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From Sahelian agropastoralism to global drylands: biodiversity-poverty linkages

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Abstract

Using the model of co-evolving, interacting human and ecological systems presented in the *Drylands Development Paradigm,* a brief analysis is offered of biodiversity management among Sahelian agro-pastoralists in northern Nigeria and southern Niger, in terms of agro-diversity (cultivars), useful plants (spontaneously regenerating), protected and spontaneous on-farm trees, and domesticated livestock. The analysis identifies generic findings applicable to the Sahel biome and argues that values must be understood both in economic terms (correctly estimated) and in 'non-economic' terms. To restrict policy thinking to US $ equivalents misses the balance achieved by some indigenous systems and invites alienation, accelerated land use change and destructive exploitation. These conclusions are extended to global drylands based on a recently published Challenge Paper (IUCN/UNDP/IIED), *Dryland opportunities: a new paradigm for people, ecosystems and development.* An opportunistic framework for dryland development must replace the 'desertification scenario' that inspired many inappropriate and unsuccessful interventions. However, local ownership and strong community-based institutions and regulation are needed to secure 'useful biodiversity' for the benefit of poor people and the advancement of dryland development. A biodiversity strategy is needed at international and national levels that realistically conjoins local and indigenous values with those of external agendas and pressure groups.

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Intro

I am cautious about global generalisation on biodiversity management and conservation. Instead of arguing from the general to the particular, 'top-down' from global conventions to local ecosystem users, I want to approach 'bottom-up' from a brief analysis of local ecosystem service management to its generic implications, and on to policy lessons at a global level. I do not feel qualified to discuss the conservation of 'wild' biodiversity, protected areas and tourism. The time when fortress conservation was an option in West African dryland ecosystems – which are the focus of this paper - has long passed. Rather I wish to comment on the benefits of 'managed' biodiversity within ecosystems that are already appropriated and used at varying degrees of intensity by human populations, a vision I caught from reading Bill Adams' eloquent argument in *Future Nature.* This is particularly relevant in the world's drylands, with their large human and livestock populations, environmental and climatic variability, and economic risk. Such co-habitation of humans with nature is consistent with the idea of complex systems co-evolving and interacting over short and long time-scales, as put forward in the *Drylands Development Paradigm* of Reynolds and his colleagues.

Biodiversity in Sahelian agropastoralism

The Sahel sits at the heart of the so-called 'desertification paradigm' in which biodiversity loss is believed to be associated closely with 'deforestation', 'over-cultivation', 'overgrazing' and salinization of irrigated soils – the four horsemen of the apocalypse in 'doomsday scenarios' of ecological degradation. This is not the place for a critique of this paradigm but I want to examine the view that biodiversity loss is a necessary outcome of rural population growth, the impact of markets, the conversion of woodland to farmland, the intensification of agriculture and mobile pastoralism. The setting from which the following data are drawn is semi-arid northern Nigeria and southern Niger, which is home to Hausa, Fulani (Peulh) and Manga communities practising farming with livestock, and visited by nomadic and specialist livestock herders. Suffering declining rainfall from the mid-1960s to the mid 1990s, prone to unpredictable droughts and livelihood risk, this region is characterised by a very high incidence of poverty, rapid population growth, and rural densities of >200 /km^2 over extensive areas. As in nearly all drylands, diversity in the Sahel is governed by a rainfall gradient – from arid through semi-arid to dry subhumid. I have drawn on the findings of four village level studies conducted in Nigeria along a rainfall gradient from 571 mm/yr to 345 mm/ yr, and from four Niger sites down to 250 mm/yr average rainfall.

Cultivars and landraces

25 cultivars (cereals, beans, earth nuts, root crops, melons, vegetables, sugar cane, cotton and kenaf) were inventoried in the Nigerian sites. The number of named and maintained landraces ranged from 76 in the wetter site (including irrigation) to 23 in the drier (no irrigation). Nearly all of this agro-diversity was found in the indigenous cereal grains: pearl millet (ranging from 12 down to 3 landraces) and sorghum (from 22 to 6).

