THE COTINGO DAM AS A TEST OF BRAZIL'S SYSTEM FOR EVALUATING PROPOSED DEVELOPMENTS IN AMAZONIA

running head: BRAZIL'S COTINGO DAM

Philip M. Fearnside*
Reinaldo Imbrozio Barbosa**

* National Institute for Research in the Amazon (INPA)
Coordenadoria de Pesquisas em Ecologia (CPEC)
C.P. 478
69011-970 Manaus, Amazonas
BRAZIL
FAX: 55-92-236-3822

** National Institute for Research in the Amazon (INPA)
Núcleo de Pesquisa de Roraima (NPRR)
C.P. 96
69301-970 Boa Vista, Roraima
BRAZIL
Tel./Fax: 55-95-224-7403

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ABSTRACT

The proposed Cotingo Dam in Brazil's far northern state of Roraima is examined with the objective of drawing lessons for Brazil's system of evaluating environmental, social and financial consequences of development decisions. The Cotingo Dam illustrates the difficulty of translating into practice the principles of economic and environmental assessment. Examination of the financial arguments for the Cotingo Dam indicates that justifications in this sphere are insufficient to explain why the project is favored over other alternatives and points to political factors as the best explanation of the project's high priority. Strong pressure from political and entrepreneurial interest groups almost invariably dominates decision-making in Amazonia. The analysis indicates the inherent tendency of the present system to produce decisions in favor of large construction projects at the expense of the environment and local peoples. The requirements intended to assure proper weight for these concerns, such as the Report on Environmental Impacts (RIMA) and the Public Hearing, fail to serve this role. Cotingo also provides a test case for constitutional protections restricting construction of dams in Indigenous lands.

KEYWORDS: Hydroelectric Dams, Amazonia, Indigenous Peoples, Brazil, Roraima

I.) COTINGO AS A TEST OF DEVELOPMENT DECISIONS

Brazil, like many other countries, has a regulatory system governing the evaluation and approval of proposed development projects. This system is composed of a series of decrees, laws and constitutional provisions, and is designed to assure that wise development choices are made, such that 1.) public funds are not wasted on projects that are economically unattractive, and 2.) limits on environmental and social impacts are respected, including impacts on indigenous peoples. Gross discrepancies between the safeguards that exist in theory and the decision-making that takes place in practice would indicate, among other things, that the confidence of agencies that finance Amazonian developments is misplaced when it is assumed that funds will not be used to the detriment of the environment and indigenous peoples. This is especially important for sector loans; in the case of the World Bank, for example, dams or other public works financed through sector loans escape from the case-by-case review process that applies to project loans (see Fearnside 1989).

How Brazil's regulatory system functions, the degree of protection it provides and how it might be improved cannot be ascertained from the text of the various regulatory measures, but only by observing how the system functions in practice. Most revealing are situations where the system is under stress--that is, under pressure to approve a development project regardless of what its comparative benefits and impacts might be. The case of the proposed Cotingo Dam provides such a test.

The Cotingo Dam has been proposed for construction in the Raposa/Serra do Sol Indigenous Area, located in Brazil's far northern state of Roraima (Figure 1). The main tribe in the area is the Macuxi, with smaller contingents of Ingarikó and Taurepang/Wapixana. The dam has become a test of the protections that Brazil's 1988 constitution provides to the country's indigenous peoples. Although the probable environmental impacts of the dam are modest by Amazonian standards (the area is savanna rather than rain forest), the developments at Cotingo illustrate serious problems in Brazil's incipient environmental review and licensing system that make the system's functioning in practice a poor reflection of the protective guarantees that were intended when it was launched in 1986 when the Environmental Impact Study (EIA) and Environmental Impact Report (RIMA) became requirements for dams with over 10 megawatts (MW) of installed capacity. These problems are common to the environmental approvals of large public works throughout the Brazilian Amazon and, indeed, to similar situations in many parts of the world.

The Cotingo Dam also illustrates the difficulties of long-term planning in the context of explosive growth on the Amazon frontier, and the strong impediments that exist to taking

decisions on development that give adequate weight to concerns about the environment and human rights. The normal assumption when such concerns are overridden is that financial arguments were more compelling to decision-makers. Examination of Cotingo, however, reveals that the project cannot be justified on financial rounds, making political considerations the most convincing explanation of the high priority the dam has assumed. Understanding how the decision-making process works in practice is an essential prerequisite to identifying changes that would protect the environment and indigenous peoples. The problems illustrated by Cotingo are not unique to Brazil nor to hydroelectric projects. The political value of public works can set in motion a sequence of events to circumvent the evaluation and authorization system. The force for approval is pitted against not only environmental licensing requirements but also against the judicial system's vigilance over constitutional protections. Each hurdle is tested to its limits in the process. So far, only the judicial system has resisted the pressure against it. Complacency would be misplaced, however, that judicial defense of constitutional protections will be sufficient in the long run. The future of Cotingo remains undefined.

(Figure 1 here)

II.) HYDROELECTRIC PLANS FOR THE COTINGO RIVER

A.) HISTORY OF THE COTINGO DAM

The proposed Cotingo Dam would be located on the Cotingo River (4°35' N, 60°20' W), in the state of Roraima. The Cotingo is a tributary to the Surumu River, which drains into the Tacutu River, Rio Branco, Rio Negro, and finally the Amazon River. It is thus a sixth-order stream, but it has an average streamflow of 86 m^3/sec at the dam site. The catchment basin above the site is a 3380-km^2 area bounded on the north by the continental divide that forms the border of Brazil with Venezuela and Guyana (CER 1994, p. 2-2).

The Cotingo River was first surveyed for hydroelectric development in 1971, when Eletrobrás (the federal power authority) undertook an inventory of potential hydroelectric sites throughout the Brazilian Amazon region. In 1973, Eletronorte (formed in 1972 as the power monopoly in northern Brazil) contracted Monasa and Enge-Rio to make a detailed inventory of the river, and the revised inventory was made in 1975. Monasa, a Canadian firm based in Montreal, also did the feasibility study for the Balbina Dam in the adjoining state of Amazonas (see Fearnside 1989). Sites were located for a string of five dams on the Cotingo River. In 1980 the government of the then-Federal Territory of Roraima contracted Monasa to revise studies for two of the five sites: Cotingo 123/113 and Cotingo

55. The numbers refer to the location in kilometers above the confluence with the Surumu River. The Cotingo 123/113 site, with the dam at km 123 and the powerhouse at km 113, is the present first priority for construction. Installed capacity at the five sites would total 548.4 MW, of which 274.2 MW would be firm power (CER 1994, p. 4-3).

In 1983 the territorial government had the Consórcio Eletroprojetos (Projest) draw up plans for a different design for a dam at the Cotingo 123 site The powerhouse would have been located at the base of the dam as is the case for most hydroelectric dams (CER 1983).

The Cotingo 123 site is unusually favorable for a hydroelectric dam, as it is perched at the top of a series of rapids and falls. The current plan would draw water from the side of the reservoir through a 4.2-km-long tunnel (CER 1994, p. 2-3) to a point on the river 10 km downstream of the dam. This is possible because the river, after passing through the narrow point where the dam would be built (km 123), loops back along the southern side of the ridge (the Araí Sill) that would form the southern bank of the reservoir (Figure 2). By tunneling through the ridge, power generation would take advantage of an additional 240-m drop in elevation in a river stretch that includes the Tamanduá Falls (CER 1994, p. 1-3).

(Figure 2 here)

Cotingo is expected to supply Boa Vista, Alto Alegre, Mucajaí, Caracaraí, Bonfim, and Normandia with power. The 1993-2002 "Decennial Plan" of Eletrobrás makes Cotingo a priority (Brazil Eletrobrás 1992, p. 38), with completion of the first phase scheduled for 1999. However, delays are commonplace with hydroelectric projects, and the beginning of construction scheduled for 1994 had not yet begun by February 1996. Cotingo would have an installed capacity of 68 MW in its first phase, and 136 MW in a second phase (CER 1992, p. 8-9). Cotingo only became a priority in 1991, at the initiative of the government of Roraima (CIR and CPI/SP 1993, p. 29). Cotingo is conspicuously absent from the 1990-1999 Decennial Plan (Brazil Eletrobrás 1989, p. 44), which announced the suspension of plans for the Paredão Dam pending comparisons with thermoelectric alternatives.

Cotingo began moving quickly to becoming a <u>fait accompli</u> in October 1994, between the two rounds of the Brazilian elections. The Public Hearing (<u>audiência pública</u>) was held to debate the EIA and RIMA on 7 October 1994, and the Preliminary License (<u>Licença Prévia</u> or LP) was granted by the state environmental agency (SEMAIJUS) on 18 October 1994. The shaky grounds of these moves by the Roraima state government are recognized by the national power authority, Eletrobrás, which, in the 23 December

1994 meeting of its executive directors, resolved (resolution No. 602/94) that the document analyzing the feasibility study of the Cotingo Dam "is not yet in a condition that allows emission of a favorable judgment (parecer) with respect to its feasibility, either in the area of socio-environmental aspects or with respect to economic aspects, since the former could require investments in addition to those foreseen." (Brazil Eletrobrás 1994a).

Macuxi Indians have one traditional maloca, or communal living area, (Caraparu II) in the area to be flooded. As dam construction approached, the tribe built an additional maloca, named Retiro do Tamanduá, in the submergence area. Military police of the Roraima state government isolated the area and tried to expel the Indians from their own land (Figure 3). The violence of the police operations has drawn international attention (e.g., Survival International 1995).

(Figure 3 here)

Implanting topographic markers was begun by U.T.M. Topografia Ltda. in January 1995. The topographic survey in Cotingo was ostensibly only to determine where the boundary of the reservoir will be and to determine whether any malocas will be within the impoundment. The area of the reservoir (16 km^2 in phase 1, increasing to 37 km^2 in phase 4) was calculated from aerial photographs (CER 1994, p. 5-6), which are not accurate enough without a ground survey. The ground survey that had been done previously was only for the location of the dam itself, not for the area to be flooded.

