RESEARCH REPORT

# ROLE OF LARGE DAMS IN THE SOCIO-ECONOMIC DEVELOPMENT OF MEXICO

Third World Centre for Water Management

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## RESEARCH REPORTS

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**Asit K. Biswas**
**President**

# Contents

# ROLE OF LARGE DAMS IN THE SOCIO-ECONOMIC DEVELOPMENT OF MEXICO*


## ABSTRACT

In Mexico, 473 $km^3$ of water is renewed annually, of which 198.4 $km^3$ is abstracted by the productive sectors, and domestic proposes. Such figure, however, give a false sense of water abundance, because its spatial and temporal distribution is not homogenous. In order to cope with this mismatch, numerous water-retaining structures have been constructed. Certainly, dams have been a key element to balance the spatial and the temporal variations in the water availability, and they have played a crucial role in the socio-economic development of Mexico. However, the benefits could be more if water management practices were more efficient, equitable and modern. This paper focuses specifically on the dams development in Mexico, and it points out that, unquestionably, large dams have had direct negative impacts. However, it should be noted that many of those negative impacts are the results of inefficient planning, inadequate expertise, and improper management. Dams, like any other major infrastructures, have economic, environmental and social benefits and costs. Accordingly, the dams must be properly planned, built and managed with the best scientific and technical knowledge available. The real question for Mexico is not whether dams should be constructed or not, but rather how should the dams be planned and managed so that the economic, social and environmental benefits to the society as a whole could be maximised and the costs could be minimised.


## INTRODUCTION

Mexico is a country with an area of 2 X $10^6$ $km^2$. The mean annual rainfall is 780 mm (1522 $km^3$), resulting in an annual runoff of 410 $km^3$, and annual groundwater recharge of 63 $km^3$. About 473 $km^3$ of water is renewed annually, of which 198.4 $km^3$ is abstracted by the productive sectors (power, industrial, domestic, agriculture, etc.). The Mexican population is around 100 millions, with an annual per capita water availability of 4730 $m^3$. Such national averages, however, give a false sense of water abundance, because its spatial distribution in not homogenous. Nearly 50% of the Mexican territory is arid to semiarid. About 50% of the rainfall occurs in 20% of the country (south-east), and only 4% of the runoff is available in the north, which is 30% of the country. Equally, the temporal distribution of the rainfall is not even. The rainy season is in the summer, with the exception of the north-east of the country, where it is in the winter.

Historically, economic and human activities have developed in the water-scarce areas. This mismatch means that 20% of the rainfall is available for use in 75% of the country, accounting for 76% of the population, 90% of irrigation, 70% of the industrial activities and 77% of the gross national product (GNP). Additionally, about one-quarter of the population lives above 2000 m above the sea level, receiving only 4% of the national runoff. This means that the Mexican water sector is a major user of energy (Figure 1) (Castelán, 2000a). In order to cope with this mismatch between water and human activities, numerous water-retaining structures have been constructed. In the past, dams have been a key element to balance the spatial and the temporal variations in the water availability, ensuring adequate water is available for different uses, over time.

At present, the Mexican economy is the 13th largest at the global level. This has been possible because water of appropriate quantity and quality was available when it was necessary. Certainly, the large dams have played an important role to promote the development of the country, but equally, the country would have benefited more if its water management practices had been more efficient, equitable and modern.


