1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

This Strategic Environmental Impact Assessment report is the final report of the Integrated Kafue River Basin Environmental Impact Assessment Study. It was commissioned by the Office for Promoting Private Power Investment (OPPPI) in the Ministry of Energy and Water Development and executed in partnership with the Environment and Social Affairs Unit at ZESCO as one of the Power Rehabilitation Project components.

The first phase of the study (August 2002 – May 2003) culminated in the State of the Environment Report. This comprised a review of documentation relating to the Kafue river basin and synthesis of points raised by participants at workshops held in Lusaka and 11 districts during December 2002 and January 2003. It concluded the process of highlighting major socio-environmental issues in the basin.

This second phase (May 2003 – August 2003) has investigated the major socio-environmental issues highlighted in the first phase. These are competition for Kafue water and the conflicts between:

- power generation for Zambia and for export, the latter being a very important potential source of government revenue;
- irrigated agriculture, with its vital role in alleviating hunger and increasing local food production; and
- a wide range of issues in Kafue Flats wetlands which are sandwiched between Itezhi-tezhi and Kafue Gorge dams.

All of these issues have to be seen within the wider context of there being widespread poverty and hunger in the Kafue basin, as in many areas of Zambia.

Terms of Reference were discussed and refined in a stakeholder workshop held in Lusaka in April 2003. Close consultations have been maintained with stakeholders throughout this latest study. In particular, traditional leaders, local government departments, small-scale and commercial farmers, Ministry of Agriculture and Co-operatives, Zambia National Farmers Union (ZNFU), Zambia Meteorological Department (ZMD), Zambia Wildlife Authority (ZAWA), Environmental Council of Zambia (ECZ), Geological Survey Department, Department of Water Affairs (DWA) and other interested parties have been consulted about irrigation developments in Chiawa, Mpongwe, Kafue Flats and elsewhere. Similarly, wide-ranging consultations have taken place concerning Kafue Flats wetlands, including traditional leaders, local government departments, ZESCO, ZAWA, ECZ,

ZMD, DWA, Department of Fisheries, Worldwide Wide Fund for Nature (WWF), Nakambala Sugar Estate, Kafue Fisheries, University of Zambia (UNZA) departments/schools (biology, geography, veterinary, mines), Food and Agriculture Organisation (FAO) in Lusaka and Rome and contributors (now retired) to the Kafue Basin Research Project which was active between 20 and 30 years ago.

1.2 DEVELOPMENT SCENARIOS, SIMULATION MODELS AND RESULTS

The report has examined the impacts of three development strategies, described as:

- Maximum Power scenario – where simulation cases are prefixed as "P";
- Maximum Irrigation scenario – prefixed as "I"; and
- Maximum Wetland Conservation scenario – prefixed as "C".

The report has also considered the No Dams "ND" situation and gone on to examine the impacts of the best – from a wetland conservation standpoint – of the wetland conservation scenarios (C3) with additional levels of irrigation development. The development strategies reported are summarised in **Table 1.1**.

Table 1.1: Summary of Development Scenarios for Model Simulations

Scenario	Upper/Middle Sub-Basin Additional Irrigation Area	Kafue Flats Sub-basin Additional Irrigation Area	Itezhi-tezhi Freshet	
	ha	ha	m^3/s	months
P-1	0	0	0	-
I-1	5,000	0	0	-
I-2	10,000	0	0	-
I-3	20,000	0	0	-
I-4	0	5,000	0	-
I-5	0	10,000	0	-
I-6	0	20,000	0	-
I-7	5,000	5,000	0	-
I-8	10,000	10,000	0	-
I-9	20,000	10,000	0	-
ND	0	0	0	-
C-1	0	0	300	Mar
C-2	0	0	300	Feb-May
C-3	0	0	400/600/600	Feb-Apr
C-3/I-3	20,000	0	400/600/600	Feb-Apr
C-3/I-6	0	20,000	400/600/600	Feb-Apr
C-3/I-9	20,000	10,000	400/600/600	Feb-Apr

The main tool to assist with quantification of differing impacts between the various scenarios has been computer simulation using two models. For this, a 95 year river flow data base was utilised, spanning the period

October 1907 to September 2002, comprising 1,140 months. The water resources simulation model has incorporated key infrastructure components of the Kafue river system including storage reservoirs and existing and planned hydropower installations (Itezhi-tezhi, Kafue Gorge Upper, and Kafue Gorge Lower). It has made provision for abstractions associated with existing and proposed irrigation and water supply projects and accruals from mine de-watering. A second, hydrodynamic model has been used to simulate the flooding regime of Kafue Flats in order that impacts of various development scenarios on the Kafue Flats can be compared in terms of frequency, duration and extent of flooding.

Principal results of simulation runs and interpretations are presented in **Tables 1.2, 1.3** and **1.4**. The principal issues raised by these results are summarised in subsequent sections.

Table 1.2: Impact of irrigation scenarios on energy generation

Scenario	Additional Irrigation ha		Firm Energy Generation GWh/yr				Mean Shortfall GWh/yr	Total Value of loss US$ million/yr
	Middle/upper Sub-basin	Kafue Flats	Itezhi-tezhi	Kafue Gorge Upper	Kafue Gorge Lower	Total		
P	0	0	328	4,678	2,207	7,213	126	-
I-1	5,000		326	4,608	2,172	7,106	125	2.65
I-2	10,000		320	4,625	2,181	7,126	126	2.18
I-3	20,000		315	4,643	2,181	7,139	136	2.10
I-4		5,000	328	4,581	2,164	7,073	122	3.40
I-5		10,000	328	4,468	2,111	6,907	119	7.47
I-6		20,000	328	4,345	2,050	6,723	123	12.17
I-7	5,000	5,000	326	4,520	2,137	6,983	122	5.65
I-8	10,000	10,000	320	4,380	2,067	6,767	119	10.97
I-9	20,000	10,000	315	4,327	2,041	6,683	121	13.12

Table 1.3: Irrigated Cereal Production (Double Cropping) and Energy Losses

Scenario	Irrigation Area ha	Potential benefit of locally grown winter wheat production over importing US$ million/yr	Potential benefit of locally grown maize[1] production over importing US$ million/yr	Total benefit of locally grown wheat and maize[1] production over importing US$ million/yr	Total Value of Loss in energy sector US$ million/yr
I-1	5,000	1.93	2.14	4.06	2.65
I-2	10,000	3.85	4.28	8.13	2.18
I-3	20,000	7.70	8.55	16.25	2.10
I-4	5,000	1.93	2.14	4.06	3.40
I-5	10,000	3.85	4.28	8.13	7.47
I-6	20,000	7.70	8.55	16.25	12.17
I-7	10,000	3.85	4.28	8.13	5.65
I-8	20,000	7.70	8.55	16.25	10.97
I-9	30,000	11.55	12.83	24.38	13.12

[1] Supplementary irrigation of rainfed maize in rainy season, on same land as wheat. Benefits are for the incremental yield ascribable to irrigation.

