DESERTIFICATION AND CLIMATE CHANGE: THE CASE FOR GREATER CONVERGENCE

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Abstract. Poor knowledge of links between desertification and global climate change is limiting funding from the Global Environment Facility for anti-desertification projects and realization of synergies between the Convention to Combat Desertification (CCD) and the Framework Convention on Climate Change (FCCC). Greater convergence between research in the two fields could overcome these limitations, improve our knowledge of desertification, and benefit four areas of global climate change studies: mitigation assessment; accounting for land cover change in the carbon budget; land surface-atmosphere interactions; and climate change impact forecasting. Convergence would be assisted if desertification were treated more as a special case in dry areas of the global process of land degradation, and stimulated by: (a) closer cooperation between the FCCC and CCD; (b) better informal networking between desertification and global climate change scientists, e.g. within the framework of the Intergovernmental Panel on Climate Change (IPCC). Both strategies would be facilitated if the FCCC and CCD requested the IPCC to provide a scientific framework for realizing the synergies between them.

Keywords: carbon budget, climate change, desertification, international environmental institutions, land degradation, research convergence, science policy

1. Introduction

Desertification, the process of land degradation in dry areas, is the ‘Cinderella’ of global environmental change. It potentially affects 40% of the Earth’s surface and 32% of the human population (UNEP 1997) and, like global climate change, is the subject of an international framework convention. Yet while the latter has been the focus of an unprecedented and continuing international research effort (Watson et al. 1996) only a relatively small amount of effort and funds have been devoted to desertification research. Consequently, our understanding of the phenomenon, and data on its extent and rate of change, are both limited. This is particularly unfortunate as the impressive programme of research commissioned by the United Nations Environment Programme (UNEP) prior to the UN Conference on Desertification (UNCOD) in 1977 set a benchmark for the role of science in UN conferences.

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The chronic lack of data on desertification has even caused some to deride it as a myth (Binns 1990), and poor knowledge of its links with global climate change has become a major obstacle to exploiting synergies between the Framework Convention on Climate Change and the Convention to Combat Desertification (SCCD 1999a). In this paper we argue that greater convergence between research into desertification and global climate change would overcome this obstacle and lead to better knowledge of desertification as well. The paper has two main parts. Part one defines desertification and suggests how it could be incorporated into the overall framework of global climate change research, by viewing it as part of the wider phenomenon of land degradation. Part two assesses the prospects for promoting research convergence.

2. Desertification as Degradation

Desertification was defined in the preamble to the Convention to Combat Desertification (CCD) (UNEP 1995) as 'land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities'. It has two main components, vegetation degradation and soil degradation, caused by overcultivation, overgrazing, reduction in tree cover, and poor irrigation management. It varies in degree from slight to severe, is generally reversible until land is eventually turned into desert, and can occur anywhere in dry areas and not just on desert fringes (Grainger 1990a).

One reason why desertification has become marginalized is disagreement over how it is, or should be, defined. UNCOD specifically refuted the idea that desertification principally involves the spreading of deserts, though some people still do not accept this and so question its existence when evidence of advancing deserts is not found (Pearce 1994). Others just dislike the term 'desertification' and want to restrict it to describing an irreversible transformation of land into desert (Nelson 1988; Warren and Agnew 1987; Mainguet 1991). Alternative terms have been used to describe this or similar phenomena in the past (Verstraete 1986), but desertification has now become the established term by virtue of its being included in the title of an international convention.

Vegetation and soil are degraded all over the world, and if desertification were regarded more as a special case in dry areas of the global process of land degradation, and less in isolation from other aspects of global environmental change, this might assuage the sceptics and provide a stronger scientific framework for desertification research. Vegetation degradation involves a temporary or permanent reduction in the density, structure, species composition or productivity of vegetation cover (Grainger 1996a), and affects cropland and rangeland as well as forests. Thus, in contrast to the total clearance of forest which constitutes deforestation, forest could be degraded by reducing the number of trees in an area or the average biomass density per tree etc. Soil is degraded by water erosion, wind erosion, compaction, waterlogging, salinization and other forms of chemical and physical deterioration. Both types of degradation appear at their most extreme in dry areas, where they are closely linked together.

