

Report prepared for Lesotho Highlands Development Authority



LESOTHO HIGHLANDS WATER PROJECT



REPORT 45

Report prepared by Panel of Environmental Experts

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**Revision 0
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INTRODUCTION

1. The purpose of this report is to provide comment to the Lesotho Highlands Development Authority (LHDA) on draft final reports on LHDA Contract 1237. The specific reports are
 - Task 3: Result of the 12-month monitoring program – LHDA Report No 1237 – 04/05 (cover says report 1237-02 and title page says Report 1237-04; see comment 17 bullet 1 below)
 - Task 4: Final project evaluation report – LHDA No Report 1237 – 06.
2. The Panel of Environmental Experts (PoE) was forwarded the reports. The comments that PoE drafted and that follow were circulated among Panel members.
3. LHDA Contract 1237 was among the better-executed of LHDA environmental contracts. Both LHDA and the Consultant (Southern Waters) deserve congratulation. There are however several serious issues regarding biophysical monitoring and IFR as a whole. These issues are raised in the paragraphs below.

REPORT 04/05

4. Report 04/05 states that flow variability is at least as important as flow volume, and that flood releases should coincide with natural rainfall events as closely as possible. Report 04/05 also finds that releases were not as variable as they should or might have been (Section 5). If flow variability and mimicking nature are important then the flow regime imposed by IFR Policy & Procedures is reducing flow variability and artificializing it. To explain, consider the following.
 - Some floods are being withheld, and the choice of which floods to release and which to withhold is inevitably artificial the full environmental consequences of which are unknowable.
 - The strategy to release a specifically sized flood (even varied in relation to hydrological classification) at the same time of year every year (even qualified to await rain) is not natural in southern Africa. One can conceive of a range of climatic events from spring starting with a big rainfall event and flood, through a series of light showers, or a pre-spring big rainfall event and flood, to drought through early and mid summer. Ecologists consider that ecosystems are biodiverse and have resilience not despite this variation, and stress, but because of it. In simplistic terms, the ecosystem, like the human body, requires to be challenged repeatedly to maintain its capacity to withstand stress and disturbance. How is a release regime designed to mimic the natural variation? The guidance to effect that ‘flood release to await rain’ is admittedly better than ‘blue-sky floods’. But the Consultant’s track record (more than 50% of predictions wrong – see Comment 11 below) does not qualify the Consultant to play god with the system.

- The principle of release regime depending on the hydrological class revised quarterly is an artifact. While streamflow is not a random variable and streamflow for successive periods might, like stockmarket prices, be positively correlated, the streamflow for a future quarter cannot be predicted from the streamflow of the previous quarter any better than stockmarket prices can be predicted. Thus, while there might be a correlation between streamflows of successive quarters, the adoption of the strategy of release according to hydrological class is liable to damp natural streamflow variability. PoE repeats the ecological principle: it is this variability, and the stress and disturbance that accompany it, that sustain habitat and species diversity and ecosystem resilience to shocks.
- The sizes of the intended flood releases are large in relation to the fraction of MAR that is allocated to IFR (*ie* the bulk IFR). PoE does not have the IFR Procedures at hand, but from recollection the intended flood releases are much bigger, for specified flood frequency, than the native flood multiplied by the fraction 'bulk IFR/MAR'.
- In Report 04/05 the occurrence of floods of various sizes and frequencies is measured against the natural (unregulated river) floods rather than the natural floods scaled down by the fraction 'bulk IFR/MAR'. Why is this comparison being made? Is it intended to retain the original river profile? Under the circumstances of bulk IFR being 10% to 20% of native MAR, can this be considered natural, or mimicking nature? Can it be considered more natural than applying the strategy of instantaneous rate of release equals instantaneous rate of inflow into dam multiplied by the fraction bulk IFR/MAR? Report 04/05 does mention the risk of lateral damage. The implication apparently is that if the pre-regulation river profile closes in, or becomes obstructed by woody vegetation, the inevitable and unstoppable big floods will cause lateral damage. This might indeed apply in other cases, but for the proximal reaches in Lesotho, people do not live near the river, and there is a minimum of built infrastructure that could be damaged. To be sure, the reduced flows have allowed sedimentation and soil and vegetation establishment on rocky banks and islands, and permitted livestock grazing and annual cropping further down the bank than in the pre-regulated condition. Even if the grazing potential is occasionally impaired by big floods, or crops are destroyed, or fields are damaged, there is liable to be a net benefit to the agro-pastoralists. The one lean year in 20 (or other such infrequent interval) must be offset against the other 19 plentiful years. The odds are better than the 7 lean and 7 plentiful years successfully handled by Joseph in the days of Pharaoh. The argument of lateral damage on the proximal reaches in Lesotho is a red herring.