Table 1.4: Impacts of Combined Wetland Conservation and Irrigation Scenarios on Energy Generation

Scenario	Wetland Conservation Release m^3/s x Months	Additional Irrigation ha		Firm Energy Generation GWh/yr				Mean Shortfall GWh/yr	Total Value of Loss US$ million/yr
		Middle/ Upper Kafue	Kafue Flats	Itezhi-tezhi	Kafue Gorge Upper	Kafue Gorge Lower	Total		
P		0	0	328	4,678	2,207	7,213	126	-
C-3/I-3	400 x 1 600 x 2	20,000		109	3,329	1,577	5,015	104	54.40
C-3/I-6	400 x 1 600 x 2		20,000	115	3,101	1,463	4,679	99	62.67
C-3/I-9	400 x 1 600 x 2	20,000	10,000	109	3,241	1,533	4,883	105	57.72

1.3 FINDINGS OF DEVELOPMENT SCENARIOS - ELECTRICITY SECTOR

The export of power is seen by Government as very important and vital for increasing government revenues, particularly in view of reduced revenue from the copper mining industry in recent years. Principal questions raised by interpretations of the model results and other areas of study are:

- Do the development scenarios question viability of Itezhi-tezhi power station?
- Do the development scenarios question viability of the Kafue Gorge Lower?
- How do scenarios affect Kafue Gorge Upper?
- What is the relevance of SAPP interconnections in resolving these conflicts?
- Are soil and water conservation programmes protecting Kafue's yield?

Answers to these questions are given below.

1.3.1 Viability of Itezhi-tezhi power station

Recent engineering studies of Itezhi-tezhi have shown that a 120 MW power station development is feasible and financially attractive. Those same studies did incorporate a 300 m^3/s release in March, every year, to improve wetland functions in Kafue Flats, but without investigating the areas of additional flooding and benefits caused by that release.

This study has considered the reduced availability of water for power generation resulting from consumptive use abstractions for up to 20,000 ha of additional irrigation upstream of Itezhi-tezhi. This is in addition to other abstractions including best working estimates of existing irrigation abstractions and allowances for future domestic, mining and industrial abstractions. The physical feasibility of the Itezhi-tezhi power station

development will not have changed; it remains feasible. Financial studies have not been up-dated during this study. The indications are that firm energy generation, whilst reduced, will remain viable with upstream irrigation developments up to 20,000 ha – the maximum considered in this report. It is considered that any future financial studies will confirm this.

When wetland conservation releases are made from Itezhi-tezhi, firm energy generation at Itezhi-Itezhi could be reduced to some 35% of its maximum potential in the most extreme case considered (C-3). Under these conditions, investment in the Itezhi-Itezhi power station development would be much less attractive than in the Maximum Power scenario. With another release pattern (C-2), firm energy generation at Itezhi-Itezhi would be greater, being reduced to some 50% of its maximum potential.

The report has drawn attention to these release patterns being demonstrations of what can be done, and that further assessment would be required to optimise release patterns.

1.3.2 Viability of Kafue Gorge Lower

Recent engineering studies of Kafue Gorge Lower have shown that a dam and power station development is feasible and financially very attractive. Those studies considered outflows from Itezhi-tezhi and Kafue Gorge Upper in approximately similar conditions to the maximum power case in this study, and also explicitly allowed for a compensation water release for riparian and *in situ* environmental needs in the bypassed channel between Kafue Gorge Lower dam and tailrace outfall, as also incorporated in this study.

This study has considered consumptive use abstractions for up to 20,000 ha of additional irrigation upstream of Itezhi-tezhi, and up to 20,000 ha additional irrigation in Kafue Flats, and combinations of both Upper/Middle Kafue and Kafue Flats irrigation up to 30,000 ha. These are in addition to best working estimates of existing irrigation abstractions and allowances for future domestic, mining and industrial abstractions in the whole Kafue basin upstream of Kafue Gorge. The physical feasibility of the Kafue Gorge Lower power station development will not have changed; it remains feasible. Financial studies have not been up-dated during this study. The indications are that firm energy generation, whilst reduced by some 7%, will remain viable with upstream irrigation developments up to 30,000 ha – the maximum considered in this report. It is considered that any future financial studies will confirm this.

The indications are that firm energy generation at Kafue Gorge Lower would be reduced by up to some 31% of its maximum power potential under the favoured wetland conservation release pattern (C-3) combined with additional abstractions for irrigation developments up to 30,000 ha.

Investment in the power station development would be less attractive than in the Maximum Power scenario. It would be expected to remain attractive to investors under this scenario but would probably require some adjustments to the design and installed capacity of the project.

1.3.3 Impacts of scenarios on Kafue Gorge Upper

Firm energy generation at Kafue Gorge Upper is reduced by upstream irrigation and wetland conservation releases in the same way as at Kafue Gorge Lower, but more so. This is because although water availability for the two projects is effectively the same, the head at the upper project is almost double that of the lower project. Thus all irrigation and conservation scenarios involve reduced potential energy sales for ZESCO. However, currently and for some years to come, there is an energy surplus in Zambia and sales are not at the economic tariff.

1.3.4 Relevance of SAPP interconnections in resolving these conflicts

Overall, the findings point to the fact that there is not very serious conflict between additional abstraction for irrigation upstream of the Kafue Gorge and Itezhi-tezhi and energy generation. Hence proposed power developments remain viable even with maximum irrigation abstractions. Nevertheless, wetland conservation scenarios have the potential to make proposed power developments significantly less attractive unless mitigation measures are taken.

SAPP interconnections are very relevant, for two reasons. They already permit exports to countries to the south of Zambia and will provide increasing flexibility in export markets as interconnections increase in future. They also provide the means, subject to limitations imposed by transmission system capacity, for making up shortfalls in energy supplies when severe droughts occur and could provide relief to the country in meeting shortfalls resulting from pursuing other development scenarios as well.

1.3.5 Soil and water conservation measures and protection of Kafue's yield

The Kafue river basin's topography upstream of Kafue Gorge is generally characterised by a gently undulating plateau, with innumerable dambos. All dambos act as natural storage reservoirs and together they provide both naturally regulated tributary and Kafue flows and buffers against sediment transport. Lukanga and other swamps, and Kafue Flats, provide additional regulation and natural sediment traps also. Generally, these are minimising sediment loads which might otherwise enter and reduce live storage at Itezhi-tezhi and Kafue Gorge Upper reservoirs. With such natural protection upstream of Kafue Gorge, the need for soil and water conservation programmes is less than it might otherwise be.

Three areas of concern are relatively small in extent and are described in the State of the Environment report. Upstream of Itezhi-tezhi, there is background concern that the fine materials in the 68 km^2 of tailings dams in the Copperbelt area of the Upper Kafue sub-basin remain *in situ*, as intended by engineering designs during their construction. Similarly, that new mining activities, such as proposed at Kansanshi, will not contribute sediment loads to Itezhi-tezhi reservoir. In the eastern Kafue Flats, there is concern about changing land use practices and reduced land cover contributing to sedimentation and reducing reservoir storage in the neck of the Kafue Gorge Upper reservoir. Similarly, conservation of land cover in the small tributary catchment areas between Kafue Gorge Upper dam and Kafue Gorge Lower dam site is very important for successful long-term operation of the Kafue Gorge Lower project. Thus a detailed environmental conservation and monitoring plan is required to protect this development.

