GOOD AND BAD FORMS OF PARTICIPATION IN WATER MANAGEMENT: SOME LESSONS FROM BRAZIL

Jerson Kelman

Abstract. Implementation of hydraulic infrastructure usually stirs controversy and raises several questions. Some are of economic nature. For example, would the beneficiaries pay the entire cost? Others are related to less tangible issues. For example, who are the stakeholders and in which degree their interests should be taken into account? Would it be only those to be resettled? Or perhaps, in case of hydropower, all those that would benefit from the electricity transported by high voltage transmission lines, even if they live thousands of miles from the infrastructure? These questions are answered through the description and discussion of four case studies.

Keywords. Sao Francisco River; Dom Luiz Cappio; Trans-basin Diversion Project; Water Security; Minimax Criterion; Water Rights; Water Rationing; Output Based Aid; Sewage Treatment; Greenhouse Gases; Natural Gas; Bolivia-Brazil Pipeline; Argentina-Brazil Electrical Interconnection; Amazon; International Rivers Network; Gas Fired Thermal Plants; Socio-Environmental Licensing of Hydropower; Santo Antonio Hydro Plant; Madeira River.

Author Bio. Jerson Kelman is the general-director of the Brazilian electricity regulatory agency – ANEEL and board member of the Brazilian Foundation for Sustainable Development – FBDS. Previously he was president of the Brazilian water regulatory agency - ANA. Since 1976 he has been professor of water resources at the Federal University of Rio de Janeiro. In 2003, he received the King Hassan Great World Water Prize.

KELMAN, J.**Good and Bad Forms of Participation in Water Management: Some Lessons from Brazil.** In: DINAR, Ariel and ALBIAC, José (Org.). Policy and Strategic Behaviour in Water Resource Management, Earthscan, 2009, p. 189-206.

1. Introduction

On his first hunger strike in protest against the Sao Francisco river interbasin transfer project, Dom Luiz Cappio - a bishop of the Catholic Church that lives in a small city at the banks of the Sao Francisco River – was successful by getting an agreement with the Federal Government. When finished the interbasin scheme will benefit 10 million people outside the Sao Francisco basin that, on the average, have a very low income, mostly due to climatic uncertainties. He halted the hunger strike under the Federal Government commitment to promote a national debate about the project and restore the river basin, essentially through investments on sewage collection and treatment, as well as on the protection of the river banks against erosion.

The Government kept its word but Dom Luiz changed his mind and went into a second hunger strike. This time it seemed that he was prepared to die, if necessary, in order to halt the construction works. The political iron arm between Dom Luiz and the Government took the duration of the hunger strike – almost one month. It was followed closely by the media and aroused intense debate and deep emotion in millions of Brazilians. Many thousands went trough short duration fasts in solidarity to Dom Luiz.

A bishop is not a naïve person. He knows that a democratic government cannot give in to blackmail. So, what was his intention? To achieve sanctification through self sacrifice? Perhaps, but more likely, he counted on beating the government once again. After all, from the Government's point of view, it would be unthinkable to allow him to become a martyr. If in fact the Government had given up, Dom Luiz would become an important religious leader. This is less than being a saint. But there is no need to die.

However, the Government stayed firm. Minister Patrus Ananias, a devote catholic responsible for social security, classified the bishop's behavior as blackmail by suicide. He asked what happened if another Bishop started a hunger strike for the project?

When Dom Luiz's health reached a critical condition, he accepted the advice from his physician and ended the hunger strike.

Dom Luiz was not interested in a win-win alternative. After the first hunger strike, he was received by Mr. Lula da Silva, the Brazilian President, in a meeting where

technicians tried to explain that the infrastructure being built would not harm the river basin because less than 3% of the mean flow of the river would be diverted. From the positive perspective, this small quantity of water would benefit enormously the population living in the receiving area. Dom Luiz kept silent during the entire presentation. At the end, he said that he was not interested in technical or economical explanations. He knew in his heart that the project was evil. He refused to discuss the issue within a rational framework. His point of view was supported by faith, not by reason.

The current Brazilian democracy was installed more than twenty years ago, but it still carries the scars of the previous autocratic regime ruled by the military, for a similar period of approximately twenty years. These scars are engraved in the current Constitution, approved in 1988, when the record of violation of human rights of the previous regime was still fresh in the memory of the population. The Brazilian Constitution strongly supports individual rights, frequently at the expense of collective rights. This explains why Dom Luiz's standpoint has become such an important issue in the country.

In this paper a few cases related to water resources allocation and river use dispute will be described. The focus will be on the description of an environment where the search for utopist unanimous decisions often obliterates the functioning of the democratic decision making process. This is an issue common to many countries which lack strong democratic traditions and institutions. For these countries, extreme care should be adopted when enunciating a problem to be solved. One should resist the temptation of assuming that stakeholders will act in an objective, rational pattern. This would be helpful to make the problem solvable by some mathematical friendly decision making process. But it could produce a "solution" that would lack political feasibility.

