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Letter to the Editor

Comments on 'Proxy global assessment of land degradation' by Bai *et al.* (2008)

There is an urgent need for a quantitative, repeatable measure of land degradation and remote sensing provides the only viable option at a regional to global scale. It is therefore commendable that Bai *et al.* (2008) attempted to use remote sensing methods to quantify trends in land degradation across the globe. However, their rationale and methods contain some fatal flaws and thus the results can be very misleading. As this analysis is used by the FAO Land Degradation Assessment in Drylands (LADA) programme to identify 'hot spots' of land degradation, the errors in the paper might have serious consequences. The problems with the methods are outlined below:

1. Trends in rain-use efficiency (RUE), i.e. ratio of vegetation production to rainfall, might be an indicator of land condition in arid and semi-arid rangelands but not in commercial forested or cultivated areas. In these areas, negative trends in observed RUE might be due to management practices such as logging and crop rotation rather than degradation. Cultivated and forested areas should therefore not be reported in the statistics or included in the global map.
2. In the southern hemisphere, a calendar year cannot be used when calculating seasonal NPP and seasonal rainfall to test their correlation. In the summer rainfall areas of the southern hemisphere, the growth season starts in the latter months of year one and continues into the months of the following calendar year. Using a calendar year will severely distort the relationship between NPP and rainfall often resulting in negative correlations, not to mention trends in RUE. Growth season sum NPP and rainfall should be calculated across calendar years according to the hydrological growing season.
3. Rainfall is not a limiting factor to net primary production NPP in humid areas (Nemani *et al.*, 2003). In these humid areas, there is unlikely to be a statistically significant correlation between rainfall and NPP and thus the RUE method is not applicable. Therefore, the comment that '78% of degradation by area is in humid areas' is largely misleading. 'LADA' after all stands for Land Degradation Assessment in *Drylands*.
4. Recent analyses have demonstrated that RUE ratios still largely correlated with rainfall ($r = -0.8$) and thus trends in RUE merely reflect trends in rainfall (Wessels *et al.*, 2007). Alternatively, the residual trends method (Evans & Geerken, 2004) provides a more reliable option where residuals did not correlate with rainfall and thus can be monitored for trends in land condition, i.e. vegetation production per unit rainfall.
5. Annual NPP was predicted from AVHRR NDVI using a linear regression between the average annual sum AVHRR NDVI and average annual sum MODIS NPP values (2000–2003) (Bai *et al.*, 2008). The regression of AVHRR NDVI vs. MODIS NPP was therefore derived from a large number of pixels from across the globe. Such regressions are always strong as they span environmental gradients across the globe, but this does not necessarily indicate a strong relationship between AVHRR NDVI and MODIS NPP on an annual, per-pixel basis, which is incorrectly inferred. In short, the regression performed does not test the ability of AVHRR NDVI to predict NPP on an annual basis, instead it merely shows a strong relationship between AVHRR NDVI and MODIS NPP across the globe.
6. Production efficiency models driven by the same global AVHRR data set have been used to model NPP for most study period under investigation (Nemani *et al.*, 2003). Such reputable NPP data sets should be used instead of the MODIS NPP–AVHRR NDVI regression applied by Bai *et al.* (2008).

Based on the above, it is unlikely that the results represent an indicator or proxy for land condition. Methods like these should be thoroughly evaluated before being used for country-level reporting, for example, the statistics presented in Table 2 of Bai *et al.*, 2008. It is, furthermore, stated on p. 24 that 'In South Africa, NPP decreased overall; 29% of the country suffered land degradation, including 41% of all cropland…'. Was this land degradation of croplands supported by statistics such as a reduction in crop yields, data which are freely available in South Africa? Statements such as these are premature, if not irresponsible.

Global remote sensing methods should be applied and interpreted with caution, but they can make a significant contribution to the monitoring of land degradation if applied with the appropriate scientific rigor. The methods of Bai *et al*. (2008) can, and should, be substantially improved before this approach can provide useful information on land degradation.

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