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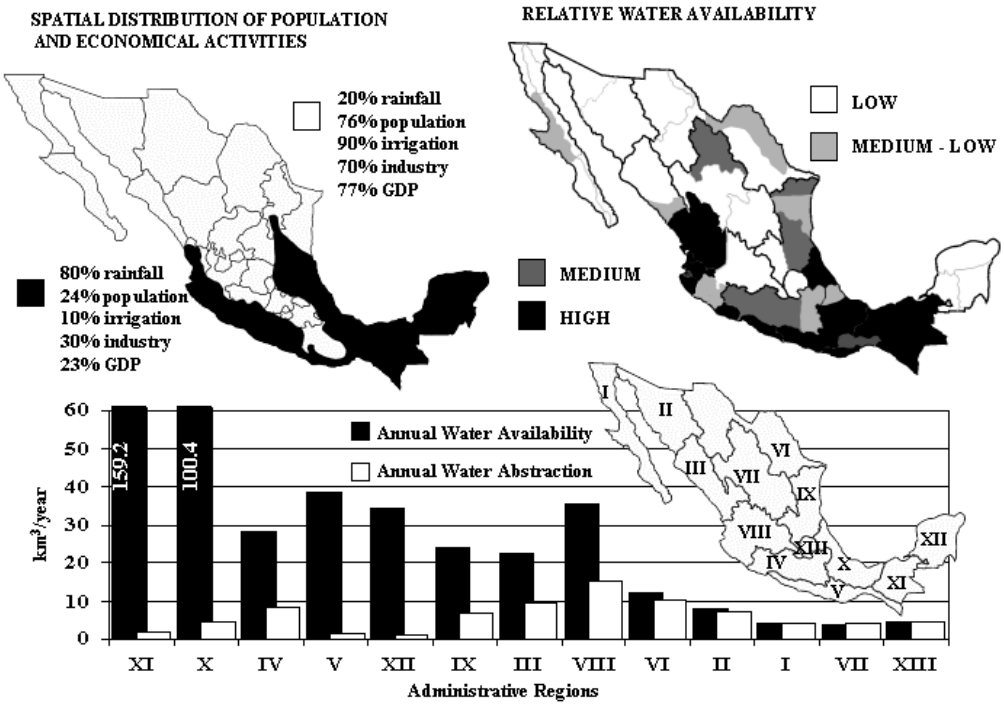
Large dams, like any other major infrastructures, have economic, environmental and social benefits and costs. Accordingly, the dams must be properly planned, built and managed with the best scientific and technical knowledge available so that the development is not hindered, poverty is alleviated and the environment is protected. This can be achieved, but it requires a radical shift in the mind-sets of the bureaucrats. Regrettably, there is no sign yet that this is happening.

**Figure 1. Water availability and spatial distribution of population and economic activities**




## IMPACTS OF DAMS ON SOCIO-ECONOMIC DEVELOPMENT OF MEXICO

Overall the construction of large dams has resulted in noticeable improvements in the socio-economic development of Mexico. During the post-revolutionary period (1920), accelerated social and economic development became an urgent necessity to improve the standard of living of the Mexican people. Water was considered to be an important means to foster such development processes. During the decades between the 1940s and the 1960s, the Mexican economy grew at 6-7% per year. During this period, river basin commissions were created as one of the main strategies to launch regional development programmes, sustained by multipurpose water-related projects. Dams played an essential role to achieve the objectives of national development. During the beginning of the 1940s, the total storage capacity of the reservoirs was 12 $km^3$, and the installed capacity of hydro-electricity was 400 MW. At the end of the 1960s, these figures increased to 125 $km^3$ and 5 GW, respectively. This period is know as 'the Mexican miracle'. (Herrera, 1998; Castelán, 2000b).

At present, according to the Comisión Nacional del Agua (National Water Commission of Mexico) (CAN) (1999), there are 4,500 dams in Mexico, of which 840 are large dams. The total storage capacity of dams is approximately 150 $km^3$. Large dams represent 18% of the dams constructed in Mexico. However, these dams represent 58% of the total storage capacity. It is clear that large dams play an important role in the development of Mexico. Water-retaining structures have been built in different parts of the country to ensure that water is available for domestic, agricultural, industrial and power generation purposes throughout the year. The storage capacity of the dams is used at present as follows: 42% for agriculture,

39% for hydro-electric generation, 9% for water supply, and 10% for sediment storage. Of the 198.4 $km^3$ of water that is abstracted and used by the productive sectors annually, 86% is from surface sources. The main users of the water are hydropower (119 $km^3$/year) and agricultural (44.4 $km^3$/year) sectors, which represent 82% of the total abstractions of surface water. The following are some considerations which indicate the importance of the dams in the present socio-economic development of Mexico.

- Mexico is the seventh country in the world in terms of irrigated area. The irrigated area is 6.3 X $10^6$ ha, of which 54% is divided into 81 irrigated districts, and the remaining 46% is divided into 39 000 irrigation units. The irrigated land represents 30% of the cultivated land at national level. However, this irrigated land accounts for 50% of the agricultural production, and 70% of the agricultural exports. It provides direct employment to 6.5 million people and economic support to 25% of the Mexican population. Equally, it contributes to 5% to the GNP. The agricultural sector uses 60.5 $km^3$/year of water, out of which 44.4 $km^3$ is extracted from reservoirs. The development of irrigated land has been linked closely to the constructions of dams. In fact, in the northern and central part of the country, where 73.5% of irrigated land is located, and where average rainfall is from 600 to 900 mm, agricultural activities are possible only with irrigation (Castelán, 2000a).

