参考資料５．クドゥダム計画の環境影響評価報告書

クドウダムプロジェクト環境影響評価報告書の要点

KUDU DAMU PROJECT:
Environmental Impact Assessment
Report

1992年 10月

ARA-TECHTOP, HARARE

このメモは、１９９２年１０月にＡＲＡ－ＴＥＣＨＴＯＰにより出された" ＫＵＤＵ　ＤＡＭＵ　ＰＲＯＪＥＣＴ：Ｅｎｖｉｒｏｎｍｅｎｔａｌ　Ｉｍｐａｃｔ　Ａｓｓｅｓｓｍｅｎｔ　Ｒｅｐｏｒｔ" の要点をまとめたものである。　以下" ＥＩＰ報告書" と呼ぶ。

まずＥＩＰ報告書の目次を示す。

目次

（1。0）はじめに

－水没地はダムサイトから上流にむけ２０ｋｍも伸び、水没地の面積派は、７，７００ｈａに及ぶ。
－ダム建設の目的は、綿花の収量の増加を図ること、干ばつによる綿花の不作への予防対策をとることフ－ドクロップや綿以外の現金作物の生産を可能にすること。
－クドウダムに貯められた水により２５，０００ｈａの土地を灌漑できると推計されている。

（3。0）方法論

－現地踏査は２回にわたって行なわれた。初回は、８月２２日、２３日の２日間に遺伝子資源担当専門家と野性生物・植生の専門家によって行なわれた。２回目は、８月２８日から３０日の３日間にさらに農業地理と水文学の専門家を加えた４名で行なわれた。

（4。0）エリアの地形

－ダム建設による水没地の範囲（付図参照）
－水没する農業的に価値ある土地は、主にＫａｒｏｎｉｋａ川とＭａｎｇｗａｒａｎｇｗａｒａ川沿いの現在人々が定着しているエリアである。
－ダムの上流部の環境保全のためにムニャティ川とＭａｚｏｗｅ川との合流点より上流の右岸全部と左岸の上流部をａｔｉｏｎａｌ　Ｐａｒｋ　Ｌａｎｄとすることを強く推薦する。

（5。0）居住パターンと人間活動

－この節では、Ｚｈｏｍｂｅ　Ｃｏｍｍｕｎａｌ　Ｌａｎｄについてのみ記述されている。前節によると、Ｍｕｚｖｅｚｖｅ川とムニャティ川の合流点より下流にあるムニャティ川の右岸（Ｚｈｏｍｂｅ　Ｃｏｍｍｕｎａｌ　Ｌａｎｄの外である）は、以前国有農場か大規模商業農場であったところである。
－Ｚｈｏｍｂｅ　Ｃｏｍｍｕｎａｌ　Ｌａｎｄには、水没する居住地がある。ここには、１９６０年代初めより入植者を受け入れてきた。実際その人口増加率は、１９６９－１９８２で年率５．５％であった。人口密度は、１９８２年の人口センサスによると３５人／ｋｍ２であった。
－Ｋａｒｏｎｉｋａ川とＭａｎｇｗａｒａｎｇｗａｒａ川沿いに住む人々は、ダム建設による水没のため移転されなければならない。地元のリーダーによると2，５００－３，０００人（４００－５００世帯）が、水没の影響をうける所に住んでいる。
－水没地には、ローカルサービスセンターであるＳａｍａｍｂｗａセンターも含まれ、２－３の店、クリニック、小学校、中学校がある。
－ムニャティ川の右岸（Ｍｕｚｖｅｚｖｅ川の左岸）には、Ｍｕｚｖｅｚｖｅ　Ｒｅｓｅｔｔｌｅｍｅｎｔ　Ｓｃｈｅｍｅが数キロ東に伸びているが、水没予定地には居住者がいない。しかし水没地は、移住民によって放牧に使われている。
－移転しなければならない住民の移転先は、できるだけダムに近くにその土地を見つけるのがよいとEIP調査チームは考えている。そうすることによりダム建設から直接便益（ダム建設や観光分野で増加する就業機会等）を受けることができる。
－５００世帯をResettlement Model Aで移転させたときの世帯あたりにかかる費用はZ$20,000で、住民移転の総費用は、Z$10millionとなる。

－ダムの上流部の環境管理や土壌流出の軽減を図るために、もし左岸の一部もしくは全部を国立公園に転換するならもっと多くの人と世帯を移転する必要がある。そうすると住居の移転や農地の喪失によって直接の影響を受ける世帯以外にも、Muzvezve Resettlement AreaとZhombe Communal Landの両方の村民たちがそれまで使っていた放牧地が水没で失われることになる。
－ダム建設後も、家畜のために水へのアクセスをある程度可能にする必要がある。しかし、水へアクセスを許された家畜がダム貯水池の岸の環境を破壊しないような手立てが取られる必要がある。
－このエリアの川では堆積している土砂から金採取を行っている者がいる。チームが現場視察したときに一地点で６０－７０人が金採取作業をしていたのを発見した。このような金採取は違法であるが、ダム建設により貯水池が出現するとこれまでの採取場所が水没し、地元民にとって重要な収入源の一つが失われる。

（５．１）建設時の社会経済インパクト

（正のインパクト）
１．短期的な就業機会の増加
２．地元ビジネス機会の増加
３．農産物の地元販売量の増加
４．地元交通条件の改善
５．保健サービスの提供

（負のインパクトと対策）
１．健康の問題：建設工事にともない売春が増加＜＝対策：教育プログラム
２．大型トラックの交通量の増加＜＝対策：ダムサイトへの工事用アクセスは右岸（北側）のカドマ＝サニャティ道路を使うこと
３．住民の立ち退き＜＝対策：出きるだけ近くに移転先を見つけること。またコミュニテフィーごとまとめて移転すること。
４．工事キャンプの存在による汚染＜＝対策：工事キャンプをダムサイトの下流部に設ける。

（５．２）運営時の社会経済インパクト

（正のインパクト）
１．Smallholderへの灌漑施設整備による生活水準をあげることができる。
２．農業及び観光分野での賃労働機会が増す。
３．ダムによって地元での家庭用水、家畜の飲み水の状況が改善される。
４．ダム貯水池での商業的漁業の可能性により、雇用機会と収入機会が提供される。
５．ダムや観光のための道路や通信インフラの改善により地元住民も道路や通信サービスが受けやすくなる。

（負のインパクトと対策）
１．水に関連した病気の発生の増加（マラリア、住血吸虫病）＜＝対策：病原菌動物の駆除のための保健衛生プログラム
２．エリアに外部からの流入者がおおくなり、地元民に疎外感や搾取されている感じがますと、観光客に向けた犯罪が増える可能せいがある。＜＝対策：配備する警察官の数を増やす。
３．ムニャティ川の水への直接の無制限のアクセスが失われてしまう。＜＝対策：ある程度ダムの貯水へ

のアクセスを確保するひつようがある。（コメント；ダムの下流でのこの問題はどうなのか？）

4。訪問客や観光客の増加にともない地表や水の環境に与える悪影響。＜＝対策：国立公園の設立し、低インパクトのレクリエーション施設を作る。

5。ダム建設による地域経済の拡大が外部の労働者を引きつけ、その結果、地元の農村社会構造を乱してしまう。さらに、地元の社会サービスやインフラへの負荷をます。＜＝対策：人口増をモニターし、人口増に合わせて社会サービス、インフラを拡充する。

（6。0）河川システム

（6。1）既存の河川システム

－クドダムサイトの上流に水資源プロジェクトがある。

Cactus Poort Dam (the Kwekwe River)

Zivagwe and Lower Zivagwe Dams (the Sebakwe River)

Mamina Dam (the Ngezi River)

－クドダムサイトの下流に流れ込むNgondoma DamにはNgondoma Damがあり、もともとEmpress Mine（現在は閉山）に水を供給していたが、今は小規模かんがいへ水が使われている。

－上流部：岩でできた河床をもち、安定した堤をもっている。雨期にのみ流水がある。ジンバブエの他の河川と違って、ムニャティ川のダムに対する土砂堆積負荷は低い。またクドダムの上流のムニャティ川の集水域は良く管理された商業農場からなる。

－下流部：ダムの建設予定池の下流部で河岸が、岩石から粘土へ変わる。Ngondoma Riverにはかなりの土砂がたまっているところがある。おもにZhombe Communal Landからでてきたものであろう。

（6。2）クドダムの河川システムへ与える影響

－上流部：貯水池の出現による土砂の堆積が川にそって上流部に伸びるだろう。渇水時期には、貯水池の干上がった部分に堆積した土砂は、水を飲みにくる家畜の妨げとなるだろう。

－貯水池：貯水池の水深が６０メートルに及ぶので、水温度の階層化起きて、富栄養化を助長することが考えられる。

－下流部：ダムの建設とオペレーションにより一年を通じての河川の水流のパターンが大きく変わる。ピーク時の流量が減少する。それにより、それまで河岸へ供給されていた湿気とシルトがなくなる。これによりそれまで土壌の流出を防いでいた河岸の植生が衰えてしまうだろう。

（6。3）対策

－ダムによる土砂の堆積の問題については、ムニャティ川上流のダムの集水域で行われている農業の、主にcommunal areasでの技術を改善する必要がある。家畜の土地あたりの数を調べて土地の許容量以上になっていないかたしかめる必要がある。もし、許容量以上の家畜がいるようならば、牧草地の改良などのスキームを実施する必要がある。

－下流部では、土壌流出の抑止が、主目的となる。ダムのスピルウエイからの水のエネルギーを弱めるためにStiling Basinを作る必要がある。

（7．0）植生と野生動物

－河川と河岸生息地：水没地とアップランドには地表植物がかたよりなく分布しているので、クドダム建設は重要な樹種の喪失を引き起こさない。

（8．0）種多様性と遺伝子資源

－水没する生物コミュニテフィーと水没しないものは、根本的に異ならない。したがって水没により失われてしまう希少植物種や遺伝子資源はない。これは植物にも動物にも言える。
－水生生物については、地元にもともといない種が持ち込まれる可能性がある。そうなれば既存の種の固体数等が影響を受ける。
－魚類は、現在の河川システムでは、乾季に渇水の影響を受けていたが、ダム建設後は乾季にも制御された放水をするので、渇水の影響を強くは受けなくなる。その結果魚類の他の水生生物の数が増えるだろう。
－貯水池の出現で、そのエリアにbilharzia snailsが増え、schistosomaiasisにかかる住民が増えるであろう。また蚊の数も増えマラリアの感染者も増えるだろう。他の水を媒介とする病気（salmonellosis やenteric fevers）が、特に貯水池の近くに住み、その水を家庭用に利用している人々の間に増えるだろう。またダムの水を灌漑に利用することで、上記の病気が増えるだろう。
－貯水池ができることで鳥の餌となるものが増え、その結果鳥類の数も増えるだろう。

（8．7）建設時の植物と動物に与えるインパクト

（正のインパクト）
建設時には植物と動物に与える正のインパクトはない。

（負のインパクト）
1．植生の破壊：アクセス道路の建設と貯水池になるエリアの水没でおこる。＜＝対策：できるだけ既存の道路を建設のために使うこと。
2．汚染：建設用の重車両を使うことで大気汚染、騒音、廃油による汚染が起こる。＜＝対策：大気汚染、騒音については銅にもできないが、廃油はダム壁からできるだけ離れた下流部に特別に廃油ピットに埋めること。
3．まきの需要の増加：建設工事の労働者が料理等のためにまきを使う。＜＝対策：水没予定地内の森林からまきを収るようにすること。
4．野生動物の捕獲：建設工事労働者によるものが増えると予想される。＜＝対策：建設会社がそのようなことは違法行為であることを労働者に周知させること。。国立公園省が定期的パトロールを行うこと。

（8．8）運営時の植物、動物に対するインパクト

（正のインパクト）
1．水生動物、地表動物の増加：貯水池の建設で水生動物（魚類、両生類、爬虫類）が増える。クドダムのエリアは野生生物の数は多くない。左岸には家畜が主、右岸には数種の野生生物がいる。これらは移転するか、国立公園に指定して密漁から守る必要がある。
2．鳥類の個体数の増加：餌となる動物の生息地が増える結果である。

（負のインパクト）

1。地表生息地の喪失：水没により地表生息地が失われる。＜＝対策：計画されているダムの回りに国立公園の設立すること。

2。貯水池の富栄養化と藻の繁殖：水没した植物の腐敗により水質が劣化する。そして水の富栄養化につながる。これらの藻はダムのスピルウエイや灌漑路を詰まらせる。また貯水池内の航行を妨げ、水分の発散により貯水池の水も失われる。＜＝対策：水没地の木々を取り除くこと。

3。酸素の消耗による水生生物への影響：もし水没地の木々を取り除かないとそれらの腐敗により酸素が消耗され水中の酸素量が下がる。それにより、水生生物に有害物質が発生する。またこの酸素欠如の腐敗によりグリーンハウス効果を持つメタンガスや二酸化炭素が発生する。＜＝対策：ダムによる水没地の木々を取り除く必要がある。

