

Ecological and Economic Context of the Proposed Paraguay-Paraná Hidrovia and Implications for Decision-making

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Abstract

This chapter contrasts different approaches to assessment of the costs and benefits of the development of the Hidrovia, with emphasis on potential impacts on the Pantanal, and on implications for decision-making of using the information derived from these different approaches. We begin by illustrating the relationship of the flood/drought cycle, to its extremely rich biodiversity, and its importance to the human economy. We then show how both are vulnerable to small changes in water levels that could be brought about by development of the Hidrovia, and the cumulative impacts of other development that would be supported by it. The costs and benefits of these and other changes are difficult to value because they are related to conflicting social objectives, including geopolitical considerations, diverse stakeholder perspectives, and to goods and services with significant non-market and subsistence values. Also, given the complexity of the problem and inherent uncertainty, attempts to analyze costs and benefits all rest on questionable and often arbitrary assumptions, and depend on the interests and perspectives that have a voice in the decision-making process, and on how the problem is defined. In new kinds of complex problems such as this, that are beyond the response capacity of existing institutions, an adaptive approach to valuation is suggested, that provides stakeholders with opportunities for mutual learning, to reframe the problem in a broader context that includes cumulative impacts of further regional development that would be supported by the Hidrovia, to reconsider their values in light of new information, and to engage in a process of negotiation and conflict resolution regarding what is to be sustained. The results of this process can then provide a set of criteria for evaluating the success of development efforts, and to identify inevitable tradeoffs. Valuation becomes an institutional problem, of access to the decision-making process. The value of a participatory process, and the costs of not including stakeholders, are discussed with reference to case studies elsewhere.

I. Introduction

In complex and controversial environmental decisions, a question that is often the subject of controversy is whether all of the costs and benefits of the proposed action have been considered, how these have been determined, and how they are distributed among various stakeholders. In a watershed context, it is difficult or impossible to ever have complete information necessary to determine this because of inherent uncertainty regarding the links between causes and effects -- there are multiple causes of environmental degradation, while effects depend on vulnerability and response capacity, as well as on what is measured and counted, which in turn depends on what is valued. In addition, benefits and costs are geographically separated between those upstream and those downstream. This chapter considers the implications for decision-making of using information derived from different methodological approaches used to analyze the potential consequences of developing the proposed Paraguay-Paraná “Hidrovia” or waterway, with special attention given to the conservation of biodiversity in the Pantanal. The decision to develop the Hidrovia is generally illustrative of problems associated with development in large river basins, and of conserving biodiversity.

We begin with an overview of the complex ecological and socioeconomic context in which this development scenario would occur, the potential impacts, and the assessments that have been done. We then contrast these assessments with a participatory approach to integrated assessment, the aim of which is to establish a process for stakeholders to reconsider their values in light of new information, by allowing them to engage in a process of mutual learning, and in negotiation and conflict resolution regarding their rights and responsibilities and the distribution of costs and benefits of potential unintended consequences. It is a process in which stakeholders also provide information about how they might be affected, based on local knowledge, and may contribute towards the generation of new options made possible by this learning process. We show that the main obstacle to implementing such an approach is an institutional one.

II. Description of the area

The Pantanal is the largest freshwater wetland in the world and is located in the Upper Paraguay River Basin, which is at the interface of 3 national political boundaries – of the 496,000 km² that it covers, 396,000 km² lie in central western Brazil in the states of Mato Grosso and Mato Grosso do Sul. The remainder is found in eastern Bolivia and north-eastern Paraguay. It is also at the interface of 4 major South American ecosystems that contribute to its vegetation composition—the Amazon tropical rainforest, the cerrado scrub forests of central Brazil, the Chaco semi-arid scrub forest, and sub-tropical Atlantic humid forest. Within it, 10 different ecological subregions have been identified, controlled primarily by the annual flood/drought cycle in which the degree of fluctuation also varies in a multi-year pattern, and that regulates water flow downstream by releasing it very slowly. The annual floods are also a source of nutrients responsible for high primary production in otherwise poor and sandy soils. Biodiversity in the Pantanal includes over 650 species of birds (Thomás, pers. comm.), over 250 species of fish (Britski, Silimon, and Lopes 1999) of which about 10 are caught for commercial purposes, approximately 90 species of mammals, 50 species of reptiles, 1050 butterflies (Brown Jr. 1986), over 1000 plants, and many unidentified insects.

Underlying all of this is an immense alluvial plain with a very small elevational gradient. Within the Pantanal, the slope is only 1-3 cm/km from north to south, and 6-12 cm/km from east to west. Thus the rivers are very meandric, with many oxbow lakes and 4 large lakes in the western part. In contrast, altitudes in the upper basin range from 80-150m on the plains, to over 250m in the upperlands, with some isolated peaks of over 1000m (Wade, Tucker, and Hamann 1993). The rivers, which originate in the upperlands, generally drain sandy soils, and deposit large amounts of sediment when they reach the plain. Most of these rivers have elevated sand banks along their margins, and, in extreme cases like Taquari River, have beds higher than the plain. During the rainy season, the water exceeds these margins, invades the grasslands, and spreads and forms a very extensive inundated area. Because of low declivity, the rain water on the plain produces temporary rivers, regionally named as "corixo" and "vazante" and replenish the lagoons or "bacias".