- Annually, 13.1 $km^3$ of water is extracted for domestic purposes, of which 31% is extracted from surface sources, satisfying the water demands of 20% of the population at the national level. In Mexico, the domestic water supply in all large cities (Mexico City Metropolitan Area, Guadalajara, Monterrey, Tijuana) is dependent, totally or partially, on reservoirs. According to the CNA (1997), surface water will continue to be an important part of the national strategy to supply drinking water to the main cities of the country, especially in the north of Mexico, where the main problem is the over-exploitation of aquifers. However, the poor quality of the surface waters, due to the lack of wastewater treatment plants and sanitation services, has restricted its use for domestic purposes.

- Mexico has one of the best electricity supply systems in Latin America. Approximately 98% of the Mexican population has access to electricity. The electricity demands are satisfied mainly by thermal and hydro-electric plants. In 1997, almost 160,000 GWh of electricity were generated, with the hydro-power sector contributing 28%, and the thermal sector the remaining 72%. Hydropower satisfies the electricity demands particularly in peak hours. In order to satisfy the future electricity demands in Mexico, it will be necessary to develop additional capacities. According to the Comisión Federal de Electricidad (Federal Power Commission of Mexico) (CFE), there is a high potential for developing hydropower, which is estimated to be equivalent to an annual generation of 123 107 GWh (77% of the present production). Additionally, hydro-electric plants are more efficient in producing energy than thermal plants, with 85% efficiency, compared to 50-55% efficiency for the thermal plants (CFE, 1998).

- In Mexico, the large reservoirs represent a surface of about 500 000 ha, with an important potential for aquacultural development and recreational activities. However, this potential is very often unutilized because of poor water quality, information on which is mostly not available at present. Flood control has been essential for the sustainable development of the regions that are affected regularly by floods, especially in the areas around the Gulf of Mexico. Flood control projects have ensured that 500 000 ha of land are available for productive activities, mainly for agriculture. This would not have been possible without the construction of hydraulic structures. However, it would be necessary to develop additional capacities for flood and drought control. According to the official figures, some 30 million people in 624 municipalities are now vulnerable to floods. CNA (2000) estimates that the average annual cost due to damages by extreme meteorological phenomena during the 1980-98 period was $500 million.

By 2020, it is estimated that the Mexican population will increase to 130 million, and the economy will grow by 3% annually. Such increases are likely to enhance water demands and the pressure on the national water resources. The water demand for consumptive uses is likely to reach 92.42 $km^3$/year by 2020 (Paz, 1999). This means 20% more water will be needed than the present requirements. This is an enormous challenge to the Mexican water sector. Some of the additional water will be available because the existing water management practices are likely to become more efficient, and because of new technological developments. However, it is highly likely that this water will not be enough to cover the future water demands. Large-scale storages will be necessary to supply water to major urban centres, assure necessary food production, employment and electricity generation, ensure ecosystem conservation and to mitigate the adverse impacts of floods and droughts.

Thus, the real question facing Mexico is certainly not whether large dams have an important role to play in the coming decades, but rather how best their performances can be enhanced so that their economic, societal and environmental benefits can be maximized, adverse impacts can be minimized, and simultaneously equity issues can be properly considered. Within this overall philosophy, the following issues will be discussed herein: hydropower and thermal power, environmental impact assessment and resettlement of populations.

## HYDROPOWER AND THERMAL POWER

Currently, the demand for electricity at the national level is satisfied by both thermal and hydropower stations. Until the 1960s, hydropower generation represented nearly 60% of the total electricity generation of the country. However, the high initial investments necessary to develop hydropower, and the relatively low cost of fossil fuels, encouraged the power sector to favour thermal power plants. At present, thermal and hydropower generation represent 80% and 20% of electrical production respectively. In 1999, official projections indicated that power demands are likely to grow by 6-10% per year during the next 6 years. This growth represents an additional generation capacity of 13 000 MW, which is equivalent to one-third of the current installed capacity. The investment required to achieve this projections is estimated at $25 000 million, which represents 25% of the national budget for 1999. Furthermore, CFE estimates that by 2015, it will be necessary to have a total installed capacity of 76 500 MW, which represent, approximately, twice the current capacity (Secretaría de Energía, 1999). Thus, the power sector must develop during the next 15 years, the same capacity that was developed during the last 100 years. Viewed from any direction, it is a major challenge facing the country.