4。川の魚類の減少：これはダムの建設による川の流れの変化、水質の劣化、水温の変化、魚の産卵場所の喪失、魚の移動の障害物のためである。＜＝対策：（i）ダムの下流の川の魚類への影響を最小化するために、漁業のために最小水量を維持すること。（ii）魚類の産卵場所を保護すること。（iii）魚の減少を補償するために魚の養殖を振興し、貯水池漁業を発達させること。

5。生物コミュニティーの分断：ダムという人工的な障害物によって分断される。ダムの上流と下流でそれぞれの栄養状況によって生物ポテンシャルが異なってくる。

6。廃水の危険と貯水池の汚染：汚染物質の貯水池への注入レベルをモニターする必要がある。その汚染物質は貯水池周辺の農業セクターや他の商業活動を源とする。＜＝対策：廃水の処理と排水の条件を厳しくすること。

（9。0）結論

この報告書の以上の議論から、クドダムがに住民の社会経済、植物、動物、それらの生息地に与える負のインパクトはわずかで、このプロジェクトから得られる社会経済便益はその負のインパクトにまさっている。したがって、クドダムプロジェクトを計画通り実施することを勧告する。

（10。0）勧告

クドダムプロジェクトは環境に対して重大な悪影響を与えることなしに実施することができる。しかしながら、次ぎの勧告は、真剣に配慮するべきである。

1。地形および人間の居住

(i) クドダムのまわりのゾーンを動物や鳥の禁猟区とし保護するべきである。このエリアは低インパクトの観光やレクリエーション目的にも利用できるものとする。

(ii) 立ち退かなくてはならない世帯はダムに近いエリアに移転されるべきである。できればMuzvezve Resettlement Schemeに移転地をみつけるべきである。

(iii) 立ち退かざるを得ない世帯数は、国立公園に転換される左岸のエリアの大きさによって変わってくる。

(iv) 住民移転による混乱を最小にするために、政府の関係省間の協調が重要である。

(v) 立ち退く必要のある世帯の家屋の数やタイプを詳細に調査し、政府の標準レートによって補償額を算定する必要がある。

(vi) ダムの周辺に居住し続ける世帯については、貯水池の水を家庭用水として使う必要のないように替わりの浄水源を提供する必要がある。
(vii) 計画されているアースフィルダムの建設には大量の土石材料が必要とする。もし周辺の景観を損わないように、必要な土石材料は水没予定地から採取するべきである。
(viii) ダムサイトへのアクセス道路は、右岸を走るカドマ＝サニャティ道路とすべきである。
(ix) ダムの建設に携わる企業は非熟練工については地元から雇用する努力をすべきである。
(x) 多くの社会経済的、環境的配慮点については、モニタリングと適切な救済手段を取る必要がある。病気の発生パターン、水質汚染のレベル、周辺の汚染レベル、密猟の発生、地元住民の人口サイズと構造の変化についてモニタリングをする必要がある。

2。河川システム

(i) ダムのシルトの堆積レベルを、ムニャティの集水域でチェックするべきである。特にCommunal farming areasでチェックするべきである。
(ii) スピルウエイからの排水の影響と土壌流出レートをモニターする必要がある。

3。植生、野生生物、遺伝子資源

(i) 外来種の導入を厳しく制限することによって、土着の魚種、ワニ種を保護する必要がある。
(ii) 病原菌媒介動物をコントロールするプログラムを実施し、マラリアや住血吸虫病のような病気の発生をモニターし対処していく必要がある。
(iii) ダムの汚染物質による汚染や藻の繁殖をチェックするために定期的な水質検査を実施する。
(iv) 建設会社は既存道路を迂回、新しい道路を水没地の上流に作るのを避けることにより、工事車両による動物や植物に対する被害を最小化する。
(v) 水没地以外の植生を傷つけないために、工事材料は水没予定地内から取るようにする。
(vi) 廃棄物や廃液（油、燃料、固形廃棄物等）は、ダムの下流に作った深いピットに埋めるべきである。
(vii) 工事労働者は水没予定地内の森林から薪を取るべきである。
(viii) 建設会社は雇用する工事労働者が密猟をしないように指導すべきである。また国立公園局も密猟防止のためにパトロールを実施する必要がある。
(ix) 藻の繁殖を促進し、貯水池内の酸素を消耗してしまう水没予定地の植生を、水没前に、すべて取り除くべきである。

コメント

ダム建設の影響が及ぶエリアの状況の概略を理解し、イシュー（問題領域）を見いだしているが、それぞれの影響の程度までは評価しきれていないという意味で、プレＥＩＰと考えられる。

しかしこのＥＩＰ調査ではダムサイトの下流３ｋｍまでしか観察しておらない。ダムの水を灌漑に利用するため取水地の下流で、それまで河川の水を飲料水、農業用水、家畜の飲料水としてつかってきた人々の存在や影響について触れられていない。また灌漑用水が届く受益地での負のインパクトの可能性についての観察や考察がない。

他方、水没の影響を受ける居住地の特定については、それなりに行なわれているという点で評価できる。

All communications should be addressed to The Director of Natural Resources

Telephone: 705661 705671
Telegrams: RESOURCES

ZIMBABWE

Ref.:

DEPARTMENT OF NATURAL RESOURCES
MAKOMBE COMPLEX, BLOCK 1
Harare Street/Herbert Chitepo Avenue
P.O. Box 8070, Causeway
Harare

Reference: 17/1/1/14

November 20, 1992

The Permanent Secretary
Ministry of Environment and Tourism

Attention: Mr. Devious Marongwe

Re: EIA of the Proposed Kudu Dam

We have reviewed the "Environmental Impact Assessment Report, October 1992" of the proposed Kudu Dam prepared for the Department of Water Development, Ministry of Lands, Agriculture and Water (MLAW). We also conducted a one-day reconnaissance of the project area on November 18.

The proposed dam was the subject of feasibility studies in 1987 and funding is now being sought for both detailed engineering design and construction. In this context, the subject report is an acceptable preliminary EIA. It quite adequately scopes the environmental issues associated with the dam and suggests measures needed to both mitigate adverse impacts and capture potential benefits. Based on the report and our field examination, we see no compelling reason why the project should be shelved or altered.

At the same time, there are two significant issues which our Ministry and MLAW should ensure are adequately dealt with. Since the dam is in the early planning stages and both the project scope and budget have yet to be finalised, there is a real opportunity to implement this project in a way which demonstrates best-practice in integrated management of natural resources. We strongly recommend that the opportunity should not be missed. The two issues are:

1) Resettlement. The report estimates that some 500 families and infrastructure to support them will need to be relocated. A thorough survey of the families involved is required, and a detailed resettlement and compensation plan must be prepared, as an integral part of detailed project planning. The plan should not just encompass the families in the flooded area. Families in any buffer zone or new national park around the reservoir, as well as families who live outside these areas yet depend on the resources of the flooded area, must also be included.

The report's recommendation that entire communities be resettled should be followed.

Most importantly, it is imperative that an information and consultation programme be launched in the near future to ensure that local people have accurate information about the project and are able to contribute meaningfully to the development of the resettlement and compensation plan. At minimum, resettled families must be at least as well off as they are now. If, through resettlement, their general well-being can be improved, even marginally, local resentment such as has been experienced at the Osborne and Mazvikadei dams will be avoided and the support for future projects will be enhanced. The criterion for the success of resettlement should be the opinions of the families themselves.

2) Reservoir management. The creation of the reservoir will create new opportunities for the use of natural resources in the project area such as tourism, stock watering and pump irrigation. At the same time, if buffer zones and a national park are established on the reservoir margins, communal area residents may also experience problems with access to water which they have so far enjoyed. It is crucial that a comprehensive plan for managing the lands surrounding the new reservoir be prepared, funded and implemented so that opportunities rather than problems are created and surrounding land use does not negatively impact the long-term viability of the dam. The plan should guarantee access to the reservoir for legitimate use by communal area residents.

Both resettlement and reservoir management will require the coordinated efforts of several government ministries. Our Ministry and MLAW should ensure that the appropriate mechanisms are established to achieve this coordinated effort. For example, both the Department of National Parks and Wild Life Management and the Zimbabwe Tourist Development Corporation should be involved in the development of a reservoir management plan. Unquestionably, the costs of planning and executing the needed resettlement and compensation must be part of the project budget. We also recommend that funds for planning the management of the new reservoir area, and for some initial capital and operating costs, also be included in the project budget. While the dam has been proposed primarily for irrigation purposes, it can generate other benefits only if it is conceived, planned and implemented in an integrated fashion.

In the course of detailed planning for the project, we recommend that a specific plan for monitoring and managing both the anticipated negative impacts and potential benefits of the project be prepared and included in the project budget. This plan would provide the means for adjusting the implementation of the project to minimise impacts and maximise benefits. It would also specify the responsibilities of various national and local government agencies in executing

the plan. Our Ministry should require an annual progress report on the execution of the plan from the monitoring team.

We recommend that a detailed environmental management plan be prepared by MLAW and reviewed by our Ministry to fulfil the EIA studies required by the current five-year plan. This plan would encompass (1) the impact monitoring and management plan, (2) the resettlement and compensation plan and (3) the reservoir management plan.

Finally, we recommend that MLAW arrange for clearing of the larger trees from the flooded area to both reduce the amount of decomposing biomass in the new reservoir and to provide fuelwood. The fuelwood could be given to local residents and/or sold in nearby towns.

Mr. S. Chaibva

for: Director of Natural Resources

cc. Director of Water Development
PNRO, Midlands
Ecologist, Midlands
PNRO, Mashonaland West

KUDU DAM PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

REPORT

OCTOBER 1992

ARA - TECHTOP

HARARE

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT ON THE PROPOSED KUDU DAM PROJECT

1.0 INTRODUCTION

The proposed Kudu Dam is situated on the Munyati River near the Ngondoma River confluence. It lies on the border between the Mashonaland West (Kadoma district) and Midlands Provinces (Zhombe Communal Land). In the area of the proposed dam the Munyati River flows northward through mountainous country with a high plateau close to the river on the left bank (Fig.1). The Ngondoma River is a left bank tributary which also passes through major hills close to the confluence. The lake that would be formed by the dam at the site would stretch for 20km up the Munyati River. It would have a total capacity of 1230 $10^6 m^3$ (1550 000 m litres) at 947.0m Full Supply Level, covering an area of 7 700 ha.

The Kudu Dam is sited and sized to give complete control of the water resources of the Munyati River on a large catchment area (approx 17 520 km^2) for development of the agricultural potential in the downstream regions of Sanyati and Gokwe districts. The land in the vicinity of the reservoir in Kadoma district which is largely resettlement schemes and the Zhombe communal areas could also benefit by pumping water from the lake.

The areas to be served represent some of the major cotton producing areas of Zimbabwe. Since the crop is grown under dry land conditions it is thus prone to droughts. Irrigation would thus enhance yields and provide security against years of crop failure as well as enabling the production of other food and cash crops such as wheat (a dry season crop), vegetables, beans, maize, sunflower, groundnuts and soyabeans. It is estimated that Kudu Dam could serve the water requirements of 25 000 ha of irrigated land.

The purpose of this report is to provide an Environmental Impact Assessment on the proposed Kudu Dam. This follows a feasibility study carried out by the then Ministry of Energy, Water Resources and Development. This E.I.A. report, therefore, provides the required prerequisite for possible funding of this development project by the Japanese Government.

2.0 TERMS OF REFERENCE

The assessment (consultancy) team was expected :

i) to identify, predict, quantify and assess the potential significant impacts or effects of the dam project or any activity relating to it;

ii) to collect necessary baseline information needed to facilitate impact prediction and monitoring;

iii) to identify and estimate the cost of alternative or mitigatory measures for minimising or avoiding harmful environmental impacts;

iv) to make recommendations on impact monitoring and project evaluation;

v) to produce an acceptable draft report for review in a form that is non-technical and understandable by the public; and

vi) to participate in a review process before producing the final report.

3.0 METHODOLOGY

A multi-disciplinary assessment team from ARA-Techtop (Zimbabwe) carried out the study. (More details about the team are given in Appendix II). It undertook two visits to the proposed Kudu Dam site. The first 2-day visit was carried out on 22 and 23 August 1992 by Dr. J.M. Gopo and Mr. B.N. Dube. This was followed by a second 3-day visit on 28-30 August 1992 by Dr. J.M. Gopo, Mr. B.N. Dube, Prof. L.M. Zinyama and Mr. D. Mazvimavi. During these visits the assessment team visited:

i) the proposed Dam wall site;

ii) flood basin on the left bank (Zhombe Communal Land);

iii) catchment area in the Zhombe communal area;

iv) flood basin around the Muzvezve River confluence;

v) flood basin on the right bank (Muzvezve Resettlement Scheme area); and

vi) downstream from the proposed dam wall site past the Ngondoma River confluence for a few kilometres.

