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THE NATURE OF CLIMATE CHANGE: IT IS TIME TO REUNITE INTERNATIONAL CLIMATE CHANGE MITIGATION EFFORTS WITH BIODIVERSITY CONSERVATION AND WILDERNESS PROTECTION

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For the good of the climate, the time has come for a major initiative to re-unite climate change mitigation efforts with biodiversity conservation and wilderness protection. Recent scientific research has shown clearly that protecting primary ecosystems such as forests, wetlands and peatlands (whether they be tropical, temperate or boreal) keeps their carbon stocks intact, avoids emissions from deforestation and degradation, and is a necessary part of solving the climate change problem. This new understanding provides a way to make important advances to mitigate both climate change and the biodiversity extinction crisis.

Climate change has emerged as the leading environmental issue of our time with good reason (IPCC 2007a). The rapid rise in Earth's temperature threatens human well-being in several ways: rising sea levels will render millions homeless, populations of malaria-bearing mosquitoes will reach millions of African people who live in areas that were once too cool for these insects, and there will be an increase in the frequency of extreme climatic events such as droughts, fires, floods, and hurricanes. Freshwater will get scarcer in some areas which will lead to increasing tensions and potentially armed conflict about access to this basic resource. It is even possible that we could experience "climate surprises" - rapid, large scale and difficult to predict changes in the climate system that we know have occurred in the geological past. For example, ocean currents such as the North Atlantic Gulf Stream could change rendering the climate of Western Europe cooler and less agriculturally productive.

Climate change also threatens other forms of life with whom we share Earth as home. Coral reefs are bleaching thus destroying critical fish habitat, climate shifts will result in the extinction of many temperature sensitive species like mountain-dwelling pikas, and the habitats of other species such as cold water trout and polar bears will shift or disappear thereby leaving them homeless. These changes are already underway and they threaten many wildlife species.

Climate changing carbon dioxide comes from both burning fossil fuels and clearing and degrading natural ecosystems.

The general problem that has led to rapid climate change is that we humans are releasing carbon dioxide (and other greenhouse gases) into the atmosphere faster than it can be

removed by natural processes. We can think of carbon dioxide as a means of heating our home, which in this case is planet Earth. A certain amount of heat in the atmosphere is good and gives us a liveable climate. But now the rapidly increasing concentration of carbon dioxide in the atmosphere is turning up the Earth's greenhouse thermostat beyond its natural level. This is causing a very "inconvenient" rise in global temperature with disastrous consequential effects.

The cause of the rapid climate change we are now experiencing is primarily the result of two main kinds of human actions - burning fossil fuels and clearing or degrading natural ecosystems. These activities release carbon dioxide (a gas) into the atmosphere from places on or under the Earth's surface where it was previously harmlessly stored or "sequestered" as one of a number of forms of carbon we call fossil fuels. The burning of carbon dense oil, coal, and gas stocks (which have been dug or drilled from places in which they are naturally stored beneath the Earth's surface) is widely known as the primary source of carbon dioxide.

The second human action (less well known) that also releases large amounts of carbon dioxide into the atmosphere is the conversion and degradation of natural forests and other carbon dense ecosystems. A substantial amount of carbon dioxide is stored in natural ecosystems, especially forests, wetlands and peatlands which act as a vital buffer regulating atmospheric levels of carbon dioxide. There is the equivalent of more than 7 trillion tonnes of carbon dioxide stored in forests and other terrestrial ecosystems such as wetlands and peatlands. Humans are depleting these green carbon stocks (Mackey et al. 2008a) and releasing the carbon dioxide into the atmosphere at an alarming rate: about half the world's forests have already been cleared and rates of land conversion and degradation continue to increase (Millennium Assessment Report; Shearman et al.). Similarly, about half of the world's wetlands have been degraded in the last century (Finlayson and Davidson).

