a pattern of resource allocation in the past. At the same time, redistribution may compromise some efficiency gains, especially in the short-term. The tradeoff in social welfare between smaller gains shared by more people versus a bigger cake for only a few, remains to be evaluated empirically. Nevertheless, improved access of the larger segments of the population to productive resources like water certainly contributes to higher welfare gains through enhancing the capacity of the poor to participate in generating larger economic benefits in the long run.

Given the very short time available for this research, the study presents preliminary analysis of economic efficiency aspects of water resources use under the current water allocation regimes and land use patterns in the Komati catchment. The analysis compares economic benefits from alternative agricultural production activities per unit water and land under the current pattern of resource allocation. The emphasis is placed mainly on irrigation farming and plantation forestry. This quick and crude analysis serves the purpose of generating indicative information on the existing economic value of water in the catchment and where larger economic benefits currently lie. The presented information should help planning and policy design for future allocation and management of water resources in the catchment by identifying options for increased efficiency of water use and how those can be exploited for larger economic gains and broader social benefits.

An attempt was made to estimate not only economic benefits directly generated in using sectors, but also indirect benefits realised elsewhere in the economy because of the considered water using productive activities. Total economic benefit was then derived as the sum of direct and indirect benefits. Water use was defined to be the amount of irrigation water applied to irrigated crops (net irrigation) and volume of streamflow reduction in the case of plantation forestry. The following three indices were constructed (for both direct and indirect benefits) as measures of water use efficiency:

a. Physical productivity: measured as the average crop yield per unit of water used (streamflow reduction in forest plantations).
b. Annualised average net economic returns: measured in terms of value added (VAD) per unit of water.
c. Employment effects: measured as the number of full-time jobs employed per unit water used

Data used to support the subsequent analysis were compiled from various secondary sources. Detailed discussion of data sources is given in the appendices. Five agricultural production activities were compared: field crops (sugar cane, maize and cotton), citrus (oranges and grapefruit), sub-tropical fruits (mango, banana and avocados), vegetables (beans, cabbage, onion, tomato, chillies and potato) and forest plantations (pine and eucalyptus). Estimates of average benefits from dryland

farming were also presented for comparative analysis purposes.

4.2 Direct Economic Benefits (DEB)

These represent economic gains from water use directly generated in and by the water using activity. The three indices of water use efficiency listed above were derived to measure DEB.

Average Physical Productivity of Water{tc \l2 "6.3.1 Average Physical Productivity of Water}

This index measures water productivity as the yield in tons per m^3 of irrigation water applied in the case of the irrigated crops, or per m^3 streamflow reduction in the case of forestry. To calculate this index, total production over the entire crop rotation was divided by the number of years in the cycle of tree crops to derive average annual yields. This was necessary to correct estimates for variations in yield levels over the crop cycle. Estimates of average water applied for irrigation of the various crops and streamflow reduction by plantations were then used to calculate physical output per unit water used (Table 5).

The results show that forest plantations produce the highest physical output (17.86 t) per m^3 of water. Citrus and vegetables among irrigated crops rank second to plantations. Although, forest plantations in general, clearly outperform irrigated crops, these results are not comparable as physical production units are different (e.g. tons of timber, fruit, vegetables, maize and sucrose). The higher weight of forest products is consistent with expectation as wood in the case of forestry is structural fibre, whereas the fruit from most of the irrigated crops is reproductive tissue. However, it is important to emphasise that the measure of water productivity is of little value in comparing these activities, as higher physical yields may not necessarily mean higher economic returns when values of inputs and products are considered as in the following sections.

Annualised Average Net Returns (value added - VAD){tc \l2 "6.3.2 Annualised Average Net Returns (ANR)}

VAD is a measure of the returns to factors of production such as labour, capital, land and water. It is calculated by subtracting from total receipts the value of materials and services purchased from other economic sectors to use as intermediate inputs in the production process. What remains from total receipts belongs to the owners and providers of primary factors' (labour, capital, etc.) services used in generating this value. Hence the name VAD refers to this portion of the total value of receipts generated in the economic activity in question (in addition to the value of purchased intermediate inputs used). Aggregate VAD of an economy defines its gross domestic or national product (GDP or GNP). Total VAD generated in an economic sector measures that sector's contribution to national income (GNP). VAD is accordingly considered a better and more appropriate measure of economic value than other measures such as gross margins, etc. VAD is allocated between wages, profits and taxes paid to government. This study calculated

average VAD generated in each of the compared water using activities based on output value and production costs estimates for the year 1994 as reported in the COMBUD (Department of Agriculture, 1994) as well as other sources reported in the appendices. The 1994 data were then updated to 1997 prices using the production price index for SA. Table 5 also presents VAD per 1000 m^3 of water used.

As in the case of the above physical efficiency measure, average yield per ha was calculated over the entire production cycle, and not at maturity, again to account for yield variability at ages other than full maturity. Results indicate that the relative ranking of the crops changed dramatically when economic variables (e.g. prices) are taken into account in addition to physical production measures (Table 5). Irrigated horticultural crops (both fruits and vegetables) switched position with plantation forestry and came top. Vegetables ranked highest generating close to R 2 of VAD per m^3, followed by fruits. Plantations however, outperformed sugarcane and other irrigated field crops, which generated the lowest VAD. On the other hand, dryland crops produced the highest value added per unit water (R 3.7/m^3). This is mainly due to the low water use by dryland crops, which is calculated as 70% of plantations' streamflow reductions.

It is important to note, however, that this measure does not account for the fact that some costs and returns are paid and received at earlier dates that can be as far back as 18 to 30 years ago, e.g. at establishment of plantation or tree crops. Therefore, this method assumes that timing of cost payments and receipts of revenue make no difference to resource allocation decisions. This is certainly a deficiency, given the importance of time preferences to economic investment and resource allocation choices. To address this, measures that account for the time factor in economic decisions such as the discounted cash flows and net present value calculations must be derived for proper comparative assessment.

Recent research (Hassan et al, 1998) used an analysis of this kind to compare water use efficiency for pine and eucalyptus plantations, sugarcane, and a series of subtropical fruit crops (orange, grapefruit, bananas, mangoes, avocados). Net returns (R/m^3) to each type of water use were calculated over a 30-year cycle using data for costs and prices for each crop for the period 1964-94, adjusted for time preference using a discount (compound) rate of 16%, to calculate a 'net terminal value' (NTV). This research found that over the 30 – year period NTV (Rands per m^3 of water at 1994) was in general highest for sub-tropical fruit and lowest for forestry plantations grown on short cycles for pulp (table 6). Sugarcane tended to be a more efficient use of water than forestry under average conditions, but less so than the best Eucalyptus plantations. Sugarcane appeared a much less efficient use of water than sub-tropical crops. Under average conditions mango orchards produced ten times the NTV of sugarcane. In addition to average practice, this study also analysed production potential for the compared alternatives employing research data as a proxy for best practice.

Employment Benefits (Jobs)

Employment benefits were measured in terms of full-time jobs created in the activity considered. A full-time job is defined by this study to be equivalent to 1200 hours per year[1]. Based on estimates of average number of hours used directly in production and management given in the respective data sources, an index measuring full-time jobs employment equivalents was derived for the compared activities. Employment per unit water used was then calculated accordingly (Table 5).

Results show that, again irrigated horticultural crops dominate all other activities, both in terms of full-time jobs per ha and per m^3 of water as well with vegetables being the highest. More people, however, are employed in sugar cane than in citrus, plantations and other field crops. Nevertheless, the difference between these three in number of jobs per m^3 of water is not significant.

4.3 Indirect and Total Economic Benefits

In addition to generating VAD and creating opportunities for employment and income directly on the farm, the compared production activities also generate many indirect economic benefits through multi-sector linkages. For instance, intermediate inputs and services used in the production process are produced and supplied by other economic activities that support further VAD generation and jobs in the input supplying sectors. Moreover, output produced on the farm is further processed and marketed by other economic activities, supporting another forward chain of VAD and employment opportunities in post-harvest operations. Accordingly, a production activity generating lower direct economic benefits may have a bigger total economic effect through such forward and backward economic multipliers. This study therefore attempted to measure indirect multiplier effects in order to calculate total economic benefits.

Available information on the value of intermediate inputs purchased from other sectors was used to derive the backward income multiplier. The share of VAD in total receipts of the production activities analysed was employed as a proxy for VAD shares in input supplying sectors. VAD in input supply sectors from purchases made by the analysed agricultural production activities was then calculated accordingly. The ratio of VAD in input supply to VAD directly generated in the production activity in question gives the income (VAD) backward multiplier. The same multiplier was assumed for job creation upstream. However, data were not readily available to similarly estimate forward economic multipliers. This study used an adapted social accounting matrix for the SA economy in 1995, in which agriculture was disaggregated into activity groupings similar to the ones analysed here to derive forward (down stream) multipliers (Hassan, 1998). It is important to note the economic multipliers derived by the present study represent only inter-sector production effects or linkages. In other words, feedback effects from final

1 This was based on the assumption of 20 days of work per month for 10 months a year and 6 work hours a day. A full-time job in agricultural work will most likely require much less hours given the seasonal nature of farming operations.

demand (consumption spending) are not taken into account. Most agricultural activities and especially food production are known to have large consumption spending multipliers. That means indirect benefits derived based on our multiplier estimates may be underestimated. Table 7 uses the estimated backward and forward multipliers to derive indirect and total economic benefits.

Irrigated citrus and vegetables have the highest multipliers, followed by plantations, other field crops, sub-tropical fruits and sugar cane. Whereas irrigated fruit crops had higher backward multiplier effects, vegetables, plantations and sugar cane showed stronger forward linkages. This may be attributed to the fact that most of the fruits' produce is sold fresh and hence involves less processing compared to plantations and sugar cane output that goes into a sequence of timber and sugar milling and processing chain of activities. Production of vegetables under irrigation dominated all activities in terms of total benefits per unit water used. Sub-tropical fruits ranked second. While plantations did dominate the rest in terms of total VAD generated, other production activities created more jobs per unit water, at a small margin, however.

It is important to note that the analysed production activities not only have indirect economic benefits, they also cause indirect social costs. Examples are the resource use and environmental externalities of upstream and downstream activities linked with them. For example, while horticultural crops show lower forward multipliers, their downstream activities are less water using than those of processing sugar cane and timber for pulp. That means for a proper assessment of total social costs and benefits per unit water, at least water used in forward and backward multiplier activities should be accounted for. Moreover, environmental externalities of those activities vary significantly among the source options compared. For instance, while horticulture and sugar cane farming promote higher backward multipliers, their input supply activities may be more environmentally damaging than those supplying inputs and services to forest plantations. Other social costs and benefits, such as carbon sink values in plantations, erosion of biological diversity, etc. were also not measured in the present study. Accordingly, one should take the results of this research with caution given the outlined limitations of the analysis.

4.4 Conclusions and limitations of the economic efficiency analysis

Although forestry plantations emerge from this analysis as a relatively uneconomic user of water, this does not imply a switch of land use from forestry to irrigated agriculture, for much of the forestry area is established on land unsuitable, for reasons of slope and soil depth, for agriculture. The findings of this research do, however, raise questions as to whether the current programme of expansion of sugar cane production, which according to TSB may ultimately reach 43 000 ha of cane out of 60 000 ha irrigated in the lower Crocodile and lower Komati, represents the most economic use of the increasingly scarce water resource. In this context, the frequent assertion, from within the industry, of possible improvements in irrigation efficiency in sugarcane is significant. More specifically, it is claimed that, using improved technology (eg drip irrigation) existing sugar yields can be produced using 30 % less water, or reducing current abstraction from

current levels of about 12000 m^3/ha for sugar to about 8000 m^3/ha. Not only would such savings improve the returns to water use on sugar cane, but, if they were achieved on the existing irrigated sugarcane area of about 34000 ha, they would represent about 136 Mm^3/a. This would be enough to expand irrigation for approximately 14500ha of citrus, or 22500ha of vegetables, or 27000ha of mangoes.

However, the economic efficiency analysis results should not be interpreted to simply mean allocation of all land and water resources in the catchment to the option generating the highest total economic benefits or NTV. This is mainly because of the various practical limitations associated with such an option of monocropping. For instance, diversification in production activities is an important strategy to hedge against production and market risks associated with monocropping. The risk aspect is discussed separately in the following section.

Another important limitation on the above analyses at present is that the data on which water use efficiency calculations are based were found to be very uneven. Information for forestry and sugarcane is in general more comprehensive and allows more reliable predictions of potential long-term productivity shifts than the data for sub-tropical fruit, which at present are derived from relatively short-term field trials. Data shortcomings also mean that estimates for water use by different crops were not strictly comparable, since stream flow reduction as a measure of forest water consumption should strictly be compared with gross irrigation, less return flows. Lack of data meant that net irrigation values had to be used instead. Even in comparisons between irrigated crops, it is not always the case that all analysed production systems use comparable regimes of irrigation application (e.g. microjets, sprinkler, drip, etc.). Economic efficiency analyses clearly need more information on how much water is actually used on commercial crops, and the sensitivity of yield (on criteria of both quantity and quality) to lower rates of irrigation.

4.5 Risk issues in alternative production systems

In discussions with irrigators, a key issue, which is apparent in their choice of productive enterprise – and one which was not addressed by the economic efficiency analysis presented above – is that of risk. Two particular aspects of risk appear most important: risks attached to assurance of water supply; and risks associated with the market for their output. While the primary concern of the new water legislation is with the first of these, water supply, the reality expressed by irrigators is that access to water means little unless their produce has a reliable market. In this respect sugar cane scores heavily over most of the alternatives, particularly among black smallholder growers with relatively little experience in using capital-intensive irrigation. TSB's expansion of capacity at its Komati mill is to be allocated with priority to black cane farmers on the 1800 ha of NIEP schemes still to be completed and on a further 4000 ha of irrigation proposed for second phase of Nkomazi irrigation expansion (A.Winterbach pers com.). The sense of an assured market and a predictable income is a clearly stated reason black irrigators in the Nkomazi, and as far afield as the Nsikasi river in the central Crocodile sub-catchment, regard sugar cane as their best alternative in irrigated agriculture. This is despite their equally clear recognition of the risks of overdependence on a single agricultural

commodity, and the higher returns possible on alternative crops, such as sub-tropical fruit (see section 7.3).

A view frequently stated by planners and sugar industry representatives is that the assured income from sugar will enable less experienced growers to become established and to acquire the managerial experience needed to diversify into other crops with higher returns. While this seems possible in general terms, its feasibility as a route to improved farm-level and wider social efficiency in water use depends critically on two factors. Firstly, the involvement of smallholder growers in the sugar industry must truly provide them with adequate technical and managerial skills, rather than simply a share of the profits from a production system largely contracted out to the existing corporate operators. Secondly, the risk factors associated with alternative crops, such as vegetables and sub-tropical fruit need to be reduced to levels closer to those associated with sugar.

