The text that follows is a TRANSLATION
O texto que segue é uma TRADUÇÃO

The human species as a component of the global ecosystem in the 21st century

Please cite the original article:
Favor citar o trabalho original:

Fearnside, P.M. 2001. A espécie humana como componente do ecossistema global no século XXI. *Revista de Geografia* 17(2): 27-32.

THE HUMAN SPECIES AS A COMPONENT OF THE GLOBAL ECOSYSTEM IN THE 21st CENTURY

Philip M. Fearnside
Coordination of Research on Ecology-CPEC
National Institute for Research in the Amazon-INPA
Av. André Araújo, 2936
C.P. 478
69011-970
Manaus – AM

Fax: (92) 3642-8909
Phone: (92) 3643-1822
e-mail pmfearn@inpa.gov.br

30 October 2001

TABLE OF CONTENTS

ABSTRACT

Humans are part of the global ecosystem, and their actions can alter basic functions which maintain the environmental quality on Earth, including its productivity and living conditions. These relationships have been quickly changing since the beginning of the 21st century and are expected to keep changing throughout the century. Changes in the perception of the place humans occupy in the global ecosystem support the real changes in these relationships, but they are also likely to accelerate during the next 100 years. Important changes include the greenhouse effect, the frequency and severity of El Niño, the possibility of climatic “surprises”, and the biodiversity losses. Changes in our “guardian”-type relationship with ecosystems are necessary but not automatic. This kind of change requires societies to take actions to realign their relationships with the global ecosystem. Work in forests, such as biodiversity maintenance, water cycling and carbon balance, are environmental services which, if incorporated into the economic system, could redirect human actions, especially in the Amazon.

KEYWORDS: Global warming, biodiversity, climate, greenhouse effect, climate change, environmental changes

I.) HUMANS IN ECOSYSTEMS

Although human beings have always been a component of the global ecosystem, the present moment, which coincides with the beginning of the 21st century, seems to correspond to a still incomplete change of our role in this system, that is, nowadays, we can change the basic role of the ecosystem, for instance, causing climate changes (Falkowski *et al.*, 2000). The growing awareness of this fact, which is different from the fact *per se*, gives us a new role: that of a “guardian”, i.e., being responsible for caring for maintaining the quality of the planet’s environment.

The ability to foresee the future, even imperfectly, is something exclusive to humans, as far as we know. This enables us to make decisions before catastrophes take place, using our vision of the future as a basis to take decisions. Increasing the effective base and developing analytical tools which enable the construction of future operational scenarios, with hypotheses for different courses of action, is an important ingredient in making decisions, but this is not, per se, enough. We have to be

brave to take decisions and take the actions that they imply.

Many economists see the market system as taking care of the environmental problems by itself (see: Daly, 1997). As the environmental quality gets lower and income increases, people will be more prepared to pay in order to maintain or improve the environment. As a result, the environment will be automatically protected against the worst scenarios of destruction. An “environmental Kuznets curve” is seen as leading to environmental quality recovery (see reviews by: Barbier, 1997; Stern, 1998). For instance, the increase in the value of trees leads people to plant trees quicker than deforestation destroys them (Grainger, 1995: 346). This happens in a way which is similar to demographic transition, with environmental destruction and reconstruction rates taking the place of mortality and birth rates in population dynamics.

Unfortunately, environmental problems do not usually reach a conclusion by themselves. Deforestation is likely to continue until the last tree is cut down. Exponential curves do not automatically become logistic curves, leveling themselves asymptotically at some point below complete destruction. In countries like Haiti and El Salvador, deforestation has been almost total. The same can take place in areas such as in the majority of the former Atlantic Forest in Brazil. Even where reforestation has taken place, the same level of biodiversity is rarely achieved: when trees are planted in deforested areas many of the natural forest characteristics cannot be recovered.

There is a real danger of adopting fatalism in our actions. Many people still think the forest will be cut down regardless of anything that can be done, and they turn their attention to other issues. In the case of the Amazon, many of the fundamental determining factors of the future path of development are in the hands of decisions makers, and they must take their decisions with this responsibility in mind. The future depends on human decisions.

