STUDIES THAT DON'T HOLD WATER:

30 ERRORS IN THE ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MADEIRA RIVER HYDROELECTRIC COMPLEX

November - 2006

Amigos da Terra
AMAZÔNIA BRASILEIRA

IRN
International Rivers Network

Studies that don’t hold water: 30 Errors in the Environmental Impact Assessment for the Madeira River Hydroelectric Complex

Introduction

On June 26, 2006, the Rondônia State Public Attorney’s Office and the consortium comprised of the private construction company Odebrecht and the state electric company Furnas signed an Agreement to carry out a series of studies evaluating the environmental and feasibility studies for the Madeira River Hydroelectric Complex in the Brazilian Amazon.

The legal Agreement also called on Brazil’s environment protection service, Ibama, to “consider the results of the report” in their deliberations regarding the licensing process for the project. The consulting firm COBRAPE, of São Paulo was paid directly by the dam building consortium, and 19 specialists, well known in their diverse disciplines were called upon to analyze the project environmental studies, with their results to be publicly disseminated and discussed in public meetings.

This document contains excerpts, which present the 30 principal questions raised by the specialists. These point to serious errors in the project studies, and raise issues that question the feasibility of the project itself, and the licensing process currently underway. Some also question the terms of reference for the studies, which were established by Ibama in consultation with the construction consortium.

The excerpts are presented in thematic groups, with the names of the specialist who raised each point.

- GENERAL ASPECTS AND FOCUS OF THE STUDIES -

1. Inadequate scope: The impacts of the Hidrovia (industrial waterway) were not studied

"The Santo Antônio e Jirau hydroelectric dams must be analyzed within the context that four dams are being planned, in addition to a gas pipeline, a railway, and an industrial waterway which would permit navigation along 4,200 km to integrate energy and transport infrastructure between Brazil, Bolivia, Peru, and eventually to connect with Pacific ports"
"The choice of sites for the dams explicitly considers the option of an alternative which would permit navigation on the Madeira River, in detriment to other options which would consider greatest energy potential: therefore, the sites at Jirau rapids, 130 km above Porto Velho, and Santo Antônio rapids, near Porto Velho"
(*Sílvio Rodrigues Persivo Cunha*[1]*)*

"In May, 2006, the Mines and Energy Ministry made it clear that no decision has yet been made regarding construction of navigation locks (Brasil, MME, 2006). The fundamental question is ***whether the postponement of a decision regarding the locks relieves the proponents of the dam from any responsibility to consider their impacts in the environmental impact studies*** (our emphasis). Constructing navigation locks at Santo Antônio and Jirau dams implies that the Guajará-Mirim dam upriver would be built. This dam would be located between the cities of Abunã and Guajará-Mirim. In practice, making a huge investment creates political pressure on the regulators to approve the next dam upstream. A solution for minimizing this effect would be to merely leave the space to construct the locks later, without actually building them."
(Philip Fearnside[2]*)*

2. The area flooded by the dams could be double that which has been estimated

"Taking as an example the area around Jirau dam, shown in Figure 8 of the RIMA (summary of environmental impact assessment), a reduction of 20 meters in the base level of the MDE (digital elevation model) would result in an increase in the limits of the flooded area up to a curve at a level of 95 m, ***which would represent an increase of more than 100% in the flooded area*** (our emphasis) shown in the figure. If this error really took place, ***all the impact studies carried out until now would be affected*** (our emphasis). The direct and indirect areas of influence would have to be redefined and all the studies and simulations re-done."
(Bruce Forsberg[3]*)*

---

[1] *Silvio Rodrigues Persivo* is an economist and Doctor in Sustainable Development from the Federal University of Pará state. He was a professor in the Faculty of Administrative and Technological Sciences (FATEC) in Porto Velho and is a consultant for the Federation of Commerce of the State of Rondônia (Fecomércio).
[2] *Philip Martin Fearnside* graduated in biology at Colorado College and has a PhD in Biological Sciences from the University of Michigan. Currently, he is a researcher at the National Institute of Amazon Studies (INPA) in Manaus.
[3] *Bruce Forsberg* graduated in biology at Michigan State University and has a post-