2. The Sao Francisco River Interbasin Diversion Project

Table 1 shows the main features of the Sao Francisco River. Despite its impressive drainage area (larger than France), is entirely located in Brazil, covering 5 of the 27 states (Figure 1). A brief description of the Interbasin Transfer Project (from now on referred to as ***Project***) is presented in Box 1. Its purpose is to convey excessive water of the donor

basin in wet years, that otherwise would flow into the Atlantic Ocean, to be stored in the existing reservoirs of the recipient region (Figure 2). The ***Project*** will work in a dual mode. The high mode will be activated in wet years, when the main reservoir of the Sao Francisco (Sobradinho, which storage capacity is 34 billion cubic meters) will be spilling or close to spill. In this case, the pumping will be at highest capacity of 127 m^3/s and the opportunity cost of the electricity used in the pumps will be close to zero. Otherwise, the low mode will be activated, which means a pumping of only 26 m^3/s. Roughly, this is equivalent to 80 cubic meters per capita per year. Simulation studies have shown that the probability of operating in low mode is close to 60%.

As it became clear in the introduction, the ***Project*** has caused heated discussions. On one side, those that view any water exportation as the bleeding of a dying river. They think that diverting water is analogous to forcing an unhealthy person, under intensive care, to donate blood. On the other side there are those that prefer the analogy of the Sao Francisco River being a healthy person donating blood in order to save the life of a moribund region located outside the river basin.

It is regrettable that both sides appeal to these dramatic and emotional images because it limits the discussion to irrelevant topics. But before revealing what are the relevant topics, it is necessary to give a brief description of the recipient region.

The water availability of the recipient region, formed by the states of Ceará, Rio Grande do Norte, Paraiba and Pernambuco (Figure 1), considering the regulated outflow of the existing reservoirs, would be sufficient to meet, for several years in the future, the basic needs of the population (roughly 40 cubic meters per year is all one person needs to drink, bathe, clean and cook). Dom Luiz thinks that all the Government should do is to help people have these basic needs attended. This may mean the construction of pipelines to connect remote villages to the local reservoirs or the building of individual tanks, one per household, capable of storing rain that falls on the roofs.

However water is not used exclusively to satisfy human consumption. It is also used as input for agricultural or industrial production. Taken all the water uses into account, it is necessary the order of 1,500 cubic meters per year and per capita for a

technologically unsophisticated community to achieve a reasonable income level and, associated with it, a reasonable quality of life.

Because the water availability of the recipient states is around this threshold level, there are two possible policies for the region: export people or import water. The first alternative has been implicitly applied for decades, as a significant portion of the population in the Brazilian Southeast, including President Lula, as a child, migrated from the dry Northeast. This alternative is defended by those that propose public investments where water is easily available, like in the Sao Francisco River valley. These investments would create an immigration flux coming from the dry area, and the problem would be solved. The second alternative is more political than economical. It tries to avoid the suffering of moving millions out of places that have been inhabited for centuries and where successive generations have built an infrastructure to survive in the semi arid.

The recipient region has very limited groundwater and on non-perennial rivers. The obvious solution has been to store water, which the region has done. However water managers face a major problem in reconciling two conflicting objectives. Objective One is to ensure that the cities of the Northeast have water in the droughts which regularly ravage the region. To achieve this objective water managers have to hold water in the reservoirs for years. Objective Two is to maximize the number of jobs and economic product from available water. The conflict arises because pursuance of Objective One means that, with very high temperatures and low humidity, immense quantities of water are lost through evaporation producing neither jobs nor economic product. The reconciliation of this conflict requires that managers can have some other mechanism for meeting basic needs in times of drought, so that evaporative losses can be reduced and existing water resources can be used more productively. In other words, managers need to have the possibility of using water from the Sao Francisco in case a drought lasting several years occurs, like one that happened in the XIX century, when close to one million people died.

Most of the irrigated land in the recipient region yields low economic value crops, such as beans. Considering that a hectare planted with mango trees is much more

profitable than if planted with beans, why someone would choose to grow beans rather than mangos?

The main reason is the lack of water security. In this situation and applying the minimax criterion, it makes sense to decide in favor of the beans. Explanation: if there is a water failure, the damage is limited to one year; on the other hand, lack of water for someone that has planted mango trees may imply a much greater loss because the tree may die and a new one would take several years to yield the first fruits. For the same reason, few job intense industries decide to open factories in the region, despite the low labor cost. The Brazilian Northeast has been the set of this "vicious cycle": people are poor because there are few investments to raise high value crops; there are few investments because there is no firm water supply; there is not firm water supply because people are poor and can not pay the firm water supply cost.