Desertification has been recognized since UNCOD as a long-term trend in land degradation but, in common with degradation in other parts of the world, identifying this trend is made difficult by short-term fluctuations. Degrading impacts are often offset by subsequent regeneration, though whether this fully compensates for the initial loss depends on the intensity and length of the impact. Vegetation growth generally declines during a period of drought, which is usually a relatively short-term fall in precipitation from the long-term average, and normally recovers when the drought ends. But since human beings often respond to the lower vegetation growth by overusing the land, drought can become a contributing cause of desertification by accelerating the long-term trend in degradation caused by previous overuse (Grainger 1990a).

3. Integrating Desertification into Climate Change Research

Desertification could be incorporated into four major categories of global climate change research: mitigation assessment; accounting for land cover change in the carbon budget; land surface-atmosphere interactions; and climate change impact forecasting.

3.1. Suitability of Degraded Land for Climate Change Mitigation

Desertification is already integral to assessments of the potential for mitigating global climate change by restoring degraded lands to sequester surplus carbon from the atmosphere (Watson et al. 1996). The Framework Convention on Climate Change provided for a pilot phase of Joint Implementation forestry projects in developing countries funded by developed countries, and there are new initiatives to extend this as part of the Clean Development Mechanism included in the Kyoto Protocol (e.g. World Bank 1998), though their implementation is likely to be affected by political controversy (Trexler and Kosloff 1998).

Over half the degraded tropical lands are potentially in dry areas (Grainger 1990b). According to a UNEP workshop about 1.0 Gt C yr^{-1} could be sequestered by restoring them, at a cost of \$10-\$20 t^{-1} C (Anon 1995; Squires et al. 1997). Lal et al. (1999) gave a higher mean figure of 1.4 Gt C yr^{-1}, or more than 40% of the total annual rise in atmospheric carbon dioxide concentration (Table I). Besides the additional carbon sequestered in the vegetation and soil this also allowed for the reductions in carbon emissions from soil erosion and the use of fossil fuels (substituted by biomass fuels). Both estimates were stated to be very approximate, not least because they relied on highly inaccurate estimates of the extent and severity of desertification (Squires 1998).

TABLE I
Potential of desertification control and land restoration to sequester carbon (Gt C yr^{-1}).

Process	Range	Mean	% of total potential
Emission reduction through erosion control	0.2–0.3	0.25	18
Restoration of eroded lands	0.2–0.3	0.25	18
Restoration of physically and chemically degraded soils	<0.01	<0.01	–
Reclamation of salt-affected soils	0.2–0.4	0.3	21
Agricultural intensification on undegraded soils	0.01–0.02	0.015	–
Fossil fuel C offset through biofuel production	0.3–0.5	0.4	29
Sequestration as secondary carbonates	0.01–0.4	0.2	14
Total	0.9–1.9	1.4	100

Source: Lal et al. (1999).

TABLE II
Distribution of desertified lands (ha. 10^6).

	Lands affected by soil degradation	Rangelands with degraded vegetation
Africa	319.3	na
Asia	370.4	na
Australia	87.6	na
Europe	99.5	na
North and Central America	79.3	na
South America	79.1	na
Total	1035.2	2559

Source: UNEP (1997). NB. Data not available.

The shortage of reliable national and global data on the extent and rate of change of desertification has been a persistent problem since the 1970s (Dregne 1985). It results from both a limited monitoring effort and inadequate monitoring procedures, and contrasts with the wealth of localized evidence of widespread and substantial dryland degradation, e.g. in East Africa (Mung'ong'o 1991; Stahl 1993), Australia (State of Environment Advisory Council 1996), China (Sheehy

1992), and the USA (Committee on Rangeland Classification 1994). UNEP's most recent global estimate of the area of susceptible dryland suffering from desertification, included in the second edition of its World Atlas of Desertification, is 3.6 billion ha. This includes 1 billion ha of dryland suffering from soil degradation, mainly caused by overgrazing, overcropping and deforestation, and another 2.6 billion ha of rangeland with degraded vegetation (Table II) (UNEP 1997), and is essentially the same as the estimate in the first edition of the Atlas (UNEP 1992). An external review claimed that the accuracy of the latter was limited by (a) considerable subjectivity, which meant that observations were not repeatable; (b) lack of resolution, which made comparisons over time impossible; and (c) the use of sample data unrepresentative of larger areas (UNEP 1994). Given this inaccuracy, estimates of the annual rate of desertification, which had previously been as high as 27.0 million ha yr^{-1} (UNEP 1987), are not very meaningful and none were included in the Atlas.