3. Diagnostic is too general, lacks analysis and consistent conclusions

"The Study contains a great deal of information on the three areas of influence in items described as "socio-economic aspects", history of occupation of the region, sector analyses, secondary data (when available), descriptions of indigenous populations, etc. However, one can evaluate that the information, besides being restricted to the defined areas of influence and the determined indicators, is not conclusive or analytic, and is limited to descriptions and to providing a diagnostic, without establishing relations in any consistent manner."
"In general, we can affirm that the diagnostic and the (mitigation) proposals in the Environmental Impact Assessment are on a level of generality which is not adequate considering the magnitude of this project. The measures proposed are few and are superficial and while we are aware that the dam builders cannot assume the role of the government, greater precision is needed, principally on those issues which directly affect the quality of life of local populations."
(*Simone Tavares Coelho*[4])

4. Avoids complex problems

"The EIA specifies ... the exclusion of a stretch of the river which could imply possible impacts on Bolivia requiring the project to be considered bi-national. This option to avoid more complex problems is reflected in the definition of the areas directly and indirectly affected by the project. In this sense there is a clear option to want to restrict these areas to the Municipality of Porto Velho, principally regarding socio-economic impacts, due to costs and the extent, when there is no way to not consider that the construction of Jirau and Santo Antônio dams is a project of regional impact, with immediate consequences on living conditions, economic reorganization and the migratory flux to the State of Rondônia."
(*Sílvio Rodrigues Persivo Cunha)*

---

doctorate specializing in Ecosystems Ecology from the University of Washington. Currently he is a researcher and professor at the National Institute for Amazon Research.

[4] *Simone de Castro Tavares Coelho* is a sociologist and doctor in Political Science from the University of São Paulo. She is an independent consultant, specializing in Third Sector Policies (non-profits, social and civil society).

- TERRITORY AND POPULATION -

5. Negligence in estimates and impacts of population increases

"We cannot accept that, as indicated in the EIA, the populational impact would be as small as calculated, when local historical experiences are that the region has a high potential to attract migrants, and moreover, based upon other projects that have been carried out, in retrospect the impacts involved leaps in the population well above those expected."
(Simone Tavares Coelho)

"The projection of population increase is under-estimated and does not reflect the increase in migration which is induced by large projects."
(Artur de Souza Moret[5])

6. Territorial impacts studied only superficially

"There is a lack of crucial information needed to evaluate the adequacy of proposals (which also do not consider the implantation of the dams). Also, we did not find references in the studies and proposals for territorial organization for the small towns and villages in the municipality. The EIA and other complementary studies look only superficially at the project's territorial impacts."
"The studies and proposals for the Master Plan of the city of Porto Velho did not incorporate the territorial impacts which would take place due to the implantation of the Santo Antonio and Jirau dams. It is worth remembering that an adequate perception and solution are fundamental to making sustainable integrated development feasible and are the guarantee for an adequate quality of life for the population of the city and the municipality."
(Rajindra Singh[6])

7. Relationship not made between regional and local development

"The mitigation/compensation measures for the project, including those regarding affected transport infrastructure (road, river, and rail), as well as on ports, road stations, and terminals should be inserted within the overall context of development (of the macro-region, of the state, of the Territorial Reorganization area and the city of Porto Velho)."
(Rajindra Singh)

---

[5] *Artur de Souza Moret* is a Doctor in Energy Planning from the University of São Paulo, Campinas and is a professor at the Federal University of Rondônia.
[6] *Rajindra Kaur Singh* has a degree in architecture from the Federal University of Paraná and specializes in Regional Territorial Development and Socio-economic Analysis.