Popular cereal landraces, favoured for their early maturing, high yielding, drought resistance or other characters, occupy most of the cultivated land each year. Elderly people sometimes maintain the stocks of 'old' and less popular landraces. A landrace is not a taxonomic entity but a dynamic artefact. All farmers select seed from their fields, store and plant it, using markets if necessary to enlarge their genetic resources. Genetic analyses of millet samples from four sites showed that individual farmers' husbandry practices result in the isolation of their own group of ideotypes each in their own unique 'gene pool'. There is a constant struggle against unwanted outcrossing.

Changes in cultivars in southern Niger have been attributed to adaptation to declining rainfall. Between 1960 and 2000, at four sites, farmers reported from 0 to 7 lost millet varieties and similar numbers for sorghum; but they also reported up to 8 new varieties. The amount of change was greater in the more humid places, which had a wider genetic pool. Similar adaptation occurred with bean and groundnut varieties. Thus the heritage of agro-diversity is dynamic, adaptive and specific to place and time, maintained by selection and controlled crossing in the face of an uncontrolled 'genetic anarchy' in the surrounding wild vegetation.

Trees and shrubs

Deforestation is always assumed to lead to biodiversity loss. In southern Niger, cultivated land, cleared from woodland by waves of incoming Hausa farmers (1920s – 1970s), occupied 59 percent of the area in 1975, and 73 percent in 1996. Many indigenous species did indeed become scarce, while exotics promoted by development projects were planted around towns and villages (especially *Azadirachta indica).* By the 1990s, a conservationary ethos was developing focused on the practice of *défrichement amélioré* (protected regeneration of selected individuals on newly cleared farmland). In 2004, an assisted micro-scale community nursery set out to propagate 18 economic species prioritised by farmers - including 13 native trees, 5 long-established and proven exotics, and citrus. In 2005 new studies based on remotely sensed data announced extensive tree growth on up to 500,000 km^2 of farmland across southern Niger. This consisted mainly of spontaneous regeneration of the native species, *Faidherbia albida,* protected by the farmers.

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This revolution could have been predicted from experience in the densely populated Kano region of Nigeria. A study in 1990 inventoried 75 species growing on farmlands, the great majority of them native to this or adjacent ecosystems. These were sustained through major drought cycles in the 1970s and 1980s despite moisture stress and the presence of a major fuelwood market in nearby Kano, offering incomes to food-starved farming households. As many as 43 tree and 14 shrub species have been inventoried in a site of 1-4 km^2. In a drier ecosystem, less densely populated, 34 multi-purpose tree species are protected; however, a community nursery here preferred to propagate the exotic *A. indica* which is considered more robust, more reliable in germination and faster growing under the harsh conditions.

The common factor in the Niger and Nigerian cases is the convergence of medium or long-term trends bringing about a reversal in the values of trees from being (a) a source of fuelwood and an impediment to farming to (b) a means of intensifying and adding value to real incomes on increasingly valuable farmland. Key determinants are: consolidating individual tenure (both of land and of trees); growing density of the farming population, and hence demand for land; and market values of non-timber forest products.

The transition is observed all over West Africa, though it may be fragile where a balance between these variables is not sustained. In particular, there is a tension between fuelwood demand and the multipurpose values of farm trees. In Nigeria, urban demand has been transferred to less costly, more distant sources of wood in hitherto open access woodland (or illegally from forest reserves). Biodiversity has everything to gain from such a balance between the human and ecological systems. During this evolution, shrubs (other than tree seedlings) are however progressively eliminated under repeated annual cultivation.

