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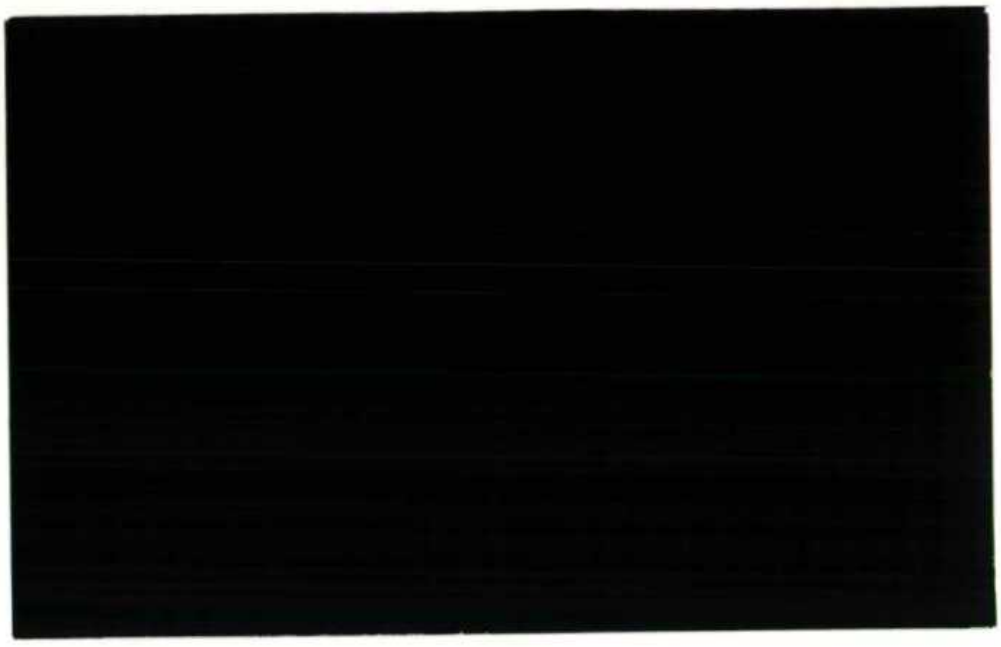

Natural Environment Research Council

THE GK EXPERIMENTAL AND REPRESENTATIVE BASIN PROGRAMME

REPORT ON A SUPPORT VISIT IN FEBRUARY 1981

BY

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INSTITUTE OF HYDROLOGY

Contents

Introduction

This research programme was initiated in 1976 jointly by the Ministry of Water Development and the UK Overseas Development Ministry. The objectives were to instrument four small catchments within the medium potential area of Kenya, to accumulate rainfall, streamflow, sediment transport and meteorological data over a number of years and to derive from these data a detailed understanding of the hydrology and erosion rates within this zone. This knowledge will form an invaluable basis for planning the development of water resources in this agriculturally important zone of Kenya. The data will also help to identify the problems arising from present agricultural practices in the zone and provide a reference basis against which the effects of improved practices can be judged.

The establishment phase of the Programme (normally referred to as the ODM Hydrology Project) over the period 1976-1980, was supported by ODM who provided, through the UK Institute of Hydrology, the instrumentation required, two full-time expatriate hydrologists, two Land Rovers and a number of other services including a training programme. GK investment in the project was considerable. It included the provision of counterpart staff, field staff, the building of the flow and sediment measuring structures, the provision of a JCB, a tipper truck and a 4 WD lorry to deal with sediment removal and, of course, provision of housing, office space and operational costs.

In their Review at the end of this phase ODM (now ODA) decided to reduce their support for the Project. The residual support they provide covers the translation of Automatic Water Station tapes, the provision of spares for the equipment and the provision of advisory and specialist services from the Institute of Hydrology. After the withdrawal of the two full time expatriate hydrologists the senior counterpart, Mr J O Nyagua, became leader of the project and the Ministry of Water Development took on the major part of the cost of

continuation of this important study. The Institute of Hydrology has continued to provide the translation services and has extended this to include some translation of water level recorder tapes.

The first support visit was made by Dr Edwards in May 1980. During the visit he concentrated mainly on negotiations with EEC to provide support for the Programme on the basis of its relevance to the Machakos Integrated Development Project. These negotiations and the reasons for their ultimate failure are described in his report of August 1980.