Recommendation Ensure flow variability. Consider following as closely as feasible the strategy that instantaneous rate of release equals instantaneous rate of inflow into dam multiplied by the fraction bulk IFR/MAR. A review of IFR Policy & Procedures is implied (see recommendation to Comment 12).

5. Mention of spills in Report 04/05 was not found. Are spills included in what is defined as ‘release’? Unless spills are taken into account, the downstream response of rivers to flows is liable to be difficult to explain.

Recommendation Make explicit mention of spills (when they occur and details as far as possible), and take spills into account explicitly when explaining or describing downstream river responses.

6. Readers are not provided with sufficient information to know the confidence that can be attached to inferences from water quality data presented. Examples of the kinds of deficiencies are as follows. Report 04/05 Table 8.2 gives regression coefficients (r^2) for the trend in water quality parameters over time. The degrees of freedom are not provided so the significance of the r^2 values cannot be understood by the reader. Regression coefficients in Table 8.2 for trend in total phosphate are all low (0.00 to 0.03) yet, in contradiction, in subsequent subsections decreases in total phosphates are claimed. For example, for IFR sites 2 and 3 the trend over time is an increase in total phosphates but the text claims a decrease (in median value). What must the reader believe? What variability is associated with sampling, say, total phosphates? If several replicate samples were taken from the same river reach on the same day, how does the laboratory-determined total phosphate vary? If samples were drawn from the same river reach over successive days or weeks, how do they vary? PoE has not seen the Consultant’s Report 03 on monitoring protocol where, maybe, answer to these questions can be found. Possibly the season during which certain water quality data are collected strongly affects the values (*eg* temperature). Simply lumping all data together could add undue variability so that actual trends are obscured.

Recommendation Remedy deficiencies in data analysis, interpretation and write-up, as far as possible.

7. While PoE does not disagree with the main conclusions of section 9 to effect that riparian woody vegetation has increased, PoE queries what confidence can be attached to the data collected in biophysical monitoring, and whether the expensive monitoring is any more reliable than fixed point photography. The methods are insufficiently described for the reader to understand the data in the tables (*eg* Table 9.1). Values are given in percentages to the first decimal place, which is surely spurious accuracy. The percentages for the plants recorded do not add to 100%. What is the replicate similarity? On what basis are comparisons made between times? Using normal statistics? But the samples are not random since they are at fixed sites. Perhaps there is an intention to show only crudely whether or not there is trend over time. Yet to what extent do the plots represent the river reaches in which they are located? Without answers to these questions the inferences to be drawn from data compilations as in Table 9.15 are uncertain. PoE has not seen the Consultant’s Report 03 containing the monitoring protocol, and maybe the above kinds of queries are answered in the protocol, but the write-up of the vegetation monitoring data as it now stands does not permit demonstrably secure inferences to be drawn.

Recommendation The monitoring data must be qualified to show what, if any, confidence can be attached to them.

8. Report 04/05 infers that, since *Gomphostigma* and *Salix fragilis* increased during the past wet year at control site 9 (where there has been no flow reduction), and increased slightly at sites 1 and 2, moisture conditions are the determining factor. However, why does the report overlook the decreases at other sites during the same period? Why should a moisture limitation mechanism necessarily apply, and how are other determinants of vegetation, such as flooding and scouring, exploitation and herbivory, excluded? Plausibly the recruitment originated from the absence of flooding, and scouring, prior to the recent wet year. Maybe the Consultant is correct, but compelling evidence to exclude other explanations is not provided, in which case the Consultant's inferences are just one among many possibilities.