The subjectivity of estimates reflects a general readiness in the early stages of global change research to accept that data collection need not meet the same high standards required for other branches of science (Simonet 1989). Fortunately, the situation is now changing (Baulies and Szejwach 1998). For want of anything better, UNEP traditionally based its desertification estimates on subjective assessments by a small group of experts, instead of remote sensing and ground data. This remained the case with the estimates of soil degradation included in UNEP (1997), though the approach was more structured than before and involved more experts (Thomas 1993). The same used to be true of UN estimates of tropical forest areas and deforestation rates, though deforestation is easier to monitor by remote sensing techniques and their use has gradually increased (Grainger 1996b). A Swedish Agency for Research Cooperation with Developing Countries workshop at Orenas in 1990 concluded that desertification data would not improve unless expert assessments were replaced by a global monitoring system that collected primary data (Helldén 1991). This would, of course, require the use of sampling. Although there is continual innovation in the analysis of satellite images of dry areas (e.g. Kumar et al. 1997), certain fundamental problems remain, e.g. those related to the respective reflectances of soil and the sparse vegetation cover (Tueller 1987).

No monitoring system will be effective if its resolution is inappropriate to the phenomenon being observed. The resolution of satellite remote sensing techniques has so far been too low to monitor desertification effectively on a large scale. Desertification is a spatially complex, fine-grained phenomenon that mainly consists of dispersed, patch-like degradation, not the frontier expansion of desert fringes of popular imagination. A UNEP expert panel has called for the use of high resolution remote sensing data to produce 'geographically explicit and precise assessments of dryland resources' (UNEP 1994).

These difficulties are exacerbated by the lack of an agreed set of desertification indicators. Some experts argue that physical indicators of soil and vegetation degradation are sufficient; others go further and claim that only soil degradation can show a long term decline in potential land productivity, as vegetation degradation is easily reversed (Thomas and Middleton 1994). This was the general approach taken by UNEP (1997), which was almost exclusively concerned with soil degradation. It has also been suggested that physical indicators should be complemented by socio-economic and agricultural indicators, but this could lead to difficulties, e.g. studies in Sudan found that only 10–15% of the fall in crop yields in a drought-prone area was due to land degradation, with the rest explained by climatic variation (Olsson 1993). The first sets of desertification indicators were proposed over twenty years ago (Berry and Ford 1977; Reining 1978). Others have been put forward since then (Mabbutt 1986), but UNEP still had to decide on which set to use by the time the CCD came into force (Cardy 1995). In 1999 the CCD's Committee on Science and Technology circulated a draft set of indicators and benchmarks to governments so they could assess its feasibility for use in preparing national reports (SCCD 1999b). Of course, once a proper global monitoring system was in place, a pragmatic decision on the choice of indicators would have to be taken to make the system operational.

3.2. The Role of Land Degradation in the Carbon Budget

In contrast to its keen interest in the area of desertified land suitable for carbon sequestration, the climate change community has been much less concerned with the actual degradation of these lands and the contribution this makes to greenhouse gas emissions. This reflects a general neglect of land degradation as a whole. Gross annual carbon emissions from deforestation and other land use change (1.6 ± 0.8 Gt C yr^{-1}) are currently only a quarter of those from fossil fuel combustion and cement production (6.3 ± 0.6 Gt C yr^{-1}). Yet the biota and soil are also important sinks and there is an assumed net terrestrial uptake of 2.3 Gt C yr^{-1} (IPCC 2000a). However, the sizes of specific terrestrial fluxes are still uncertain, and poor knowledge of the complex balance between carbon emissions and uptake on degraded lands contributes to this.