Unfortunately, the carbon dioxide released from burning fossil fuel or clearing and degrading natural ecosystems will continue to interact with the atmosphere for many thousands of years before it is incorporated into the sediment at the bottom of the ocean through deposition and weathering processes (Archer)

It is obvious that efforts to address climate change should go to the root of the problem, namely, identifying sources of carbon release and then rapid action to prevent or reduce such release. We therefore need to do two things simultaneously – achieve deep cuts in emissions from using fossil fuel as a major source of energy and protect the carbon stored in forests and other ecosystems by leaving them undisturbed. Both tasks are important as about seventy percent of the total historic increase in greenhouse gases levels in the atmosphere (that is, accumulated since around 1750) due to human activity are from burning fossil fuel and about thirty percent are from deforestation (see <<http://cdiac.ornl.gov/aboutcdiac.html>>). And, on an ongoing basis, about twenty percent of annual global emissions come from disturbing forests (IPCC 2007b).

Yet despite the great deal of scientific evidence, there is no coordinated attack on both root causes. Instead of being addressed as parts of the same whole, the ongoing destruction of the world's remaining natural habitats and associated biodiversity and the

climate change problem are being treated as two distinct and largely unrelated problems. This current state of affairs is clearly off- course. But it was not always so.

Two existing global conventions can be part of an integrated solution

The United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) were both negotiated at the Earth Summit in Rio de Janeiro in 1992. They were designed to tackle the same primary problem - humanity's overuse of Earth's natural resources which impairs other life forms directly and exceeds the planet's capacity to absorb and recycle materials; most notably greenhouse gases such as carbon dioxide. We thus already have in place international treaties on climate change and on the conservation of biological diversity which were intended to be used and could still be used complementarily.

UNFCCC seeks to limit emissions of carbon dioxide and other greenhouse gases that cause dangerous levels of climate change. The CBD seeks to halt the loss of biodiversity through protected areas and other means. Both conventions have also been charged with development goals for poorer countries. Their respective implementation mechanisms include the Kyoto Protocol and the Programme of Work on Protected Areas; there are other programs under the CBD, and a new agreement under the UNFCCC is sought as an outcome of the Copenhagen climate change conference in December, 2009.

Sixteen years after these two treaties were developed together as complementary strategies to safeguard the future of life on Earth, a strange thing has happened - they have become separated. Politicians, policy experts, technicians, financiers, entrepreneurs, scientists, Non-Government Organizations, and the general public, in the main consider the two conventions as addressing unrelated problems. While the importance of forests is acknowledged by both treaties, the UNFCCC process has yet to accept the significance of the carbon stored in natural forests and other ecosystems like wetlands and peatlands, the resilience provided by their biodiversity, and the need for whole-of-ecosystem carbon accounting. Consequently, programs can occur under the Kyoto Protocol that actually harm the goals of the CBD - such as clearing natural forests to plant palm oil for bio fuels. And no credit is given under the Kyoto Protocol for protecting wildlands and the vast stocks of biomass carbon they store.

Unlike UNFCCC and the Kyoto Protocol, the CBD gets scant attention. Governments that are signatory to both conventions often assign responsibilities for the conventions to different departments, with CBD efforts being the poor cousin; under-resourced and ignored compared to much better resourced climate change programs that are focused on fossil fuel emissions. Since the US is not yet a signatory to the CBD, many US NGOs are either unaware of it or simply ignore its potential. Ironically, the same NGOs make much of the fact that the US has yet to ratify the Kyoto Protocol. Even in Canada, which is a signatory to both conventions and which houses the CBD Secretariat, the CBD has a very low profile. Further, many environmentalists working on climate change are fearful that allowing for the protection of nature in the Kyoto Protocol rules will undermine efforts at reducing emissions from wealthy countries that burn fossil fuels.

The separation of the UNFCCC and CBD is bad for the goals of both conventions. Current structures and mindsets are preventing them from working together to solve the primary problem of helping humans live sustainably on a limited planet. Both the climate change and the extinction crises are getting worse, and to date efforts have failed to meet even modest goals of slowing the rate of change and loss; let alone turning things around. Science has now made clear that the protection of natural ecosystems – and especially primary forests and other wildlands such as wetlands and peatlands - will help achieve climate change goals. This separation of the conventions must change.