1.4 FINDINGS OF DEVELOPMENT SCENARIOS - AGRICULTURAL SECTOR

Based on Ministry of Agriculture and Co-operatives and ZNFU sources, it has been estimated that some 60,000 ha of additional irrigation are required to meet existing food deficits. This assumes high yields from commercial irrigation enterprises. More irrigation will be required to meet future domestic needs. Even more will be required if Zambia is to regularly export cereals, having satisfied the domestic market.

Principal questions raised by interpretations of the model results and other areas of study are:

- Can Kafue water resources meet Zambia's irrigated food needs?
- Should irrigation developments be restricted in the Kafue basin?
- Should smallholder irrigation be restricted in the Kafue basin?
- Should commercial irrigation be restricted in the Kafue basin?
- Should any type of irrigation be restricted in the Kafue basin?
- Should applications for dams for additional irrigation be authorised?
- Will additional irrigation contribute to alleviation of poverty and hunger in the Kafue basin?
- Are abstractions for irrigation from groundwater preferable to surface water?
- Is groundwater integrated into water resources management?
- Will additional irrigation developments be in conflict with Game Management Areas?

Answers to these questions are given below.

1.4.1 Kafue water resources for meeting Zambia's irrigated food needs

This study has estimated the area of existing irrigation in the Kafue river basin to be about 35,000 ha. Almost half of this land is growing sugar cane. As important as sugar is for the local and national economy, mainly casual employment, and in contributing to the alleviation of poverty, it is noted that the large area devoted to this crop is not directly alleviating hunger.

The remaining potential is large but has been set at about 35,000 ha for the purposes of this study. This study has considered abstractions for up to 20,000 ha of additional irrigation upstream of Itezhi-tezhi, and up to 20,000 ha additional irrigation in Kafue Flats and a combination of these up to 30,000 ha. The study has assumed that some 10,000 ha (and much more, if suitable land is available) can be developed in the Lower Kafue under every development scenario. Thus, it is apparent that the Kafue basin can, if required, meet most of the estimated national cereal deficit.

From general estimates of irrigation potential, it appears that Zambia's need for an additional 60,000 ha of irrigation could be met from the Congo, Upper Zambezi and Luangwa river basins. These general estimates of potential irrigation appear likely to be reduced when detailed investigations are made but even then these basins may be expected to have the capacity to meet national demands, and surpluses for export if required. Thus, other things being equal, strategic choices are available.

1.4.2 Restrictions on irrigation developments in the Kafue basin

Additional abstractions for irrigation in the Upper Zambezi would reduce power generation at Victoria Falls (108 MW) and Kariba North (600 MW), whilst additional abstractions in the Luangwa basin would affect no power generation facility in Zambia unless they are upstream of Mulungushi/Lunsemfwa (38 MW) and/or Lusiwasi (12 MW). Although the firm energy generation at Victoria Falls and Kariba North combined is large (4,481 GWh/year) and of similar magnitude to that at Kafue Gorge Upper (4,678 GWh/year), the impact of a given reduction in flow (caused by irrigation abstractions) and hence energy generation on these Zambezi power stations would be only 60% of the impact on Kafue Gorge Upper because of the marked differences in head available (230 m at the two Zambezi power stations and 390 m at Kafue Gorge Upper).

Also, when the 186 m head at Kafue Gorge Lower is developed, these differences will increase (230 m at the two Zambezi power stations and 576 m at Kafue Gorge Upper and Lower) for a given reduction in flow. This will give a national advantage to the electricity sector (or more correctly, less disadvantage) from developing irrigation in the Upper Zambezi compared to the Kafue upstream of Kafue Gorge in the order of 576/230 – a ratio of

2.5:1. Thus, other things being equal, there is a significant advantage from a national power generation point of view in abstracting water for additional irrigation in the Upper Zambezi and not in the Kafue upstream of Kafue Gorge. Similarly, there is an even greater advantage from a national power generation point of view in developing additional irrigation in the Luangwa, Congo basins and in the Lower Kafue and not in the Upper Zambezi or in the Kafue basin upstream of Kafue Gorge.

These points lead to the conclusion that there is a strong case from the points of view of power generation and power exports for policies to restrict additional irrigation upstream of Kafue Gorge.

However, any blanket restrictions on additional irrigation upstream of Kafue Gorge would be considered counterproductive and socially unjust in the face of poverty and hunger in the basin, and commercially unviable if the national cereals deficit is to be effectively addressed, and the deficit to be turned into a surplus for export. Furthermore, the highest amount of abstraction in this study results in only 7% loss in firm energy generation.

This study has shown that the value of additional food production less the cost of importing the same amount significantly exceeds the value of the resulting energy losses (**Table 1.3**). It is thus concluded that additional irrigation should not be restricted on grounds of electricity generation as the resulting gain will not compensate for foreign exchange loss of importing food.

1.4.3 Restrictions on smallholder irrigation in the Kafue basin

The general levels of poverty and hunger in the Kafue basin are unacceptably high. There can be no doubt that farmers who can access water for irrigation to feed their own families and others should be encouraged throughout Zambia, including residents of the Kafue basin.

The study has demonstrated that incomes of smallholder farmers can be substantially raised while meeting the food needs of households by adopting the growing of irrigated vegetables as well as using the same facilities for supplementary irrigation on maize. If smallholder farmers were to take up 50% of the additional irrigated land for the production of maize and vegetables, it has been estimated that they will generate between US$ 3.14 and US$ 18.83 million in gross returns, i.e. output value above variable costs. This amount exceeds the US$ 2.65 to US$ 13.12 million total value of loss in energy, which in fact is a gross figure that does not remove operational costs. Restricting smallholder irrigation will thus not only contribute to perpetuating poverty and hunger in the basin, but cannot be justified on economic grounds as well.

It is understood that restrictions on issuing water rights for irrigation were once imposed on farmers in the Lunsemfwa and Mulungushi catchments in order to protect power generation for ZCCM's mining and industrial operations at Kabwe and elsewhere. As the national grid expanded, and other power sources became available, this policy was relaxed. This precedent for a restrictive policy is therefore abandoned. Furthermore, as there is currently a power surplus in Zambia, and Itezhi-tezhi and Kafue Gorge Lower projects are proposed to supply energy primarily for export, it would appear counter to Government policies to prevent farmers in say Kasempa, Namwala or any other district from helping themselves to alleviate hunger if they have the means to develop some irrigation.

1.4.4 Restrictions on commercial irrigation in the Kafue basin

Macro and micro aspects of the Zambian economy are heavily influenced by the line of rail corridor. Its influence on commercial agriculture (communications, infrastructure and urban markets) has been described in this report. Any limitation on irrigation development in the eastern parts of the Kafue basin, which is along the line of rail, would be likely to prevent the goal of reversing the current large cereals deficit being reached. Thus, additional irrigation by commercial farmers should not be restricted.

