



Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program

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Trip Report: Zambia 6- 26 March 2007

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Purpose of Trip: Collaborate with LTRA project partners to define objectives and begin implementation of the Watershed Modeling and Assessment cross-cutting research. Specifically:

- Better understand the hydrology and landscape conditions in the rainy season
- Assess suitability of candidate watersheds and locations for stream-flow monitoring
- Collect ground truth data for imagery classification

Sites Visited: Lusaka: WCS head office, Univ. of Zambia, ZARI Mt. Makulu Centre
Lundazi: WCS/COMACO Center, Emusa, Manga

Description of Activities/Observations:

Approximately two weeks in the field provided a great background for better understanding cropping systems and practices, runoff, erosion, and water management issues in the plateau, hill, and valley regions of Eastern Zambia. Weather conditions were good. There was heavy rainfall in some areas the day prior to my arrival in Lundazi, generating significant runoff for observation. There was little rain the rest of the time facilitating travel and field access.

Plot studies. I visited three of Lydiah Gatere's field plots, two near Emusa, one in Chasato on hilly land near the ZAWA gate. The goal was to assess the possibility of monitoring/observing runoff from the different plot treatments in conjunction with the primary yield study. While only a few sites were visited, from these it did not seem likely that meaningful observations could be made this year, and the possibility of collaborating in the future is limited due to variability in plot layouts, lack of difference in surface treatments, and difficulty in collecting adequate weather data. Specific, replicated plot studies at a few locations will be a more manageable and feasible way to collect data to demonstrate and quantify the impact of the improved farming practices on runoff and erosion. Two types of approaches should be considered: large plots relying on natural rainfall (good records needed), and small (1x2m) plots using a portable rainfall simulator.

Watershed studies – Plateau. Two *dambos* (grass wetland drainageways) immediately south of Emusa look like good monitoring sites to characterize the upland hydrology function, in particular, the role of *dambos* in water storage and peak flow reduction. Other similar sites are available, but these two are conveniently located close to Emusa. During this visit (5 observations over 11 days), flow from the *dambos* was never muddy although turbidity did increase during the period of highest flow, and peak flow from the *dambos* was significantly moderated (i.e. did not see a “flash flood” rise in water levels even when significant runoff was occurring nearby).

- The preliminary assessment is that these upland *dambos* provide a very significant ecosystem function. To what degree the *dambos* can be encroached on for crop production should be evaluated carefully.
- Additional monitoring sites on comparable watersheds with less area in *dambo* would be desirable to provide a point of comparison. Such areas were not explored on this visit, but from imagery, it appears there may be a candidate site near Lundazi. (There appear to be many sites in Malawi!)

Paired watersheds. To assess the impact of forest versus agriculture land use in the hill region, two rivers west of Emusa along the Chifunda road looked like good candidates for a paired watershed study based on my Nov 2006 visit and analysis of satellite imagery and GIS data. Both are off the plateau, side by side, and have differing land cover. The first is headwaters of the Luelo River and is predominantly cleared, while the second is the Kamwamphula River and is predominantly forested (National Forest). Observations from this visit (4 times over 11 days):

- Flow in the Luelo was very turbid compared to the Kamwamphula on the first and second visits following apparently heavy rains in the area. On recession of the storm runoff (11th day), water in the Luelo remains cloudy while the Kamwamphula is clear.
- The stream beds of the two rivers are distinctly different (mud/muck for Luelo, versus course sand for Kamwamphula), indicating very different flow regimes, sediment loads and geomorphic condition.
- A pressure sensor was put in a pipe under a rock on the upper side of the Kamwamphula River Bridge and a reference sensor left at White’s house in Emusa. This sensor will provide 10min interval record of depth and is to be removed when flow ceases.

A number of advantages and limitations of these sites were identified during this visit.

- The stations are on a road that is typically passable by vehicle throughout the year.
- The proximity of the monitoring points to the ZAWA gate. The guard was very willing to assist with monitoring rainfall data, and hopefully will collaborate with manual observations of flow depth.
- Presence of schools in the headwaters as possible points for rain gauges.
- A major difficulty with these sites will be to establish a good monitoring point on the Luelo River. The best approach would be replacing the woefully undersized bridge with a new bridge/culverts that can carry the peak flows and in which we can incorporate a design for monitoring flow.