During these visits, the team identified, assessed, collected information on, and attempted to predict the possible environmental impacts that would be caused by the implementation of the Kudu Dam project. The methodology used by the team involved a) direct observations, b) collecting of samples and specimens for laboratory observations, and c) carrying out informal interviews with the local inhabitants who were deemed to be opinion-makers in the areas visited. These informants included farmers, business people, teachers, nurses, local councillors and VIDCO leaders. A check-list of key questions that

were used to solicit responses and guide the discussions with the interviewees is given in Appendix IV.

4.0 LANDFORMS AND RELIEF OF THE AREA

The area of Kudu Dam is a dissected plateau with numerous residual hills that rise to approximately 1000m separated by valleys dropping to around 900m above sea level. It is anticipated that the water will flood all the land upstream of the dam below 960m above sea level (Fig.1). At its widest the reservoir will be almost 15 km from north to south where it follows the present valley of the Karonika River on the left bank of the Munyati. The lake will extend for some 20 km upstream to beyond the confluence of the Muzvezve River. Along much of its length, the lake will be confined within a range of hills that at present form the steep-sided valleys of the Munyati and its tributaries. Above the present confluence of the Mangwarangwara River, the lake will have an average width of less than 2 km, becoming even narrower in the upper reaches where the hills come closer to the present river channel. Below the Mangwarangwara confluence, the hills on the right bank are situated much farther from the river and have been dissected by several small tributaries to form more open valleys which, upon flooding, will form wide bays. A few of the residual hills will remain standing above the waterline to form small islands.

The area on the left bank below the Mangwarangwara confluence comprises more gentle terrain, interspersed with small isolated hills. The area is drained by the two northward flowing tributaries, the Karonika and Mangwarangwara Rivers. The open valleys and undulating terrain have encouraged settlement and cultivation along these two rivers.

Overall, there are no unique or exceptional landscapes either within the proposed flood basin or its immediate environs that will be adversely impacted or which could be regarded as the loss of a site of exceptional characteristics following the construction of the dam. Instead, the hilly terrain and steep-sided valleys will serve to contain the amount of land that is going to be lost through flooding. The main losses of agriculturally valuable land will be in the areas that are at present settled and cultivated along the Karonika and Mangwarangwara Rivers.

The hills that will form the shores of the lake, particularly on the right bank and in the area upstream of the Mazowe confluence on the left bank, are at present covered with relatively undisturbed tree vegetation. The hills on the right bank which was previously either state land or large-scale commercial farmland, also have some wild animals. The hilly terrain, combined with the indigenous forest vegetation and game, make this area very attractive for tourist and recreational purposes. It is therefore strongly recommended that all of the right bank and at least the upper sections of the left bank above the Mazowe River confluence become National Parks land in order to preserve the physical environment in conjunction with low-impact recreational and tourism development.

5.0 SETTLEMENT AND HUMAN ACTIVITIES

The Zhombe Communal Land which lies south of the Munyati River has experienced in-migration since the early 1960s when the area was opened for settlement. Many of the people who came to settle in Zhombe in search of agricultural land were from the over-populated districts in the south such as Chirumanzu, Shurugwi and Mberengwa. Human settlement in the area has therefore progressed from the south. The proposed dam is located in the extreme north of the communal land.

At the 1982 national census, Zhombe Communal Land as a whole had a population of 68170 people (excluding Empress Mine which had 5240 people but has since closed down), with an average density of 35 persons per sq. km. The average annual growth rate during the inter-censal period 1969-82 was 5.5%, considerably above the national average of 2.7% or the mean of 3.1% for all communal areas alone. This high rate of growth was primarily due to the in-migration that had been taking place in the district since the early 1960s.

The area within a 5 km zone along the length of the Munyati River from the Ngondoma River confluence in the north to the Empress Mine-Kadoma road and bridge was divided into four enumeration areas which had a total population of about 4800 people. Using the district average of 6.1 persons per household, there would have been 790 households within this 5 km zone along the Munyati River in 1982.

Within the vicinity of the proposed lake there are three main areas of population concentration, namely the valleys of the Karonika and Mangwarangwara Rivers and the area lying between the Munyati River and the gravel road running northeast past Kasawi School and shops. In this latter area which lies west of the Munyati River, flooding after the construction of the dam will not directly affect the inhabitants for two reasons: (i) the flood basin upstream of the Muzvezve confluence will be narrow and confined between the hills on either side of the Munyati River; and (ii) because most of the settlements are situated some 2-3 km away from the river on the undulating watersheds where the land is more suitable for cultivation. However, the inhabitants of this area (est. 150-200 families) will have to be relocated as well if it is decided to proclaim the upper reaches of the lake a National Parks area.

It is therefore those people in the Karonika and Mangwarangwara valleys that will need to be relocated at the outset because their land will be flooded. The team was informed by some of the local community leaders that there are probably 2500-3000 people (400-500 households) living in three VIDCOs in these two valleys. Within the Karonika valley there is also a local service centre that will be flooded. The centre at Samambwa includes a couple of general dealers' shops, a clinic, a primary and a secondary school.

The land on the right bank of the Munyati River falls within the Muzvezve Resettlement Scheme which extends for several kilometres eastwards. But the land within the proposed

lake basin is not inhabited. The nearest settlements are Village 15 which is situated about 3 km downstream of the proposed dam and Village 16 which is situated several kilometres to the east. The lake basin on this side is at present being used for livestock grazing by the settlers on the resettlement scheme.

It is therefore the 500 or so families in the Karonika and Mangwarangwara valleys whose lives are going to be most directly disrupted as they will have to be relocated to make way for the dam. Most of the people interviewed by the team were already aware of the project as consultative meetings had previously been held by the local leadership. More importantly, virtually all those who were interviewed were quite willing to be resettled to make way for the dam, but with the proviso that they be relocated as entire communities. This is necessary in order to enable them to maintain their support networks at their new locations. Although some of the informants hoped to be resettled on commercial farmland within the Midlands province, this would be quite some distance away from the dam. (The Munyati River in this area forms the boundary between the Midlands and Mashonaland West provinces). They chose to remain within the Midlands province for what appears to be mainly sentimental reasons such as the fact that they had originally come from other districts within the province such as Chirumanzu or Shurugwi. The team recommends that land for the displaced families should be found as close as possible to the dam, perhaps within the Muzvezve Resettlement Scheme on the Mashonaland West side of the river, so that they can benefit directly from the dam in the form of increased opportunities for formal employment in the tourist and other related activities, commercial fishing, as well as from the expected irrigation development.

The relocation of these families will entail additional costs to the project as a whole. These extra costs include (i) land purchase wherever the families are going to be resettled, (ii) costs of developing new social services and infrastructure such as a primary school, a clinic, roads, etc., (iii) transport costs during the relocation operations, as well as (iv) compensation for loss of fixed property to be paid to the residents for their dwellings and, in the case of the shop-owners at Samambwa service centre, for their buildings. Assuming that the families displaced from these two valleys are relocated elsewhere on land in Natural Regions II or III, under Resettlement Model A and with only dryland cultivation (no irrigation), each family will require 55 hectares of land for residential, arable and grazing purposes, using current criteria set by the Department of Rural Development (Derude) which is responsible for resettlement planning. The resettlement of 500 families will therefore require the acquisition of 27500 hectares of commercial farmland. Using the current average resettlement cost of Z$20000 per family, it will cost Z$10 million to resettle the 500 displaced families. This figure is inclusive of both land acquisition and basic infrastructural and service development. It will be necessary to conduct a detailed survey of the number and range of house types in the area in order to establish the precise amount of compensation that will be required. However, it was noted that some families have, over the years, built 3-5 roomed dwellings with corrugated iron or asbestos roofing. The amount of compensation is unlikely to differ markedly from that being paid to the nearly 1000 families being displaced from the site

of the Osborne Dam in Manicaland, and is based on standard rates fixed by government valuators in the Ministry of Public Construction and National Housing.

The number of families to be resettled will be greater if it is decided to convert part or all of the land on the left bank to National Parks for purposes of environmental management and to reduce the danger of siltation caused by erosion emanating from Zhombe Communal Land. If only a small strip of land of up to 3km width in the upper reaches of the left bank becomes Parks land, it is estimated that an additional 150-200 families will have to be relocated. If, on the other hand, the whole of the left bank down to the dam wall becomes a National Park, then a much larger number of families will have to removed and resettled elsewhere as there are many more settlements in the upper parts of the Karonika and Mangwarangwara River catchments. Therefore, for budgetary and planning purposes, the overall costs of resettlement should be adjusted in relation to the final decision on the amount of land on the left bank that is turned into National Parks property.

Apart from those families who will be directly affected through relocation and the loss of arable land, other villagers both in the Muzvezve resettlement area and in Zhombe Communal Land will lose some of their present livestock grazing areas. The inhabitants graze their cattle and goats in the surrounding hills and along the Munyati River valley and its tributaries. The importance of the Munyati to the livestock economy of the peasant farmers in the area has been highlighted this year (1992) when there is hardly any pasture available and most sources of surface water have dried up leaving only the pools of water along the course of the Munyati and some of its larger tributaries. After the dam has been built, it is necessary that the peasant farmers on both sides retain some degree of access to the water for their livestock, particularly during the dry season or in the event of a drought. But such access should also ensure that the animals do not destroy the environment of the lakeshore areas through overgrazing, trampling of the flora, and the resultant soil erosion.

The low level of water in the Munyati River this year has revealed several areas of bare rock in the river bed. Driven by the drought and the shortage of food, people from the surrounding areas have been panning for alluvial gold in the sands deposited within these areas of exposed river bed rock. It was not possible to establish the numbers of people involved in gold panning as they fluctuate on a daily basis. But there was clear evidence from conversations with some of the panners that large numbers are engaged in panning at several sites along the river. Driving along the Empress Mine-Kadoma road on one occasion, the team saw as many as 60-70 people panning the sand deposits just below the bridge across the Munyati River. The panners also include some foreigners who previously worked on nearby commercial farms and mines but are now too old to work or have been laid off. Although gold panning is illegal, it appears from discussions with some of the panners that it is providing them with a vital source of livelihood, especially under the current harsh economic conditions. The flooding of the Munyati River bed for a distance of some 30 km will therefore deprive some of the inhabitants of the area of an

important source of income, albeit an illegal one.

From the foregoing as well as from the discussion in latter sections of this report, it is possible to identify a number of socio-economic impacts that are going to affect the inhabitants of the area, both during the construction phase and also after the completion of the dam.

5.1 SOCIO-ECONOMIC IMPACTS DURING THE CONSTRUCTION PHASE

There are several aspects of the lives of the local communities that are going to be affected, both negatively as well as positively, during the construction of the dam.

5.1.1 Positive Impacts

i) Short-term Employment Creation: Construction of the dam, which is expected to take up to four years, will generate a demand for labour, particularly unskilled labour, which can be recruited from within the local community, thereby providing the inhabitants employed on the dam with a regular income for at least the duration of the project. Local recruitment of as much of the unskilled labour as possible will also help to reduce the numbers of workers who would need to be accommodated at the actual construction site, since the local workers could live with their families within their villages, or at least be able to be with their families at weekends.

ii) Increased Opportunities for Local Businesses: The influx of a large number of construction workers with regular weekly and monthly wages will have a positive spin-off effect on local businesses at both Samambwa (before the owners are relocated and the centre is flooded) and Empress Mine, which is already a relatively large centre on the main road to Gokwe about 20km south of the dam site.

iii) Increased Local Sales of Agricultural Produce: There will be an increase in cash earnings for some of the local peasant farmers arising from the sale of agricultural produce such as vegetables, fruits, fresh mealies, etc. to the construction workers at the site.

iv) Improvements in Local Transport and Mobility: The development of access roads to the dam area and the resultant increase in vehicular traffic will improve access and mobility for the local inhabitants.

v) Provision of Health Services: If the construction companies working on the project should bring medical and/or first aid facilities, these would also be available, albeit on a limited access basis, to those inhabitants living close to the construction site but who are at present rather far from the local clinic at Samambwa.