- IMPACTS ON BOLIVIA -

8. Omission regarding the flooding of Bolivian territory

"Even disregarding the effects of sedimentation, the water in Jirau Reservoir would affect Bolivia. (our emphasis) At a normal operational level of 90 meters above sea level, the reservoir would extend upstream from the Araras Rapids, where Bolivia shares the Madeira River as its border and where the water level is only 85 meters above sea level during the low-water period, between August and October (Molina Carpio, 2005, p. 109). The feasibility study also indicates this situation takes place during low flow periods (5,600 m^3/s) and medium flow periods (16,600 m^3/s): even with the operating plan and with variable water levels, the water level would rise at the level of the confluence with the Abunã River, located 119 km upstream from Jirau dam, which is where the Madeira River begins to form the border between Brazil and Bolivia. This elevation of the water level signifies that lands in Bolivia, which normally are exposed during the low water period, would be flooded during these periods (Molina Carpio, 2006). Also, the sedimentation would raise the level of the bed of the Madeira to the level of the mouth of the Abunã River, creating in this way a damming effect that would raise water levels on the Abunã River. The Abunã River is bi-national, forming part of the border between Brazil and Bolivia. The effects of the project on this river were not included in the feasibility and environmental impact studies. Besides, this refers to the normal operational level, while the maximum level would be at 92 meters above sea level, meaning that ***a greater area in Bolivia would be flooded when the river flow is higher than normal."*** (our emphasis)
(Philip Fearnside)

- SEDIMENTS AND EROSION -

9. One-dimensional models used to analyze three-dimensional processes

"One-dimensional models were used to simulate the sedimentological and biochemical processes in each reservoir that would take place following their formation. However, these processes are, by their very nature, three-dimensional and complex and the use of models which are too simple to represent them tends to produce inadequate results to evaluate expected impacts. As the lateral and vertical dimensions were not considered in the model, it was not possible to predict the real distribution of sediments, of habitats and of biota expected after the closing of the dams' floodgates. A reduced stream flow, a greater density of flooded vegetation, and a greater tendency toward anoxia are expected for the lateral margins of the reservoirs. The lack of oxygen could restrict the development of diverse wildlife groups and could also promote the methylation and bio-magnification of mercury in these regions."
(Bruce Forsberg)

10. Inadequate analysis of the potential of eutrophication

"The increase in sedimentation rates, and of penetration of light upstream could result in a chain of impacts causing proliferation of algae and also of the growth of aquatic macrophytes in the regions of the upper limits of the reservoir, and in basins and forks of the future reservoir. Proliferation of cianobacteria and a very rapid growth of floating and immersed macrophytes could take place … In the specific case of the Madeira River, dissolved phosphorous and nitrogen can be sufficient to ***initiate a chain of processes of eutrophication which have undesirable consequences in terms of water quality, principally for public consumption and even in terms of hydroelectricity generation."*** (our emphasis)
(José Galizia Tundisi[7]*)*

11. Sedimentation: Inadequate focus and inconsistent calculations

"The analysis of questions relating to the sedimentological studies should always consider the hydrographic basin as the spatial unit for evaluation of the problem. The study presented even mentions that ***the Madeira River is one of the world's rivers with highest sediment load,*** (our emphasis) the result of erosive processes which begin at its headwaters, in the Andes Mountains."
"Considering the high complexity of nature in the Madeira River basin, ***the analysis of sediment production in the entire basin is essential,*** (our emphasis) and these rates can be related to natural susceptibility and/or induced by human activities. The sedimentometric data observed by diverse authors for the Madeira River, which were presented by the project proponents, present contradictions resulting from the lack of

[7] *José Galizia Tundisi* is a historian and full professor in Limnology at the University of São Paulo. He is a researcher and is president of the International Ecological Institute.

reliable and sufficient historical records of discharged solids. All of the calculations carried out by the project proponents are based on a relation of 95% for the suspended load to 5% on the riverbed in Porto Velho and 93% for the suspended load to 7% on the riverbed in Abunã, meaning that the samples taken by the project proponents do not agree with the data obtained by other authors."
(José Galizia Tundisi)

12. Insufficient analysis of the impact of erosion on riverbanks and downstream

"'The Madeira is a dynamic river, in full activity of erosion of its ancient sedimentary deposits and in generation of current deposits' *(cited in the EIA)*, meaning that if increased flow due to increased rainfall in Bolivian territory were to take place, erosive processes on the river channel would increase;"
"2) (...) the erosive processes observed can be classified, in decreasing order of importance, in the following categories:
(...)
III. '***landslides along the banks*** [our emphasis) of the Madeira River caused by the presence of natural springs and streams (open-air aquifers)' *[cited in the EIA].* This problem will certainly take place when the lakes are filled and the water table rises, affecting the riverbanks and increasing the transport of sediments into the reservoirs, in addition to those from the river channel;
(...)
3) 'the Madeira River is currently, in the study area, under a process of sedimentation superimposed on the erosive process. It should also be emphasized that the current sedimentation is basically conditioned on the banks and bed of the river, and very rarely on the floodplain, since the Madeira River has, according to its morphology, a straight path and banked valley' [cited in the EIA].
"The implantation of the reservoirs will favor even more the deposit of sediments along the upstream course and will favor downstream erosion (our emphasis), since the deposited sediment load will not be transferred downstream."
(José Galizia Tundisi)