Grasses, herbs and wild plants

As suggested earlier, there is a widespread belief that biodiversity is being lost in drylands owing to overgrazing of pastures, as well as to deforestation in favour of crop production. In some Sahelian rangelands, such as the Manga Grasslands on the Niger-Nigeria border, dominant perennial species gave way to annual grasses during the Sahel Drought of the 1970s, but its timing suggests that this change was due to declining rainfall rather than grazing practice. Rangelands are not equilibrial in growth and species composition, but highly variable both locally and between years. This – together with evidence of animal

mortality in drought years - suggests that the livestock rather than the pastures are the dependent variable. Delayed seed germination ensures than even under heavy grazing pressure a community of preferred edible species may be more robust than expected. Grassland has recolonised moving dunes when rainfall has improved. Annual grasses, surprisingly, can equal perennials in carrying capacity. Large cattle herds are maintained on some pastures throughout the year without transhumance. Such complicating considerations suggest that generalisations on degradation and biodiversity loss may be simplistic.

Paradoxically, in the most intensively cultivated of the sites here considered, 86 named types of grass and herb were identified. This impressive diversity occurs notwithstanding the virtual elimination of rangeland and woodland from the local ecosystem by its conversion into a mosaic of very small permanently cultivated and hand-weeded fields. Weeds, live fencing and pathway vegetation are assiduously collected during the rainy season for stall-fed ruminants. Nothing is wasted (crop residues and tree foliage are similarly recycled through animals, whose dung – of course including the seeds - is redistributed to the fields). This suggests that biodiversity loss need not follow from land use conversion; and that its conservation is valued in a tightly integrated human-ecological system.

Wild plants have another role in drought-prone areas where food security of rural households is periodically at risk. A wide range of plants in semi-arid ecosystems yield edible products (mostly leaves, but also roots, flowers or seed). Finding these during the hungry season was often women's work, and they conserved and passed on the knowledge between generations. There was ample opportunity during the drought cycles of the 1970s and 1980s to exercise such knowledge, even in Nigeria with its oil wealth, because markets failed to deliver food at affordable prices in rural areas. A compilation of famine foods used during the Sahel Drought of 1972-74 or referred to in the literature yielded 68 species of herbs, grasses, trees and shrubs used commonly or less commonly as food sources. Interviews with farmers and herders at a single site yielded 67 foods derived from 53 species, used to supplement the daily diet, generate income, or substitute for meals.

Livestock

Diversity characterises Sahelian animal production systems. A standard typology may be lacking in common usage; however, it is interesting to note local perceptions and typologies of biodiversity as a pointer to social or economic values. For example, in one Nigerian village cattle can be described in eight colour classes, or in four classes based on shape and size of horn, or only two based on body weight. In the same village, six types of sheep are recognised on the basis of various characters, but only two in terms of size. Six types of goat are recognised by their colours, though in two other villages only one type is recognised, the ubiquitous red goat. In the most arid of the Nigerian villages, where livestock are the basis of the economy, a more coherent typology of two cattle, five sheep, five goat and five camel types was offered.

Diversity also characterises the fodder plants used – matching each animal with fodder sources at different times of the year, and all of them ranked in order of preference, cost (if bought) and expected benefit (e.g., strength, fatness). Fodder strategies are finely tuned, in the village closest to the city of Kano, where animal fattening for the market (cattle and

sheep) is becoming so important that it challenges crop production as a source of income. The use of such strategies, in conjunction with spatial herd mobility, is of course highly developed in mobile pastoral systems in the arid zone, beyond the reach of settled farming. It is known that livestock ownership has shifted significantly since the Sahel Drought in favour of farmers, and it should not be surprising that the knowledge required for exploiting the ecosystem – even an intensively managed one – for maximising animal growth, performance and breeding is not beyond the reach of farmers.

As for mobile pastoralists, recent work by Saverio Kratli with WoDaaBe cattle breeders in Niger has demonstrated the asymmetrical distribution of nutrients in the uncertain environment. Rather than being a simplistically conceived 'coping strategy' in risk management, the skills of mobile herders are employed in targeting and 'intelligently harvesting' transient concentrations. This is biodiversity on a temporal as well as a spatial scale. Breeding, through careful selection of bulls and cows, is also critical for producing progeny with high performance including a learned capacity for selective feeding – in this environment.