5.1.2 Negative Impacts and Mitigatory Measures

i) Promiscuity and Related Health Problems: The establishment of a predominantly male construction camp is going to result in increased prostitution in the area, with either local women being drawn to the site or the workers patronising the local service centres, particularly Empress Mine. This will in turn lead to an increase in the incidence of sexually transmitted diseases (STD) and the risk of HIV transmission. Empress Mine is already prone to this problem as it is situated on a busy trunk road running from Kadoma to Gokwe and the recently opened Sengwa Mine beyond Gokwe. Increased promiscuity will put additional pressures on the local clinics and health personnel at Samambwa and Empress Mine which will therefore need to be strengthened and appropriately equipped in terms of drugs and equipment. The health staff in the area will also need to embark on vigorous health education programmes on the risks of STD and HIV infection and the distribution of condoms in order to encourage safe sex.

ii) Increased Road Traffic: The increased flow of heavy construction vehicles is going to cause considerable damage to, and reduce the expected life-span of, the local gravel roads and will create a lot of dust in their vicinity. It is therefore recommended that access to the dam site be principally by way of the Kadoma-Sanyati road on the right bank. This road is tarred for much of the way up to the point where the gravel road branches off for the remaining 20km to the dam site. More importantly, it does not pass through densely populated communal land like the access roads on the left bank. Furthermore, excessive use of the roads in Zhombe will not only create a lot of dust and noise for the communities living along the roadside, but will also place at risk the people and their livestock from road accidents involving construction vehicles.

iii) Displacement of Families: The construction of the dam will result in the immediate displacement of some 500 families who at present live in the valleys of the Mangwarangwara and Karonika Rivers which are going to be flooded. The number of displaced families will be greater depending on the amount of land on the left bank that is proclaimed National Parks area for purposes of environmental management and protection of the zone around the lake. While the social costs of relocation cannot be quantified, it is necessary that they be minimised as much as possible. The people spoken to were generally supportive of the project, but it is recommended that they be resettled as near as possible to the dam so that they can benefit directly from it. It is also recommended that they be resettled as entire

communities in order to minimise the disruption to local social and other support networks. It is important that the resettlement of the displaced families be co-ordinated with other aspects of the project implementation to enable other government ministries and department concerned with resettlement planning, financing and the provision of social services (e.g. Department of Rural Development, Agritex, Treasury, Education and Health) to fulfil their obligations timeously and without adding too much to the trauma of resettlement. Lack of inter-ministerial co-ordination appears to be evident even now whereby the DDF has been repairing and upgrading the gravel road passing through Samambwa service centre, which road is going to be flooded in the Mangwarangwara River valley.

iv) Siting of Construction Camp and Pollution Problems: The siting of the main construction camp where both the workers together with their machinery and equipment will be housed and serviced raises a very important environmental issue. The machinery and equipment will create a lot of pollution in the form of noise and oil spills. The large concentration of workers will require toilet and ablution facilities. If the camp is sited upstream of the proposed dam wall, this will cause problems of water pollution through seepage later when the basin is flooded. It is therefore recommended that the camp be located on any of a number of stretches of level ground downstream of the dam wall, preferably on the right bank to facilitate access from the Kadoma-Sanyati road. Furthermore, the construction company should be required to ensure that all waste is properly disposed of in deep excavations which will then be reclaimed and covered with topsoil for plant regeneration afterwards. The disposal of oil and other pollutants into the Munyati River should not be permitted at all as the local inhabitants use the river for washing and other domestic purposes. Large items of waste such as metals and discarded equipment should not be disposed of at the site but should be taken out of the area.

5.2 SOCIO-ECONOMIC IMPACTS DURING THE OPERATIONAL PHASE

Although the proposed Kudu Dam could be used for a multitude of purposes, it is envisaged that the principal uses will be the provision of water for irrigation development in the downstream areas and for recreational/tourism purposes. The development of the latter will bring in increased numbers of people from outside, particularly urban dwellers from the major urban centres. These developments will have significant socio-economic and environmental impacts on the local region and society after the completion of construction works.

5.2.1 Positive Impacts

i) Smallholder Irrigation Development: The development of smallholder irrigation agriculture will enhance the standard of living of the families on the schemes that will be established both in the vicinity of the dam and farther downstream in Sanyati and Gokwe Communal Lands. Already, there are a few small irrigation schemes in the area. The plotholders on these schemes have been growing and selling vegetables and other crops, thereby ensuring a source of income for themselves even in a particularly difficult year such 1992. The dam will provide a larger and more reliable source of water for greatly expanded irrigation development extending over some 25000 hectares of land.

ii) Employment Opportunities: Expanded irrigation development will generate a demand for wage labour on the schemes, thereby providing new employment opportunities in an area where up to now such opportunities have been limited. The development of recreational and tourist facilities will also create additional employment opportunities for the local inhabitants.

iii) Improved Water Supplies: The dam will provide a plentiful supply of water for domestic purposes for the local communities and their livestock.

iv) Commercial Fishing: The development of commercial fishing will provide an alternative source of employment and income for the inhabitants.

v) Improved Accessibility: The development of roads, communications and other infrastructure to service the dam and the recreational and tourist facilities will benefit the local inhabitants by improving accessibity for them, both internally as well as with the rest of the country.

Overall, it is envisaged that construction of the dam will provide a major impetus for the development of the region, create alternative off-farm employment opportunities for the inhabitants, and help to diversify the regional economy away from peasant subsistence agricultural production alone.

5.2.2 Negative Impacts and Mitigatory Measures

i) Increased Incidence of Water-related Diseases: As discussed later in this report, the abundance of water will lead to an increase in the population of disease vectors such as bilharzia snails, mosquitoes, etc. These in turn will result in an increase in the incidence of water-related diseases such as malaria, schistosomiasis, enteric fevers, etc. As it is, Gokwe Communal Land immediately to the north has a high incidence of malaria, with a number of fatalities reported each wet season. The development of irrigation also means that the plotholders and their workers will be spending a lot of time in close contact with large amounts

of stagnant surface water. As a result of these dangers, the disease patterns in the area will change and local health services will need to be equipped appropriately to meet these changes. It will also be necessary to implement public health programmes for the control and eradication of disease vectors such as mosquitoes and bilharzia snails.

ii) Social Alienation of Locals: The recreational and tourist facilities that will develop around the lake will be patronised by people from outside the area and not by the local inhabitants. The latter will mainly benefit as employees rather than as consumers of these facilities, whether public or privately owned. Experience elsewhere has shown that this can create a feeling of alienation and exploitation on the part of the local communities, often resulting in an increased incidence of crime directed at tourists. It will therefore be necessary to increase the police presence in the area and to introduce patrols by National Parks staff.

iii) Loss of Access to the River and its Resources: Once the project is completed, the local communities will lose the direct and unlimited access to the waters of the Munyati River and the grazing areas along the river which they and their livestock have enjoyed up to now. (In the case of the gold panners, this income-generating activity will disappear completely when the river bed is flooded). It will be necessary to ensure that the inhabitants continue to have a certain degree of controlled access to the water for domestic use and for the livestock, but without risking damage to the lakeshore environment through trampling by cattle, soil erosion of the banks and siltation, etc.

iv) Influx of Visitors and Tourists: Large numbers of visitors and tourists coming to the lake for recreational purposes will put considerable pressure on the terrestrial and aquatic environment in the area. As stated elsewhere in this report, it is recommended that the land on the right bank and either part or all of the left bank be proclaimed National Parks land in order to facilitate its proper environmental management and development with low-impact recreational facilities (along similar lines as other National Parks areas with chalets and lodges). The dense natural vegetation on the hills around the proposed lakeshore, together with the wild animals therein, should be protected and, where appropriate, stocked up.

v) Influx of Work Seekers and Population Changes: The expansion of the regional economy induced by the dam will draw employment seekers from other parts of the country in large numbers. This is going to disrupt the local rural social structures and will exert more pressure on the area's current social services and infrastructure (e.g. health, schools, roads) and housing, together with a possible increase in petty crimes. These problems can in turn result in social tensions between the newcomers and the local inhabitants. It will therefore be essential to monitor the growth of the population in order to ensure that public services are not over-burdened and that they are developed and expanded concurrently with the

growth of the population.

5.3 MONITORING

Monitoring of the various impacts of the dam on the socio-economic well-being of the inhabitants will be necessary during both the construction phase and after completion of the project. The preceding sections have highlighted the negative impacts that can be expected to affect the people as a result of the project. The areas that will require monitoring are as follows:

i) Changes in disease patterns with the posible increase in STD and HIV cases both during the construction phase from the influx of a large number of construction workers and afterwards as more people come into the area in search of employment or as tourist visitors;

ii) Changes in disease patterns arising from the establishment of a permanent large body of relatively stagnant water in the lake and also from increased contact with the water on the proposed irrigation schemes, as well as from a deterioration in the quality of the water caused by oil pollution from pleasure boats, disposal of effluents, inflow of agricultural chemicals, etc;

iii) Levels of noise pollution, solid wastes (e.g. foodstuffs, paper), and oil spills on land and in the river caused by construction vehicles and, after completion of the project, by tourist traffic;

iv) Poaching activities both during the construction phase by site workers and others in order to protect the animals on the right bank and afterwards, especially if the area around the lake becomes National Parks land and is stocked with wild animals;

v) Changes in the size and demographic structure of the population in the area in order to ensure that social services such as schools and health facilities are not over-burdened and that they are developed and expanded in line with the growth of the population;

vi) The numbers and movements visitors coming for recreational purposes in order to minimise damage to the terrestrial and aquatic animal and plant life and not to disturb their breeding patterns.

6.0 DRAINAGE SYSTEM

6.1 EXISTING DRAINAGE SYSTEM

The proposed Kudu Dam is sited on the Munyati River which is one of the major rivers draining into Lake Kariba. The major tributaries of the Munyati River upstream of Kudu Dam are the Sebakwe, Ngezi, and Muzvezve Rivers. Due to the hilly topography of the area immediately upstream of Kudu Dam, there are several small tributaries of the Munyati River that will drain into the lake created. Downstream of the dam the major

tributaries of the Munyati River are the Ngondoma and Mupfure Rivers.

Several water resources projects already exist upstream of Kudu Dam. Cactus Poort Dam on the Kwekwe River supplies water to Redcliff and Kwekwe. Similarly, Zivagwe and Lower Zivagwe (Dutchman's Pool) Dams on the Sebakwe River supply water to Sable Chemical Industries, Kwekwe and Redcliff. The town of Kadoma draws its water from Claw Dam on the Muzvezve River. There is also Mamina Dam on the Ngezi River which is used for irrigation. Ngezi River is a tributary of the Sebakwe River. Water is abstracted from the Munyati River for use in the Munyati thermal power station. The confluence of the Ngondoma River is immediately downstream of the proposed Kudu Dam. The Ngondoma Dam which was built to supply water to the now closed Empress Mine is currently used for small scale irrigation. There are no major water resources projects on the Munyati River downstream of Kudu Dam.

6.1.1 Flood Basin

The lake that will be created upon the completion of Kudu Dam will stretch for about 20 km from the dam wall to the area above the Muzvezve and Munyati confluence. During periods of high water levels, the lake may stretch as far as the Kadoma-Empress Mine road bridge. Due to the hilly topography within the lake basin, the upper reaches of the lake will be narrow. It will widen just before the Mangwarangwara confluence, extending upstream into the Mangwarangwara, Karonika, and Marimari Rivers.

The geology of the area to be flooded consists mostly of andesitic and dacitic metavolcanics. Dolerite dykes and faults also occur within the area to be flooded and its environs. The soils found in the proposed lake basin and the surrounding area are the brown and reddish clays of the siallitic group.

6.1.2 Upstream Rivers

Most of the small tributaries such as the Karonika River that will drain into Kudu Dam have rocky beds and flow only during the rainy season. Sediment deposition is not evident on most of these small rivers when they join the Munyati River. The lack of sediment deposition indicates that the sediment load is at present transported into the Munyati River. The slopes of most of the rivers are in general moderate which does not favour the deposition of the sediment load. Erosion along the channels when they join Munyati River is not also evident. This again suggests that the flow regimes are mostly transporting the sediment in these sections as they join the Munyati River.

The profile and pattern of the Munyati River has been strongly influenced by geological factors. This is evident from the rocky river bed and stable banks. There is no evidence of either erosion of the channel or substantial sediment deposition along the Munyati River from the Kadoma-Empress Mine road bridge to the site of Kudu Dam. This does suggest that in comparison to other major rivers in Zimbabwe such as the Save River,

the Munyati has low sediment loads. This is expected since the greater part of the catchment area of the Munyati River upstream of the Kudu Dam site consists of well conserved commercial farms. The only communal areas occurring within the catchment area are Zhombe, Ngezi, Chiundura and part of Mhondoro. In addition, the major tributaries of the Munyati River have dams on them which trap the sediment load. This is also true of the Karonika, Mangwarangwara, and Bako Rivers which are small tributaries draining Zhombe Communal Land.

There is substantial sediment deposition along the Muzvezve River at its confluence with the Munyati River. The deposited sediments vary from sandy fractions at the confluence, and clay deposits in pools within the Muzvezve River upstream of the confluence. The sediment may be originating from Ngezi and Mhondoro Communal Lands where severe gullying of the sodic soils is taking place. Claw Dam on the Muzvezve River traps some of these sediments, but during times of spillage part of the sediment will pass the dam.

6.1.3 Downstream Rivers

The downstream characteristics of the Munyati River were observed for a distance of about 3 kilometres from the Kudu Dam site. The channel profile changes from being rocky to one with clay banks. This change is quite evident after the confluence with the Ngondoma River. The river banks which are vegetated by trees have terraces indicating the different levels at which the river may flow. Large and deep pools occupy this downstream section. The bank material seems to be a result of sediment deposition at high flows. There is no evidence of serious erosion of the bank which has been stabilized by the vegetation.

At the confluence of the Ngondoma and Munyati Rivers, most of the sediment deposited is confined to the Ngondoma River. This suggests that the Ngondoma River brings in substantial amounts of sediment, most of it derived from Zhombe Communal Land. A large proportion of the catchment of the Ngondoma River is underlain by granitic rocks which produce sandy soils that are easily eroded. This seems to explain the high sediment load of the Ngondoma River.

