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Ecological space and a low-carbon future: crafting space for equitable economic development in Africa

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Contents

Key facts and findings

Ecological space

- The concept of "equitable ecological space" translates well into "per capita carbon dioxide emissions" and the "per capita right to emit carbon dioxide", as recognised under the UNFCCC Kyoto Protocol. While the Kyoto Protocol explicitly recognises the need for both equity in emissions and non-restrictive economic development for developing countries in order to achieve a sustainable low-carbon future, these are not fully operationalised components. That is, there is current global inequality in the distribution of ecological space utilisation through carbon emissions and there is no sanction to redress this balance or mechanism for compensation for under-use.

- Global per capita average carbon emissions is 3.6 tonnes. The UK average is 9.2 tonnes; the African average is 1 tonne, although this is heavily weighted towards oil-rich countries. Only two African countries, Libya and South Africa, have higher emissions than the global average. The gap between the highest and lowest emitters (including many African nations) is increasing.

- Under current calculations, a sustainable level of carbon emissions is 1.8 tonnes per capita annually. This represents the estimated absorption capacity of natural carbon sinks, both land and sea. At present these sinks are absorbing roughly half of the anthropogenic emissions. Yet this per capita space is falling because of the projected warmer climate, which will accelerate decay of carbon in soils and lead to large releases of CO_2, coupled with projected population increases.

- There is a strong relationship between the level of industrial economic development of a country and its carbon emissions. To this end, without transfers of cleaner technology to African countries from developed countries, it is likely that future ecological space utilisation in Africa will be far higher.

- There is inequality in the impacts and adaptive capacities of climate change. Many African countries are bearing the brunt of the impacts of climate change when its causes were largely produced in developed countries. Poorer countries have fewer disposable financial resources to commit to adapting to climate change.

Opportunity knocks?

- For countries with high levels of "carbon credit", such as those in Africa, there is potential to use or sell some of their "excess ecological space" to reduce poverty and increase low-carbon economic growth and development.

- Export horticulture is one of the few genuine opportunities for developing countries to use their excess ecological space in ways that directly and indirectly benefit rural areas. Indeed, experience shows African horticulture export to be a 'trade-not-aid' champion. It provides significant social benefits, and there are few alternatives that can inject the capital and skills that export horticulture brings to a national economy and particularly a rural economy. Furthermore, there is projected future growth in export horticulture from existing and emerging producer countries in Africa (because of tourism, economic development and more socially conscious procurement patterns in all industries).

- At present, emissions from aviation are not included in national emissions calculations because there is no agreed methodology for allocation. Some advocate a 50-50 split between departure and arrival countries. Others suggest using final destinations of passenger/cargo to avoid presenting a misleading picture, owing to transit issues, entrepots and locations of hub airports. If the carbon emissions from importing fresh fruit and vegetables (FFV) from Africa to the UK were allocated:

  wholly to the UK's emissions budget, they would account for an extra 0.2 per cent of total emissions for the UK. Per capita emissions would rise to 9.22 tonnes (512 per cent of natural carbon sink capacity)
  entirely to Kenya's emissions budget, they would account for an extra 4.8 per cent of total emissions for Kenya. Per capita emissions would rise to 0.42 tonnes (23 per cent of natural carbon sink capacity).

  The UK is in ecological debt but Kenya is in ecological credit Kenya therefore has the space to invest this and chould sell its space to the UK.

Focus on producers not consumers

- Innovative financial and economic incentive mechanisms need to be identified, developed and piloted to encourage best practice. Under the UN Framework Convention on Climate Change, these will need to address the impacts of climate change as well as enable poverty alleviation and equitable economic development. The sorts of tools envisaged include:
  - A socially-differentiated carbon tax (SDCT) on aviation that incorporates social considerations without transforming incentives aimed at producing environmental benefits. A differential tax regime could weigh heaviest on developed country produce and provide incentives for developing countries to develop their export horticulture sector. For example, under a hypothetical SDCT, FFV exported by air from New Zealand would pay 5p/kg; from Kenya 1p/kg; and from Ethiopia 0p/kg.
  - Allocation of the carbon load from FFV exports to the producer country.