There is a strong correlation between poverty and lack of water security, although world statistics based on mean values may fail to capture it. Indeed, depending on the size of the region/country and on the internal hydrological diversity, mean values may mean little. Brazil, for example, which covers roughly half of South America, has a per capita availability of 36,000 m^3/year, which is much higher than the threshold level. Nevertheless, scarcity of water is the major problem in the semi arid Brazilian Northeast because: (a) the variance of the annual river flows is very high; (b) the rainy season is short, typically three months; (c) most of the rivers are intermittent due to the low water retention capacity of the shallow soils (the Sao Francisco is an exception and for this reason it is called the Brazilian Nile). In this environment, life would be impossible without the existence of hundreds of reservoirs which were built along the last decades.

Most of the prosperous regions of the world do not suffer water scarcity. Exceptions, like the American West, were benefited by heavy investments on water infrastructure. However, water security is a necessary but not sufficient condition to achieve progress. An example is the population of the donor region, living in the Sao Francisco River basin. Although there are a few prosperous zones in the basin, due to the production of fruits for exportation, most of the population is still very poor.

Worse, they believe, insufflated by Dom Luiz and others, that if the ***Project*** is constructed they will become poorer. In a strange way, they could be right. The financial resources devoted to the ***Project***, all other factors remaining constant, would probably exhaust the Government's capability to invest on other projects that could benefit the population of the donor river basin. In other words, the dispute for water between the donor and the recipient regions is unjustified, but for money it is real.

The Government understood the nature of the problem and decided to invest in the Sao Francisco River Basin Revitalization hoping to calm down the opposition, lead by Dom Luiz. At the expense, obviously, of other parts of the country. But Dom Luiz and others ignored the Government's initiative, putting at risk the win-win outcome. They preferred to center the discussion on a moral issue: the pretense right of the population of the donor basin to freely decide how to allocate the water.

This is a false premise. First, because there is more water than it would be necessary to satisfy, in the foreseeable future, all the water needs for consumption in the basin and for exportation to the recipient region. This has been demonstrated in the Sao Francisco River Basin Plan, developed by the Brazilian water regulatory agency – ANA. Second, because the population of the river basin does not own the river. It is a natural asset of the country and should be used in the benefit of all Brazilians, living inside and outside the basin.

The absurd suspicion, highly inflated by the media, that the ***Project*** could "kill" the Sao Francisco River, led to a diversion of the Government's focus of some relevant topics. First, the ***Project*** did not include the implementation of a capillary network of shorter and smaller channels and pipelines, both in the recipient and the donor regions, in order to convey the water from local reservoirs to wherever people live and work (Figure 2). In fact these hydraulic structures should be built before initiating the major construction works that will allow exportation of water. Unfortunately Dom Luiz and his followers failed to understand that these smaller hydraulic structures, although necessary, would not be sufficient to solve the drought problem. Local reservoirs need to receive water from the Sao Francisco River, in addition to the intermittent flow of local rivers.

Second, water users in the recipient region did not commit themselves to pay for the use diverted water before the beginning of the construction works. This means that very likely they will be allowed to get benefices from the ***Project*** without assuming any responsibility. In this unfortunate possibility, the maintenance cost of the ***Project*** would depend on the governmental budget. In developing countries this is not a good option because it is easier to convince politicians to build a new structure than to maintain an existing one.

The Government should have set the political, legal, institutional and financial arrangement for the operation and maintenance of the ***Project*** before hiring any contractors. In reality it only achieved to set the first one: the political arrangement. Governors of the recipient states signed a political pact recognizing their interest and joint responsibility in the ***Project***, but the water users, public and private, have not been obliged, as they should, to commit themselves to pay at least the O&M costs of the ***Project*** through firm contracts. As it is, there is not proper ownership and the whole infrastructure could become a white elephant.

Third, although a water rights system has been successfully implemented by ANA in some river basins in the semi-arid Brazilian Northeast, it is still necessary to extend this experience to all basins of the region and adopt enforceable rationing procedures (Kelman and Kelman, 2002). The key is to have a system which recognizes that there are many "waters" – at the extremes low reliability and high reliability (and similarly for quality). Entitlement and tariff systems must differentiate between these different products.

The lesson from this case study is that policy makers should focus attention on the real problem to be solved and refrain from paying excessive attention to issues raised by people that in fact do not want the status quo to be changed.

3. Water Supply to the Metropolitan Region of Sao Paulo - MRSP

The hydraulic connection between the Piracicaba River basin and MRSP, located outside the basin, occurs through a series of reservoirs, tunnels and channels, forming the so called "Cantareira System". Mean natural inflow to the system is 40 m^3/s and the maximum authorized flow out the system, through the conveyance structures, is 33 m^3/s.

The authorization for the diversion was granted by the Federal Government in 1974, at a time in which there was no dispute for the use of water. The authorization was valid for a period of 30 years. In recent years the political leaders of the donor basin resented the effects of water shortage and claimed that the authorization should be revised in order to decrease the water quantity at the authorization renewal date, in 2004. Their purpose was to remove the bottleneck to the development of the valley itself. But, contrariwise to the political and religious leaders of the Sao Francisco valley, they never denied the possibility of an authorization. Interestingly enough, the percentage of diverted flow in the Piracicaba case was 83% of the mean flow, as compared to less than 3% proposed in the Sao Francisco case!