On 17 March 1995, Federal Judge Marcos Augusto de Sousa (1995) issued a judicial decision (liminar) ordering all work with the exception of "research" to be stopped and prohibiting the Roraima state government from sending its Military Police into the area. The decision points out that it is not demarcation that gives indigenous peoples the right to their traditional lands. If not overturned by an appeal reportedly being prepared by the state government (Folha de Boa Vista 24 March 1995), a final decision on dam construction would be made by a vote of the National Congress. The government of Roraima asserts that the dam can be built without approval of the National Congress on the basis of the area being "outside of demarcated areas or reserves, but inside an area claimed by the Macuxi Indians for demarcation ... the legal situation is as an identified area, which, in the jargon of FUNAI (the federal Indian agency), is the starting point for the demarcation process" (CER 1994, p. 10-15, emphasis in the original). Although Brazil's constitution makes clear that traditional occupation, rather than demarcation, is the basis of protection (Article 231, Paragraph 3), the possibility of events unfolding differently is real. We shall explain this very important point

in greater detail later.

The 17 March 1995 judicial decision (de Souza 1995) is a hopeful sign for the application of constitutional protections for indigenous peoples. The decision does not allow generalization regarding the independence of the judiciary. It is relevant to note that both the federal prosecutor who formulated the case against the Roraima state government and the judge who handed down the decision were substitutes on short-term postings from Manaus, in the neighboring state of Amazonas, rather than residents of Roraima who would be subject to the full force of that state's political pressures.

On 8 January 1996 a new threat to the Raposa/Serra do Sol reserve arose when Federal Decree No. 1775 was issued, allowing most indigenous areas in Amazonia to be challenged retroactively by other claimants, including state governments. The Roraima state government has appointed a commission to prepare a case against demarcation of the area.

B.) FUTURE PLANS FOR THE COTINGO RIVER

A string of five dams is planned for the Cotingo River, as power demand in the region increases to make use of this potential (Figure 4). It is a common phenomenon for rivers to be developed as a series of dams, thereby regulating the flow of water through the system and increasing the total electrical output beyond what could be obtained as the sum of the dams individually. Such plans can cause severe problems when dams following the first one are more damaging than the initial dam that sets in motion the process of river development. The most dramatic case of this is the series of planned dams on the Xingu River, where the first dam (Belo Monte, formerly Kararaô) would provide the justification for later building five additional dams, including the 6140 km^2 Babaquara Dam that would flood extensive areas of indigenous land (dos Santos and Andrade 1990, Cummings 1990).[(1)]

(Figure 4 here)

The damaging potential of future dams is much lower in the case of Cotingo than that of the Xingu River. Nevertheless, the fact that the EIA and RIMA are restricted to the first dam in the series is part of a generic problem in impact assessment that inevitably will lead to major problems. All five dams in the Cotingo basin would be in Macuxi or Ingarikó territory.

III.) ECONOMIC RATIONALE

A.) ECONOMICS IN DEVELOPMENT DECISIONS

Economic arguments are generally assumed to explain decisions to implant development projects despite damage to the environment and to indigenous peoples. Economic analyses normally do not account for environmental and human costs, and it usually assumed that decisions would be 'rational' from the perspective of society's true interests if only these factors were properly valued in the analyses. Examining the economic rationale for the Cotingo dam is necessary if one is to understand how the decision to build it was made and what barriers exist to protecting the environment and indigenous peoples. If traditional economic justifications are insufficient to explain the project, as the information presented below will show, then one can have greater confidence in the deciding role of other considerations, such as politics.

B.) PROJECTIONS OF POWER DEMAND

The rationale for building Cotingo is based on projections of demand for electricity in Roraima (CER 1993, pp. 2-8 to 2-10) which are founded on studies by Eletronorte and the Energy Company of Roraima (CER) using a scenario assuming tremendous population growth in Roraima (approximately 10% per year over the 1991-2001 period). Although the EIA stresses that the projections were made "from extrapolations of market configurations observed previously" (CER 1993, p. 2-9), no correction factor was applied to break the trend of explosive expansion that characterized the period on which the extrapolation is based, or that allows evaluating the likelihood of a future boom in consumption. The three scenarios for energy consumption in Roraima up to 2020 are not accompanied by any information on how the percentages of demand per "micro-period" were derived. It appears that these scenarios are merely guesses (optimistic guesses from the point of view of those building dams) as to the future market for electricity. It is difficult to justify large public expenditures without a reasonable basis for believing that the amount of energy to be supplied will really be needed.

The EIA paints a somber picture of the future of Roraima if the dam were not built: "the environmental tendency in the region is to maintain the condition of economic and social stagnation in a degraded environment" (CER 1993, p. 8-1). This vision of the future conflicts sharply with the consultants' own evaluation that the economy of Roraima grew by a factor of seven from 1970 to 1985 (CER 1993, pp. 6-82 and 6-83). It is difficult to imagine how this growth, which was achieved without hydroelectric power, can be called economic "stagnation." One needs a scenario for economic growth without the dam but with expansion of the present diesel-powered system. Scenarios with hydroelectric or thermoelectric supply need to be evaluated in terms of costs and benefits. Such analyses must identify who will pay the greatest

costs and what strata of the population will be most benefitted.

Demand projections after 2000 (the year when Cotingo is expected to be operational) are based on the assumption that demand has been repressed in the pre-Cotingo era (CER 1994, p. 2-2). Needless to say, this adds an additional impulse to the explosive growth of demand calculated from the uncritical extrapolation of Roraima's population growth.

C.) PHYSICAL VIABILITY OF THE DAM

A source of doubt about the physical viability of the Cotingo Dam is the magnitude of sedimentation that could be caused by erosion from goldminers (garimpeiros) in the catchment area upstream of the dam. The presence of goldminers is recognized in the EIA (CER 1993, p. 6-29), but sediment rates are not calculated.

The ecological-economic zoning for Roraima puts an "organized goldmining area" and dam on the same map. Jaime de Agostinho, who coordinates the zoning, favors zoning the Quinô River area, upstream of Cotingo, as an "organized garimpo" (personal communication 1995). This would make likely the continuation and expansion of the goldmining activity that produces sediment entering the Cotingo reservoir: zoning for both the goldmining area and the dam is inconsistent.

The EIA states that "with construction of the dam, conditions will be created for deposition of sediments that are transported, the volumes of which should, however, be of little significance as compared to the dead volume of the reservoir" (CER 1993, p. 6-19). The limnology team, however, had a different interpretation. In the limnological section of the EIA (CER 1993, p. 6-36), "sedimentable solids" in the Cotingo River are estimated to be 0.50 ml/liter, a value much higher than those found in the tributaries to the Cotingo (Lages and Laimã), which have values of zero. This is explained in the EIA as being the result of goldmining in both the Quinô River (the main tributary of the Cotingo) and in the Cotingo River itself (CER 1993, p. 6-31). The EIA describes this sediment as a "small volume" (CER 1993, p. 6-31). However, one needs to know what the behavior of these solids would be in the scenario with the dam and goldmining activity (CER 1993, p. 6-80).

The EIA mentions the modest dimensions of the reservoir and the loss of velocity of water entering it from upstream as indicating that there could be significant siltation (CER 1993, pp. 7-46 to 7-51). These statements appear to conflict with the dismissal of siltation as a major problem (CER 1993, p. 6-31). The model used for estimating the volume of silt accumulation (CER 1993, p. 7-48) requires information on the type of solid

load and quantification of the volumes of sediments from the different tributaries. Obtaining this information would be a wise precaution, given the importance of sedimentation to arriving at a decision on the technical feasibility of the dam.

The EIA indicates that the Cotingo River contains 45 mg/liter of humic substances, a concentration 5.6 times greater than the results for two streams (Lajes and Laimã) that are tributaries of the Cotingo River with little human disturbance. It would be wise for the government of Roraima to obtain a more detailed interpretation of the modeling results on siltation and water quality, based on a greater amount of field research. Scenarios should be developed with and without the dam.

The feasibility study states: "no record exists that any field campaigns have been undertaken with a view to obtaining information on solid discharges in the Cotingo River. The validity of a sedimentological study carried out without any basis in data is questionable" (CER 1994, p. 7-9). The report goes on to make a rough calculation taking the highest sediment transport in rivers in the state of São Paulo (420 t/km^2 of catchment area) reported by Setzer (1982) and Bittencourt (1978), and assuming a mean apparent specific gravity of 1.24 t/m^3 and 100% retention in the reservoir. Under these assumptions, the reservoir would take over 100 years to silt up. Using the same value for specific gravity, the 0.50 ml/liter value for sedimentable solids given in the EIA for the Cotingo River (CER 1993, p. 6-36) is equivalent to 0.62 g/liter of water, a value confirmed by a sample taken in January 1995 (R.I. Barbosa, personal observation). Given the mean streamflow of 86 m^3/sec (CER 1993: 6-23), 1.4 million m^3 of solids would enter the reservoir annually. If all of these solids were retained, the 139.7 million m^3 storage volume of the reservoir at the first phase water level (CER 1994, p. 2-10) would be filled in 103 years.

While this time period may appear long, it should be remembered both that the sediment load could increase with more goldmining, and that half of the storage volume would be lost over the 50-year "useful life" time horizon used in the CER calculations (CER apparently made no adjustment for loss of storage volume in the calculations used in the feasibility study, EIA and RIMA). The volume of solids is large: as an illustration, the annual volume entering the reservoir is more than the 1.2 million m^3 of "common excavation" to be done in constructing the dam (CER 1994, p. 14-4). At the US$4/$m^3$ cost of excavation under terrestrial conditions (CER 1994, p. 14-14 ff), removal would cost over US$5.4 million annually.

The EIA report mentions that the open vegetation and presence of gullies and ravines in the catchment area suggests "a

not insignificant susceptibility to erosion," and goes on to observe that "the existence of mining activities upstream of the dam site, in the headwaters of the Cotingo River, could result in serious problems, due to these conditions of natural fragility" (CER 1994, p. 10-10).

Soil in the reservoir and catchment area is described as "lithic dystrophic with presence of dystrophic hydromorphic laterite and rocky outcrops" and as "poorly developed and very shallow" (CER 1994, p. 10-10). This implies that almost all rainwater would run off over the surface, making the area prone to erosion. Streamflow in the Cotingo River has a "rapid response to precipitation" (CER 1994, p. 10-9).

D.) FINANCIAL COSTS OF CONSTRUCTION

Estimates of the financial costs of construction are given in Table 1.

(Table 1 here)

Information on costs is sharply conflicting, as is common for Amazonian dams (see Fearnside and Barbosa nd). The information gleaned from scattered statements in the EIA totals US$142.8 million (Table 1). The National Council of Legal Amazonia, a working group made up of representatives of Eletrobrás, Eletronorte, Petrobrás and state electrical companies, which was formed in 1994 to draft a coherent policy for regional supply of energy, projected investment needs over the 1995-2000 period (the period during which the same study foresees construction of Cotingo) to supply Boa Vista. These investments total more than twice as much: US$305.5 million (Conselho Nacional da Amazônia Legal 1994, p. 63). If discounted at 12% per year, this investment total has a net present value of US$213.7 million.