After discussions with the new project leader in June 1980 and with Chief Hydrologist MOWD in November 1980 it was agreed that a further support visit should be made in early 1981 by an appropriate member of staff of the Institute of Hydrology. This report covers the work done during this visit and suggestions and recommendations arising from discussions during the visit.

Objectives of the Visit

The agreed objectives of the visit were:-

(a) Following initial discussions with Director, Water Resources and Chief Hydrologist, to explore the current status of the project with the Ag. Project Leader and his staff.

(b) To visit the catchments to assess the field work.

(c) To contribute suggestions and work on the project where this seemed necessary.

(d) To review the status of the project, to discuss its future development and determine the extent to which future assistance will be necessary.

(e) To determine how the limited funding provided through ODA to the Institute can be used to provide the most effective support for the project.

Items (a), (b) and (c) have been carried out, though unfortunately leave and other committments meant that Director Water Resources was not able to join in the discussions. A summary of the work done and copies of notes for the assistance of the project team in the more efficient execution of the field work are contained in the appendices. The following sections of this report refer to items (d) and (e).

The Catchments

The achievements of the Project team in the establishment phase have been impressive. They have succeeded in establishing raingauge networks in all four catchments at Iiuni and Utangwa in Machakos, at Kitimui in Kitui and at Kune in Siakago. At an early stage Automatic Weather Stations were installed and brought into operation in all four. Despite major difficulties with exceptionally heavy rains in 1977 and 1978, combined flow measuring structures and sediment traps have been built and brought into operation in three of the catchments. These have been fully equipped with water level recorders and automatic sediment sampling equipment. From the early data the need for an additional sediment trap at Iiuni was determined and this has been built and brought into operation. Competent field observers have been recruited, trained and are now dealing confidently with their work in the catchments.

All concerned are to be congratulated on achieving so much during this phase in what, considering the geographical, topographical and meteorological difficulties, was a remarkably short time.

The remaining major item of establishment work is the building of the structure/ sediment trap on the Utangwa catchment. This is an exceptionally difficult site both topographically, geologically and politically (in the sense that any structure will interfere with local microscale irrigation and could also affect the road crossing the Utangwa river at the catchment outfall). Final discussions on the design and siting of this structure must be a priority when the Project Leader returns. Should it not prove possible to site an acceptable structure, the future of the catchment should be reviewed.

In addition to the four catchments designated under the original feasibility

survey, the Project team have also installed a basic raingauge network, a stable section and staff gauges in the much larger (70 Km^2) Kitete catchment which comprises the headwaters of the hydrologically important Ngaa River. Further development of work on this catchment must be considered in due course.

The HQ Team

The organisation of the project is such that the HQ team are responsible not only for checking, processing, filing and analysing the data but also for a major part of the field operation. They form the key to the success or failure of the entire project. Unless they can maintain the schedule of fortnightly visits to each catchment to change recording tapes and batteries, to service and reset the sediment samplers and to collect the accumulated data from the field observers then the continuous high quality data necessary will not be forthcoming for analysis. Decisions must also be made on each visit as to when sediment basin surveys are necessary and when and where the sediment clearing team should be brought into operation. Valuable back-up is provided to the HQ team by the MOWD Instrument Engineer who undertakes any instrument repairs and recalibrations required, using spares supplied by IH when these are not locally available, and who also undertakes the charging of the specialist batteries for the AWS and Water Level Recorders.

With the absence of the Project Leader on a 1 year postgraduate course in UK and the withdrawal of the two expatriate hydrologists a heavy burden has been placed on the comparatively young and inexperienced Ag. Project Leader. In the circumstances he and his team have had to concentrate on ensuring the continuing day to day operation of the data collection system, dealing with checking and the basic minimum of processing as time permits and carrying out very little analytical work.

The Ag. Project Leader and his team have coped reasonably well with this schedule. Where gaps have occurred in the data collection this has generally been due to instrument problems or circumstances for which their training had not fully prepared them, rather than due to any lack of application on their part.

Viewing the operation with fresh eyes it has been possible to identify some areas where the methods can be modified and improved and to suggest that a firmer approach to scheduling and recording catchment visits would be beneficial. These points have been discussed in detail with the Ag. Project Leader and his team and notes written on them are included in the appendices.

Whilst the depleted team have coped reasonably well with the restricted programme of scientific work, some difficulties appear to have arisen over administration and accounting aspects of the project.