On the first of these, a positive signal is TSB's active engagement not only in providing advice to smallholders through three of its six staff in its existing advisory service to cane growers, but also in working with the Mpumalanga Department of Agriculture to devise a more effective structure to provide 'managerial leadership and training in farm management' for smallholder cane growers. This is motivated by the company's perception that current extension services to farmers are inadequate, and clearly respond to its interest in securing a reliable supply of cane for its expanded processing capacity.

The second factor determining the feasibility of using smallholder sugar as a 'development' pathway depends on the establishment of marketing information, institutions, and infrastructure which would reduce market risks for smallholders producing irrigated vegetables, citrus, and sub-tropical fruit. This is unlikely to be provided by TSB, and indeed runs counter to TSB's interests by potentially reducing the supply of cane for its factories. As a consequence, it seems likely that additional measures will be needed to ensure improved efficiency of water use through agricultural diversification by smallholders 'graduating' from cane growing is not blocked by a high risk disadvantage associated with irrigation alternatives to sugar.

4.6 Current water tariffs and efficiency allocation instruments in the Inkomati basin

Allocation of water to irrigated agriculture is based on a quota system set by irrigation boards. The maximum quota is set at 9,950 m^3 /ha/annum. However, except for a small area of about 400 ha of vegetables in Tonga Canal (a government scheme) where water is delivered directly from public bulk water supply system, all other water is directly pumped by farmers from the river. The only control measure in place for this quota pumping is based on the government gazette requirement of a pump capacity size of 1.2 lit/second/ha. That means pump stations of a bigger size can therefore abstract more water from the river than the set quota. To control for such situations, farmers practice some self-organised initiatives for monitoring and control, especially during shortage periods. An example is the allocation of pumping time between farmers that approximates quota allocation based on the actual installed pump capacity (not the

gazetted capacity). To support this monitoring regime, farmers have also installed controls electronically operated through a radio system (WAMS) that can automatically switch off pumping after a given interval (K. van Rensberg of MBB, personal communication). Moreover, farmers have invested in other water management and control systems, such as weirs, in collaboration with the irrigation board. Farmers do pay certain fees however, for such a service.

The schedule of charges levied on farmers in the catchment include a combination of fixed charges per ha (for administration and management, Water Research Commission (WRC) fee, control and storage structures investment costs, etc.) and per unit water charges levied on water supplied from public works such as the Driekoppies and other dams. Table 8 shows average water tariffs currently collected from farmers and total VAD generated from the use of that water. In general, except for the high VAD per m^3 from subtropical fruits and vegetables, water charges are currently of the order of 10% of VAD. This of course excludes plantation forestry where no charge is currently levied. The lower charge on small-scale farmers is mainly due to exclusion from services involving capital costs (weirs, etc.) plus the lower per unit water government charges. This leads to an on average tariff on small-scale farmers that amounts to approximately 10% of the levy on commercial farmers.

On average irrigation farming pays about 15 cents per m^3 for the water it uses, which is equivalent to 8% of average VAD (Table 8). If one attributes only 15% of VAD (28 cents) to water (after deducting labour, land, management and labour values), that means farmers currently pay about half of what water is worth of in this catchment. Comparable values of water in SA have been calculated by other studies (Hassan et al., 1996; Hassan 1999). This of course doesn't consider the opportunity cost (scarcity value) of water elsewhere in the economy, which could be lower or higher. Currently, forest plantations pay no charge on water used (e.g. rainfall).

Besides charging the correct price for water, which is often not easy to determine, other environmental economics instruments can be exploited to promote allocation of water resources based on economic efficiency rules. Market-based mechanisms provide an example of efficiency allocation instruments. While the authors' investigations indicate little, if any, trade in water has taken place in the Komati catchment, water sales have been reported in the Sabie catchment (Woodhouse, 1995), and there is evidence that water markets have emerged and been in operation over the past few years in the Crocodile catchment. Bate et al. (1998) report on more than 45 contracts of trade in water that took place during 1994 in the Crocodile catchment. Both temporary and permanent trades in water rights were found between farmers in the Crocodile catchment exchanging a water volume estimated to be about 8% of the total irrigation water in the catchment. The total value reported amounted to close to one million Rand in 1994. Farmers paid up to 6 cents per m^3 over and above water charges (Bate et al., 1998). This is an indication that, at the average value of 28 cents/m^3 of water we estimated above (Table 8), farmers in the Inkomati basin have a strong incentive to trade water at the average premium of 2.5 cents/m^3 reported in the Crocodile catchment (Bate et al, 1998). This however, requires the essential prerequisites of clearly defined and transferable water rights among other things. The impact of the new water bill and emerging CMA

organisation on security of water rights and hence the potential for using markets to guide water allocation on economic efficiency basis is therefore a crucial institutional change to consider.

5. Existing institutions governing access to water

5.1 Water Legislation

Until the passage of the National Water Act, in 1998, water use was governed by the Water Act (No. 54 of 1956) and its amendments. Under this legislation rights to abstract water resided principally in ownership of land riparian to a stream, or of land originally belonging to a property riparian to a stream. Abstraction by riparian landowners was not subject to limits unless formally apportioned by a Water Court among different users of the same stream, or regulated by a government Water Control Area, or an Irrigation Board. In addition, groundwater, and surface water flowing across land were considered the private property of the owner of the land. Forestry was not considered as a water user, although the impact of afforestation on streamflow was acknowledged with the introduction in 1972 of a permit system for new plantations which in principle limited streamflow reduction by new afforestation to 10% of MAR in any catchment. The legislation did not recognise water use for maintaining ecological systems.

In the proposed Inkomati Basin WMA, the following Government Water Control Areas (GWCA) have been declared:

- Carolina GWCA: along the Boemanspruit river which is used to transfer water from the Usutu River Basin for emergency replenishment of the Nooitgedacht Dam.
- Upper Komati River (Nooitgedacht Dam) GWCA: controls abstractions above and below the Nooitgedacht Dam.
- Upper Komati River (Vygeboom Dam) GWCA: controls abstractions above and below the Vygeboom Dam.
- Nkomati River GWCA: controls abstraction along the lower Komati from the Swazi frontier to the confluence with the Crocodile river.
- Lomati River GWCA: controls abstraction along the Lomati river from the Swazi frontier to the confluence with the Komati river.
- Crocodile River GWCA: controls the entire length of the Crocodile River from its origin to its confluence with the Komati river at Komatipoort.
- Ngodwana GWCA controls the catchment for the Ngodwana dam, built to serve the SAPPI paper mill at Ngodwana.
- Sand river GWCA controls abstraction above and below the Witklip dam on the Sand river, a tributary of the Nels river (central Crocodile sub-catchment – not to be confused with the Sand Catchment to the north of the Sabie).

Within these GWCAs abstraction of water for irrigation or other purposes requires approval of the Department of Water Affairs and Forestry. In practice, on most stretches of river with significant irrigation, responsibility for protection, abstraction and distribution (including operation of government water works) is devolved to an Irrigation

Board through the declaration of an Irrigation District. The Irrigation Boards within the proposed Inkomati Basin WMA are discussed further in 5.3 below.

The National Water Act of 1998 repealed all previous water legislation in South Africa, and introduced a fundamental change in the principles underlying water management. The main changes are summarised in section 6.

5.2 The Department of Water Affairs and Forestry

Until 1997, responsibility for water in the Catchments of the Komati, Crocodile, Sabie, and Sand rivers lay with DWAF's Highveld regional office at Centurion. A small branch office in Nelspruit undertook local liaison and monitoring, but decisions rested with the Centurion office. Following the reorganisation of provincial and local government, DWAF regional boundaries were re-drawn to coincide with those of provinces, and a new regional office was established in Nelspruit, the administrative centre of Mpumalanga Province. The provincial boundaries of the new DWAF region mean that it is responsible for a large part of the upper Olifants river catchment, which falls under the proposed Olifants WMA, as well as the catchments within the Inkomati Basin WMA.

The DWAF regional level consists of 4 sub-Directorates:

- Water Quality (pollution control)
- Water Resources (Dams, infrastructure, water allocation to Irrigation Boards and Water Boards)
- Planning and Development (new projects, essentially concerned with RDP initiatives)
- Operation and Maintenance (ex-homeland supply and sanitation, to be transferred eventually to Water Boards and local government administrations, under the terms of the Water Services Act of 1997.).

Capability is quite uneven across these sub-Directorates, and, for the purposes of this report, it is significant that there is currently no Regional Deputy Director for Water Resources in post at Nelspruit, so that the two staff based in Nelspruit report to Chief Engineer W van der Westhuysen in DWAF's Highveld Regional office at Centurion. Of the two water resources staff in Nelspruit, one is retired, contracted on a consultancy basis. This weakness of capacity in the water resource subdirectorate has potentially important consequences for implementation of the new legislation intended to change the terms of water allocation. This issue is discussed further in section 7.

5.3 Irrigation Boards

Irrigation Boards established under the 1956 Water Act are responsible for water distribution along many of the stretches of river under GWCAs, and significant portions of the Sabie catchment, on which there are no GWCAs. It is common for Irrigation Boards to be organised hierarchically, with more than one 'minor board' under the umbrella of a 'major board'. The Irrigation Boards within the proposed WMA are:

Nkomazi Major Irrigation Board, covering the lower Komati and lower Lomati. It includes the following minor boards:

- Komati River Irrigation Board
- Lomati Irrigation Board
- Kaalrug Irrigation Board

Major Crocodile River Irrigation Board, covering the entire Crocodile River GWCA, and including the following minor boards:

- Friedenheim Irrigation Board
- Malelane Irrigation Board
- Tenbosch Irrigation Board

Elands River Valley Irrigation Board

Six Kaap River Irrigation Boards: Queens IB, Suidkaap IB, Nordkaap IB, Eureka IB, Low's Creek IB, and Laerkaap River IB.

White River Valley Conservation Board, which is a major board for the following five minor boards on the White River: White River Estates IB, Curlews IB, Ranch Karino IB, Manchester Noordwyk, and Good Hope IB.

Sand River Irrigation Board, within the boundaries of the Sand river GWCA (central Crocodile sub-catchment)

Sabie River Irrigation Board, concerned with irrigation by 24 farmers from the Sabie River Canal.

The White Waters Main Irrigation Board, owns and operates the Da Gama Dam in order to supply water to two minor boards: the Burgers Hall IB, and De Rust IB.

Irrigation Boards differ in their status and powers, according to whether their jurisdiction is within a GWCA or not. In the former case, irrigation boards operate within an area where government has asserted control of all water abstraction, so that adherence of irrigators to the irrigation board on the river concerned is mandatory. Outside GWCAs irrigation boards were set up more as irrigators' organisations (water users' associations), rather than agencies of government administration. This is the case for the White River Valley Conservation Board and the White Waters Main Irrigation Board. One consequence evident in both these cases is that irrigation boards outside GWCA do not necessarily control water use along the whole length of rivers under their jurisdiction, 'gaps' having originated with riparian farms whose owners decided not to join the irrigation boards when they were established.

Outside the jurisdiction of irrigation boards, irrigators have access to water through riparian rights and also through the right to build dams to store 'surplus' (flood) water in streams draining across their land. This situation may lead to extremely intensive use of

the water resource. For example, in the Sabie catchment almost all of the flow of the Langspruit river, a tributary whose confluence with the Sabie is a little upstream of Hazyview, is stored by some 132 farm dams (J Lubbe, pers com), so that the river is considered 'a closed system' and 'consequently the water in the Langspruit rarely, if ever, reaches the Sabie' (Chunnet, Fourie and Partners, 1991: appendix p3.9).

In the Inkomati Basin WMA, substantial areas of irrigation outside the jurisdiction of an irrigation board are not common outside the Sabie catchment. In the Crocodile catchment, abstraction by farmers is subject to schedules determined by the GWCA since the completion of the Kwena dam in 1984. Irrigation Boards (listed above) also control irrigation schedules on the principal tributaries to the Crocodile (Elands, Kaap, and White rivers). In the Komati catchment abstraction is controlled along most of the principal stem of the river through GWCAs in the upper and lower catchment, and irrigation boards in the lower catchment. A relatively small stretch of unregulated irrigation occurs in the Mswati area (ex-Kangwane) upstream of the Swazi frontier. Administration of irrigation abstraction by an irrigation board does not always mean that irrigators have a formal water allocation. For example, while irrigation allocations on the lower Komati were formally proclaimed in 1982, none were proclaimed on the lower Lomati where instead irrigators were given temporary abstraction permits, which persist to the present. In the upper Komati also, a survey by the farmers' union indicated that formal water rights applied to only about 30% of the irrigated area.

Irrigation boards manage the distribution of water to their members, including the issue of quota reductions in water consumption by irrigators in times of water shortage. For these services the boards levy water management charges, and, where water is supplied from government water works, collect water tariffs determined by DWAF. Historically, charges have been low: R248/ha on the White Waters Main Irrigation Board in 1993 (Woodhouse, 1995), and R97/ha on the Crocodile River Irrigation Board in 1994, according to Bate et al. (1998). Irrigation Boards may also act to facilitate trade in water, which as noted in section 4.6 has reached a significant scale on some catchments.

5.4 Mpumalanga Department of Agriculture

The Mpumalanga Department of Agriculture, although nominally responsible for support to all farmers in Mpumalanga, devotes most of its attention to the responsibilities it took over from the departments of agriculture of the homeland administrations of Kangwane and Kwandebele. There are two principal aspects to its role in governing access to water. The first is that of allocating water to black farmers, and the second is that of supporting investment, operation and maintenance in irrigation schemes.

Water rights for black farmers

The 1956 Water Act was considered not to apply to homeland areas, as it was founded on the principle of private use and ownership and homeland resources were considered to be 'communally' owned and controlled by tribal authorities. In practice, water resource allocation within homeland areas was delegated by the DWAF to homeland

administrations' departments of agriculture through a block allocation by DWAF. This responsibility has now been inherited by the Mpumalanga Department of Agriculture (Technology Support Services), making it effectively responsible for water allocation to prospective black irrigators, although DWAF (water resources subdirectorate) is responsible for issuing permits for water abstraction. This has created a situation of some confusion. Black farmers who approach their local irrigation board seeking water are referred to DWAF, who respond that "there is no water available because it has all been allocated already". By this is meant water for black farmers must be obtained from the 'homeland' amount allocated to the Department of Agriculture. The Department of Agriculture effectively allocates water by approving irrigation projects, which then receive a DWAF permit. This procedure is seldom clear to applicants, however. Even if it were, it is unlikely to prove helpful as the Department of Agriculture is unsure how much water the homeland administrations were allocated and, therefore, how many projects can be supplied with water.

