Why do global land use patterns matter so much?

Transition Oxford/Slow Food

Chris Goodall

20th November 2008

The purpose of this talk:

- To show that the conflict between using land to grow food and to capture energy is severe

- To suggest some ways of avoiding part of this conflict

World land area	149,000,000	sq km
World population	6,600,000	
Area per person	0.023 sq km	
Or	2.3 hectares, about 5 1/2 acres	

What do we have to get from this land **now**?

Food

Some of our textiles

Some building materials

Wood for cooking fuel

In a world of limited fossil fuel use, what may we have to get from this land **in the future**?

Food

Fertiliser

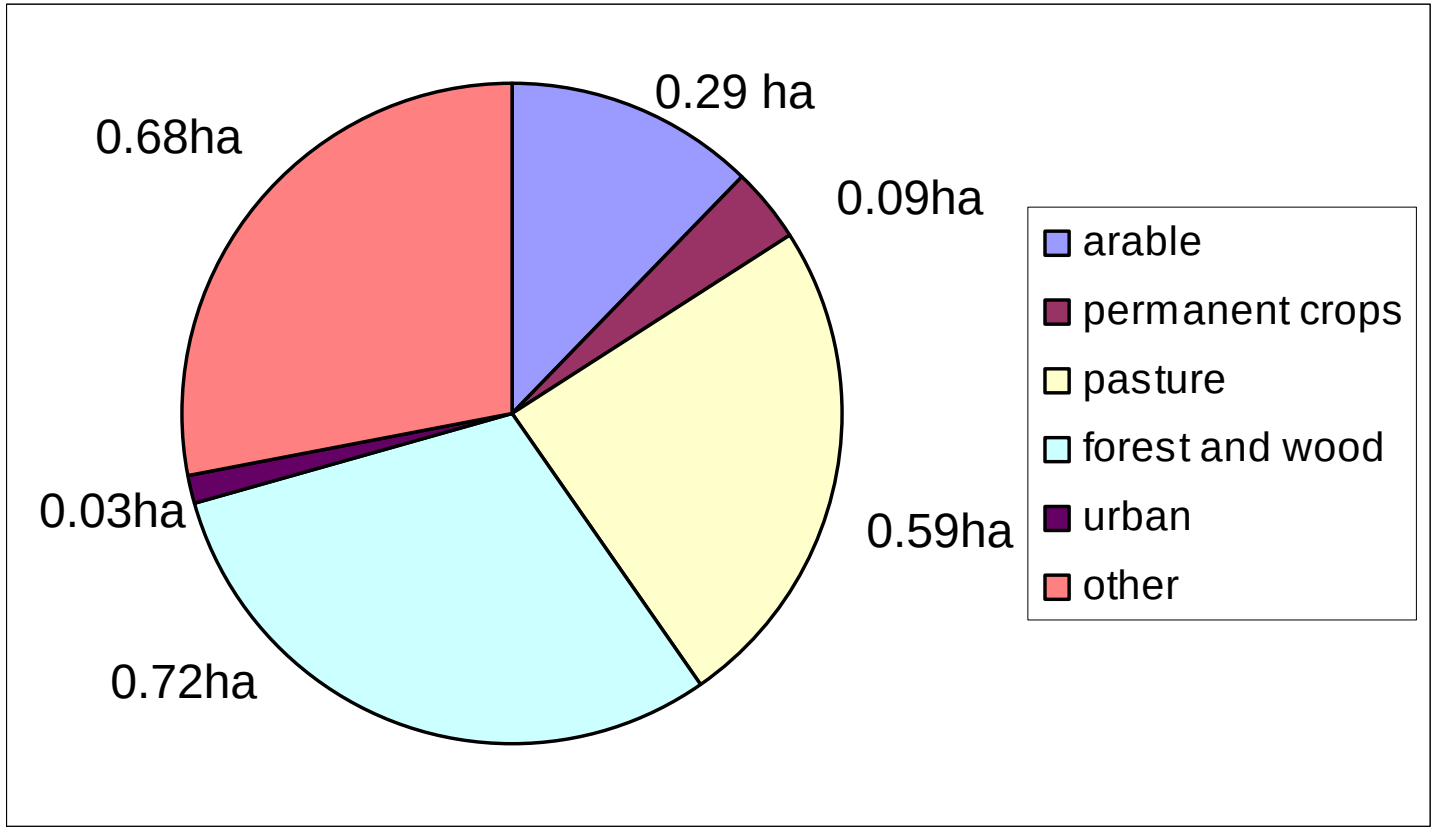
More of our textiles

More of our building materials