Nevertheless, for reasons given, any tariffs and other policies which might help to offset the costs of irrigated production and its promotion in other river basins, and which might therefore relieve the Kafue river basin upstream of Kafue Gorge of additional consumptive use abstractions, would be advantageous to the electricity sector.

1.4.5 Restrictions on any type of irrigation in the Kafue basin

All successful irrigation, whether by smallholders or commercial farmers, involves investment and hard work. It brings benefits to owners and employees alike. There are probably no cases where irrigation does not contribute to alleviating poverty and hunger, even when the crops grown are not edible (e.g. flowers for export) or are inessential beverage food crops and non-staple diet (e.g. sugar, coffee). However, in view of the declared national goals of alleviating poverty and hunger, and the nationwide economic benefits arising from potential energy exports, it nevertheless might appear contrary to the national good to issue more water rights for irrigation regardless of the intended crops grown. A recent case example relating to sugar has been described. This is one of several policy issues which OPPPI, Ministries and the Water Development Board will need to consider.

1.4.6 Applications for dams for additional irrigation in the Kafue basin

It follows from the above that new water conservation dams should not be restricted. Normally, under present day trading conditions, the costs of new dams are very rarely justified by the sale of irrigated produce and proposals for dams may consequently be expected to be few. However, in all cases, surveys should include assessments of the needs of adjacent and downstream communities and adequate provisions made for their existing domestic and livestock needs and for their future needs.

Stakeholders in the Monze District Workshop conducted in Phase I expressed great concern about the vicious cycle of poverty in their communities which was claimed to be aggravated by existing upstream dams having reduced and even stopped their water supplies. With modern concepts of planning and social justice, such instances should never occur with any new dams. Indeed, there is a very strong case for farm dams and their impact areas in the Kafue Flats sub-basin to be systematically surveyed and for mitigation measures for those causing hardships to be assessed in consultation with owners and stakeholders.

1.4.7 Contribution of irrigation to alleviation of poverty and hunger in the Kafue basin

It is expected that additional irrigation will undoubtedly contribute to the goals of alleviating poverty and hunger which were identified as major scourges in the State of the Environment Report. The question is “how much?” and answers are variable according to circumstances, particularly those relating to irrigation technology. The contrast may be illustrated by consideration of the irrigation of 1,000 ha using different technologies.

If 1,000 ha is irrigated by furrow irrigation by some 1,000 to 2,000 smallholders, two crops a year (one irrigated, one rainfed with supplementary irrigation) may be expected for the benefit of 1,000 to 2,000 families and related dependents, with sales of surpluses contributing to those families’ livelihoods and contributing to hunger alleviation in surrounding areas.

If 1,000 ha is irrigated with 10 to 14 centre pivots, two crops a year may similarly be expected, with relatively few employees and their families benefiting from the enterprise. In this case, high yields may be expected and the cereals produced would be sold in bulk to millers for onward national distribution through retailers. Such large-scale irrigation mainly benefits urban populations.

Both types of irrigation are very valuable and greatly needed. In order to increase the socio-economic value of both types, field work during this study

has observed that there is potential for some blending of the two where circumstances permit.

There appear to be opportunities at both Chiawa and Mpongwe, for example, where future designs of technologically advanced irrigation systems for commercial farmers could accommodate and provide water supplies for irrigation on surrounding smallholdings, whether as out-growers or not. In these cases, commercial farmers may be expected to benefit from neighbours having a stake, or a greater stake than at present, in the commercial farmer's enterprise and investments. At the same time, smallholders may be expected to grow more food for themselves and/or enjoy the benefits of bulk buying and marketing. Adjacent stakeholders may then provide a buffer around the commercial farm with related advantages to the commercial farm.

Such cooperation would be expected to reduce tensions which are currently experienced continuously or intermittently. These tensions are greatest when droughts occur and subsistence farming produces insufficient produce for families adjacent to highly productive commercial farms. Hunger and poverty then drives non-stakeholders to thefts and other anti-social behaviour in order to survive. The concept is not new and the modalities have to be worked out case by case. It is expected that this model should become more prevalent in future and that oases of highly productive land surrounded by less productive land with high levels of poverty and hunger should dwindle. For this to be achieved, enlightened approaches by all kinds of farmers and financial lending agencies are required.

This report has used irrigation of winter wheat in the dry season and supplementary irrigation of maize in the rainy season as crop examples of additional food production for comparison with losses in energy. This has been somewhat inevitable as there is need to meet the cereals deficit and the values of both crops may be reasonably estimated for import substitution for comparisons with energy losses. However, because of the technologies involved, they may necessarily imply production by and a bias to commercial farmers. It is emphasised here that it is not expected that all additional cropped areas in the irrigation scenarios will or should be double cropping by commercial farmers. Smallholder irrigation of vegetables, root and other crops is required throughout the Kafue basin to provide more food, with good nutrition, and gainful employment locally, and thereby contribute to alleviation of the widespread poverty and hunger. However, although such irrigated crops, especially horticultural crops, frequently have greater values per hectare than wheat and maize, they are not amenable to similar monetary comparisons as wheat and maize with energy losses as current production levels are relatively small. Moreover, many of these crops are perishable, requiring specialised storage and transport systems, and it is not envisaged that many thousands of hectares of vegetables would be irrigated

within the total areas of additional irrigation considered in this report (up to 30,000 ha). Thus, there is a very important role for smallholders' and out-growers' irrigation and their development requires encouragement. Relative to the major cereal crops which respond well to irrigation, the land areas under smallholders' irrigated winter vegetables and irrigated summer maize may be expected to increase, and thereby contribute to improving livelihoods, but remain relatively small.

1.4.8 Preference for abstractions for irrigation from groundwater

The issue of whether groundwater abstractions were preferable to surface water abstractions was raised during stakeholder workshops for the State of the Environment report, and has been addressed in a detailed study at Mpongwe. The principal benefits of using groundwater over surface water, with regard to minimum impacts on flow downstream, relate to two processes. Any surplus irrigation water (through over-application and beyond the plant's needs) returns to the aquifer below for recycling, or to the river. Secondly, lowering of the water table reduces aquifer spillage through springs and dambos, some of which would be evaporated from water surfaces or transpired by dambo vegetation. By lowering the water table, less water is evaporated in such locations and water which would have transpired through stomata of dambo vegetation (and lost to the Kafue) is transpired through stomata of irrigated crops. Potential adverse impacts of this then relate to reductions in riparian spring-fed water supplies, and less productive dambos. Neither of these potentially adverse impacts have been observed and reported at Mpongwe during this study.

The principal high yielding aquifers in the Kafue basin are of karstic limestone. These are characterised by high transmissivity which means that the reaction time between water abstractions from them and response in springs and tributaries which join Kafue river are rapid. This indicates that groundwater abstractions at Mpongwe are almost pseudo-abstractions from surface flows, and therefore reduce flows to Kafue Flats and Kafue Gorge as if they were taken directly from the river. Nevertheless, some benefit has been suggested. Net impacts of groundwater abstractions for a given irrigation area may be effectively 75% of surface abstractions, but there is insufficient available data to support this estimate strongly. It has been therefore concluded that abstractions for irrigation from groundwater are preferable to abstractions from surface water and should be encouraged.