13. Under-estimation of sediments and erosion, due to inadequate methodology

"The values of solid discharge of the river bed, which involved an inadequate number of samples, are under-estimated. Data obtained in sedimentometric studies were not able to determine with the necessary precision the granulometry and the load of the river bed, making subsequent modeling vulnerable in its reliability."
"Figure 3.6 of the chapter presents an increase of erosion/transport in the basin from the period 1978-1990 to the period 1991-2004. ***Possibly, the difference of the declivities of the curves is much greater, if we were to consider that the data collected by Furnas were under-estimated*** (our emphasis). In the same way, figure 3.7, which presents the diagram of double mass of accumulated solid discharge vs. liquid discharge ***is rendered inaccurate by the samples*** (our emphasis), and consequently the increase of 1.83% per year estimated for the rates of erosion must be greater. The HEC-RAS model adopted, consequently, may be correct in its application, but since it is based on the key curve of sediments it also ***should not be considered to be valid*** (our emphasis). As the reservoir loses its volume due to sedimentation, its capacity for retention tends towards zero, in any of the hypotheses considered, with fine or gross sediments. On this specific point, ***part of the quantity of tree trunks deposited in the upstream stretch of the reservoir would not pass through the water outlet, and***

would mean the depositing of heterogenic material which cannot be predicted by the modeling (…)"
(...) it is known that with the siltation of the river channel, besides the increase in velocity ***erosion of river banks takes place*** (our emphasis) caused by the increase in the velocity of the flow along the banks, since the river tries to 'compensate' for the hydraulic loss of the channel with increased flow along the banks, promoting in addition to expected flooding the removal of sediments and organic material previously deposited on the banks. At the same time, the existence of deposits of siltation at the upper stretch of the reservoirs can serve to halt the largest sediments and tree trunks, causing ***the deposits to evolve upstream, altering the boundaries of the reservoir*** (our emphasis)"
(José Galizia Tundisi)

14. Imprecise estimates of sedimentation cause inconsistencies in the calculations of the effective life of the dams

"The sedimentometric data presented by the project proponents were collected based upon samples of suspended sediments, while those sediments on the river bed were not collected due to the fact that sampling devices of this type are not found in Brazil. This means that ***estimates of sediment loads in the riverbed were not adequately carried out*** (our emphasis)**,** as the project proponents themselves admit. ***The final result is unacceptable, being very imprecise*** (our emphasis). Therefore, the direct measurement of riverbed sediments was abandoned. The failure to achieve reliable measurements of river bed sediment loads, which certainly should have great mobility, ***produces inconsistency in subsequent calculations."*** (our emphasis)
(José Galizia Tundisi)

15. Omission of analysis of possible impacts of sediments on Santo Antônio dam

"The difference of less than 2 m between the top of the anticipated pile of sediments and the top of the wall of the dam appears to be very small, given probable uncertainties in the calculations. ***No indication of the degree of certainty is given in the EIA and no test of sensibility is presented. Nothing is said regarding the consequences that could take place if the sediments were to accumulate to a greater height than the retaining wall of the dam,*** which is planned "to guarantee that the water intakes are not silted up during the period covered by the studies (100 years)."
(Philip Fearnside)

- FISH -

16. Failure to identify the most affected aquatic species

"The list of species presented does not specify which would be the endemic species or those of restricted distribution which would be the most vulnerable to the impacts of the dams -- that is, those which are most associated with the rapids environment. There was no list of which species are related to the rapids environment, and which are not. These species should be monitored during the construction of the dams and also during the period of energy generation."
(Ronaldo Barthem[8] e Michael Goulding[9])

