Large Catchment Study

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Introduction

In Malawi, soil erosion has been a major concern dating back to the colonial era. Furthermore, recent studies (e.g. Public Lands Utilization Study [PLUS]), have demonstrated that population pressure is causing people to exploit resources on public lands. As such, one would expect that there is increasing soil erosion and degradation of watersheds. However, long-term trends have not been recognized.

In Malawi, long-term sediment yield data are not available for the major river basins. As such, to understand long-term changes in sediment yield, it is necessary to look at proxy measures. In general, more surface water discharge implies a higher capacity for the river network to transport sediment out of a basin. In contrast, conditions which result in ground water storage, or evaporation and transpiration by vegetation, should produce less runoff resulting in less sediment yield. Therefore, recognizing long-term changes in the water budget for the major river basins may give some indications about changes in sediment yield.

Methods

In this study, long-term changes in rainfall, runoff and vegetation cover changes were studied in order to determine what changes occurred in the watershed and that affected the water budget. About 30 years of rainfall and runoff data were available from some of the drainage basins, the Lisungwe, the Rivi Rivi, the Diamphwe, the Bua and the Rumphi.

As a first approximation to determine whether runoff was increasing or decreasing, water years with similar rainfall characteristics were recognized from the 1960s and the 1990s. Then the relative runoff was determined. In other words, the fraction of rainfall that went to runoff was determined for the same basin 30 years apart. In this way, it might be possible to identify long-term trends.

Specifically, rainfall and runoff were compared for the months of December, January and February. Similar trends and depths in rainfall were identified, and then the relative runoff determined. As such, it was possible to determine the relative fraction of the rainfall that became runoff for similar rainfall conditions 30 years apart.

In order to verify these trends, the fraction of the rainfall going to evaporation and transpiration was also studied using remote sensing. NDVI (Normalized Difference Vegetation Index) are available from the middle 1980s to present. These data are available at 10 day intervals on 7.5km x 7.5km pixels. In this case, only data from the months of (August, September and October) were used.

Results

The results are summarized in Table 1.

Basin	Base Water Year	Runoff Coefficient	Recent Water Year	Runoff Coefficent	Runoff Trend	NDVI Trend
Diamphwe	196?	0.24	198?	0.15	Decrease	Increase
Rumphi	1976		1989		Decrease	Increase
Rivi Rivi	1961	0.2	1987	0.2	No Change	No Change
Lisugwe	1965		1994		Increase	Decrease
Bua	1961		1989		Increase	Decrease

The results show consistent trends in that when runoff increased, evapotranspiration as determined by NDVI decreased. As such, a degree of confidence can be place in the results.

Discussion of Results

The results show that trends in the Rumphi and Diamphwe basins suggest a decrease in runoff and a consequent increase in vegetation growth which is inconsistent with the expected trend of increasing runoff. In contrast, trends on the Rivi Rivi and Lisungwe show an increase in runoff and a consequent decrease in evapotranspiration as indicated by NDVI. Furthermore, the Bua River data showed no significant trends.

The results then suggest that runoff is increasing and vegetation cover is decreasing in the Middle Shire basin to the south of the country where the Rivi Rivi and Lisungwe drain. This is consistent with the possibility of increased deforestation and soil erosion in the most intensively agricultural region of the country.

In contrast, the Rumphi and Diamphwe basins in the north show a decrease in runoff and a corresponding increase in NDVI. Therefore, the trends are not consistent with what would be expected as the result of deforestation.

Conclusions

It is not possible to determine long term trends in soil erosion and sedimentation in Malawi based on the existing sedimentation data. It is, however, possible to observe trends that might be consistent with erosion, and might result in increased capacity of the rivers to transport sediment. These trends suggest an increase in the capacity of the major rivers draining the heavily agricultural basins in the south of the country, the Rivi Rivi and Lisungwe basins, to carry sediment. In contrast, in the less agricultural portions of the north, the trend has in fact been the opposite with decreasing runoff and increasing NDVI.