Nature protection is necessary for both climate change mitigation and adaptation

There is widespread agreement that to address climate change both mitigation and adaptation are necessary. In climate change parlance, “mitigation” means efforts to prevent or reduce release of carbon dioxide into the atmosphere; “adaptation” means coming to grips with the fact climate change is already under way and that some harmful climate change is now unavoidable. Adaptation involves doing what we can to adjust to the changes, as well as doing our best to anticipate what things will be like in the future, and putting plans in place with that in mind.

In a forest ecosystem, carbon is stored in living and dead biomass and in the soil. In the tropics, more of the organic carbon is stored in the living trees. In boreal forests, there is proportionally more found below ground due to slower decomposition rates. Temperate forests store large amounts of carbon in living trees, dead biomass, and the soil. Most of the living biomass carbon is found in big old trees. Protecting mature, primary forest in all biomes (tropical, temperate or boreal) from human activities that deplete carbon stocks by removing, in particular, large old trees and disturbing dead biomass and soil carbon, must be recognized as part of the climate change solution in economically developed as well as developing countries. Similarly, wetland conservation is also important to prevent release of greenhouse gases (CUIBA). And, the vast peatlands in northern boreal ecosystems have also been shown to be cooling the climate through the uptake of carbon and will continue to do so if left undisturbed (Frolking and Roulet). Simply put, all wilderness and intact habitat conservation efforts wherever they occur are good for the climate as well as for biodiversity and associated ecosystem services.

In addition to mitigation, intact natural ecosystems and wildlands are critical to adaptation efforts. In different regions in different ways, climate change will place stress on ecosystems and the environmental services they provide, especially the provision of food and freshwater. Many communities, especially in poorer countries, will be affected. Intact, natural ecosystems with their biodiversity fully functioning are more resilient to stresses than degraded lands. Healthy ecosystems will prove an invaluable resource for helping communities adapt to unavoidable climate change. Leaving extensive wild areas intact will enable those natural processes to operate by which species can adapt and persist through changing conditions (Fischlin et al., Mackey et al. 2008b). Connectivity conservation initiatives - vast systems of protected areas connected by conservation management in the intervening lands that span elevations and altitudes - are the best strategy to allow terrestrial species to adapt and ecosystems to remain resilient to climate change (World Conservation Congress, Worboys et al., Heller and Zavaleta). The Program of Work on Protected Areas under the CBD recognizes these tools, and the

upcoming Copenhagen agreement under the UNFCCC should include connectivity conservation initiatives as a key climate change mitigation and adaptation response.

Unfortunately, attempts to educate people about the important roles played by healthy natural ecosystems (especially primary forests, from their soils to the tops of the trees) in mitigation and adaptation are being undermined by various climate change myths. One widespread myth is that old growth forests are not helpful to mitigate climate change because they are sources rather than sinks of carbon dioxide. This view of primary forests has led some commentators to argue that they should be cut down and replaced with younger trees that absorb carbon dioxide from the atmosphere at a faster rate than old trees. This argument is wrong for a number of reasons. For a start, it ignores the fact that old forests have very large stocks of carbon in place. Mobilizing and releasing this carbon into the atmosphere through deforestation and degradation creates a carbon debt that takes hundreds of years to recover through new plantings (Righelato and Spracklen). Furthermore, the underlying assumption is simply incorrect because mature and very old natural forests in boreal, temperate and tropical forests have been shown to be more likely to be sinks than sources (that is, are actively sequestering more carbon dioxide than they emit). As Luyssaert and colleagues discussed - “We find that in forests between 15 and 800 years of age, net ecosystem productivity (the net carbon balance of the forest including soils) is usually positive. Our results demonstrate that old-growth forests can continue to accumulate carbon, contrary to the long-standing view that they are carbon neutral.” They argue further that the only way to keep those benefits is to keep those forests intact. “Old-growth forests accumulate carbon for centuries and contain large quantities of it. We expect, however, that much of this carbon, even soil carbon, will move back to the atmosphere if these forests are disturbed.” In other words, primary forest, and especially old growth forest, should be kept intact for the good of the climate.