We have free will, and human relationships with nature are often as we want them to be. However, there are limits (*e.g.*, Cohen, 1995; Fearnside, 1997a; Meadows *et al.*, 1992). We cannot simply ignore these limits and keep throwing gases into the atmosphere, destroying forests and polluting water without suffering the consequences. We are interdependent on the rest of

nature, and these relationships apply in both directions: from human beings to the rest of nature, and vice versa.

II.) THE 21st CENTURY

The current century is an appropriate time scale to think about future events for several reasons. Longer time horizons could result in decisions that contradict what might be thought of as a fundamental ingredient for a rational approach to the future (Fearnside, 2002). For instance, wasting important opportunities to preserve the Amazon Forest in exchange for expected climate benefits in the coming centuries would be foolish (Fearnside, 2001).

Analyzing the course of a century requires a certain modesty in order to admit that we cannot predict how this development will take place. Imagine someone in 1901 trying to foresee how the world would be nowadays. A world dominated by colonial empires where women did not even have the right to vote, not to mention the huge technological changes, seems strange to us now. The events throughout the 19th century were as dramatic. In 1800, slavery was the basis of labor relations in a large part of the world, including Brazil, and it was seen as a completely natural situation. During just one century slavery was abolished almost all over the world. The point is that dramatic changes can take place during the period of one century and this kind of change could take place in some basic characteristics of the present world, during the 21st century. As Reverend Desmond Tutu perspicaciously asked, if slavery has been abolished, "Why not war?" And in this study, "Why not our role as destroyers of the environment?"

III.) CHANGES IN PERCEPTION

A.) The role of human beings

A fundamental change has to happen in order for human beings to fulfill their role in nature. Neoclassical economists still refute the fact that humans are part of nature. This group is bigger and holds more influence in political decisions than ecologists or geographers (see Daly, 1997). Humans are responsible for maintaining 'natural' processes and balances. The role of a guardian implies that each generation is a fiduciary for future generations (Scott, 1999). As fiduciaries of financial assets, we have to pass on what is essential to the next generation and live only on income.

Changes in the relationship between humankind and nature are gradual, but there are also discontinuities, as much in the relationship itself as in our perception

of the relationship and in our will to take action. Perception is subordinated to interruptions that can greatly affect the course of history. For instance, the invention of the atomic bomb can be held responsible for an increase in the level of responsibility for starting wars. This strengthened the creation of the United Nations Organization and other international initiatives which are not perfect but which have, at least, been preventing nuclear conflicts.

The awareness that humans can cause extinctions, including their own, also brings a new level of responsibility to decision makers. The fact that humans can change the climate of the planet is part of this. The discovery of the hole in the ozone layer in 1985 led to the Montreal Protocol in 1987. The least dramatic and uniform depletion of the ozone layer forecast at the time of debates on supersonic transport (SST), in 1973, was not enough.

B.) The greenhouse effect

Global warming is much more complex scientifically and diplomatically than the hole in the ozone layer. In 1896, the Swedish chemist Svant Arrhenius identified the mechanism of the greenhouse effect and predicted global warming, but only in 1956 did Roger Revelle bring up the subject again, and further research was carried out. I remember when I was a forest guard in the National Park Service in the US, in 1968. I started to give lectures on the greenhouse effect to explain the likely future of the glaciers in the Glacier National Park, in Montana. At that time, few people had heard about the greenhouse effect. Nowadays, basic notions about it are taught all around the world in children’s school books. In the 1960s, people were astonished and skeptical of the possibility of the glaciers eventually melting. At present, projections indicate that all glaciers in this national park will disappear by 2030 (Hall, 1994; see: Mastny, 2000: 126).

Scientific research on the greenhouse effect and public awareness of the phenomenon has grown, but not enough to make nations do what is necessary in order to control this effect. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was formed, and its first report, entitled “Scientific Assessment of Climate Change”, was published in 1990. A supplement was published in 1992, when the United Nations Framework Convention on Climate Change (UN-FCCC) was signed by 155 countries at the United Nations Conference on Environment

and Development (UNCED, or “ECO-92”) in Rio de Janeiro. The IPCC Second Assessment Report (SAR) was completed in 1995, and in 1997 the Kyoto Protocol became the first agreement to reduce gas emissions, although this reduction target would not be enough to control the greenhouse effect. In addition, certain key points of the arrangement were missing. The IPCC Third Assessment Report (TAR) was released in 2001. In the same year, the Bonn Agreement in Germany kept the Kyoto Protocol alive despite the decision of the United States President, George W. Bush, to withdraw the US from negotiations.