In order to satisfy the future power demands, the high investment costs necessary will be a major burden on the national budget. The Federal Government has now recognised its lack of financial capacity to develop the future power projects, and has promoted reforms to encourage the participation of the private sector in the power generation and management processes of the country. According to the Secretaría de Energía (Ministry of Power of Mexico) (1999, pp. 4-5) (Figure 2):

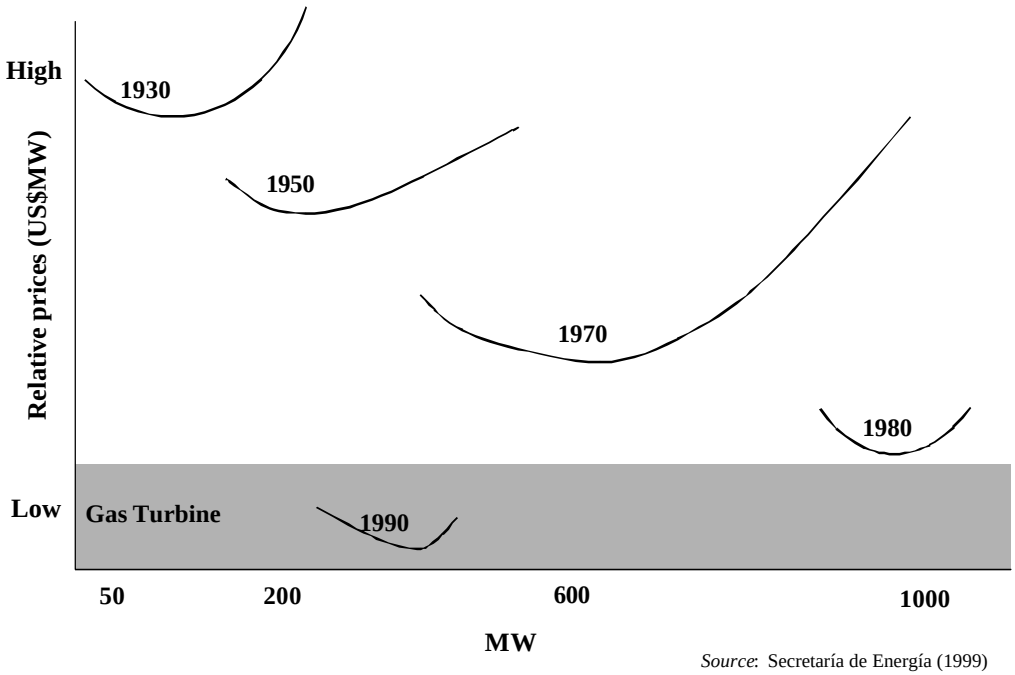
> … power generation has experienced important changes due to technological advances, as a result of which the size of the plants and the generating costs are now the lowest. At present, small stations are used to generate power, requiring less time for their construction. Such developments allow small companies to finance and construct new power plants and compete freely to sell the energy.

Two trends are now clear: the opening up of the power sector to the private investment; and the new power plants, which are mainly thermal.

The generation of electricity by thermal power plants is cheaper in terms of infrastructural development cost. However, from a broader perspective, it is essential to analyse the total economic and environmental

costs of using fossil fuels. In 1997, 19 736 X $10^6$ $m^3$ of oil and oil derivatives, 5617 X $10^6$ $m^3$ of gas, 8853 X $10^6$ t of charcoal, and 0.343 X $10^6$ $m^3$ of diesel were used for generating electricity. In 1990, the total annual emissions of carbon dioxide were estimated at 444 489 X $10^6$ t, of which the energy sector accounted for 66.8%. According to CFE, in 1997 each percentage point of electrical power generation released into the atmosphere 18 687 t of sulphur dioxide, 3451 t of nitrogen oxide, 795 699 t of nitrogen dioxide, 33 t of hydrocarbons, and 1273 t of particulates. Additionally, it is estimated that 164 000 t/year of pollutants, in terms of biochemical oxygen demand, are released into the surface waters of the country (Instituto Nacional de Estadística, Geografía e Informática (INEGI), 1998; Lecanda, 1999).