Efforts under the climate change convention will have perverse effects unless they recognize biodiversity and natural ecosystems

Under the UNFCCC process at present, the role in mitigation of natural ecosystems and wildlands, including primary forests and wetlands, is not acknowledged. This worldview is manifested in several of the key decisions and rules that have been developed since this convention came into effect. The Kyoto Protocol definition of “forest” is blind to biodiversity and does not distinguish between a natural primary forest, a heavily logged modified natural forest, and a monoculture plantation. This is self-defeating because the current carbon stocks of a forest ecosystem vary enormously depending on its condition as the result of land use history (Gibbs et al., Mackey et al 2008a.) If the failure to acknowledge the critical role intact nature plays in the stabilization of the climate persists into the Copenhagen conference we risk further decisions being made that will lead to more perverse outcomes for biodiversity and climate change mitigation.

There is also the potential for perverse outcomes from active mitigation efforts. Some renewable energy technologies could fragment wilderness areas, leading to further deforestation, degradation and associated emissions. Road infrastructure designed to serve windmills, or new hydro electric reservoirs and associated power line corridors, perturb natural ecosystems, release green carbon, reduce the resilience of ecosystems, and disrupt the natural processes that enable species to adapt to and persist in the face of

climate change. Such outcomes would be self-defeating. Renewable energy facilities should be located in already disturbed areas of which there is no shortage.

Similarly, there is increasing talk of “geo-engineering” to address climate change (Victor et al.). Instead of relying on emissions reductions only, geo-engineering would endeavor to cool the climate by human interventions at a planetary scale. One idea is to attempt to increase oceanic uptake of carbon dioxide from the atmosphere by fertilizing the ocean with nutrients to stimulate plankton growth. Another idea involves sending particles into the upper atmosphere as “albedo enhancers” to reflect the sun’s warming rays back into outer space. These kinds of solutions assume Earth is a simple, linear system – like a clock – amenable to conventional engineering thinking. But, Earth is a complex adaptive system, driven by non-linear feedbacks, and full of climate surprises. The risk to biodiversity and the goals of both the CBD and climate change treaty from such large-scale meddling with natural systems is great. If these activities had unanticipated negative effects it would be nearly impossible reverse them. The real solutions – reducing emissions from burning fossil fuel and prevention of deforestation and degradation of natural ecosystems and wilderness areas– are more prosaic but have a high probability of success with no negative consequences to Earth’s natural systems.

The UNFCCC process needs a fundamental re-orientation that integrates CBD goals

Bringing nature conservation in to the heart of the UNFCCC process at Copenhagen will not be easy. The word “biodiversity” does even not warrant a mention in the Bali Action Plan (the main outcome from the 2007 Bali climate change conference). The concept of ecosystem-based management – which implies biodiversity – is on the adaptation agenda. But when nature is discussed during climate change negotiating sessions it is usually in the context of “impacts” not mitigation.

The lack of focus on mitigating impacts through protecting natural carbon rich ecosystems can be seen in the approach taken to land management in wealthy countries. Under the Kyoto Protocol, land management issues for such countries are considered under the policy theme of “Land Use, Land-Use Change and Forestry” (LULUCF) (Kyoto Protocol, Article 3.3.) Wealthy countries are required under Article 3.3 to report on emissions from deforestation, but under Article 3.4 reporting on emissions from forest management is optional. The definition of forest adopted by the Kyoto Protocol is very general and allows for perverse outcomes such as permitting a biodiverse natural forest to be converted to a monoculture plantation; even though in reality it is “deforestation” and degradation (i.e. depletion) of carbon stocks has occurred (Mackey et al. 2008a).