Public perception of climate change keeps growing, although this perception is minimal in the United States. This growth is partially due to events such as the fact that 1998 was the hottest year since the beginning of instrumental records about 150 years ago; to the 5,000 km² iceberg that broke away from Antarctica in 1999; to the release of military data showing that the ice in the Arctic Ocean has lost 42% of its thickness since the 1950s (Rothrock *et al.*, 1999); and to the appearance, in 2000, of open water in the North Pole, for the first time ever.

The trouble about politicians and the public in general accepting the reality of the greenhouse effect is the confusion about the difference between statements concerning specific climate events and statements concerning the climate system as a whole. Every time a year is particularly dry or hot scientists are asked if that was the result of climate change. The regular answer is that they do not know, which makes people think that the climate is not changing or that so little is known about it that no action is justified.

A similar situation is the relationship between smoking and lung cancer, which holds many parallel aspects with the greenhouse effect. If a smoker dies of lung cancer we cannot assert that his death was certainly caused by smoking, since some non-smokers also die of this disease. However, we know that smoking increases the risk of lung cancer and this probability can be quantified. Therefore, a climate event in particular cannot be attributed for sure to the greenhouse effect, since rain and temperature variations always take place for other reasons. This does not mean that there is a lack of strong evidence that the emissions of greenhouse effect gases cause global warming and that the greenhouse effect increases the risk of droughts and other climate events with direct impact on humans.

A second parallel with smoking is also highly pertinent. For decades, the tobacco industry refuted the relationship between smoking and cancer with an argument very much like what is heard nowadays concerning the greenhouse effect: that there are too many uncertainties in order to do anything. More than 90% of the medical research community that worked on this issue was convinced that smoking was the main cause of lung cancer. The thought that we should not take expensive measures now because of uncertainty is still part of President George W. Bush's argument to justify the withdrawal of the US from the Kyoto negotiations on March 13, 2001. Bush tried to discredit the IPCC, whose more recent estimate of expected warming until 2100 is from 1.4 to 5.8 ºC. For a "business as always" scenario, these models indicate a more likely warming of about 3.8 ºC (Knutti *et al.*, 2002). The National Academy of Sciences in the US formed a special committee to evaluate the IPCC's results. The committee approved the IPCC's conclusions (Schrope, 2001).

Thus, are nations ready to pay for environmental maintenance, i.e., the cost of being guardians? The answer is: "Not completely". However, I believe this has been changing since the beginning of the new century.

An important reason is that a faster climate change is expected in the next years when compared with what has happened so far. It has been calculated that the rise of average temperature observed during the 20th century was 0.5ºC, that is, just a fraction of the rise of 1.4-5.8ºC expected in the 21st century (Houghton *et al.*, 2001). The pace of change in land-use is also faster, for instance, that of deforestation in the Amazon and the loss of other types of vegetation such as the Brazilian savannas.

It is important to understand that attitudes towards important subjects like this can change dramatically and rapidly. Once more, an example from the smoking issue: throughout the last twenty years, government attitudes and regulatory restrictions on smoking have changed completely.

C.) El Niño

Science can make a huge difference to public perceptions. A scientific topic that still awaits a solution is the connection between the greenhouse effect and El Niño. At the present time, the phenomenon called El Niño is always presented as something unpredictable.

No one was blamed when 200,000 people died of starvation in Ethiopia during the 1982 El Niño.

Nowadays the greenhouse effect is seen as an event that will affect our grandchildren. On the other hand, El Niño is killing people at this moment, as can be seen clearly on television. It is not something abstract or hypothetical. If people started to think that El Niño happens due to the gases released by their cars, this perception would change.