The Pantanal ecosystem is regulated by an annual cycle of flooding and drought, including a multi-year pattern of variability in the magnitude of the fluctuations, or pulses, in the cycle. Hydrologically, it functions as a large sponge that slowly releases the flow of water coming from the upperlands. In 1988, the highest flood of the century occurred, in which all of the Pantanal appeared to be a big freshwater sea, justifying its ancient name, Xaraes Sea. On the other hand, from 1960 to 1974, the floods were so low that people were saying that the Pantanal was drying and becoming a big desert. When a big flood came in 1974, local people were surprised -- most ranchers had no time to save the cattle and many animals died, including native ones.

Total yearly rainfall in the basin is approximately 1100-1500mm, 80% of which falls between November and March (Alfonsi and de Camargo 1986). Beginning in November, the Pantanal is inundated from north to south along the Paraguay river and from east to west along the main tributaries, the São Lourenço and Taquari rivers, turning it into a vast, shallow inland sea, interspersed with higher unflooded areas. Flooding may last from 3 to 9 months, depending on local elevation, with maximum water levels normally occurring in January and February in the northern and eastern reaches of the Paraguay and its tributaries, and during May and June in the southern areas. After peak floods, the system dries slowly through evaporation, evapotranspiration, absorption and outflow. The area changes to a huge savanna, with open grasslands, isolated pockets of cerrado vegetation, and many shallow water bodies in which a large number of trapped fish attract wading birds and other wildlife.

The Pantanal is one of the world's largest breeding grounds for wading birds, an important migratory bird stopover point, and probably the most important area in South America for wetland birds. Its other wildlife includes some of the most unique animals in the world, some of which are nearly extinct elsewhere in Brazil. Among these are: the giant anteater, giant river otter, maned wolf, tapir, jaguar, puma, neotropical river otter (*Lutra longicaudis*) and bush dog (*Speothos venaticus*) -- most of which are included in the international red book list of endangered species (Gustavo, da Fonseca, and al 1994).

Fish migration, plant flowering, bird breeding, and caiman nesting are strongly regulated by and dependent on water level. For example, when water levels begin to decrease, migratory fishes like curimbata, *Prochilodus lineatus*, a very abundant iliophagous fish,

and most of which have market value, start to shoal, and by the end of the dry season (generally by September/October), are migrating upstream, forming spectacular shoals. After breeding on the upper reaches of the rivers, they move again downstream (by January/February) and enter the flooded areas to feed. A similar process occurs to alewives carried passively by the river currents into the flooded areas, in which they find food and shelter. They stay there until water begins to lower, when adults return to the main channel (by June/July), and begin another upstream migration.

Success of caiman nesting is also related to flooding intensity and duration. Low and short floods mean few nests and reduced breeding success. The same happens to fish-eating birds like jabiru stork, woodstork, spoonbill and animals like the giant otter and neotropical river otter. They are largely dependent on the flooding and subsequent drought that enable them to get enough food (fish) for their young and themselves.

Population density in the Pantanal region is very low, concentrated on very sparse ranches, each typically occupied by 3 or 4 families. Cattle ranches, which constitute the main economic activity in the Pantanal, are owned by approximately 3,500 "fazendeiros" or ranchers. The tradition of cattle ranching in the Pantanal goes back approximately 200 years. The cattle are raised in a very extensive system (1 animal/3 hectares) that is based on native pastures. By some estimates, each ranch needs at least 10,000 hectares to be economically viable (Cadavid-Garcia 1986).

Another traditional activity is fishing, now performed by approximately 3,000 fishermen. It is also attracting increasing numbers of tourists – 46,000 in 1994 (just to fish in the Southern Pantanal) (Catella, Peixer, and Palmiera 1996), and an estimated 60,000 to the entire Pantanal. This led to increased employment for the local population, in tourism agencies, hotels, airway companies, local commerce, and on ships and boats. There is also an increase in ecotourism, for photographing and sightseeing, as well as a special kind of "jungle tourism" made by young foreign tourists.

Other potential uses of Pantanal resources are natural population management of caiman for skin, meat and other products, capybara for meat and leather, and a feral pig for meat production, now under research by the Pantanal Agricultural Research Center, EMBRAPA, at Corumbá, in the state of Mato Grosso do Sul.

Most of the regions population of approximately 2 million, live in the highlands surrounding the Pantanal where, in the last 20 years, landuse has shifted dramatically toward intensive agriculture and cattle production. Use of great amounts of agrochemicals and poorly planned water management systems have chronic long-term negative effects on the biology and hydrology of the area. Though public attention has recently begun to focus on the impacts of large scale agricultural operations, given the continuing economic crisis in Brazil and traditionally low concern for environmental values, it may be difficult to achieve meaningful change in agricultural practices in the near future. An exception was the county of Sao Gabriel D'Oeste, which developed a large program of soil conservation in the Coxim River basin, a tributary of the Taquari River.

III. The Hidrovia Project

Historically, the Paraguay River has been used as a waterway for the transport of commercial goods. It has also been an important trade route, both in colonial and modern times. In recent years, because of improved road transportation, at least in Brazil, navigation has decreased and a number of operational port facilities have fallen into disuse. The revitalization of this waterway through a development project known as "Hidrovia" was agreed upon in the late 1980's by the La Plata Basin countries – Argentina, Bolivia, Brazil, Paraguay and Uruguay, as a way to ensure permanent navigation of the Parana-Paraguay waterway, from the interior regions of Brazil and Bolivia to the Atlantic ocean near Buenos Aires in Argentina (Bucher 1993). It was also seen as a way to integrate the economies of these countries by providing a low cost transportation system for commercial goods. The main objectives of the countries are to transport, along the Paraguay and Parana Rivers, grain, timber, paper and pulp, iron and manganese ores, energetic and vegetal coal, clinker, steel, plaster, calcareous stones, limestone for agriculture, cotton, liquid fuel and fertilizers.