6.2 IMPACTS OF KUDU DAM ON THE DRAINAGE SYSTEM

The hydrological impacts of Kudu Dam will vary spatially depending on whether the area being examined is upstream, around, or downstream of the dam. In the upstream part, the impacts will be mostly confined to the rivers flowing into the dam, while the immediate environs of the dam will be affected by the presence of the water body. Downstream of the dam, the impacts will again be confined to the channel since the flows will now be regulated. Since no monitoring of the channel processes was made along the Munyati River at the time the team visited the proposed dam, only qualitative statements about the likely effects of the dam can be made.

6.2.1 Upstream Rivers

The immediate effect of any water body into which a river is flowing is to reduce the flow velocity as the water enters that water body, due to the backwater effect. The extent to which flow velocities are reduced will depend on the initial velocity which the water had, and this depends on river characteristics such as slope, width and depth. Lake characteristics such as its width and depth at the point at which the river enters it will also have an effect.

It is expected that when flows from the Munyati River begin to enter the lake, sediment deposition will occur as a result of the decrease in flow velocities. This is expected to start from about the Kadoma-Empress Mine road bridge. The coarsest fractions such as sand will be the first to be deposited along the Munyati River. It is likely that by the time the flows get to the Muzvezve River confluence, the coarse particles will have been deposited. Since the Munyati River is narrow in this section, the deposited sediments will lead to a substantial loss in channel capacity. With time the presently rocky bed may be transformed to an alluvial bed. This will enable the growth of vegetation which promotes sediment deposition.

On the Muzvezve River similar processes are expected to take place. As has already been stated, there is substantial deposition of the sediment delivered by the Muzvezve River at its confluence with the Munyati River. The lake created after the construction of Kudu Dam will enhance this deposition due to reduced velocities as the water enters the lake. This deposition will also extend upstream along the river. However, the Muzvezve flows will be entering the lake at a point where it will be wide. Thus, it is expected that these deposits will be spread over a wide area.

The loss in channel capacity along the Muzvezve River upstream of the confluence will not be as great as that along the Munyati River. Similar processes are expected to take place where the various small tributaries enter the lake. Rivers such as Karonika, Mangwarangwara, Totororo, Nyamatani, Marimari will deposit their sediment load as they enter the lake. This deposition will extend upstream along the rivers due to the backwater effect. It is in these zones that aquatic plants such as weeds will grow. During periods of low water levels the deposits will be exposed which may cause problems to livestock when they come to drink water.

6.2.2 Flood Basin

The immediate effect of the construction of the Kudu Dam will be to change a terrestrial environment to an aquatic one over the whole area that is going to be flooded. Initially, this will have a great impact on the underlying and surrounding rocks and soils. The presence of the water body will compress the rocks. In regions that are tectonically active, this may trigger earthquakes. However, this area has not been known to be tectonically active. Earth tremors in Zimbabwe tend to be confined to the Zambezi valley farther north.

An increase in the soil moisture of the area immediately surrounding the lake is expected. This is not expected to lead to any serious waterlogging since most of the shoreline will consist of hills. If any such problems occur, they will be localised. The creation of a lake can sometimes lead to a change in the groundwater particularly in areas with very pervious rock such as in the Save valley.

In regions with cavernous features such as caves, these may be flooded. The geology of the area to be flooded by Kudu Dam consists mostly of andesitic and dacitic metavolcanics. These do not have such a high permeability to the extent that subsurface seepage would be substantial.

The presence of a large water body can have some effects on the atmosphere of the area immediately above and surrounding the dam. The most noticeable effects are increases in the humidity of the air, cooling of the air during summer and its warming during winter. However, the degree to which a water body can affect atmospheric properties depends on its areal extent. A large water body has obviously a greater effect than a smaller one. There have not been reported any significant changes in atmospheric characteristics due to large dams such as Mutirikwe (Kyle) which have surface areas comparable to that of the proposed Kudu Dam. The only noticeable change that has been reported in atmospheric characteristics in Zimbabwe is a slight increase in rainfall over Makuti as a result of the Lake Kariba breeze. It is not expected that Kudu Dam will affect the atmosphere to such an extent. There may be some increases in humidity since the dam is surrounded by hills that inhibit the mixing of air over a wide area.

Since the depth of Kudu Dam is expected to be approximately 60m, thermal stratification of the lake may occur during winter. With time, thermal stratification may promote eutrophication if the lake receives nutrients. Run-off from cultivated lands may contain such nutrients derived from fertilizers applied to fields. At the time the water overturns in winter, the warm water at the surface will cause frequent mists around the dam. However, thermal stratification should not be as marked as in Lake Chivero because the differences in summer and winter temperatures in the Kudu Dam region are not expected to be as large as those in Lake Chivero.

6.2.3 Downstream Effects

The most important effects of Kudu Dam to the downstream area will be a result of changing the flow regime from one whereby flows occurred during the wet season only to one with regulated flows throughout the year. The quality of the water released from the dam will also change since most of the sediment will have been deposited in the lake. Such water will have a capacity to take more sediment. This will result in the flows eroding the downstream channel which will result in its widening and deepening. Currently the Ngondoma River tends to deposit its sediment at the confluence. After the completion of Kudu Dam, the Ngondoma River will initially erode the deposited sediments. Thereafter, during periods of peak flows on the Ngondoma River, it will erode the channel

as it joins the Munyati River because there may be no flows at such high levels on the Munyati River to reduce the Ngondoma flow velocities.

Kudu Dam will cause a reduction in the peak flows in the downstream section. The peak flows were supplying moisture and silt during periods of high water levels to the banks. These enabled the growth of vegetation which binds the bank soil and thus prevents its erosion. When the banks are deprived of these inputs, it is likely that the vegetation will deteriorate resulting in slumping which will in turn lead to gullying. This may be compounded by an increase in livestock numbers that visit the river to drink water.

Spillway discharges will also have adverse effects on channel stability. The planned spillway will discharge into a small tributary of the Munyati River. Since such discharges are likely to be large, they may exceed the capacity of this tributary resulting in erosion. Erosion is also expected to occur where the spillway discharges enter the Munyati River since the river will not have adjusted to such flows.

The reduction of flows is likely to affect the amount of water getting to Lake Kariba. There is a need to ascertain the contribution of the Munyati River upstream of Kudu Dam to the inflows of Kariba Dam. This effect has to be examined taking into consideration the effects of Lakes Chivero and Manyame on the Manyame River, and the planned developments on the Gwayi and Shangani Rivers.

6.3 MITIGATORY MEASURES

Since the greatest effect of Kudu Dam will be the deposition of the sediment load, it is important that the watershed be properly managed to reduce the rate of soil erosion and the resulting siltation of the dam. Current practices within the whole Munyati catchment area that promote soil erosion need to be discouraged. This requires the improvement of cultivation techniques particularly in the communal areas within the catchment area. The current stocking rates need to be examined so as to determine if they do not exceed the land carrying capacity. In areas where this is occurring the stocking rates may need to be reduced. Improvements in pastures through grazing schemes will need to be implemented.

In the downstream section the prevention of erosion of the channel will be the main objective. This will require the assessment of the channel erosion rates as a result of the water releases. Appropriate measures will then need to be taken to reduce channel erosion. It is expected that a stilling basin will be constructed downstream to dissipate the energy of spilling water. However, it may be necessary to take measures that will reduce erosion of the channel downstream of the stilling basin within the tributary into which the spillway will be discharging. Similar measures may need to be taken where the tributary joins the Munyati River.

6.4 MONITORING

The sediment loads on the Munyati River and its tributaries that flow into the dam will need to be monitored so as to assess the likely rates of siltation. It is recommended that sediment transport rates be measured on a routine basis on the Munyati River upstream of the Kadoma-Empress Mine road bridge, the Muzvezve River, one or two tributaries flowing from Zhombe Communal Land, and another on the right bank. The rates of sediment siltation within the dam will also have to be measured to determine the rate at which storage will be lost.

Within the downstream channel, the changes to the channel profile need to be monitored. This will enable the determination of any serious erosion that may be taking place. The impact of the reduction of the peak flows on the stability of the banks will also need to be assessed.

7.0 VEGETATION AND WILDLIFE

The vegetation of the proposed Kudu Dam area, including the flood basin (left bank and right bank), the catchment area and downstream from the dam wall site could be described under two ecological categories: (i) the terrestrial Mopane and Acacia woodland and (ii) the river and riparian fringe.

7.1 MOPANE AND ACACIA WOODLAND

This dry terrestrial habitat dominates the flood basin on both the left and right banks of the Munyati River including the catchment area. The predominant tree species is the tall and short scrub Mopane (Colophospermum mopane). The acacia woodland comprises mainly of the short scrub Muunga (Acacia nilotica) in the river valley and dense impenetrable thickets of Mupangara (Dichrostachys cineria). This tree often forms secondary bush on impoverished soil and is often an indication of overgrazing or abandoned arable land. The wood is hard and durable and often used for construction poles and handles of farm and household implements. However, its use is somewhat limited by the small size of the tree.

Other tree species found in this habitat include the Muunze (Kigelia africana) which is found mainly on hills, Musasa (Brachystegia spiciformis), Mutowa (Diplorhynchus condylocarpon), Mupembere (Combretum molle) and some isolated Baobabs (Adansonia digitata).

The bird fauna that dominate this habitat are the crimson breasted shrike (Lanianus artrococcineus) and the hole nesting red-billed and yellow-billed hornbills (Tockus erthrorhynus and Tockus flavirotris).

The flood basin on the right bank of the proposed Kudu Dam is also primarily Mopane and Acacia woodland. However, because this was until recently unoccupied state and commercial farmlands, the Mopane and Acacia woodland comprises of taller and more mature trees. The small scraggy tree species of Mupangara (Dichrostachys cineria) is less abundant in the habitat. The tall thorny Munanga (Acacia polycantra); Mopane (C. mopane) and Musasa (B. spiciformis) are the dominant tree species. Also found are Mutondo (Julbernardia globiflora), Muunze (Kigelia africana) and some dry grasses. The same bird fauna typical of the Mopane and Acacia woodland are also evident in this habitat.

7.2 THE RIVER AND RIPARIAN HABITAT

The dominant tree species in this habitat are those that require a high moisture level and fertile silted soil. The weeping willow (Salix subserrata) is the predominant shrub found along the river banks. Other tree species associated with this aquatic ecosystem are the Musuma (Diospyros mespiliformis), Muchechete (Ziziphus mucronata) and Mupfuti (Brachystegia boehmii).

The bird fauna identified are those associated with river fringes. These include the Hamerkop (Scopus umberta), Reed cormorants (Phalacrocorax africanus), Arters fishing (Anhinga rufa) and white-faced duck (Viduata dendrocygna). In spite of the severe loss of water in the Munyati River due to the drought, the few patches of open water along the river support some varied species of aquatic fauna. Some of the fish species identified are Tilapia spp., Clarius spp. and Kapenta (Limnothorisa spp.). Crocodiles are also present.

There are few wild animals (kudu, baboons, monkeys and squirrels) inhabiting the Mopane and Acacia woodland. These animals are generally found in the flood basin and catchment area on the right bank of the Munyati River which was sparsely populated until recently. There is virtually no evidence of wild life in the flood basin of the left bank. The establishment of human settlements in Zhombe Communal Land must have driven away the few wild animals that had survived from hunting across the Munyati River to the sanctuary of the uninhabited protected land on the right bank.

Since the terrestrial flora type species is evenly distributed between the proposed flood basin and the dry upland areas, the implementation of the Kudu Dam will not cause any significant loss of important tree species. Moreover, none of the tree species dominant in this area is of high commercial value. The few wild life species that would be affected can easily be relocated into state protected wild life sanctuary as recommended in this report.

8.0 BIODIVERSITY AND GENETIC RESOURCES

Biodiversity describes the living component of an environment, while the biotic community means the association of the varied interacting species, existing in a common environment. Such a biotic community can exist either in sympatry i.e. populations that occur together in the same genera, geographic region or whose biogeographic ranges overlap, or in allopatric situation which means that the populations are partially isolated from one another. In respect of the Kudu Dam project, the areas which will be flooded have had terrestrial plants and aquatic animal species existing in a sympatric situation.

The proposed Kudu Dam site has terrestrial and aquatic biotic communities that have existed from time immemorial, in a sympatric situation. Part of this biotic community is going to be affected by the dam, both adversely and advantageously, in both the flooded areas and in the downstream areas. The team set out to investigate the possible impacts on this biotic community that are going to arise from the creation of a large water body. It was realised that it would be necessary to establish the biodiversity and genetic composition of this biotic community in order to be able to make any predictions on the possible impact of the dam.

It was observed that, by and large, there are at present no geographic barriers in as far as the aquatic biotic communities are concerned. A number of fish species that are now common in Lake Kariba, such as Tilapia spp., Kapenta (Limnothorisa spp.), and Clarius spp., are also present in the Munyati River, particularly in the large pools found in the areas below the proposed dam wall. Crocodile species common to Lake Kariba are also found in the area.