A considerable overexpenditure has already occurred in this financial year. The main items in this appear to have been:

(a) Equipment ordered in the last financial year but delivered in the current one. The main items involved were a tractor and equipment for manual meteorological sites amounting to close to 200,000/-.

(b) An increase in salaries and allowances during the year.

(c) Continuing high repair costs on the older of the project Land Rovers.

In addition, however, some savings could have been effected by tighter scheduling of the necessary fortnightly field visits and by closer control over the

numbers employed in the field on building and maintenance work.

Future Development of the Programme

As indicated above, the field establishment phase of the programme is now essentially complete, apart from the Utangwa structure, and has progressively moved into the data accumulation phase. A minimum of five years data should be acquired from each catchment in its present state in this phase before any further modifications are considered. During this the HQ and field teams must continue to operate at their present level of efficiency or improve on it where possible.

This requires the HQ team and the field observer complement to remain at its present strength. After the Utangwa structure problem is solved the construction team can be reduced in strength to a level necessary to maintain the structures and carry out the sediment operations. A minimum of two serviceable Land Rovers plus the JCB and the tipper truck must be available to cope with the schedule of fortnightly visits to all four catchments and twice yearly clearing of each sediment trap. In view of the protracted 'down time' and high repair costs, it would be advisable to replace the older Land Rover in the next financial year.

Short term Developments

Experience in the UK, in Kenya and elsewhere has established the importance of implementing a computer based system of data processing, quality control and storage at the earliest possible time after the field routines have been established. Retrospective computer mounting of long runs of data is a difficult and time consuming operation to be avoided insofar as possible. Thus, in the immediate future a suitable system of computer storage for the

data from this Programme should be designed and implemented.

The Institute of Hydrology has evolved over the last 10 years a range of systems suitable for application to experimental catchment data. These were used for the data from the EAAFRO based experimental catchment studies and are currently in use for studies in the UK and elsewhere. It is suggested that, assuming the ODA support funding continues at least at its present level, IH should assist in this operation by adapting their system to the specific requirements of these studies. This would involve close cooperation with the Project team, and the Data processing Section of MOWD.

Implementation of this proposal could be accomplished by

(a) Initial discussions with the Project Leader on data to be stored, the time intervals required and the likely analytical methods to be applied to it. These discussions could take place at IH over a short period after the Project Leader finishes his course but before he returns to Kenya.

(b) As soon as is practical at least one of the Project team members should be given the opportunity to undertake an introductory computing course locally.

(c) Funding should then be sought to enable him to spend some time at IH gaining experience in computer data processing and working with the IH team on adapting the system to the Project requirements.

(d) The Project member, together with an appropriate member of the IH Processing section, would then set up the system in Kenya, working closely with the MOWD processing section, and initiate the mounting of the catchment data on it.

It is stressed that the person to receive this training should be a member of, or at least fully familiar with, the Project. This is necessary to ensure that the system designed is compatible with the data being collected and the analyses to be done. To ensure that the data collection exercise does not suffer, it may be necessary to recruit another team member.

Equipment Work

The equipment in use on the project is in good condition at present. Some minor replacements such as batteries and specialist tubing from the sediment samplers are required. These will be provided by IH out of present funding. The solar panels for recharging the AWS batteries should ease this problem when they become operational. Work on installing these panels was initiated during the visit. MOWD Instrument Engineer is competent to deal with any minor faults that develop provided he is informed by the Project Team.

Nevertheless it is good policy to undertake preventative maintenance on systems where continuity of data collection is so essential. To this end it is suggested that a visit in the period 1981/82 by the Senior IH Weather Station Engineer to carry out major checks and refurbishment of the AWS would be a wise use of part of the available ODA funding.

Soil Moisture Work

A Wallingford Neutron Soil Moisture Meter was supplied by ODA as part of the equipment for the Project. In the limited time available during the establishment phase,a small programme of soil moisture measurement was initiated on maize and grass on the Iiuni catchment. The maize part of this study was suspended late in 1980 due to a disagreement with the

farmer concerned. An attempt should be made to re-establish this part of the programme before the coming long rains. If the previous daily readings prove impossible to maintain then a twice-weekly reading schedule should be followed.