The lower Komati demonstrates the problem. At the establishment of the Kangwane administration in 1982, the Nkomazi region was allocated the water rights of 17 farms, totalling 7327 ha along the lower Komati which fell within the homeland boundary (Government Gazette No 8061, 5/3/82). Water rights were also proclaimed on farms totalling 7196 ha, also on the lower Komati but within 'South African' (white farming) territory. In the decade that followed, irrigation development on the Komati in Kangwane amounted to only 400 ha, but by 1995 JIBS reported developed irrigation on the lower Komati as 14335 ha, which suggests either that the Komati Irrigation Board had permitted the South African commercial farmers to use the Kangwane water allocation, or that the water for about 7000ha was found elsewhere and the Kangwane allocation was not used, and should be available to supply new irrigation development. There is a consensus that water use by the commercial sector exceeded allocation (an "overallocation" according to water resources Director W van de Westhuyzen, "commercial farmers exceeded their allocation" according to Technology Support Services director, Roché Mataré), but it is not clear what the consequences are for current water availability for black farmers. Within the 1992 agreement between Swaziland and South Africa on water use in the Komati catchment, the then Kangwane administration was allocated 6.6 Mm^3 /a at high assurance, and 120 Mm^3 /a at low assurance, providing water for 12000 ha (sugar cane). Under the NIEP, projects were distributed between the different tribal authorities in the Nkomazi region, up to a total of 9500ha, with a further 2500ha to be developed in the Mswati region of the upper Komati subcatchment. There is confusion in the Department of Agriculture as to whether this is additional to the 1982 allocation, and, indeed, whether DWAF will issue permits even up to the level of the 1992 agreement. Under such circumstances it is unlikely that any prospective irrigator can expect an informed response on water allocations from the Department of Agriculture.

The confusion over homeland water allocations – which often masked black farmers' exclusion from water rights – is also apparent in the Nsikasi area (central Crocodile subcatchment). Interest in irrigation appears high, but there is little infrastructure to support it, and what existed was severely damaged during floods in 1996. Four farmers'

associations are seeking construction of a dam on the Nsikasi river to irrigate vegetables, but according to Department of Agriculture officials, "this is not considered a DWAF priority because it is only for irrigation". An earlier proposal for a dam at Gutshwa was rejected in 1994, "because Mozambique did not agree" (a curious reason, given the context of approval of the ten times larger Injaka dam in the same year). In the upper Nsikasi about 40 farmers are reported by the local agricultural office (Ngodini) to be irrigating vegetables but are hampered from signing contracts to supply local supermarkets and the Kruger National Park due to insecurity of water supply. Further downstream on the Nsikasi, attempts to abstract water for irrigation are obstructed by the Kruger National Park fence. Meetings between communities and the KNP to negotiate moving the fence to allow farmers access have been 'inconclusive'. It is clear that the ex-homeland areas have inherited a very confused water allocation problem, which the Department of Agriculture has been ill-equipped to resolve. In many instances, the volumes of water concerned may not be very significant in terms of overall water consumption within the WMA, but may have considerably greater political importance in that the problems of access continue as manifestations of inequitable conditions of the past.

Support to irrigation development and operation

The agricultural development agencies of the Kangwane and Kwandebele administrations (Agriwane and KLM, respectively) were incorporated into the Mpumalanga Development Corporation (MDC), reporting to the MEC Economic Affairs. MDC, responsible for government investment in a variety of sectors ranging from agriculture to housing is now facing closure, possibly to be reconstituted as a series of sector-specific investment agencies reporting to sectoral ministries, one of which would be agriculture. In the interim, uncertainty over MDC's future has led to loss of staff and a collapse of its support to agriculture in the critical area of irrigation pump maintenance. A consultancy firm (ACER) has been contracted to provide organisational support to farmers on the NIEP schemes on a temporary basis, but pump maintenance is often contracted to the private sector. Elsewhere, such as the canal irrigation at Mooiplas, Mswati (upper Komati subcatchment) the absence of government support has made the system effectively 'farmer-managed' (S Woodburn, pers. com.).

The Mpumalanga Department of Agriculture has no investment capability (ie it is legally prohibited from taking out loans) but is responsible for providing advice to farmers on agrochemicals use and irrigation scheduling. It has four specialist advisors for sugar, including staff seconded from the South African Sugar Association. Elsewhere, it expects to provide one extension officer for every ward in the province, although commercial farming wards are excluded because farmers can usually contact the Department's office in Nelspruit by phone. Of 48 ward-level extension positions, however, a third are currently vacant, leaving the Department's capability to support farmers' irrigation initiatives substantially weakened.

5.5 Sabie River Working Group

The Sabie River Working Group was set up during the 1992 drought by staff at Kruger National Park, concerned to maintain minimum flows in the Sabie and thereby avoid loss of riverine ecosystems in the Park. The role of water in ecological maintenance was not recognised in the legislation (the 1956 Water Act) in force at the time, and the KNP needed ministerial authorisation to set up the Working Group, which brings together water users on the catchment – mainly irrigation boards and homeland administrative officials - in order to co-ordinate water conservation measures. The Working Group was widely seen as a precursor of catchment-based management agencies, and has continued to seek such a role by broadening its membership to include the forestry industry (SAFCOL), government departments, and representatives of TLCs. Although actively involved in promoting the Injaka Dam, and the Bushbuckridge Water Board who will be responsible for providing water from the dam to local councils for supply to domestic users, the Working Group has been criticised in some quarters as not being sufficiently representative of black water users, and it is not currently represented on the Water Board.

6. Changes under the National Water Act

The purpose of the National Water Act of 1998 is stated (sect 2) as:
"to ensure that the nation's water resources are protected, used, developed, conserved, managed, and controlled in ways that take into account…

- meeting basic human needs of present and future generations;
- promoting equitable access to water;
- redressing the results of past racial and gender discrimination;
- promoting the efficient, sustainable and beneficial use of water in the public interest
- facilitating economic and social development;
- providing for growing demand for water use;
- protecting aquatic and associated ecosystems and their biological diversity;
- reducing and preventing pollution and degradation of water resources;
- meeting international obligations;
- promoting dam safety;
- managing floods and droughts,

and for achieving this purpose, to establish suitable institutions and to ensure that they have appropriate community, racial and gender representation."

Key aspects of the new legislation are as follows:

- Effective abolition of water rights tied to ownership of riparian land.
- Abolition of the distinction between 'private' and 'public' water, and the assertion of the status of "all water in the water cycle whether on land, underground, or in surface channels, falling on, flowing through or infiltrating between such systems" as "an indivisible national asset" over which the National Government will act as the custodian in the public interest (DWAF 1997).

- The guarantee of water to meet basic human needs and to maintain environmental sustainability, to be known as 'the Reserve'.
- The allocation of water to meet other needs that are beneficial in the public interest.
- Allocations will not be permanent, but for a 'reasonable period', and may be traded between water users with Ministerial consent.
- The new legislation broadens the definition of water use to include any activities which result in reduction of stream flow (eg forest plantations), or deterioration of the water resource (eg waste, effluent, or cooling water disposal), or removing and disposing of underground water (eg mining).
- All water, wherever in the water cycle it occurs will be subject to a catchment management charge which will cover actual costs of catchment management activities.
- Some or all charges may be waived for disadvantaged groups to promote equitable access for productive purposes such as agriculture.
- Water management will be carried out in regional or catchment water management areas, "recognising that conflicting interests will intensify the need for national management and supervision, and that the policy of subsidiarity does not interfere with the need for a perspective on water use.
- Phased establishment of catchment management agencies, subject to national authority, to undertake water resource management in water management areas. (DWAF, 1997)
- In shared river basins, Government will be empowered to give priority over other uses to ensure that the legitimate requirements of neighbouring countries will be met.

The institutional framework for operating the new legislation has three main elements: a National Water Resources Strategy (NWRS), Catchment Management Agencies (CMAs), and Water Users Associations (WUAs).

National Water Resources Strategy (NWRS)

The NWRS sets out the "strategies, objectives, plans, guidelines and procedures of the Minister and the institutional arrangements relating to the protection, use, development, conservation, management and control of water resources" in order to meet the purpose of the National Water Act and to satisfy the water supply and sanitation standards defined in the Water Services Act of 1997.

The NWRS will set guidelines for catchment management by (National Water Act sect 6):

- Defining the Reserve, and the water resources from which it must be drawn;
- Defining how international obligations will be met;
- Identifying actions to meet future water needs;
- Defining Water Management Areas, estimating the total available water and present and future requirements within each of them, identifying WMAs with a surplus or deficit of water, and arranging inter-catchment water transfers between them;

- Stating water quality objectives, through a classification of water resources, in terms of such characteristics as the Reserve, flow characteristics, and aquatic and riparian ecology;
- Setting out objectives for institutions to undertake water resource management, and the inter-relationships between different institutions.

Catchment Management Agencies (CMAs),

Each Water Management Area defined under the NWRS is to be managed by a single Catchment Management Agency (CMA). The governing board of a CMA is appointed by the Minister of Water Affairs " with the objective of achieving a balance among the interests of water users, potential water users, local and provincial government and environmental interest groups." (National Water Act sect. 81). In order to achieve this the Minister must appoint an advisory committee to recommend which interests and agencies should be represented on the governing board. Once appointed, the governing board will elect a Chief Executive Officer for the CMA. CMAs will be funded, at least in part, by water management charges payable by all water users in the WMA.

In line with the phased implementation of changes in water management under the new legislation, the National Water Act states that CMAs have three *initial* functions:

- To investigate and advise on the protection, use, development, conservation, management and control of water resources in a particular WMA.
- To develop a catchment management strategy.
- To co-ordinate the related activities of water management institutions within a particular WMA.

Subsequently, and while subject to the requirements of the NWRS (eg in relation to water allocation), a CMA may be assigned far-reaching powers, which include:
- Management and monitoring of water resources within the CMA and implementation of catchment management strategies, which must include water allocation plans.
- Regulation of water use
- Collection of charges payable by water users for water resource management and development.
- Requiring water users to install equipment to monitor water use, and to provide records of water use to the CMA.
- Requiring water users to alter or remove waterworks to protect public safety, water quality, or water use by other users, or to facilitate monitoring.
- Limitation of water use during periods of water shortage.

As the 'responsible authority' the CMA may also, in principle, require all water users to apply for a licence to continue using water, in order to achieve a fair allocation of water, improve efficiency of resource management, or protect water quality (sect. 43). In practice, the need to issue licences is limited by the provision (sect. 22) that water may be used without a licence if it is a "permissible water use", which covers domestic use, including watering livestock and non-commercial gardening, and "existing lawful use",

that is: uses which were authorised under earlier legislation . This effectively means that with the passage of the new legislation most existing water use remained legal, but subject to phased change in the future as catchment management strategies are developed.

Water Users Associations (WUAs).

Although water users associations are water management institutions, their primary purpose, unlike CMAs, is not water management. They operate at a restricted local level, and are in effect cooperative associations of individual water users who wish to undertake water-related activities for mutual benefit. A WUA may exercise management powers and duties only if these have been assigned or delegated to it. The National Water Act prescribes the procedures for establishment and operation of WUAs (chapter 8) and a model constitution (schedule 5). It is anticipated that in the short term WUAs will be formed from existing irrigation boards.

7. Implementing Catchment Management Agencies

7.1 Introduction

The process of implementation of the Catchment Management Agencies specified in the new legislation has been the subject of a number of studies, notably those prepared by DWAF's Policy Implementation and Task Team (PITT) for Planning Institutions and Catchment Management (DWAF, 1998a). Preliminary proposals for WMA boundaries, and priority WMAs for implementation of pilot CMAs were published in October 1998 (DWAF, 1998b). The Inkomati Basin WMA was one of three identified in the northern part of the country as priorities for pilot CMA implementation. Priority WMAs were identified as those confronting particularly urgent catchment management problems. In the case of the Inkomati WMA these were identified as the need to meet international obligations on cross-border flow, and because of environmental issues, particularly in relation to the Kruger National Park (KNP). Responsibility for guiding the preparatory work for pilot CMAs was allocated to DWAF regional offices. In the case of the Inkomati WMA this was to be the Mpumalanga regional office at Nelspruit.

A number of steps in the process of preparing the establishment of CMAs identified by DWAF (1998b) include:

- "public consultation workshops in relevant water management areas" which will be utilised to establish "Regional Steering Committees tasked with making firm coordinated recommendations to the Minister on the establishment of high priority CMAs within a prescribed time schedule."
- A financial viability assessment for each proposed CMA.
- Recommendations on the powers that should be delegated to the CMA and the broad representation that should be reflected on the CMA board.
- An inventory of assets and personnel that should be transferred to each CMA.

- Recommendations to the Minister.

DWAF (1998b) also identifies a series of tasks to be undertaken in parallel to the establishment of CMAs. These include a number of core components of the National Water Resources Strategy which set key parameters for CMA operation:

- The requirements of the Reserve
- International rights and obligations
- Estimates of total water available in each WMA, and of present and future water requirements
- Water use of strategic importance
- Actions to be taken to meet future water needs, for intercatchment water transfer between water-surplus and water-deficit WMAs.
- Principles relating to water conservation and demand management.
- Water quality objectives for each part of the water resource.

In addition, a water use register and licensing policy will need to be developed, and a water pricing policy formulated if the CMAs are to implement effectively the new water legislation.

These proposals, published in October 1998, are as yet in early stages of implementation, and, while important as background, their detailed discussion is beyond the scope of this report, which focuses on the consultative process on catchment management begun earlier, in January 1998, under the direction of the DWAF regional office in Nelspruit. The issue of particular concern is to identify how interest groups have been represented in this exercise, their relative bargaining strength in influencing catchment management decisions of the CMA, and the implications this may have for CMA strategies.

7.2 The Consultative Process: Catchment Management Forums

This process is being directed by Dr M Ligthelm, Regional Deputy Director for Water Quality for Mpumalanga. It has involved a series of public meetings (Catchment Management Forums) to inform water users about the new water legislation and proposals for catchment management agencies, and to identify and take action on specific preparations that need to be made. Between the meetings of the Forums, progress was monitored and maintained by a catchment steering committee made up of representatives of key stakeholder groups. This process has been conducted throughout 1998 in two separate but parallel programmes in the Crocodile and Komati catchments. These are briefly summarised next.