E.) COMPARISON WITH ALTERNATIVES

1.) Expansion of Thermal Generation

The 1993-2002 Decennial Plan states: "In 1999, with operation of the Cotingo Dam (3 X 40 MW), there will be a reduction in thermal generation by 318.9 GWh, or almost the total demand for electricity forecast for that year. This implies a reduction in diesel consumption by 137.7 million liters (2336 BEP/d), yielding a savings of about US$29 million yearly." (Brazil Eletrobrás 1992, p. 38). As is frequent in such comparisons, the "savings" claimed represents only the cost of fuel, and assumes that the dam (and also the thermoelectric plants) are built and maintained for free.

A comparison with alternatives is a required item in an EIA (CONAMA Resolution No. 001, Article 5, Incision I of 23 January 1986).[2] The EIA presents this "comparison" in a singularly confused fashion, hardly what is implied by the "clear language" specified in CONAMA's requirements for such reports (CONAMA Resolution No. 001, Article 9, Incision VIII). Numbers referring to costs of different items appear scattered throughout the text, rather than being presented in a table that allows the reader to visualize the comparative advantages and disadvantages of the different choices. The numbers presented disguise, or at the least make difficult to see, the true relationships among the options. Values mentioned for Cotingo and for alternatives are not for the full costs: interested readers are obliged to locate and sum the various components of the project to make the obvious comparison of the bottom line.

The values for costs presented in the EIA have been organized in Table 1. The conclusion that the numbers indicate when so organized is not necessarily the same as that reached by the INTERTECH consultants. The EIA states that "as can be seen, the hydroelectric dam ... allows energy to be supplied ... under economic conditions clearly better than those that correspond to expansion of the thermal park" (CER 1993, p. 2-34). However, adding up the different cost components from the EIA (Table 1) gives a total cost of US$2100/kW of installed capacity for Cotingo in March 1992 values. Considering the 306,600 MWh/year of expected generation (CER 1992, p. 16), the installation cost per kW generated would be US$4082/kW. The installation cost of expanding thermoelectric generation capacity is estimated at US$700/kW (CER 1993, p. 2-34).

The implantation cost of expanding the thermoelectric park could be fairly small. CER estimates that, to be equivalent to the 68 MW first phase of Cotingo, Boa Vista would need 102 MW of installed thermoelectric capacity, including a 50% margin for use during maintenance (CER 1993, p. 2-34). Since Boa Vista already has 83.26 MW of installed thermoelectric capacity (Conselho Nacional da Amazônia Legal 1994, p. 38), only 18.7 MW would have to be added to complete the necessary configuration. At an installation cost of US$700/kW (CER 1993, p. 2-34), this would cost only US$13.1 million, or less than one-tenth the cost of building the Cotingo Dam and its transmission line (Table 1). Even if one assumes a catastrophic situation in which all of the thermoelectric facilities had to be replaced, since much of Boa Vista's thermoelectric equipment was bought used from Porto Velho, Rondônia, and is now in poor repair, the installation cost would be US$71.4 million, or half the cost of Cotingo.

The aspect of thermoelectric generation that is inherently more expensive than hydroelectric generation is in operating expense, since fuel must be purchased. The cost of fuel "saved"

is invariably the major focus of arguments for this and other hydroelectric dams. In order to have a fair comparison, one must treat these different types of costs in a consistent manner that reflects the values of society. What appears to have been done is to assume that the entire cost of dam construction would be financed. The debt at the time operation begins is calculated, considering the capital expenses plus the interest accumulated up to that point. From then on, amortization is assumed to occur in a straight-line fashion over 50 years, and interest at 10% is calculated on the remaining balance (e.g., CER 1994, p. 9-18). The 50-year amortization implies a 2% per year cost at the beginning of the period, making the result with 10% interest approximately equivalent to the 12% per year discount rate mentioned in the report in describing how the "global" costs per MWh were derived (CER 1994, p. 2-6).

The costs calculated in this way indicate that the Cotingo Dam is cheaper than thermoelectric generation (Table 1). Part of the difference lies in the social decision as to whether the government should make a large initial investment to be slowly written off over 50 years, or whether the costs should deferred and paid over this period through oil purchases. In practice, the theoretical 100% loan on which the calculations are based would not occur, and most or all of the construction expense would have to be paid by taxpayers at the outset. It is also quite possible that real loans, such as those granted by equipment-supplying countries for Tucuruí and Balbina, would be on terms less favorable than those used in the calculation.

Perhaps the biggest impediment to the thermal option, as well as to importing electricity from the Guri Dam in Venezuela, is the low status that these forms of energy supply have within the culture of barrageiros. Barrageiros, or dam builders, represent a distinct subculture in Brazilian society, which exerts an influence on hydroelectric development decisions that goes far beyond what their numbers might suggest (see Fearnside 1989). This influence can also go beyond what the economic benefits of the hydroelectric dams might warrant. Building a dam is a high-status pursuit, whereas installing and repairing thermoelectric plants are activities that carry low social status. A dam like Cotingo, which involves tunneling through kilometers of rock and erecting a wall of gleaming concrete (rather than the simple earth-fill structures of many dams) represents the kind of challenge that makes engineers' eyes twinkle.

CER staff are quick to point out the disadvantages of thermal generation--that the power plants are aging and continually breaking down. Boa Vista has the additional disadvantage of periods in the dry season when the Rio Branco has insufficient water to allow barges carrying diesel to make the

journey from Manaus. However, these low-water periods are a regular phenomenon, and the frequency of blackouts could be brought within acceptable limits by investing in sufficient storage capacity to continue generation at normal levels through any but very rare long droughts.

A frequent touchstone in condemning thermoelectric generation in Amazonian Brazil is the example of the blackouts common in Belém before the 1984 inauguration of the Tucuruí Dam. It must be remembered, however, that thermoelectric generation is a straightforward technology that has been in use for about a century. There is no mystery to designing a routine of maintenance and replacement, and to estimating the amount of spare generating capacity needed to ensure against blackouts. However, the temptation would be strong to allow thermoelectric facilities to deteriorate when electrical authorities are anticipating substitution of thermal generators by hydroelectric projects, even if the dams in question still lack key approvals such as the assent of the National Congress for building a dam in an indigenous area. There is also the possibility of electrical authorities not expanding thermoelectric capacity sufficiently rapidly and allowing thermoelectric plants to deteriorate as a means of building popular support for the dam. In Boa Vista, for example, people are likely to blame each blackout on the Indians and/or environmental restrictions that stand in the way of completing the Cotingo Dam.

The current thermoelectric capacity in Boa Vista is substantially greater than demand. The thermoelectric capacity installed in Boa Vista totals 83.26 MW (Conselho Nacional da Amazônia Legal 1994, p. 38). CER regards only 42.0 MW of this to be effective power, some of the units being expected to serve as spares for use in case of breakdowns (CER 1994, p. 3-5). Even without tapping the spare generators, the existing capacity provides a comfortable margin for Boa Vista's current size: average demand was projected at 22.74 MW for 1994 and peak demand at 36.60 MW (CER 1994, p. 3-7). Newly elected Governor Neudo Campos informed Brazilian President Fernando Henrique Cardoso of this thermoelectric capacity and that Boa Vista's demand is currently only 29 MW (Lima 1995). The margin between capacity and demand means that the sudden increase in blackouts in Boa Vista in late 1994 at the time that construction of Cotingo was about to begin is difficult to explain on the basis of insufficient generating capacity, as implied by the frequent reminders that blackouts would cease with completion of the dam.

Expanding thermoelectric capacity has the great advantage that it can be done in small incremental steps as the growth of demand confirms the need for more power. The incremental nature of expanding thermoelectric generating capacity fits well with the extraordinarily high uncertainty of population projections in

Roraima. Explosive population growth in recent years has been tied to events such as state government subsidy of importing voters in order to influence election results, and state government hindrance of efforts to inhibit invasion of indigenous lands by goldminers (see review of these issues in Fearnside and Barbosa nd). These are not the kinds of processes that demographers are accustomed to projecting, such as population growth through reproduction, or migration to cities from a definable pool of rural inhabitants.

Differences in the level of uncertainty between the different options needs to be considered. Cost overruns are commonplace in hydroelectric projects, such that the true cost could be much more than what has been calculated, whereas the costs of thermoelectric generation are probably more predictable and less likely to be biased in a downward direction. The Cotingo Dam has the disadvantage of high uncertainty for electricity supply plans because of the unresolved question of indigenous rights. If dam construction were to go forward in violation of constitutional and/or other restrictions, it might later be stopped by court order after considerable investment had been made. The financial advantage of US$50.9/MWh for Cotingo versus US$124.30/MWh for thermoelectric generation calculated by CER (see Table 1) is misleading as a summary of the value of each option for decision making, as each "reward" needs to be multiplied by the probability of actually obtaining it (Raiffa 1968).

Comparisons of thermoelectric and hydroelectric options should include global considerations such as the finite nature of fossil fuel reserves and the comparative impact of these options on greenhouse gas emissions. In general, these considerations favor hydroelectric solutions, although in the case of rain forest areas (not the case for Cotingo) the global warming impacts of hydroelectric generation can exceed those of thermoelectric plants (Fearnside 1995).

2.) Other Hydroelectric Sites

Other hydroelectric dams have been considered for the role now planned for the Cotingo Dam. Official favor has hopped from one proposed dam to another with the succession of different state governors. The Bem Querer Dam on the mainstem of the Rio Branco (see Figure 1), was considered in 1975 by then-Governor and Air Force Colonel Ramos Pereira. One of the published speeches of this governor states that "Eletronorte's project for installation of a hydroelectric dam on the Cotingo River ... does not satisfy the strategic objectives, guidelines and programs ... of the Second National Development Plan" (Brazil Ministério do Interior 1975, p. 28). The Bem Querer Dam could eventually have an installed capacity of over 600 MW and would allow locks to

provide year-round navigability to Boa Vista by submerging the Bem Querer rapids that can render the Rio Branco impassible during low-water periods (CER 1993, p. 2-2). A 1975 estimate placed the cost at US$235.7 million for an initial configuration of 195 MW (Brazil Ministério do Interior 1975).

