THE TELES PIRES DAM'S CDM PROPOSAL: COMMENTS ON THE PROJECT DESIGN DOCUMENT

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The Project Design Document (PDD) for the Teles Pires Dam's proposal for carbon credit under the Kyoto Protocol's Clean Development Mechanism (CDM) is indeed revealing, both of the flaws in the current CDM system and of the inconsistencies between Brazilian government's stated concern for climate change and its engaging in maximum exploitation of loopholes in CDM regulations.

The document begins by stating (p. 3) that "The Project will make use of the hydrological resources of the Teles Pires River …. in order to generate greenhouse gases (GHG) emission free electricity". No literature is cited here or anywhere in the document to substantiate the claim that Amazonian hydroelectric dams such this one are emissions free. Instead, the calculations later in the document rely on a CDM procedural clause related to the power density of the dam as the justification for using a value of zero for the project's emissions in the calculations. Unfortunately, the fact that Amazonian dams produce large amounts of greenhouse gases, especially during their first ten years of operation (the time horizon for the current CDM project), has been shown in many peer-reviewed studies in the scientific literature, such as:

Abril, G., F. Guérin, S. Richard, R. Delmas, C. Galy-Lacaux, P. Gosse, A. Tremblay, L. Varfalvy, M.A. dos Santos & B. Matvienko. 2005. Carbon dioxide and methane emissions and the carbon budget of a 10-years old tropical reservoir (Petit-Saut, French Guiana). *Global Biogeochemical Cycles* 19: GB 4007, doi: 10.1029/2005GB002457

Delmas, R., S. Richard, F. Guérin, G. Abril, C. Galy-Lacaux, C. Delon & A. Grégoire. 2004. Long term greenhouse gas emissions from the hydroelectric reservoir of Petit Saut (French Guiana) and potential impacts. pp. 293-312. In: A. Tremblay, L. Varfalvy, C. Roehm & M. Garneau (eds.) *Greenhouse Gas Emissions: Fluxes and Processes. Hydroelectric Reservoirs and Natural Environments*. Springer-Verlag, New York, NY, USA, 732 pp.

Fearnside, P.M. 2002. Greenhouse gas emissions from a hydroelectric reservoir (Brazil's Tucuruí Dam) and the energy policy implications. *Water, Air and Soil Pollution* 133(1-4): 69-96.

Fearnside, P.M. 2004. Greenhouse gas emissions from hydroelectric dams: Controversies provide a springboard for rethinking a supposedly “clean” energy source. *Climatic Change* 66(2-1): 1-8.

Fearnside, P.M. 2005a. Brazil's Samuel Dam: Lessons for hydroelectric development policy and the environment in Amazonia. *Environmental Management* 35(1): 1-19.

Fearnside, P.M. 2005b. Do hydroelectric dams mitigate global warming? The case of Brazil's Curuá-Una Dam. *Mitigation and Adaptation Strategies for Global Change* 10(4): 675-691.

Fearnside, P.M. 2006. Greenhouse gas emissions from hydroelectric dams: Reply to Rosa *et al. Climatic Change* 75(1-2): 103-109.

Fearnside, P.M. 2008. Hidrelétricas como “fábricas de metano”: O papel dos reservatórios em áreas de floresta tropical na emissão de gases de efeito estufa. *Oecologia Brasiliensis* 12(1): 100-115. English translation available at: http://philip.inpa.gov.br/publ_livres/mss%20and%20in%20press/Fearnside%20Hydro%20GHG%20framework.pdf

Fearnside, P.M. 2009a. As hidrelétricas de Belo Monte e Altamira (Babaquara) como fontes de gases de efeito estufa. *Novos Cadernos NAEA* 12(2): 5-56. [English translation available at: http://philip.inpa.gov.br/publ_livres/mss%20and%20in%20press/Belo%20Monte%20emissions-Engl.pdf

Fearnside, P.M. 2011. Gases de efeito estufa no EIA-RIMA da hidrelétrica de Belo Monte. *Novos Cadernos NAEA* 14(1): 5-19.

Galy-Lacaux, C., R. Delmas, C. Jambert, J.-F. Dumestre, L. Labroue, S. Richard & P. Gosse. 1997. Gaseous emissions and oxygen consumption in hydroelectric dams: A case study in French Guyana. *Global Biogeochemical Cycles* 11(4): 471-483.

Galy-Lacaux, C., R. Delmas, J. Kouadio, S. Richard & P. Gosse. 1999. Long-term greenhouse gas emissions from hydroelectric reservoirs in tropical forest regions. *Global Biogeochemical Cycles* 13(2): 503-517.