To convert the readings into meaningful soil moisture units for subsequent analysis a calibration programme for the soils in question is necessary. This involves the installation of at least two additional access tubes 3 times in the course of a year, at the end of the main dry season, during the main rains when the profile is fully wetted up and at an intermediate stage. On each occasion readings are taken in the calibration tube and followed immediately by the extraction of 2 undisturbed volume cores adjacent to the tube at each reading level. These cores are fresh weighed, oven dried and weighed again to give Volume Moisture Content. By plotting VMC v. neutron probe reading over a range of moisture contents, calibration curves for each horizon in the soil are built up.

To carry out this calibration programme it may be necessary to cooperate with National Agricultural Laboratories, Kenya Agricultural Research Institute or the soils department of the University, all of which have the necessary laboratory facilities.

Consideration should also be given to extending the soil moisture programme to other areas and other catchments when time and staffing permit.

One minor but very necessary job remaining from the establishment phase of the Project, is the accurate pin-pointing of the raingauge positions within each catchment. At present catchment rainfall is estimated using the Arithmetic Mean technique, but in areas subject to considerable spatial variations in rainfall it is necessary to determine which of a range of techniques gives the best estimate of volume rainfall input. To apply

techniques such as Domain Theory, Thiessen Polygon or the various altitude related methods, accurate positions of the gauges within the catchment are required.

1:10,000 maps of each catchment were prepared during the LRDC survey of the catchments (see following section). 1:10,000 aerial photographs were also prepared by them. The positions can be located on the maps with sufficient accuracy by identification on the photographs followed by triangulation checks.

Medium Term Developments

As part of the feasibility study and catchment selection programme which preceded the formal initiation of the Project, the ODA Land Resources Development Centre carried out a comprehensive survey of the geomorphology, soils and land use of the four catchments. Towards the end of the suggested five year data collection phase of the Project it would be valuable to have the same team undertake a repeat survey of the soils and land use in the catchments. This would establish the long term trends and provide background information which could be tied in to any trends in the hydrological responses and erosion rates. Such a survey would necessitate an approach to ODA within two years or so to determine whether funding and a team could be made available for this work.

During the establishment phase some initial work was done by the Departments of Agricultural Engineering and of Soil Science in the University of Nairobi on erosivity of the Iiuni catchment soils using a rainfall simulation technique. The extension of this work to the other catchments and the initiation of other 'process studies' in the catchments either by the Project Team or by outside bodies working in cooperation with them should be encouraged.

Information derived from such studies is of considerable value in the interpretation and modelling of runoff and erosion responses. Aspects of particular relevance for such work include water use of the major indigenous and cultivated species, geomorphological 'source area' studies of erosion, soil moisture penetration and depletion studies (as mentioned above) and detailed studies of the composition and density stratification of the bed load in the stilling basins (see appendix III).

The Project Leader will become familiar with some aspects of mathematical modelling during his current postgraduate course. These he will no doubt extend and modify to suit the needs of the Project catchments and the medium potential areas generally. Should it be found however that specialist advice on modelling techniques is necessary the Institute of Hydrology has a wide range of expertise in the field. Whether this could be provided under the residual ODA funding or through an application for additional funding would depend on the circumstances at the time of any such request.

Long Term Developments

As stated earlier it is recommended that at least five years' data be collected from the four project catchments in their present state. Whilst data collection, processing and analysis is proceeding during this period consideration should be given to the longer term use of these instrumented catchments, so that the maximum return in information may be obtained from the investment. Consideration should also be given to the most productive use of what will be by then an experienced and competent catchment research team.

The most obvious use of the Project catchments after the present phase would be as 'test beds' for new developments in dryland cropping and soil and water conservation systems. The opportunity exists on these catchments

for water resources and agricultural research interests to work together in assessing the performance of dryland utilisation techniques, not only in terms of soil stabilisation and productivity, but also on their effect on water resources.

It is a regrettable fact of life that, in many areas of the world,research in water resources and in agriculture are undertaken independently of each other, often to the detriment of both. In Kenya from the 1950s onwards, cooperative studies of the effects of land use change by agriculturists, foresters and hydrologists were pioneered in the EAAFRO-based high rainfall catchment area studies. With this precedent in mind, discussion and planning of the future use of the Project catchments should be initiated between MOWD, Ministry of Agriculture, KARI, Forest Department and other interested parties in the next few years.

With most of the land in the catchments being owned and worked by small farmers, the implementation of improved cropping and soil conservation techniques will call for sensitive handling, if it is to be successful. To this end the local Agricultural Extension Services as well as the scientists should be involved in the planning as well as the negotiation and implementation stages.