Differently from the Sao Francisco case, in the Piracicaba case it was possible to keep the discussion within a rational framework. The leadership of the donor basin knew that the interruption of flow to MRSP would create a chaotic situation that would harm all.

Both the donor basin and the recipient region are intensely populated and highly industrialized. The MRSP has a population of 18 million people, 39 counties, concentrates a significant share of Brazilian GDP and demands a supply flow of 65 m^3/s. Many important big cities are located in the donor basin and their interests are defended by a capable political leadership that acts in the river basin committee.

In order to decide on allocations to the MRSP and downstream to the Piracicaba basin, it was proposed the constitution of an "allocation authority". However, it was soon detected that this would only transform a problem that could be solved once and for all into a recurrent problem to be solved every month. Worse, the political battle would be around who would be entitled to integrate the authority, rather than on how to evaluate the costs and gains of each possible allocation.

Instead of that, ANA and the Sao Paulo State Government chose a "mathematical solution" very simple to understand. It is based on a pro rata allocation of the inflow proportional to the basic water needs respectively in the donor and in the recipient regions. Volumes of water that are eventually not used are counted, for later use, as if there were stored in a "water bank". Occasional overflows are also counted and

subtracted from the “savings” of each region, proportional to the volume each region decided to keep in storage. This naïve proposition was the object of intense debate, particularly in the Piracicaba Basin committee. At the end, it was approved by all.

The lesson from this case study is that stakeholders participation in the decision making process is a necessity. Nevertheless, this participation should go beyond the mere selection of representatives that will make the actual decisions. Stakeholders need to understand the rational of the water allocation criteria and agree that it respects common sense. The best water allocation rule is not necessarily the optimal one, from the economical point of view. A simple rule, but highly understandable and accountable, may be the best choice. This is the case of the Piracicaba-MRSP hydraulic connection. (The record of water allocation and use of the two regions can easily be accessed on the following website:

http://www.ana.gov.br/bibliotecavirtual/pesquisa.asp?criterio=cantareira&categoria=0&pesquisar=Pesquisar&NovaPagina=1)

4. Sewage treatment

Considered as a country with abundant freshwater, Brazil has been using its rivers in an unorganized manner. The previous case study of the MRSP is a good example. The local water and sewage company must get bulk water from a river located some 100 km away, as the rivers in the metropolitan area are, to a large extent, too polluted to be used for water supply.

The Brazilian Water Act of 1997 allows the implementation of water charges, both for diverting bulk water from the rivers or for polluting them, so as to prevent abuses. The Act was enacted as a reaction to the business as usual scenario, in which rivers would continue to be degraded, penalizing current and future generations on their water capital.

The Water Act adopts the "polluter pays" principle, an idea successfully implemented in Europe: whoever pollutes more pays more. The River Basin Committee decides how much and who to charge for discharging polluted effluents. The committee is a sort of "water parliament", with representatives of federal, state and local

governments, civil society and the productive sector. To this last segment belong the companies that use the river, such as water and sewage companies, irrigation districts, hydroelectric plants, navigation companies and some industries located along the river.

The funds raised are invested in programs aimed at the improvement of the rivers conditions, according to the priorities set by the Committee. In order to boost the Committees' activities, the Brazilian water regulatory agency - ANA launched, during its first year of existence (2001), a revolutionary program based on "output based aid".

The River Basin Pollution Abatement Program - PRODES, focuses on cleaning up river basins. It does not subsidize engineering work or equipment, but pays for the final result, which is treated sewage. The Program consists in providing economic incentives for the construction of new sewerage treatment plants, aiming at the environmental recovery of the country's most polluted river basins.

Paying for treated sewerage is an innovative response to decades of ineffective subsidies, allocated to water and sewerage companies in Brazil and other developing countries. A considerable part of these subsidies were used up to build "white elephants", that is, huge ineffective infrastructure works. PRODES also depends on the taxpayer money. However it has improved the quality of public expenditures through reliance on a simple concept: it is more effective to pay for an actual result than for a promise of result.

Within the PRODES program the sewerage treatment is paid for throughout the first five years of the Sewerage Treatment Plant operation. The disbursement, however, is subject to an adequately provided service. If the service provision does not meet the required standards, the allocated funds, which have been deposited in a development bank, return to the National Treasury. The required standards are set in terms of sewage quantity and on the quality of the treatment. This arrangement reduces risks for both sides. It ensures the service provider that there is no *non-compliance* risks due to government budget cuts as the committed funds were set aside in a development bank. The Government, on the other hand does not take the chance of having to pay for inadequately implemented services.