- The opportunity cost of doing nothing is high. Thus leveraging opportunities for developing countries is critical with a focus on maximising the opportunities that are best for developing nations and not just those that are convenient for the developed world.

Objective

This briefing paper aims to provide background on the ‘ecological space’ concept and illustrate the importance of using an ecological space evaluation framework within the climate change mitigation and adaptation debate for sustainable livelihoods in Africa supported by the export trade.

1. 'Ecological space' and carbon emissions

'Ecological space' extends the concept of individualised (per capita) rights to natural resources such as energy, food, land and clean air and water to global public goods - such as carbon emissions. In theory, everyone should have equal opportunities to access a sustainable level of global public goods. Ecological space usefully focuses on the *productive* use of natural resources, not on their *consumption*, bringing both the onus and opportunities from global public goods decisions to bear at a local level.

The concept of "equitable ecological space" translates well into "equitable per capita carbon dioxide emissions" as supported by the Kyoto Protocol.

This briefing paper focuses on climate change impacts, and specifically individual and national "rights" to access carbon dioxide emissions and analyses how these rights can be used to ground-truth and reorient current thinking on carbon emissions. This paper focuses on the opportunities currently being foregone in the context of African production and trade of fresh horticultural produce.

In the context of emissions, equity is a core principle of the UNFCCC Kyoto Protocol (herein referred to as "the Convention") and a long-term goal for many proposed solutions to climate change that are driving the current debates, including 'contraction and convergence'. Moreover, the Convention agreements to collectively reduce carbon emissions are based on current and target national per capita carbon emissions. In relation to developing countries, the Convention agrees to a set of "common but differentiated responsibilities", with the Parties agreeing that:

- the largest share of historical and current global emissions of greenhouse gases (GHGs) has originated in developed countries;
- per capita emissions in developing countries remain relatively low;
- the share of global emissions originating in developing countries will grow to meet their social and development needs.

Yet, this equity principle for emissions is not central to operations or discussions under the Convention. Compounding this is added inequality in vulnerability to climate change impacts, which are expected to hit the developing countries hardest.

2. Anthropogenic carbon emissions in context

2.1 Key data sources – sinks

The earth's natural ecosystems (both land and sea) currently absorb roughly half of the anthropogenic emissions of CO_2 (Schimel *et al*, 1996), thus buffering us from the full climate impacts of our emissions (Schimel *et al*, 1996; Jones *et al*, 2005) (see Figure 1). However, this is a 'moving target' since future changes in climate will affect this rate of natural absorption. This in turn influences the future rate of change of atmospheric CO_2 since the warmer climate accelerates decay of carbon in soils and leads to large release of CO_2, which causes further warming (Jones *et al*, 2005; Monbiot, 2006). Moreover, the population is projected to increase. The current size of the global natural carbon sink is estimated to be 3-5 billion tonnes of carbon (GtCE) – approximately 2 GtCE by ocean and 1-3 GtCE by land, depending on differing rates of deforestation (Rettalack, 2005; Prentice *et al*, 2001; Houghton, 2003). A global level of 4 GtCE is often used (Monbiot, 2006; Retallack, 2005).

2.2 Key data sources - emissions

There are a number of datasets on emissions, disaggregated by country, including:

- IPCC Data Distribution Centre – data collated from a number of sources, 2003.
- IEA - International Energy Annual, 2003.
- WRI – Climate Analysis Indicators Tool (CAIT) information on emissions – using land use change, national total, sectoral emissions.