The future development and utilization of the Project Team in the long term is of course a matter for policy decisions by the Ministry. The value of an experienced catchment research team of this nature cannot be overemphasised however, particularly in a country such as Kenya which is faced with a very wide range of water resources problems. Continuity and accumulating experience increase the value of the team with time. Thus it would be preferable to ensure that this team is not disbanded, as happened to the previous EAAFRO-based team, but presented with a continuing succession of problems to investigate and solve.

The Kimakia Problem

One such problem on which the team could be asked to work relates to the effects in water resources and on erosion rates of harvesting the plantation softwood forests in the Aberdare headwater catchments of the Tana and Athi rivers.

The effects of bamboo clearing and pine planting, and the subsequent comparison of the effects on water yield during the mature phase, were investigated by the EAAFRO-based team using two small catchments in the Kimakia area of the Southern Aberdares. The basic instrumentation on these catchments has been maintained by MOWD since 1975. The pine catchment is due for clear felling within the next two years; this opportunity to study clear felling effects at a relatively low cost should be exploited. The current status of these catchments is described in Appendix V and a proposal on how such a study could be implemented in attached as Appendix VI.

Summary of Conclusions and Recommendations

1. Apart from the building of a structure on Utangwa the instrumentation and establishment phase of the project has been successfully concluded and the data accumulation phase is now underway.

2. Despite being deprived of two senior hydrologists and the Project Leader, the HQ team and the field observers under the Ag. Project Leader are coping reasonably with the data collection and checking.

3. Some additional instruction has been given and notes for guidance prepared during the support visit.

4. The value of the data obtained from these catchments for characterisation of hydrological response and erosion rates in the medium potential areas is critically dependent on its continuity and quality which must be uniformly high. To ensure these, the team must be able to visit each catchment at fortnightly intervals and implement the clearing of the sediment traps each dry season. This requires that two fully operational Land Rovers, the JCB and the tipper truck continue to be assigned full time to the Project. Access to a lorry at peak work periods in the catchments is also desirable.

5. The construction team has done a competent job in building the structures. Once the Utangwa structure problem has been resolved, consideration should be given to reducing the size of this team to the level required for maintenance work and sediment clearing operations.

6. Until the Project Leader returns the Ag. Project Leader would benefit from some constructive supervisory advice on the administrative and budgeting aspects of the Project.

7. As soon as the Project Leader resumes his duties consideration must be given to designing and installing a streamflow structure on the Utangwa catchment. If no method of doing this can be devised the catchment should be abandoned.

8. The locations of each raingauge in each network should be surveyed in as soon as possible.

9. At least five years' run of data should be accumulated from the catchments in their present state.

10. Within the next financial year a computer based system of data processing should be selected and implemented.

11. In addition to the valuable maintenance work being done by MOWD Instrument Engineer a preventative maintenance visit by an AWS expert within the next year would be advisable.

12. When time and staff permit, the soil moisture programme should be extended with assistance from local soils experts.

13. At the end of the 5 year data collection phase a second land use survey should be carried out.

14. Active encouragement of relevant 'process' studies would add to the value of the basic hydrological data acquired.

15. Towards the end of the data accumulation period increasing emphasis can be placed on the use of the data to develop mathematical models.

16. In the longer term these instrumented and hydrologically calibrated catchments could form ideal 'test beds' for field testing of new techniques in dryland utilisation.

17. To utilise fully the accumulating expertise of the team they should have an opportunity, as a team, to tackle other relevant problems arising from the interaction of land use and hydrology.

Appendices

Appendix I

Diary of J R Blackie's Visit

29-31 January 1981	Arrive Kenya. Initial Contacts with BHC Aid Section and with Chief Hydrologist MOWD (Charania).
2 February	Introduction to Ag. Project Leader, Hydrology Project (J Kanyanjua) and his team. Agreed programme of visits to catchments. Discussion with BHC Dev. Div. (Mr Little and Mr Tesoriere).
3 February	Initial briefing on current status of catchments. Discussion of instrumentation status with MOWD Instrument Engineer (Mr Svennson).
4-6 February	Visits to the Iiuni, Utangwa, Kitimui and Kune catchments.
9-14 February	At MOWD HQ. Detailed discussions with team on all aspects of field operation and data processing. Initiated work on mountings and control units for installation of AWS solar cell panels. Worked out simplified methods of computing bedload sediment loads.