Wood for cooking fuel

A lot more of our energy both for liquid fuels and for heat

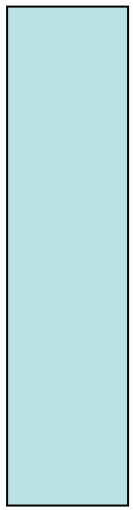
Most of our electricity


0.29 ha
0.09ha
0.59ha
0.72ha
0.03ha
0.68ha
arable
permanent crops
pasture
forest and wood
urban
other

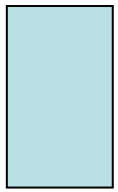
If we just ate grains, would this amount of arable land be enough?

Potential supply

2.5 tonnes



0.73 tonnes

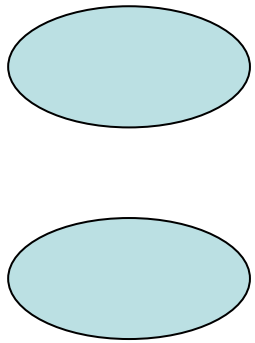


Grain yield/ha

Grain yield/arable/ person

Demand

Wheat
3,500 kcalories/kg



X 75% metabolizable

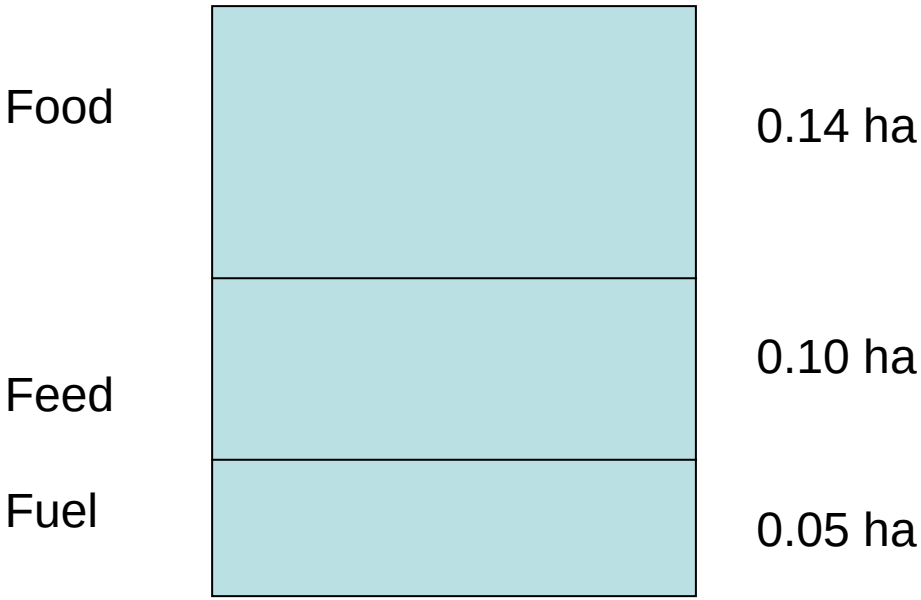
=209 kg/year
or **0.21 tonnes**

2,000 kcalories/day

World grain supply – 2008

1,023 m tonnes	Grain for food
765 m tonnes	Grain for feed
407 m t	Other, principally biofuels