What the case study shows

This admittedly superficial scan of biodiversity in real time and space points to the following conclusions, which may be formulated and tested as a multiple hypothesis of ecosystem management in all drylands, at least in poor countries not yet transformed/distorted by industrial agriculture:

- Biodiversity as a resource is *intrinsic* to indigenous agro-pastoral systems, not merely as an omnipresent characterisation but in terms of *functionality* in the human-ecological systems. One may go so far as to say that, given the present state of knowledge, it is not possible to conceive of an alternative, sustainable mode of exploitation in the dryland habitat.
- Genetic management (crop breeding, animal breeding, wild plant protection and harvesting) is the key 'bridge' between the human and ecological systems, as proposed in the Drylands Development Paradigm, and is supported by a knowledge system that may be improved, but certainly not replaced, by science-based knowledge. The sustainability of this knowledge bank is of the utmost importance
- There are many tensions (trade-offs) in dryland ecosystems, but these are *not* all about sustainability *versus* productivity. Contrary to much conventional wisdom, resource scarcity need not or does not promote destructive exploitation. Given the right conditions, it has helped to drive sustainable management of ecosystems. As the value of ecosystem services increases, there is every reason to expect such an outcome.
- Thus, 'good news' for biodiversity paradoxically accompanies persistent poverty. While it is in the interest of poor people to maintain the biodiversity which they are skilled in using and from which they derive value and benefits, its removal would undoubtedly precipitate greater poverty.
- Given the complexity of dryland ecosystems (both human and ecological), 'poverty reduction' when conceived merely in terms of financial incomes and assets lacks clarity. Since the primary determinant of poverty or wellbeing (as used in the Millennium Ecosystem Assessment) is the state of health of the coupled human-

ecological system, interventions aiming to reduce poverty need a broader reference than has been usual. Sustainable biodiversity can help reduce poverty only in this wider system context.

The Challenge Paper on dryland opportunities

In 2009 the IUCN, UNDP and IIED published a Challenge Paper entitled, *Dryland opportunities: a new paradigm for people, ecosystems and development.* It aimed to bring

> 'a perspective on conservation and sustainable development to particular approaches and strategies for development. It is argued that conservation – of biodiversity in particular – can only take place in healthy ecosystems, which in turn can only be maintained where poverty is reduced and appropriate institutions are operating.'

The argument is developed through four themes: realising the true value of ecosystem services, investing in drylands, linking drylands with markets, and institutions for managing rights, reform, risk and resilience. The study rejects the long-standing 'desertification paradigm' in favour of an opportunistic framework for dryland development, supported by an upgraded knowledge base.

Within this frame, I want to focus briefly and rather more sharply than the paper does, on poverty-biodiversity linkages. The *first step* is to accord biodiversity *per se* the status of an ecosystem service. For example:

- Soil biodiversity is a supporting service for agriculture and food security
- Vegetational biodiversity is a supporting service for livestock
- Agro-diversity and animal breed diversity support a range of land use options, and having these options itself has value in an uncertain environment.
- Biodiversity (in the form of landscape, animals) supports tourist revenues
- Biodiversity when locally owned supports local autonomy in natural resources management , free from dependence on the state

The case study just reviewed provides multiple illustrations of biodiversity services that are valued by dryland peoples, though not necessarily in US $ equivalents. So the *second step* is to find a basis for valuing biodiversity in monetary or non-monetary terms, as appropriate. These values play a critical role, first, in the rationales that underlie land use systems such as mobile livestock herding and intensive farming, second in local knowledge and innovation, and third in adaptive capacity to changing environments. They need to be included in national accounting.