In September 1989, an Intergovernmental Committee on the Parana-Paraguay Hidrovia (CIH) was created to: (A) Identify specific projects; (B) Determine the priority of works and projects to be undertaken; and to (C) Study the compatibility of applicable laws of the La Plata Basin countries. In 1991, the InterAmerican Development Bank provided the CIH US \$7.5 million to develop technical, financial, social, economical, legal, institutional and environmental studies (Lammers, Moore, and Treacle 1994). Support was also provided by UNDP (US\$ 485,000), Fonplata (US\$ 1.66 million), and national governments (US\$ 1.35 million), for a total budget of US\$ 11 million.

The main concerns of opponents are that it would involve dredging and straightening of river channels as well as removal of rock outcrops that regulate the flow of water from the Pantanal, which could have profound effects on flooding and sedimentation problems throughout the river basin (Ponce 1995) as well as on the biodiversity of the Pantanal itself and on the regional economies. It would also be a catalyst for other related development activities that would lead to industrialization of the region and cumulative impacts.

The feasibility studies, required to obtain a loan from the Interamerican Development Bank, included two potential levels of development of "Hidrovia", modules A and B. Module A, represents a short-term, more restricted project, consisting mainly of dredging from Santa Fe (Argentina) to Corumba /Puerto Quijarro (Brazil - Bolivia), including the Tamengo Channel, and signposting from Corumba to Nueva Palmira (Uruguay). This module includes the Pantanal region marginally, if removal of the rock bed at Passo do Remanso Castilho in Paraguay is not considered.

Module B is a more ambitious, long-term project intended to make the 1670 kilometres of the Paraguay River navigable through the Pantanal region year round. Module B would entail:

- dredging of the main channel to achieve a permanent width of 50 meters and depth of 3 meters;
- cutting off existing meanders, to reduce travel from Caceres to Corumba by 62 km;

- extraction of rock beds in some places;
- construction of 32 dikes to close river arms between Caceres and Corumba;
- construction of a slope protection system;
- improvement of existing harbours by dredging and constructing new terminals as well as modernization and re-equipment of the existing terminals.

It is estimated that 86.6 million cubic meters would be dredged in 10 years.

The estimated budget is US\$ 1.1 - 1.3 billion for construction and US\$ 2.6- 3 billion for maintenance and operation, during the period from 1990 to 2015.

IV. Assessment of Effects

Under Brazilian National Environmental Policy, an environmental impact assessment is mandatory. The Pantanal must be given special consideration because it has been designated as a National Heritage site in the Brazilian Constitution, and includes two national protected areas along the Paraguay River:

1. the National Park of Cará-Cará; and
2. the Ecological Station of Taiamã.

Within Brazil, legal and jurisdictional complexities arise from the fact that the Pantanal region is in the territory of two states -- 2/3 is in the state of Mato Grosso do Sul and 1/3 in the state of Mato Grosso. Regionally, there is concern because Argentina, Paraguay and Uruguay have no environmental impact assessment legislation.

Key issues identified in the assessment were hydrological and ecological effects which have consequences for landuse and socioeconomic factors.

1 - Hydrological Effects

A principal concern is that channel dredging, cutting off meanders, construction of dikes, and slope protection systems will alter the hydrological regime of the Paraguay River by accelerating water flow speed, reducing the floodable area and the flooding period. If as is suggested, the rock beds are removed, the Pantanal likely would lose its sponge-like character which serves as a natural buffer and is responsible for the exceptional stability of water flow through the Paraguay River. In turn, it will result in an overlap of the peak flooding period in both the Parana and Paraguay rivers which would increase the risk of catastrophic rises in the lower Parana River, affecting all the existing human activities which includes petrochemical, chemical, frozen meat processing plants and power plants (including one atomic power plant) and also the city of Buenos Aires. During the dry season, extreme low water levels would be expected along the middle and lower Parana River.

The Pantanal is a region still being formed by the sediments brought from the highlands. The cutting off of existing meanders and the removal of rock beds would increase the water velocity. As a consequence, sediments currently in the process of stabilization,

could be carried away by the fast waters, which would initiate a process of erosion from the region and deposition downstream, and strongly increase existing navigation problems on the lower Parana River. More and continuous dredging would then be needed, which would increase the previously estimated costs of the Hidrovia.

Another expected consequence is the lowering of the water table, which would progressively lead to a drier condition and most likely, to a "desert", because of the existing sandy soils in most areas of the Pantanal, and loss of nutrients. As is typical in floodable areas, the nutrient cycle is highly dependent on the nutrients brought from the highlands and deposited in the lowlands by the flood. Life is also directly dependent on the flood level and flooding duration. Hazardous loads transported by the Hidrovia could have strong effects on the Pantanal if spillage occurs, particularly during the flood season.

2. Ecological Effects

Alteration of the hydrological regime would drastically modify the relationship between land, water and floodable area. Terrestrial habitats would increase and aquatic habitats would be reduced both temporally and spatially, which would also affect wetlands, particularly lentic habitats. This would in turn have complex ramifications for the existing food web in the Pantanal region, as is illustrated in the following characterization of ecological relationships.