Arable land used for growing grain for food per person



Only need 0.08 ha to feed someone with enough wheat to live on*

* Only, of course, from the point of view of calories

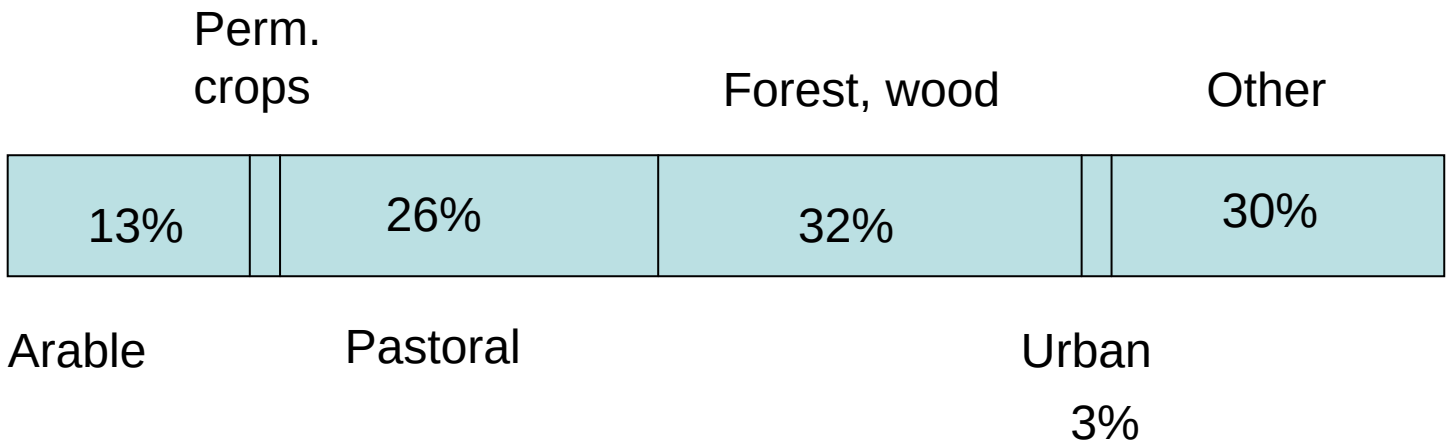
Impact of expected population increase?

- Population up 1-2% a year from 2008 to 2050?

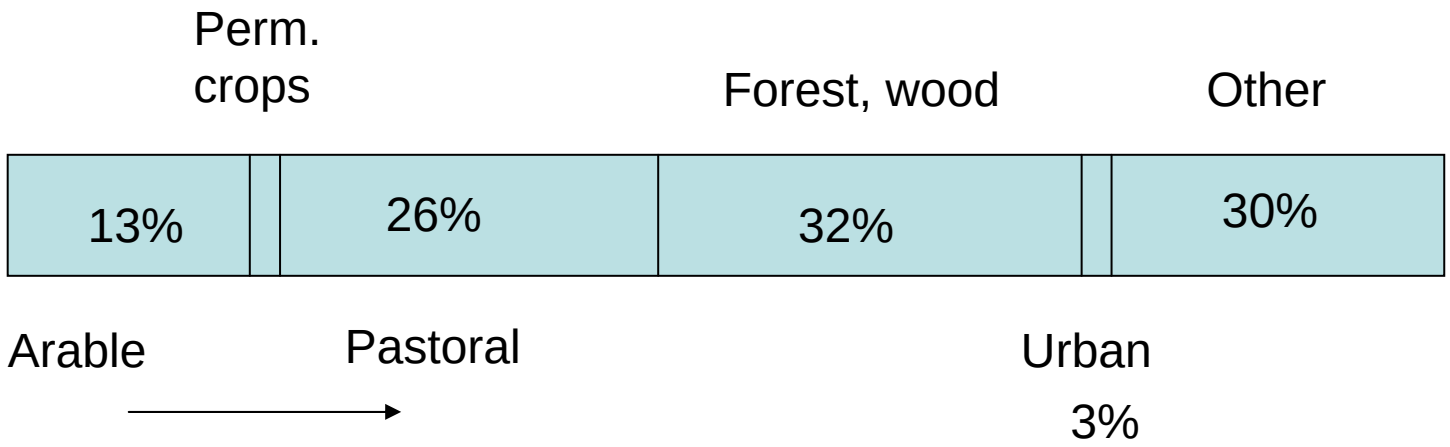
- Yields up about 1% a year?*

- Even if all arable land used to produce wheat, very tight supply by mid-century?