17. Uncertainty regarding the feasibility of the fish passage mechanism

"The interruption of the migratory routes of fish is a common consequence of construction of hydroelectric dams. The construction of a fish passage mechanism is a way to handle this situation, permitting the fish to swim upstream. ***This solution is not always possible,*** (our emphasis) because when there is an immense artificial lake upstream there is the possibility that river-oriented fish will become disoriented and will not conclude their journey … Studies to design fish passage mechanisms and their construction should be initiated as soon as possible, so that there will be no interruption to the repopulation of migratory species upstream. As the migratory event of the Madeira River rapids is not well known, studies observing migratory schools climbing these rapids should be undertaken immediately to be able to instruct the construction of fish passage mechanisms. It is important to know which species manage to swim upstream through Santo Antônio and Jirau rapids, and which do not. These studies should begin before construction and should be maintained throughout the construction process."
(Ronaldo Barthem e Michael Goulding)

18. Failure to study the mortality of eggs and larvae in turbines and on the river bed

"The blocking of the river does not only impede the ascent of migratory fish. The reproduction of the fish can be affected when there is a barrier to the descent of eggs and larvae downstream. (...) The process of generating energy requires concentrating the force of the river current in the water intakes and the powerhouse in order to drive the turbines, which in this case will be laid out horizontally. ***The water pressure in these compartments will be extremely high and can be a factor in multiplying the mortality of eggs and small fry of migratory fish*** in general. ***The situation can be even more serious during the dry period, when 100% of the water flow passes through the turbines.*** (our emphasis) Once again, studies on the descent of eggs and

---

[8] *Ronaldo Borges Barthem* graduated in marine biology from the Federal University of Rio de Janeiro and has a doctorate in Freshwater Biology and Freshwater Fishing from the National Institute for Amazon Research.
[9] *Michael Goulding* has a doctorate and is a professor at the National Institute for Amazon Research.

larvae should be undertaken to estimate the critical periods, when there is greater concentration, as well as in relation to the months of the year as well as the hours of the day.

"The siltation process in the reservoir requires that measures be taken to avoid operational difficulties and the compromising of the durability of the hydro-mechanical equipment. In this regard, construction of submersed dikes upstream from the penstock of the water intake of Sto. Antônio dam are planned as well as a security level for the water intake at Jirau (Sedimentological studies of the Madeira River, pp. 8.9-8.10). The reduction of the current as a whole and especially at the bottom of the river, with the construction of an underwater eddy could permit the depositing of eggs/larvae on the riverbed, especially those of Bagres (catfish), which ***would adversely impact their descent and eventually their survival*** (our emphasis). Studies on the descent of eggs and larvae and their relationship with the rapids should be undertaken in greater detail and over a longer period and they should begin as soon as possible, so as to create a sufficient historical series for the elaboration of reliable predictive models."
(Ronaldo Barthem e Michael Goulding)

19. Dourada and Babão fish are threatened with extinction

"Dourada and Babão climb these rapids each year and reproduce at the headwaters of the Madeira River, on the slopes of the Andes. For this reason, at least ***the populations of Dourada and Babão are threatened by this project.*** With the intensification of fishing (in Bolivia and Peru) of the reproducers, the maintenance of the reproductive population will depend more on the maturing of the individuals that migrate via the rapids and less from successive egg laying by older individuals, which are more exposed to upstream fisheries. ***In this way, the complete blocking of the upstream migration of migratory catfish will inevitably have an adverse affect on the reposition of reproducers, and the tendency of these populations upstream from the rapids would be to become extinguished over a short time period.*** The viability of these populations would depend on the survival of young individuals, which are sparsely collected upstream. In any case, ***their biomass would enter into collapse and their importance for fishing would be null.*** On the other hand, the temporary blocking, during the construction period, could have uncertain consequences for these populations even with the later construction of the fish passage mechanism.

"The occurrence of a homing behavior (instinct to return to the place where they were born) would make these species very vulnerable to damming, because blocking the river would eliminate a distinct population, even if it were only temporary. During the period of the blocking there would not be a repositioning of individuals to the reproductive areas upstream from the rapids and the reproducers at the Madeira's headwaters would diminish in number over time, with ***their complete disappearance depending on the intensity of fishing at the headwaters and the time of the blocking.*** Without the eggs produced in this area there would be no return migration and ***this population would be extinct.*** Tagging studies are necessary to complement this project,"
(Ronaldo Barthem e Michael Goulding)