The Komati catchment

Discussions on the implementation of catchment management in the Komati catchment were initiated as early as July 1997 between DWAF, the Komati Irrigation Board and KOBWA, the international agency set up by Swaziland and South Africa to oversee the construction and operation of dams (mainly the Driekoppies and Maguga) on the Komati. In November 1997 the first catchment management Forum meeting was held, bringing

together representatives from agriculture, industry (Eskom), mining, local government, and a number of government departments (Health, Agriculture, and Environmental Affairs and Tourism). At this meeting it was resolved to pursue discussions in two separate forums, one each for the lower and upper Komati sub-catchments. The upper Komati subcatchment Forum met in February and April 1998 in Badplaas, while the lower Komati Forum met in February in Driekoppies and in April in Malelane. At the latter, the issue of representation for black farmers and black communities (as primary users) was raised, and DWAF resolved to hold a meeting with TLCs in the Nkomazi area in May. In the event this meeting was abandoned due to disruption by councillors who by an oversight had not been invited, and a further meeting was held with more positive results.

In May DWAF contracted MBB consultants to act as facilitators of the work on catchment management, with a view to drafting a proposal for a catchment management agency for submission to the Minister of Water Affairs and Forestry. A second public meeting for the combined upper and lower Komati catchment management Forum was held in July 1998. This meeting agreed the representation required on a steering committee which would be responsible for working with the consultants (MBB) on the preparation of the CMA proposal. This steering committee met in October and November 1998 to consider background information prepared by MBB (MBB, 1998a) on the Komati catchment water resource and its use. The steering committee was scheduled to meet in February 1999 to consider a organisational scheme for the proposed CMA.

The Crocodile Catchment

A catchment management Forum for the Crocodile catchment was first convened by DWAF in January 1998 and proceeded to nominate representatives (defined at that stage as two from each sub-catchment) to form a steering committee whose first task was to identify interest groups which should be represented in the discussions on catchment management. The steering committee met in February and adopted the task of presenting a proposal on catchment management to the next Forum, scheduled for May. Over the next three months, members of the steering committee held a series of 'information meetings' with specific interest groups to explain the implications of the new water legislation for catchment management. At the meeting of the steering committee in April, and the Forum meeting held in July, amid generally positive feedback from interest group meetings, the representation of black communities and black farmers was judged to have been inadequate. Consequently, DWAF convened a meeting of black farmers associations in August, attended by representatives of 22 associations, who elected five representatives to attend future steering committee meetings. As in the Komati catchment, DWAF appointed MBB to work with the steering committee in drafting a proposal for the establishment of a catchment CMA. The steering committee had considered and suggested amendments to draft documents for this proposal (MBB, 1998b) at its meetings in October and November.

General observations

A review of the minutes and other documentation relating to catchment management meetings, supplemented by interviews with people who had participated, suggested four main observations:

- A tension between the proposed Inkomati WMA, covering the Komati, Crocodile, and Sabie catchments, and a locally-preferred model of a WMA (and CMA) for each catchment.
- A progressive enlargement of the consultation, with steps taken specifically to involve groups such as local government and black farmers in the process.
- The role of environmental/conservation interests.
- The absence from the process of the Regional Water Resource Sub-Directorate of DWAF.

The CMA model

The consultations on catchment management began with a presumption that separate CMAs would be formed for the Komati and Crocodile catchments. It became known that both catchments would be incorporated, together with the Sabie and Sand, in the Inkomati Basin WMA only in October 1998. MBB documentation reflects this combined CMA in its current organisational model. Steering committee members in each catchment voiced concerns that a CMA covering such a large area would be unable to address the catchment-specific detail of water management currently understood at catchment level. There are also concerns that management of catchment water resources may become dictated by factors originating outside that particular catchment. On the other hand, there appears to be widespread recognition of the economies of scale, particularly in relation to the cost of technical staffing for a CMA, which would be gained with a larger agency. A compromise structure is indicated by current MBB draft CMA proposals (MBB, 1998c), in which each catchment has its own 'catchment management committee' (CMC) made up of 26 representatives from geographical areas (subcatchments) and interest groups or sectors. Each of the four CMCs (Komati, Crocodile, Sabie, and Sand) provide four representatives to sit on the CMA board, where they would be joined by two representatives of DWAF, and one representative each from the governments of Mpumalanga and Northern Provinces. A CEO elected by the CMA board would have responsibility for running the 'executive branch' of the CMA, containing four divisions dealing with, respectively, water quality, licensing, finance, and information systems. Following publication of the boundaries of the Inkomati WMA, DWAF in Mpumalanga extended the contract with MBB to cover facilitating the consultation process in the Sabie catchment. In the Sand subcatchment this work will be done by the AWARD team who carried out the first phase of the Save the Sand project (Pollard *et al*., 1998).

Black Representation

Tables 9 and 10 summarise information recently collated and analysed by DWAF about which interests were represented in catchment management Forums and steering committees for the Crocodile and Komati catchments. The tables suggest that in both catchments the process achieved a broader representation of interests during the course of the year. This is particularly marked in the case of black farmers, who were entirely absent from the early meetings in both catchments. By the middle of 1998, this was an

issue of discussion in the steering committees. On the one hand was a view that black communities ('grassroots') were adequately represented by TLC's and required no further consultation. Further justifications for 'emerging' black farmers' non-participation in 'interest group' discussions were that there weren't any in a particular area (White River Valley Conservation Board), or because they had been "difficult to identify and contact" (Crocodile River second catchment management Forum meeting). Against this were concerns that a large part of the community was unrepresented in the process, and that this threatened a lack of ownership of – and consequent lack of respect for - a future CMA and any water use regulations it may try to implement.

The minutes suggest that the eventual inclusion of black farmers' representatives in these meetings was the result of specific efforts by DWAF to identify black farmers' organisations and invite them to additional briefing meetings at which were identified representatives to take part in subsequent meetings. This observation does not imply any judgement about the quality of the representation so achieved for black farmers, but it does indicate the difficulties of relying on better-established local interest groups (in particular irrigation boards) to represent the more disadvantaged.

The representation of black farmers and communities is not only a matter of achieving visibility through their direct representation (eg by farmers' associations), but also through ensuring that consultation includes government agencies most closely involved with issues that affect black communities. In this regard, two sets of issues have particular priority. Firstly, the large number of communities who do not yet have access to clean water for primary use means that agencies responsible for water services – TLCs and Water Boards - will need to act as channels for this concern. Secondly the absence of the Department of Land Affairs from the consultation process (until January 1999) is significant because issues of access to land are increasingly intertwined with availability of water for irrigation development.

The environmentalist interest

In addition to black farmers, a number of other interest groups became better represented (quantitatively) over the course of the consultation process. These include TLCs and the Lowveld and Escarpment District Council in the Crocodile catchment steering committee. Another interest group that made progress in the Crocodile catchment was that concerned with environment. The conservation interest group was numerically the largest in the last four steering committee meetings (though not in the larger Forums) for the Crocodile catchment. The strengthening organisation of this group reflects not only the organisational and technical capacity of KNP and Mpumalanga Parks board, but also the large number of private conservancies on the Elands, Kaap and Crocodile rivers, many of which are linked to tourism enterprises (trout farming etc). The comparative absence of such interests in Swaziland and the ex-Kangwane areas may explain why no comparable level of representation is visible on the steering committee for the Komati catchment.

The DWAF Regional Water Resource Sub-directorate.
A feature of the consultation process in Mpumalanga thus far is that it has been led from within the Regional sub-Directorate for Water Quality. There are historical reasons for this: the CMA consultation process was led by Water Quality personnel with previous experience on DWAF's Policy Implementation and Task Team (PITT) for Planning Institutions and Catchment Management. Initial consultations on establishing CMAs were also based on established experience with an existing Water Quality Management forum (the Gladde Spruit Forum). Dr Ligthelm has clarified that the CMA consultation process has focussed on, firstly, ensuring that all stakeholders are identified and then involved in the process, and, secondly, developing a proposal for the establishment of the CMA. In this it is emphasised that the purpose of the consultation exercise is not to provide immediate answers to water problems but that relevant DWAF departments at regional and national level have been called upon to provide information and advice where appropriate. An example of the need for such input arising out of the CMA consultation process is the involvement of the DWAF Regional Planning and Development sub-Directorate to inform on plans to extend reticulated water supply.

However, it seems clear from events during the short period of this study (January-April 1999) that the question of water allocation for black farmers will not wait for the establishment of the CMA. In response to repeated requests for clarification, the CMA consultation process convened a series of meetings in March 1999 explicitly to discuss the question of water availability, particularly in the Komati, but also in the Inkomati system more generally. The meeting produced a series of recommendations which constructively and imaginatively address some of the uncertainties about water availability identified in section 3, and are discussed further below (section 7.4). It remains the case that the Water Resource Sub-Directorate has had a low profile (noted in the Komati catchment steering committee minutes for 27.11.98) in much of this activity. This situation perhaps reflects not only the weak capacity of the Water Resource Regional Sub-Directorate in Mpumalanga (noted in section 5.2), but also the fact that, historically, DWAF has not dealt directly with water allocation for black farmers (section 5.4). Briefings on water availability and allocation have therefore been made mainly by consultants, and by staff from DWAF head office. This has implications for DWAF's regional capacity in many of the key areas of concern to a CMA: monitoring and management of water resources, water allocation, regulation, monitoring, recording water use, and collection of charges for water resource management.

7.3 Water Quality Management

This report focuses on representation of interests primarily in relation to management of quantitative aspects of water use. It has paid less attention to the management of water quality. This is partly due to the extremely short timescale for the pilot study, and the consequent need to restrict the scope of the work. It also results from our perception that the problem of maintaining a prescribed set of standards for water quality, while presenting a considerable challenge in practice, is one that is more clearly defined than that of quantitative allocation among competing interests. Water quality management will

be an integral part of catchment management, and we wish to note a number of points which appear relevant to the establishment of a CMA and the integration of a water quality management function within it.

Firstly, water quality objectives are to be defined for each stretch of river as part of the process of defining the Reserve. Some attention needs to be given to deciding the competence and participation required for this process, particularly in relation to ecological aspects of the Reserve.

Secondly, the main industrial sources of water quality problems are already identified and are part of a DWAF monitoring, consultation, and licensing framework. This forms an important institutional base on which a CMA can build. One respect in which a CMA could develop the existing consultative framework would be to enlarge its scale to allow more strategic issues to be addressed. An example relevant to the Inkomati basin WMA would be to look at whether the large water transfers out of the Komati catchment by Eskom (from the Vygeboom dam) could be reduced by treating the more local, but heavily polluted, water sources on the highveld (Oliphants catchment) to allow their use for power station cooling.

Thirdly, and more generally, many water users have their own criteria and monitoring procedures for water quality. Irrigation interests operating downstream from mining operations, and conservation interests downstream of agriculture, for example, have clearly defined concerns in water quality monitoring and compliance by upstream users. Perhaps the biggest challenge in water quality management arises from the big expansion in sewage treatment as sanitation in townships is improved and as the tourist industry expands. Both developments can be expected to increase the risks of contamination of rivers in the Inkomati Basin WMA.

7.4 Representation Issues

White Farmers
The largest users of water in both the Crocodile and Komati catchments, this group have a long tradition of organisation to secure access to water, and most of the existing government investment in storage dams in the Inkomati WMA was designed to serve their needs (the exceptions being the Vygeboom and Nooitgedacht dams for Eskom, the Injaka dam for primary consumption, and - partially - the Maguga dam to serve Swaziland and black farmers in Nkomazi). As the largest users of water, this group has the best knowledge about how much water agriculture actually uses. This includes not only allocated water from ‘public’ sources such as government dams and canals and regulated rivers, but also water from historically less accountable sources (often considered ‘private’ under previous legislation) such as farm dams across smaller streams, and ‘off-channel’ storage dams filled by pumping from rivers in spate during the rainy season. The advantages, in terms of negotiation of water use, conferred by this detailed knowledge of their own and neighbours’ water use, are compounded by white farmers’ control of the irrigation boards through their election of the boards’ officers.

The extent to which irrigation boards can be considered to represent white farmers' interests varies, however, according to the status of the boards and the diversity of farmers which they serve. In the absence of government water control areas, as in the Sabie catchment, irrigation boards are essentially farmers' organisations, governed by representatives of quite small 'communities' of commercial irrigators, who historically have only rarely had to negotiate use of water with 'outsiders'.

In contrast, under government water control areas, irrigation boards on the Komati, Lomati , and Crocodile rivers have been more subject to centralised planning of water allocations, due to international agreements (eg the Pigg's Peak agreement with Swaziland and Mozambique), and major upstream industrial (eg Eskom) or primary users. Further, the intensity of water use by agriculture, particularly in the lower subcatchments of the Komati, Lomati, and Crocodile, make the likelihood of water shortage greater, and hence increase the frequency with which the irrigation boards' imposition of restrictions on abstraction will come into conflict with individual farmers' need to maintain profitability. Where irrigation boards cover a range of different farming systems, as in the case of the Crocodile River Main Irrigation Board, there are suggestions that they more closely represent the interests of the large irrigated estates in the lower catchment, where the CRMIB has its offices, rather than the smaller-scale farmers in the upper catchment. For example, Bate et al (1998:40) observed that an officer of the CRMIB acted as 'broker' for water trading between sellers in the upper catchment and buyers in the lower catchment, while at the same time acting as solicitor for the latter – a situation which led some of the sellers to express concern that a conflict of interest might have reduced the price they received for their water.

Despite the potential for conflicts between the irrigation boards and commercial farmers, in the CMA consultation process reviewed above it may be significant that individual white farmers largely dropped out of the consultation process in its later stages, except where they were not covered by an irrigation board, as in the case of farmers in the upper Komati sub-catchment, who were represented by a Badplaas TLC councillor.

Irrigation Boards

As day-to-day managers of the water resource in large areas of the Inkomati WMA, the irrigation boards are one of the key players in implementing catchment management. Together with their individual members, they constitute the main body of expertise and information about water use for agriculture. It seems inevitable, therefore, that a CMA for the Inkomati WMA would have little choice but to delegate considerable management powers and duties to irrigation boards, once they have been reconstituted as water users' associations (WUA) to conform to the requirements of the National Water Act.

In addition to the scheduling, operation of water works, and dispute resolution activities which CMA could expect to delegate to a WUA, a fundamental aspect of such duties would be the monitoring and recording of water use, and the provision of this data to the CMA. It seems clear that this would mark a departure from past practice, for, while irrigation boards are custodians of information on land and water use for irrigated agriculture, the wide disparity between estimates of these, noted in section 3, indicates

that so far the collection of this information has either been unreliable or unsystematic, or so lacking in transparency that accurate information is seldom accessible outside the irrigation boards themselves. Absence of accurate and accessible information about water consumption is not a problem where water is not scarce and the individual's freedom to abstract water is the priority, but becomes more problematic in situations of scarcity demanding coordination of water use and resolution of disputes. This appears to be recognised by some irrigation boards, who have made recent investments in monitoring equipment. The Nkomazi Major Irrigation Board, for example has installed equipment for the telemetric control of irrigators' pumps (WAMS). Board officers say that the system, so far used only on commercial farms, has greatly reduced disputes and suspicion and are convinced "it is the way to go, even for black farmers". The Board is also installing flow gauges on all eleven of the weirs under its management so that they "should be able to pinpoint illegal abstraction".