16 February	Review of progress to date with Chief Hydrologist. Arranged alternative dates for discussion with Mr Kirori and with Chief Conservator of Forests Mr Mburu Discussion with Mr Wain, Hydrologist TRDA. Discussion with Mr Lamprey, Advisor to UNESCO IPAL Project.
17 February	Visit to Iiuni and Kitete catchments.
18 February	Discussion with Charania and Mr Kirimi, Head of Data Processing Section. Meeting with Kirori postponed.
19 February	Discussion with Charania, Kirimi and Kanyanjua on future development of project.
20-21 February	Worked on notes for Project Team and on Report.
23 February	Work on report. Unsuccessful attempts to see Kirori and Chief Conservator Mburu.
24 February	At KARI in am. Meeting with Director, Dr Majisu, and Director (ARD), Dr Ngundo. Discussion with Dryland Project team (Dr Fort and Mr Stewart).
25 February	Forest Department. Chief Conservator Mburu, Charania. Discussion on Kimakia catchments. University. Senior Assistant Registrar. UNEP Dr Gwynne.

26 February	With Dr Wangati to Stellascope (printers) and their colour plate sub-contractors, Team Ltd. UNESCO (IPAL): Dr C Field MOWD Project estimates.
27 February	TRDA. Mr Kariuki and Mr Wambui. MOWD. Suspended sediment measurement methods.
2 March	BHC Dev. Div. MOWD.
3 March	Field trip, Kimakia catchments.
4 March	BHC Dev. Div. Forest Dept. Natural Agric. Labs.
5 March	Return UK.

Appendix II

Revised field procedures for suspended sediment sampling

Comment

The automatic samplers installed at Iiuni, Kitimui and Kune are a valuable asset to the Project. With the modifications to their triggering mechanisims designed and installed by the Project Team working jointly with MOWD Instrument Engineer they make it possible to obtain much more detailed information on the variations in suspended sediment loads in each stream.

Apparently there were some problems with them during the short rains in 1980 and very few samples were obtained. Examination has shown that, apart from a few perished rubber tubes, there are no technical faults with the samplers.

The following suggested field procedures should ensure that a minimum loss of data occurs in future.

Field Procedure

1. Dry Season

Close to the end of each dry season each sampler should be checked. Any rubber tubes which show signs of cracking must be replaced. The inlet pipes from the sampling head in the stream should be checked to ensure they are not split or blocked. The triggering mechanism should be checked by closing the float switch and observing whether the trigger arm operates next time the water level recorder punches.

If all checks are satisfactory the system should be made ready for operation by setting the trigger to the start position, setting the float switch to the

prescribed height above the weir zero and pumping down the vacuum in all bottles to the prescribed level. Each bottle is then closed off by the pinch plates.

Rainy season

On each fortnightly visit to the catchment after the sampler has been serviced the following procedure should be carried out whether or not any samples have been taken since the last visit.

(a) Remove all sample bottles which have been filled, put caps on, label and replace with clean bottles.

(b) Check that the correct number of samples have been collected by examining the Ott W/L chart. One sample should have been collected for each ¼ hour when stage exceeded the level of the float switch (30 cm in most cases). If the number is not correct carry out the above 'Dry season' checks to determine what is wrong with the sampler.

(c) Reset the trigger head to the zero position.

(d) Connect the vacuum pump to the sampler.

(e) Release all the pinch plates.

(f) Pump the vacuum down to the prescribed level.

(g) Reset all the pinch plates.

(h) Note the numbers of all 24 bottles in the sequence, so that the correct numbers can be related to each time of sampling derived from

Appendix III

A revised technique for the estimation of bedload accumulation in the catchment stilling basins and in Iiuni sediment trap.

by J R Blackie, Institute of Hydrology, U.K.

Comment

This method incorporates the present survey techniques but the computation of the bedload accumulation during each rain is simplfied.

The method assumes that each basin or trap will be emptied each dry season, surveyed, and then surveyed again after the end of the next rains. The volume accumulation during that wet season is then computed as the difference between the surveys.

The Method

For each basin or trap, a pegged area, including the entire basin area within which sediment accumulates and is cleared, is surveyed on either a 2 m. or 3 m grid as at present.

It is suggested that base plans, including the grid points, of the fixed area to be surveyed at each site should be drawn up and copied. Each survey can then be plotted on a copy of the standard plan.

In plotting this grid survey, datum is taken as a level either 1m, 2m or 3m below the weir crest depending on the depth of the basin in question.