The need to account for the contribution of land degradation to greenhouse gas emissions has been recognized for some time (Graham et al. 1990; Grainger 1991), but so far it has received less scientific attention than deforestation in land cover change studies, and in the Kyoto Protocol too. Deforestation, afforestation and reforestation together do provide a good approximation to the land cover change processes in most developed countries (with the notable exception of Australia). But the situation is more complicated in developing countries, where the error involved in ignoring land degradation is also more important because carbon emissions from land cover change account for a much higher proportion of total carbon emissions (World Resources Institute 1996). So giving more attention to degradation in carbon accounting is justified by the need for comprehensiveness and political inclusivity.

TABLE III

Comparison of deforestation and forest degradation, shown by a change matrix for 31 sample areas in Africa 1980–1990 (ha. 10^3)

State in 1980		Classes in 1990								
Classes	Area	Closed Forest	Open Forest	Long Fallow	Frag-mented Forest	Short Fallow	Shrubs	Other Land Cover	Water	Plant-ations
Closed Forest	18319.3	16781	382.1	82.6	291.8	524.3	9.5	247.5	–	–
Open Forest	11021.8	23.6	10049	48.3	371.2	117.8	12.7	397.3	0.1	1.4
Long Fallow	665.4	7.7	14.6	556.8	1.6	51.7	4.4	28.5	–	–
Fragmented Forest	8461.1	24.1	40.0	1.0	8088.8	5.8	7.7	293.5	–	–
Short Fallow	2338.6	7.6	10.9	9.6	2.1	2254.8	–	53.3	0.4	–
Shrubs	4055.1	0.8	10.8	–	1.1	–	3877.9	154.3	0.1	–
Other land cover	26752.8	16.9	38.2	11.0	63.1	34.3	86.6	26452	51.2	–
Water	3045.9	0.5	–	–	0.5	3.2	0.1	81.5	2960.1	–
Plantations	5.3	–	–	–	–	0.4	–	0.4	–	4.6
Area in 1990	74665.2	18863	10546	709.2	8820.2	2992.4	3999.0	27718	3011.9	6.0

Source: FAO (1993).

The magnitude of degradation in tropical forests generally is indicated by a change matrix based on 31 samples in Sub-Saharan Africa (Table III), though this only provides data on areas and not biomass (FAO 1993). Between 1980 and 1990 7.0% of all closed forest was converted to some form of degraded forest, compared with only 1.4% deforested and converted to another type of land cover. Open forest (or savanna woodland) is the more typical forest cover in dry areas and accounts for 69% of Africa's total forest area (Lanly 1981). Some 5.0% of open forest in the study was degraded, compared with the 3.6% converted to another type of land cover. If this was a representative sample then the error involved in basing estimates of carbon emissions from land cover change in forested areas on deforestation estimates alone could be considerable. Although indirect methods have been devised to compensate for the lack of data on forest degradation (Brown and Gaston 1995), they are no substitute for a proper programme to monitor the contribution of all vegetation degradation to global climate change. New techniques and activities to monitor desertification could be developed as part of such a programme.

Vegetation change in the dry tropics makes a much lower contribution to overall carbon emissions than it does in the humid tropics. Estimates are very inaccurate, but carbon emissions from deforestation in the dry tropics in 1980 (there were no data on the degradation of forest and other vegetation) were estimated at only 0.10 Gt C yr^{-1}, compared with up to 0.70 Gt C yr^{-1} for closed forests in the humid tropics (Grainger 1990c). Monitoring is made difficult by the masking of long-term trends by short-term variations. As desertification data were sparse at the time of UNCOD, UNEP publicized the results of an aerial and ground survey (Lamprey 1975) that seemed to give evidence of an advancing desert front in Sudan's Kordofan province. This was later challenged by Helldén (1991), whose remote-sensing studies of the area found no evidence of changes in vegetation cover that could not be explained by short-term climatic variation. When low resolution Advanced High Resolution Radiometer (AVHRR) satellite imagery of the entire Sahel showed a large-scale cyclical spatial variation in biomass production in the 1980s that could be linked to changes in growing season rainfall (Tucker and Choudhury 1987; Tucker et al. 1991), sceptics concluded that what had been regarded as desertification was just part of a short-term fluctuation (albeit a rather extended one in this case). But remote sensing studies need good support from ground-truth data, and misleading conclusions can be drawn if such data are obtained using a poor sampling design (Pickup 1989). Ironically, questions about ground truth data and the choice of change detection period later put Helldén's own findings in doubt (Stiles 1995). Separating long-term trends from short-term variation in remote-sensing studies of dry areas is difficult but possible (Bastin et al. 1993, 1995) and would undoubtedly show long-term human-induced changes in some regions.