During the flooding period, iliophagous fishes like *Prochilodus scrofa*, an important commercial fish, enters very shallow water, in order to feed on the periphyton and organic load brought by inundation. Thousands of them can be seen feeding during the flooding season in shallow waters no more than 20 to 50 cm deep, where periphyton and organic particulate matter are very abundant. Periphyton grows fast in these shallow areas on submerged vegetation. Young and small fishes feed on zooplankton in open areas and on aquatic insects from the macrophytes. These fishes are particularly eaten by biguá (*Phalacrocorax olivaceus*), a very abundant fish-eating bird and by most commercial fish. Gastropods and crabs that feed on periphyton beneath the macrophytes are eaten by several economically important fishes, like pacu (*P. mesopotamicus*) and piavucu (*Leporinus macrocephalus*). The snail-hawk, named gavião-caramujeiro, feeds only on aquatic gastropods.

A particular vulnerable fish species is *Gymnotus carapo*, widely used as fish bait to catch large catfishes like pintado (*Pseudoplatystoma corruscans*), cachara (*Pseudoplatystoma fasciatum*) and jaú (*Paulicea luetkeni*). Both young and adults are only found beneath the macrophytes, where they are protected against predators and feed on abundant aquatic insects. Other related gymnotoid fishes like *Eigenmannia*, species also live only beneath macrophytes, are also particularly vulnerable, as the growth of macrophytes is directly dependent on flooding.

Small and young fishes are primarily eaten by jabiru stork, woodstork, spoonbill and herons. Their reproductive behaviour is strongly related to the flooding season when food (i.e. fish) is very abundant. Very large communal nesting of woodstork, herons and spoonbill can be seen between July and October when the water is lowering and a great quantity of fish in drying oxbow lakes and temporary rivers are available. A long period

of low and short floods, from 1960 to 1974, drastically reduced the population of these birds. Also nesting and success of nesting of jabirus, a bird that is symbolic of the Pantanal, depends on available fish, grown during the flood season. Giant otter, a threatened species outside the Pantanal, lives there in good condition, in rivers and oxbow lakes, feeding mainly on fishes.

The success of fish reproduction, also depends largely on the flood season for food, growth and shelter. According to local populations, during the long low flooding period, fish populations were so reduced in the Paraguay River that they couldn't see even one fish jumping in the water. Caiman populations at that time were so reduced that a law prohibited their hunting. Briefly, all these animals, most of them threatened in other parts of the South America, would also be threatened in the Pantanal with the Hidrovia project.

The distribution of vegetation in the Pantanal, which comes from the *cerrado*, the amazonian forest, the chaco and the sub-tropical forest, is also largely dependent on the water table. In the Pantanal, maximum differences in the mesorelief are no more than 2 meters. Small elevations named *cordilheiras* and *capoes* are covered by forests, mainly with cerrado trees, while the surrounding areas, less than 2 meters below have grass coverage. Ponds, locally named as *baias*, are shallow waters covered by floating and submerged vegetation. Along the rivers, amazonian vegetation influence can be seen through the occurrence of amazonian trees and amazonian victoria-régia, the largest aquatic leafed plant species.

A number of animals depend on grasses and aquatic vegetation. Capybaras live along the rivers and baias feeding mainly on grasses and aquatic vegetation. Mating occurs in the water, each male having 5 or more females. When in danger, they dive and stay under water for long periods. The only vigorous and abundant population of marsh deer occurs in the Pantanal (Mauro 1993), along the marshy areas of the rivers. Its diet consists of soft grasses that grow in these areas. Peccaries and feral pigs feed on roots, insects and small animals found around the ponds and use the *cordilheiras* and *capão* forest for shelter. Pampas deer is abundant in open grasslands. Jaguars and pumas have abundant food, feeding on herbivorous species like capybara, pampas deer, wild and feral pigs and marsh deer.

Any alteration on the water table, would lead towards predominance of forest type vegetation. This would reduce available food for herbivores, reduce their population, and probably reduce the marsh deer population below their minimum viable population size. Reduction of available food could also either reduce the population of jaguars and pumas directly, or induce them to kill more and more calves, in which case they would be increasingly threatened by hunting from the ranchers.

The vegetation distribution is very peculiar in the Pantanal. At some places there is dominance of some species with very large areas covered almost by a single species. Among these are Paratudais (*Tabebuia sp*), carandazais (*Copernicia sp*), cambarazais (*Vochysia divergens*), whose occurrence is dependent on the water table, flooding and soil type. So, small differences on water table can kill large forest vegetation and drastically alter the vegetation cover of the region, and consequently, the abundance and distribution of large native animals.

Loss of soil fertility and lowering of the water table may also be expected to lead to depletion of nutrients and groundwater, which would then lead to the *conversion of wetlands into dry lands* in areas of the Pantanal more distant from the rivers. Lands now used for cattle ranching could be invaded by woody weeds and transformed to non-use conditions.

3. Effects on land use and livelihoods

In addition to direct impacts on livelihoods of fishermen, ranchers, those employed in tourism, and their families, development of the Hidrovia is also expected to stimulate increased agricultural activities in the surrounding highlands, which would increase soil erosion. These were previously considered non-productive areas, which were converted to agricultural uses during the green revolution of the 1960's.

For lack of experience and poor professional assistance, most farmers didn't use soil conservation management or proper levels of fertilizers and agrochemicals. In the first years, many of them became sick from self-contamination by agrochemicals, and much soil was lost before initiating soil conservation management practices, but even now, many farmers, mainly ranchers, are not conscious of the problem. Thus, soils continue to be lost through erosion and continue to enter into the Pantanal. If the Hidrovia project stimulates grain production, it is expected that even more lands would be deforested and cultivated, and more soil eroded and deposited as silt in the Pantanal. Economic development, under these conditions, even if it generates more employment on the highlands, would not be sustainable.