As far as terrestrial animals are concerned, again there has been no continual physical or geographical barrier. The Munyati River receives seasonal flash floods which do not impose a permanent separation of the animal populations. This situation may change after the construction of the dam.

The plant biotic communities in the area to be flooded are not essentially different from the communities in the areas beyond the flood basin. The plant species are also the same as those present in the area below the proposed dam wall. This is very significant because it means that there are no rare plant species in the flood basin whose genetic resources could be lost after flooding.

8.1 PLANT BIODIVERSITY

The construction of the dam and the resultant flooding will not threaten the biodiversity of the area because, as noted above, there are no rare plant species in the flood basin. Furthermore, there are no plant species of major economic value. The Mopane tree (Colophospernum mopane) which is used as a source of fuel wood is widely distributed throughout the region. Other plant species that could be used economically such as the

Mupfuti (B. bohmii) and Mutondo (B. spiciformis) are also widely distributed. It is considered that none of these tree species are threatened with any genetic loss. The genetic resources that will be destroyed by the flooding are well represented in the area.

The heavy deposition of silt on the banks of the river below the proposed dam wall has affected the types of plant species. The presence of the silt has encouraged the growth of those plants which require high nutrients. The controlled release of water from the dam will change the river flows downstream. This will cut down on the amount of water going downstream in summer, reduce the chances of flash floods and thereby prevent silt deposition on the banks. Those plant species which depend on the high nutrients within the silt will be adversely affected. However, the plant species observed in these areas such as Mutepe (Salix subserrata) are also found elsewhere such that their diversity will not be threatened. The construction of the dam will therefore not alter the area's plant biodiversity and genetic resource base because the flood basin does not have rare plant life.

8.2 TERRESTRIAL ANIMAL BIODIVERSITY AND GENETIC RESOURCE

The animal life observed on the left bank is mostly domesticated animals such as cattle, goats and donkeys. There are very few wild animals as these have been displaced by human settlement and hunting. The only wild animal species on the left bank are small animals such as rabbits, squirrels, snakes, rats and field mice. These small animal species will be threatened by the flooding. As for the domesticated animals, these will be moved away together with their owners who will be relocated elsewhere. Thus the flooding of the left bank of the Munyati River will not lead to a serious loss to the large animal biodiversity because the animals that are at present found this area are mainly domestic animals. However, the biodiversity of the small wild animals which are often associated with human settlements will be threatened.

The expected effects of flooding on the right bank are quite different because of the fact that there are at present a number of large animal species. The wild animal species on the right bank include kudus, baboons and monkeys. These animals will obviously have to be relocated before the basin is completely flooded. Equally, there are small animal species which will not be easy to relocate and these may also be lost due to flooding. Their biodiversity is therefore threatened.

When all this is taken together, it becomes clear that the Kudu Dam will not, in the main, pause a major threat to the biodiversity and genetic resource base of the area in as far as the terrestrial animal species are concerned. Obviously, the flooded area will cause a partial geographic barrier, but it will not be serious enough to cause genetic isolation that might bring about changes in the terrestrial animal gene frequency distribution in the area. The biotic communities of both banks will continue to be similar because the flooded area will form only a partial geographical barrier.

8.3 AQUATIC BIODIVERSITY AND GENETIC RESOURCE

The impact of the Kudu Dam on aquatic and amphibious species is going to be very significant. The dam wall will serve as an artificial geographic barrier, separating the aquatic species that are currently present in the areas to be flooded and upstream from those in the area below the dam wall.

At present, a large number of aquatic species move upstream from Lake Kariba through the Sanyati River into the Munyati River past the proposed Kudu Dam site. Once the dam wall is built, the majority of the aquatic species will not be able to cross this barrier. This will lead to some geographic isolation, genetic isolation and a reduction in the gene pool. These changes in the structure of the populations might affect the gene flow and gene frequency distribution in the flooded area in particular, because the continued movement of aquatic species from Lake Kariba will have been effectively stopped.

The dam wall will also prevent the downward movement of aquatic species from the dam's catchment area, although not to the same degree as for upstream movements since some species will be able to swim down the spillway. The catchment area that includes communal lands and commercial farms could face the possible introduction of new and exotic aquatic species which would affect the gene pool, gene flow and the population structure.

8.4 POPULATION DYNAMICS

The fish species present in the Munyati River at the site of Kudu Dam include Tilapia spp., Clarius spp. and Kapenta (Limnothorisa spp.), a variety of other smaller fishes as well as zooplankton and phytoplankton species. There are also crocodiles, lizards and other amphibious species. The flooding as well as the controlled release of water downstream will have direct effects on the population dynamics of the aquatic species. The present situation is that water is available at certain periods of the year, followed by periods of relatively severe water stress. The flooding will provide abundant water throughout the year in the flooded areas. The controlled water release will also eliminate the periods of water stress downstream of the dam.

The aquatic and amphibious populations that at present experience water stress during dry periods will be able to increase in numbers throughout the year, resulting in changes in their population structure. Any introduction in future of exotic Tilapian species for commercial fish farming purposes will lead to cross hybridization with the present fishes which are in sympatry, thus threatening the biodiversity of the indigenous Tilapian species. Commercial crocodile farming using new and exotic species would also threaten the crocodile biodiversity in the area. The abundance of water both in the flooded area and downstream will result in an increase in the populations of crocodiles, hippos, water snakes, lizards and other forms of animal life that depend on water.

8.5 DISEASE VECTORS

The flooding and the resultant abundance of water will lead to an increase in the population of bilharzia snails in the area. This in turn will lead to an increase in the incidence of schistosomiasis in the human population. The team observed a few snails in the river, especially in the few pools which hold stagnant water. The continuous presence of a large water body will also encourage an increase in the mosquito population in the area, resulting in an increase in malaria.

Other water-borne diseases, such as salmonellosis and enteric fevers, are also likely to increase in the area, especially if the people living in the vicinity of the reservoir draw their water for domestic purposes directly from the dam. This is very likely to be the case, particularly during dry periods, unless alternative sources of safe drinking water are provided within easy walking distance. During the current drought, some of the inhabitants are getting their domestic water from the few stagnant pools that remain in the Munyati River. Use of the dam water for irrigation will also bring about an increase in schistosomiasis, enteric fevers, salmonellosis and other water-borne diseases, due to the increase in the populations of the disease vectors.

8.6 BIODIVERSITY OF BIRDS

As mentioned earlier, a number of birds species were observed in the area (Appendix I). The populations of these bird species will increase when the basin is flooded. The abundance of water will lead to an abundance of food to support a population increase in the bird species.

8.7 IMPACTS ON PLANTS AND ANIMALS DURING THE CONSTRUCTON PHASE

8.7.1 Positive Impacts

During the construction phase, there will be no positive impacts on the vegetation, wildlife and aquatic life due to the disruptions caused by construction vehicles and machinery.

8.7.2 Negative Impacts and Mitigatory Measures

During the construction phase, most of the impacts on the vegetation, wildlife and aquatic life will be negative. These negative impacts include:

i) Destruction of Vegetation: This will occur during the process of preparing access roads to the site and within the flood basin. To minimise the destruction of vegetation outside the actual flood basin, it is recommended that the construction teams be restricted to using existing roads and that new roads above the flood basin be opened only where it is absolutely necessary to do so.

ii) Pollution: The use of heavy construction machinery will result in air, noise and waste matter (oil, diesel and petrol) pollution. The noise pollution will drive wild animals and birds further away from the dam site. The resultant air and waste matter pollution will seriously affect the vegetation along the access roads leading to the dam wall site. While nothing can be done to minimise the impact of air and noise pollution, however, used oil and similar waste should be buried in deposit pits. These pits should be sited away from the flood basin and preferably further downstream of the dam wall. This will avoid the subsequent seapage of pollutants into the reservoir. These pits should then be covered with topsoil and re-vegetated. Broken down machinery should be taken out of the site.

iii) Fuelwood Demand: There will be a substantial demand for fuelwood for cooking and heating by construction workers. To minimise the indiscriminate felling of trees, the workers on the site should not cut down trees above the flood basin but should only use vegetation that will have been cleared within the flood basin.

iv) Poaching: Poaching of wild animals including fish species will increase through hunting by the construction workers. The use of snares to trap wild animals, a method most likely to be used by small-time poachers, will also raise the possibility of ensnaring stray cattle and goats belonging to neighbouring communal and resettlement area farmers. To minimise the problem of poaching, the construction companies should impress upon their workers that it is a criminal offence to hunt wild animals without permission. The Department of National Parks and Wild Life Management will also need to carry out regular patrols in the area in order to discourage poaching. Construction workers should be educated on the dangers and consequences of illegal hunting.

8.8 IMPACTS ON PLANTS AND ANIMALS DURING THE OPERATIONAL PHASE

8.8.1 Positive Impacts

i) Increase in Aquatic and Terrestrial Fauna: The provision of a large reservoir will result in an increase in aquatic fauna such as fishes, amphibians and some reptiles. It has been pointed out above that the area of Kudu Dam does not have a large amount of wild life. The animals on the left bank are mostly domesticated animals. There are, however, a few wild animal species on the right bank and these will need to be re-located or have their habitat be proclaimed National Parks land in order to protect them from poachers.

ii) Increase in Bird Population: The populations of a wide variety of birds that are associated with open watef bodies and riverine habitats will increase due to the availability of food.

8.8.2 Negative Impacts and Mitigatory Measures

i) Loss of Terrestrial Habitat: The greatest impact on wild life will come from the loss of terrestrial habitat in the flood basin and subsequent land use changes in the catchment area. Migratory patterns of wildlife will be disrupted by the reservoir and associated developments. This loss of habitat can be minimised by the establishment of a compensatory protected Parks estate around the proposed dam. This will also remove the need to rescue and relocate the affected wild animals.

ii) Nutrient Enrichment and Growth of Aquatic Weeds: One of the major negative impacts of the Kudu Dam will be the enrichment of nutrients in the flooded area due to the decomposition of organic matter, such as trees and grasses, resulting in a deterioration in the quality of the water in the reservoir. The area to be flooded by the the Kudu Dam is large and heavily wooded. If these trees are not removed, there will be an increase in nutrients, leading to increases in the growth of aquatic weeds such as water lettuce and water hyacinth. The weeds and algal mats, once established, are very difficult and expensive to control. They clog dam outflows and irrigation canals. They also add to the costs of water treatment. The abundance of weeds will impair navigation, and substantially increase water losses through increased transpiration. The woody vegetation within the flood basin will therefore have to be cleared before flooding.

iii) Effects of Oxygen Loss on Aquatic Life: If the vegetation within the flood basin is not cleared, the decomposition of the woody matter will cause serious depletion of oxygen levels in the water. This oxygen depletion will in turn affect all aquatic life. The products of the anaerobic decomposition will include hydrogen sulphide which is noxious to aquatic organisms. The anaerobic decomposition will also lead to the production of methane gas and carbon dioxide which increase the greenhouse effects. It is therefore essential that the flood basin of Kudu Dam be cleared of woody organic matter if the deterioration of water quality and its consequences on aquatic life are to be minimised.

iii) Decline in Riverine Fisheries: The riverine fisheries will decline due to changes in river flow, deterioration of water quality, water temperature changes, loss of spawning grounds and barriers to fish migration. The disruption of riverine fisheries downstream can be minimised by:

- maintaining a minimum flow for fisheries;
- providing protection of spawning grounds;
- promoting aquaculture and developing reservoir fisheries in compensation.

It is also possible that the reservoir fishery which will be created can be more productive than the previous riverine fishery. But it will be necessary to monitor the fish species in the reservoir and control the issuing of permits to prospective fisheries.

iv) Separation of the Biotic Community: The creation of an artificial barrier in the form of the dam wall will lead to the separation of the biotic community. This may lead to different biotic potentials depending on the differences in nutrient levels above and below the dam wall. At the same time, care will have to be taken to prevent the wanton introduction of new exotic fish species into the lake or indeed even in the small farm dams on commercial farms in the catchment area. Such introductions would threaten the aquatic biodiversity of the lake. Fish farming should be encouraged but it must be based on the use of indigenous species. Where exotic species are used, strict control measures must be taken to protect the lake against unplanned introductions. Similarly, crocodile farmers must be encouraged to use indigenous species. Where they choose to use exotic species, care should be taken to prevent their introduction into the lake.

v) Risk of Effluent Disposal and Lake Pollution: It will be necessary to monitor the levels of pollutants entering into the water body. The pollutants will come from the farming sector and from other commercial activities that are going to develop around the lake. Strict requirements on effluent treatment and disposal for these activities will need to be enforced. Untreated sewage or other pollutants should not be allowed into the lake or into the rivers in the catchment area. The lake management authority should institute strict measures for monitoring effluent disposal in the upstream areas to ensure good water quality control.