In dry areas soil degradation is the leading source of carbon emissions from land cover change, and could be as high as 0.227–0.292 Gt C yr^{-1} (Table IV) (Lal et al. 1999). Dryland soils contain larger stocks of carbon than the vegetation which covers them: in hyper-arid, arid and semi-arid zones the mean ratio between carbon

TABLE IV
Carbon emissions from soil degradation in dry areas.

Degree of degradation	Total area affected by wind and water erosion ($ha.10^6$)	C emissions to atmosphere ($Gt\ C.yr^{-1}$)
Slight	372.3	0.08–0.10
Moderate	423.9	0.11–0.14
Strong	97.0	0.015–0.02
Extreme	6.6	0.0015–0.002
Exposure of Calciferous Horizon	–	0.02–0.03
Total		0.227–0.292

Source: Lal et al. (1999).

TABLE V
Global carbon stocks in vegetation and soil carbon pools down to a depth of 1 m.

Biome-Type	Area	Carbon stocks (Gt C)			Carbon densities (t C/ha)	
	($ha.10^9$)	Vegetation	Soil	Total	Vegetation	Soil
Tropical forests	1.76	212	216	428	121	123
Temperate forests	1.04	59	100	159	57	96
Boreal forests	1.37	88	471	559	64	344
Tropical savannas	2.25	66	264	330	29	117
Temperate grasslands	1.25	9	295	304	7	236
Deserts and semi-deserts	4.55	8	191	199	2	42
Tundra	0.95	6	121	127	6	127
Wetlands	0.35	15	225	240	43	643
Croplands	1.6	3	128	131	2	80
Total	15.12	466	2011	2477	31	133

Source: IPCC (2000a).

stocks in soil and those in vegetation is about 20/1, compared with 1/1 in tropical moist forests (Table V) (IPCC 2000a). The ratio is lower in sub-humid savannas, which are also affected by desertification.

3.3. Land surface-atmosphere interactions

Studies of desertification could also improve our knowledge of land surface-atmosphere interactions, the importance of which has been appreciated for some time (Verstraete 1989). Although the role of drought in catalyzing desertification is well understood (Grainger 1990a) much more needs to be learned about other possible links between desertification and climate (Williams and Balling 1996). Desertification is known to change thermal processes, e.g. by affecting the albedo (Lyons et al. 1993), and one explanation proposed for the prolonged drought in the Sahel in the 1970s and 1980s was biogeophysical feedback, in which drought led to reduced vegetation cover, prompting overexploitation by humans and animals, which fed back through albedo changes to reduce rainfall, leading in turn to increased exploitation etc. (Charney et al. 1975). However, there was no conclusive proof of this, nor of other suggestions that the drought was caused by global climate change, and variation in sea-surface temperatures seemed to offer a more convincing explanation (Hulme 1992). The present consensus, based on empirical and modelling studies, is that the main impacts of desertification on climate are at local and regional levels (Williams and Balling 1996).

3.4. Impacts of Global Climate Change

Despite continuing advances in the ability of global climate models to simulate possible future climate changes it is difficult to predict the impacts these might have on the terrestrial environment, owing to the behavioural responses of human beings as climate zones shift. A similar situation could arise to that seen in Africa in the 1970s and 1980s when human beings responded to the prolonged drought by overusing the land, and causing desertification to accelerate. So more empirical research into desertification could help to improve global climate change impact models and the formulation of mitigation and adaptation policies.

4. Capitalizing on Synergies Between the Rio Conventions

In principle, therefore, greater convergence between research into desertification and global climate change would enhance our understanding of both fields. The key question is how to stimulate this. One approach would be to assume that it would occur as a natural consequence of growing cooperation between the three environmental regimes that emerged from the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Both the Framework Convention on Climate Change (FCCC) and the Convention on Biodiversity (CBD) mention the importance of desertification. The value of cooperation to realize synergies between the three regimes was also stressed in the Agenda 21 action plan agreed at UNCED, and restated by the Special Session of the UN General Assembly in June 1997 that reviewed progress in the intervening five years.