Recommendation If explanations are to be offered, then all competitive ones should be evaluated. Positive or confirming evidence is not enough, since no matter how many black crows are seen it can never be asserted with absolute confidence that all black crows are coloured black. Effort must be directed at excluding explanations, by showing that they fail to account for the facts.

9. In section 10 of Report 04/05 it is stated that though macroinvertebrate species diversity has increased, sensitive species have been replaced by tolerant species. PoE asks, what is the purpose of downstream river management? Is it to sustain biodiversity? Or are there pre-identified sensitive or Red Data macroinvertebrate species warranting preservation? If the latter is so, it is not evident from the present and previous IFR reports. In any case, what is a sensitive species? One that is sensitive to reduced river flows? What is a tolerant species? One that is tolerant of reduced river flows? Are these not just circular arguments? Of what environmental or conservation import are these issues? The report does not explain. In a narrow sense, change from the pre-regulation river state might be regarded as degradation. But change from the pre-regulation river state does not necessarily involve loss of biodiversity or environmental function – it might just be a shift in species composition and an altered mode of environmental function. By analogy, for some people a proper savanna is the 'out of Africa' scene of grassland with scattered big umbrella thorn trees (and black-maned lions, big-tusked elephant and distinctly striped zebra). But in reality savanna structure and function vary in time and space and from a conservation viewpoint the variety, not the 'out of Africa' scene, is preferred. Some years ago, the then current notion of norms, an ideal to create and maintain a view of what a savanna should be (*cf* 'out of Africa' in Kruger Park) was condemned as 'gardening'. The notion of norms presumed what savannas were supposed to look like (*cf* 'out of Africa'). In reality savannas are fluctuating event-driven ecosystems (*viz* a flood, a drought, a cold snap, a heat wave, a fire, a bout of overgrazing, anthrax, foot-and-mouth, a locust plague, a mopani worm invasion) whose biodiversity persists not despite this 'noise' but because of it. Back to rivers, PoE perceives these as event-driven systems, and yet the impression created by Report 04/05 is that there are good (the equivalent of super tuskers) and bad (the equivalent of TB-infected lions) macroinvertebrate species, and the bad are

displacing the good. If this is indeed the case, the report is thin on the explanation why. Some of the inferences are very tenuous. For example in Table 10.5 numbers of Physidae in 1998, 2005 and 2006 were 0, 1, and 0 respectively, yet the conclusion is 'Increased, as predicted'. Even if sampling variation is attached, this conclusion is not justified.

Recommendation Substantive explanations are required for how and why biodiversity and environmental function are changing for better or worse. A simple deviation from the pre-regulated state is not compelling for it could involve increase in species richness, as in the present case, and, if increased biodiversity is bad, then the Consultant is challenged to explain why.

10. Section 11 of Report 04/05 suffers from the same kind of deficiency as the preceding sections, that is that the precision and accuracy of sampling are unstated and possibly undetermined. By precision is meant sampling variation. If the sampling effort were repeated the next day or week, or by a different monitoring team, how different would the results be? By accuracy is meant how representative is the sample of the reach that it is supposed to reflect. If the sampling were done upstream or downstream of the site, would it matter, and by how much? These are not trivial questions. The numbers of fish caught are small, and the fishing effort is not stated. Was the same catch effort expended on each occasion? Maybe the monitoring protocol of Report 03 explains. But we amateur fishermen are familiar with the vagaries of nature. One day you catch a bag full in no time. But the next day at the same place there is not a fish to be caught nor even to be seen if you go snorkeling. The fish monitors caught no trout in Reach 1, but Dr John Ambrose, the World Bank's environmental expert, caught a whopper rainbow below Matsoku weir.

Recommendation For secure inferences to be drawn from the monitoring data, precision and accuracy must be stated.

