



and allows a whole suite of moisture-loving plants to prosper. Amongst these are the familiar bromeliads with their thick fleshy leaves and their pink and red flowers.

What are countries doing about it?

Countries around the world have, to varying degrees, always been concerned about their state of the climate, but where their climate changes significantly during a politician's lifetime they tend to be a little bit more focused. Thus in 1992 the Koyoto Protocol was adopted by the United Nations on 9 May 1992 in Kyoto, Japan. One of the aims of the Protocol is to promote sustainable development. Although rainforests are not mentioned at all in the Koyoto Protocol, the various measures to achieve this aim involve the:

Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation

and the

promotion of sustainable forms of agriculture in light of climate change considerations.

The implication of these protocols is to lessen the effects of greenhouse gases heating up the world's climate and subjecting people and habitats to the effects of global warming. To date there have been 188 ratifications, but it is hoped that all the industrialised countries of the world will ratify, including the largest producers of greenhouse gases, which currently include the USA and Russia. The projection is to see all the industrialised countries reduce their greenhouse gas emissions by 5% below their 1990 rates by 2008–2012. In the meantime, what does this mean for countries that have rainforests, and what does it mean for rainforests that may be subject to global warming? There are some interim measures.

The idea of carbon sinks was born out of Kyoto. Planting new rainforest would be helpful for the stability of world climate, many argue. This is because rainforests are said to act as 'carbon sinks'. That means that all the carbon that is absorbed through their leaves as carbon dioxide is incorporated into new plant growth, such as stems, leaves and flowers. Therefore the more photosynthesis, the more carbon is built up in the body of all the combined plants in the rainforest. Hence the notion of carbon sinks. Therefore the more trees planted, the more carbon is locked up and saved. Like an investment, the carbon will grow. But at what cost?

Basically, if a nation is prepared to protect existing forests, or to reforest an area, then certificates would be issued on their stock exchanges. These could then be traded, as a green asset, as a

Jatropha sp., the physic nut, grown as a biofuel. It is better than sugar cane or maize since it thrives in arid conditions and needs no irrigation. It can yield two tonnes of biodiesel fuel per hectare per year.





means of conserving the nation's biodiversity. Costa Rica was one of the first to respond, with a desire to conserve 1.25 million ac (0.5 million ha) of forest for which 'CO₂ uptake certificates' were issued. This was equivalent to 1 million tons of CO₂ being saved. The London Stock Exchange has started trading in these certificates. As Salati says *'It is calculated that ... some 15.6 million tons (14.15 million tonnes) of CO₂ could be absorbed.'* In Costa Rica it was thought possible that eventually around US\$20 million would be brought to Costa Rica through the trading of Certified Tradable Offsets (CTOs) as Certified Emission Reductions (CERs).

In the case of Brazil, which has an energy system free from CO₂ emissions (hydro-power), it still contributes to releasing CO₂ into the atmosphere through deforestation at the rate of 0.3 Gtons of carbon per year.¹⁷ Brazil is in a unique position to address the Kyoto aspirations for climate change, by reforesting those areas of abandoned lands that it already has, some 100×106 ac (40×106 ha), and thereby being in a position to trade certificates. It is known that 1 hectare of eucalyptus forest returns 4–5 tons (3.7–4.5 tonnes) of carbon to the plants each year, so the gain on reforesting just 30% of the abandoned lands would yield carbon stocks of 128–160×106 tons of carbon each year. Not bad for a vast carbon sink within the Amazon and it would be sustainable. The conservative figure of 30% is based on Brazilian law, which dictates that 50% of each hectare must be reforested with native species, so that 30% is what, on average, might be achieved in reality.

However plausible the reforestation of Brazil is by using eucalyptus, it has to be said that the use of trees of this Australian genus are not the best for boosting local biodiversity. In fact, where they have been planted in the past, the trees have been an ecological disaster, for they grown fast and tall and lock out many native species from their new dark evergreen woodland habitat.

So what is the cost of these carbon sinks on the rainforest habitat, and on the people who live there? There are the detractors who believe that planting up the rainforest with totally inappropriate tree species is the wrong way of doing it.¹⁸ Of course the biodiversity of the rainforest will be completely changed, will never be restored, and the welfare of the people of the forest will never return to what it was before. This, they argue is the wrong way of restoring balance, and they point to bad decisions in various rainforests around the world where these inappropriate plantings have already been in existence since the 1990s.