The Hidrovia is also expected to reduce employment presently generated by road transportation of agricultural products. According to studies conducted by CEBRAC (Galinken, Guimarães, and Libânio 1994), employment in road transportation pays an average of US\$300 a month, while employment generated by the Hidrovia would only pay US\$108 a month. This would impoverish rather than improve the lives of workers.

Mineral products that would be transported by Hidrovia, mainly iron and manganese ores, from Bolivia and Brazil to Paraguay and Argentina, depend largely on international markets and also, the ability of Paraguay and Argentina to process them for local use or for export. The future of these activities is not clear and international markets are highly uncertain.

Timber, from native forests in Brazil and Bolivia, may be exported, producing only temporary employment, because the activity is not sustainable, and leading to a permanent loss of biodiversity. Native forests in these countries are not normally managed to sustain production, in part because there is not enough knowledge for this, and in part because of short term economic considerations.

Also directly affected would be the lifestyle of the remaining indigenous populations, many of whom are negotiating return of land and recognition of property rights. The Guató indians who are negotiating the return to their island in the Paraguay River, in the Pantanal, would be directly affected by the Hidrovia and their chances of survival reduced. Unemployment produced as consequence of the Hidrovia, to local fishermen, to local people involved in fishing tourism and ranch employed people would not be

replaced. The social consequences of unemployment of people who lack the skills required in a modern and rapidly changing society, such as social alienation, abandoned children and increase of teenage prostitution, have unfortunately become all too familiar, particularly in the developing countries.

VI. Economic analysis of the Hidrovia project

The first economic analysis of the Hidrovia project, conducted by Internave (1992), shows a positive net return for the project of 17.88% for the spontaneous integration scenario and 26.22% for the intentional integration scenario. The spontaneous integration scenario is the most conservative and assumes that growth in shipping will occur naturally, while the intentional integration scenario assumes that growth will be stimulated by the formation of a common market from countries of the La Plata Basin. It is limited to a simple analysis of benefits resulting from savings in transportation costs considering the costs of construction, maintenance and equipment. However, in a review of the Internave analysis, Bucher et al (1993) found that, because of calculation errors, the internal rate of return of the project under such assumptions would actually be 6.2% for the spontaneous integration scenario and 14.4% for the intentional integration scenario.

Two additional shortcomings of the existing economic feasibility study were identified that suggest the savings in transportation costs attributable to the project are overestimated -- it is assumed that, without the project, *shipping costs will increase as production in the region increases, but that with the project, these costs would be less*. Three other key assumptions are that: 1) transportation costs are US\$ 0,007/ton/km by water, US\$ 0,05 /ton/km by road and US\$ 0,017/ton/km by rail; 2) that shippers will always select the least cost shipping method available; and 3) that the only variable costs of water transport are the operation costs of the ships and barges, which neglects to consider the constant dredging operations necessary to maintain the channel.

Another source of uncertainty identified by Bucher et al (1993) that would directly affect shipping costs, is that structural and institutional barriers may prevent producers from transferring their current shipping modes to water transport. For example, shippers have invested in trucks and shipping terminals, have contracted with railroad and warehouses facilities, and have formal and informal relationships with labour suppliers along existing routes of transportation. Changes are not costless, nor without risk. Moreover, even if there is a desire to change transportation modes, the need to depreciate existing capital before reinvesting in alternative transportation equipment, facilities and long-term contracts may preclude shifting from overland to water transportation for a considerable time.

An analysis of the same data, by a group of NGOs -- CEBRAC, ICV & WWF (Galinken, Guimarães, and Libânio 1994), found that even if the Hidrovia is implemented as planned, with the maximum of transport of Brazilian grains, the internal rate of return, in the most favorable situation, is very near 12%, which is considered the minimum acceptable rate of return for this kind of project. In what they consider more realistic scenarios, the internal rate of return is lower than 12%. If just some of the environmental

costs are considered, even with the assumed maximum level of transport, they estimate the internal rate of return would be 2/3 of the minimum value that would be accepted by the Intergovernmental Committee of the La Plata Basin.

Subsequent to the preliminary economic feasibility study discussed above, more extensive economic and engineering feasibility studies and an environmental assessment were conducted by the Intergovernmental Committee on the Hidrovia (CIH), under the sponsorship of IDB and UNDP, that were intended to include environmental costs. However, an expert panel convened by two NGOs to review these assessments (Dunne et al. 1997) found that the included costs were arbitrary and represented only a small fraction of potential costs, that impacts that appeared difficult to value were simply assumed to be negligible, and that cumulative impacts and uncertainty were ignored. Methods used to estimate those impacts that were valued were found questionable -- for example, impacts were classified as high, medium or low based on the percentage of resources in an area that were expected to be affected. Following this logic, estimates of decreased yields from fisheries were simply assumed to be a percentage equal to the percentage of water area affected by turbidity, ignoring the complexity of increased hydrological variability and of ecological interactions such as are described in this chapter. Although these studies included biological surveys and surveys of indigenous populations, this information is not reflected in the cost estimates and is presented descriptively, without analysis.

The ultimate estimate of environmental costs however, is simply based on estimated costs of proposed monitoring and mitigation measures (\$1.7 million a year compared with the \$7 million spent on these assessments alone), which the expert panel judged to be a gross underestimate. According to Panayotou (1997) (a member of the expert panel), reasonable estimates of costs of potential impacts could have been obtained with standard contingent valuation surveys that assess willingness-to-pay to avoid harm and willingness-to-accept compensation for damages.