11. Table 12.3 of Report 04/05 describes the river states in terms of several criteria. Departure from the pristine or unmodified condition is implicitly, if not explicitly, regarded as degradation. In a sense, departure from unmodified nature might be regarded not just as change but degradation. However, if this view of the world were widely accepted then we should all go back to being hunter-gatherers. Quite as cogently, with the bulk IFR being only 10% to 20% of native MAR, is it realistic to measure river condition in relation to the pre-regulation condition? Why not allow the river to downsize in relation to the reduced river flows, and then manage for compatible biodiversity? (Compare the farming situation where the farmer dispenses with lions and elephants and other species incompatible with his cattle, goats and sheep that depend on the productivity of the native flora that supports a variety of antelope, birds, other wild animals, and [modified] ecosystem function.) The Consultant was challenged with down-sizing the river at the first IFR workshops in Lesotho. In deference to the experts, the Consultant's view prevailed. But the situation has arisen now where a rethink is warranted. On the one hand we have the World Bank writing to the Lesotho Highlands Water Commission arguing that the Consultant is the Project's expert on IFR, not PoE. On the other hand biophysical

monitoring undertaken by the Consultant shows >50% of the Consultant's predictions about riparian vegetation, macroinvertebrates and fish to have turned out mistaken (see Exhibit 1). (PoE applauds explicit testing of predictions.) PoE pointed out some of these mistaken predictions long ago. Returning to Table 12.3, if the inevitable is accepted, the regulated river is going to get smaller, then the criterion regarding pool size warrants revision. The criterion on mean monthly temperature is not sufficiently explained for most readers, but presumably what is intended is difference in mean monthly temperature from a reference river. Obviously the choice of the reference river becomes important since small rivers in Lesotho are known to undergo large diurnal variations in temperature.

Recommendation LHWP IFR must be revisited, the various approaches identified and considered, to ensure that LHDA pursues the most cost-effective management to satisfy needs.

Exhibit 1 Outcome of IFR Consultant's predictions. The most conservative evaluation scores only where predictions were correct or incorrect, the undetermined predictions being omitted. In this case, 55% of 115 predictions were incorrect. If the undetermined outcomes are added, then up to 58% of 126 predictions were incorrect. The determinations are based only on prediction of the direction of change (constant, increase or decrease) not the amount of change. The Consultant is inconsistent, or not always justified, in deciding whether increase or decrease was significant (*eg* Comment 9).

Report 1237-04 table	Predictions					
	Correct		Incorrect		Undetermined	
	Number	%	Number	%	Number	%
9.2	1	33	2	67	0	0
9.4	3	50	3	50	0	0
9.6	3	60	2	40	0	0
9.7	1	25	3	75	0	0
9.9	0	0	2	100	0	0
9.10	3	75	1	25	0	0
9.12	2	40	3	60	0	0
10.5	5	45	6	55	1	8
10.9	3	33	6	67	1	10
10.13	7	54	6	46	0	0
10.17	2	20	8	80	0	0
10.22	4	44	5	56	0	0
10.26	2	40	3	60	1	17
10.30	6	46	7	54	0	0
11.1	1	50	1	50	0	0
11.2	1	33	2	67	1	25
11.3	1	50	1	50	2	50
11.4	2	100	0	0	2	50
11.5	2	100	0	0	2	50
11.6	1	33	2	67	0	0
11.7	2	100	0	0	1	33
Totals	52	45	63	55	11	9

12. In Section 13.1 of Report 04/05 it is mentioned that in not one of the cases was there statistically significant change in key resources. However, the preceding sections and the subsequent sub-sections mention many instances of decrease or increase. Strictly, if there is no statistically significant change then one is not entitled to say decrease or increase. The report is therefore riddled with contradiction. In terms of comments made above about precision and accuracy of data, on the basis of the information given in Report 04/05, no confidence limits are attached to the data, statistical significance is beyond the reader's reach, and the Report's claim of no statistically significant change is not backed up with the necessary information.

Recommendation The entire report requires revision, and no inferences should be drawn by the Consultant unless justified on the basis of sampling variability and representativeness of data.