* USDA forecasts yields going up less fast than global population within a few years, reversing productivity gains since the 1950s.


Perm.
crops
Forest, wood
Other
13%
26%
32%
30%
Arable
Pastoral
Urban
3%

Conflict 1: pastoral versus arable

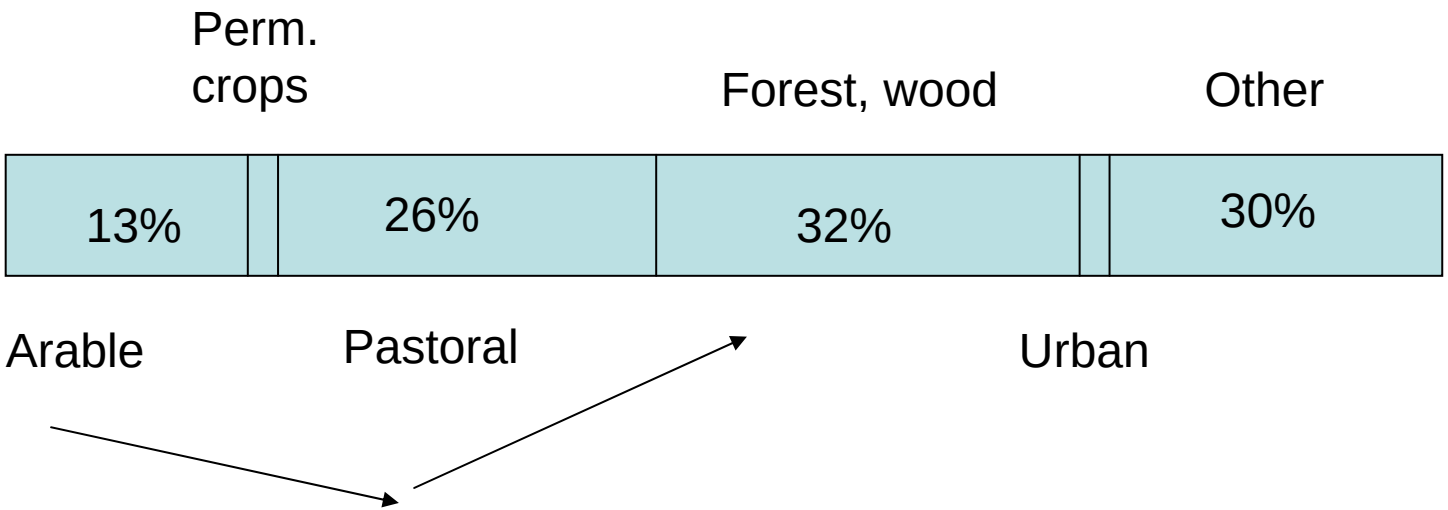


Use more pastoral land for growing crops

Problems

1. **Richer people want to switch from grain to meat**
2. **Much pastoral land unsuitable for arable (too dry)**