1.4.9 Integration of groundwater into water resources management

Groundwater development is not effectively managed at present. There are currently no provisions for contractors to surrender drill logs, depth to water struck, pumping test results, etc. for national archive purposes of the Geological Survey Department or Department of Water Affairs. Abstractions

from groundwater are not covered by water rights procedures. Thus the hydro-geological and groundwater abstraction database in the Kafue basin (and nationally) is weaker than it could otherwise be. These and other deficiencies are recognised in the National Water Resources Master Plan (1995) and are reviewed in the State of Environment report.

Investigations of groundwater at Mpongwe have further confirmed the importance of an integrated water resources management policy given the close relationship between what is deemed as groundwater and surface water. Suggestions being considered under the Water Resources Action Programme that groundwater exploration be subject to the issuance of water rights and strict monitoring are consistent with findings in this report.

1.4.10 Irrigation developments and conflicts with Game Management Areas

There is no known schedule or map indicating where farmers may develop irrigation in the Kafue river basin in future. Thus there is no way that potentially irrigated areas may be compared with maps showing the distribution of Game Management Areas (GMAs). Nevertheless, a few irrigation expansion concepts plans are known.

On the basis that commercial farmers will seek to expand irrigation in areas along and adjacent to the line of rail, there are no GMA areas in Copperbelt Province which would be affected by large-scale irrigation developments. In Central and Southern Provinces, there is the possibility that Kafue Flats GMA might be affected, but no detailed plans for large-scale irrigation are currently known to be prepared in this area.

The only known potential conflict area is along the north side of Kafue river in Kafue District where Chiawa Estates are considering further development within the Chiawa GMA. However, ZAWA's zoning of management areas indicate that the proposed irrigation expansion areas are within a "settlement and cultivation" zone and not a "conservation" area.

This is very significant because the Lower Kafue area, including some land in Siavonga District on the south side of the river, is the only area in the Kafue river basin where large water abstractions for irrigation may take place with no conflicts with power generation at Itezhi-tezhi, wetland conservation in Kafue Flats or power generation in Kafue Gorge. The point is made that if suitable soils and topography here were within ZAWA's "conservation" zone of Chiawa GMA (or if, for example, the area had been designated as part of Lower Zambezi National Park), strong opposition might have been expected.

Even without these designations, some opposition from those with ecotourism commercial interests may be expected. Given the reported

unviable wildlife populations based on recent ZAWA surveys, and the overwhelming need to use Kafue water to produce more food in areas without wetlands and power conflicts, this area is seen as the foremost area for large-scale irrigation development in the Kafue basin and its development should be promoted.

1.5 FINDINGS OF DEVELOPMENT SCENARIOS - WETLAND CONSERVATION

The State of Environment report reviewed documentation on Kafue Flats and confirmed that the wetland resources are locally, nationally and internationally important. Indeed the importance of the Flats to people's livelihoods and wildlife and the impact of changes in the river flow and water quality have been well recognized. On-going studies by WWF, in partnership with the Ministry of Energy and Water Development and ZESCO, bear witness to the importance attached to Kafue Flats by Government and NGOs. An examination of the Maximum Wetlands Conservation development scenario therefore has a number of serious implications.

Principal questions raised by interpretations of the model results and other areas of study are:

- Are Kafue Flats wetland resources reduced in value?
- Can Kafue Flats wetland resources and functions be improved?
- Should Kafue Flats wetland resources and functions be improved?

Answers to these questions are given below.

1.5.1 Reduction in value of Kafue Flats wetland resources

Socio-economic surveys have sought views of local stakeholders and confirmed that wetland functions continue to be considered valuable but some are reduced compared to former times. These reductions are perceived by stakeholders, including professional staff of ZAWA, Fisheries Department, WWF and other agencies, to be largely associated with hydrological impacts of ZESCO constructing and operating Itezhi-tezhi and Kafue Gorge Upper dams and reservoirs. Many of these adverse impacts were predicted in the Kafue Basin Research Project's research papers and seminars during the 1970s and early 1980s. Simulations of inundated areas in this study have demonstrated changes in inundation patterns and generally support these perceptions, there being less occasions when large areas are inundated (**Tables 1.5** and **1.6**) and less occasions when the Flats are drained and available for grazing (**Table 1.7**) since the dams became operational.

Table 1.5: Frequency of Kafue Flats flooding exceeding 4,000 km^2

Case	Months No.					Months No. (in 95 years) Inundation greater than 4,000 km^2	
	Jan	Feb	Mar	Apr	May	Total[1]	% of ND
ND	1	4	19	12	2	38	100
P-1	0	2	7	6	1	16	42
C-1	0	2	7	6	1	16	42
C-2	0	2	9	6	2	19	50
C-3	0	2	10	7	2	21	55

Note: [1]Total refers to these five months.

Table 1.6: Frequency of Kafue Flats flooding exceeding 3,000 km^2

Case	Months No.					Months No. (in 95 years) Inundation greater than 3,000 km^2	
	Jan	Feb	Mar	Apr	May	Total[1]	% of ND
ND	6	47	75	78	50	256	100
P-1	5	26	38	35	21	125	49
C-1	5	26	38	36	19	124	48
C-2	5	27	50	55	32	169	66
C-3	5	27	62	72	31	197	77

Note: [1]Total refers to these five months.

Table 1.7: Frequency of Kafue Flats flooding being less than 1,000 km^2

Inundation < 1,000 km^2 Months No. (in 95 years)														
Case	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	% of ND
ND	80	87	68	7	0	0	0	0	7	20	54	74	397	100
P-1	7	7	7	1	0	0	0	0	0	0	2	5	29	7
C-1	7	7	8	1	0	0	0	0	0	1	3	6	33	8
C-2	45	34	6	2	0	0	0	0	0	3	34	46	170	43
C-3	47	42	24	8	0	0	0	0	3	30	46	51	251	63

However, the dams are not the only causes of problems perceived by stakeholders. There are many other factors involved. Among these are increasing population pressures over the past 30 years and severe and prolonged drought conditions in the 1990s (with a frequency of occurrence in the order of once in 50 years, and not experienced before by any resident) which have contributed to the competition for resources and the maintenance of the vicious cycle of poverty and hunger.

Thus, the Flats' wetland resources and functions can be said to be reduced by both ZESCO's operations and other related and unrelated factors. In local people's perceptions, these are estimated to heavily outweigh some benefits which have accrued locally and nationally from ZESCO's projects which influence the wetlands.

1.5.2 Improvement of Kafue Flats wetland resources and functions

Simulations of inundated areas have demonstrated the large contrast in flooding patterns which the Maximum Power development scenario produces compared with the natural "No Dams" case (**Figure 1.1**).