13. PoE has read Section 14 of Report 04/05 on the Consultant's responses to key questions. In this regard, and in regard to the IFR Policy & Procedures, PoE questions whether this vast complexity is warranted. Are we not making work for ourselves by adopting hydrological classifications, calculating flow regimes, and trying to conform with these regimes? What is this achieving? We must have spent M60 million in consulting fees, downstream compensation (more to come still) and administration. More than half of the Consultant's predictions turned out wrong. (As the gurus say, it's not what you don't know that matters, but rather what you think you know but don't.) The rivers seem not to have changed significantly, in the words of the Consultant (see comment 12 above). The proximal river reaches are in better condition than targeted. Is there not a simpler, less costly way of achieving the same or even better? For example, why not change the objective from minimizing deviation from the unregulated river to managing for a smaller healthy river? Why not, after determining what fraction bulk IFR is of native MAR, release so that, as closely as feasible, the instantaneous rate of release from a reservoir equals the instantaneous rate of inflow into that reservoir multiplied by the fraction 'bulk IFR/MAR'? If this can be done it would avoid tedious determinations of hydrological classes, determining flow regimes, trying to conform with flow regimes, invoking inevitably fallible human decisions at every turn, and still oversimplifying natural variability in streamflow. The release management could probably be automated, with over- or under-releases over the past day/week/month immediately compensated for in the next release valve adjustment, and override being allowed only in case of emergency or top management authorization. Parsimony is a cornerstone of science, technology and economics. Why have anything more complicated, more labour-intensive or more costly than the minimum needed to achieve the objective?

Recommendation See recommendation under Comment 11 above.

14. In overview of Report 04/05, PoE does not dispute the general conclusions of the Report to effect that river conditions are better than targeted, that riparian woody vegetation on proximal reaches is increasing and that there is little change on distal reaches where flow-related resource losses are not evident. But, as outlined above, PoE considers that there are shortcomings in the biophysical monitoring. These shortcomings are glossed over, even ignored, by the Consultant, and certainly not sufficiently addressed in Report 06. It is not enough to say that monitoring provides snapshots of a moving system. We know that. But what reliability can be attached to a snapshot? What are the relative contributions of (im)precision and (in)accuracy? How secure are the inferences being drawn from the snapshots? Reports 04/05 and 06 get nowhere near answering these important questions, nor in recommending remedies. Further, PoE cannot find in Report 04/05 how adequately the data demands for applying the decision rules are being satisfied by the monitoring and what, if any, remedies are warranted (see PoE Report 41, April 2005, pages 21-22). Finally, the biophysical monitoring has not been tied in with participative monitoring on biophysical resources and socio-economics. What is the point of participatory monitoring when the hypotheses it generates (as the World Bank calls them) are not tested?

Recommendation Monitoring reports must identify the shortcomings of monitoring and recommend how to improve technique efficiency (*ie* maximize precision and accuracy per unit effort or cost). The Consultant must evaluate the biophysical monitoring data explicitly in relation to the decision rules concerning 2nd tranche proximal reach compensation and distal reach compensation. Cross reference to participatory monitoring on biophysical resources and socio-economic is warranted.

REPORT 06

15. PoE has not seen the Consultant's Report 03 on the monitoring protocol, PoE is therefore not in possession of the full picture, and PoE is thus not able to advise on whether the methods have the potential to yield the data necessary to apply the decision rules regarding distal reach compensation and 2nd tranche compensation on proximal reaches.

Recommendation PoE should review Report 03 containing the monitoring protocol.

16. Despite the good intentions and effort of the Contract 1237 Consultant and LHDA, the biophysical monitoring is falling short in implementation. Why is this, and what might be done? What are the options?

- *In-house or out-sourcing* The monitoring program is ambitious and there must be few, if any, organizations that would undertake such an operation entirely in-house. The standard practice today, for operation efficiency reasons, is to employ fulltime only that expertise needed for core business, and to hire other expertise if and when it is needed. At the moment LHDA is practising a mixed approach with some out-sourcing and some use of in-house resources. If LHDA out-sources completely then the cost will rise, LHDA might lose ownership over the program, and the skills transfer would fall away. As the Consultant identifies, the use of some in-house human resources is vulnerable to staff turnover. The other extreme, a completely in-house operation, is simply not a proposition at the moment. One is reminded of the current fad in corporate risk assessment particularly in relation to catastrophes and global threats such as a disease pandemic. The companies that survived 9/11 were those with a flat corporate structure and multi-skilled staff scattered beyond the twin towers.