While there is agreement that a global contract is needed to reduce carbon emissions, the methodology for developing indicators monitoring this reduction remains a subject of considerable debate. The most popular of these is the concept of 'contraction and convergence' which seeks to place a long-term cap on each country's carbon emissions and enforce this internationally. There is a scientifically-based globally agreed target of 0.45 tonnes per capita by 2100. It is clear that for this target to be achieved, various actions are required. For example, low-carbon economic development needs to be facilitated through technology and knowledge transfer from developed countries; and global enforcement mechanisms must be used to ensure developed countries make substantial cuts in their emissions. Furthermore, there is debate around the best mechanisms to achieve this target and whether requiring reductions of over 90% in per capita carbon emissions in many developed countries will allow unconstrained economic development in developing countries in line with the Convention.

As with any dataset, there are significant limitations. Emissions data are estimated and collated from numerous sources, requiring many assumptions to be made, particularly about the attribution of certain emissions sources among nations. There is considerable variation among these datasets, chiefly over whether to include only carbon dioxide or all emissions, or carbon dioxide equivalents. For instance, the CAIT by WRI include CO2, CH4, N2O, PFCs, HFCs, SF6. Carbon emissions are a factor of current, past and future emissions, and there is a strong argument to include the past 10, 25 or 50 years when calculating targets, further weighting in favour of developing countries.

2.3 Emissions

In 2005, global emissions of carbon dioxide were 23.8 billion tonnes, an average of 3.6 tonnes per capita. UK emissions were 9.2 tonnes per capita – over twice the global average. In African countries current per capita emissions are 1 tonne per capita. In contrast to the UK, only two of the

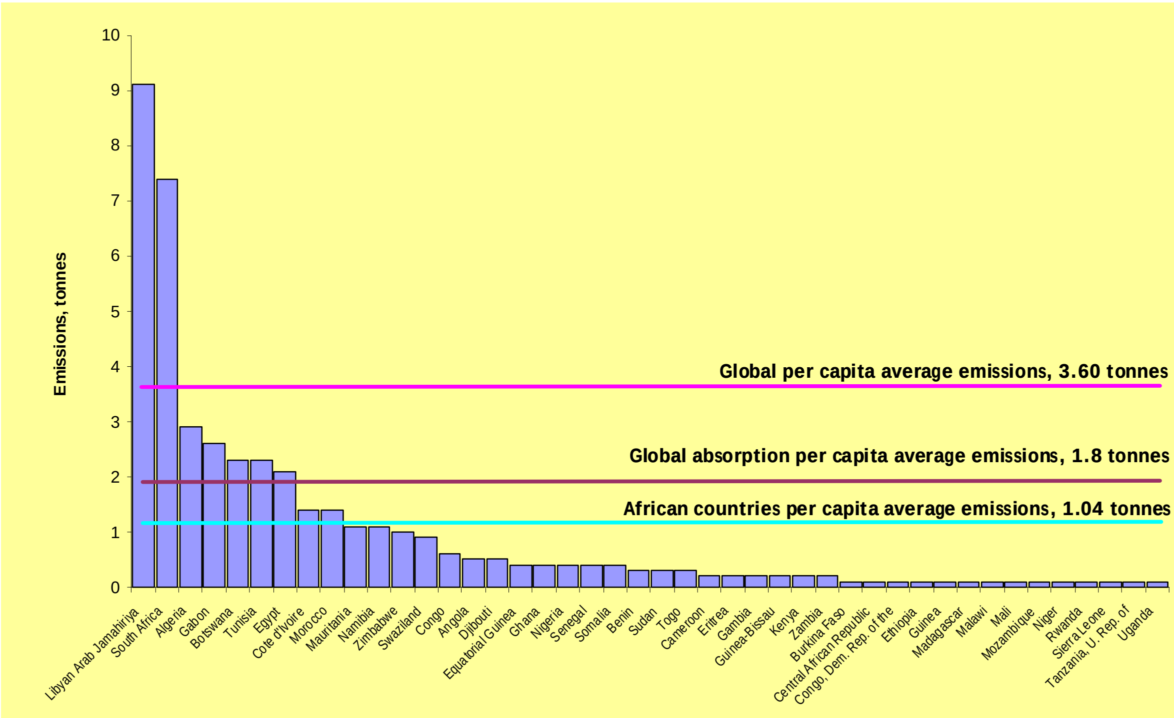
54 African countries have per capita emissions in excess of the global average (see Figure 1). Only 13 countries exceed the natural sink capacity estimate.