**Figure 2. Technological changes and electricity generation prices, 1930 - 1990**



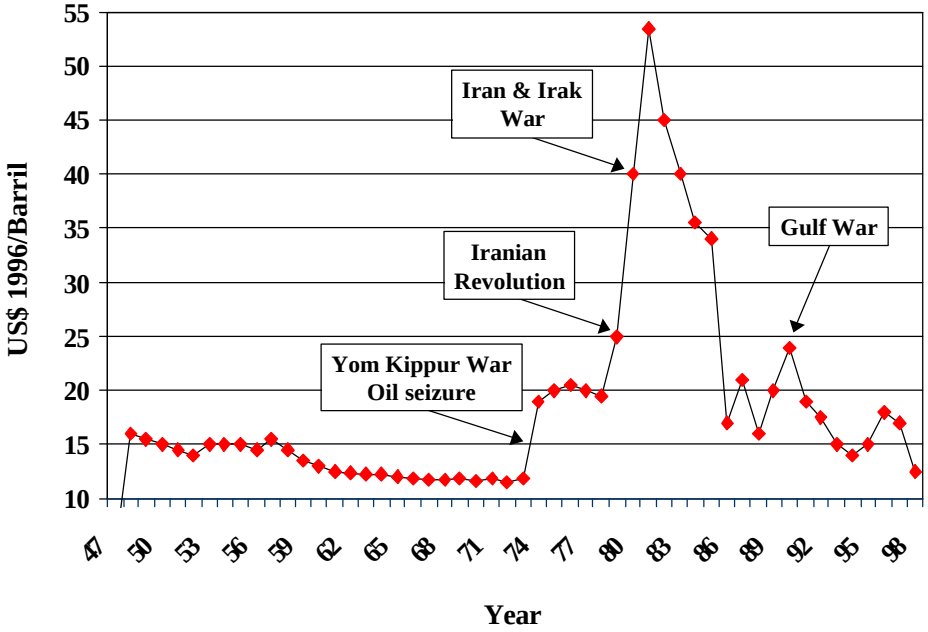

*Source*: Secretaría de Energía (1999)

Mexico is endowed with considerable reserves of oil and natural gas, which have played a critical role in its economic development. However, extensive reliance on fossil fuels for power generation may become risky in the long term. According to the Secretaría de Energía (1999), in 1990 the oil reserves were 66 450 X $10^6$ barrels. By 1999, it had decreased to 58 683 X $10^6$ barrels. At the current rate of oil production, this reserve will last 38 years. Furthermore, political instability and conflicts in major oil producing countries have contributed to extreme variability in oil prices, as shown in Figure 3. Thus, it is very difficult to identify the trends in oil prices, and, thus, to estimate the future cost of electricity generated by thermal power plants and its impact in the socio-economic structure of the country. It should, however, be noted that in the past Petróleos Mexicanos (Petroleum Corporation of Mexico) (PEMEX) has not been run efficiently, one result of which has been that investment in oil and natural gas exploration has been minimal. This trend may change with the current administration, as a result of which petroleum reserves can increase very significantly in the coming years.

The Mexican power sector is dominated by thermal plants, which use mainly hydrocarbons. Non-renewable sources represents 85.1% of the primary energy supply. However, considerable abundance of these resources in Mexico has contributed to its inefficient use. According with the Organisation for Economic Co-operation and Development (OECD) (1998), Mexico's energy intensity increased by 15% between 1980 and 1995, while that of most other OECD countries decreased. A combination of slow modernization

of industrial equipment, low energy prices, development of energy-intensive industries, and inefficient management is probably responsible for this phenomenon. If the trend in use of non-renewable sources of energy continues, and hydrocarbon exploration activities do not receive higher priority, Mexico will face serious problems in satisfying the energy demands of the country over the medium term. Such a situation could have serious negative impacts on the economic, social and environmental conditions of the country. It would thus be necessary to develop alternative, renewable sources in order to satisfy the energy demands in a sustainable way.