The Paredão Dam (see Figure 1) was proposed in a 1984 feasibility study (CER 1984), and considered seriously from 1985 to 1986 during the governorship of Getúlio Cruz. Paredão is no longer a priority because other sources (thermoelectric alternatives considered for this role in the Eletrobrás plans published in the 1990-1991 period, and Cotingo beginning in 1992) would be sufficient to supply all of the energy needs of Boa Vista (see Brazil Eletrobrás 1992, p. 38). Paredão would have only 27 MW of installed capacity at a cost of US$110 million (CER 1984), making it compare poorly with Cotingo and non-hydroelectric alternatives. Because of small storage capacity, Paredão would have only 9 MW of firm power (CER 1994, p. 4-2). At its first phase water level, Cotingo would have 48.3 MW of firm power (CER 1994, p. 2-3). Both Paredão and Bem Querer were the subject of considerable political fanfare when they were being considered, but this has since been transferred to Cotingo.

3.) Power from Venezuela's Guri Dam

One possibility for supplying power to Boa Vista and to Manaus would be to import electricity from Venezuela's 10,000 MW Guri Dam. The primary objective of transmitting power from Guri would be to supply Manaus: supply of Boa Vista being a relatively minor additional benefit. The transmission line from Guri to Manaus would be 1600 km long, 1000 km of which would be in Brazil. Advances in transmission technology have lowered costs of long-distance lines such as those contemplated for linking Amazonia to industrial centers in southeastern Brazil: lines are considered viable up to 2500 km, for which the cost would be US$16/MWh transmitted, including investment, operating costs, maintenance and power loss (Conselho Nacional da Amazônia Legal 1994, p. 56). The proportional cost for transmission from Guri to Manaus would be US$10/MWh transmitted.

The tariff to be charged for power from Guri has not yet been settled, according to the report of an August 1994 Eletrobrás mission to Venezuela (Brazil Eletrobrás 1994b). According to one unofficial account, imported energy would have a total cost of US$32/MWh, while the mean cost of generation in Amazonia is US$100/MWh (Instituto Socioambiental 1994). Consideration of the Guri option continues.

A decision on importing power from the Guri Dam must be made as part of a larger decision on the future of power supply to Manaus. Manaus is at least seven times larger than Boa Vista,

making the supply of power there a priority sufficient to justify major investments, such as the power line from Guri or from other alternative sources. Transmitting power from Guri would be much too expensive if only Roraima were to be supplied, and building the line to Manaus would be unnecessary if that city were to get its power from the proposed Cachoeira Porteira Dam, from gas fields in the Urucu River and Juruá River, or from the Tucuruí Dam.

IV.) POLITICAL CONTEXT

Because of its high visibility, Cotingo would be a major asset to any politician in Roraima who is able to claim credit for it. Former governor Ottomar de Sousa Pinto (known as "Ottomar") is in a good position to do this, as he has been the most voluble spokesperson for the dam since his first term as governor (1979-1983), for example in his development plan for the state (Brazil Ministério do Interior 1980). During his second term in office (1991-1994), Ottomar's administration was able to obtain environmental approval for Cotingo on 18 October 1994 (between the first and second rounds of Brazilian elections, and two months before the end of Ottomar's term in office). The political benefit of votes won by building Cotingo would be especially valuable for Ottomar, as the major beneficiary of the dam would be the city of Boa Vista, where 55% of Roraima's population lived as of the 1991 census. This is where Ottomar has the least support: he got 49.3% of the valid votes in the município (county) of Boa Vista (including rural areas surrounding the city) in the second round of the 1990 gubernatorial election (just behind his principal opponent with 50.7%), but won the election by getting 61.5% of the valid votes in the remainder of the state)(see Fearnside and Barbosa nd). Support in Boa Vista, when combined with votes from southern Roraima where Ottomar's popularity is already high, would make him virtually invincible in future elections.

A consortium of two construction firms (Paranapanema and Andrade Gutierrez) and one state government agency (CODESAIMA) has been proposed to build Cotingo (Folha de Boa Vista 4 January 1995). Construction contractors and commercial suppliers of the construction effort often provide a strong impetus to overcome bureaucratic and other impediments to major public works (see Fearnside 1989).

V.) ENVIRONMENTAL IMPACTS

A.) IMPACTS ON TERRESTRIAL ECOSYSTEMS

The area flooded by the Cotingo Dam is modest compared to many existing and proposed projects. It is also one of the only proposed hydroelectric sites in the Brazilian Amazon that has

savanna vegetation, rather than tropical forest. The loss of forest and the problems of decomposing vegetation are therefore much less severe than elsewhere.

The feasibility study emphasizes what the consultants considered the biological poverty of the area: "the fauna is very poor, not being noted abundance of birds, insects, mollusks and amphibians" (CER 1994, p. 10-11). This leads to the conclusion that "the fauna and flora are, therefore, almost negligible" (CER 1994, p. 10-16). The Macuxi would dispute the worthlessness of the area's biota, from which the tribe has been able to support itself for millennia. Botanists would also reach a contrary conclusion: the savannas of northern Roraima, southern Venezuela and eastern Guyana constitute a mosaic of small patches of different types, each with a great variety of endemic species (Carneiro Filho 1991, Eden 1964, Huber 1982).

Changing the flood regime of a river would have impacts on the riparian vegetation downstream of the dam. The EIA and RIMA contain no information on oscillation of the river, and no information on how the water will be budgeted to both maintain power generation during the dry season, and maintain at least 80% of the minimum water flow as required by the National Department of Water and Electrical Energy (DNAEE Norma 3, Portaria 125, see CER 1993, p. 4-9).

The feasibility study includes power generation scenarios with and without a sanitary discharge (CER 1994, p. 9-4), implying that CER might decide to operate the dam without maintaining downstream water flow. In fact, prior to the 1994 revision of the feasibility study, all cost calculations had been done under the assumption that no sanitary discharge (minimum downstream flow) would be maintained (CER 1994, p. 1-2)! The 1994 revision of the feasibility study implies that CER is disputing the size of the sanitary discharge: calculations are made of the years that different additions to the dam complex would be needed "in the case where the value of the sanitary discharge is confirmed" (CER 1994, p. 14-7).

At the first phase level, maintaining the sanitary discharge implies foregoing 32% of the potential firm power of the dam. The feasibility study always refers to the sanitary discharge as an "energy loss" (e.g., CER 1994, p. 9-3), and emphasizes that maintaining it will mean raising the dam two years earlier than planned (CER 1994, p. 9-5). The temptation to disobey the requirement of a sanitary discharge would stem from the low streamflow of the Cotingo River during the dry season.

The feasibility study, EIA and RIMA appear to be misrepresenting the "minimum observed monthly mean streamflow" that DNAEE regulations (DNAEE Norma 3, Portaria 125, see CER

1993, p. 4-9) indicate as the criterion for determining the sanitary discharge. Sanitary discharge must be at least 80% of this value. The reports repeatedly cite a value of 8 m^3/sec (CER 1993, p. 6-2, 1994, p. 7-3), implying that the 80% requirement would be for only 6.4 m^3/sec. However, 8 m^3/sec refers to the minimum observed in a single month (April 1988), rather than a monthly mean for a series of at least 10 years as required by the DNAEE regulation. The monthly streamflow data presented in the EIA (CER 1993, p. 6-25) for the 1950-1990 period indicate that the lowest monthly mean is 34 m^3/sec (mean for February). The minimum flow downstream would therefore have to be 80% of this, or 27.2 m^3/sec, thereby decreasing the firm power that can be credited to the dam. Each 34-MW-capacity turbine requires 14.6 m^3/sec of water (CER 1994, p. 2-13). The minimum needed to maintain one generator in operation would therefore be 27.2 + 14.6 = 41.8 m^3/sec, plus an unspecified amount for evaporation in the reservoir. The flow curve presented in the report (CER 1994, p. 7-4) indicates that for about 25% of the year, on average, the water flow would be less than this amount.

B.) IMPACTS ON AQUATIC ECOSYSTEMS

The EIA and RIMA claim that the Cotingo River is poor in fish (CER 1992, p. 30, 1993, p. 6-4). It is not specified whether this poverty is natural or a result of the siltation from goldmining that the river has experienced in recent years. The consultants can have little basis for claiming that impact on the ichthyofauna will be low without knowing what factors are influencing the alleged low diversity. Introduction of exotic fish species in the reservoir would be likely to cause further impact. The EIA suggests introducing tilapia (CER 1993, p. 9-30), a species that is well-known for outcompeting native species in many parts of the world.

The statements on fish illustrate the problem of consulting firms generating lengthy reports on the basis of little or no fieldwork. In a technical opinion (parecer) on the EIA and RIMA, de Carvalho and Barbosa (1994) ask a series of rhetorical questions:

> With respect to the poverty of fish in the Cotingo River, this statement is compromising. Is the poverty with respect to the number of species or of individuals? When were the collections made? What was the fishing effort? Who collected the material? What was the section of the Cotingo River where the collections were carried out? Who identified the material collected? Without these basic data, and especially without the collected material, it is not possible to say anything at all about the diversity and number of individuals. How did they arrive at their

> conclusions? If there really is low diversity of ichthyofauna in the Cotingo River, is it a function of human-caused changes that the river has suffered over the last few years [pollution from goldmining] or is it natural? How can there be low impact on the ichthyofauna if the limnological factors influencing the low diversity are unknown?
>
> Furthermore, on page 6-4 of the EIA there is another compromising statement on the "...poverty of fish species that was also shown by the studies that were carried out." No study was done by the consulting firm that relates limnological aspects to the diversity of fish species. In the next paragraph the reader is induced to accept that the "...<u>results obtained</u> justify the various guidelines and recommendations indicated in the Environmental Management Plan." But where are the results? (de Carvalho and Barbosa 1994)

C.) THE EIA/RIMA

The EIA and RIMA for Cotingo contain a variety of irregularities. One is that the RIMA was done before the EIA. Since the RIMA is supposed to "reflect the conclusions of the EIA" (CONAMA Resolution 001 of 23 January 1986, Article 9), the EIA should have been done first. The EIA is dated June 1993, while the RIMA is dated September 1992. In addition, INTERTECHNE apparently began its work before it was contracted by CER. According to the foreword to the EIA, work on the RIMA was conducted beginning in September 1991. However, the firm was only contracted in October 1991 (CER 1993, p. 2-5).

The close association of consulting firms with the government agencies that repeatedly contract them is a well-known problem for obtaining objective reports. The regulation that requires the EIA and RIMA (CONAMA Resolution 001 of 23 January 1986, Article 7) is explicit in requiring that "the environmental study will be carried out by a qualified multidisciplinary team that does not depend, either directly or indirectly, on the proponent of the project." However, consulting firms are well aware that they are more likely to be invited to perform services in the future for an agency if they produce reports favorable to that agency's proposals. INTERTECHNE, for example, wrote the feasibility study for the Jatapu Dam (CODESAIMA 1991), and undoubtedly hopes to maintain a long-term commercial relationship with the government of Roraima.

