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Land husbandry: an agro-ecological approach to land use and management Part 1: Considerations of landscape conditions

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Abstract

In this, the first of two papers, the roles of key features of any landscape in determining potentials for erosional losses of soil and water are considered from an agro-ecological viewpoint. In this light, the effectiveness of past commonly-accepted approaches to soil and water conservation are often found to have been inadequate. In many cases they have tackled symptoms of land degradation without appreciating fully the background causes, which often relate to inadequate matching of land-use/land-management with features of the landscape. A number of reasons for this mismatch are suggested. Understanding the ecological background to land husbandry (as defined below) will improve the effectiveness of attempts to tackle land degradation. In particular, an ecologically based approach to better land husbandry helps to foresee potential problems in some detail, so that appropriate forward planning can be undertaken to avoid them. This paper describes some practical ways of undertaking an appropriate survey of significant landscape features, enabling the definition and mapping of discrete areas of different land-use incapability classes. This is accompanied by an example of how the outcome was interpreted and used to guide the selection of appropriate areas which were apparently suitable for growing flue-cured tobacco within an area of ca. 140 km^2 in Malawi. This process relied on knowledge and experience in various disciplines (interpretation of air-photos, topographic survey, soil survey, vegetation analysis, hydrology, soil & water conservation, geology, agronomy) so as to ensure that the mapping process was based on the principles of better land husbandry.

Key Words: Agro-ecology, Soil & water conservation, Land-use incapability, Foresight

1 Introduction

The productive capacity of many areas of land now in use has already been compromised by damage to soils, following inappropriate matching of preferred systems of land use, and of their management, with the characteristics of the land on to which they have been imposed.

Is the present paradigm of "soil and water conservation" (SWC) still adequate to address the rising concerns about non-sustainability? Have we achieved all that we had expected or hoped? Are the positive results sustainable under the rising pressures being now being put onto land? (Shaxson, 1993, 2006). The answer is: it seems not. Mortimore (2013) notes that "*because development puts additional pressure on ecosystems, and rich populations continue to multiply destructive resource exploitation, the agenda for the planet is shifting from food supply constraints to sustainability themes".* This emerging realization implies that field-engineering approaches – on their own – to controlling soil erosion and strengthening sustainability of production systems are inadequate. An agro-ecological approach to land use and management which is effective in achieving conservation, as set out in this two-part paper, offers better opportunities for addressing both aspects simultaneously.

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1.1 *Land husbandry*

"Good land husbandry is the active process of implementing and managing preferred systems of land use and production in such ways that there will be increase – or at worst, no loss – of productivity, of stability or of usefulness for the chosen purpose; also, in particular situations: existing uses or management may need to be changed so as to halt rapid degradation and to return the land to a condition where good husbandry can have fullest effect". (Shaxson, Douglas and Downes, 2005) [after Downes (1982, 1971)]. This approach is described in two linked papers. The first (this paper) suggests that topographic catchments should be considered as key physical features onto which land uses are imposed. The second paper suggests that any land-management activities be based on considering soil as a living matrix from which yields of plants and water are derived.

2 A starting-point: the former paradigm

The sense of soil degradation as a problem of land use has long been acknowledged. It came to wide prominence with the wind- and water-erosion in the Mid-West of the USA in the 1930s, characterized in Bennett (1939). This perceptive and significant book set out many of the factors contributing to – and militating against – soil erosion. Many of these remain valid today. However, much subsequent anti-erosion action has commonly taken a mechanical – or "earthworks" – approach to reducing soil erosion, but this fails to ensure that soils remain sustainably productive. The long-held assumptions that mechanical land treatment methods would be automatically effective in halting erosion and maintaining productivity have proved illusory, and land damage continues, particularly where rising population-pressure on land results in the opening and tillage of land whose characteristics indicate it is at greater risk of suffering rapid loss of productivity.

2.1 *Processes*

In the past, levels of human populations and their constituent communities on the land tended to stay in relatively-stable equilibrium within the particular ecozones to which their inhabitants had adapted (e.g. Trapnell,1943; Makings 1966). Traditional local observations, experiences, knowledge and actions were able to maintain agro-ecosystems which were appropriate to, and sufficient for, their needs (e.g. Tenywa et al., 2013). However, these systems in turn imposed limits on increases of output over time when rates of soil degradation became faster than those (if any) of soil restoration. Ensuing decline in land-based ecosystem functions (notably those of sustained production of vegetation and water) resulted in net losses of plant-nutrients, soil particles, soil organic matter and soil moisture. With the ongoing increases in human populations and their rising density on potentially-productive land, expansion of "traditional" knowledge alone now often proves to be insufficient to confront, avoid or ameliorate problems of increasing degradation of their lands' productive capacities. Old "bush-fallow" systems for cropping-agriculture, and/or transhumance/grazing-rotation systems for "rangeland" management, are increasingly ineffective in countering the pressures imposed by rising populations and degrading land resources. Governments and aid-agencies' scientific knowledge has then been added into the mix, but the combined effects of "conventional" soil and water conservation measures – with or without local knowledge – have seldom proved sufficiently-effective always to halt and reverse the declining trends.

2.2 *Symptoms of land degradation*

There have been many past studies of soil erosion, but recent reports on fieldwork in western Kenya characterize some of the common processes and consequences of land degradation in small catchments after undisturbed forest has been cleared. On small farms under traditional tillage in the past - for up to 100 years - rapid initial rates of decline in soil organic carbon, soil nitrogen and crop-yields have been recorded. Over 35% of the declines during the first 50 years had evidently occurred within the first five years after clearing (see Solomon et al., 2007; Marenya and Barrett, 2007, 2009; Moebius-Clune et al., 2011).

As part of the cluster of inter-related studies in W. Kenya, on kaolinitic acrisols Recha et al. (2012) studied the effects of these declines in soil quality on stream discharge from four small catchments which were – at least in terms of changes in soil organic carbon and soil physical properties –*"broadly representative of the studied region and corroborate more rigorously replicated plot studies"* (item 4.1, p.10). Within an area of 6 km^2, they studied four plots: one had been maintained in original forest, and three more had formerly been forested but subsequently maintained under smallholder maize cultivation for 5, 10 and 50 years. These different lengths of cultivation provided a useful proxy for a time sequence of the changes that had occurred. They reported that, in