Guérin, F., G. Abril, S. Richard, B. Burban, C. Reynouard, P. Seyler & R. Delmas. 2006. Methane and carbon dioxide emissions from tropical reservoirs: Significance of downstream rivers. *Geophysical Research Letters* 33: L21407, doi: 10.1029/2006GL027929.

Guérin, F., G. Abril, A. Tremblay & R. Delmas. 2008. Nitrous oxide emissions from tropical hydroelectric reservoirs. *Geophysical Research Letters* 35: L06404, doi: 10.1029/2007GL033057.

Gunkel, G. 2009. Hydropower – A green energy? Tropical reservoirs and greenhouse gas emissions. *CLEAN – Soil, Air, Water* 37(9): 726-734.

Kemenes, A., B.R. Forsberg & J.M. Melack. 2007. Methane release below a tropical hydroelectric dam. *Geophysical Research Letters* 34: L12809. doi: 10.1029/2007GL029479. 55.

Kemenes, A., B.R. Forsberg & J.M. Melack. 2008. As hidrelétricas e o aquecimento global. *Ciência Hoje* 41(145): 20-25.

Kemenes, A., B.R. Forsberg & J.M. Melack. 2011. CO_2 emissions from a tropical hydroelectric reservoir (Balbina, Brazil). *Journal of Geophysical Research* 116, G03004, doi: 10.1029/2010JG001465

Pueyo, S. & P.M. Fearnside. 2011. Emissões de gases de efeito estufa dos reservatórios de hidrelétricas: Implicações de uma lei de potência. *Oecologia Australis* 15(2): 114-127. doi: 10.4257/oeco.2011.1502.02 [English translation available at: http://philip.inpa.gov.br/publ_livres/mss%20and%20in%20press/Pueyo%20&%20Fearnside-GHGs%20FROM%20%20RESERVOIRS--engl.pdf.

Despite the document's using zero as the emission for the project in its calculation of climate benefits, a table is included (p. 10, Table 3) where the admission is made that the dam would produce methane (although no quantities are mentioned). The same table also states that emissions of CO_2 and N_2O are zero, each of these being only a "minor emission source". Unfortunately, both of these gases are also produced. Creating the reservoir will kill forest trees in the flooded area, and these generally remain projecting out of the water, where the wood decays in the presence of oxygen, thus producing CO_2. The quantities are quite substantial over the ten-year time horizon of the current CDM project. See calculations for existing Amazonian reservoirs in:

Fearnside, P.M. 1995. Hydroelectric dams in the Brazilian Amazon as sources of 'greenhouse' gases. *Environmental Conservation* 22(1): 7-19. doi:10.1017/S0376892900034020

Nitrous oxide (N_2O) is also emitted. See:

Guérin, F., G. Abril, A. Tremblay & R. Delmas. 2008. Nitrous oxide emissions from tropical hydroelectric reservoirs. *Geophysical Research Letters* 35: L06404, doi: 10.1029/2007GL033057.

The project proponents choose to ignore the scientific evidence for greenhouse-gas emissions from Amazonian dams and take advantage of a CDM regulation that allows zero emissions to be claimed if the power density is over 10 W/m² (p. 27):

> "Emissions from water reservoir are set to zero if the power density of the project activity is greater than 10 W/m^2. The Project power density is 19.18 W/m², thus by definition emissions from water reservoir are zero (*PEHP,y* =0)."

Unfortunately, having a high power density does not, in fact, result in zero emissions. A high power density means that the area of the reservoir is small relative to the installed capacity, which, in turn, reflects the amount of water available in the river. The small area means that emissions through the reservoir surface (from bubbling and diffusion) will be smaller than in a large reservoir, but not zero. The amount of water in the river, however, has the opposite effect: the more the streamflow the more the emission that will result from water passing through the turbines and spillways. The turbines and spillways are, in fact, the major source of methane emission in most Amazonian dams (see the references listed above). The water passing through the turbines and spillways is normally drawn from a depth below the thermocline that separates the layers of water in the reservoir. The deeper layer (the hypolimnion) is virtually devoid of oxygen, and decomposition of organic matter therefore generates methane instead of carbon dioxide. The water with high concentrations of methane, under pressure at the bottom of the reservoir, is released to the open atmosphere below the dam, and the most of methane quickly emerges as bubbles (Henry's Law). Note that the only valid means of measuring these emissions is by the difference in concentration of methane in the water above the dam (at the depth of the turbines) and in the river below – not by floating chambers to measure flux through the surface of the river some distance downstream, as has been done in several studies that claim only small emissions from "degassing" at the turbines. See comparative data in the paper by Kemenes et al. (2011) cited above.