Since 1976, something has changed in the climate system to explain the increased frequency of El Niño (Nicholls *et al.*, 1996). El Niño is caused by an increase in water surface temperature in the Pacific Ocean. Why does the water temperature rise? The most likely explanation is the rise in global temperature due to the greenhouse effect, which has taken place in recent years, since the surface temperature often passes the threshold which causes El Niño. We are not scientifically sure that the greenhouse effect causes the frequency of El Niño to increase, but what we often hear is that this possibility "cannot be excluded" (Fedorov & Philander, 2000). Perhaps within 10 years, research will advance enough to allow for strong statements on the relation between global warming and El Niño to be done. What would be your bet? Is the increase in both the frequency of El Niño and global temperature just a coincidence?

The recent discovery (Levitus *et al.*, 2000) that oceans are warmer than expected accentuates the connection between the greenhouse effect and El Niño events. The triplication of the global set of data of temperature profiles of the oceans (totaling 3 million measurements) explains the "lost heat" predicted by global circulation models (GCMs) of the atmosphere. Thus, this increases the confidence in the model generated projections of future climate (Kerr, 2000).

Once the link between El Niño and global warming is admitted, the political importance of the greenhouse effect should suddenly change. For instance, if El Niño events are 50% more frequent due to the greenhouse effect, so 50% of human deaths which occurred during those events may have been caused by emissions of greenhouse effect gases. The annual emission of 5.6 tC/capita (tons of carbon per capita) in the US becomes less acceptable. The same can be applied to other important emitters, including the emission in Brazil which was 2.3 tC/capita (deforestation and logging included) in 1990. The United States in particular, as

the biggest contributor to the greenhouse effect, would behave differently if they were held responsible for a substantial part of the current impact.

D.) Climatic “surprises”

An extra factor that can affect the perception of the greenhouse effect might come from future progress in research on non-linear effects, or “surprises” such as the thermohaline circulation change in the Atlantic Ocean, which would produce a catastrophic cooling in Europe (Broecker *et al.*, 1997). Some climate models indicate the collapse of thermohaline circulation as a consequence of the greenhouse effect (Wood *et al.*, 1999). The scenarios produced by the IPCC (Nakicenovic *et al.*, 2000) do not consider the possibility of non-linearities of such a nature. The IPCC classifies the probability of thermohaline circulation instability to be less than 5% in the 21st century (Houghton *et al.*, 2001). This deadline is an important detail since this probability is expected to increase in the 22nd century.

Evidence of a thermohaline circulation instability risk includes the comparison with the Younger Dryas event at the end of the last glaciation: the world was heating up, a situation similar to the current warming by the greenhouse effect. In addition, temperature records from data from probes in the Greenland ice and European palynologic proof indicate the sudden cooling of Europe. At the same time, the rest of the planet kept heating up as indicated, for example, by equipment in the Antarctic ice. It is believed that the instability of the thermohaline circulation in the Atlantic caused the cooling and, therefore, the dramatic climate change in less than a decade, and which lasted for approximately 2000 years (Broecker *et al.*, 1997). There is no safe estimate for the probability of this kind of event to take place at a certain period of time, but it is clear that the chance is greater with the increase of the greenhouse effect. The appropriate means to incorporate unlikely but catastrophic events, when making decisions, is an important issue in the debates on global changes (Keller *et al.*, 2000).

E.) Biodiversity

Biodiversity represents another area in which the role of humans in the ecosystem is changing, as much in relation to its nature as in our perception of this role (Sala *et al.*, 2000). At the moment, budgets for biodiversity conservation which could be used to change destructive processes such as tropical deforestation are not as much as those for climate change issues. I believe

that during the 21st century the importance given to biodiversity will become similar to that of climate change.

The most important thing is that we must not wait until biodiversity resources, such as the tropical forests, are almost completely destroyed, in order to allow traditional economic forces to start inflating the price of tropical forest and, therefore, to stimulate investments in conservation and restoration. A similar situation is found in the statement made by Don Huberts, CEO of Shell Hydrogen: “The Stone Age did not end because we ran out of stones, and the oil age will not end because we run out of oil” (Dunn, 2001: 8). Thus, the age of predatory deforestation will not end because we run out of forests.