8.9 MONITORING

In order to maintain a healthy balance of flora and fauna in the terrestrial and aquatic ecosystems, the factors to be monitored should include:

i) Changes in water quality through measurement of such variables as salinity, pH, water temperature, turbidity, oxygen levels, phosphates and nitrates (nutrient levels);
ii) Hydrogen sulphide and methane generation from submerged vegetation;
iii) Limnological sampling of microflora, microfauna, aquatic weeds and benthic organisms;
iv) Fisheries assessment surveys (species, populations. etc.) in the reservoir and downstream of the dam;
v) The species, numbers and distribution of wildlife in the area around the lake;
vi) Vegetation changes (cover, species composition, growth rates, biomass. etc) in the upper watershed, reservoir drawdown zone, and downstream areas;
vii) Prevalence of disease vectors in the water and the surrounding areas.

9.0 CONCLUDING STATEMENT

From the foregoing discussion, the negative impacts of the proposed Kudu Dam on the Munyati River at the selected site on the socio-economic life of the inhabitants, the flora and fauna and their habitats, are going to minimal and will be outweighed by the socio-economic benefits that will derive from the project. It is therefore recommended that the Kudu Dam project be implemented as planned.

10.0 RECOMMENDATIONS

The Kudu Dam project on the Munyati River can be implemented without serious adverse impacts on the environment. However, the following recommendations should be seriously considered and acted upon in the implementation of the project and after.

1. Relief and Human Settlement

   i) A zone around the Kudu Dam should be declared state protected land to provide sanctuary to animal and bird species. This area will also be utilized for low-impact tourism and recreational purposes.

   ii) The displaced families should be relocated in the area close to the dam, possibly within the Muzvezve Resettlement Scheme in the Mashonaland West Province. By so doing, the displaced families will benefit directly from the dam in the form of increased opportunities for formal employment in the tourist and related activities, commercial fishing as well as from the expected irrigation development.

   iii) The total number of families to be displaced will depend on the extent of the area on the left bank that is declared National Parks land. If only the upper reaches of the lake become Parks land, then a smaller number of families will be displaced. But if, for reasons of proper environmental management of the lakeshore and surrounding areas, the whole of the left bank is converted from communal land, the number to be displaced will be much greater.

   iv) In order to minimise the trauma and upheavals of relocation, inter-ministerial co-ordination with other relevant ministries and departments is essential from the initial phases of project implementation.

   v) It will be necessary to conduct a detailed survey of the number and variety of house types owned by the families to be displaced in order to establish the amount of fair compensation to be paid, based on the standard rates

determined by government valuators in the Ministry of Public Construction and National Housing.

vi) Families remaining in the vicinity of the dam will need to be provided with alternative sources of clean water so that they do not draw directly from the dam for their domestic requirements. Water in the dam will be polluted and using it in untreated form will lead to an increase in the incidence of water-borne diseases.

vii) Construction of an earthfill dam of the size proposed will require large quantities of earth materials which will scar the surrounding landscape and reduce its scenic value for recreational purposes afterwards. It is therefore recommended that all the materials be obtained from borrows or excavations sited within the flood basin where they will be flooded later when flooding takes place.

viii) Access to the dam site should be by way of the Kadoma-Sanyati road on the right bank. Likewise, the construction camp to house the workers should be located on the right bank as well, downstream of the dam wall.

ix) The companies working at the site should endeavour to recruit locally for their requirements of unskilled labour.

x) A number of socio-economic and environmental areas of concern will require monitoring and appropriate corrective action to be taken, both during the construction phase and afterwards when the dam is operational. These issues include changes in disease patterns, levels of pollution in the water and the surrounding areas, incidence of poaching, changes in the size and demographic structure of the local population, and the effects of recreational usage of the dam on the terrestrial and aquatic life.

2. Drainage System

i) The level of silt deposition in the dam should be checked by encouraging the use of proper agronomic techniques in the whole Munyati catchment area, particularly the communal farming areas.

ii) The effects of the spillway discharges and erosion rates along both the tributary that will carry them and within the Munyati River channel downstream of the dam will need to be monitored.

3. Vegetation, Wildlife and Genetic Resources

(i) The indigenous fish and crocodile species should be protected by effecting strict controls against the introduction of exotic species in the catchment area of the dam. Reservoir fisheries should be developed to compensate for the disruption of riverine fisheries. There should be regular surveys of the wildlife and of any vegetation changes arising from the construction of the dam.

(ii) A disease vector control programme must be established to monitor and respond to any possible increase in the incidence of diseases such as malaria and schistosomiasis.

(iii) There will be need for regular monitoring of the water quality in order to check for possible contamination of the dam by pollutants, and colonisation by aquatic weeds.

iv) The construction teams should use the existing access roads and avoid opening new roads above the flood basin in order to minimise damage to the flora and fauna by construction vehicles and machinery.

v) The excavation of borrows and quarry pits to obtain construction materials should be done within the flood basin in order to avoid further damage to the vegetation outside the flood zone.

vi) Waste matter and other pollutants (e.g. oil, fuel, solid wastes, etc) should be buried in deep pits which should be sited downstream of the dam wall below the flood basin. The pits should be covered with topsoil and re-vegetated afterwards. Large items of waste such as old equipment and machinery should not be disposed of in the area, but taken elsewhere for proper disposal or storage.

vii) Workers on the site should use for fuelwood the vegetation that will be cleared within the flood basin.

viii) The construction companies should be impressed upon to ensure against poaching of wild animals by their employees. The Department of National Parks and Wild Life Management will need to patrol the area around the lake to monitor poaching of wildlife.

ix) All vegetation should be cleared from the inundation zone prior to flooding in order to remove a major source of nutrients which would encourage the growth of aquatic weeds, to avoid the depletion of oxygen in the reservoir, and generally to minimise the deterioration of water quality.

APPENDIX I

List Of Flora And Fauna

a) Tree species identified in the flood basin, catchment area and downstream along the Munyati River near the proposed Kudu Dam.

Habitat: Mopane and Acacia Woodland (MAW) and Riverine Fringe (RF)

Shona	Scientific Name	Habitat
Mumvee	Kigelia africana	RF
Mopane	Colophospermun mopane	MAW
Munanga	Acacia polyacantha	MAW
Muwunga	Acacia nilotica	MAW
Mutondo	Julbernardia globiflora	MAW
Musasa	Brachystegia spiciformis	MAW
Mupfuti	Brachystegia boehmii	MAW/RF
Mutowa	Diplorhynchus condylocarpon	MAW
Mupembere	Combretum molle	MAW
Muunze	Brachystegia glaucescens	MAW
Mutepe	Salix subserrata	RF
Mutamba	Strychnos cocculoides	MAW/RF
Muruka	Hippocratea africana	MAW
Mushonjowa	Pseudolachnostylis maprouneifolia	MAW
Muhwakwa	Strychnos innocua	MAW/RF
Mubvumira	Kirkia acuminata	MAW
Mujese	Combretum spp	MAW
Mikaya	Acacia nigrescens	MAW
Muchechete	Ziziphus mucronata	RF
Musuma	Diospyros mespiliformis	RF
Muwuyu	Adansonia digitata	MAW
Mupangara	Dichrostachys cinerea	MAW

b) Animal species identified

Common Name	Scientific Name
Kudu	Tragelaphus strepsicerus
Baboon	Papio ursinus
Monkey	Cersopithecus pygerythrus
Crocodile	Crocodilia spp

c) Fish species identified

Scientific Name

Tilapia spp
Clarius spp
Limnothorisa spp

d) Bird species identified

Habitat: MAW = Mopane and Acacia Woodland, RF = Riverine Fringe

Habitat	Scientific Name	Habitat
Reed Cormorants	Phalacrocorax africanus	RF
Darter	Anhinga rufa	RF
Hamerkop	Scopus umbretta	RF
White faced duck	Viduata dendrocygna	RF
Crimson-breasted shrike	Laniarius atrococcineus	MAW
Reh-billed Hornbill	Tockus erythrorhynchus	MAW
Yellow billed Hornbill	Tockus flavirostris	MAW

e) Grass species identified

Habitat: RF= Riverine fringe; CL = Cultivated Land; MAW = Mopane and Acacia Woodland

Common Name	Scientific Name	Habitat
Nile grass	Acroceras macrum	RF
Devils horsewhip	Achyranthes aspera	CL
Upright starbur	Acanthospermum hispidium	CL
White flowered sedge	Cyperus angolensis	MAW
Blue bush	Eriosena engleranum	MAW

APPENDIX II

Composition of the Team

This E.I.A. was carried out by a team of four consultants. These are :

MR D MAZVIMAVI: Hydrologist - was responsible for aspects of the EIA that relate to the distribution of water on the surface of the land, in the soil, underlying rocks and the immediate atmosphere.

PROF L M ZINYAMA: Agricultural geographer - was responsible for aspects of the relief features, land use and human settlement.

MR B N DUBE: Invertebrate zoologist - was responsible for the biological aspects of wildlife and vegetation with special emphasis on how aquatic and terrestrial ecosystems are affected.

DR J M GOPO: Molecular Geneticist - was responsible for the biological aspects of animal and plant life with special reference to genetic resources and how these could be affected by the project.

APPENDIX III

Figure I

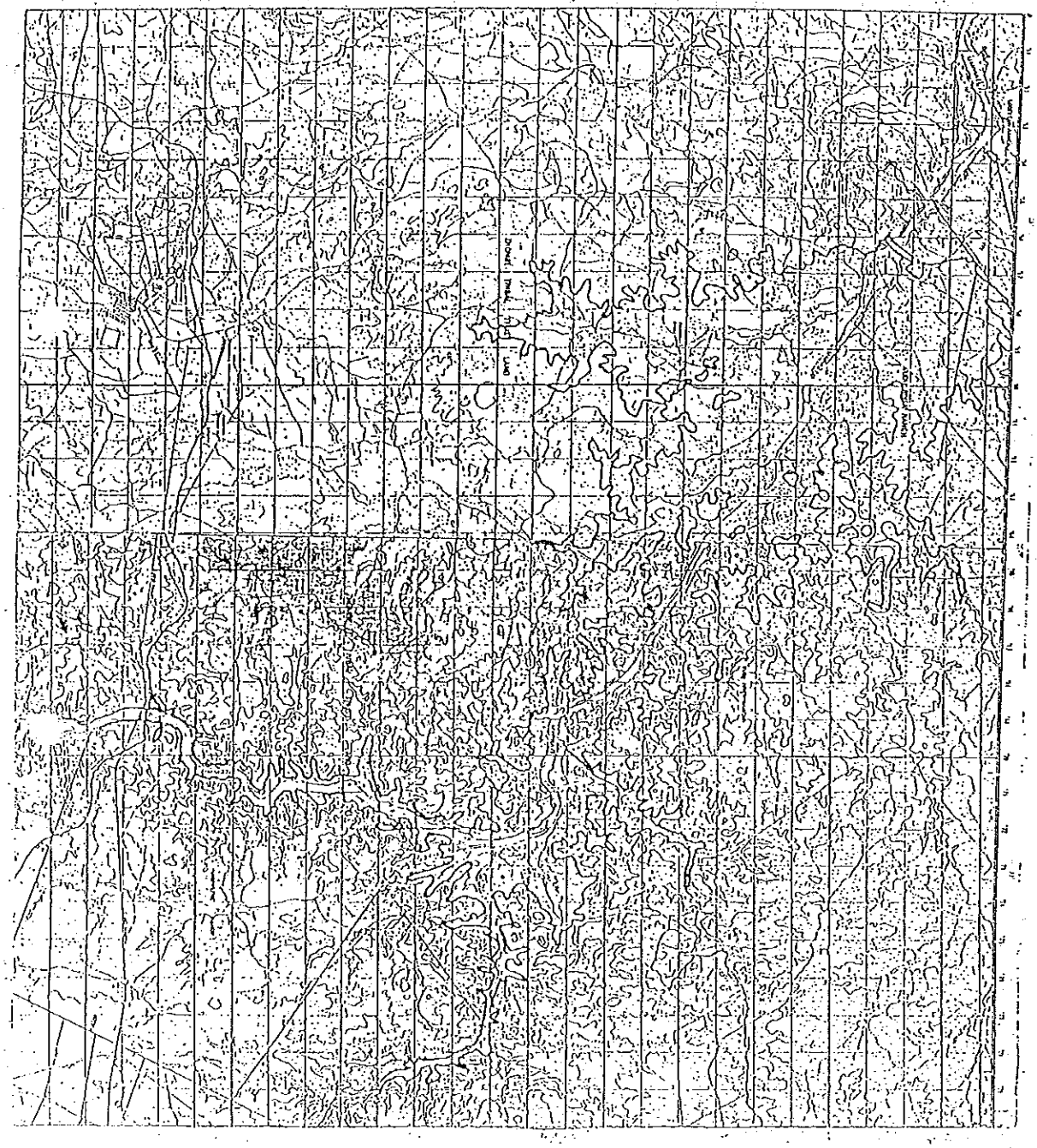
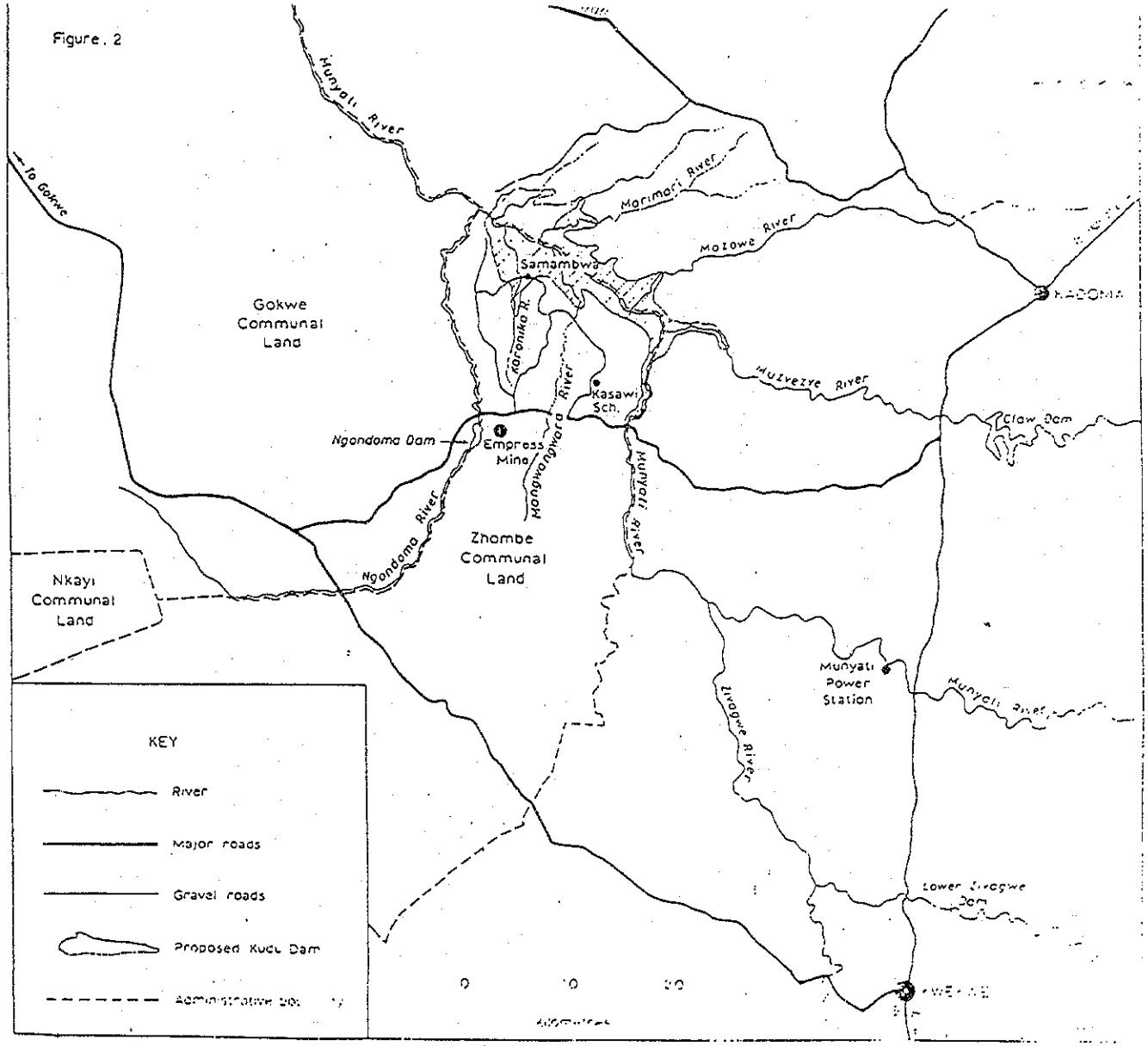