Further initiatives to improve the quality of information are being generated by the efforts to improve efficiency in the sugar industry. Environtek-Nelspruit (CSIR) has been contracted by TSB to generate a GIS incorporating canefield size, tenure, irrigation, soil type for the 34500ha of cane on the lower Crocodile, lower Lomati and lower Komati subcatchments. The purpose of the project was "to meet a need by the TSB and the growers to determine the area under cane (<1% error) and to improve cane supply agreements" (CSIR, 1998). The availability of systematically collected and digitally recorded data on water use and availability, coupled with comparable information on crop productivity, offers a powerful means by which both farmers and irrigation boards can improve their efficiency in water use, for example by cutting water use where it is least productive in times of shortage. Data stored in digitised form is also much more easily transferred to other users, and in particular a future CMA, for whom it will be an essential input to informed decision-making on water allocation and development issues.

This scenario suggests that WUAs may need to be run in a more transparent way than irrigation boards have been to date, and this transformation may present a challenge to the existing board administrations, which are heavily concentrated: for example, the Crocodile River Main Irrigation Board and the Nkomazi Major Irrigation Board, each of which cover three minor boards, share the same office in Malelane, and the same secretary. Black cane growers on the NIEP schemes are represented on the Komati Irrigation Board, and their expectations of the transformation of irrigation boards into WUAs are radical – producing a better representation for blacks and a less top-down administration which will "take suggestions" from its members. These expectations are possibly not shared by the present irrigation board officers who nonetheless are clearly committed to working with black farmers, are in favour of the current concessionary tariffs for black smallholder growers, and argue that black farmers should have priority in allocation of any additional water that may be available on completion of the Maguga dam.

The visibility of black farmers for the Komati Irrigation Board, and its umbrella Nkomazi Major Irrigation Board, contrasts sharply with almost all other irrigation boards, few of which have black farmers as members. There is little indication that these boards have any knowledge of, nor feel a need to engage with, the needs of black farmers. Rather

there is a sense of protecting 'their' resource from encroachment. For example, the purchase of the Da Gama dam from DWAF by the White Waters Irrigation Board in 1993 (for the 1967 construction price of R2.3 million payable over 30 years) was undertaken explicitly to pre-empt any outside interference in water allocations from the dam. More recently, irrigation boards perceived their support for the Injaka dam as a way of protecting the Sabie river from increased abstraction to supply the primary needs of the quarter of a million people living in the catchment – an approach based on separate, rather than shared resources. For this reason, perhaps, interviews in the Sabie catchment found an anxiety about sharing a CMA with water users on Crocodile and Komati catchments, who they felt would 'dominate' the smaller irrigation sector in the Sabie catchment, on whom, as a consequence, they felt much of the burden of supplying the ecological Reserve and cross-border flow to Mozambique would fall.

In other catchments, irrigation boards' views of the CMA were more positive. Officers of the Komati Irrigation Board saw it as means of forcing DWAF to deal with a series of problems, of which they cited the following:

- The injustice and secrecy associated with the transfer of water out of the catchment by Eskom, rather than, it was said, dealing with the gross pollution of more local sources of cooling water supply in the Olifants catchment.
- The failure of DWAF to consult the irrigation boards on water tariffs, which had been set, it was said, on "a take it or leave it basis".
- The continuing uncertainty about future water allocations to Swaziland and Mozambique

Overall, some considerable frustration and hostility was expressed towards DWAF over its handling of these issues, and the CMA is seen as a way of addressing this.

The irrigation boards, and through them the commercial (white) farming sector, are in a strong position to influence a future CMA, given their role as day-to-day managers of much of the water resource, and their consequent control of much of the knowledge base about water consumption by agriculture. Reconstituted as WUAs they can expect to carry on many of their current managerial functions. It is questionable, on the evidence of this study, that a transformation from irrigation board to WUA will bring about any change from the concentrated administrative control and narrow range of interests served which charactarised irrigation boards in the past.

The discussion above suggests, however, three areas of concern for irrigation boards which may provide pathways to a dialogue for change. Firstly, all irrigation boards contacted in this study expressed apprehension that a CMA at the level of the Inkomati WMA would mean a loss of their ability to control their water: those in the Sabie feared domination by those in the Crocodile catchment; those in the Komati feared domination by industrial and primary users and by the need to submit to international water allocations. Secondly, in those catchments where water shortages are frequent, there appears an acceptance of the need for more systematic measuring and recording of data on water use by individual users, and of the benefits of greater transparency which this can bring. Thirdly, the need for some irrigation boards (though emphatically a minority)

to integrate an expanding black irrigation sector means that it is in those boards' interest to ensure efficient and productive water use by black farmers.

The sugar industry – TSB

The sugar industry, represented in Mpumalanga by TSB, is the sole purchaser of the output of about 34000ha of cane, or about a third of the entire irrigated area in the Inkomati Basin WMA (table 1). With a capacity to produce 400 000t of sugar per year, it is responsible for about 17% of South Africa's sugar production. It will clearly be a large player in a future CMA, representing its interests through a number of separate channels: as an industrial water user (TSB); through large-scale commercial agriculture, and, consequently, also through the irrigation boards; and, increasingly, through black farmers' representatives and associations. The industry is aiming to increase the area under cane to 43 500 ha, with much of the increase coming from the expansion of the African smallholder schemes in Nkomazi which currently supply 21% of the cane for the Komati mill (NOWAC, 1999). Most South African sugar is sold within the national market at a price supported by government above that of the world market. In addition to the fact that much of the potential for expanding cane production is on land controlled by tribal authorities in the ex-Kangwane area, it is also politically advantageous for the Mpumalanga sugar industry to justify continued government price support by reference to the thousand or so smallholder cane growers who benefit from it.

The industry therefore has a strong interest in the successful development of irrigated black farming. Moreover it is well endowed with technical and financial resources to promote this goal. TSB management considers the Department of Agriculture's current extension support to black farmers, using staff seconded from the South African Sugar Association, is ineffective, largely, they claim, because it fails to tackle the lack of contracting skills and experience among black farmers and their organisations, with the result that they "get ripped off by contractors". There seems no doubt the sugar industry can play an important role in building the capacity of black farmers to achieve greater access to water, ensuring industry-standard water efficiency levels, at relatively low risk. The mutual advantage offered by the miller-grower relationship has been argued elsewhere to be the key to assuring effective support to smallholders from the commercial sector (Armstrong and Ashby, 1995:83). It does, however represent a relatively inefficient use of water (see section 4 above), and any strategy using this approach must also work to ensure that farmers' managerial capacity and commercial linkages enable alternative, more efficient, uses of irrigation such as vegetables or fruit orchards to be developed by black farmers – something the sugar industry would not regard as being in its interest to do.

Black Farmers

The evidence supplied from the experience of DWAF's Crocodile and Komati catchment forums indicates the existence of a large numbers of black farmers' organisations with an interest in irrigation development. Their effective representation in a future CMA is undermined by a number of factors, including: weak institutional and technical support from the Department of Agriculture (section 5.4, above); the suggestion, made by a number of those interviewed, that leading spokesmen for black farmers were more active

on their own account than in the interests of those they claimed to represent; and internal tensions due to challenges to the legitimacy of land allocations made by tribal authorities.

This last factor is evident particularly in Nkomazi where the perceived success of the NIEP sugarcane schemes has prompted competing claims over land with potential for irrigation: in Schoemansdal on land occupied previously by an Agriwane coffee project (Visser and Fischer, 1995), and also in the continuing dispute between Hoyi and Mlambo tribal authorities over land near Mbuzini (lower Komati subcatchment). The basis of land allocation by tribal authorities for the 'Spoons 8' scheme of the NIEP was also challenged by the local TRC, who, with support from SANCO, claimed the right to allocate land. This challenge failed when TSB refused to accept contracts except in the names of original nominees of the tribal authority. The complexity of overlapping claims to land which are the legacy of repeated removals and resettlement of communities presents a particular hazard for water allocation. In particular, the allocation of an abstraction permit may strengthen one set of competing claims against another. A future CMA will need to ensure an institutional framework that ensures adequate consultation and legitimacy for allocation decisions in such cases.

It seems clear that the relatively large sums earned by black cane growers on the NIEP schemes, coupled with the large numbers of potential growers excluded by the 'first phase' of the NIEP, have generated many proposals for further irrigation schemes to spread the benefits more widely among the population of Nkomazi. A main focus for representation of claims for a 'second phase' NIEP is the Central Steering Committee (CSC) for the NIEP, which brings together representatives of each of the separate irrigation schemes under the NIEP. In addition to itself taking part in catchment management forums, the CSC has asked a couple of black consultants with Nelspruit-based firms to represent the interests of aspirant black irrigators on DWAF's catchment management steering committee for the Komati catchment. One of these consultants has been involved in securing off-shore funding for a new irrigation scheme for black smallholders in the Nkomazi area.

The CSC leadership, while pressing for wider access to irrigated sugar, also makes clear its view that the advantages of a guaranteed market for sugar are offset by risks of dependency on a single crop, and are anxious to see diversification either within the sugar industry (TSB is exploring the possibilities of glycol and glycerine production derived from sugar cane), or based on alternative crops such as vegetables or fruit orchards and their processed products (eg fruit juice). In interviews for this study, CSC awareness of this range of possibilities was tempered by a recognition of the limitations: that TSB intends to stipulate minimum areas for sugar contracts to ensure 'full-time sugar cane farmers', reducing scope for diversification; and the gap in influence between themselves and the commercial sector, describing their participation in irrigation board meetings as "window dressing" for an organisation whose decisions (understandably, say the CSC) reflect the interests of the largest water users.

For all the sophistication of the CSC leadership's analysis, black farmers remain inexperienced in the day to day operations of growing cane, and consequently heavily dependent upon managerial support, currently provided by MDC and ACER consultants,

one of whose field staff expressed concern at the high level of dependency he felt from the irrigation groups with whom he worked. Perhaps the biggest weakness of black farmers and their representatives is the almost complete lack of an independent technical (ie hydrological or engineering) competence to interpret, let alone challenge, information about water availability and use. Even the Nelspruit-based consultants who are working on black farmers' behalf are from non-engineering backgrounds, one being in marketing and the other in social development. The reality is that the technical competence needed for viability in the market economy exists only in the commercial sector. For black farmers it is presently only on offer from TSB. Other initiatives are being developed. These include employee-ownership schemes, such as Inala Farms near Malelane, and the Nkomazi Farmers Co-operative, a joint venture with Lowveld Co-operative to support production and marketing of fruit and vegetables and specialist crops such as paprika. It was not possible to examine this initiative in Nkomazi, so no judgement can be made on progress so far. The venture may eventually offer to black farmers the co-operative financial and advisory services used by white farmers, but currently it does not appear to have caught the imagination of black farmers in the way sugar cane has.

Forestry

This study was unable to interview the personnel from the forestry sector most closely involved with the catchment management forums and their respective steering committees, as many were not available during the brief period during which interviews were conducted. The impressions obtained were therefore largely from people working with, but from outside, the forestry sector.

The forestry sector is in general in a strong position because it occupies the upper catchments where water is most abundant and effectively intercepts water before it can become available to any other user. This pre-emptive water use by forestry earned it much criticism in the past from downstream users who claimed forest plantations had caused an excessive reduction in streamflow, particularly the low flows during the dry season.

The most important observation in this study is perhaps that of a positive change in perceptions of the forestry industry by commercial farmers and environmentalists, by contrast with those five years earlier. Examples include forestry companies' participation in the Sabie River Working Group, which produced cooperation with the Whitewaters Irrigation Board to reduce forest plantation encroachment on riparian zones in the catchment of the Da Gama dam. As a result, while the secretary of the Irrigation Board in 1993 regarded forestry as the chief reason why farmers' lacked water, his successor today speaks highly of the partnership between his board and the forestry industry. Other examples quoted by Jaape Lubbe, of the Sabie River Working Group, include foresters' agreement to avoid planting on sponge areas and the use of SAFCOL's monitoring of river biology to detect inadequate sewage and solid waste treatment by municipalities, providing the SRWG with an opportunity to pressure DWAF to take action against the TLC concerned. More generally, the Working for Water programme being undertaken in the upper catchments has done much to restore forestry's image as a 'good citizen' following widespread criticism in earlier years. In the Sand catchment the prospect of

permanent reduction in the afforested area has also been widely greeted as a positive step towards increasing streamflow in the dry season. According to another observer, an important element in the rehabilitation of forestry's reputation has been the greater transparency provided by more systematic and accurate inventory of plantation areas using satellite images and GIS.

Environmental Interests

Environmental interests have been at the forefront of developing ideas of catchment management agencies. The Kruger National Park initiated the Sabie River Working Group, and, more recently, the Save the Sand project, funded by the Sabi Sand Game Reserve, developed proposals for catchment management of the Sand subcatchment. Elsewhere in the Inkomati WMA environmentalist representation was less of an organising force, but increasingly visible in catchment management steering committees. As observed above (section 7.2), the environmentalist presence in the Crocodile Catchment management steering committee grew considerably in successive meetings as the conservation interests became more coordinated. While the weight of numerous conservancies in the upper subcatchments is important, the involvement of the KNP, who appointed a member of staff specifically to undertake a coordinating role for conservation interests in catchment management, is significant.

Environmentalist interests have considerable potential leverage in a future CMA. Through the commercial and state wildlife and conservation agencies they have considerable technical expertise, and are possibly the only set of interests able to match commercial agriculture and the irrigation boards in this respect. This strength of technical expertise will be enhanced further by its deployment in both defining and monitoring the ecological aspects of the Reserve. As such, environmentalists may have a key role in setting limits to the availability of water for 'beneficial use' by the largest users – irrigated agriculture. In early 1999 the conservation group on the Crocodile catchment put forward proposals for the incorporation of environmental concerns into a Catchment Management Strategy, and at the time of writing are consulting DWAF Legal Services on the options for establishing a WUA to represent conservation interests.

A weakness of environmentalist agencies is the historical displacement and exclusion of black communities, and difficulties in acceding to those communities' current development needs which encroach on conservation areas. The current negotiations between black communities and the KNP over access to water from the Nsikasi river is an example of this. The environmentalist lobby must evidently avoid the temptation to repeat patterns of the past where conservation of resources is achieved not by curbing the excesses of white irrigators but by suppressing incipient black irrigation.