20. Lack of adequate Studies on the impact of fishing in the lower Madeira

"There is no quantitative idea of the participation of individuals (of other migratory species) that climb the rapids during reproductive events in this region. Despite the fact that there are extensive areas for fish reproduction above the rapids, especially in Bolivian territory, it is not known to what extent the repopulating of the Madeira River

floodplain, especially just downstream from Porto Velho, depends on the egg laying of individuals that climb the rapids. Migration studies on the Madeira River upstream from the rapids, with eventual quantification of areas of mating and reproduction, are essential to predict impacts on commercial fishing in the lower Madeira River."
(Ronaldo Barthem e Michael Goulding)

21. Omission of large-scale impacts on fishing in the Amazon River estuary

"Two aspects which should be taken into consideration for a river the size of the Madeira are the immediate effect of the reduction of recruits for fishing in the estuary and rivers of the Amazon floodplain. ***If the production of eggs/larvae were proportional to the flow of the river or its sediment discharge, the Madeira River would have an importance nearly equal to that of the Amazon*** (our emphasis) and an interruption of the descent of these young could dramatically aggravate the effect of growing over-fishing of these stocks in the estuary. Fishing in the estuary has a very great social and economic importance, being one of the few places from where regular export of Amazon fish is maintained. The combination of over-fishing and the construction of dams in the Amazon has already been studied, with the negative effect of fishing in the Tocantins and Tucuruí dam on the stocks of mapará. To evaluate the dimension of this problem, studies are needed to estimate the density of dourada and babão youth (no longer eggs and larvae) on the Madeira River in relation to the Amazon River. These studies should be carried out at the mouth of the Madeira with the Amazon to compare the density of these young before the two rivers flow together."
(Ronaldo Barthem e Michael Goulding)

- MERCURY -

22. Lack of knowledge of the dynamics and methodology of analyzing mercury

"The authors of the EIA did not present data for mercury in water, a key parameter in the evaluation of the impacts of damming. They collected samples for this, but they did not detect mercury with the method used, whose limit of detection was cited as being 30 ng/l. They blamed the method of preservation, showing in this manner a complete lack of knowledge not only of the natural dynamic of mercury, but also of the methodology most appropriate for analyzing it. It is essential to measure the levels of Total mercury, methyl mercury and % methyl mercury in the channel of the Madeira River, in the tributaries and in the associated flooded areas before construction to identify current sources of mercury and sites of methylation, and also to make it possible to evaluate changes in these parameters following flooding."
(Bruce Forsberg)

23. Omission of estimates of the impacts of mercury on riverbank dwellers

"The relatively high levels of mercury found in the hair of the riverbank dwellers living in the area of influence are of concern. The population already runs a risk, which can get worse after dam construction. That means that measuring the levels of mercury in fish and hair and comparing them with national and international standards was insufficient to evaluate the potential impacts of the project on these populations. To do this, it would be necessary to determine the concentration of mercury in the fish species most commonly consumed and to estimate the average quantity of each fish consumed per day, which was not done."
(Bruce Forsberg)

24. Failure to study the descent of mercury from the gold mines in the Madre de Dios region of Peru

"Mercury from the gold mines on the Madre de Dios River was not observed; there could be "hot spots" of mercury outside the area studied in the EIA, which perhaps are being transported to the area of the Santo Antonio and Jirau dams. In any case, occurrences of gold mining activity on the Madre de Dios and Madeira Rivers already denote the nature of the riverbed as possibly sandy, which was not confirmed in the sampling. The same is true of the Beni River…"
(José Galizia Tundisi)

- ECOLOGY AND BIODIVERSITY -

25. Fauna: Insufficient collection and failure to evaluate impacts

"The effort to collect fauna was insufficient, as admitted by the authors themselves, in order to be able to evaluate the real taxonomic diversity of local mastofauna. … The lack of information stands in the way of being able to make comparative analyses between the study area and other portions of the Amazon. The work in evaluating environmental impacts…is limited to listing species which are present, evaluating their abundance and comparing the list of species found with those considered to be threatened with extinction. It is a lamentable paradox, and therefore the study of environmental impacts presented has a restricted capacity to serve its principal function: to evaluate the environmental impacts that building the dams would cause."
(Horácio Schneider[10])