The most interesting result of PRODES is not what went right, but what went wrong. In the beginning of the program, many municipal authorities responsible for

sanitation approached ANA, at the negotiation stage, with excessively ambitious projects, in terms of quantity and quality. When they realized the difficulty of fulfilling their promises, either because the sewage collection system did not work as satisfactorily as originally thought or because the pollution removal process was not as efficient as foreseen, they would return to ANA seeking a renegotiation. They came to the obvious conclusion that it is preferable to receive less than to receive nothing. The, population, on the other hand, stopped paying for a service that was not being rendered.

The lesson from this case study is that a policy of subsidies for sanitation is not necessarily bad, as it benefits the whole community, rather than individual citizens, contrariwise to the water supply case. However, these subsidies should be used to pay for results, rather than promises.

5. Hydropower

Rich countries have already used most of their hydropower potential (on average 70%), and developed their economies in the process. Brazil and other developing countries, on the other hand, have still a long way to go. Brazil has developed 27% and Africa 3% of the potential for this low-cost, renewable source of energy (Figure 3). Many developing countries could emulate Brazil's successful hydropower program, which accounts for more than 80% of the electricity production. Natural and technological conditions are ideal for major hydropower programs in many developing countries, including the mountainous countries, which are among the poorest in the world.

Hydropower technology is mature, proven, and applicable wherever there is falling water. Brazil has shown that the much-publicized social and environmental problems associated with hydropower can be addressed. Local people can and do benefit as Brazilian laws mandate that 3% of revenues from hydropower are fed back to local communities. Also, the environmental footprint can be dramatically reduced: the next generation of hydropower plants in the Amazon will, per unit of energy generated, inundate about 1% of the area inundated by last-generation technologies.

Given all these favorable conditions, one would think Brazil would stay clean, in terms of production of energy, many years to come. Unfortunately the future can be the other way around, thanks, mainly, to the efforts of some dam hating NGO's (for short,

DAHNGOs), both national and international. The DAHNGOs are doing their best to impede any new hydropower development, often in open conflict with other environmental NGOs that are truly concerned with the sustainable development. The DAHNGOs work is facilitated by the very liberal Brazilian system, in which a single, unaccountable prosecutor can hold up any project for years, on any pretext, irrespective to the stand point of his peers. A DAHNGO's power becomes immense when it manages to gain the hearth and mind of just one prosecutor. And there are thousands of them! The result in the energy sector is that Brazil is not using its abundant, cheap, climate-friendly hydro, and instead is using more and more fossil fuels and now more nuclear energy and cost more.

Probably there is not one single hydropower plant in the world with sufficient merits to receive the seal of approval by the DAHNGOs. They are few but capable of doing a lot of noise. In Brazil, they act to increase the complexity of the already cumbersome socio-environmental licensing process, including judicial disputes. They have successfully created a major obstacle for the timely and predictable expansion of generation capacity. This, in turn, is a serious threat to economic growth, elimination of poverty and controlling the emission of gases that enhance the greenhouse effect.

The DAHNGOs effort is facilitated by the fact that much of the Brazilian unexplored hydropower potential is in the Amazon, which is an environmentally sensitive region. It is understandable that people around the world get concerned with the perspective of constructing dams there. They fear that the rain forest could be destroyed, although only 0,25% of the Amazon land has been inundated or will be inundated in the next ten years by hydropower reservoirs.

The DAHNGOs take advantage of this fear. For example, International Rivers Network – IRN proclaims in its site that they are "working with a coalition of civil society organizations based in the region to stop the construction of these projects and promote viable alternatives to meet Brazil's energy needs."

It is reassuring that IRN accepts that a developing country has energy needs. This eliminates the simple and wrong alternative of freezing the per capita consumption at a level so low that the country would be condemned never to be developed (presently per

capita consumption in Brazil is 15% of the USA's). What then would be the viable alternatives?

Let's start with the most desirable of all: solar. In a tropical country, with plenty of sunshine all year around, this seems to be an interesting alternative. Indeed, most forms of energy derive from solar. For example, hydropower depends on rainfall provided by the hydrological cycle which, in turn, depends on solar energy for "pumping up water" through evapotranspiration. Also, solar energy provides the photosynthesis for producing sugar-cane-based ethanol.

Incidentally, the blend of ethanol to gasoline may be the simplest and most effective act to control the emission of Greenhouse gases. In Brazil, ethanol accounts for 32% of all energy used in automobiles, either through the mix with gasoline (20% ethanol) or in flex-fuel vehicles. The boost of ethanol consumption in the developed countries could help to mitigate poverty in several tropical countries. Brazilian ethanol production alone could easily increase six fold, to roughly 100 billion liters per year, without decreasing food production or cutting one single tree from the Amazon forest (presently the area planted with sugar cane is less than 3% the area dedicated to low density cattle raising). This would be sufficient to substitute 5% of the worldwide forecasted consumption demand for gasoline in 2025.

Solar energy can also be used directly to heat water for industrial and household use. This saves electricity and natural or petroleum derived gas and, obviously, is a good practice. But, when it comes to producing electricity directly from solar energy, unfortunately technology has not yet delivered a process in which the cost could be competitive. Presently, its unit costs is roughly ten fold the hydropower.