Consistent with the Kyoto Protocol’s focus on reporting changes in emissions, current rules do not emphasize the mitigation value of protecting intact carbon stocks in natural ecosystems in either wealthy or poor countries. Indeed the current rules tend to the opposite in wealthy countries - “The mere fact of carbon presence (shall) be excluded from accounting” (LULUCF Decision 16/CMP. 1.). However, if we are serious about mitigating the second largest source of emissions then we need to find ways of avoiding emissions and maintaining carbon stocks in all countries. This can be done through public policy with no exchange of funds because it is in the interests of wealthy nations to act by protecting their own natural ecosystems to prevent climate change (just as they

often set aside watersheds to safeguard drinking water supplies); or through financial incentives such as “payment for ecosystem services” (Costa 2009, Costa and Wilson 2000).

REDD – a necessary but insufficient first step

Recently (starting at the Bali climate change conference in 2007) a fledgling effort has been launched that recognizes the mitigation value of reducing the rate at which emissions are released from deforestation and degradation in tropical forests (hence “REDD”). This is an important step in the right direction to protect carbon stored in the natural ecosystems of poorer countries. However, discussions to date are focused on a narrow subset of issues such as how current rates of emissions can be reduced; implying that significant deforestation and degradation must occur before financial rewards can be received. Such deforestation and degradation is clearly important to reverse. But, where are the rewards for nations who have already been doing the right thing by protecting their primary forests? Often they struggle to adequately resource their protected areas with adequate enforcement which is critical to prevent their carbon stocks from being disturbed by illegal activities such as logging.

A key issue being debated is which approaches and mechanisms should be adopted to fund REDD action. Very prominent are discussions concerning the potential to use carbon credit schemes whereby wealthy countries can offset some of their industrial emissions through the transfer of funds from rich to poor countries - the proposition is that emitters from wealthy countries will be able to “offset” a percentage of carbon dioxide emissions from factories and utilities by paying poor countries to keep an equivalent amount of green carbon in place through reducing the rate of deforestation and degradation. While it is essential to find mechanisms that can finance nature protection in developing countries, it is not clear that such purchased offsets will always be the most efficient, fair and ecologically appropriate. As discussed earlier, we need to reduce fossil fuel emissions and green carbon emissions simultaneously – one is not really a substitute for the other.

In developing countries that are struggling to eliminate poverty and provide the basic needs for all their people, rich countries could and should be helping by exploring all options, including through integration of the UNFCCC and CBD as part of their international cooperation activities. For example, wealthy countries could use the Program of Work under the CBD to transfer funds to poorer countries for programs aimed at protecting their natural ecosystems. This can be justified because of the other multiple and reinforcing benefits to climate, biodiversity and sustainable livelihoods that result. Tradeable “carbon credits” is but one of a range of approaches that should be tested as we work towards finding sustainable solutions.

A major concern with current discussions of REDD is the narrow focus on the tropics. The result is that the large amounts of carbon stored in undisturbed temperate and boreal ecosystems are not being considered in the REDD process because most of these forest biomes are located in wealthy countries. This narrow focus on the tropics is not

scientifically justified as the atmospheric warming of a pulse of carbon dioxide is the same whether it comes from a tropical forest in Brazil or Indonesia, a temperate forest in Australia or the United States, or the boreal forests of Canada and Russia. We need immediate global action to protect carbon-rich ecosystems wherever they occur.

The Convention on Biological Diversity process has established an Ad Hoc Technical Experts Group on Biodiversity and Climate Change which is exploring the relationships between actions under the two conventions. While this is an important initiative, it is a technical working group informing the CBD and through it the UNFCCC process, and needs to be complemented by new thinking in the policy arena.

Current activities such as REDD and the CBD Ad Hoc Technical Working Group are necessary but not sufficient. There is a pressing higher-level need for politicians and NGOs in all countries to show leadership in recognizing that the climate change problem, the biodiversity extinction crisis, and the destruction of wilderness, have the same root cause and that coordinated, holistic solutions are required for the Copenhagen agreement and beyond.