For example: Iiuni stilling basin has a maximum depth marginally greater than 1m below the crest level. For this basin, the datum will be 2m below the crest level.

Using levels reduced to this datum, the grid survey is plotted and contours are drawn in at 0.5m intervals. The areas contained between each successive contour level are then planimetered. The areas are entered in a table on the computation sheet and added to ensure that their sum is equal to the known area covered by the survey.

The volume content of the basin at the time of the survey is then computed as shown.

By subtracting the volume contents calculated before and after each rains, the volume accumulation during that wet season is computed.

Data Storage

A file should be prepared for each stilling basin. The survey plot and the computation sheet should be entered in it. The file should also contain a summary sheet as shown in the example. From this can be seen the date, basin status, and volume content of each survey and on it the volume accumulation during each rainy season is computed.

Future Development

The method as outlined above will give volume accumulation in each rains. To convert this to mass and hence to tonnes/ha erosion loss from the catchment, estimates of the density of the sediment are necessary.

It has not been possible to carry out systematic sampling of the sediment so far but when the project is back to full strength this should be initiated.

The method adopted will depend on the resources available and also on the extent to which stratification into size ranges occurs in each stilling basin.

This problem could be a suitable one for University Students to work on under the Project Leader's direction.

It seems unlikely that the densities will vary much with time in each basin. Thus when the best method of density estimation has been determined, it can be applied retrospectively to the volume data computed as above.

Appendix IV

Recommendations for improving data collection operations.

1. The Project leader should keep a desk diary showing the dates of visits to each catchment by HQ staff and work done. When making each entry he should pencil in, on the calculated date of the next visit, the work to be done then.

This should be in addition to the present wall chart showing projected dates of visits.

2. Each officer must carry and make use of a field notebook on his visits to the catchments.

3. A standard report form should be completed by the senior offiver on each visit to each catchment and submitted to the project leader for checking, action and filing. A separate file should be kept for report forms on each catchment. A sample form is attached.

4. Before each catchment visit the senior officer should check the report file on that catchment and ensure that he has the necessary batteries, tapes, charts and other requirements. This check should be done at least one day before the visit is due.

5. Arrangements should be made the day before the visit for refuelling and loading of the Land Rover so that prompt departure on the day is ensured.

6. HQ officers and field observers should be encouraged to make notes on any major events in the catchments (fires, exceptional storms, drought periods, etc.).

.. A 'sediment diary' should be kept from each catchment. Entries in these should be made after each catchment visit indicating the status of the sediment traps. Details of each clearing operation, including dates of surveys, duration of clearing, equipment and casual labour used, dates of testing the surveys, etc, should be entered. (See appendix III).

Appendix V

Note on a visit to Kimakia Forest Station and the Experimental Catchments on 3 March 1981.

Objectives

The objectives of the visit by Mr Blackie of UK Institute of Hydrology, accompanied by Mr Kori of MOWD who is responsible for data collection in drainage area 4 were:

(a) To clarify with the forester the proposed clear felling dates for the Pinus Patula in experimental catchment A.

(b) To check on the state of all streamflow structures and recorders, raingauge networks and the meteorological site in the experimental area.

The reason for the check was to ascertain whether the proposed intensification of the hydrological study over the clear-felling phase of the forestry cycle was possible.

Findings

Five observers are employed on the study. The Meteorological site is operational and in reasonable condition apart from the meteorological screen which needs to be replaced.

Catchment A (Pinus patula)

The weir is in good condition. The stilling well will need to be cleared of silt before the next rains. The Lea Recorder is operational but the Leupold

and Stevens recorder failed and has been removed. The raingauge network comprises 2 Dines on platforms, 3 tower gauges and one daily raingauge by the weir.

According to the forester the catchment is due for felling in 1982/83 (KAKUYU 5A and 3G blocks). This is not shown on the felling plan produced by Chief Conservator.

A Problem has arisen however. In block 5A at the top of the catchment a small patch of some 30 trees has been killed off by some disease. Forest Pathologist Mr F M Mungo in a letter (FOR PATH 14.9.182 of 27 January 1981) to forester, copied to Chief Conservator, has recommended that block 5A be felled immediately to prevent the disease spreading.

Catchment C (Bamboo - the control catchment)

The weir is in good condition. Both the Lea and the Leupold and Stevens recorders are operational. The raingauge network comprises 6 storage gauges plus 2 dines (one on met. site).