VII. Valuation in a participatory, conflict resolution framework

In calling for a “broader analysis including all of the relevant benefits and costs” (Bucher and Huszar 1995), an implicit unanswered question is how to decide and agree on what are to be included as costs. To a large extent, this is arbitrary and depends on how the problem is framed, which in turn depends on the interests and perspectives given a voice in the decision process, what are considered to be relevant factors in decision-making, and the kinds of solutions proposed. Bucher and Huszar avoid this issue by simply suggesting that the benefit-cost method is appropriate as a way to rule out areas where development is clearly not cost effective - which they conclude it would not be if any additional environmental costs were included. However, this doesn't change the arbitrary nature of the task.

Standard valuation methods used to determine costs and benefits are also problematic when applied to complex problems, particularly, in developing country settings. For example, Moran and Moraes (1999) who conducted a CV study in the Pantanal to assess the value of the sport fishery, call attention to the difficulty of surveying the affected

populations with a single survey instrument, as they come from a wide range of socioeconomic classes. It is also difficult because the resource in question has significant subsistence and non-use values. Use of multiple survey instruments on the other hand, contribute to a perceptual problem, of determining what is being valued, and of reconciling the information obtained. Because of perceptual differences, there is also no objective verification of what is being valued and it is difficult to project the results of the survey beyond the socioeconomic group dominant among the survey respondents.

When faced with new kinds of complex problems that are beyond the response capacity of existing institutions, and in which uncertainty and value conflicts are inherent, an adaptive approach to valuation is called for, that provides stakeholders the opportunity to reconsider their values in light of new information, and to engage in a process of negotiation and conflict resolution among those with different perspectives. Valuation itself then becomes an institutional problem, of access to participation in the decision-making process (Wynne 1997). This implies the need for qualitatively different kinds of information than when problems can be defined in narrow technical terms. Given that complete information is unobtainable, there is no “right price” that can be determined using the “right methods”. Prices are not simply a matter of supply and demand but rather, are negotiated and reflect prevailing institutional structures such as property rights, power relationships, and the ability to pay to avoid harm (O'Connor and Martinez-Alier 1997). Standard valuation methods are also not appropriate when public goods are involved, because decisions affect others and cannot be justified on the basis of individual private preferences— to be seen as legitimate, they need to be justified on the basis of how they affect the public rather than individual interests (Jacobs 1997). A key consideration is what is to be sustained, which involves social objectives.

From this perspective, environmental problems are viewed as social and political conflicts regarding the distribution of risk among different social groups both within the present as well as between the present and the future (O'Connor 1997). They may also give rise to conflicting values within individuals derived from their multiple social roles and interests, as citizens and as consumers (Sagoff 1988). Identification of existing and potential conflicts can serve to anticipate difficult decisions that will need to be made, and provides an opportunity to reframe problems in a broader context and reconsider what factors are considered relevant to the decision. Often, “explicit value statements about the environment emerge only when these principles are compromised or ways of life are threatened.” The objective of valuation then becomes one of finding an accommodation among multiple and often conflicting goals and aspirations for the future, identifying the resources needed to achieve them, and the difficult choices to be made or opportunities forgone (O'Connor 1997). This implies “satisficing” of needs and an ideal of achieving symbiosis between different interests, rather than optimization, which presumes a single correct choice in accordance with values revealed by the market.

Narrow and technical definitions of the problem and use of deterministic valuation methods that do not take uncertainty into consideration merely reinforce such conflict by imposing a particular perspective. Also, by implying that there is a single correct answer, participation is reduced to an exercise in public relations intended to sell an expert point of view that pretends to be value free. However, value judgments remain implicit in the problem definition. By viewing the problem in a larger context or frame of reference, we

can also recognize that decision-makers themselves are intrinsic to the system and are influenced by feedbacks, such as pressure from interest groups, rather than neutral external forces who may influence the system through policy and technological instruments for the sake of efficiency.

In the case of the environmental assessment for the Hidrovia project, narrow definition of the project and its impacts, limited to consideration of dredging the channel, in effect excludes not only the construction of ports, barges and service roads that would be associated with it (Dunne et al. 1997), but also most of the issues considered important by many of the stakeholders. In addition to the direct impacts of dredging and consequences of altering the hydrology, a primary concern is with the cumulative impacts that would result from the broader vision of regional development that would be supported by the Hidrovia. This includes expansion of commercial agriculture, mining and processing of iron and manganese ore, and timber export.

For example, not considered are the impacts of expansion of trade and commercial agriculture that are implied by the development of the Hidrovia. These have the tendency to displace small and subsistence farmers, and to favor the larger scale enterprises, which results in increased economic disparity and land use conflicts that, in a number of other cases, have also been violent. As illustrated by May (1997), previous expansion of trade in the southern cone region, which led to dislocation of Brazilian wheat production to Argentina, has already raised doubts as to whether there is in fact any overall net benefit - - after considering the environmental and social costs of labor and land use dislocation in the push country, the environmental costs of intensification in the pull country, and increased transaction costs. If there was, it was not evident in the price of wheat flour in Brazil, which remained the same after opening of trade to Argentine wheat. According to May, the distribution of returns from trade accords and infrastructure investments has more to do with geopolitical imperatives and policy choices that are not revealed in econometric modeling of price response behavior or cost-benefit analysis, which suggests that resolution of these conflicts requires a political rather than technical arena.