A call to action

Large-scale nature conservation is a first order climate change strategy for both mitigation and adaptation. Keeping green carbon stored in large intact natural landscapes is a mitigation strategy. Connectivity conservation is an adaptation strategy. Both are needed. Such action is also necessary to address the biodiversity extinction crisis and preserve the ecosystem services such as freshwater on which all humans rely.

It is time to take a holistic view of the CBD and UNFCCC by bringing them back together to ensure that actions under the one help the other, rather than cause harm. We must ensure that the carbon already stored in primary forests, wetlands, peatlands and other intact ecosystems stays there. The UNFCCC and the CBD should be seen as two parts of an inseparable whole - like the Chinese and Korean Yin Yang symbol.

The need for a coherent strategy to address climate change that simultaneously keeps in place the green carbon stored in natural wild ecosystems and meets emissions reduction goals will be a major focus of WILD 9, the 9th World Wilderness Congress in Merida, Mexico in November, 2009. The message from WILD9 will be carried to the next meeting under the UNFCCC in Copenhagen in December, 2009.

We have no illusions that the message from WILD9 alone will be sufficient to return international efforts to protect our environment to their holistic Rio Earth Summit origins. But, we can all add our voices to the growing international call for a more integrated approach. We encourage anyone interested in the future of our climate and the fate of wild nature to begin disseminating and debating these ideas now and to join us at WILD9(www.wild9.org)

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References:

- Archer, D. (2005) Fate of fossil fuel CO₂ in geologic time. *Journal of Geophysical Research* 110, C09S05, doi:10.1029/2004JC002625.
- Convention on Biological Diversity (2004) Programme of Work on Protected Areas, COP 7 Decision VII/28 Kuala Lumpur, 9 - 20 February 2004.
- Costa, P.M. (2009) *Compensation for carbon stock maintenance in forests as an alternative to avoiding carbon flows*. Unpublished report. Oxford Centre for Tropical Forests, Environmental Change Institute, University of Oxford, UK.
- Costa, P. M. and Wilson, C (2000) An equivalence factor between CO₂ avoided emissions and sequestration – description and applications in forestry. *Mitigation and Adaptation Strategies for Global Change* 5, 51-60
- CUIBA Declaration on Wetlands, 2008, Scientific Advisory Committee of the 8th INTECOL Wetland conference, Cuiba, Brazil;
< www.intecol.net/info-esk/past_events/Eighthth-wwg/eighthth-wwg.htm>
- Finlayson C.M. and Davidson N.C. (1999) *Global Review of Wetland Resources and Priorities for Wetland Inventory. Summary Report*. Report to the Bureau of the Convention on Wetlands (Ramsar, Iran, 1971) from Wetlands International & the environmental Research Institute of the Supervising Scientist, Australia. Ramsar COP7 DOC. 19.3; < http://www.ramsar.org/cop7/cop7_doc_19.3_e.htm>
- Fischlin, A., Midgley, G.F., Price, J.T., Leemans, R., Gopal, B., Turley, C., Rounsevell, M.D.A., Dube, O.P., Tarazona, J. and Velichko, A.A. (2007) *Ecosystems, their properties, goods, and services. Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 4, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, 211-272.
- Frolking, S. and Roulet, N. T. (2007) “Holocene radiative forcing impact of northern peatland carbon accumulation and methane emissions” 13, 1079-1088, *Global Change Biology*
- Gibbs H.K., Brown, S., Niles, J.O. and Foley J.A. (2007) Monitoring and estimating tropical forest carbon stocks: making REDD a reality. *Environmental Research Letters* 2, 1-13.
- Global Carbon Project (2008) Carbon budget and trends 2007;
<www.globalcarbonproject.org, 26 September 2008>
- Heller, N. E and Zaveleta, E, (2009) Biodiversity Management in the face of Climate Change: A review of 22 years of recommendations. *Biological Conservation*, 142 (2009) pp 14-32