Local and Provincial Government

A fundamental aspect of the 1998 National Water Act is that water resources should be managed to achieve developmental goals. This was underlined during the April 1999 workshops, in which a number of participants emphasised that, while the CMA Board would be appointed to be broadly representative of a range of interests in the WMA, members of the CMA Board would have a mandate not to represent their particular

sectoral interest, but to manage the resource in a socially optimal way. The discussion of sectoral interests in this section has observed that these are commonly guided by technical and economic priorities. A key challenge for the implementation of a CMA, therefore, is to reconcile a political and developmental agenda to eliminate poverty with these technical and economic needs of individual sectors. An important element of this settlement will be the National Water Resource Strategy, which will establish guidelines for the operation of the CMAs. Another crucial component will be the role of elected government at Provincial and local levels.

Provincial government representation in the CMA will be important to ensure a catchment management strategy is geared towards meeting development goals, particularly in terms of poverty reduction. The Inkomati Basin WMA includes part of Northern Province, as well as Mpumalanga. During this pilot study there was not an opportunity to consult departments in Northern Province, but it is evident that the operation of a CMA will have to involve representation of, and consultation with, constituencies and departments from both provinces.

The role of TLCs, in addition to providing a channel for local-level concerns and priorities, also offers an opportunity to ensure the integration of water service provision within strategies of catchment management. TLCs, after a period of transition and capacity-building, will be responsible for providing water services to the communities under their jurisdiction. Provision of water to households is covered by legislation (the Water Services Act of 1997) separate from that for water resource management (the National Water Act of 1998). However, the two are evidently linked, and, for many communities in the Inkomati Basin WMA, the provision of clean water for domestic use remains the most important priority of a catchment management strategy.

7.5 Conclusions: Development Strategies and Trade-offs

The consultative process on catchment management in Mpumalanga has focused on the catchments of the Inkomati Basin. It has been conducted by DWAF for some 15 months in the Crocodile and Komati catchments. More recently, it has been extended to the Sabie catchment, where it builds on catchment management activities begun in 1992 by the Sabie River Working Group, and to the Sand subcatchment where it will form a further development of the Save the Sand project begun in 1997.

The process started with the understanding that each subcatchment would have its own CMA. When it became apparent (in October 1998) that a single CMA would cover all four catchments, a revision of earlier concepts was required, and a model for the combined CMA is under discussion.

This discussion appears to acknowledge advantages (cost saving, simpler information systems, higher calibre technical staff) from a larger CMA, but also reveals anxieties among groups within each catchment that the combined CMA will result in less efficient management than could be achieved by a single CMA for each catchment.

These fears signal the importance of ensuring that detailed local knowledge at catchment level should be fully used in catchment management, possibly through 'catchment management committees' outlined in draft proposals prepared during the consultation process in the Crocodile and Komati catchments. It is also possible, however, that worries at catchment level about the scale of the proposed CMA also reflect a management culture formed by the historical dominance of water resources by a relatively small number of interests in any given catchment, unaccustomed, therefore, to negotiating with competing demands for water.

The data on water use is deficient in all catchments, but there are initiatives to improve the measurement and recording of water use data in order to improve internal management by irrigation boards and the sugar industry. Data on water availability, while generally derived from a common hydrological model calibrated with rainfall and streamflow records, are presented by different authorities using a variety of geographical boundaries and water use assumptions that makes comparison between different estimates of water availability problematic.

DWAF have sought black farmers' representation on the steering committees and forums, and have an extensive list of farmers' associations they have contacted. There is evidence of a strong growth in demand for irrigation opportunities, which is currently not being met.

In the Sabie and Crocodile subcatchments, black farmers have negligible access to irrigation and there are no apparent incentives for catchment management committees to be concerned about this. The situation in the Komati catchment is different because the TSB has an interest in securing cane deliveries from black cane growers for the expanded capacity at Komati Mill.

The situation in the lower Komati raises a number of issues about representation of disadvantaged groups and strategies for 'developmental' roles for a CMA:

- Black farmers voice concerns about dependency, both in terms of sitting as 'junior' members of Irrigation Boards dominated by larger commercial farmers, and in terms of reliance on a single crop, using unfamiliar technology.
- Black farmers see the IB as radically transformed when it becomes a water users association, while white farmers see the IB remaining largely unchanged
- Sugar cane schemes have excluded many potential growers and there is strong demand for further schemes.
- The extent of water availability is confused, both institutionally (DWAF, Irrigation Boards, and the Dept of Agriculture all avoid responsibility), and technically. The most common response to applications for irrigation permits is: 'all water has already been allocated'.
- TSB says the existing cane yields can be achieved with 30% less water by investing in more efficient application systems and improved management.

- Risk is an important element in favour of sugar cane as a crop for black farmers using water allocations in a strongly market-dominated environment, because the sugar mills provide technical support and a guaranteed market.

The positive short-term effects of sugar cane as the basis for development for black irrigators, in terms of reduced risk and potential for managerial capacity-building, must be weighed against our conclusion that this is a relatively inefficient use of water, representing suboptimal allocation of the resource in terms of both direct and total benefits. Other crops, notably vegetables and fruit can provide higher returns to water use than sugar, both to individual farmers, and to the wider society. Incentives are therefore needed to maximise irrigation efficiency in sugar cane, and to use the water saved to both widen the distribution of benefits from water use while diversifying that use into activities with higher returns.

For many communities in the Inkomati Basin WMA, access to a source of clean water for domestic use remains the overriding priority of catchment management. For such communities, legitimacy of a CMA, and respect for its authority over water management will very likely depend on maintenance of a priority for seeking opportunities to improve and extend water service provision as part of all aspects of a catchment management strategy.

This study suggests four strategic areas where implementing a CMA may provide opportunities for strategies which seek more equitable distribution of the beneficial use of water, while also improving the efficiency of water use.

1. A strategy of representation of interests

A strategy of representation of different interest groups must recognise that under previous legislation control of water resource became, in many respects, highly decentralised. Some 75% of all water use in the Inkomati Basin WMA is accounted for by two sectors, forestry and agriculture, both of which are highly organised, either as large corporations, or through irrigation boards. Consequently, with few exceptions (eg Eskom on the Komati, and KNP on the Sabie) these interests dominate water management water at catchment level. Representation on a CMA offers an opportunity to counterbalance controlling interests in each catchment to enable experience to be developed in management through broad consensus rather domination of one group by another. This counterbalancing of current dominant groups will also offer scope for better representation for groups such as black farmers whose interests have previously remained invisible. It is important that such representation for disadvantaged groups must allow multiple channels of representation. In particular, black farmers should be allowed representation through farmers' associations, as well as through water users' associations which, despite claims to the contrary, are likely to continue to reflect irrigation boards' priorities in representing the interests of larger commercial farms. In this regard, the representation proposed in current draft proposals from the catchment management steering committees in Mpumalanga should be reviewed. In particular the representation of 'agriculture' as a single sector may fail to discriminate adequately between the problems and priorities of smaller-scale black irrigators on the one hand and those of

larger scale white farmers on the other. Separate representation of these as two sectors is important to avoid the former being obscured by the latter under the 'unifying' institution of a water users' association.

2. A strategy of information management

The requirements for accurate and systematic collection, recording and reporting of data on water use need to be implemented by all water users, as current data is often inconsistent. While more accurate and accessible data inevitably renders the operations of irrigation boards (WUA) and individual water users more transparent to other interests in the WMA – essential if the CMA is to promote equitable water use – the relative discomfort this may cause to established water users can be offset by the advantages irrigation boards and individual irrigators will gain from better efficiency in resource use, leading to improved profitability, and fewer disputes over water use. Further, a policy of transparency over water use would allow irrigation interests to obtain a clearer picture of water use by upstream industrial users (notably Eskom on the Komati catchment) and, as a consequence, enable negotiations over possible releases of water by industrial users for irrigation during drought periods. As part of an information strategy, the dissemination of information on water availability needs to be improved in the public domain. In particular, the translation of hydrological models into estimates of water availability at different points of the WMA needs to be reviewed, with the objective of providing an agreed set of expectations of water flow (its range and probability) at different times of the year that can be compared with measured values (eg from flow gauges). Both expected and measured flow data should be published in such a form that they would be widely accessible to all water use interests in the WMA.

3. A strategy of irrigation access for black farmers.

Developing better access to irrigation for black farmers is a matter of providing access not simply to water, but to a viable production system. For relatively inexperienced black irrigators operating in a sophisticated market economy, that means adequate technical support, appropriate managerial advice, and a product with a guaranteed market. In South Africa, this is found only in the commercial sector. Currently, it is only on offer from the sugar industry. While the miller-grower relationship of sugar cane is likely to provide mutual benefits, it is likely to be available to only a relatively small number of growers. It is also not likely to be an optimal use of water in terms of the net return to the individual farmers or in terms of the wider social benefit.

The obligation on CMAs to ensure that water use is both equitable and beneficial in the public interest suggests that the licensing of water should include incentives or conditions requiring commercial interests to form partnerships with black irrigators that develop the latter's managerial skills and experience by providing technical, managerial, and marketing support. Partnerships could be a way of making available additional water for reallocation to previously disadvantaged groups from efficiency savings in existing water use by the commercial sector. Attention needs to focus on incentive structures for such savings and for commercial partnerships which provide black irrigators with long-term, high-quality, technical, financial, and marketing support.

4. A strategy of interdepartmental collaboration on land tenure for irrigation.
The removal and resettlement of many African communities under homeland administrations has left a legacy of overlapping land rights in ex-homeland areas which may lead to conflict between competing claimants seeking to develop irrigation. Equally, occupation of an irrigated plot offers an African smallholder an opportunity to 'upgrade' his or her tenure to that of individual title. In effect, therefore, the expansion of irrigation for African smallholders precipitates the need to redefine land tenure under 'tribal' authority and may accelerate the shift of irrigated land to individual, rather than tribal, title. In this way the allocation of water is inextricably linked to the resolution of land rights in ex-homeland areas. If a CMA is to be able to manage this potentially conflictual situation, DWAF needs to engage with other government departments in laying the foundation for an institutional framework for allocating land and water in ex-homeland areas. Firstly, DWAF needs to remove the anomaly whereby water allocation is made to black farmers by the Department of Agriculture. Future permits for water use by black farmers should be based on a review of water availability on the rivers concerned (see 2, above). Secondly, DWAF needs to engage the Department of Land Affairs, the Department of Agriculture, relevant TLCs, LRDCs, and Tribal Authorities, in order to review systematically the tenure status of land where irrigation expansion is proposed with a view to identifying areas of conflict, clarifying the terms under which water permits are issued, and seeking equitable allocations for those with legitimate claims.

References

Armstrong K and Ashby S (1995) Komati River Basin Development Swaziland Smallholder Cane Growers Pilot Project. UNDP, and Kingdom of Swaziland Ministry of Agriculture and Cooperatives.

Bate R, Tren R, and Mooney L (1998) An Econometric and Institutional Economic Analysis of Water Use in the Crocodile River catchment, Mpumalanga Province, South Africa. Project 5/855. Water Research Commission, Pretoria water

Carney D (1995) Management and Supply in Agriculture and Natural Resources: Is decentralisation the answer? Natural Resource Perspectives 4. London: Overseas Development Institute

Carney D and Farrington J (1998) Natural Resource Management and Institutional Change. Routledge/Overseas Development Institute, London.

Chunnet, Fourie and Partners (1991) Sabie River Catchment Development Study. Chunnet, Fourie and Ptnrs for Planning Directorate, RSA Department of Water Affairs and Forestry, Pretoria

CSIR (1998) Technobrief Mpumalanga supplement, August 1998. CSIR, Nelspruit.

DWAF (1995) Report on the Proposed Sabie River Government Water Scheme (First phase: Injaka Dam and Bosbokrand transfer pipeline). Department of Water Affairs and Forestry. Pretoria.

DWAF (1997) White Paper on a National Water Policy for South Africa. Department of Water Affairs and Forestry, Pretoria.

DWAF (1998a) Water Law Implementation Process. *A Strategic Plan for the Department of Water Affairs and Forestry to Facilitate the Implementation of Catchment Management in South Africa.* WRC Report KV107/98. Department of Water Affairs and Forestry and Water Research Commission, Pretoria.

DWAF (1998b) Preliminary Proposals for Water Management Area Boundaries and the Establishment of Catchment Management Agencies. October 1998. Department of Water Affairs and Forestry, Pretoria.

Hassan R, Olbrich B, and van der Merwe M (1998) Comparative Analysis of the Economic Efficiency of Water Use. In: Olbrich B (ed) A Comparison of the Economic Efficiency of Water Use of Plantations, Irrigated Sugarcane and Sub-Tropical Fruits. A Case Study of the Crocodile River Catchment, Mpumalanga Province. Water Research Commission, Pretoria.

JIBS (1995) Joint Incomati Basin Study, Main report (vol 1 of 7). Chunnet, Fourie and Partners and Consultec, for the Tripartite Permanent Technical Committee. Report PX000/00/0195, DWAF. Pretoria

Levin R and Weiner D (1997) (eds) "No More Tears": Struggles for Land in Mpumalanga, South Africa, African World Press, Trenton NJ

MBB (1998a) Towards the establishment of a catchment Management Agency for the Komati River Catchment. Discussion Document II. MBB for Department of Water Affairs and Forestry, Nelspruit.

MBB (1998b) Towards the establishment of a catchment Management Agency for the Crocodile River Catchment. Discussion Document II. MBB for Department of Water Affairs and Forestry, Nelspruit.

MBB (1998c) Towards the Establishment of a Catchment Management Agency which will manage the water resources of the Crocodile River Catchment Discussion document 3

Institutional framework, detailed description of functions and responsibilities, staffing structure. MBB for Department of Water Affairs and Forestry, Nelspruit.

Manor J (1995) Democratic Decentralization in Africa and Asia. IDS Bulletin 26 (2) 81-88

Midgeley D, Pitman W, and Middleton B. (1994) Surface Water Resources of South Africa 1990. Vol VI Appendices. Water Research Commission. Pretoria.

NOWAC (1999) The Contribution of Irrigation to the Nkomazi/Onderberg region of Mpumalanga. Nkomazi /Onderberg Water Action Committee. Malelane.

Olbrich B (ed) A Comparison of the Economic Efficiency of Water Use of Plantations, Irrigated Sugarcane and Sub-Tropical Fruits. A Case Study of the Crocodile River Catchment, Mpumalanga Province. Water Research Commission, Pretoria.

Pollard S, Perez de Mendiguren J, Joubert A, Shackleton C, Walker P, Poulter T, and White M. (1998) Save the Sand Phase I. Feasibility Study: The Development of a Proposal for a Catchment Plan for the Sand River Catchment. AWARD for Department of Water Affairs and Forestry, Pretoria.

Schmitz T and Ashton P (1999) Equity and Integrated Water Resource Management in South Africa. Draft Report to DWAF, Pretoria

Visser E and Fischer A (1995) Natural Resource Utilisation in Schoemansdal: claims by resource users.