Table 1: Carbon dioxide emissions for African countries per capita by country 2000/2

Country	**Per capita CO2 emissions**	**Population (in 2000)**	**Total emissions (CO2 tonnes)**
Libyan Arab Jamahiriya	9.1	5,550	50,505
South Africa	7.4	45,030	333,222
Algeria	2.9	31,800	92,220
Gabon	2.6	1,330	3,458
Botswana	2.3	1,790	4,117
Tunisia	2.3	9,830	22,609
Egypt	2.1	71,930	151,053
Cote d'Ivoire	1.4	4,170	5,838
Morocco	1.4	30,570	42,798
Mauritania	1.1	2,890	3,179
Namibia	1.1	1,990	2,189
Zimbabwe	1	12,890	12,890
Swaziland	0.9	1,080	972
Congo	0.6	770	462
Angola	0.5	13,620	6,810
Djibouti	0.5	700	350
Equatorial Guinea	0.4	490	196
Ghana	0.4	20,920	8,368
Nigeria	0.4	124,010	49,604
Senegal	0.4	10,090	4,036
Somalia	0.4	480	192
Benin	0.3	6,740	2,022
Sudan	0.3	33,610	10,083
Togo	0.3	5,429	1,629
Cameroon	0.2	16,020	3,204
Eritrea	0.2	4,362	872
Gambia	0.2	1,430	286
Guinea-Bissau	0.2	1,490	298
Kenya	0.2	31,990	6,398
Zambia	0.2	10,810	2,162
Burkina Faso	0.1	13,000	1,300
Central African Republic	0.1	3,860	386
DRC	0.1	52,770	5,277
Ethiopia	0.1	70,680	7,068
Guinea	0.1	8,480	848
Madagascar	0.1	17,400	1,740
Malawi	0.1	12,110	1,211
Mali	0.1	13,010	1,301
Mozambique	0.1	18,860	1,886
Niger	0.1	11,970	1,197
Rwanda	0.1	8,390	839
Sierra Leone	0.1	4,970	497
Tanzania	0.1	36,980	3,698
Uganda	0.1	25,830	2,583
Africa	**1.04**	**802,122**	**851,853**

Data: IPCC DDC. WRI, HDI

Figure 1: Ecological space in context: per capita carbon dioxide emissions (tonnes) in African countries in a global context, 2000/2



Historical emissions

The aggregate emissions of African countries are in stark contrast to those of more developed nations. The UK has been exceeding the 2005 global per capita average (3.6 tonnes) for many years, whereas African countries have not. Data from 1950 to 2000 from CAIT/WRI indicates that African countries have contributed 4.6 per cent of cumulative global carbon emissions. Today African countries account for 3.5 per cent of global emissions, indicating growing inequality of emissions between African countries and the rest of the world.

Productive emissions

There is a great divergence between what countries are producing with their emissions. In developing countries, particularly African countries, both currently and in the immediate future, emissions are required for survival, whereas in many developed countries there is a substantial "luxury" element to emissions.

What will success look like?

It is clear that under any successful scenario, a period of lower-carbon growth is needed. Achieving this while creating opportunities for developing countries to benefit from their current and historically low emissions will require unprecedented coordination and collaboration. Technology transfer will be key.

3. Limitations of using ecological space as a benchmark

3.1 Population trends

Global population is rising. Per capita conceptions of "space" are hence constantly changing, and globally the capacity of natural sinks (in per capita terms) is shrinking. For each 160 million extra people, the per capita rate shifts downwards by 0.1 percentage points.

To illustrate, Africa's emission might fall before they rise. Africa's population is forecast to double by 2025 to 1.45 billion (IPCC DDC, 2006). Hence, for per capita CO2 emissions to exceed current levels, economic growth will need to expand faster than population growth. In other words, total economic growth will need to expand.