Figure. 2


Hunyali River
To Gokwe
Marimari River
Mozowe River
Samambwa
KADOMA
Gokwe
Communal
Land
Karonika R.
Kasawi
Sch.
Muzvezve River
Ngondoma Dam
Empress
Mine
Mongwongwora River
Clow Dam
Ngondoma River
Zhombe
Communal
Land
Munyati River
Nkayi
Communal
Land
Munyati
Power
Station
Munyati River
Lower Sinoswe
Dam
KEY
River
Major roads
Gravel roads
Proposed Kuch Dam
Administrative Bdy

APPENDIX IV

Checklist of Key Questions Used During Interviews with Residents

1. Period of settlement in this area by the family.
2. Area of origin of the family.
3. Prior awareness of proposal to build a large dam in the area.
4. Methods of dissemination of information about the dam and the extent effectiveness of local consultations.
5. Anticipated benefits from the dam.
6. Willing to be relocated from present locality to make way for the dam.
7. Preferred area for resettlement in the event of relocation.
8. Anticipated losses - economic, social, etc - arising from relocation.

参考資料６．ジンバブエ国クドゥダム灌漑事業計画に関する事前確認事項

1993年8月
JICA農調部農調課　勝又　淑美

ジンバブエ国クドゥダム灌漑事業計画に関する事前確認事項

以下は、本件事前調査派遣に先立ち、日本側の対処方針を決定するにあたり必要な情報収集のため業務出張した際に先方政府から確認した内容をとりまとめたものである。調査日程は２日間で、在ジンバブエ日本大使館参次官との打ち合わせおよび先方関係機関（AGRITEX、DWDおよびDNR）との協議に１日を費やし、残り１日を調査対象地域の視察にあてた。なお、下記の確認事項は事前に開催した外務省および農林水産省との勉強会の結果に基づき、決定したものである。

調査実施体制

本調査の実施機関となっているMinistry of Lands, Agriculture and Water DevelopmentのDepartment of Agricultural, Technical and Extension Services (AGRITEX)の役割、管轄事業等は何か。同様にDepartment of Water Development (DWD)の役割、管轄事業等は何か。また、本調査実施にあたっては、複数の局が協力をしていく必要があるが、どのような組織体制を考えているか。

→　灌漑事業では、水資源の確保とmain canalに関することはDWD、secondary canal以下いわゆるon- farm managementに関すること（営農栽培に係わることも含む）はAGRITEXの責任・管轄にあるということだった。

日本側に要請している調査の内容は、クドゥダム建設によって確保される水資源を利用して開発する地区を確定することおよび灌漑開発計画の策定であるので、調査実施にあたってはAGRITEXがカウンターパート機関となるべきと考えていた。これに対し、提出されているTORの中には、main canalの計画およびクドゥダム建設計画のレビューも含まれており、DWDも本調査の実施に役割を果たす必要があるということを当方から指摘したところ、DWDにはそのような認識はなく、いいかえれば、提出されているTORの中味を充分に理解していないことがわかった。

DWDは、とにかく便益地さえ明らかになればmain canalの計画はDWD自身で実施する意向のようでもあり、要請している調査の実施にあたっては中心となるのはAGRITEXと考えている。

一方、AGRITEXのほうは、本調査実施の要請をしている当事者としての自覚がないようにもうかがえられた。

受益地の現況

受益地に関する情報がほとんどないので、以下について可能な限り情報提供を依頼する。

土地所有
人口分布
土壌・土地利用状況
気象状況（降雨量等）
社会インフラ整備状況

→　時間不足のため、充分な情報を得られなかったが、気象・水文データについては、全国を網羅したかたちで観測所が設置されているので、調査に必要なデータは整っているということであった。社会・経済面での情報は充分に整備されていないようであった。

事業化の目処

事業化の目処は案件採択に際し重要なポイントであるが、事業実施の資金調達先として考慮している機関はあるか。

事業実施の費用としてどのくらいを予定しているか、あるいはどのくらいであれば財政上対応可能と考えているか。

OECFでは現在のところジンバブエに対する借款の規模として100億円を上限としているようであるが（これも約３年に１回の割合）、それ以上の費用については自国で準備できる可能性はあるか。また、その上限はどれくらいか。

→ ダム建設コストはZ$343,000,000（約50億円）と積算されているが、それ以外は調査の費用は調査してみなければわからない。OECFのソフトローンは魅力的だが、F/Sの結果、経済性が高ければ融資に関心を示す国は他にもあるはず。問題なのは融資の規模ではなく、経済性であって、F/Sの結果あまり優良案件でないことが明らかになれば、事業化はむずかしいだろう。ジンバブエ国政府のこの点の判断は厳しく行っている。

現在建設中のオズボンダムはイタリアの融資による。フランスの援助によって現在トクウェムコシダム（クドゥダムよりも規模は大きい）のF/Sを実施中であるが、ポテンシャルが高そうなので、フランス及びイタリアが融資に関心がありそうである。

国際河川としての問題

ムニャティ川は、ザンビア国との国境に位置するカリバ湖にそそぐサニャティ川と合流しているが、本計画のダムを建設することで、ザンビア国との間に水利権の問題は生じないか。

→ 国際河川の問題については、なんだかの協定を結ぶ必要があることは認識しており検討中であるが、現在のところ関係諸国との間で具体的な協議はない。

ムニャティ川も、国際河川として扱う協定はない。カリバ湖の規模から考えても、本計画が及ぼす影響は僅かなものである。

国際援助機関の動向

UNDPが小規模かんがい開発の援助を実施しているようだが、どのような内容か。また、その他の援助機関の農業分野における協力はいかなるものか。

→ AGRITEXの管轄事業のなかでは、現在EEC、DANIDA、KFW、UNDP/FAOが灌漑開発事業の援助を実施している。その中味の概要は追って送付する。

地形図

計画対象地区の地形図整備状況（縮尺、コンター、作成年度等）及びの航空写真の有無と縮尺。土地利用図、土壌図の有無。

ダムについてのD.D.において作成した地形図でカバーしている範囲と縮尺。

→ 地形図は縮尺1/50,000、コンター20mのものがある（入手済み）。ジンバブエでは４年間に全国をカバーするペースで地図を作成している。

調査対象地区全体の土壌図はすべてないが、一部communal land 等について作成してあるところもある。

ダムのD.Dでは国内の業者によってダムベースについて縮尺1/500、ダムサイトについて縮尺1/1000の地図を航空測量によって作成した。ちなみに、コスト

は7000m×300mの範囲について縮尺1/1000、コンター0.5mの地図を作成するのに、写真撮影を含めZ$155,000であった。

その他

既存のダムについてsiltationの問題が発生しているようだが本ダム計画においては同様の問題が生じる可能性はないか。

→本ダム計画では充分な滞砂量を見込んで設計されている。

提出されたEIAレポートに関する質問事項

水没地のKaronika and Mangwarangwara Valleysに住んでいる2,500～3,000人（400～500家族）の移転の候補地とされているMuzvezve Resettlementの位置と現況。

→ 移転候補地はムニャティ川右岸にあり、Resettlement地区として開発されてきたが、面積的にまだ充分余裕があるので移転先として利用できる。（現況については現地視察中に確認する予定であったが、時間がとれなかった。）

Department of Rural Developmentの基準によると、非かんがい地に移転させる場合1家族あたりの割り当ては55ヘクタールで、500家族を移転させる場合には27,500ヘクタールのcommercial farmlandを確保する必要があるということだが、1家族あたり55ヘクタールという基準の根拠は何か。また、移転の対象となる地域はcommunal landであるのにcommercial farmlandを確保する理由は何か。上記の基準によって移転計画を策定した場合、実際27,500ヘクタールの土地をまとまって確保することは可能なのか。

→ 上記はあくまで基準であり、現実としては移転前の環境よりベターであれば住民は納得して移住をする。従って、本計画実施に伴う移転先の確保はあまりむずかしくないと考えている。

移転事業に関わる複数の関係機関から、住民移転について充分に協力を得られる可能性はあるか。また、住民移転についての主務官庁はどこか。

→ 移転事業に際しては、農業省以外の機関との調整を必要とするが、移転実施の責任は開発計画の実施機関である農業省となる。

Departmenet of Natural Resourcesのcovering letterに触れられているOsborneダムあるいはMazvikadeiダム建設時に起きた地域住民の反対とはどのような内容のものか。また、それにはどのように対処したか。

→ Osborneダムの場合には、事業実施に際し前もって充分な話合いを住民と持たなかったため、一部の住民から補償が充分でないという反発があった。この問題は現在は解決されている。クドゥダムの場合には、住民に充分なヒアリングをすることでそのような問題は回避できると思う。Mazvikadeiダムはcommercial areaにあり、住民の移転問題はなかったが、一般の人がダムを見学できるアクセスがないという不平があった。ダムまでの道路を整備することで問題は解決された。

提出されているレポートはpreliminary EIAとして位置付けられているが、Department of Natural Resources が提言している環境配慮にかかる詳細調査及び環境管理計画の作成は今後どのように実施する予定か。特に、住民の意向については詳細調査をなるべく早く実施する必要があると考えるが、その実施時期と方法は具体的に考えているか。

→ 開発対象地区の確認がされ、ある程度事業の実施に目処がついた段階で個々の農民にヒヤリングをする。現時点では、事業実施が不確定すぎるため、詳細環境調査を実施する必要はないと考えている。詳細調査は主に住民移転に関することなのでジンバブエ側で実施すべき考えている。