Conflict 2: arable uses demanding more forest land

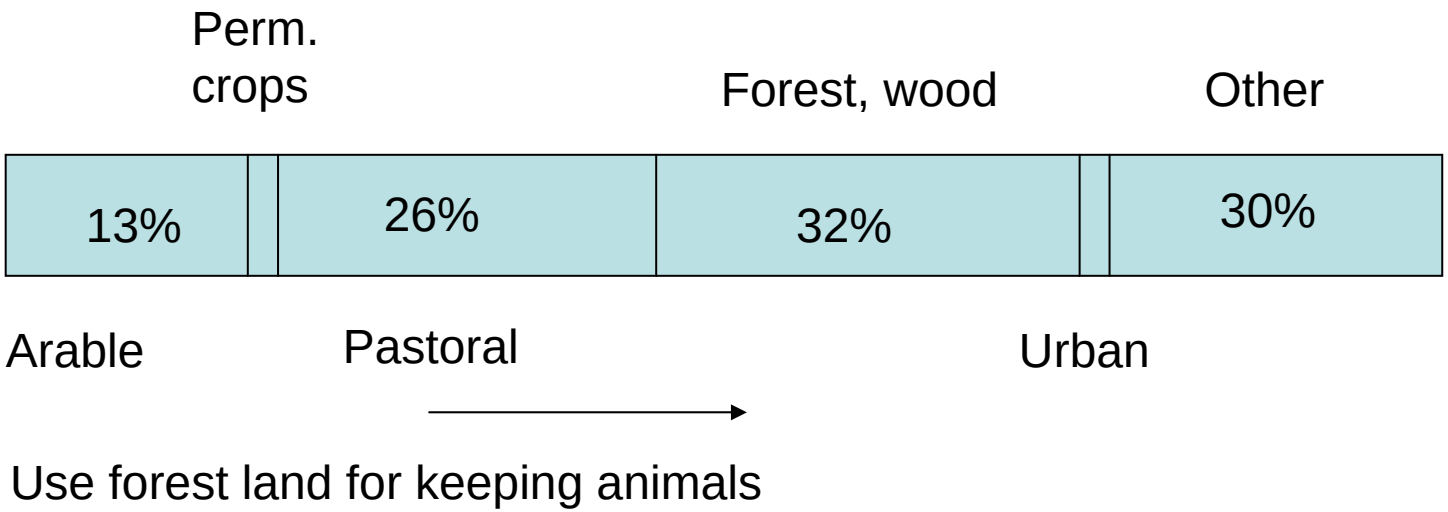


Use forest land for growing crops

Problems

1. **We need to increase forest cover for climate change reasons**
2. **Much forest land has highly fragile soils and poor fertility**

Conflict 3: increasing meat demands result in forest pressure



Problems

1. We need to increase forest cover for climate change reasons
2. Much forest land has highly fragile soils and poor fertility. Grazing will reduce soil carbon content further

So

- Enough arable lands for basic food now, but not a huge surplus

- Pressure to use more potential arable land for meat production (far fewer calories from the same amount of land)

- And population pressure, combined with declining yield growth rates, means real shortage of arable land in prospect unless yields can be improved

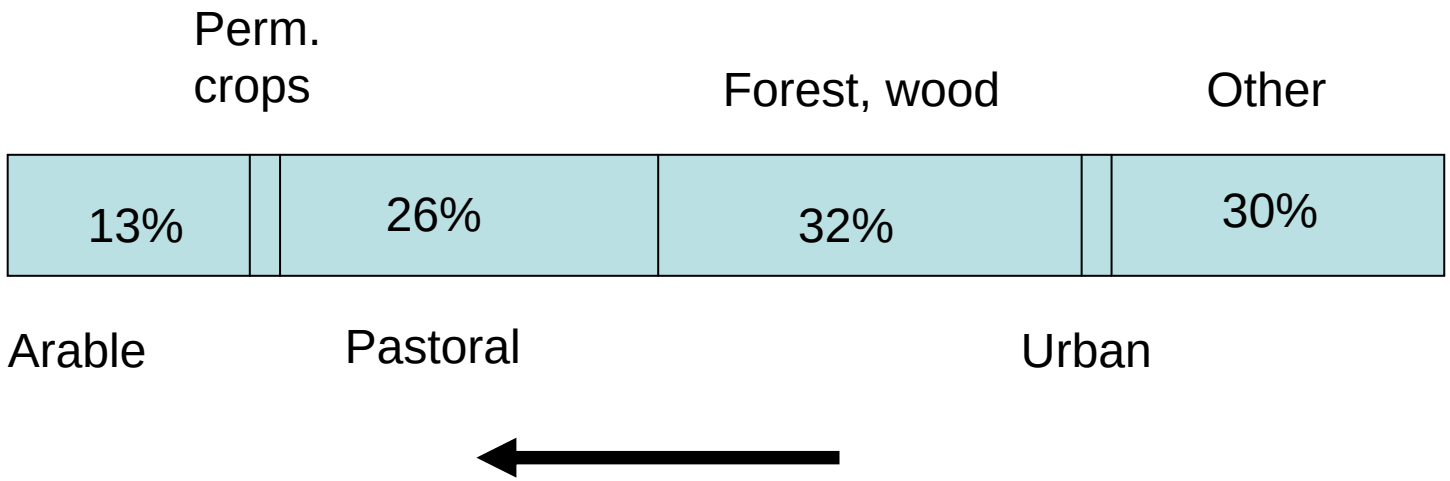
- Pastoral lands also spreading into forest land