In addition to the need to consider cumulative impacts, participants in a public forum held after the Pantanal workshop sponsored by the SCOPE/UNEP project on Ecological Economics and Integrated Assessment, specifically called attention to the lack of a relationship between the different assessments conducted for the region – specifically the Hidrovia assessment sponsored by IDB and UNDP, and the conservation assessment for the Upper Paraguay River Basin sponsored by the World Bank in conjunction with regional governments and research institutions. In the expert panel report (Dunne et al. 1997), Panayotou points out that even within the environmental assessment, there is little or no relationship between estimates of economic value and surveys that were conducted. Salati and Klabin also call attention to the need to evaluate the project in the context of cumulative impacts associated with global climate change.

Although multilateral development agencies in general, and UNDP in particular, are in principle committed to public participation in decision-making, the expert panel found participation to be virtually nonexistent in the assessment process. As implemented, “participation” has consisted of unspecified interviews and public meetings for purposes of information exchange, following which public and NGO concerns were formulated as

key questions that were then answered with information from the assessment. Information was not well disseminated to those who would be most affected, who did not actually have an opportunity to influence the decision, and who appear to have been invited to participate in a decision already made, rather than in negotiating a shared vision of regional sustainable development objectives.

Lack of transparency makes it difficult to determine whether the decision is based on anything other than geopolitical considerations and the interests of those who stand to benefit directly. According to the expert panel (Dunne et al. 1997), no benchmark study of poverty was conducted that could provide a basis for determining whether the project contributes to poverty alleviation. They also conclude that the project would most likely increase economic disparity. Failure to address such issues in the context of the Hidrovia and similar projects may lead to a crisis of legitimacy for those governmental and multilateral organizations who are supporting these kinds of projects and who have also committed themselves to public participation and to an interpretation of sustainable development as development that meets human needs in the present without sacrificing those of future generations.

Ultimately, the framing of issues and analytical methods used depends on the explicit or implicit policy objective. The cost-benefit analysis decision framework is associated with the objective of weak sustainability, because an underlying assumption is that manufactured capital can substitute for natural capital, that uncertainty can be at least probabilistically quantified, and that values are commensurable by reducing them to a common denominator of monetary values. At a very minimum, this would need to include environmental costs through some of the standard environmental valuation techniques (e.g., defensive expenditure, replacement cost, substitute goods, travel cost and contingent valuation). However, if the objective is strong sustainability, which implies protection of natural capital, the magnitude of uncertainty and the high stakes associated with proposed and imminent large-scale irreversible development activities suggest the need for a broader approach. At a minimum, such an approach should allow consideration of proposed development and its impacts in the same context as conservation planning, and provide all stakeholders an opportunity to express their future aspirations for the region before such decisions are made. This could in turn provide a yardstick or criteria with which to evaluate cost effectiveness of proposed development activities for achieving those aspirations and to identify the tradeoffs and the choices involved.

IX. Valuation as an Institutional Challenge

Participatory processes present an institutional rather than a methodological challenge, and require a process of social learning and capacity building in both developed and undeveloped countries alike. Social learning refers to attitude changes among participants in the process, as a result of involvement in working out a mutually acceptable solution to a problem (Webler, Kastenholz, and Ortwin 1995). By considering “what is at stake” and “what kind of a future they want to sustain”, mutual interests can be identified that provide the legitimate basis for policy. Coexistence then becomes a problem of design

and scenario negotiation. According to Davis (1996), many of the constraints have to do with styles of governance and administration which run counter to democratic or participatory modes of decision-making, and cannot be changed by legislation alone, or by holding public hearings that are in effect inaccessible to those most affected and that don't actually provide an opportunity to influence the decision.

Although participation can be expensive and time consuming, there are also arguments and historical cases showing that the costs of not using a participatory approach in the initial phase can also be quite high. According to Hanna (1995), participation can also contribute to economic efficiency because it allows for a better understanding of the resource context, i.e., "a description of resource users, processors, markets, and the analysis of social and economic characteristics of all resource interests". This in turn provides the basis for designing more effective resource management programs that reflect their social and environmental context, and allow for anticipation of regulatory implications and conflicts.

Even if the Hidrovia project were to go forward, processes for public participation in decision-making would still be important because they would facilitate the development of social and institutional infrastructure that would be crucial to its success beyond the construction stage. According to Ostrom et al (1993), social and institutional infrastructure may be equally important factors because they provide the structure of incentives that determine whether a project will be maintained. In an evaluation of 25 World Bank projects, efforts to enhance institutional capacity at the design stage was found to be a key factor that distinguished 12 of them that remained economically sustainable following the termination of financial and technical support. Such processes also provide a foundation for democracy and would also give those affected a means for understanding and adapting to the magnitude of changes that are expected under such circumstances.

An illustration of the costs of not including stakeholders in the early planning stages is seen in the Mississippi river basin, where flood control structures have paradoxically led to an increase in flood damages. The marshlands of the Mississippi delta are also disappearing because these structures prevent silt transport and deposition to these areas. Not included in the extensive costs of flood damages are the costs of extensive basin-wide litigation, loss of trust and destruction of long term relationships among state governments, as well as destruction of ecosystems, found in the basin of the Missouri river (the major tributary of the Mississippi) as a result of large inequities in the distribution of costs and benefits among stakeholders. Development in that basin was based on the 1944 Pick-Sloan plan -- an agreement developed by federal agencies and that was intended to benefit all parties in the basin but which primarily benefited the lower basin states at the expense of the upper basin states. Indian tribes, who legally hold senior water rights in the basin and who paid the highest price through loss of land to flooding for reservoirs and displacement of population, were excluded from the process (Thorson 1994). Monetary damages in the 1993 flood alone, which brought about the failure of approximately 1000 levees, were estimated at 16 billion.