The second in the rank in the preference of environmentalists is wind-power. It is the world's fastest-growing energy industry with an average annual growth rate of 29% over the 1996-2005 decade (Florence, 2006). Unfortunately wind-power availability is intermittent, as the wind is. Contrariwise to water, that can be stored in reservoirs, there is no possibility of wind storage. Therefore, wind-power can only be used as complementary to some other energy source suitable to be turned on whenever necessary. Also, it is very expensive. Not as much as solar, but still the unit cost is roughly twice the

hydropower. It is a reasonable choice for countries that have to decide between nuclear or wind power, like Germany or Spain. But for a developing country that still has hydropower to develop, it would mean to abdicate from getting competitiveness in the global economy, which would be a strategically unacceptable decision.

Nevertheless, some countries are subsidizing wind-power in order to keep pace with the advances of technology. This is the case of Brazil where a program subsidized by the consumers was launched by Government to construct 1,100 MW. Although this is a significant amount of power, it will account for 1% of the country's installed capacity. This is not surprising: wind-power is always a small percentage of total power, even in countries that invested heavily on it. Germany, for example, the country with the highest installed wind-power capacity, gets only 6% of its electricity from this source. All considered, although wind-power can be used, it can not be considered the alternative solution for hydropower.

The next alternative is very competitive with hydropower: bio-electricity. It consists on burning the remains of a seasonal harvest to produce electricity. It is neutral in terms of emission of Greenhouse gases because the same quantity of carbon released to the atmosphere during the burning stage gets trapped into vegetal tissue, at the plant growing stage.

Because burning sugar-cane bagasse is an efficient way of producing bio-electricity, it may play a major role in developing countries, in case the developed ones decide to mix ethanol to gasoline. In Brazil, this is already happening. In the next three years, some 5,000 MW of bio-electricity plants are expected to be installed in the agricultural frontier, located in the states of Goias and Mato Grosso do Sul. These new plants, associated to sugar and ethanol production, are economically efficient and can compete without subsidies. Again, this is an impressive quantity of energy, but it is equivalent to just one year of the country's demand growth. All should be done, and is being done, to expand bio-electricity. However this alternative by itself is not sufficient do meet entirely the new load.

Much less desirable are the alternatives based on fossil fuels. The least harmful to the environment and least costly would be natural gas. But very few countries can

presently produce large quantities of it. Brazil is not one of them, mainly because the most important offshore fields were only recently discovered and a few years will be needed before they enter in the production mode. But some neighbor countries, namely Bolivia and Argentina are known, for a long time, to be rich in natural gas.

Only a few years ago the energy integration of the southern part of South America seemed to be a win-win situation. Accordingly a 2,200 MW transmission line was constructed to interconnect Brazil and Argentina, with the main purpose of transporting electricity that would be produced in Argentina by natural gas fired plants and consumed in Brazil. But the energy flux could be reversed when Brazilian reservoirs would be spilling. Unfortunately most investments on the energy sector in Argentina ceased when the energy prices were frozen by the Government in a movement to control a major economical crisis. Now this transmission line is used only sporadically. For example, in 2007 it served, during four months, to transport energy from Brazil to Argentina, which was experiencing a particularly severe winter.

The energy integration between Bolivia and Brazil is more successful but much more could be achieved. Presently some 30 million cubic meters of natural gas flows daily from Bolivia to Brazil trough a long pipeline. It is used by the industry, vehicles (some of them can run on natural gas, gasoline and ethanol) and gas fired thermal plants. This last use, for electricity production, only occurs when the reservoirs of the hydro plants are low. Presently, if all the gas fired plants were dispatched, there would be either a natural gas or an electricity shortage. Perhaps both shortages would occur simultaneously. As an emergency solution, Brazil decided to build two gasification plants capable of processing 20 million cubic meters per day of liquefied natural gas, which will be transported from producing countries by ships. This energy supply deficiency would not exist if in the last ten years hydropower entrepreneurs, public and private, had not experienced many rejections of their license requests to build new plants, either from the socio-environmental administrative branch or from the Judiciary.

Other than natural gas and among the fossil fuel alternatives one can think about oil and coal. Definitely, no environmentally concerned person or institution would think that this is a reasonable option. Oil and coal are the villains of the Greenhouse effect.

All considered, and contrariwise to the standpoint of the DAHNGOs, Brazil needs to develop its hydropower potential. The challenge is to do it wisely in order to avoid the errors committed in the past, mainly in the seventies, when some hydropower plants that today would get a red light, at the time got a green light from the ruling military dictatorship. This is what is happening – the area submerged per unit of power developed at the recently-approved 4000 MW Rio Madeira project is 3% of that for the infamous 250 MW Balbina project. Serious consideration has to be given to the socio-environmental constraints, which in practice means to have the ability to differentiate the good from the bad dam sites, adopting a holistic point of view. To do that, it is necessary to evaluate the trade-offs between the local (in general negative) and the global (in general positive) effects associated to the proposition of a new hydropower plant.