One initiative to chivvy everyone along has been the 'Contraction & Convergence' concept put forward by the Global Commons Institute in London, or C&G for short.¹⁹ This is the brainchild of the inspirational Aubrey Meyer and it is based on getting countries to reduce their greenhouse gas (GHG) emissions to a target level based on their populations. Meyer uses his 'rhino analogy' to drive home the point about the inevitability of climate change. He recalls that the train from Nairobi to Mombasa passes through rhino country, and that an alpha rhino took exception to the train passing through his protected territory, so that one day it charged up the line to confront the train travelling in the opposite direction. Inevitably, the train was derailed and the rhino killed. In our case of the Amazon, the canary would be dead in its cage. The build-up of GHGs is such that there is an

As water recedes in the Amazon some amazing shapes appear.





inevitability about the Earth's changing climate. The evidence is so overwhelmingly obvious that anyone can see what is going to happen. Meyer is a musician and demonstrates how everyone knows how obvious a wrongly played note sounds, and how demonstrably harmonious the chords are when in tune. There is a hint of Gaia here too.

This is a conceptually simple idea that says that every person has his or her own carbon allowance, and that each country therefore has an allowance based on the sum of its total population. That is the 'contraction' bit. It also gives a time in the future, say 2050, when this individual country figure can be reasonably achieved. The 'convergence' bit is where all these countries come together at this time in the future. At the present time, the C&G principle has a lot of unreserved approval from many countries and individuals across the world and reserved approval from the remainder.

What this means for ordinary people is that it gives people some control and responsibility over their own carbon output. They have carbon quotas. In a world where most of the land is in the hands of the 'elite' or ruling party, their production of carbon is likely to be relatively small compared with the workers whose output is likely to be high. If a carbon tax is eventually produced from new legislation, for instance from the Domestic Tradable Quotas Bill, then the majority of people will be hit by a standard carbon tax, unless they can prove that they are reducing carbon emissions. For instance you may be able to collect carbon 'Brownie points' by staying at home, or riding your bicycle, rather than using the car.

The reluctance of the USA to adhere to the principles of the Kyoto Protocol – despite appreciating environmental messages from the Katrina and Rita Hurricanes in late 2005 – are easily addressed by taking up the C&G principle. Under the personal quota system, the USA would initially be way over its *per capita* quotas, but would commit to reduce emissions to the stated date, but at the same time would buy carbon quotas from developing countries, such as China. China is presently in a position to sell its excess carbon credits, since it has a large population that does not presently produce lots of carbon. China's excess would be the USA's gain. And the price at which the USA buys the certificates from China would pay China to develop the necessary technology for it to develop, expand, and level off at its stated carbon level. It is a win-win situation for both countries, and in the short term gets the USA out of its current procrastinating dilemma.

So what effect does all this have on the consequences of rainforest loss? Any effect of a contraction of carbon in the atmosphere will presumably have a beneficial effect on the health of all remaining rainforest. There will not be the inevitable change in global climate at the expense of the rainforest.

China is currently buying a lot of tropical hardwood out of South America and, with the construction of the new road linking Acre Province in western Amazon to the Pacific, this will pave the way for expansion along the road, with marginal loss of rainforest and resultant settlement. So not only will products of the rainforest pour out of Amazonia westwards (soya products and tropical hardwoods) but the environmental impact along the main roads will reduce the biodiversity of the adjacent rainforest.

The large open flowers of the vigorous climber *Aristolochia* sp.





A stable climate and environment explained by the Gaia hypothesis?

'Change' is the normal process that is experienced in all habitats on Earth. It is normally considered that habitats go through a succession of different types of habitat until the final mature one, which is called a climax community. At this stage, if it is ever achieved (and it is not in some cases), the rate of change slows down. If this was measured on a graph, the early years representing growth and change would be shown as a rising line, thereafter it levels off at maturity or when the habitat settles down to its mature state, i.e. thick woodland. However, in the tropics this is not always so, because strong winds and shifting soils in steep mountain areas are causing abrupt changes in the habitat. Many rainforest habitats never have the opportunity to reach a climax community, since they are being refreshed all the time.