The EIA and RIMA are peppered with references to the positive points of the Cotingo Dam, and give strikingly scant attention to alternative solutions to the energy supply of Boa Vista. The tone of the documents leaves no doubt as to the

endorsement of the consulting firm for the dam construction option. Tendentious language is not restricted to the portions of the document reserved for conclusions or recommendations, but permeates all parts of the text. Independent of whether Cotingo is the best option, CONAMA, Resolution No. 001 implies strongly that the objective of the EIA and RIMA is to allow the public and decision-makers to arrive at their own conclusions as to the best course of action.

One of the problems with the EIA/RIMA process is an inevitable lack of objectivity. An EIA/RIMA that emphasizes problems that would lead to not approving the project in question is virtually unknown. This is to be expected because 1.) The proponent pays the consulting firm that writes the reports. 2.) The consulting firm usually is asked to submit drafts of the reports to the proponent at various phases while it is being prepared. The proponent often makes requests for substantive changes, and the consulting firm inevitably complies. 3.) The contracts usually specify that the last parcel of payment (which amounts to 20-30% of the total) is only paid after the RIMA or EIA is accepted by the appropriate government agency (Jaime de Agostinho, personal communication 1995).

D.) THE PUBLIC HEARING

The Public Hearing, which is a required part of the licensing procedure, was a landmark in making clear the gulf that exists between the intent of the environmental licensing system and its functioning in practice. Every attempt was made to exclude the Indians and their representatives from having more than a token appearance at the hearing. The Indians and their representatives were not included among the speakers on the dais at the Public Hearing, but rather were relegated to the audience. Questions from the audience were limited to three minutes, with no right to ask any follow-up questions on the answers given. Having the hearing and inviting the Indians were essential to give credibility to the dam.

Cotingo illustrates well one of the most frustrating aspects of the environmental review system in Brazil: that it matters not how critical or negative the findings of the environmental reviews or hearings may be, it is only the fact that these stages in the licensing process have been passed that matters in the end. Providers of technical opinions (parecers), and those who testify at the required Public Hearing, may say what they like, but the process of approval and construction goes inexorably forward. Ironically, the fact of their having contributed with testimony, even though negative, can even help the project go forward by allowing proponents to say that all sides have been consulted. This is not to suggest that potential witnesses should boycott public hearings, as silence also has its costs.

At the Public Hearing on the Environmental Impact Report (RIMA) for Cotingo, held in Boa Vista on 7 October 1994, Paulo Sérgio Lemos Latjê, President of the Roraima Energy Company (CER), was asked a series of questions regarding the economics of the dam, such has how the decision to build Cotingo could be justified given that Boa Vista's power requirements could be met much more cheaply by expanding thermoelectric capacity (in a 102 MW installation presented as a "second alternative" in the EIA). As compared to this option, Cotingo is at least twice as expensive in terms of total installation cost even if all present installations are scrapped (see Table 1). No answer was forthcoming.

The meeting had a "theater of the absurd" aspect, with actors playing their parts in a play with a preordained conclusion (Barbosa and de Carvalho 1994). Although virtually everything presented at the meeting was highly critical of the Cotingo Dam, the project received its Preliminary License from the state government environmental agency (SEMAIJUS) only 11 days later, on 18 October 1994. As one of the actors (Jaime de Agostinho) put it later "everyone knew that this would happen."

E.) USE OF ZONING TO JUSTIFY THE DAM

In 1988 the Brazilian government announced commencement of an ecological-economic zoning for the country, after the completion of which all development projects will have to be done in accord with the zoning (Decree No. 96.944 of 12 October 1988). The zoning exercise is separate from the process of identifying and demarcating indigenous lands. Responsibility for the zoning was given to the Secretariat for Strategic Affairs (SAE) (Decrees 99.193 of 27 March 1990 and 99.246 of 10 May 1990), which acts in a supervisory role over the state government agencies that do the mapping at a more detailed level (Decree 99.540 of 21 September 1990). In Roraima the zoning project has given top priority to the area around Cotingo, and this priority was accepted by SAE. The zoning project in Roraima is receiving US$1.2 million from the World Bank as part of the "G-7" Pilot Project to Conserve the Brazilian Rainforest; ironically, the objective of the Roraima government for use of the funds is to block demarcation of the Raposa/Serra do Sol reserve, according to a statement by Edileuza Melo, one of the coordinators of the zoning project (CCPY 1995).

Why was the Cotingo area given the highest priority for zoning in Roraima? A likely answer is that the effort hoped to find valuable resources in the Raposa/Serra do Sol area that could be used as an argument for not finalizing the demarcation process. The head of the zoning project stated that the zoning hoped to document the value of resources in the area in order to serve as an argument for compensation of the state for not

developing the area (Jaime de Agostinho, personal communication 1994).

It is worth noting that indigenous lands are held by the federal government in trust for the tribal peoples who have traditionally inhabited them. These lands have never been part of the states' resource base for exploitation; demarcating them as indigenous reserves therefore does not "take away" anything from the states, and no compensation is warranted.

The view of ecological-economic zoning as a means of opening up indigenous and other protected areas to exploitation is a perversion of its original intention, which was to serve as a means of avoiding inappropriate development projects causing environmental damage. When the requirement of zoning was included in then-President José Sarney's "Our Nature Program," it was viewed as a victory of the environmentalists. Instead, state governors, not only in Roraima but also in several other Amazonian states, have viewed the zoning process as a means of increasing the legitimacy of their own priority projects. In Roraima, this places Cotingo at the top of the list.

The head of the zoning project in Roraima (Jaime de Agostinho) explained the agricultural capability of the different land units in his presentation at Public Hearing on the Cotingo Dam's EIA and RIMA. The Cotingo Dam was included in the maps produced by the zoning project, thereby adding credibility to the vision of Cotingo as an inevitable part of Roraima's future.

VI.) INDIGENOUS PEOPLE

A.) IMPACTS ON INDIGENOUS PEOPLE

The dam would flood indigenous land (Figure 1). Construction crews while the dam is being built, and then a permanent presence of maintenance and other personnel, can have negative effects on the tribe that go well beyond the loss of land to flooding.

Cotingo represents a cruel dilemma for the indigenous peoples whose land would be flooded. They know that Cotingo represents a wedge with which government, "military" and private interests hope to open a precedent that will allow free access to exploit resources of all kinds in indigenous lands throughout Amazonia. Highly visible proponents of Cotingo make no secret of this intention. Elton Rohnelt, former head of CER and now a Federal Deputy from Roraima, whose 1994 electoral campaign billed him as "energy Elton" and whose advertising featured a lightning bolt symbol, declared: "the greatest obstacle to building Cotingo is the political question, which involves the problematic question of demarcating the Raposa/Serra do Sol area" (Souza

1995).

Indigenous lands represent a sort of last frontier for exploiting timber, minerals and other resources. Those segments of Brazilian society that are in a position to take these riches frequently view Indians as mere obstacles. For the Indians, defending their land is the key to survival. This is not to be taken for granted. The Cotingo Dam is seen as a "spear point" of penetration into indigenous lands, serving to pierce through legal protections, obstruct further demarcation of reserves throughout the region, and gain time for other encroachments on indigenous lands to establish themselves as faits accomplis.

The Macuxi are split into factions with respect to Cotingo and to relations with the government in general. Protestant malocas are in favor of the dam and against demarcation of the indigenous area as a continuous reserve. This group is referred to as "good Indians" (Índios do bem) by dam supporters, and has been favored with such government benefits as health centers, running water, electricity, and telephone posts. The majority of malocas, which opposes the dam and fragmentation of the reserve, has ties to the Catholic Church; of 90 malocas in the area, 13 (14%) favor the dam and 77 (86%) oppose it (Instituto Socioambiental 1995). This split, for example, allowed the Secretary of Public Works and Services to describe the topographic survey as having been "demanded by the indigenous communities" (letter of 16 January 1995 SOSP/GAB/of./CIRC. No. 005/95 from Ariomar Gouvêa Coelho, State Secretary of Public Works and Services, to Suami Percílio dos Santos, Administrator of FUNAI in Roraima). However, the majority of the tribal population affected unquestionably opposes the dam and any preparation for it.

Aside from passively awaiting government decisions, the Indians have only two options: they can fight Cotingo with all the force that they can muster (their current strategy), or they can try to negotiate a settlement that would allow the dam to be built in exchange for certain benefits. If they fight and lose, then the "wedge" that they fear will indeed be created and the loss will be far greater than the Cotingo project itself. If the Indians grant permission (in exchange for some share of the material benefits from the dam), then Article 231 of the Federal Constitution will not be thrown in the trash. Flooding a small area of the vast savannas of northern Roraima may seem like a small price to pay for the benefits of Cotingo. The problem, of course, is that the real issue is much bigger.

The EIA for the Cotingo Dam contains little on the indigenous problem, despite this being the key issue affecting the dam's viability. The EIA states (CER 1993, p. 6-4) that the indigenous question is approached "through bibliographic

research, visits to the area of interest, contacts with local residents and the taking of testimony." However, none of the content of these interviews and testimony is revealed, nor does the report even state how many people were interviewed.

One of the most incredible passages in the EIA (CER 1993, p. 2-3) is its classification as a "positive impact" of the dam its leading to "...consolidate definitively the presence of non-Indians in the region." Far from being a positive factor, this represents a severe threat to the future of the indigenous communities in the area, and would lead to exacerbating land conflicts that already affect the area.

Eletrobrás has been trying to convince CER to take a less hostile approach to the indigenous peoples in the area. The president of Eletrobrás (José Luiz Alquéres) wrote to the president of CER (Paulo Sérgio Lemos Latgé) to advise him that Eletrobrás was communicating to DNAEE that it could not endorse an approval of Cotingo at present (Ofício No. CTA-PR 10762/94 of 3 November 1994). The indigenous peoples were the key factor preventing a favorable judgment. Eletrobrás pointed out the need for consultation with the indigenous peoples, and considered the anthropological studies to be inadequate. Eletrobrás warned CER that Cotingo could turn into a harmful precedent if there is polarization between a "false dichotomy" of environment versus development, and points out that the Public Hearing of 7 October 1994 should serve as the beginning, rather than as the end, of dialogue with the different groups on environmental and indigenous questions.