This task has become more difficult in recent years because of the fundamentalist wave, leaded by people and institutions like Dom Luiz and the DAHNGOs, against the construction of any new hydraulic structure. They have followers (fortunately not many!) working in the licensing agencies (State and Federal), in the Judiciary and in the Public Prosecutor's Office (incidentally, the power granted by the Constitution of 1988 to this institution is virtually without precedence in other countries). For them, there is no good dam site and their focus is on what are the bad things that can occur at the local scale if the proposition of a new infrastructure gets the green light. They never ask what would be the consequences in the global scale if it gets the red light. They focus entirely on the sins of commission, and avoid entirely the sins of omission

As a result of this myopic ideological environmentalism, close to 70% of all energy to be produced in Brazil by new plants in the next fifteen years will burn oil or coal. Before the fundamentalist wave, the share of oil and coal in the Brazilian electricity matrix was limited to 20%!

This terrible result was achieved through the conception of an environmental licensing process which is performed case by case, without an overall view of the system. Both, the Executive and Judiciary, tend to decide about the social-environmental feasibility of a new plant based mainly on local considerations, which is a criterion that benefits the thermal option. Explanation: hydro plants occupy in general large areas, are

site specific and displace local people, even in remote areas of the Amazon; thermal plants, on the other hand, occupy relatively small areas and can be built in carefully selected sites not to disturb local people.

The implicit objective function applied by the decision makers is to minimize local disturbance. Very little attention is given to the fact that if a large hydro plant can not be built because of local socio-environmental concerns, very likely it will be replaced by several small thermal plants that, although disturbing very little the local socio-environment, will collectively disturb severely the global environment though the emission of Greenhouse gases. Or even worse, no plants will be built and the electricity will not be produced, causing an economic crises. In any case, either the electricity will be more expensive because of the use of oil rather than water, or it will be unavailable. This would harm the country's competitiveness, decrease the number of jobs and increase poverty.

It is difficult to believe that even a DAHNGO would align itself to such evil purposes. But, perhaps unintentionally, some do. For example, in December 2007, the Brazilian electricity regulatory agency – ANEEL organized an auction to decide which company would get the concession to build the Santo Antonio hydro plant of 3,300 MW. It is located in the Madeira River (a tributary of the Amazon River that runs from Bolivia to Brazil), a few kilometers upstream of the capital city of the Rondonia State (Figure 1). The concession is for a period of 35 years. The bids were in terms of unit price of energy to be sold along 30 years, through firm contracts, to a set of distribution companies. The winner would be the one to offer the lowest bid.

The auction was the last step of a lengthy and laborious process of public hearings held by the Federal Socio-Environmental Licensing Agency (Ibama) and of disputes in the Judiciary. The DAHNGOs, including IRN, tried their best to impede the issuing of the environmental license. However, they had a difficult task due to four reasons.

First, Santo Antonio is a run-of-the-river plant. This means that its 'inundated area – installed capacity' ratio is much smaller than of the old hydro plants built in the seventies. For example, its ratio is 3% of Balbina's, which is a "bad" hydro plant located in one of the Amazon tributaries that would not be built nowadays.

Second, the Law ensures fair compensation to the people to be resettled. Although they constitute a minority, their rights must be respected. But the rights of the majority also must be respected. Almost two hundred million Brazilians that will receive electricity from Santo Antonio, transported by high voltage transmission lines, belong to this majority.

Third, despite the effort of international DAHNGOs in transforming this matter into an international dispute, the backwater of Santo Antonio reservoir does not reach Bolivia.

Fourth, Santo Antonio's energy will replace at least 25% of the energy presently produced in the Amazon region by oil burning thermal plants. Annually they cause the emission of the equivalent of 5 millions tons of carbon dioxide and costs around US$ 2 billions. Because the 5 million consumers that live in the Amazon region can not afford such a large bill, this oil cost is shared by all 50 million consumers scattered throughout Brazil.

For all these reasons, all legal obstacles were removed and the auction could proceed. But the DAHNGOs respect the democratic process only when it serves their own interests. Otherwise they follow the twisted stakeholder participation theory, which "asserts that any group that has an interest in, or could arguably be affected by the outcome of a public policy debate, has the right to pressure the decision makers until they accede to the activists' demands" (Driessen, 2003). In the auction of the Santo Antonio power plant the activists exercised this "right".

In the early morning of the auction day, around 6 AM, a group of some 150 activists invaded the headquarters of ANEEL. Most of them belong to a Brazilian DAHNGO called MAB which is closely associated to IRN. They demanded the cancellation of the auction. The police was called and acted firmly. The invaders were expelled, fortunately without serious injuries. The auction was realized and the winning lowest bid of US$ 48 per MWh (rate: 1 US$ = 1.8 R$) was US$ 30 per MWh bellow the mean unit cost of thermal plants. For the consumers, this means an annual saving of almost US$ 700 million.