26. The region is of extremely high priority and requires additional analysis regarding its biodiversity

"The area around Porto Velho has inestimable environmental importance. Here, we should explain why current knowledge permits us to affirm the extreme value of the affected area. In the first place, ***the area is located at the junction of different eco-regions of the Amazon Ecosystem.*** (our emphasis) One of these, the Savanna-Amazon is one of the richest eco-regions and also one of the most threatened of the region and it is characterized by great heterogeneity in its biological composition and for its being covered with mosaics of different types of vegetation which wed species present in the two ecosystems, in addition to a considerable number of endemic species. The condition of the Ecotone itself makes the region, a priori, an environmental priority. "The Madeira River has been recognized as a bio-geographic barrier since the Nineteenth Century, and it is the boundary which defines two areas of endemism…In order to have a clearer vision in a short timeframe of the diversity the area could have, the studies MUST be correlated with genetic population studies. There are many DNA sequences published for mammals in various parts of the Amazon. A comparison between these sequences and those of the area in question will be essential in order for a clearer evaluation of impacts to be carried out."
(Horácio Schneider)

"The information available about the range of species present in the umirizais, in comparison with other types of campinaranas that enjoy some kind of protection, is insufficient to affirm that the umirizais are adequately represented in other places as protected areas." (umirizais are a type of rare campinarana vegetation in the Amazon)
(Philip Fearnside)

---

[10] *Horácio Schneider* graduated in biology from the Federal University of Pará and has a post-doctorate in Molecular Genetics and Microorganisms from Stanford University.

27. Failure to analyze impacts on downstream floodplain lakes

"***The area of direct impact should include downstream floodplain lakes which will be affected by the loss of the pulse of the waters, affecting thousands of people.*** (our emphasis) As the period of flux toward the lakes (downstream) takes place when the Madeira River is low … it is therefore probable that the pulse of the flux will be captured to fill the reservoirs instead of being passed as a pulse of the same intensity to the lower Madeira with the impact of diminishing sediments in the lakes, as in the Cuniã Lake. This should affect the principal source of pirarucu fish for Porto Velho … Neither the Cuniã Extractive Reserve now any other conservation unit downstream of the dams was considered in the EIA/RIMA. Studies are needed in order to estimate the changes on the sediment and nutrient loads to the floodplain lakes."

(Philip Fearnside)

- ENERGY -

28. Cost of project and energy generation greatly under estimated

“The installation costs in the documents are under-estimated, and therefore the values of energy generated are about one-third of those calculated by independent institutions … The costs of the dams are under-estimated and therefore when calculated with more realistic values could be US$2.8 billion greater.”
(Artur de Souza Moret)

“The 20-30 years when the quantity of gross sediment that passes through the turbines will be reduced by the quantity that is being deposited behind the retaining walls of the dam will be a period of relatively easy maintenance for the turbine rotors. After the sediments stabilize, in the thirtieth year, and particulates of all dimensions are passed through the turbines, the abrasive effect will be greater. A discount rate applied to future maintenance costs undoubtedly means that this factor will have little weight in the financial calculations made to justify the construction of the dams, but this increase in maintenance needs represents a cost which will have to be borne by future energy consumers…”
(Philip Fearnside)

- HEALTH -

29. Failure to study the need for preventative public health measures

"The Environmental Studies make no comments about preventative Public Health measures. There is a need to strengthen Public Health services before the city receives the huge number of immigrants predicted in the studies."
(Silas Antônio Rosa[11])

30. Failure to analyze and propose solutions for increased sanitation problems

"The lack of sanitation, drinking water, and sewers is a chronic problem in Porto Velho. The Madeira River dams will aggravate this problem, which will no longer be a problem of statistics, but rather will become a far more serious problem…The best and most rational way to look at it is through prevention. Among those items which will require compensation should be added the participation of the project proponents in the solution of two obstacles which hinder the ability of the municipality to resolve the problem: compensation for impacts on the water district and the drawing up and financing of a project."
(Silas Antônio Rosa)

[11] *Silas Antônio Rosa* graduated in Medicine from the University of São Paulo, and has an MBA in Management of Cooperatives from Getulio Vargas Foundation (FGV-SP), and a Masters' in Experimental Biology from the Federal University of Rondônia. He currently is the Secretary of Health of Porto Velho.