The external effects of weather, erosion and subtle climate change also play their part in all habitats to make small changes that, over time, make larger differences. Change is therefore part of life, and all plants and animals have default mechanisms to evolve with these changes. This is called natural selection, whereby species experience small adaptations that make them more suited to the slightly changed environment in which they live. You lose some, gain some, and the winners take all. Those that are fittest always win.

And so it is with rainforests. The environment is always changing in the rainforest, the movement of the river over time, the movement of man and his industries, and the changing weather patterns, whether it is the irregular El Niño or regular seasonal changes. So how does this fit neatly, if at all, into the 'homeostasis' of James Lovelock's Gaia hypothesis proposed in the 1970s?

If Lovelock is correct, the Earth (he called it 'Mother Earth') self-regulates entirely by itself. This kind of homeostasis – otherwise defined in its physiological definition as 'maintaining a constant internal environment', i.e. the body being able to maintain its normal temperature whatever the environment, cold or hot – as hypothesised by Lovelock, combines the forces of the air, sea and land to maintain a kind of equilibrium. The essence of the Gaia hypothesis is that all life on Earth is self-regulating. If you take away from one place, you have to add something elsewhere.²⁰

Not very many scientists espouse his hypothesis, and Lovelock defined Gaia (borrowed from the Green Earth Goddess, Gi, on the suggestion of fellow villager and author, William Golding) as being

a complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet. The maintenance of relatively constant conditions by active control may be conveniently described by the term 'homeostasis'.

The hypothesis consists of a disparate collection of external factors such that is difficult to believe that it is causing Lovelock's conception of stable life on Earth. The fact that many habitats on Earth

Low water encourages grasses to grow on the banks thus producing the yellow-green band of colour in this picture – food for the herbivorous capybaras.





are disappearing at such a rate, especially rainforests, would seem to run counter to Lovelock's ideas. Where is the profit to balance the loss account? There are just no other different or new habitats being produced, to counter the losses. All these pointers would suggest that Lovelock's hypothesis, however quaint and idealistic, is simply wrong, even though he said that it was impossible to quantify or prove his theory. My own feeling is that it is a neat and convenient, all-encompassing theory, and why not? There surely is interconnectivity with the living world, and much that we can observe. The only problem is that it is too often messed up by the effects of man.

There are, of course, those who do preach Lovelock's ideas, and others who are adamantly against. Lovelock's fascination with the living world revolved around a study of the chemicals in the sea and gases in the atmosphere (e.g. CFCs).²¹ Professionally he is a scientist and inventor and made an apparatus for measuring minute traces of chemicals. He was thus fully attuned to Rachel Carson's book, *'Silent Spring'*²² and had some sympathy for her views on DDT in the environment. Lovelock was professionally active when Greenpeace and Friends of the Earth represented the green movement to which Lovelock said that he allied his support.

In his book, Lovelock hardly mentions rainforests but he does have some prescient words to say about the effect of losing rainforests at the expense of messing up the atmosphere:

The 'core' regions of Gaia, those between latitudes 45 North and 45 South, include the tropical forests and scrub lands. We may also need to keep a close eye on these areas if we are to guard against unpleasant surprises. It is well recognised that the agriculture of the tropical belt is often inefficient and that large stretches are already worked out or are being devastated through the same sort of primitive farming methods which led to the Bad Lands of the United States. What is less well known is that this bad farming is also disturbing the atmosphere on a global scale and to an extent at least comparable with the effects of urban industrial society.

The rainforests are therefore used by Lovelock as a core on which Gaia is based. Lovelock seems to be reconciled to the fact that his hypothesis has not been generally adopted by the scientific community, and that the equally unquantifiable hypothesis of 'the selfish gene' has been taken up. Like Darwin's 'natural selection' theory, it is just that – a theory. But he now has his doubts.

The Stern Review

Sir Nicholas Stern is an economist employed by the Cabinet Office of HM Treasury in London and *'The Stern Review'* was pre-published late in 2006 to much media attention.²³ The Review – which is indeed a fair description of what it is and not a quick fix – was used at the time to draw the public's attention to the alarming state of climate change: a hot political topic.

Coastal locations where the rainforest meets the sea will be threatened by a rise in sea levels. This is near the Cabo Blanco on the Nicoya Peninsula, Costa Rica on the Pacific Coast.