Catchment D (Bamboo upper, Pines lower)

After a period in 'shamba' (1973-75) the lower part was planted with pines in 1979/80. 3 raingauges are maintained. The weir is in reasonable condition and both recorders are operational though the Lea needs repair.

Catchment M (Grass)

The grazing scheme operated on this catchment by the Naivasha Animal Husbandry Research station is still in operation. The catchment is subdivided into paddocks for rotational grazing. The grass looks good and

there is very little sign of 'tracking' or erosion. The weir is in good condition. Both recorders are operational, though both would benefit from a thorough overhaul. 8 raingauges plus a dines are in use though these had not been read since the last rain on 20 February.

Conclusion

Operations could intensified on these catchments at little cost in a very short time. The critical factor is the action to be taken on block 5A in catchment A. If Forest Department decide that it must be felled, I would suggest urgent discussion with them to determine whether:

(a) Felling could be postponed for, say, one year while the instrumentation is augmented and some pre-felling data collected.

(b) It would be possible to fell both 5A and 3G (ie the complete catchment) simultaneously.

If some other means of containing the disease can be derived, it would be preferable to postpone felling till 1982/83 so that a longer pre-felling period can be monitored.

James R Blackie

Appendix VI

Outline Plan for a Study of the Effects of Clear felling on the hydrology and sediment loss from Kimakia Catchment A.

by

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Introduction

The long term EAAFRO based and ODA supported catchment studies in the Kimakia area of the Southern Aberdares established the effects of replacing bamboo forest with plantation softwoods (Blackie, Edwards and Clarke 1981). This study covered the bamboo clearing, 'shamba', establishment and mature forest phases of the pine plantation. In view of the present worries about the sediment loads of the Tana headwater tributaries it would seem logical to complete the study by following through on the clear-felling and subsequent re-planting phases.

Since 1975 the basic instrumentation on the Kimulia experimental catchments has been maintained by MOWD. Forest Department have agreed in principle to cooperate in any enhancement of the study to cover the clear felling phase which is due within the next two years. KARI, as the successors to EAAFRO, have also expressed interest in seeing this study completed. ODA part funded the project from 1972-76 and would no doubt have some interest in seeing it brought to a logical conclusion. The UK Institute of Hydrology, who carried out much of the analysis and interpretation of the earlier phases, would be prepared to assist in this aspect and also in the provision of the additional instrumentation necessary, provided such work could be supported financially

by ODA or some other sponsor.

Because of the imminence of the clearing operation, discussion, planning and, if agreed, implementation of the study must be approached with some urgency.

Proposed Approach

The Kenya IHP Research Committee is a forum for discussion, coordination and information transfer on matters relating to hydrological research in Kenya. The interested parties mentioned above are represented on this Committee. It would be logical, therefore, for the Committee to undertake the planning and coordination of the proposed study if agreement in principle were forthcoming from the Water Development, Natural Resources and Agriculture interests.

As a starting point for detailed planning, an outline proposal is given below, covering a three year period starting from 1.5 years before felling is due and continuing for 1.5 years thereafter.

Outline Project Schedule

Period	Work to be done
-1.5 to - 1 years	Check existing raingauge networks and streamflow structures on Catchments A (forested) and C (bamboo) and check the Meteorological site. Enhance networks and upgrade equipment where necessary. Modify the bedload traps in the stilling pools and devise accurate methods of measurement. Install water sampling equipment for suspended sediment and water quality. Re-install access tube network for soil moisture

	Review rainfall and flow data collected from 1975 to date.
	Recruit and train additional field staff if necessary.
	Negotiate with MOWD Water Quality Lab to have samples analysed.
	Identify and instrument small plots within both catchments for detailed soil structure, soil moisture and erosion studies.
-1 to 0 years	Implement full data collection programme for both catchments.
	Sample analyses by MOWD Water Quality Lab.
	Soils work by KARI or NAL.
	Data processing by MOWD Hydrology Project or possibly by Institute of Hydrology.
	Detailed discussions of felling plans with Forest Dept.
	CLEAR FELLING OF CATCHMENT A
0 to +1.5 years	Continue full data collection programme through felling and subsequent treatment and re-planting period.
	Analyses and data processing as above.
From +1.0 years	Increase effort on data analysis and interpretation.
	Preparation of reports.
At +1.5 years	Consideration of reports. Review results.
	Decision on whether to extend, modify or terminate data collection.