Woodhouse P (1995) Water Rights and Rural Restructuring in South Africa: a case study from Eastern Transvaal. *Water Resources Development* 11 (4) 527-44.

Tables

Table 1 Land Use Summary

Catchment	subcatchment	Area	Afforestation		Irrigation		Population	
		km^2	ha	% of total	ha	% of total	1995	2010
Komati	upper Komati	6049	65984	10.9	6307	1.0	136306	217167
	Swazi Komati	1995	18748	9.4	13505	6.8	84623	149541
	lower Komati	1668	0	0.0	19104	11.5	173391	298735
	upper Lomati	228	7543	33.1	0	0.0	0	0
	Swazi Lomati	566	14200	25.1	708	1.3	29733	52542
	lower Lomati	699	16206	23.2	13227	18.9	114907	198390
Subtotal		11209	122681	10.9	52851	4.7	538960	916375
Crocodile	Upper Crocodile	950	7600	8.0	3700	3.9	7140	9240
	Elands	1572	42900	27.3	1090	0.7	7140	9240
	Central Crocodile	2858	108600	38.0	14790	5.2	97150	114750
	Kaap	1669	38900	23.3	7683	4.6	42170	49500
	Lower Crocodile	3420	2000	0.6	15058	4.4	240660	453590
Subtotal		10469	200000	19.1	42321	4.0	394260	636320
Sabie	Sand	1919	7600	4.0	2605	1.4	241000	462000
	Sabie	4421	64500	14.6	8986	2.0	250000	468000
Subtotal		6340	72100	11.4	11591	1.8	491000	930000
TOTAL		28018	394781	14.1	106763	3.8	1424220	2482695

Notes:

1.Sources:JIBS (1995), MBB (1998a, 1998b), Mpumalanga Department of Agriculture (Nkomazi Irrigation Expansion Programme areas)

2. Subcatchment afforested areas are the 'maximum permitted' under existing agreements.

1. Irrigated areas are those already developed, or under development (eg schemes under the Nkomazi Irrigation Expansion Programme).
2. I n some subcatchments 'developed irrigation' appears substantially underutilised at present, notably in the Sand where 2050 ha (79%) are irrigated, and the upper Komati, where only 3523ha (56% of 'developed' irrigation) were estimated to be in use. Similarly JIBS (1995) estimates some 4500ha (10%) fallow irrigated land in the Crocodile catchment .

Table 2 Population distribution

Catchment	subcatchment	Area km^2	Population		% of total		population per km^2	
			1995	2010	1995	2010	1995	2010
Komati	upper Komati	6049	136306	217167	9.6	8.7	22.5	35.9
	Swazi Komati	1995	84623	149541	5.9	6.0	42.4	75.0
	lower Komati	1668	173391	298735	12.2	12.0	104.0	179.1
	upper Lomati	228	0	0	0.0	0.0	0.0	0.0
	swazi Lomati	566	29733	52542	2.1	2.1	52.5	92.8
	Lower Lomati	699	114907	198390	8.1	8.0	164.4	283.8
Subtotal		11209	538960	916375	37.8	36.9	48.1	81.8
Crocodile	Upper Crocodile	950	7140	9240	0.5	0.4	7.5	9.7
	Elands	1572	7140	9240	0.5	0.4	4.5	5.9
	Central Crocodile	2858	97150	114750	6.8	4.6	34.0	40.2
	Kaap	1669	42170	49500	3.0	2.0	25.3	29.7
	lower Crocodile	3420	240660	453590	16.9	18.3	70.4	132.6
Subtotal		10469	394260	636320	27.7	25.6	37.7	60.8
Sabie	Sand	1919	241000	462000	16.9	18.6	125.6	240.8
	Sabie	4421	250000	468000	17.6	18.9	56.5	105.9
Subtotal		6340	491000	930000	34.5	37.5	77.4	146.7
TOTAL		28018	1424220	2482695	100.0	100.0	50.8	88.6

Source: JIBS (1995), DWAF (1995)

Table 3 Summary of Water use in the Inkomati WMA

Catchment	subcatchment	MAR	Storage	Water consumption Mm3/a								% of MAR	
				Primary and Industrial		Afforestation	Irrigation	game & livestock	IFR	Total			
		Mm3/a	Mm3	1998	2010					1998	2010	1998	2010
Komati	Upper Komati	703	160	138.2	150.3	62	13	2.2		215	228	31	32
	Swazi Komati	360	347	10.6	18.9	23	171	1.5		206	215	57	60
	Lower Komati	44	42.6	5.4	22.2	0	211	1		217	234	494	532
	Upper Lomati	77	7.3	0.0	0.0	13	0	0.1		13	13	17	17
	Swazi Lomati	149		1.0	3.9	22	4	0.4		27	30	18	20
	Lower Lomati	87	237.0	3.6	14.7	21	136	0.3		161	172	185	197
Subtotal		**1420**	**794**	**159**	**210**	**142**	**534**	**5.6**	**42**	**883**	**934**	**62**	**66**
Crocodile	Upper Crocodile	122	161.1	0.6	1.2	9	15	0.3		25	25	20	21
	Elands	257	11.8	13.0	13.6	55	6	0.4		74	75	29	29
	Central Crocodile	514	38.3	7.5	14.3	132	133	0.5		274	281	53	55
	Kaap	220	3.4	3.2	6.2	49	38	0.22		91	94	41	43
	Lower Crocodile	113	7.3	18.1	43.7	1	105	0.6		125	150	111	133
Subtotal		**1226**	**222**	**42.3**	**78.8**	**247**	**298**	**2**	**63**	**652**	**689**	**53**	**56**
Sabie	Sand	158	7.9	8.7	24.6	13	8	1.06		31	47	20	30
	Sabie	606	139.9	9.5	27.3	115	72	1.33		198	216	33	36
Subtotal		**764**	**148**	**18.1**	**51.9**	**129**	**80**	**2.39**	**62**	**292**	**325**	**38**	**43**
TOTAL		3410	1164	219	341	518	912	10	167	1826	1948	53	57
(% of total 1998 consumption)			64	12	19	28	50	0.6	9	100	107		

Notes:

1. MAR from JIBS (1995), MBB (1998a and b), Midgeley et al (1994).
2. Storage includes Maguga Dam (Swazi Komati: 303 Mm^3), and Injaka Dam (Sabie: 120 Mm^3), both under construction. Storage also includes estimates of total in small dams (MBB, 1998a,b; Woodhouse, 1995).
3. Primary water use data from DWAF (1995), JIBS (1995).
4. Industrial use includes: ESKOM (131.5 Mm^3/a transfer, Upper Komati), SAPPI (12.4 Mm^3/a , Elands), and TSB (9 Mm^3/a, lower Crocodile)
5. Water use by afforestation is from JIBS (1995)
6. Water use by irrigation is that for 'developed' irrigation (including NIEP), except in upper Komati, where 'fallow' areas have been excluded. Sources differ on allocation of irrigation use between central and lower crocodile, because 5845ha in lower crocodile subcatchment is supplied from the central crocodile via the Malelane Canal.

Table 4 Water consumption and water availability

Catchment	Afforested MAR [3] Mm^3/a	'system supply capability' [4] Mm^3/a		non-forestry water use Mm^3/a		water use/supply percent	
		85% assurance	100% assurance	1998	2010	1998	2010
Komati [1]	1278	725	595	587	626	81	86
Komati [2]	1278	882		737	878	84	100
Crocodile [1]	979	327	233	360	397	99	110
Crocodile [2]	979	450		482	581	107	129
Sabie [1]	490	104	82	83	101	80	97

1. Source: JIBS (1995), supply capability and demand for selected portions of catchments:
   Komati: Swaziland and lower Komati and Lomati subcatchments only
   Crocodile: excluding upper Crocodile, Elands, upper Kaap, and part of central Crocodile (White river) subcatchment
   Sabie: downstream of Injaka dam and Sabie-Marite confluence, excluding Sand river catchment
2. Source: MBB (1998a, 1998b), supply capability and demand for entire catchment. Use excludes forestry but includes IFR.
3. 'afforested MAR' is Mean Annual Runoff for entire catchment after deduction of water consumed by forest plantations.
4. 'System supply capability' estimates include water provided by the Maguga, Injaka, and Driekoppies Dams.

Table 5. Direct Economic Benefits from Water use in Irrigation and Forestry in the Inkomati WMA (1997 prices)

Crop	Water Use (m^3/ha)	Yield		Value Added (VAD)		Employment	
		t/ha	t/1000m^3	R/ha	R/1000m^3	Job/ha	Job/ 1000m^3
Field crops							
Sugar cane	10,900	19.2	1.76	9,043	830	0.68	0.06
Other	4,500	4.35	0.97	660	147	0.13	0.03
Citrus	7,925	46.5	5.87	9,926	1,252	0.37	0.05
Sub-tropical fruit	7,905	16.33	2.07	11,401	1,442	1.14	0.14
Vegetables	5,500	30.43	5.53	10,212	1,857	2.01	0.37
Forest plantations	1,131	20.20	17.86	1,163	1,028	0.043	0.04
Dryland Crops	791[a]	6.72	8.49	2,940	3717	0.16	0.20

a. Represents 70% of runoff reduction by plantations.

Table 6. Indirect and Total Economic Benefits from Water in irrigation and Forestry in the Inkomati WMA (1997 prices)

	Income Multiplier			Total VAD		Total Employment	
	Backward	Forward	Total	R/ha	R/000 m3	Jobs/ha	Jobs/000 m3
Field crops							
Sugar cane	0.15	0.46	1.61	14,559	1,336	1.10	0.10
Other	0.43	0.38	1.81	1,195	266	0.24	0.05
Citrus	0.73	0.38	2.11	9,920	1,252	0.78	0.10
Sub-tropical fruit	0.25	0.38	1.63	18,584	2,351	1.86	0.24
Vegetables	0.33	0.84	2.17	22,160	4,029	4.36	0.79
Forest plantations	0.09	0.76	1.85	2,152	1,903	0.08	0.07
Dryland Crops	0.34	0.67	2.01	5,909	7,470	0.32	0.04

Table 7 Comparison of efficiency of water use by forest plantations and irrigated crops (over 30 years).

Crop and cycle (years)	**Average annual water use (m^3/ha/a)**	**Physical yield (tons/1000m^3)** (range)	**Net Terminal Value: Rands/ m^3 water** (over a 30-year period)	
			average	**best**
Pine (pulp) 18 years	1071	20 - 50	0.27	0.44
Eucalyptus (pulp) 10 years	1091	50 - 60	0.82	1.99
Pine (sawlog) 30 years	1271	8 - 11	0.16	0.70
Eucalyptus (sawlog) 25 years	1284	20 - 50	3.0	1.79
Sugarcane 6 years	9836	1.6 – 1.7	1.0	1.04
Orange 20 years	6270	6.2 – 7.2	5.7	8.47
Grapefruit 12 years	8182	5.7 – 10.7	7.7	14.52
Banana 10 years	11560	2 – 2.5	4.5	5.79
Avocado 25 years	6340	1.1 – 1.9	6.1	3.79
Mango 16 years	4630	5.5 – 9.0	10.9	19.04

Source:Hassan et al (1998)

Average annual water use: streamflow reduction for plantation forestry, net irrigation for agricultural crops.

Physical yield: wood, sucrose (sugarcane), or fruit.

Table 8. Water tariffs and VAD in the Inkomati Catchment (1998)

	Field Crops	Citrus	Sub-tropical	Vegetables	Forest Plantations	Average
Average water use (m^3/ha/year)	4,500	7,925	7,910	5,500	1,131	
Average VAD (R/m^3)	0.27	1.25	2.35	4.03	1.90	1.86
Average water charge (R/m^3)						
Small-scale	0.024	0.019	0.019	0.022	0.00	0.020
Commercial	0.173	0.151	0.151	0.163	0.00	0.156

Table 9 CROCODILE RIVER CATCHMENT: Numerical Analysis of Representatives in the Meetings held within the CMA Process

Date	Meeting	TOTAL *	*Percentage Representing Sectors * [1,2,3]												
			Agriculture			Civil Society (LRDC's, CBO's Tribal Authorities, SANCO)	Nation-al & Prov Govt	Local Govt & Water Boards	Forestry	Indust	Mining	DWAF	CONSUL-TANTS	CONSERV-ATION	TOURISM
			Societies	Irrigation											
				Commercial Farmers	Emerging Farmers										
30/1/98	**Crocodile Main Forum**	**43** *0*	7	25	0	0	2	12	5	19	5	7	5	11	0
24/2/98	**Steering Committee**	**14** *2*	0	28 *1*	0	0	7	14	14	0	0 *1*	14	7	14	0
6/4/98	**Meeting: Local Authorities**	**17** *0*	0	5	0	29	12	41	0	0	0	12	0	0	0
14/4/98	**Meeting: Industries**	**12** *0*	0	0	0	0	0	0	0	58	17	17	0	8	0
22/4/98	**Steering Committee**	**17** *1*	0	41	0	0	6	11	0	11	6	6	6	11 *1*	0
27/6/98	**Crocodile Main Forum**	**43** *11*	0	37 *4*	9	2 *2*	7	9 *1*	2	7 *2*	0 *1*	9	7	9 *1*	0
17/8/98	**Meeting: Conservation**	**10** *0*	0	0	0	0	0	0	0	0	0	30	0	70	0
17/8/98	**Meeting: Emerging Farmers**	**33** *0*	0	0	70	0	21	0	0	0	0	6	3	0	0
9/10/98	**Steering Committee**	**26** *7*	0	23 *2*	15	0 *1*	14 *1*	0 *1*	11	7	4	7	7	15 *2*	0
26/11/98	**Steering Committee**	**28** *3*	0	18 *1*	7	0 *1*	7	7	14	7	0 *1*	10	10	21	0
9/2/99	**Steering Committee**	**16** *9*	0 *1*	19 *1*	0	0	19 *3*	6	12 *1*	0 *1*	6	12	12	25 *2*	0
30/3/99	**Steering Committee**	**21** *0*	0	14	0	0	7	5	19	5	5	14	10	21	0
21/4/99	**Steering Committee**	**16** *3*	0	12	6	0 *1*	0 *1*	0	12	6 *1*	6	19	12	25	0
INVITATION LISTS															
Crocodile Main Forum		**157**	2	13	28	9	12	9	2	6	3	6	2	6	1
Steering Committee		**53**	2	15	9	2	19	9	9	4	2	11	4	13	0

**** Italics = No. of apologies*** [1] sometimes one person represents more than one level of governance [2] Provincial Government includes: Agriculture, DEAT, Health, and Land Affairs [3] The Conservation Group includes KNP and Mpumalnaga Parks Board who are members of the Conservation Sub-Committee..