By changing Itezhi-tezhi releases from the existing regulation pattern which supports power generation at Kafue Gorge to one which favours wetlands, and more closely resembles natural conditions (C-2 and C-3), conservation benefits are believed to accrue to fisheries, wildlife habitat and wildlife and grazing which would also improve local livelihoods. Although these benefits are difficult to estimate in monetary terms and estimates have not been made, there is no doubt that wetland resources and functions can be improved by changes in release patterns at Itezhi-tezhi. They may be improved further by adjustments in operating levels at Kafue Gorge Upper where the level/inundation area relationship is demonstrated to be extremely sensitive.

1.5.3 Need to improve Kafue Flats wetland resources and functions

It has been noted that releases for wetland conservation have adverse consequences on the Maximum Power scenario. They reduce firm energy generation and potential energy sales and revenue. However, there are other energy matters and environmental and social aspects to consider.

Currently, without new power developments at Itezhi-tezhi and Kafue Gorge Lower (which are primarily intended for energy exports), Zambia's energy surplus is expected to continue for some years. Thus, an opportunity appears to exist to introduce a release pattern similar to scenarios C-2 or C-3 with no disruption to energy supplies in Zambia and without loss of revenue to ZESCO from domestic supplies and sales, though some loss of export revenues would result. This would require careful consideration and planning on ZESCO's part and consultations with stakeholders. It may be noted that consultations with stakeholders might reveal that a change in release pattern would be welcomed but that it could also be opposed on the grounds that the change may not be permanent and would be subject to reversion after some years.

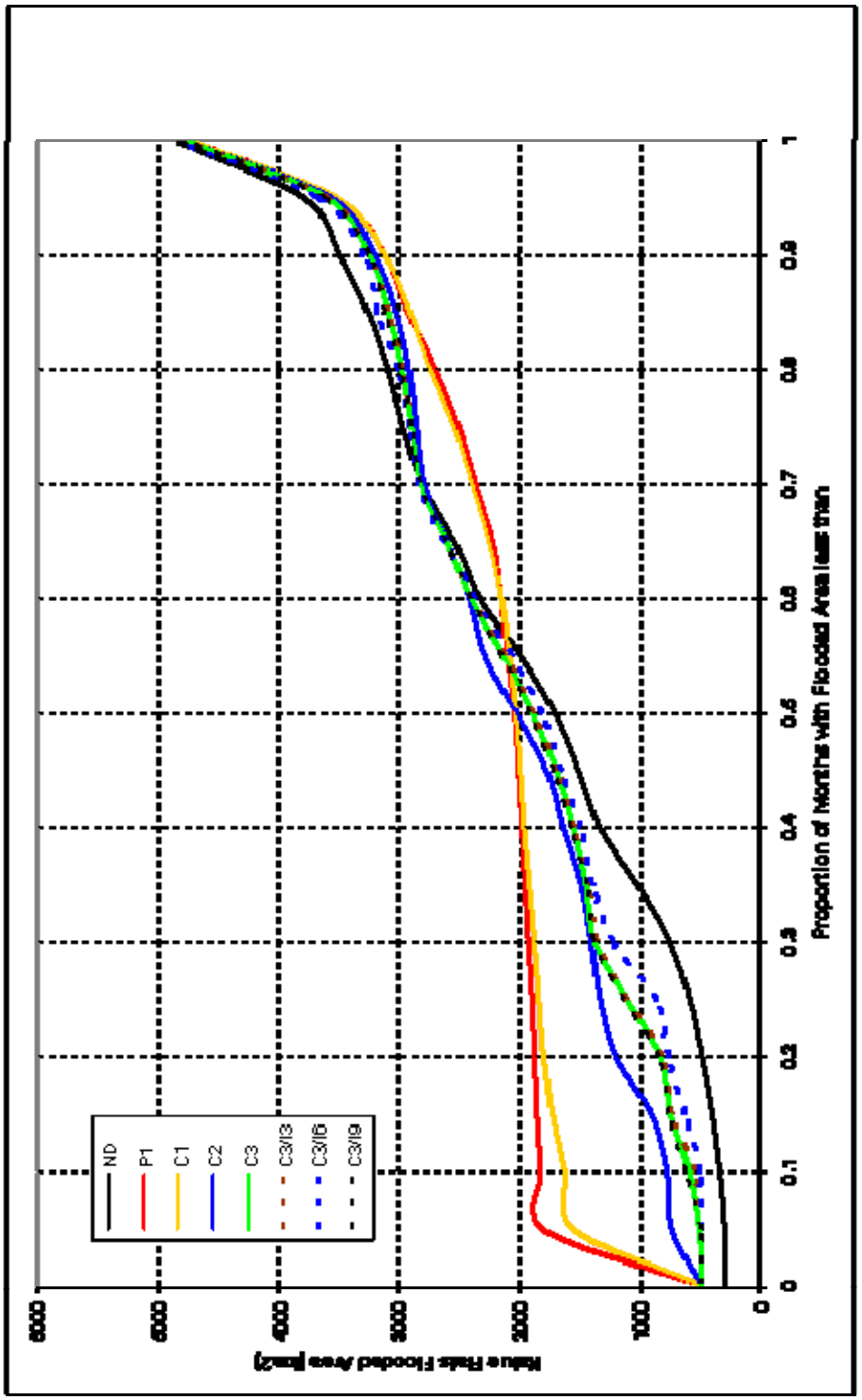

Figure 1.1: Frequency of Monthly Flooded Areas on the Kafue Flats

If a release pattern similar to scenarios C-2 or C-3 were to be implemented, and a severe prolonged sequence of droughts occurred as in the 1920s and 1990s, forward planning should allow for suspension of freshet releases and avoidance or minimising of load shedding. This is because it is already expected that 5% of months in the historical flow record will cause shortfalls, and some of these may occur within the period of trial releases. Indeed, the scenarios reported can be modified to suspend them in very dry years when widespread natural flooding would not have occurred naturally.

1.6 RESEARCH AND MONITORING NEEDS

1.6.1 Monitoring and Valuation of Wetland Functions

This study has not placed values on the wetland resources and functions on Kafue Flats. The benefits of wetland conservation release patterns over the release pattern of the Maximum Power scenario have not been described in monetary terms. The fact that the former benefits are unquantified here does not mean that they are zero. On the contrary, if and when they are estimated, the balances between loss of firm energy, which has been determined, and the benefits of these release patterns would be expected to reduce markedly.

Since the 1970s, there has been no research on Kafue Flats fisheries relevant to quantifying ichthyomass, stock abundance and catches which would assist quantification of impacts of flooding regimes in the development scenarios considered in this report. There have been no surveys or research on Kafue Flats' grasses biomass and productivity, and livestock grazing, since the major Kafue Basin Survey by Government, supported by FAO, in the 1960s. Research on control methods and implementation of these for arresting bush encroachment has not begun, although recognised and being promoted by ZAWA. With regard to creating conditions to improve lechwe and other wildlife populations, which might foster eco-tourism and licensed hunting, there are no known research studies which would assist quantification of benefits. Indeed, improvement of wetland habitat for wildlife would not necessarily increase revenues for local communities and ZAWA owing to the poor state of road and other infrastructure leading to and within the two National Parks at Lochinvar and Blue Lagoon.