**Figure 3. Petroleum Prices**




*Source*: WTRG Economics, (2002)

Hydropower generation requires higher initial investments, but its running costs are low. It has different social and environmental impacts, both positive and negative, compared to thermal power generation process. Many experts agree that hydropower is the first step towards the use of renewable energy in terms of large-scale electricity generation. However, at the global level, there is now strong opposition to constructing new, large dams from certain sectors. This movement is headed, mainly, by some non-governmental organizations (NGOs), and their activities have focused mainly to stop construction in developing countries. Paradoxically, many of these NGOs are from the developed world, even though the developed world has basically completed its dam construction processes quite some time ago. These NGOs often affect their counterparts in the developing world through their direct financial and intellectual support (Biswas & Tortajada, 2001).

It should, however, be noted that neither CFE nor the CNA has given adequate attention to analysing the potential social and environmental impacts of electricity generating infrastructures, and then take appropriate remedial actions. Based on an objective assessment of the past results, it has to be admitted that the senior management has mostly given lip-service to the social and the environmental issues. Furthermore, social and environmental expertise available in the concerned institutions leaves much to desired. In addition, laws and regulations in the environmental area are some times contradictory, and their implementation continues to be poor (Tortajada, 2001).

One case is the Zimapan Hydroelectric Project (CFE, 1995). Federal Power Commission developed the Zimapan hydro-electric project to supply electricity energy to the states of Hidalgo, Queretaro, Guanajuato, Mexico, San Luis Potosi and the Federal District. The Grupo de Protección Ambiental (Environmental Protection Group) (GPA) within CFE was staffed unskilled and inexperienced professionals with very limited knowledge of the environmental and social aspects. It was also wrongly directed and managed. The actions of the group were focused only to identify the flora and fauna of the areas and to monitor water quality of the rivers to be dammed. In the beginning, the environmental protection actions lacked of planning and adequate programmes to implement them. The lack of experience of the GPA staff was supposed to have been counterbalanced by university advisors. Unfortunately, these advisors turned out to be inexperienced too. For these reasons, the activities of GPA continued to be focused on data collection, without any thought as to why the data were being collected, how they would be used, the purposes for which they would be used and who would use them. Thus, data collection became and end by itself.

The construction activities of the Zimapan project began in 1988. However, the Environmental Impact Assessment was completed in 1989, and was approved by the then Ministry of Urban Development and Ecology (SEDUE) in 1990. Mitigation measures were proposed to rescue flora and fauna and for reforestation activities. Unfortunately, SEDUE did not have the necessary expertise either. Under these conditions, the engineers in CFE who were in charge of the project were considered be the most qualified staff available to identify the adverse impacts of the project. Thus, the gatekeeper became the poacher: the proponent of the project became *de facto* responsible to identify and ameliorate its social and environmental impacts.

In 1992, the newly created Environmental Protection Department was incorporated within GPA. Up to the time, the environmental protection activities were developed without timely programs or planning. As recommended by the World Bank, several Workshops on environmental protection in hydro-electric projects, such as the Aguamilpa and Zimapan, were convened. Also, a High Technical Level Environmental Protection Committee was formed. The committee included technical managers, hydro-electric project constructors, environmental protection managers, researchers from the National Autonomous University of Mexico as well as other external advisors. The technical staff of the Environmental Protection Department were trained in several national events on different disciplines related to environmental protection. The estimated cost of the Environmental Protection Programme was $4.12 millions. However, no direct environmental and social follow-up actions were ever undertaken later for the Zimapan dam.

In Mexico, historically, hydropower development considered mainly financial and technical aspects, with a very hierarchical decision-making structure. For decades, the Mexican Federal Government never developed the legal framework, institutional capacity, adequate process for evaluation or feedback and technical expertise to manage environmental and social issues related to large-scale water development projects. As a result, many water-related projects were constructed with high negative social and environmental impacts. Mexico has over 80 years of experience in the development of dams. The environmental and social impacts, both positive and negative, are now well known; it can thus be concluded that the fact that negative environmental and social impacts are still occurring is because of negligent management and a poor planning process. Even today, with a environmental legal framework (General Law for Ecological Balance and Environmental Protection (Ley General de Ecología y Protección al Ambiente, LGEEPA), 1988), environmental institutions (Ministry of Environment and Natural Resources), and environmental units in each ministry to manage environmental aspects of its own sector, management of the environmental and social impacts continues to be extremely inefficient (Castelán, 2000a,b; Torajada, 2000)

All the current estimates indicate that the electricity demands of the country will continue to increase at a rate of 7-10% per year compounded, in the foreseeable future. This energy would be essential to promote and sustain the economic and social development of the country. Thermal and hydropower have different types of economic, social and environmental benefits and costs. A national debate on these issues is

necessary, as are strategic environmental and social impact assessments for thermal and hydropower generation practices. There is no indication at present that such a national debate could be initiated in the near future, or even the institutions concerned would welcome such a debate before taking appropriate decisions which are likely to have long-term implications.