What the Macuxi might gain from Cotingo is a subject with the most divergent views possible. During a visit to the Macuxi indigenous area that contains the Cotingo site, the head of the SEMAIJUS environment department (Rita de Cassia) suggested that the dam would allow the Indians to use microwave ovens (Edimar Figueiredo Vasconcelos, personal communication 1995). The gulf between this vision of what Indians need and the reality of life in a Macuxi village would be hard to exaggerate.

There are some things that the tribe might gain that could be valuable to them. Indians need a source of financial independence if they are to enjoy any benefits of the "modern" world. The quest for money has led leaders of a number of tribes to strike deals with loggers and miners to allow exploitation in indigenous areas, often illegally. These deals are often not on favorable financial terms and can have negative impacts on the environment, health and culture of the tribe. Given this background, the possibility of the Macuxi gaining a steady income stream through royalty or other payment arrangements from the Cotingo Dam could be a unique opportunity to avoid the unenviable experiences of other tribes in trying to gain a source of

financial income.

If government authorities should see fit to negotiate with the Macuxi, the tribe would undoubtedly want as a first priority the demarcation of their land. This might well be a precondition to any kind of negotiation. After all, demarcation is a service to which this and all other tribes supposedly have a constitutional right, and not something that they should have to make concessions to obtain. The strategy of government authorities in trying to impede demarcation at all costs can only be expected to lead the tribe to fight Cotingo to the last person.

B.) CONSTITUTIONAL PROTECTIONS

Cotingo demonstrates dramatically the ease with which Brazil's constitution can be ignored when it is convenient to do so.[3] The constitution of October 1988 (Article 231, Paragraph 3) states clearly that hydroelectric dams in indigenous lands must be approved by the National Congress. This applies to all land that is "historically occupied" by Indians--not only to land in demarcated reserves. In the case of Cotingo, the area has been the home of the Macuxi, Taurepang/Wapixana and Ingarikó tribes for millennia, and is in an undemarcated "indigenous area" (Raposa/Serra do Sol). The Raposa/Serra do Sol Indigenous Area was delimited by a FUNAI act (Despacho No. 9), published in the official gazette (Diário Oficial) of 18 May 1993. Even the Environmental Impact Study (EIA) states that the land is occupied by the tribe, and that the Indians are opposed to any kind of transfer to another site (CER 1993, p. 6-99).

The feasibility study notes the presence of Indians, but presents the dam as an opportunity for development for the affected tribes and as part of an inevitable process that will lead to the end of the indigenous way of life. The report is careful to refer to the land as "occupied by" Indians, avoiding any implication that these people have a right to the land (CER 1994, p. 10-6). It also emphasizes the presence of non-Indians, and stresses contacts with the outside for at least 100 years. The report also stresses other sources of "increased presence," such as goldmining, special trading ports on the borders of Venezuela and Guyana (authorized by Law 8256 of 25 November 1991), and "various existing roads that cut the basin in different directions" (CER 1994, p. 10-6, emphasis in the original).

If the National Congress should approve constructing the dam in the tribal area, then the tribes should receive compensation for the loss of land. Any kind of indemnification for expropriating the land will require a precise estimate of the amount of land needed. The EIA mentions an estimate of 4000 ha

for Phase 1 (CER 1993, p. 6-2). Greater precision is clearly called for.

C.) ROYALTY PAYMENTS

Payment of royalties for mining on indigenous land is specifically mentioned in Brazil's 1988 constitution (Article 231, Paragraph 3). Hydroelectric dams, although mentioned in the same paragraph with respect to the need for authorization by the National Congress, are not specified for royalty payments. The paragraph reads:

> The use of hydrological resources, including energy potential and the prospecting and mining of minerals in indigenous lands can only be carried out with authorization from the National Congress, after listening to the affected communities, with their being assured participation in the results of the mining, in accord with the law. (Article 231, Paragraph 3)

The constitution (Article 176) holds that building hydroelectric dams in indigenous land should follow specific procedures to be established by law. The law alluded to has not yet been proposed to the National Congress, let alone approved.

Payment of royalties was not mentioned at any time in the feasibility study, EIA or RIMA for the Cotingo Dam. An anonymous document circulated in the federal and Roraima State electrical authorities suggests offering as a royalty 1-2% of the tariff charged for the electricity (Anonymous 1994).

VII.) LESSONS OF THE COTINGO DAM

1.) Cotingo illustrates the difficulty of controlling projects that become high political priorities. The lack of consideration of different alternatives for supplying electricity shows how little weight economic rationality has in decisions about major development projects.

2.) Most components of the project evaluation and authorization system failed in some way to fulfill their role in assuring wise development decisions. These include the Environmental Impact Study (EIA), the Report on Environmental Impacts (RIMA), the Preliminary License (LP) and the Public Hearing (Audiência Pública).

3.) It is hopeless to expect that consulting firms producing EIA and RIMA documents will be objective under the present system. The system needs to be reformed--but the failings of the system

should not be allowed to justify abandoning the EIA and RIMA requirements (as many proponents of large developments would be happy to do). Among the reforms needed are provisions for evaluation supported by financial mechanisms that are independent of the project proponents.

4.) The judicial decision barring construction pending approval by the National Congress is a hopeful sign for the application of constitutional protections for indigenous peoples. However, the fragility of these protections is made clear by the events surrounding the Cotingo Dam. Multilateral banks making loans to Brazil's power sector should not delude themselves into thinking that the funds could not be used to the detriment of indigenous peoples thanks to the constitutional and legal protections that these people theoretically enjoy. The importance of financing agencies conducting independent assessments on a project-by-project basis cannot be overemphasized.

VIII.) ACKNOWLEDGMENTS

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IX.) NOTES

1.) In 1992 the Babaquara Dam and the other four dams above Belo Monte were removed from the list of dams included in the decennial plans pending results of a study to "reallocate the fall" of the Xingu River. The temporary removal of the more controversial dams from the list implies no commitment not to flood the same areas by constructing dams in this stretch of the river, possibly at slightly different locations and most probably bearing different names.

2.) It is worth noting that the consulting firm is legally responsible for the technical and financial information presented in the EIA. If the government of Roraima were to spend public funds unnecessarily on the basis of the consulting firm's recommendation, the firm could theoretically be obliged to compensate the state (CONAMA Resolution 001 of 23 January 1986, Article 7).

3.) Constitutional protections in Brazil are much more nebulous and uncertain in practice than one might expect. The finality

with which statements are often made by legislators, lawyers, non-governmental organizations (NGOs) and judicial officials often implies that what is written in the constitution represents the final word. Unfortunately, events unfold differently in practice. In 1990, for example, a severe economic package was put into effect by then-President Fernando Collor de Melo through a series of "provisional measures" that violated the constitution; the measures were produced by Minister of Justice Bernardo Cabral, who himself had drafted the constitution in 1988 while serving as relator (head editor) of the Constitutional Convention (Isto É 4 April 1990, Fernandes 1990). Some of the measures, such as No. 153, were revoked, while others, such as No. 173, were not. NGOs that represent the Indians whose land would be flooded by Cotingo wrote of the Jatapu Dam (in Southern Roraima): "The Jatapu Dam will bring negative consequences for the Wai-Wai indigenous people. Because of this, the construction of this dam depends on the authorization of the National Congress. This is also the opinion of the Federal Prosecutor in Roraima" (CIR and CPI/SP 1993, p. 46). Yet Jatapu was never submitted to the National Congress as a case that had to be decided under Article 231 of the constitution, and the dam was built without the slightest delay for consideration of indigenous peoples (see Fearnside and Barbosa nd).

The 1988 Constitution also required that the federal government demarcate all indigenous areas by 5 October 1993 (Transitory Dispositions, Article 67). This deadline came and went with less than half of the indigenous areas demarcated. Lack of funds does not explain the failure to carry out this constitutional requirement, as funds for this task had been offered by a variety of international sources. Rather, the failure represents a victory for those individuals and institutions within the government (including the military) who do not want the portions of the constitution that protect indigenous lands to be respected. The idea that because something is mandated in the constitution it will automatically happen is extremely naive. The Indians are aware of this reality.

X.) LIST OF ACRONYMS

CCPY/RR (Comissão pela Criação do Parque Yanomamai, Escritório de Roraima): Commission for the Creation of the Yanomami Park, Roraima Office.

CER (Companhia Energética de Roraima): Energy Company of Roraima; formerly (until 1988): Centrais Elétricas de Roraima: Electric Centers of Roraima.

CIR (Conselho Indígena de Roraima): Indigenous Council of Roraima.

CODESAIMA (Companhia de Desenvolvimento de Roraima): Development Company of Roraima.

CONAMA (Conselho Nacional do Meio Ambiente): National Council of the Environment.

CPI/SP (Comissão Pró-Índio de São Paulo): Pro-Indian Commission of São Paulo.

DNAEE (Departamento Nacional de Águas e Energia Elétrica): National Department of Water and Electrical Energy.

EIA (Estudo de Impactos Ambientais): Environmental Impact Study.

Eletrobrás (Centrais Elétricas Brasileiras): Brazilian Electrical Centers (the federal power authority).

Eletronorte (Centrais Elétricas do Norte do Brasil): Electrical Centers of Northern Brazil (federal power authority for Northern Brazil).

FUNAI (Fundação Nacional do Índio): National Foundation for Indians (the federal Indian agency).

LP (Licença Prévia): Preliminary License.

MPF/RR (Ministério Público Federal em Roraima): Federal Public Ministry in Roraima (federal public prosecutor).

RIMA (Relatório de Impactos Ambientais): Report on Environmental Impacts.

SEMAIJUS (Secretaria do Meio Ambiente, Interior e Justiça): Secretariat of the Environment, Interior and Justice (Roraima).

XI.) LITERATURE CITED

Anonymous. 1994. UHE Cotingo: Uma possível posição consensual. (manuscript).

Barbosa, R.I. and C.M. de Carvalho. 1994. Cotingoblefe: A farsa da hidrelétrica e o teatro do absurdo em Roraima. Folha de Boa Vista 14 October 1994, p. 6.

Bittencourt, A.V. 1978. Sólidos Hidrotransportados na Bacia Hidrográfica do Rio Ivaí. Universidade de São Paulo, São Paulo, Brazil.

Brazil Eletrobrás. 1989. Plano Decenal 1990-1999. Grupo Coordenador do Planejamento dos Sistemas Elétricos (GCPS),

Centrais Elétricas Brasileiras (Eletrobrás), Rio de Janeiro, Brazil, 55 pp.