The following are some simple scenarios based on current information including the projected population doubling for the year 2025:

- If current per capita emissions by African countries (1.04 t/annum) are held constant, annual carbon dioxide emissions will increase by 63 per cent
- The annual extra emissions for the whole of Africa (~520 m tonnes per annum) is roughly equivalent to the current annual CO_2 emissions of the UK.
- If in 2025, Africa's citizens emit today's average annual global per capita volume (3.6 tonnes), Africa will be emitting the equivalent of half of the USA's current emissions.
- If by 2025, Africa's citizens emit today's average annual per capita for middle-income countries (2.9 tonnes per annum), Africa will be emitting the equivalent of the Russian Federation current emissions total.

3.2 Economic development

There is an undisputed link between national economic development (as measured by GDP and HDI) and carbon emissions (see Table 2). This finding has been supported by considerable research (see Baumert *et al*, 1999). Least developed countries (LDCs) emit the least carbon per capita, per GDP unit, and in total. The least developed countries have CO2 emissions of 0.2 tonnes per capita - 23 per cent of the level of the UK, 2 per cent of the USA's level and 10 per cent of Japan's level. LDCs' total emissions equate to emissions levels of countries such as Argentina (with a population of 38m), the Czech Republic (10m) and Uzbekistan (25m). Yet, it is clear that as economic development continues, total carbon emissions from the LDCs and developing countries will increase.

Table 2: Economic development and per capita carbon emissions

HDI rank	CO_2 **emissions Per capita** (metric tons)		**Share of world total** (%) 2000	**Traditional fuel consumption** (% of total energy requirements)	**Electricity consumption per capita** (kilowatt-hours)	
	1980	2002		2002	1980	2002
Developing countries	1.3	2.0	36.9	24.5	388	1,155
Least developed countries	0.1	0.2	0.4	75.9	83	106
Arab States	3.1	4.1	4.5	18.0	626	1,946
East Asia and the Pacific	1.4	2.6	17.6	11.0	329	1,439
Latin America and the Caribbean	2.4	2.4	5.6	19.8	1,019	1,927
South Asia	0.5	1.2	6.3	24.5	171	566
Sub-Saharan Africa	1.0	0.8	1.9	70.6	434	536
Central and Eastern Europe and the CIS	10.1	5.9	12.2	4.1	3,284	3,328
OECD	11.0	11.2	51.0	4.1	5,761	8,615
High-income OECD	12.2	13.0	46.2	3.0	6,698	10,262
High human development	10.9	11.2	53.0	4.5	5,676	8,586
Medium human development	1.2	2.0	39.0	17.0	368	1,121
Low human development	0.4	0.2	0.5	71.1	135	133
High income	12.1	13.0	47.8	2.9	6,616	10,198
Middle income	2.1	2.9	38.9	9.2	623	1,653
Low income	0.5	0.8	7.3	42.2	174	399
World	3.4	3.6	100.0	7.6	1,573	2,465

Source: HDI, 2005

In general, and with the exception of oil-rich countries, a nation's level of development is linked to the relative size of its economic and industrial sectors. Particularly, economic development signals a shift from agricultural production to industrial processing and manufacturing. Industrial sectors are large contributors to carbon emissions relative to agriculture. In Africa, agriculture remains significant as an economic activity and as a carbon-emitting sector. Although data are not complete, available data from 26 countries indicates that agriculture contributes at least 21 per cent to GDP. Agriculture in sub-Saharan Africa is a greater contributor to GDP (27 per cent on average across countries – see Table 3) than in other more developed regions, although the absolute values are far lower. In more developed countries, agriculture remains a key contributor to national carbon emissions, but is small relative to energy consumed in transportation, manufacturing, and power usage. If African countries follow global trends and develop larger manufacturing and industrial sectors and consume greater volumes of power, carbon emissions per capita will increase considerably.