The document calculates reservoir area for the purpose of computing the power density, which the installed capacity in Watts divided by the area in square meters. The calculation (p. 36) is described as:

> "The project's reservoir area under the normal maximum water level of 220 m is 135.4654 km^2, of which 40.6 km^2 is part of the normal river bed and, therefore, the increased flooded area is 94.8654 km^2."

The assumption is that the water over the "normal river bed" is not emitting methane. Unfortunately, this water also emits methane, as shown by numerous studies that have measured reservoir surface fluxes at a variety of monitoring points in Amazonian reservoirs (see publications cited above). Perhaps the proponents think that the same area of water in the natural river would be emitting the same amount of methane. If so, they are mistaken, since methane emissions from a free-flowing river are much lower than those from reservoirs. Rivers do not normally stratify, especially in the fast-flowing stretches that are appropriate for building hydroelectric dams.

The document calculates a benefit of 24,973,637 t CO_2eq over 10 yrs. (p. 34, Table 13) , based on the loophole of a zero value being permitted for reservoir emissions if power density exceeds 10 W/m^2. The proponents state "Therefore, once the project's power density is above 10W/m^2, no calculation of project emissions is required." (p. 34). While such a calculation may be "not required", the proponents could have opted to make such a calculation based on the best available evidence had they wanted to do so.

The claim of displacing almost 25 million tons of CO_2-equivalent over ten years represents 6.8 million tons of carbon. Much, or possibly even all, of this represents "hot air" that will contribute to further climate change. Brazil, as one of the countries expected to suffer most from projected climate changes, cannot afford to contribute to such a scheme.

Perhaps the most disingenuous statement in the document is the claim (p. 41) made (without any supporting studies cited) that:

> "The growing global concern regarding the sustainable use of resources is driving a requirement for more sensitive environmental management practices. Increasingly this is being reflected in countries' policies and legislation. In Brazil the situation is no different; environmental rules and licensing process policies are very strict in line with the best international practices."

There is a substantial literature examining the deficiencies in Brazil's licensing system. See, for example:

Fearnside, P.M. & P.M.L.A. Graça. 2006. BR-319: Brazil's Manaus-Porto Velho Highway and the potential impact of linking the arc of deforestation to central Amazonia. *Environmental Management* 38(5): 705-716. DOI 10.1007/s00267-005-0295-y.

Fearnside, P.M. 2007. Brazil's Cuiabá-Santarém (BR-163) Highway: The environmental cost of paving a soybean corridor through the Amazon. *Environmental Management* 39(5): 601-614. doi. 10.1007/s00267-006-0149-2

Fearnside, P.M. 2006. Dams in the Amazon: Belo Monte and Brazil's Hydroelectric Development of the Xingu River Basin. *Environmental Management* 38(1): 16-27. doi: 10.1007/s00267-005-00113-6

Fearnside, P.M. & R.I. Barbosa. 1996. Political benefits as barriers to assessment of environmental costs in Brazil's Amazonian development planning: The example of the Jatapu Dam in Roraima. *Environmental Management* 20(5): 615-630. Doi: 10.1007/BF01204135

Fearnside, P.M. 2011. Gases de efeito estufa no EIA-RIMA da hidrelétrica de Belo Monte. *Novos Cadernos NAEA* 14(1): 5-19.

Santos, S.M.S.B.M. & F.M. Hernandez (eds.). 2009. *Painel de Especialistas: Análise Crítica do Estudo de Impacto Ambiental do Aproveitamento Hidrelétrico de Belo Monte*. Painel de Especialistas sobre a Hidrelétrica de Belo Monte, Belém, Pará, Brazil. 230 pp. Available at: http://www.internationalrivers.org/files/Belo%20Monte%20pareceres%20IBAMA_online%20(3).pdf

The "growing concern" for the environment that the document mentions should include avoiding the creation of "hot air", or carbon credit without a real climate benefit. This project creates hot air in two ways. First, it is based on the fiction that the hydroelectric dam will have zero emissions, despite extensive evidence indicating that Amazonian dams have large emissions, especially in the first decade that is the time horizon of the project. Second, the project is not "additional", as required by Article 12 of the Kyoto Protocol in creating the Clean Development Mechanism. Projects are supposed to gain credit only if the claimed emissions reductions would not have taken place without the CDM funding. In this case, the dam is planned and financed by Brazilian companies with the full expectation of making a profit without any additional help from the CDM. None of the 25 million tons of CO_2-equivalent claimed is additional.