Following an expert meeting to explore synergies between the three conventions, held in Israel in 1997, the secretariats of the CCD and the CBD established formal bilateral links in 1998 by exchanging a memorandum of understanding

(SCCD 1998). Negotiations on similar links with the FCCC are still continuing. In the short-term, informal cooperative efforts are focusing on capacity building, information management, and community-level pilot projects that can achieve complementary implementation of the FCCC, CBD and CCD (SCCD 1998).

The forging of stronger ties between the CCD and the FCCC is being obstructed by poor scientific knowledge of the linkages between desertification and global climate change (SCCD 1999a). This is not for want of meetings: UNEP convened two expert panels on the subject in the 1990s (Williams and Balling 1996; Squires et al. 1997), and desertification was one of the 'adverse effects' of global climate change discussed at a workshop convened by the FCCC Subsidiary Body for Scientific and Technological Advice in Bonn in September 1999 (SFCCC 1999). There have also been 'initial communications' between the CCD Committee on Science and Technology (CST), the Intergovernmental Panel on Climate Change, the FCCC Subsidiary Body on Scientific and Technological Advice, and the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SCCD 1998). But a stalemate situation seems to have developed, and present links between the CCD and the FCCC may not be strong enough to promote the research needed to overcome it.

Allocation of multilateral funds for anti-desertification projects is also constrained by lack of knowledge. The CCD differs from the other two regimes in having no specific multilateral fund for its implementation. Instead, it has a Global Mechanism, coordinated by the International Fund for Agricultural Development (IFAD), based in Rome, to improve the management of existing funds. Funds can also be channelled through the Global Environment Facility (GEF) but, as presently constituted, this has only four main focal areas: climate change, biodiversity, ozone depletion and international waters. It has recognized the generic importance of land degradation by devising a framework that includes both desertification and deforestation and incorporating this into its Operational Strategy (GEF 1996), but is only allowed to only fund projects having a global impact on one of its four focal areas. Local and regional impacts of desertification on climate change (which are all that are currently recognized) are taken into account but are not by themselves sufficient. At present, since the impacts of desertification on biodiversity are more clearly identified it is mainly through this link that finance is requested for desertification-related projects. But governments still find it hard to obtain funding, owing to difficulties in clearly defining and interpreting GEF criteria for links between desertification and its four focal areas, valuing the global benefits of projects, and estimating the incremental costs of realizing the latter. The first GEF Assembly, held in New Delhi in April 1998, called for action to resolve the uncertainty about links between desertification and climate change, and the GEF Council reviewed all the problems at its meeting in December 1999. Solutions to the valuation difficulties were proposed at a GEF workshop in London in March 1999 (GEF/IIED 1999), but some procedural matters still remain to be clarified.

A unilateral initiative for basic research from organs of the CCD seems unlikely at the moment. Its CST plans to establish a network of research institutions to support implementation of the CCD, as provided for in Article 25. But the immediate priority of the network is to support field projects, so the CST has focused initially on promoting the use of early warning systems, identifying traditional knowledge of methods to combat desertification, and producing benchmarks and indicators (SCCD 1999b). It recognizes the need for more basic research into the linkages between desertification, global climate change and biodiversity degradation, but as yet has no specific plans to expand the network along those lines, even though funding for projects would appear to depend on gaining better knowledge of these linkages.

5. Extending Scientific Cooperation

An alternative strategy for achieving convergence would be to improve informal networking between desertification and global climate change researchers. One way to do this would be through the supportive institutional framework provided by the Intergovernmental Panel on Climate Change (IPCC). This indirectly helps to set research agendas and facilitate research cooperation by the way it structures its regular assessments and selects the topics for occasional workshops. However, while desertification was mentioned in IPCC's Second Assessment Report (Houghton et al. 1996; Watson et al. 1996), it is likely on present evidence to be less prominent in the Third Assessment Report. Of the four main research categories discussed above, mitigation studies offer the greatest scope for putting more emphasis on desertification, at least in the short term. On the other hand, the flexibility to address the role of land degradation in the global carbon budget appears to be limited by the Kyoto Protocol. Article 3.3 restricts the accounting of changes in carbon stocks in Annex I (industrialized) countries to those due to afforestation, reforestation and deforestation. This would appear to exclude forest degradation, which plays an important role in the reduction of tree cover (and vegetation cover generally) in dry areas. However, Article 3.4 covers 'additional human-induced activities' which could encompass cropland and rangeland degradation.