Brazil Eletrobrás. 1992. Plano Decenal de Expansão 1993-2002. Grupo Coordenador do Planejamento dos Sistemas Elétricos (GCPS), Centrais Elétricas Brasileiras (Eletrobrás), Rio de Janeiro, Brazil, 81 pp.

Brazil Eletrobrás. 1994a. Assunto: Análise do Relatório da Revisão dos Estudos de Viabilidade da UHE Cotingo. Ofícios Nos. 168-DNAEE/CGCO, de 23.09.92 e 109/CGCO-DNAEE, de 11.08.94. Resolução No. 602/94, 1638ª Reunião da Diretoria Executiva, 23/94.

Brazil Eletrobrás. 1994b. Relatório de viagem à Venezuela. Memo No. DPT-098/94. 2 August 1994. Centrais Elétricas Brasileiras (Eletrobrás), Rio de Janeiro, Brazil, 13 pp.

Brazil Ministério do Interior. 1975. II Simpósio de Integração de Projetos na Amazônia, Tema 3.5--Aproveitamento Integrado da Cachoeira do Bem-Querer. Ministério do Interior/Território Federal de Roraima/Gabinete do Governador, Boa Vista, Brazil, 29 pp.

Brazil Ministério do Interior. 1980. I Plano de Desenvolvimento de Roraima. (V. 1 - Diagnóstico). Ministério do Interior/Governo de Roraima/Secretaría de Planejamento e Coordenação, Boa Vista, Brazil, 219 pp.

Carneiro Filho, A. 1991. Contribution to the Study of the Forest-Savanna Mosaic in the Area of Roraima, Northern Amazon Basin. Masters thesis. International Institute for Aerospace Survey and Earth Sciences (ITC), Eindhoven, The Netherlands, 116 pp.

CCPY (Comissão pela Criação do Parque Yanomami). 1995. Zoneamento em Roraima, financiado pelo Banco Mundial, pode influenciar decisão sobre demarcação. p. 2 in Update 80 March 1995, CCPY, Boa Vista, Brazil.

CER (Centrais Elétricas de Roraima). 1983. Usina Hidrelétrica de Cotingo 123--Projeto Básico. CER/ELETRONORTE/GTFR/PROJEST (Consórcio Eletroprojetos) COT-10B-1536-RE, Boa Vista, Brazil.

CER (Centrais Elétricas de Roraima). 1984. Usina Hidrelétrica de Paredão -- Estudo de Viabilidade. Centrais Elétricas de Roraima, Boa Vista, Brazil, 40 pp.

CER (Companhia Energética de Roraima). 1992. Usina Hidrelétrica Cotingo, Rio Cotingo, Roraima. Relatório de Impactos Ambientais--RIMA. INTERTECHNE Consultores Associados, São Paulo, Brazil, 60 pp.

CER (Companhia Energética de Roraima). 1993. Usina Hidrelétrica Cotingo, Rio Cotingo, Roraima. Estudo de Impactos Ambientais. INTERTECHNE Consultores Associados, São Paulo, Brazil, 2 Vols.

CER (Companhia Energética de Roraima). 1994. Usina Hidrelétrica Cotingo, Rio Cotingo, Roraima. Revisão dos Estudos de Viabilidade Técnica e Económica. INTERTECHNE Consultores Associados, São Paulo, Brazil, irregular pagination.

CIR and CPI/SP (Conselho Indígena de Roraima and Comissão Pró-Índio de São Paulo). 1993. Roraima: Energia e Alternativas para o Futuro. CPI/SP, São Paulo, Brazil, 55 pp.

CODESAIMA (Companhia de Desenvolvimento de Roraima). 1991. Aproveitamento Hidrelétrico do Alto Jatapu: Relatório dos Estudos de Viabilidade Técnica e Econômica. 9101-RT-100G-004. INTERTECHNE Consultores Associados, São Paulo, Brazil, irregular pagination.

Conselho Nacional da Amazônia Legal. 1994. Política Integrada do Governo Federal para a Amazônia Legal. Revisão 1. Agosto 1994. Grupo de Trabalho-Energia, Conselho Nacional da Amazônia Legal, Brasília, Brazil, 76 pp.

Cummings, B.J. 1990. Dam the Rivers, Damn the People: Development and Resistance in Amazonian Brazil. Earthscan, London, 132 pp.

de Carvalho, C.M. and R.I. Barbosa. 1994. Parecer Técnico/UHE Cotingo. Instituto Nacional de Pesquisas da Amazônia (INPA), Núcleo de Pesquisas de Roraima (NPRR), Boa Vista, Roraima, 26 August 1994, 16 pp.

de Souza, M.A. 1995. Processo No. 950000057-1. Autor: Ministério Público Federal. Réus: Companhia Energética de Roraima-CER e Estado de Roraima. Decisão. Poder Judiciária, Justiça Federal de 1ª instância, Boa Vista, Roraima, Brazil, 5 pp.

dos Santos, L.A. de O. and L.M.M. de Andrade (eds.). 1990. Hydroelectric Dams on Brazil's Xingu River and Indigenous Peoples. Cultural Survival Report 30. Cultural Survival, Cambridge, Massachusetts, 192 pp.

Eden, M. 1964. The Savanna Ecosystem-Northern Rupununi, British Guiana. McGill University Savanna Research Series, No. 1. McGill University, Montreal, Canada, 216 pp.

Fearnside, P.M. 1989. Brazil's Balbina Dam: Environment versus the legacy of the pharoahs in Amazonia. Environmental Management 13:401-423.

Fearnside, P.M. 1995. Hydroelectric dams in the Brazilian Amazon

as sources of 'greenhouse' gases. Environmental Conservation 22:7-19.

Fearnside, P. M. and R.I. Barbosa. nd. Political benefits as barriers to assessment of environmental costs in Brazil's Amazonian development planning: The example of the Jatapu Dam in Roraima (in preparation).

Fernandes, B. 1990. "Ministro pesado." Isto É [São Paulo]. 4 April 1990, pp. 16-23.

Folha de Boa Vista. 4 January 1995. "Consórsio." p. 3.

Folha de Boa Vista 24 March 1995. "Secretário do Meio Ambiente diz que decisão foi correta." p. 7.

Huber, O. 1982. Significance of savanna vegetation in the Amazon Territory of Venezuela. Pages 221-244 in G.T. Prance (ed.) Biological Diversification in the Tropics. Colombia University Press, New York.

Isto É [São Paulo]. 4 April 1990. "Bala solitária." p. 15.

Lima, M. 1995. "Neudo vai dar murros em mesa por Roraima--Governador discute com FHC asfaltamento da BR e cargos." O Diário [Boa Vista], 23 February 1995, p. 3-A.

Instituto Socioambiental. 1994. Energia importada. Parabolicas December 1994. Instituto Socioambiental, São Paulo, Brazil, p. 6.

Instituto Socioambiental. 1995. Cotingo, Parabolicas, March 1995, Instituto Socioambiental, São Paulo, Brazil, p. 6.

Raiffa, H. 1968. Decision Analysis: Introductory Lectures on Choices under Uncertainty. Addison-Wesley, Reading, Massachusetts, 312 pp.

Setzer, J. 1982. Dados médios de suspensão carregada pelos rios paulistas. Departamento Nacional de Águas e Energia Elétrica, Brasília, Brazil.

Souza, J. 1995. "Elton quer alterar constituição para apressar desenvolvimento econômico de Roraima--demarcação de área indígena deve mudar" O Diário [Boa Vista], 23 February 1995, p. 2-A.

Survival International. 1995. Dam fuels violence in Brazil's far north. Urgent Action Bulletin January 1995, Survival International, London, 4 pp.

FIGURE LEGENDS

Figure 1 -- Brazil's Legal Amazon Region and the State of Roraima. Note that not all indigenous areas are shown.

Figure 2 -- The Cotingo reservoir.

Figure 3 -- Retiro do Tamanduá: Macuxi Indian maloca burned by Military Police in the area to be flooded by the Cotingo Dam (photograph by R.I. Barbosa).

Figure 4 -- Planned hydroelectric reservoirs on the Cotingo River.

TABLE 1: FINANCIAL COSTS OF ENERGY ALTERNATIVES FOR RORAIMA
In US$1,000

Type of cost	Cotingo Dam (68 MW - Phase 1)	Thermoelectric expansion (to 102 MW)	Import from Guri Dam
Direct	71,959 (a)		
Indirect	21,780 (a)		
Environmental protection	1,500 (b)		
Loan interest	16,940 (a)		
Transmission system	48,000 (a)	0	
Total for installed capacity	160,179	13,100 (c)	
Cost/kW installed (US$)	2,100 (d)	700 (e)	
"Global" unit cost (US$/MWh)	50.90 (f)	124.3 (g)	32 (h)

(a) Values for December 1992 from the feasibility study (CER 1994, p. 14-16).
(b) March 1992 value, midpoint of US$1-2 X 10^6 range given in the EIA (CER 1993, p. 2-35).
(c) March 1992 value estimated from the cost per kW installed given in the EIA (CER 1993, p. 2-34), assuming that the thermoelectric park is expanded to 102 MW.
(d) Estimated from the total cost/installed capacity.
(e) CER 1993, p. 2-34.
(f) Value at 12% discount (CER 1994, p. 2-6).
(g) December 1992 value from the feasibility (CER 1994, p. 2-6), lower than the US$135.4/MWh calculated for March 1992 in the EIA.
(h) Unofficial value from Instituto Socioambiental (1994, p. 6), assuming that Manaus is also supplied.