Could reduce arable land given over to biofuels

- Potential 30% increase in grain availability

- Abolition of food-based biofuels would add less than 1% to oil demand

Conflict 4: the need to increase forested area for GHG and energy crop reasons



Using forests for energy crops and for carbon storage

Energy potential from forest

About 21,000 kilowatt hours per hectare per year

World has about 0.72 hectares of forest land per person

Capable of producing about 15,000 kilowatt hours per year

BUT

Current world average use of fossil fuels is about 18,000 kilowatt hours a year

Current global averages*

6,000 kWh coal

4,800 kWh gas

7,300 kWh oil

TOTAL c. 18,000 kWh

* UK about two and a half times this level

This is the core pressure – we need 50 times as much energy as we currently grow in food

Energy need per person from food – 2 kilowatt hours a day

UK energy needs for heat, electricity, transport – 120 kilowatt hours a day

Temptation is to look at biomass (largely from forest) as important source of replacement energy

Electricity (i.e. coal) – wind, solar, marine, ***biomass burning?***

Gas – electricity, better insulation, ***biomass-based fuels?***

Oil – electricity for cars, ***biomass-based fuels?***

A digression – cellulosic ethanol

Ethanol, a simple alcohol, is today's biofuel substitute for petrol.

It is made by taking the relative simple sugars and starches in food and fermenting them.

Cellulosic ethanol takes the much more complex and robust cellulose molecule (principal ingredient of trees and most plants) and breaks into sugars and then ferments it.

Chemistry of 'cracking' cellulose is difficult. But problem will be solved.

We can then use ALL plant matter, not just food, for liquid fuel.

But needs half the forested area of the world just to replace our current use of oil.

* 10% just to grow jatropha berries for kerosene (planes)

Most all oil is used as a transport fuel. We may want to use ethanol also to replace some gas demand (e.g. for home heating).

This will impose very challenging pressure on world’s forests.

The ways forward?