The lesson from this case study is that a democratic Government should respect the rights of the people targeted for resettlement. However, the directly affected people - much less wealthy foundations in affluent developed countries - have no right to veto the construction work and condemn a developing nation to remain as such in the foreseeable future.

6. Conclusion and Policy Implications

Elected governments – much abused by the so-called progressives – are the only institutions capable of reconciling the full range of interests in complex decision making processes. The progressive project, particularly in countries that only recently became democratic, is to improve the performance of the state institutions. Those groups who systematically undermine the state and who self-proclaim themselves to "represent the people" have to be identified as the enemies of democracy.

Some stakeholders just want to preserve the status quo and are not interested in win-win outcomes. As a procrastination technique, they often call for the application of the "precautionary principle". However, for government officials the sins of omission should be as undesirable as the sins of commission. For this reason, the "precautionary principle" should be used with precaution.

Stakeholders need to understand the rational of each decision. For this reason, the best water allocation rule is not necessarily the optimal one, from the economical point of view. A simple rule, but easily understandable and accountable, may be the best choice.

A policy of subsidies for sanitation is acceptable, as it benefits the whole community, rather than individual citizens, contrariwise the case of water supply. In poor communities, subsidies for water supply are also acceptable, provided the beneficiaries pay at least the O&M costs. Otherwise there will be no ownership.

A democratic Government should respect the rights of the people to be resettled, in case of the construction of a hydraulic infrastructure. However, among these rights it is not included the right to veto.

The socio-environmental cost resulting from the implementation of a hydropower plant is not so high. However, the cost resulting from an inefficient socio-environmental

licensing process is extremely high, resulting in the substitution of hydropower by thermal power. The first alternative is inexpensive, environmentally friendly, sustainable, and it uses water. The second one is just the opposite, and it uses oil or coal. What is needed is a socio-environmental licensing process capable of evaluating not only the consequences of implementing a proposed project, but also the consequences of not implementing it.

Acknowledgements

The comments and suggestions of two close friends that read the first manuscript - Ben Braga and John Briscoe – are greatly appreciated.

References

P. Driessen, *Eco-Imperialism*, Free Enterprise Press, 2003, pp.19.

J. Florence (2006) 'Global Wind Power Expands In 2006'; *Publishing on the Internet*, Available HTTP: http://www.earth-policy.org/Indicators/Wind/2006.htm (accessed 6 January 2007).

J. Kelman and R. Kelman, 'Water Allocation for Economic Production in a Semi-arid Region', *Water Resources Development*, v.18, n. 3, 2002, 391-407.

Table 1. The Sao Francisco River Basin

	Metric	**English**
Drainage area	**630000** km2	**240000** sq.mi.
Mean flow	**2600** m3/s	**68** M ac.ft/year
Minimum flow	**600** m3/s	**16** M ac.ft/year
Regulated flow	**2100** m3/s	**53** M ac.ft/year
Projected Mean Diverson	**65** m3/s	**1.7** M ac.ft/year

Box 1. Description of the Sao Francisco River Trans-basin Diversion Project

The Rio Sao Francisco River rises in the state of Minas Gerais in the Serra da Conastra in Brazil at an elevation of approx. 1,600 m and flows through 2,700 km north and east. The river system is considered to be key to the future economic development of the semi-arid areas of Brazil. The flows of this drainage provide the hydropower to fuel the industry and water supply for the growing fruit and vegetable production. Non riparian semi arid states of the north-east have long coveted the waters of this river system as these states have suffered periodically long and severe droughts that have decimated the economy caused innumerable deaths and persistent immigration of rural people to urban areas and proposals for major trans-basin diversions to the north and east of the drainage have been put forth for over 75 years. Rio Sao Francisco Trans-basin Diversion Project has been prepared to fulfill the aspirations of these areas.

The proposed scheme will have two major points for diversion. The first diversion will divert from the river just below the existing Sobardinho Dam at a point known as Cabrobo and divert an average flow of 99 cumecs from the river through the use of a series of 3 major pumping stations, 15 regulatory reservoirs, 229 km of canals, 23 km of tunnels and 3 km of aqueducts.

The second diversion will be from the existing Itaparica Dam and reservoir located further downstream of river and will divert 28 cumecs to a system of canals, pipelines and reservoir. This system will include 6 pumping stations, 297 km of canals, 84 km of pipe lines, 8.2 km of tunnels and 25 km of aqueducts. The project will also involve en-route construction of 2 hydel plants of 52 MW capacity each. The project is estimated to cost over a billion dollars. The total annual diversion will be of the order of 1.5 km^3/yr.

Source: Compilation of International Experiences in Inter-basin Water Transfer, published by the International Commission of Irrigation and Drainage – ICID, in September 2003.

Figure 1. Location of the Sao Francisco River Basin

Figure 2. Schematic description of the water supply problem at the recipient region

Figure 3. Developed hydropower as a percentage of potential hydropower