- IPCC (2007a) *Climate Change 2007 – Impacts, Adaptation and Vulnerability*
Contribution of Working Group II to the Fourth Assessment Report of the IPCC
(ISBN 978 0521 88010-7 Hardback; 978 0521 70597-4 Paperback)
- IPCC (2007b) *Climate Change 2007 – The Physical Science Basis* Contribution of
Working Group I to the Fourth Assessment Report of the IPCC (ISBN 978 0521
88009-1 Hardback; 978 0521 70596-7 Paperback)
- Luyssaert, Sebastiaan, L., Schulze, E.D., Boerner, A., Knohl, A., Hessenmöller, D.,
Law, B.E., Ciais, P. and Grace, J. (2008) Old-growth forests as global carbon
sinks. *NATURE*, 1455.
- Mackey, B. Keith, H., Berry, S. and Lindenmayer, D.L. (2008a) *Green Carbon: the role
of natural forests in carbon storage. Part 1 , A green carbon account of
Australia's southeastern Eucalypt forest, and policy implications.* ANU E Press,
Canberra; <http://epress.anu.edu.au/green_carbon_citation.html>
- Mackey, G.B., Watson, J.E.M. and Hope, G. (2008b) Climate change, biodiversity
conservation, and the role of protected areas: an Australian perspective.
Biodiversity 9, 11-18.
- Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being:
Synthesis.* Island Press, Washington, DC;
<<http://www.millenniumassessment.org/documents/document.356.aspx.pdf?>>
- Righelato, R. and Spracklen, D.V. (2007) Carbon Mitigation by Biofuels or by Saving
and Restoring Forests? *SCIENCE* 317, pp 902.
- Shearman, P.L., Bryan, J.E., Ash, J., Hunnam, P., Mackey, B. and Lokes, B. (2009) The
state of the forests of Papua New Guinea. Mapping the extent and condition of
forest cover and measuring the drivers of forest change in the period 1972-2002.
Biotropica Published Online: Feb 10 2009 3:18PM DOI: 10.1111/j.1744-
7429.2009.00495.x
- Simon L. Lewis, Gabriela Lopez-Gonzalez, Bonaventure Sonke, Kofi Affum-Baffoe,
Timothy R. Baker, Lucas O. Ojo, Oliver L. Phillips, Jan M. Reitsma, Lee White,
James A. Comiskey, Marie-Noël Djuikouo K., Corneille E. N. Ewango, Ted R.
Feldpausch, Alan C. Hamilton, Manuel Gloor, Terese Hart, Annette Hladik, Jon
Lloyd, Jon C. Lovett, Jean-Remy Makana, Yadvinder Malhi, Frank M. Mbago,
Henry J. Ndangalasi, Julie Peacock, Kelvin S.-H. Peh, Douglas Sheil, Terry
Sunderland, Michael D. Swaine, James Taplin, David Taylor, Sean C. Thomas,
Raymond Votere & Hannsjörg Woil (2008) Increasing carbon storage in intact
African tropical forests. *NATURE* 07771.3d 23/1/09 22:02:36
- Victor, David, M Granger- Morgan, Jay Apt, John Steinbruner, and Katherine Ricke
(2009), *The Geoengineering Option: A Last Resort Against Global Warming?*
Foreign Affairs March/April Vol 88 No 2, Council on Foreign Relations, New
York.
- Worboys, Graeme L., Francis, W. and Lockwood, M (eds), in press *Connectivity
Conservation Management: A Global Guide*, IUCN and Earthscan, Sydney,
Australia

World Conservation Congress, 2008 IUCN (World Conservation Union) motion 087
“Enhancing ecological networks and connectivity conservation areas” and motion
099 “Biodiversity conservation and climate change adaptation and mitigation in
national policies and strategies”; < http://iucn.org/congress_08/assembly/policy/>