There is therefore need for research and monitoring to be carried out and supported in these areas. This does not require a costly and very extensive research effort as carried out in the 1960s with UNDP/FAO support. But it does require sustained and focused work over a long period in water resources, fisheries, wildlife habitat and wildlife, bush encroachment control, animal health and related socio-economic areas, as revealed by the State of the Environment and this report. These should be routine duties of existing

institutions but with effective coordination which, *inter alia*, insists on regular documentation, peer review and at least annual reporting.

If trial releases are to be carried out for some years, the opportunity will present itself for this monitoring and research under the auspices of the lead agency. The results would not only assist integrated management of Kafue Flats wetlands but should provide the information for evaluating the benefits of the trial releases. Thus, Government would then be better equipped to decide on terminating the trial wetland conservation scenario or adopting it, or a variant of it, in perpetuity.

1.6.2 Additional Wetland Area Data from NOAA Satellite Imagery

The application of simulation models to describe areas of inundation has been done before this study but not for such a long time period and not in a way to reveal the implications of development scenarios within the whole Kafue river basin. The models used, like all models, have sought to create "an idealized representation of reality in order to demonstrate certain of its properties". It has been demonstrated that the hydrodynamic model's output, compared with observed data, was variably good and poor. One of the problems experienced related to insufficient credible data on Kafue Flats inundation areas. Explanations were given for some of the apparently poor agreements. However, because the model has been applied uniformly to all development scenarios, it is expected that it has produced results of sufficient reliability for comparisons between scenarios, and for strategic impact assessments. Future calibration and planning by simulation models, and indeed fisheries management, will benefit from acquisition of much more data on Kafue Flats inundation areas produced from NOAA satellite imagery in dry seasons, beginning in April when possible. The 14 values available in 1992, 1993 and 1994, used in this study, are the only ones readily available. Data is available, but not analysed, for all subsequent years. It is believed these would assist water resources planning and fisheries management in Kafue Flats and that arrangements should be put in hand for analysis of past and future images.

1.6.3 Optimising Conservation Releases and Flow Forecasting

Zambia has a high standard for providing electricity to consumers with planning arranged to provide firm energy, without shortfalls, in 95% of all months of the long historical record. It has been seen that most severe shortfalls would have occurred in a few years within two decades. For most of the time, for almost eight decades in 95 years, there was sufficient water in the Kafue for firm energy generation, additional food production by irrigation and to execute an improved release pattern for the Kafue Flats wetlands. It has been shown that it is the latter which severely penalises firm energy generation, notwithstanding the fact that wetland benefits have not

been quantified in this study which, if available, would reduce the magnitude of the apparent financial penalties.

It is believed that some of the apparent disbenefits to firm energy supplies caused by the Maximum Conservation scenarios may be recovered. One method has been described and involves apportioning more of the energy generation during wetland conservation releases to firm energy because the enhanced generation in these months, every year, is 95% reliable. Also, some benefits in firm energy obtained by operating Kafue power stations in conjunctive use mode with Kariba North might be considered to offset some of the firm energy losses attributable to wetland conservation releases. Another method has been suggested that involves curtailing releases when the severe droughts occur – as the Flats would not have been naturally flooded by Kafue flows in any case. It is this which requires more investigation. It requires a thorough examination of records of flows at ZESCO's telemetry stations upstream of Itezhi-tezhi and determining reliable criteria for flow forecasting as the wet season progresses. This would be required to enable amendment of the freshet release pattern in such drought years as occurred in the 1920s and 1990s. When this is done, firm energy would be much less severely penalised.

1.7 CONCLUSIONS AND RECOMMENDATIONS

1.7.1 Power Generation

This report has examined thematic areas of the national electricity and agricultural sectors and wetland conservation in Kafue Flats. These sectors compete for Kafue river's water resources. They have been considered in the context of national objectives of economic growth, poverty alleviation and food security.

It has been demonstrated that currently there is surplus of firm energy in Zambia but that a large market exists for exports from proposed new power stations at Itezhi-tezhi and Kafue Gorge Lower. Revenue from energy exports will contribute to the national objective of promoting economic growth. This revenue from energy sales in turn will contribute to poverty alleviation.

It is concluded that the additional generation of power at Itezhi-tezhi and at Kafue Gorge Lower will contribute strongly to economic growth and alleviation of poverty and it is recommended that pursuit of investors for implementation of these valuable and attractive projects continues.

Attention has been drawn to some potentially adverse water quality issues of Itezhi-tezhi releases. Monitoring recommendations have been made; these may obviate the need for mitigation measures.

Attention has been drawn to the need to protect live storages at Itezhi-tezhi and Kafue Gorge Upper reservoirs, and limited catchment areas for monitoring have been noted. For Kafue Gorge Lower, it is recommended that a comprehensive management plan be prepared for the local incremental catchment area.

1.7.2 Food Security

It has been demonstrated that there is currently a large cereals deficit in Zambia. This may be met by additional irrigation development in the order of 60,000 ha. Each of the major river basins in Zambia appears to have vast potential for irrigation and to be capable of meeting this requirement jointly and some separately if needed. However, strong economic factors associated with the line of rail and proximity to markets cause eastern parts of the Kafue river basin (and Kabwe and Mkushi areas) to be most attractive for investment in irrigation by commercial farmers, and other areas, distant from the line of rail, to be less or unattractive.

Water resources of the Kafue river basin, without additional storage, are estimated to be capable of supplying an additional 30,000 – 40,000 ha of irrigation in the Upper, Middle and Kafue Flats sub-basins, all of which would conflict with firm energy generation and some 10,000 to 15,000 ha in the Lower Kafue sub-basin which would not conflict with Kafue's power generation. A double cropping pattern of irrigated winter wheat with supplementary irrigation on summer maize in the Upper, Middle and Kafue Flats sub-basins for large commercial agricultural production has been adopted for demonstration purposes. Illustration has also been made of the income that could be generated if 50% of the additional irrigated land is taken up by smallholder farmers instead for double cropping of vegetables and maize. The value in cereal and vegetable production has been shown to exceed the value in loss of energy which the irrigation abstractions would cause. Particularly in the smallholder farmers' case, irrigation is seen to have very significant positive implications on both poverty and hunger.

It has been emphasised that it is not expected that all additional cropped areas in the irrigation scenarios will or should be double cropping of winter wheat and maize by commercial farmers. Smallholder irrigation of vegetables, root and other crops is required throughout the Kafue basin to provide more food, with good nutrition, and gainful employment locally, and thereby contribute to alleviation of the widespread poverty and hunger. Thus, there is a very important role for smallholders' and out-growers' irrigation and their development requires encouragement.

It is therefore concluded that it is in the national interest to grow more food by irrigation in the Kafue basin and it is recommended that water rights are issued for irrigation accordingly.

It has been noted that abstractions from groundwater for irrigation at Mpongwe have some advantage over abstractions from surface water with regard to reducing flows available for Kafue Flats and power generation. It is recommended that groundwater resources in the Kafue basin be developed for irrigation in preference to surface water wherever feasible.