## ENVIRONMENTAL IMPACT ASSESSMENT AND RESETTLEMENT OF POPULATIONS

In Mexico, LGEEPA and its regulations were enacted in 1988. LGEEPA's regulations were subsequently modified in December 1996 and May 2000. LGEEPA makes preparation of environmental impact assessment mandatory for major development projects (Article 28, LGEEPA). Environmental impact assessment is the procedure trough which the Secretaría de Medio Ambiente y Recursos Naturales (Ministry of Environment and Natural Resources of Mexico) (SEMARNAT) decides whether a project can be cleared for implementation after reviewing their overall environmental impacts. Accordingly, it is necessary to submit to SEMARNAT an environmental impact statements (EIS) for obtaining legal clearance of a project. The EIS should include (at least in theory) a description of the potential impacts on the ecosystems due to the project or activities. It should include the characteristics of the ecosystems affected, as well as the preventive and mitigation measures necessary to avoid and/or reduce the negative impacts of the planned projects on the environment. It is important to note that even when LGEEPA was enacted in 1988, environmental impact assessment has been practiced since 1980.

Environmental impact assessment is an important tool for planning and evaluating economic, social and environmental impacts during the construction and operation of development projects. However, the experiences within the water sector, and a comprehensive analysis of 59 EISs prepared by CNA for irrigation projects (Tortajada, 2000), indicate a very deficient management of environmental and social issues, including resettlement of affected populations. It is mandatory to provide information on social issues, including resettlement, employment generation, mitigation measures, etc., for EISs. Nevertheless, the environmental impact assessment studies carried out basically ignore any resettlement process for the populations who would be involuntarily displaced from their lands due to the construction of the dams. Important issues like how and by whom the resettlement processes would be carried out, costs of resettlement, locations where the population would be moved, and compensations, are mostly ignored. As a result, the projects are being implemented exactly as decades before. The law in consistently ignored. In most cases, EISs are prepared primarily to satisfy the legal requirements and to justify the projects: they are not seriously considered for decision-making purposes.

In the case of the Huites dam, which was constructed during the early 1990s by the CNA, four main problems faced by the Mayo population were ignored. These were: (1) lack of recognition of their ethnic identity during the implementation of the social-economic evaluation and resettlement of the population; (2) unclear processes to obtain the authorization of the local community to transfer the land; (3) ignoring of the Mayo´s ceremonial centre in Huites as sacred; and (4) opposition from the responsible officials to conducting archaeological analysis of archaic petroglyphs around the Fuerte River, which are part of religious practices of the population residing downstream, which were to be flooded by the dam (Martínez, 1999).

As a direct consequence of the inadequate resettlement practiced, the population experienced lack of opportunities for restoring and improving their living standards. The families that practiced agricultural, pastoral and hunting activities in the dam area were forced to become 'empty beer can collectors' for survival. The traditional migration cycle was broken. Young people used to go to the USA to work every year, but they used to return to their homelands later. As a result of the construction of the dam, young people did not come back since they had no other activity. Thus, economically active population has declined by 80%. The traditional religious practices of the local population have disappeared. The CNA was later forced to reconstruct the ceremonial centre. Even then, however, the lack of recognition by the

CNA of the importance of the ethnical identity of the resettlers and the CNA's disregard of the local traditions meant that important elements of the religious practices and rituals in the new ceremonial centre were missing.

The problem was submitted to the National Indigenous Institute of Mexico, and a review process was initiated. The legal justification of this demand could be found in the Article 4 and 27 of the Mexican Constitution. In addition, Mexico has been a signatory to the Convention 169 of the International Work Organization from 1989. The convention stipulates that it is the responsibility of the government to take necessary actions to preserve institutions, goods, culture and environment of the indigenous population. As a result of this review a sustainable development programme had to be formulated for the people to be resettled. The programme stipulated $8000-8500 for all 200 families that were to be resettled. Sadly, however, only the first stage has been completed (land acquisition in other places). During this long hiatus, social and economic disintegration goes on. Furthermore, the population has had to confront long and complicated administrative and bureaucratic requirements. The main obstacle to solve the needs of the indigenous population has been the corruption and negligence in the governmental institutions responsible for the solution of the problems.