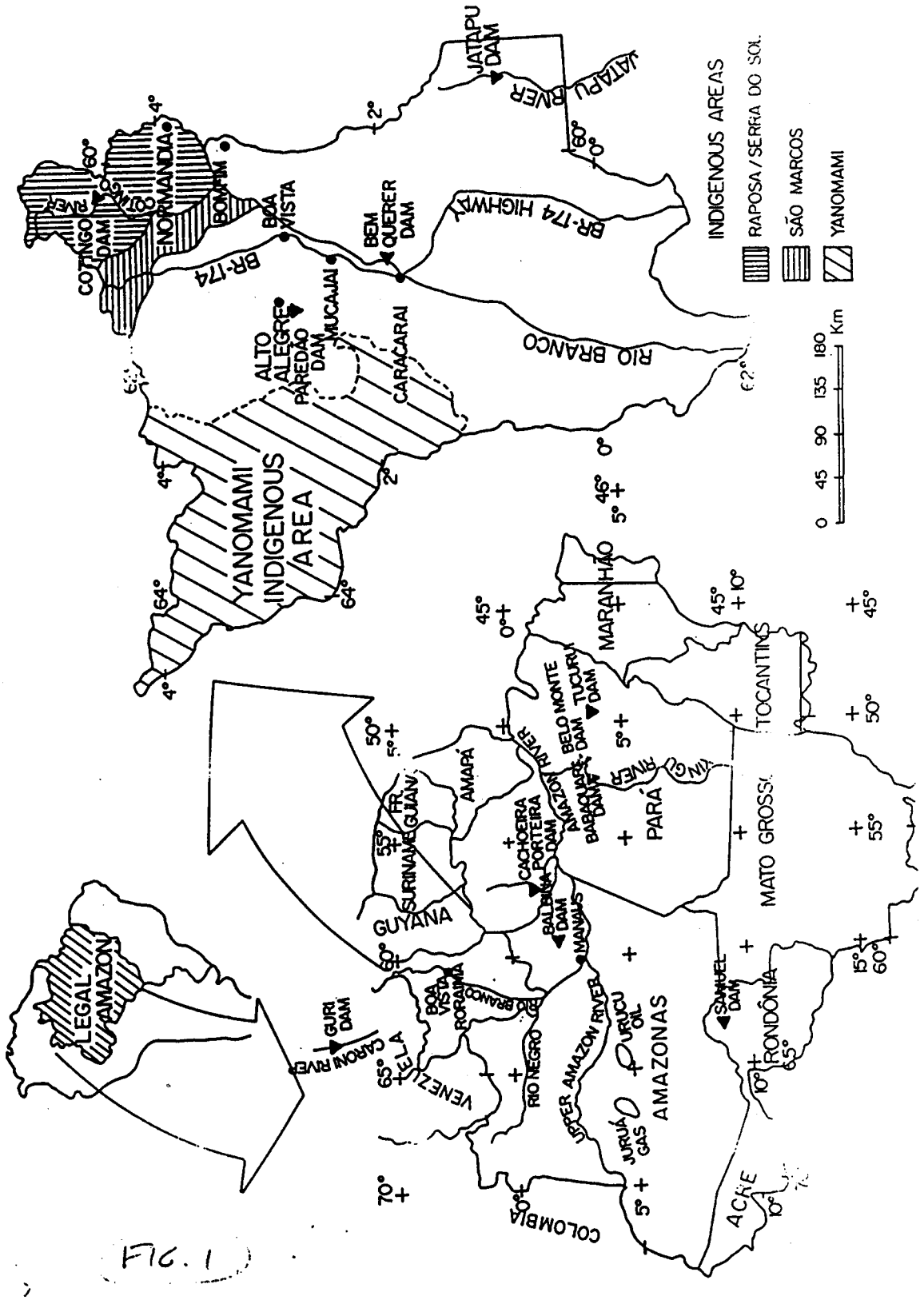

INDIGENOUS AREAS
RAPOSA / SERRA DO SOL
SÃO MARCOS
YANOMAMI
0 45 90 135 180 Km
YANOMAMI INDIGENOUS AREA
ALTO ALEGRE
PAREDÃO DAM
MUCAJAI
CARACARAI
BOA VISTA
BOMFIM
ENORMANDIA
COTINGO DAM
BR-174
BEM QUERER DAM
BR-174 HIGHWAY
JATAPU DAM
JATAPU RIVER
RIO BRANCO
MARANHÃO
TOCANTINS
PARÁ
MATO GROSSO
AMAPÁ
FR. GUIANA
SURINAME
GUYANA
CACHOEIRA PORTEIRA DAM
BALBINA DAM
MANAUS
BELO MONTE DAM
TUCURUI DAM
BARCARENA DAM
AMAZON RIVER
XINGU RIVER
GURI DAM
CARONI RIVER
BOA VISTA
RORAIMA
RIO BRANCO
VENEZUELA
RIO NEGRO
UPPER AMAZON RIVER
URUCU OIL
JURUÁ GAS
AMAZONAS
SAMUEL DAM
RONDÔNIA
ACRE
COLOMBIA
LEGAL AMAZON

FIG. 1

Fig. 2

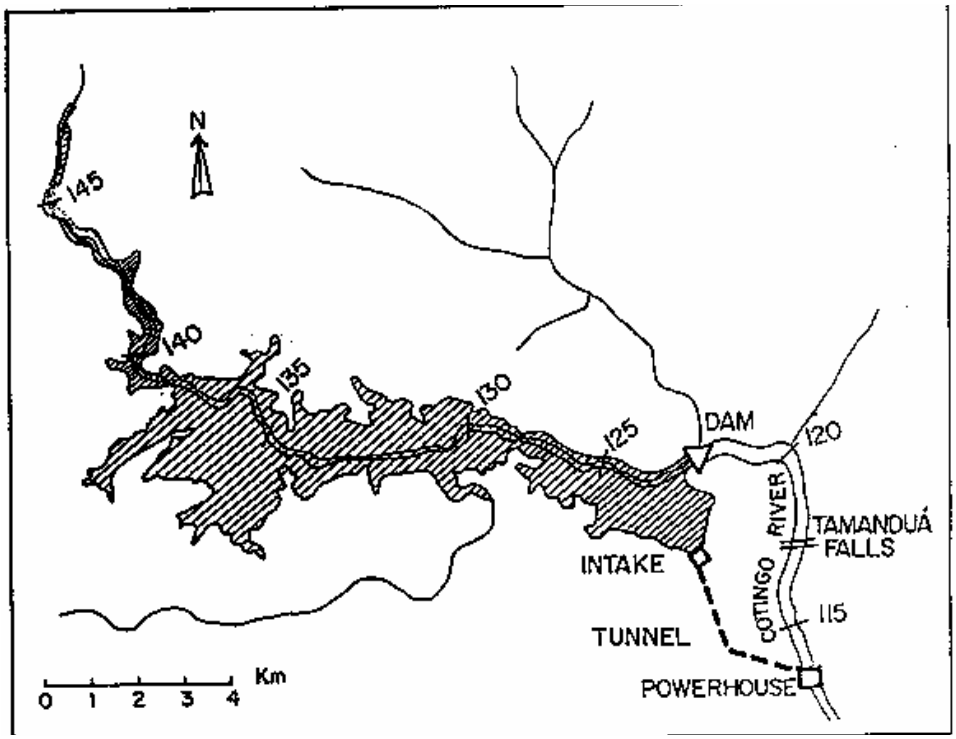
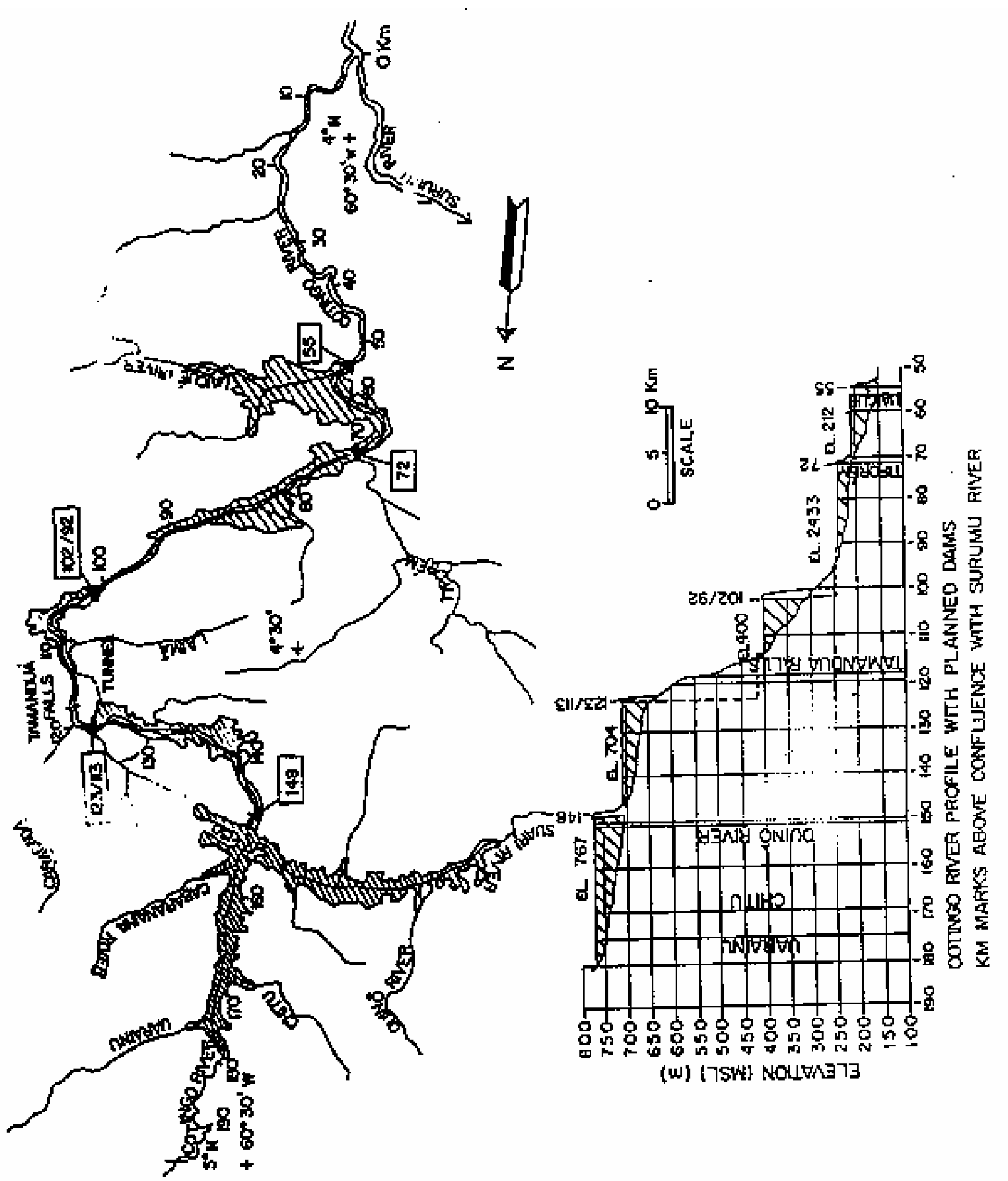

N
145
140
135
130
125
120
DAM
INTAKE
TUNNEL
POWERHOUSE
COTINGO RIVER
TAMANDUÁ FALLS
115
0 1 2 3 4 Km

Fig. 3

Fig. 4


COTINGO RIVER PROFILE WITH PLANNED DAMS
KM MARKS ABOVE CONFLUENCE WITH SURUMU RIVER
ELEVATION (MSL) (m)
SCALE