Watershed monitoring – valley rivers. In Manga, three rivers are reasonably accessible: Lunzi (largest, drains most of Magodi area), Lupwizizi (tributary to Lunzi just below Manga and primarily forested), and Lumimba (8 km north of Lunzi, catchment all in National Forest). Getting to the Lumimba does require crossing the Lunzi (chest deep last week), which would be impossible during high flows. Data on these rivers will be important to ‘anchor’ watershed modeling that looks at impacts on land use on runoff. Measured cross-section and flow velocities on each river and left basic procedures (notebook, marked measuring reeds, instructions) for re-measuring 3-to 4 additional times this season. Also left instructions for weekly recording of water depth in wells

Supporting weather data. A weather station is needed and could be located at Emusa. Supplemental rainfall data is critical due to the convective nature of the rainfall in this region. Using a plastic rain gauge I brought last November, rainfall records have been kept at Emusa (by White). Details on starting and ending times of the event, as well as comments on intensity are noted, an excellent record that is more helpful than just daily rainfall.

- a) The ZAWA camp/gate on the Chifunda road is between the two outlet points of the proposed paired watersheds thus an excellent point for measurement. One of the rangers was very enthusiastic about assisting with keeping records. I put depth marks on a cut-off water bottle and left that and a notebook with him with the promise to bring a proper rain gauge for him to use.
- b) Community schools could be a good partner for rainfall data provided interested teachers can be found and continuity and quality of the data collection can be assured. I visited with the deputy head-master (Aaron Kumwenda) of the Chasovu Middle Basic School. He is enthusiastic and supportive in concept, but unsure of the time commitment. Interestingly, he said they have a rain gauge and other equipment (from some donor) – but it is in storage. By assisting mounting the gauge, providing data recording sheets and helping with ideas on incorporating rain data into the curriculum, I think this could be a good collaborator. There are a number of schools in the watersheds, and there is potential to use rainfall measurement to introduce an ecosystem awareness and education component in appropriate grades in the public schools in the area.

Land use classification data. Over 200 data points were taken in the Emusa/Magodi area, with a primary focus on the 4 watersheds that were the focus of initial investigation. Points were taken from the road due to limitations on time, but several small tracks internal to the watershed were driven. Access to the Kamwamphula R. catchment was very limited, with only a small view at the top.

Training. There was excellent interaction and interest with the field staff at Emusa and Manga in the basic stream flow measurements. The techniques used do not take long and are simple to record. After demonstrating the first time, I had others lead in subsequent measurements. Instructions were left in notebooks as a reference for ongoing measurements.

Additional contacts

- Dr. Elijah Phiri, head of the Soil Science Dept. (UNZA), has expertise in soil physics and soil-water-plant relationships. He is interested in plot-scale erosion research. Dr. Phiri has put on training programs through SADC, so seems quite active in capacity building and advancing knowledge.
- Sesele Sokotela, Head of the Soil Survey Programme, Zambia Agricultural Research Institute (ZARI), Mt. Makulu Research Centre. The soils map for Zambia is 1:1,000,000 published around 1992. Original vector data not available. It was redigitized, but only an image file is being distributed. They are involved with more detailed surveys, but on a contract basis and on a small scale. They do have a document (several hundred pages) that is a companion to the 1992 map. There is detailed profile data for 15-20 (?) characteristic pedons including physical and chemical analyses.

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Suggestions, Recommendations, and/or Follow-up Items:

1. The four small watersheds (paired Luelo and Kamwamphula, and the two *dambos* south of Emusa (Kanyanga, Mphiri) appear to be good candidates for a monitoring effort that will contrast land use impacts on runoff. There is good accessibility and good potential for support from the Emusa WCS office, the ZAWA rangers, and the local schools.
2. At this point there is not a science partner to head the effort in Lundazi. The cooperation of the COMACO staff has been excellent, but persons trained are technicians who don't necessarily have a long-term commitment to the project. The lack of continuity is a challenge with implementing a monitoring program with consistent quality control.

List of Contacts Made:

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