Recommendation Continue with the mixed approach with outsourcing and using in-house human resources where available. Where expertise is out-sourced, select Basotho resources in preference to expertise from further away. Continue with the skills transfer to build capacity in LHDA and in Lesotho, as a corporate social responsibility project. Where individuals are indispensable, these individuals should be required to train up counterparts. In general, perform a risk assessment to identify the threats to, and opportunities of, biophysical monitoring, and then design and implement the appropriate risk management (see *Harvard Business Review* May 2006 pages 20-40 for guidance on building resilience into a project or organization so it can withstand likely shocks and, especially, unlikely shocks that could have big consequence).

- *Scope of monitoring* The present scope of biophysical monitoring – the river aspects that are monitored (flows, water quality, hydraulics, geomorphology, vegetation, macroinvertebrates and fish) – is determined partly by the demands of measuring river condition and partly to enable application of the decision rules regarding downstream compensation. As nice as all this information is to have, is it essential? A case might be made that the criteria of river condition might be reduced to water quality, vegetation and fish (information needed for applying the decision rules). As pointed out in the comments on Report 04/05, there are shortcomings in the monitoring data being collected, so one argument might be to reduce the scope and increase the quality – a little bit of really good data with confidence attached is worth infinitely more than a mountain of numbers from which secure inferences cannot be drawn.

Recommendation LHDA should consider revising the river condition assessment to depend on water quality, vegetation and fish, and to concentrate resources in collecting better information than up until now on these issues. Flow recording must of course continue.

EDITORIAL

17. The reports are not badly presented, but editorial improvement is warranted. PoE has not been exhaustive in the editorial review, and merely provides some examples of shortcomings in Report 04/05.

- The report number on the cover does not coincide with the report number in the text.
- Sometimes reports are numbered 01, 02, 03, ... other times 1, 2, 3, ..
- The Table of Contents facility in MSWord, to permit quick digital access to sections in the text, has not been enabled.
- The page numbering in Roman numerals in the beginning and Arabic numerals for the body of the report is an anachronism. In the old days the body of a book was typeset and paginated, starting with page 1. After this the introductory sections were compiled with a different system of page numbering. But nowadays the whole document can be compiled electronically, and updated instantly with one system of numbering. But whatever the history, why have two numbering systems when one will do? This is the selfsame lack of parsimony that we see elsewhere (see Comment 13, programme instead of program, Report No. 03 when Report 3 is enough (everyone can see that 03 or 3 is a number), plants measured to 0.0%, 15th – 22nd September when 15-22 September will do, pleonasms like ‘data record’ when ‘data’ or ‘record’ suffice, use of punctuation when the meaning would be the same without punctuation, etc). This criticism goes beyond nit-picking. If the report compilation lacks parsimony you can bet the substantive work suffers the same malady. And the Panel submits exactly this. The whole IFR paradigm could benefit from ruthless pursuit of economy and parsimony (see Comment 13 above).
- The footings on pages before the Introduction do not coincide with those after the Introduction.
- Page 36 line -1 required not require
- Sometimes ‘<5m’ other times ‘< 5 m’
- Sometimes personnel are given a title (Mr or Ms), other times not
- Abbreviations are inconsistent – Mr without a stop but i.e. with stops. Consistency is aided by parsimony – don’t unless you have to. Don’t punctuate, use a capital, use a word, apply a technique, make an elaboration, unless it is essential for achieving the objective.
- In Section 8 the regression coefficient is sometimes abbreviated as r2 and times as r².
- LHDA is an organization and is singular but in the reports it is repeatedly assumed to be plural.
- In most tables the passage of time goes from left to right – a convention. But in Tables 10.4, 10.8, 10.12, 10.16, 10.25 and 10.33 time goes backwards or one must read from right to left.

- It is *Pseudobarbus* not *Pseudobarbus*. The spelling is inconsistent.
- At the foot of page 88 there is a blank bullet and the last bullet is incoherent.

Recommendation The reports warrant editorial improvement along the lines sketched above.