Owing to irrigation development in the Lower Kafue having no opportunity cost on hydropower generation in Zambia, and there being large regulated flows available, it is recommended that irrigation of winter maize be expanded in Chiawa and Siavonga areas to maximum extent.

In all cases of large-scale irrigation developments, it is recommended that opportunities are taken in the design of schemes, where possible, to make provision for water supplies and other services to neighbouring communities. Examples of existing benefits and the reasons for such cooperation in future have been cited in the report.

1.7.3 Wetland Conservation – Kafue Flats

Construction and operation of Itezhi-tezhi and Kafue Gorge Upper dams have delivered many and large benefits to the national economy, and some to the local economy, over the last 25 years or so. But it has been demonstrated that these projects have also radically altered the natural flooding patterns of Kafue Flats and, along with other causes including the prolonged drought of the 1990s, have reduced wetland resources and functions, particularly with regard to fisheries, wildlife habitat and wildlife, and domestic cattle grazing. Livelihoods of communities dependent on these resources have been shown generally to be poor or very poor. Also, it has been concluded that bush encroachment of pernicious species has been encouraged by the lack of regular and extensive flooding with the consequences of reduced grazing for domestic stock and wildlife, and provision of more cover for poachers.

Investigations have demonstrated freshet release patterns at Itezhi-tezhi which would go a long way to restoring diminished wetland resources and improving livelihoods. These have been shown to have a high opportunity cost for firm energy – much greater than impacts of irrigation. The biological and socio-economic benefits of freshet releases have not been evaluated in monetary terms, and cannot be evaluated owing to an inadequate data base. Currently, an assessment cannot be made of benefits to compare with energy losses.

Owing to Zambia currently having a surplus of energy, it is concluded that the opportunity exists to implement a freshet release pattern in Kafue Flats for some years on a trial basis. It is recommended that if this opportunity is taken, a programme is prepared in consultation with stakeholders, and that

the release pattern is optimised and then adjusted with experience during the trial period.

Towards the end of the trial period, a decision will be required to continue with the wetland conservation programme in perpetuity (or some modification of it) or to revert to conditions of the Maximum Power scenario. This decision requires to be based on much more information than is currently available and likely to be produced by government departments and NGOs under current circumstances of funding.

It is therefore recommended that a project is conceived which will ensure effective monitoring and investigations of fisheries, wildlife habitat and wildlife, grazing, animal health, bush encroachment, and related public health and livelihoods of communities and the Flats socio-economy. It is expected that the project would end if the development decision is made to suspend wetland conservation releases in favour of maximising power generation; in which case, essential monitoring would revert to line departments.

1.7.4 The Overall Strategy

During preparation of this report, conscious note has been taken on the one hand of the superb natural resources of the Kafue river basin, including copper and other mineral resources, surface and ground water resources, potential for rainfed and irrigated food production, three National Parks, Kafue Flats wetlands and Kafue Gorge hydropower resources. These are assets of great local and national value; and indeed some are of international value. On the other hand, shocking poverty characterises the condition of most people in the river basin.

It is concluded that these natural resources need developing urgently for the benefit of local people and the nation. This report concludes that a “win–win” situation may be expected to be achieved for the three development scenarios. However, more time is required to test, monitor, investigate and evaluate the benefits of the wetland conservation scenario for a decision to be taken on maintaining its operation indefinitely, or suspending it in favour of a combined power and irrigation scenario.

Thus the recommended overall strategy is for maximum food production and to accept slightly lower power generation than the maximum potential; and to test the wetland conservation scenario for some years while the opportunity resulting from the energy surplus is present. Such a strategy is expected to lead to there being fully integrated water resources management of the Kafue river basin and improvement of livelihoods of its people. Stakeholder consultations have been a hallmark of this study and it

is recommended that they should be continued in working out the tactics within this overall strategy.

1.7.5 The Way Forward

In order to make progress with development and policy issues raised by this study, various actions are required by OPPPI, ZESCO and other stakeholders. These are outlined in an action programme in **Table 1.8**. In the event of trial releases being made over a number of years, it is recommended that the environmental and socio-economic research and monitoring is organised and implemented under a special task force project which might be known as the "Kafue Flats Research and Monitoring Project".

Table 1.8: Way forward – Action Programme (page 1 of 2)

Actions	Duration	Suggested Agency for Action	Suggested Funding Agency
Kafue Gorge Lower reservoir – Catchment Management Plan, local catchment area between upper and lower schemes	Rainy season 2004/05	OPPPI/ZESCO	OPPPI/ZESCO
Kafue Gorge Upper reservoir – Catchment Management Plan, eastern Kafue Flats	Rainy season 2004/05	OPPPI/ZESCO	OPPPI/ZESCO
Tailings Dams in Copperbelt – minimising sedimentation of Itezhi-tezhi reservoir	Continuous watching brief	ZESCO; ZCCM-IH and New Investors	ZESCO; ZCCM-IH and New Investors
Kansanshi Mine	Continuous watching brief	ECZ and Kansanshi developer	Kansanshi developer
Itezhi-tezhi Low Level Outlet Water Quality. Monitoring release quantity, release water quality, crocodile & hippo evacuation, fisheries and livelihoods	1 – 5 years, intermittent	ZESCO; ZAWA; Dept of Fisheries; UNZA	ZESCO
Policy on water rights for irrigation of non-food crops in Kafue basin upstream of Kafue Gorge	On agenda of a special meeting of members	Water Development Board	None
Survey of Farm Dams in Kafue Flats sub-basin	2 years intermittent	Water Development Board	To be determined
Irrigation. Design of schemes providing water and services for stakeholders on adjacent land, where feasible	Continuous watching brief	Water Development Board; ZNFU; ECZ	Irrigation Development Lending Banks
Groundwater. Surveys and drilling for assessment and further development of aquifer yield at Mpongwe	1 year	Mpongwe Development Company in partnership with Ministry of Energy and Water Development	To be determined

Table 1.8: Way forward – Action Programme (page 2 of 2)

Actions	Duration	Suggested Agency for Action	Suggested Funding Agency
Itezhi-tezhi Trial Releases Stakeholder consultations; Optimise release patterns; flow forecasting; implementation	Say 5 years, intermittent	ZESCO	ZESCO
Itezhi-tezhi Trial Releases. Monitoring and research – habitat, wildlife, bush encroachment – fish biomass, catches – grazing, grasses biomass, animal health (tick ecology) – NOAA satellite image analyses – surveys of inundation areas, levelling, mapping – socio-economic assessment of livelihoods – coordination of monitoring and research, annual writing up of "Kafue Flats Research and Monitoring Project"	Say 5 years, intermittent	 ZAWA/UNZA Dept of Fisheries/UNZA MACO/UNZA FAO/Met Dept/UNZA Survey Department ZESCO or independent agency OPPPI/ZESCO/UNZA	Development Bank under a "Kafue Flats Research and Monitoring Project"
Hydrological and Water Quality Data; Water Rights Inventory	Without limit	ZESCO; WRAP; Water Development Board	To be determined