IV.) ENVIRONMENTAL SERVICES

Environmental services is a concept that could change the way we relate to the environment and is also a form of influencing decisions on land use in the Amazon (Fearnside, 1989, 1997b). The willingness-to-pay for environmental services such as biodiversity maintenance, water cycling, and carbon stocks is always less than the results from estimates that try to attribute a “real” value to the services (*e.g.*, Costanza *et al.*, 1997; Pimentel *et al.*, 1997). There is still a lot to do to change the basis of the economy in locations like the Brazilian Amazon so that economic forces will work to preserve the forest, instead of destroying it. In order to attain the desired result of supporting human population in these locations, we must stop wasting resources through deforestation.

V.) CONCLUSIONS

Humans are part of the global ecosystem and are currently changing its basic characteristics such as climate and biodiversity. The possibility of changing and destroying ecosystems makes humans the guardians of these resources for the next generations. Perceptions of the change in the relationship between humans and the rest of the ecosystem are beginning to appear and will probably increase considerably during the 21st century. However, this change is not automatic and requires human societies to take actions in order to realign their relationships with the global ecosystem. The incorporation of environmental services, such as biodiversity maintenance, water cycling, and carbon balance into the economic

system is a priority in order to redirect human actions that now harm them.

VI.) ACKNOWLEDGMENTS

This paper was presented as the keynote address at the 9th Brazilian Symposium of Applied Physical Geography on “Building Geography for the 21st Century”, 14-18 November 2001, Recife. I thank the National Institute for Research in the Amazon - INPA (PPI 1-3160) and the National Council for Scientific and Technological Development - CNPq (AI 350230/97-8; AI 465819/00-1; EU 470765/2001-1) for their financial support. Sabrina Kamioka translated the text. All opinions expressed here are those of the author.

VII.) BIBLIOGRAPHY

Barbier, E.B. 1997. Introduction to the environmental Kuznets curve special issue. *Environment and Development Economics* 2(4): 369-381.

Broecker, W.S. 1997. Thermohaline circulation, the Achilles heel of our climate system: Will man-made CO_2 upset the current balance? *Science* 278: 1582-1588.

Cohen, J. 1995. *How Many People Can the Earth Support*? W.W. Norton, New York, U.S.A. 531 pp.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton & M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.

Daly, H. 1997. Políticas para o desenvolvimento sustentável. pp. 179-192 In: C. Cavalcanti (ed.) *Meio Ambiente, Desenvolvimento Sustentável e Políticas Públicas*. Editora Cortez, Sao Paulo. 436 pp.

Dunn, S. 2001. Hydrogen futures: Toward a sustainable energy system. Worldwatch Paper 157, Worldwatch Institute, Washington, DC, U.S.A. 90 pp.

Falkowski, P., R.J. Scholes, E. Boyle, J. Canadell, D. Canfield, J. Elser, N. Gruber, K. Hibbard, P. Högberg, S. Linder, F.T. Mackenzie, B. Moore III, T. Pedersen, Y. Rosenthal, S. Seitzinger, V. Smetacek & W. Steffen. 2000. The global carbon cycle: A test of our knowledge of Earth as a system. *Science* 290: 291-296.

Fearnside, P.M. 1989. Forest management in Amazonia: The need for new criteria in evaluating development options. *Forest Ecology and Management* 27(1): 61-79.

Fearnside, P.M. 1997a. Limiting factors for development of agriculture and ranching in Brazilian Amazonia. *Revista Brasileira de Biologia* 57(4): 531-549.

Fearnside, P.M. 1997b. Environmental services as a strategy for sustainable development in rural Amazonia. *Ecological Economics* 20(1): 53-70.

Fearnside, P.M. 2001. Saving tropical forests as a global warming countermeasure: An issue that divides the environmental movement. *Ecological Economics* 39(2): 167-184.

Fearnside, P.M. 2002. Why a 100-year time horizon should be used for global warming mitigation calculations. *Mitigation and Adaptation Strategies for Global Change* 7(1): 19-30.

Fedorov, A.V. & S.G. Philander. 2000. Is El Niño changing? *Science 288:* 1997-2002.