The value of a meaningful participatory process in the planning phase of large development projects is perhaps best illustrated in the "Mackenzie Valley Pipeline

Inquiry" which took place in Canada in the 1970s and which challenged Canadian assumptions regarding development in the far north (Berger 1977, 1988). At the time, there was a controversial proposal to build a 3860 km pipeline from Prudhoe Bay on the north coast of Alaska, to the southern, interior region of Canada, across the arctic coast, the caribou migration route, and the northern Yukon territory. A Canadian Judge, Thomas Berger, was asked by the prime minister, to form a commission to conduct an inquiry by holding public hearings on the subject. The pipeline project was largely viewed as a way to bring northerners into the mainstream economy and the hearings as little more than a formality. But in the course of the inquiry, in Ottawa, he found a region of conflicting goals, preferences, and aspirations, in which organizations both for and against the pipeline claimed to speak for all northerners. So he decided to conduct the inquiry in "the north" where he went to 35 communities and heard testimony from almost one thousand northerners and 300 experts.

The inquiry brought recognition of the importance of the subsistence economy, in a remote region in which the market economy would always be marginal, and that assumptions that guided the south of Canada didn't hold in the far north where, even if conventional economic opportunities were to become available. The commission's report, "Northern Frontier Northern Homeland", recommended that native land claims issues be resolved first, and that development plans be based on consideration of the northern way of life, and created an opportunity for a vision of progress that included native rights and environmental values. Old problems have not vanished and development activities are still at issue but the native communities now have a voice in the debate and, as land claims become resolved, have taken an active role in conservation planning.

The Mississippi case is not unique – only among those with better documented costs. Examples of development projects that became expensive failures are in abundance. Within Brazil, the expert panel that reviewed the Hidrovia assessments calls attention to Polonoreste, Carajás, Itaipu, the Trans-Amazonic Highway, and the expansion of mechanized soybean cultivation in southern Brazil and Paraguay. Particular attention is called to the Carajás project, which, like the Hidrovia, is a transportation project associated with expansion of mining and iron ore exports, and where the impacts of induced development have been particularly massive. From the perspective of promoting economic development and poverty alleviation, these are all considered to have resulted in costly failures because of massive influx of settlers, destruction of natural resources, pollution, land-tenure conflicts and increased concentration of large land holdings (Dunne et al. 1997).

The Berger inquiry may be unique in part because of the scale on which it was conducted. Bridging local, regional and global levels of discourse is a key challenge in an era of globalization and remote control -- as decisions are more likely to be influenced by international markets and climatic events such as El Nino than by local conditions. Successes are harder to identify because it depends on how success is defined and who benefits. The development of the Colorado River in the western United States is an example of development that has been perceived by some as "successful." However, this was in the past when the major competing water interests held all of the water rights and little if any consideration was given to impacts on third parties -- such as communities left with dry river beds and whose traditional institutional structures for resource

management were destroyed. This is changing as the large historical water interests, primarily irrigation and hydroelectric power, are forced to compete with growing urban areas and environmental concerns as well as with legal challenges from Indian tribes. The issue of “instream flow”, i.e., whether keeping enough water in the river to support fish and ecosystem integrity is a legitimate use of water or whether it is “wasteful”, reflects an underlying clash between those who value off-stream and in-stream uses of water (National Research Council 1992). This is not an issue that can be resolved through optimization. As with the Berger inquiry, the end result is an ongoing process of conflict resolution and negotiation regarding the distribution of rights and responsibilities.

X. Conclusion

The Hidrovia project is reminiscent of a large number of controversial water development projects, many of which are now being restored at many times the cost of the original development activities. For example, it is estimated that US\$ 2.5 billion is required to restore the Kissimmee River and Lake Okeechobee in the Florida Everglades, with US\$276 million being spent just to restore curves, or approximately eight times the cost of the original channelization and straightening (ENR 1990). Cost-benefit analysis itself was originally developed to support decisions for large and controversial water projects in the early 1930s (Hanley and Spash 1993; Porter 1995).

Sparseness of data and complexity of the Pantanal ecosystem both suggest limits to precise predictions of impacts of the hidrovia project. However, because of its location in the headwaters region of the large international La Plata river basin, the project has the potential for both local and distant large-scale irreversible impacts on the hydrological cycle and the scale and extension of the flooding period – to which the Pantanal ecosystem with its exceptional characteristics and level of biodiversity, existing traditional economies, and their associated land uses and management practices are closely coupled

Because of irreducible uncertainties, this complexity may be impossible to capture in a technical framework that seeks to establish pathways between all causes and effects of any kind of development project, and it is unlikely that these could be ever be compensated for through investments in manufactured capital. It may also lead to emergence of new kinds of problems and uncertainties that are beyond the realm of past experience and the response capacity of existing institutions. This problem is not one of how to correctly incorporate all of these unknown costs into a cost-benefit analysis, but rather, one of incorporating multiple perspectives into the decision process, and considering multiple criteria in the decision itself. Regardless of whether or not the Hidrovia project goes forward, the large and regional scale of potential irreversible impacts warrants a more extensive process of public deliberation in the context of an integrated assessment, that provides a basis for mutual understanding if not agreement among a wide range of interests, and gives a voice to those most affected.

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