Table 10 KOMATI RIVER CATCHMENT: Numerical Analysis of Representatives in the Meetings held within the CMA Process

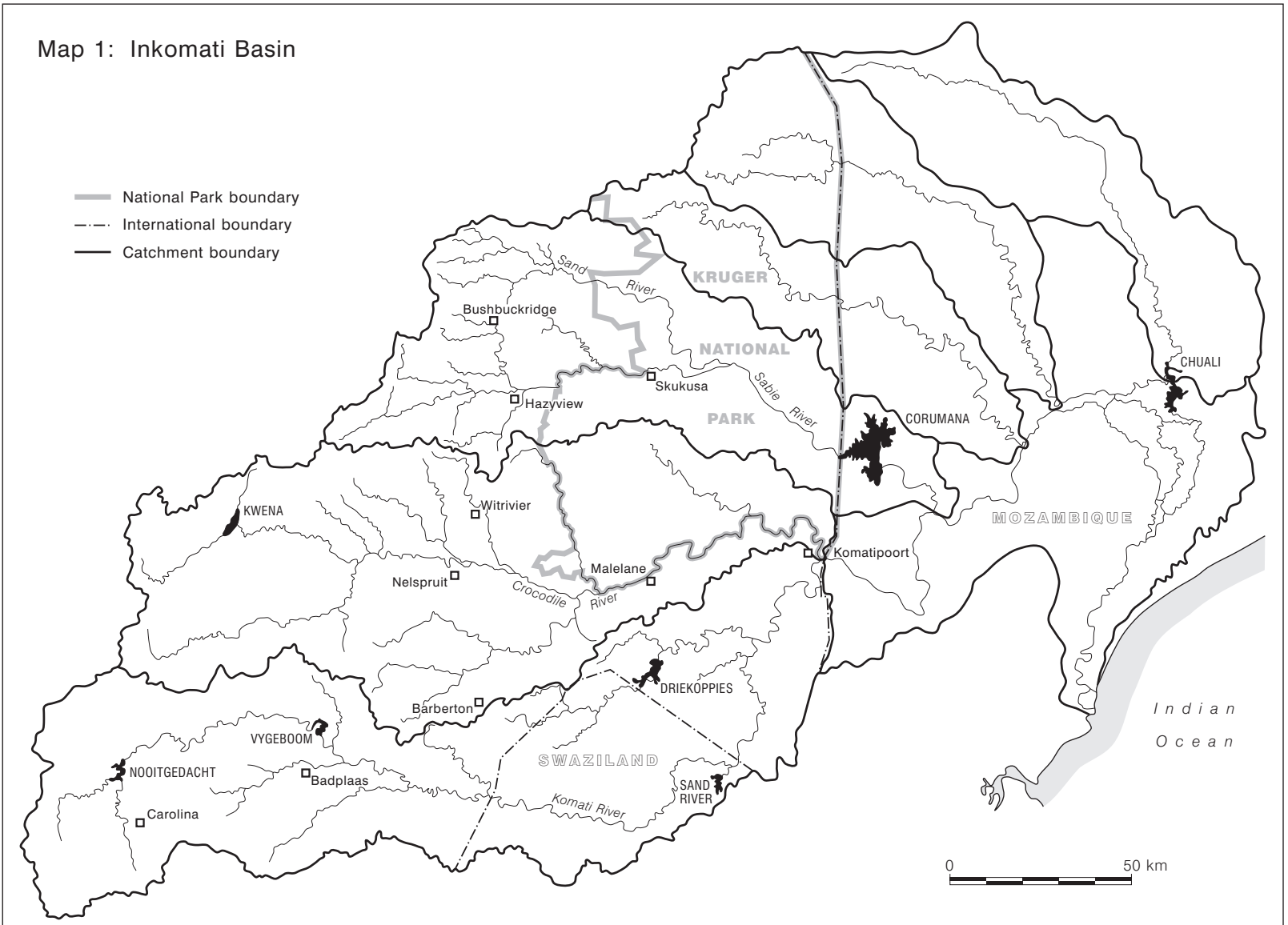
Date	Meeting	TOTAL*	Percentage Representing Sectors												
			Agriculture			Civil Society (LRDC's, CBO's Tribal Authorities, SANCO)	National & Prov Gov	Local Gov & Water Boards	Forestry	Indust	Mining	DWAF	CONSUL-TANTS	CONSER-VATION	TOURISM
			Societies	Irrigation											
				Commercial Farmers	Emerging Farmers										
21/07/97	**Planning Committee**	*14*	0	36	0	0	14	28	0	0	0	21	0	0	0
28/11/97	**Forum Meeting Barberton**	*27*	4	*11*	11	0	11	26	4	4	*11*	19	0	0	0
11/2/98	**Upper Komati Working Group**	*9*	0	33	0	0	11	34	0	0	0	22	0	0	0
11/2/98	**Lower Komati Working Group**	*10*	0	10	0	0	10	20	0	20	20	20	0	0	0
15/5/98	**Forum Meeting Mzinti**	*89*	29	0	48	2	2	1	0	0	0	3	2	0	0
21/5/98	**Forum Meeting Badplaas**	*19*	0	21	53	11	0	0	0	0	0	11	5	0	0
28/5/98	**Steering Committee**	*21*	0	5	29	*0*	*5*	29	0	*5*	10	10	10	0	0
3/6/98	**Forum meeting Mzinti**	*73*	0	*1*	94	*0*	*0*	*0*	0	0	0	3	3	*0*	0
11/6/98	**Forum meeting Elukwatini**	*19*	0	*5*	68	*0*	0	5	0	5	*5*	5	5	0	0
24/6/98	**Forum meeting Drum Rock**	*14 6 6*	8	*0*	79	*3*	2	3	0	0	*1*	1	3	1	0
27/7/98	**Forum meeting Mzinti**	*73*	*0*	*4*	85	0	*1*	4	*0*	*0*	0	3	3	*0*	0
11/8/98	**Forum meeting farmers Elukwatini**	*45*	0	0	96	0	0	0	0	0	0	4	0	0	0
8/10/98	**Steering Committee**	*13 1*	0	23	0	0	0	16	0	8	8	31	15	0	0
19/11/98	**Steering Committee**	*73*	14	4	60	4	0	0	0	1	0	3	4	0	0
27/11/98	**Steering Committee**	*24 4*	8	8	25	0	0	13	17	8	4	8	8	0	0

10/2/99	**Steering Committee**	*23*	4	30	0	*9*	*0*	20	4	*4*	4	13	13	0	0
3/3/99	**Forum Mzinti**	*14 0*	14	0	60	*6*	*6*	1	0	*4*	1	6	1	1	0
13/03/99	**Forum Mzinti**	*29*	24	7	41	*3*	*10*	0	0	*0*	0	10	3	0	0
31/3/99	**Steering Committee**	*21 2*	0	19	19	*10*	*0*	0 2	5	*1*	0	19	14	0	0
21/04/99	**Steering Committee**	*20 2*	0	15	20	*10*	*5*	20	0	*5*	10	10	10	0	0
INVITATION LISTS															
Full Forum Meeting		**234**	7	7	52	9	7	13	0.4	1	2	2	1	0	0.4
Steering Committee		**51**	12	10	16	4	8	12	14	2	4	10	8	0	0

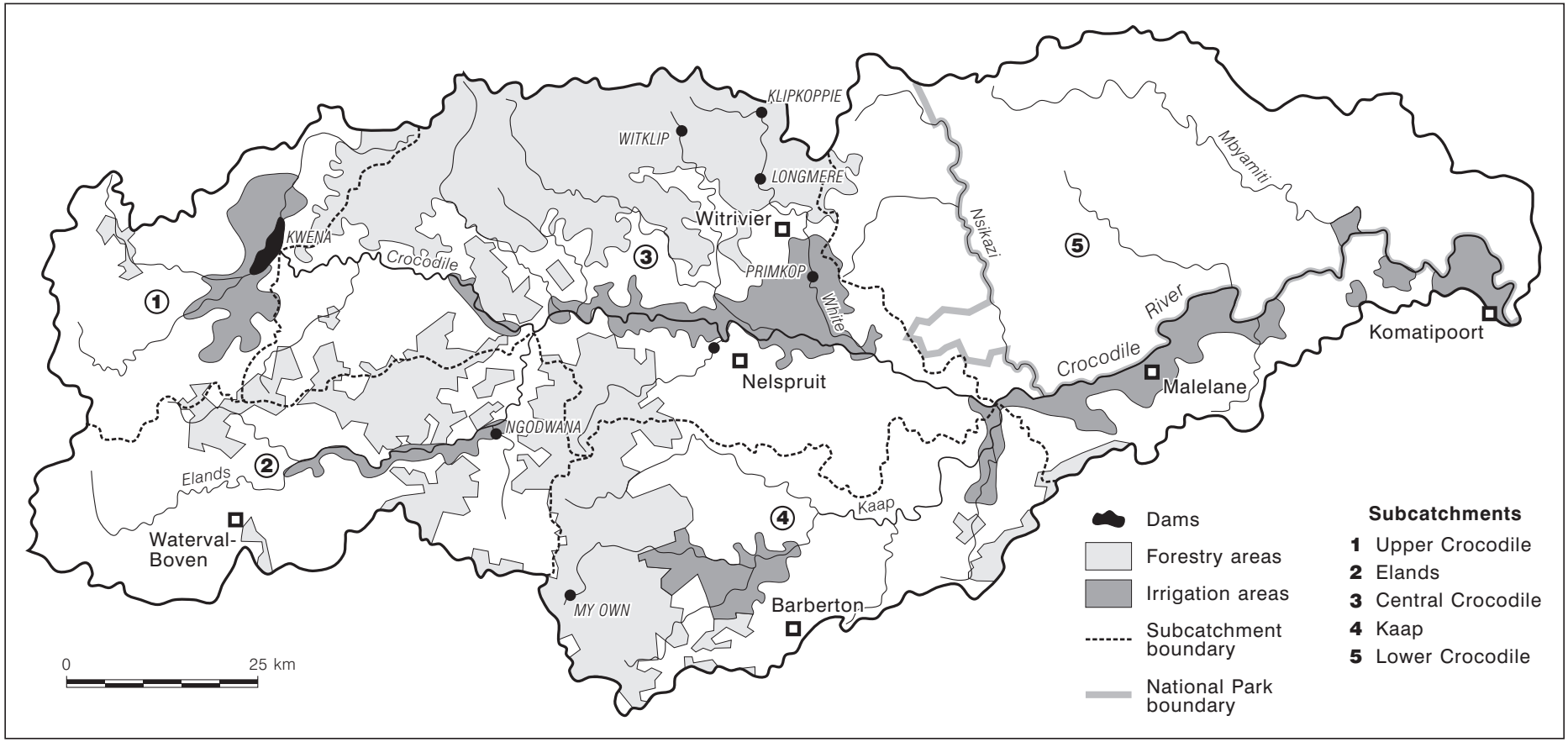
- ***Italics = No. of apologies***
- ***The Forestry Section of DWAF forms part of the Forestry Column***
- ***Sometimes the same person represents more than one sector.***

Maps

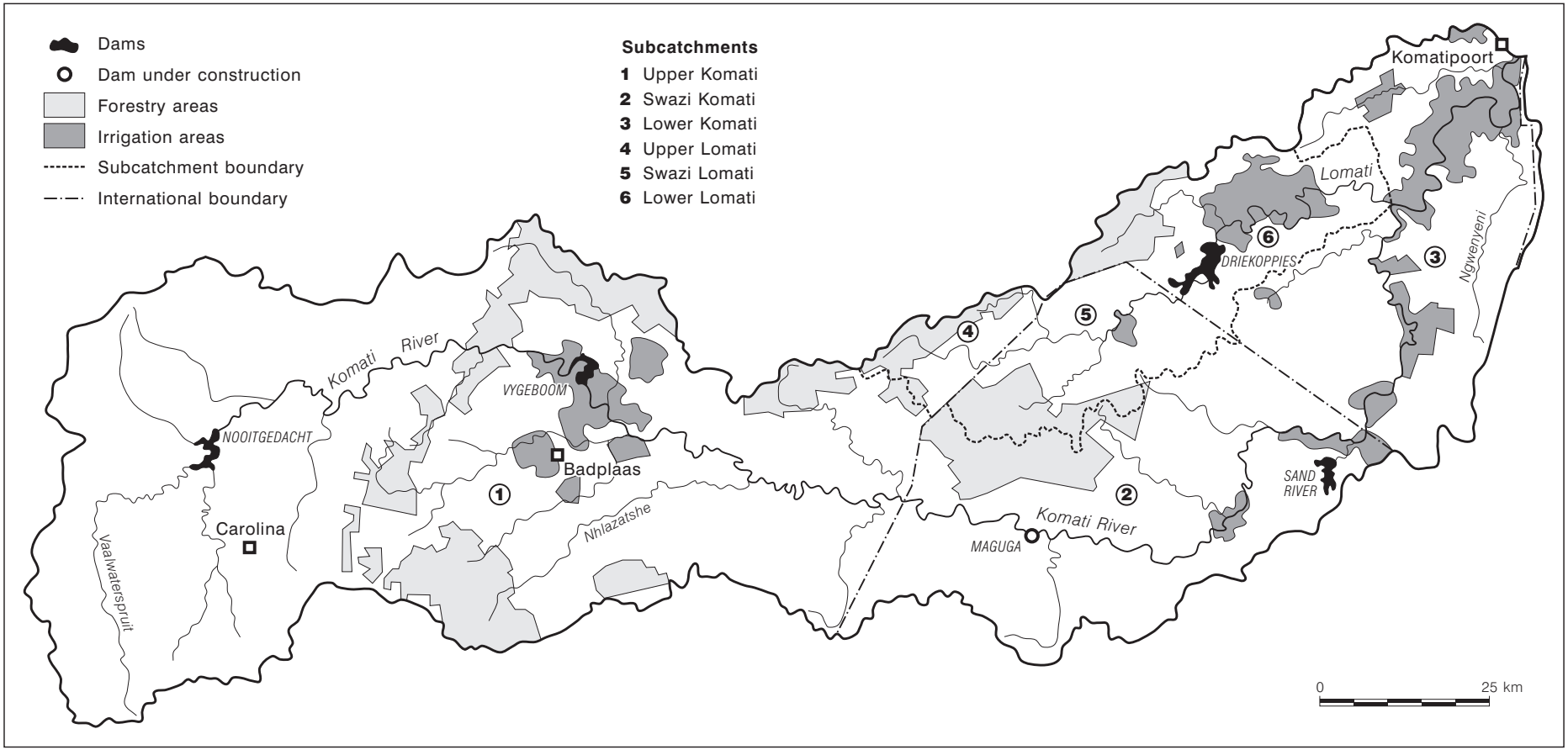
Map 1: Inkomati Basin



Map 2: Crocodile Catchment



Map 3: Komati Catchment



Map 4: Sabie and Sand Catchments