Table 3: GHG Emissions by Sector, 2000

	Elec. & Heat	Manuf & Construc	Transp	Other Fuel Combust	Fugitive Emissions	Industrial Processes	Agric	Waste	Total
World	10,269	4,328	4,810	3,742	1,641	1,367	5,632	1,484	33,272
	31%	13%	14%	11%	5%	4%	17%	4%	100%
USA	2,671	658	1,720	724	233	198	470	243	6,917
	39%	10%	25%	10%	3%	3%	7%	4%	100%
Sub-Saharan Africa	219	80	81	65	69	20	215	53	801
	27%	10%	10%	8%	9%	2%	27%	7%	100%
Europe	2,678	1,019	1,144	1,119	400	286	657	253	7,555
	35%	13%	15%	15%	5%	4%	9%	3%	100%

Source: Climate Analysis Indicators Tool (CAIT) Version 3.0. (Washington, DC: World Resources Institute, 2006)

Without considerable improvements in technology and productivity, expansion of agricultural production in Africa will need to be "financed" through agricultural land increase. This is likely to increase carbon emissions because of the greater probability of deforestation – which is estimated to account for 20 per cent of total historical emissions.

Achieving higher levels of economic development in African countries via market mechanisms, while maintaining low emissions and ensuring social development and equity of opportunity, will not be simple. Yet, some avenues exist, particularly clean technology transfers (both hard and soft) and appropriate investments. Trade is recognised as a positive technology transfer mechanism.

Any solution will require continued and probably expanded trade with African countries. Sea freight boasts a lower carbon load per kilogram transported and might be more relevant for many forms of trade. However, limiting African countries to sea freight in times of expanding tourism and aviation will not prove popular. Nor will it be easy to implement or enforce.

4. Discussion

Export horticulture is unlikely to disappear from Africa since consumers, retailers and producers all find considerable advantages in it. At sale, it is price inelastic for the typical UK consumer, retail prices have risen by 10 per cent annually and export horticulture is emblematic of East African success in trade. Indeed, export horticulture appears to provide some of the positive elements that African countries would be looking for from an “investment" of their collective ecological space. This includes direct benefits to producer countries including jobs, injections of capital into the rural economy and foreign exchange, as well as indirect benefits including opening-up of trade routes to the country, upgrading of export industries and sectors, and transfers of technology, skills and knowledge.

Refocusing carbon emissions onto producers would increase opportunities further. If emissions associated with exports of horticulture from African countries accrued to the producer country, the following statements would form the basis for calculating emissions allocation:

- To the exporting country (port of exit) for freight. For instance, Kenya is the largest exporter of vegetables to the UK. An estimated xx planes, meaning an extra yy of carbon for Kenya, raising the per capita rate by zz per cent to 0.d tonnes per capita.
- Zero-rated to both trading nations when produce is carried in passenger plane bellyhold since it is a factor of tourism (business and leisure) and utilising spare space.
- Zero-rated to the UK as a recipient country.

Trade is complex and its drivers are not clear. Export horticulture is not the only or main driver of increased freight and passenger jet usage. It is certainly part of the issue, alongside tourism, manufacturing, medicines, etc. There is no doubt that aviation needs to be reformed or significantly reduced, but without hampering sustainable development in the process. Options such as differential landing fees, recently piloted in Sweden, hold some promise.

Discussions about ecological space in light of developing country aspirations under the Kyoto Protocol brings equity to the forefront. It highlights the fact that carbon emissions are intimately linked with economic development, and underscores the need for developed countries to take action to reduce emissions. Importantly, it also corrals arguments in the other Briefing Notes in this series that focus on trade-offs between environmental and social impacts of export horticulture.

The relevance of export horticulture as a high-value use of “carbon credit” or “ecological credit” will only increase in the future – although for the foreseeable future it is only an option. But more immediately, what is needed is a way to modify export horticulture to provide incentives for exporters to develop as inefficient energy economies. Standards-setters could be catalysed here to help develop sustainable solutions.

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