Getting more calories per potential arable hectare

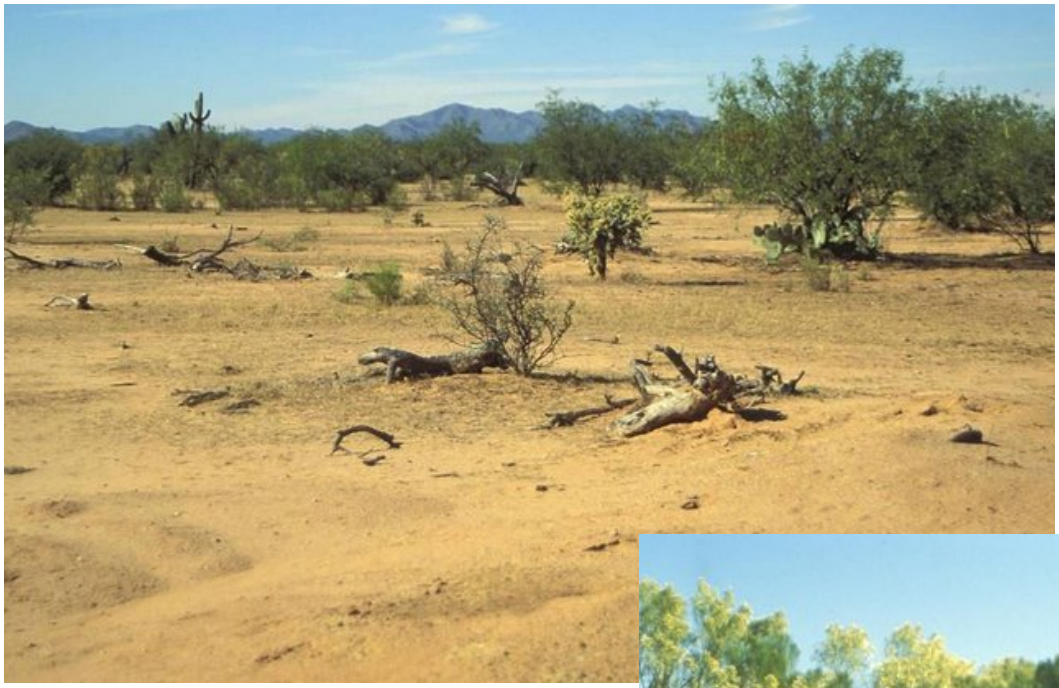
- Less meat grown on arable land
- Use GM foods, particularly in the tropics?
- Improve tropical soils. Biochar? (NOTE also extracts CO2)
- Organically managed acres not productive enough?

Biochar – soil carbon storage and tropical soil enhancer

The ways forward?

Improving animal yields per pastoral hectare

- Grazing management (NOTE improves CO2 storage)
- Disease control
- Improving water availability (requires desalination)



The ways forward?

Improving biomass availability in forests and elsewhere

- Switchgrass and miscanthus in temperate regions, cane in tropics. Use land that is currently pastoral?

- Plant breeding research on faster growing trees and shrubs (GM trees)

- Biochar for fertility retention

- Massive improvement in cooking stove efficiency

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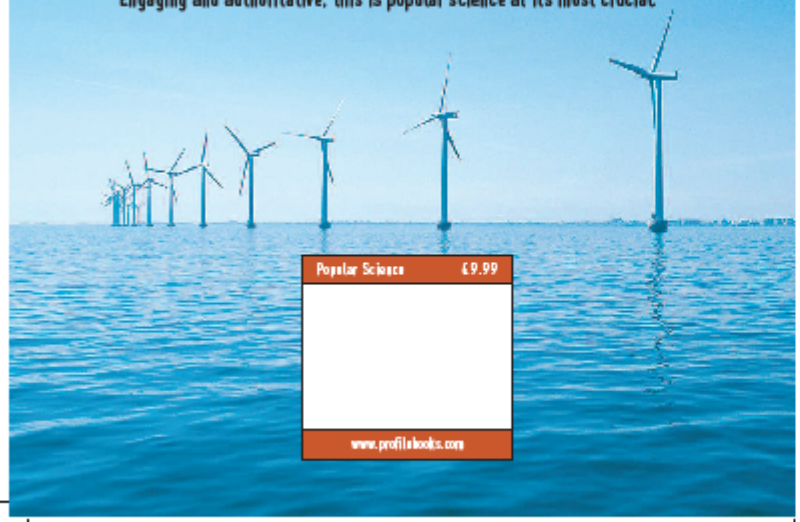

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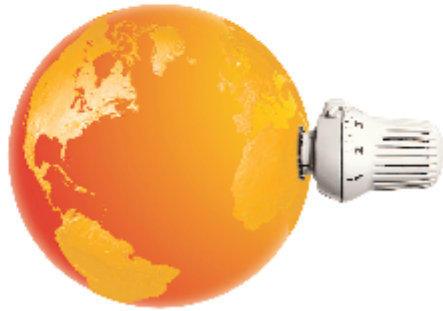

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