The *third step* is to reconsider the case for investing in dryland ecosystems and their services. Investments can pay in drylands, as shown by documented cases. Most readers will understand this to mean corporate or public investment on a grand scale. Certainly basic infrastructure and some services must be the responsibility of the state. But the majority of dryland investments are small-scale, intermittent, and private – the savings of poor people, invested in such improvements as livestock, soil and water conservation and drainage, tree planting, fencing, and re-seeding. Such investments by and large do not threaten plant biodiversity (though farming intensification is unfriendly to wild animals). But corporate

investment – for example, in biofuel, industrial crops or food production – is necessarily large in scale, dependent on fossil fuel and agro-chemicals, and based on mono-cropping.

Arguing from a biodiversity conservation perspective, therefore, a different business plan is needed for dryland investment. Instead of large-scale commercial operations, directly controlled by corporations (or the state), a model based on micro-investments by small farmers or livestock producers is more likely to protect biodiversity within a framework of agricultural intensification. There may still be a role for corporations, but as intermediaries in service provision to small and poor producers. The already noticeable drift towards dual sector development, with many African countries granting privileged status to foreign investors, may be a help to government revenues but cannot be good news for biodiversity.

The question of investment needs to be scrutinised from a range of standpoints – those of poor resource users, private commercial enterprise, national productivity, governance and sustainability – and not merely through an accounting framework. In crafting investment incentives, policy makers should have in mind that nature's benefits do not come free, and that the greater the value of an asset, the more likely it is that right-holders will wish to sustain it.

The *fourth step* is to improve access by poor resource users to profitable markets. A radical change is needed from a view that conservation is best achieved by protecting ecosystems from the market to an acceptance that ecosystem services are more likely to be sustainably managed if they have value for market production – and biodiversity is such a service. There are documented cases from African drylands where market access has encouraged sustainable agriculture, which (as the above case study found) need not reduce biodiversity. New or rapidly growing niche markets are emerging for natural products (e.g., in southern Africa), with new value-chains linking small producers with national or global markets. Given the way markets are going, from local to global, it is wiser to find ways of working with them rather than against them.

Value implies scarcity, otherwise 'mining' will occur. Proprietary rights, or institutions that can regulate on behalf of a community, are a condition for sustainability. The *fifth step* is setting up or adapting institutions. The negotiation of byelaws, local agreements or 'conventions,' governing the rights of all stakeholders to the use of contested natural resources, together with the decentralisation of governance, has positive implications for biodiversity. However it should not be assumed that local communities, in exercising their reclaimed autonomy, will value all species equally. But local institutions offer a better way forward than the draconian impositions of the state, for example in banning tree cutting or abusing property rights. In principle, the management of local biodiversity is best supervised by the local community, as it was before the colonial states were established in Africa; however, it is early to pass judgement on the impact of institutional development on biodiversity.

Conclusion

The ecosystem services concept appears to comes quite close to local peoples' perception; but valuation is essential as monetary values alone are not adequate, if only because sustainability, besides production, has value.

To sustain biodiversity in drylands will support poor peoples' livelihoods, otherwise their vulnerability to variable ecology, markets and employment will increase. Specifically, the biodiversity found in a given ecosystem is the result, not only of ecology, but increasingly of management. Sustainable management in turn will secure nature's benefits, support livelihood and may reduce poverty. Turning this circle from vicious to virtuous is the challenge. Perhaps the best form of poverty reduction is to secure biodiversity from further damage by economic interests often beyond the users' control. The solution that has been preferred in the past – state led, donor funded interventions aiming to transform indigenous practice through mainly technological innovation – is (it seems) giving way to the still more disruptive introduction of a new foreign funded and directed large-scale sector, accompanied by land alienation, mono-culture and global markets. Given the complex interactions of co-evolving human and ecological systems, it seems essential that policies and interventions, whether those of governments or NGOs, should (1) recognise the managers, their priorities, capacities and constraints, and (2) empower them with knowledge enhancement, opportunities, market links and incentives to invest, in the interest of co-managing creatively a 'useful biodiversity' (to adapt the title of Dalziell's famous work of 1937).