Grainger, A. 1995. Integrating the socio-economic and physical dimensions of degraded tropical lands in global climate change mitigation assessments. pp. 335-348 In: M.J. Apps & D.T. Price (eds.) *Forest Ecosystems, Forest Management and the Global Carbon Cycle*, NATO ASI Series, Subseries I "Global Environmental Change," Vol. 40. Springer-Verlag, Heidelberg, Germany. 452 pp.

Hall, M.H.P. 1994. Predicting the impact of climate change on glacier and vegetation distribution in Glacier National Park to the year 2100. Tese de mestrado, State University of New York, Syracruse, New York, U.S.A. 194 pp. See: (http://www.mesc.usgs.gov/glacier/glacier%5Fmodel.htm).

Houghton, J.T., Y. Ding, D.G. Griggs, M. Noguer, R.J. Van der Linden & D. Xiausu (eds.) 2001. *Climate Change 2001: The Scientific Basis*. Cambridge University Press, Cambridge,UK. 944 pp.

Keller, K., L. Tan, F.M.M. Morel & D. Bradford. 2000. Preserving the ocean circulation: Implications for climate policy. *Climatic Change* 47: 7-43.

Kerr, R. 2000. Globe's 'missing warming' found in the ocean. *Science* 287: 2126-2127.

Knutti, R., T.F. Stocker, F. Joos & G.K. Plattner. 2002. Constraints on radiative forcing and future climate change from observations and climate model ensembles. *Nature* 416: 719-723.

Levitus, S., J.I. Antonov, T.P. Boyer & C. Stephens. 2000. Warming of the world ocean. *Science* 287: 2225-2229.

Mastny, L. 2000. Ice cover melting worldwide. pp. 126-127 In: L. Brown, M. Remmer & B. Halwell (eds.) Vital Signs *2000*. W.W. Norton, New York, U.S.A. 192 pp.

Meadows, D.H., D.L. Meadows & J. Randers. 1992. *Beyond the Limits: Global Collapse or sustainable Future*. Earthscan, London,UK. 300 pp.

Nakicenovic, N. & 53 others. 2000. *Special Report on Emissions Scenarios*. Cambridge University Press, Cambridge, UK. 599 pp.

Nicholls, N. & 98 others. 1996. Observed climate variability and change. pp. 133-192 In: J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg & K. Maskell (eds.). *Climate Change 1995: The Science of Climate Change*. Cambridge University Press, Cambridge,UK. 572 pp.

Pimentel, D., C. Wilson, C. McCullum, R. Huang, P. Dwen, J. Flack, Q. Tran, T. Saltman & B. Cliff. 1997. Economic and environmental benefits of biodiversity. *BioScience* 47(11): 747-757.

Rothrock, D.A., Y. Yu & G.A. Maykut. 1999. Thinning of the Arctic Sea-Ice Cover. *Geophysical Research Letters* 26: 3469-3472.

Sala, O.E., F.S. Chapin III, J.J. Armesto, E. Berlow, J. Bloomfield, R. Dirzo, E. Huber-Sanwald, L.F. Huenneke, R.B. Jackson, A. Kinzig. R. Leemans, D.M. Lodge, H.A. Mooney, M. Oesterheld, N.L. Poff, M.T. Sykes, B.H. Walker, M. Walker & D.H. Wall. 2000. Global biodiversity scenarios for the year 2100. *Science* 287: 1770-1774.

Schrope, M. 2001. Consensus science, or consensus politics? *Nature* 412: 112-114.

Scott, A. 1999. Trust law, sustainability and responsible action. *Ecological Economics* 31(1): 139-154.

Stern, D.I. 1998. Progress on the environmental Kuznets curve? *Environment and Development Economics* 3(2): 173-196.

Timmermann, A., J. Oberhuber, A. Bacher, M. Esch, M. Latif & E. Roeckner. 1999. Increased El Niño frequency in a climate model forced by future greenhouse warming. *Nature 398:* 694-696.

Wood, R.A., A.B. Keen, K.F.B. Mitchell & J.M. Gregory. 1999. Changing spatial structure of the thermohaline circulation in response to atmospheric CO_2 forcing in a climate model. *Nature* 399: 572-575.