A recent report by the IPCC (2000a), specially commissioned to provide scientific advice on procedures for including land use, land use change and forestry in the Kyoto Protocol, recognizes the importance of forest degradation, dryland degradation and open woodlands in the global carbon budget and the advantages of allowing for them in the Kyoto Protocol. It also offers policy makers the option of relaxing the above constraints. Instead of defining deforestation in terms of a change of land use and land cover from forest to non-forest, it suggests (IPCC, 2000b) that:

> An alternative definition of deforestation might be based on a decrease in the canopy cover or carbon density by a given amount or crossing one of a sequence of thresholds.

In other words, the term 'deforestation' could be used to refer to the process of 'forest degradation' as understood in this paper. Since deforestation, as conventionally defined, is merely an extreme case of forest degradation this would allow a more inclusive treatment of land cover change, and afforestation and reforestation could be defined as the reverse of this process. IPCC (2000b) recognizes that problems could arise with respect to the size of the threshold canopy cover chosen to distinguish forest from non-forest:

> If a high threshold ... (e.g. 70%) ... is used..., then many areas of sparse forest and woodland could be cleared or could increase in cover without the losses or gains in carbon being counted under Article 3.3. If a low threshold is set (e.g. 10%) then dense forest could be heavily degraded and significant amounts of carbon released, without the actions being designated as deforestation.

The former is particularly relevant to the open woodlands characteristic of dry areas. The report acknowledges the difficulties, referred to above, of accounting for changes in carbon stocks resulting from the 'regeneration of trees immediately after disturbance or harvesting where no land use change occurs'. It also recognizes that preventing the degradation of agricultural lands could be included in 'additional human-induced activities' (IPCC 2000a).

It is up to the Conference of the Parties of the FCCC to decide on which definition of deforestation it prefers, and on the extent to which land degradation generally is incorporated in the Kyoto Protocol. As Articles 3.3 and 3.4 do not apply to developing countries at the moment there is no reason in principle why future IPCC assessments should not put greater emphasis on vegetation and soil degradation in those countries, and hence on desertification. A modest start could be made in the Third Assessment, for example, by identifying a set of research priorities on the links between land degradation and global climate change. Given the strength of feeling in developing countries about desertification, the IPCC might benefit from retaining flexibility in this area while the developed and developing countries continue to negotiate their commitments to mitigating global climate change. Developing countries might insist on land degradation being referred to in an elaborated Kyoto Protocol in return for agreeing to participate in it.

6. Conclusions

Greater convergence between research into desertification and global climate change would benefit both fields of research. Desertification requires a vast increase in research activity, and at least four areas of global climate change research would benefit from the information that this research would generate. If desertification were treated more as a special case of the generic process of land degradation, instead of the rather isolated field of study which it is at the moment, then this could provide it with a more substantial scientific framework and improve its standing within the scientific community.

Two possible strategies for stimulating convergence have been discussed. The first would rely on the fruits of growing cooperation between the Framework Convention on Climate Change (FCCC) and the Convention to Combat Desertification (CCD). Yet this is currently limited by a lack of scientific knowledge on the links between the two phenomena which such research would help to remedy. The second would improve informal networking between desertification and global climate change scientists, e.g. within the framework of the Intergovernmental Panel on Climate Change (IPCC). However, desertification has a low profile in the IPCC at the moment and this could be further reduced by restrictions imposed by the Kyoto Protocol.

If poor scientific knowledge of the links between desertification and global climate change continues to inhibit the strengthening of ties between the CCD and the FCCC, and supportive action by the Global Environment Facility, then one way to break the deadlock might be for the CCD and FCCC to ask the IPCC to prepare a special report on the subject, to provide a constructive framework for continued negotiation. This would also help to raise the profile of desertification within the IPCC as well.

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