The inefficient management of environmental and social issues in EISs should not be a surprise. There are many inconsistencies in LGEEPA, and the tools used to conduct socio-economic analyses for environmental impact assessment reports are not well understood, either by the analysts or by the decision makers. A main failure is in terms of the official evaluation process of the study of the projects. Article 35, III, states that "the Ministry [SEMARNAT] will take into consideration in the EIS, *only* the environmental implications of the projects or activities". The law does not clarify who is responsible for the social and economic implications of the projects or activities. This is a very dangerous gap, since legally the institutions concerned cannot be forced to act even when the projects could be shown to have serious negative social and economic impacts on the project areas and/or the populations (Tortajada, 2000).

According to Article 9 of LGEEPA's regulations, SEMARNAT will publish guidelines to develop EISs in order to facilitate its preparation. An objective review indicates that the EIS guidelines for large-scale water projects presents serious problems in terms of methodologies used to identify social impacts, both positive and negative. According to the Instituto Nacional de Ecología (National Ecology Institute of Mexico) (2000, p. 39), the main objective of the socio-economical analysis is "to analyse the relationships between the communities and the environment where the project would be carried out … the analyses will identify those elements which, if modified, would have negative effects on the communities". For the preparation of the analysis, EIS guidelines recommend that information on the parameters shown in Table 1 should be obtained. The quotation given above and Table 1 are the main suggestions for carrying out socio-economical analysis. The methodologies are so vague and general that it is impossible to conduct any objective social evaluation. The EIS guidelines do not establish any need to consult the communities in order to inform and know the perceptions and views of the people on the project. This is contradictory to the Law, because LGEEPA stipulates as mandatory the participation of the society in the planning, evaluation, and implementation of environmental policies and projects (Article 157, LGEEPA). In the best EIS studies, the socio-economic assessment is only a collection of figures obtained from bibliographical sources, without any serious analyses. The analyses, if any, are superficial, and thus of are questionable value to decision makers as well as for follow-up studies and monitoring.

In terms of access to environmental information, LGEEPA stipulates that SEMARNAT will publish weekly, in the *Ecological Journal* and in the electronic media, a list of EISs received for clearance. Any interested person can check the EIS studies, and also request a post-revision of the EIS. This request must be submitted within a period of 10 days after the publication of the appropriate EIS references in the *Ecological Journal.* SEMARNAT has the responsibility to evaluate the petition, and, if the petition has merit, a referendum can be carried out. If a referendum is considered necessary, SEMARNAT will request

the promoter of the project to publish an abstract of the project in the most important newspapers of the region. The abstract should include a description of the project, the potential impacts on the ecosystems, and the preventive and mitigation measures proposed to avoid and/or reduce the negative impacts of the project. Thereafter, within a period of 20 days, any person or organization can propose additional preventive and mitigation measures for the project to SEMARNAT. During this period, SEMARNAT and the promoter of the project could organize a public meeting to inform the people on the project, its potential impacts, and preventive and mitigation measures proposed. During, this meeting, any person can propose preventive and mitigation measures for the project. All the comments and proposals received during the review period and the public meeting, should be included in the EIS file, and these would be considered during the evaluation process of the EIS (Articles 4, 37, 38, 40, 41, & 43, LGEEPA's regulations).

**Table 1. Parameters to consider for socio-economic analysis in EIS**

| Regional parameters | Social parameters by human settlement | Economic parameters |
|---|---|---|
| • Economic region according to national classification<br>• Location of human settlements<br>• Population and population density<br>• Kind of human settlements<br>• Poverty index<br>• Diet index<br>• Urban services<br>• Area reserved for urban development. | • Population growth rate<br>• Identification of migration process<br>• Main social organizations<br>• Offer and demands of housing<br>• Urban services<br>• Sanitary services<br>• Health services<br>• Identification of ethnic groups<br>• Identification of cultural traditions<br>• Landscape description | • Main economic activities<br>• Per capita income<br>• Economically active population<br>• Minimum salary<br>• Employment<br>• Competition for the use of natural resources between economical activities |

*Source*: SEMARNAP/INE (2000).

Legally, at least, LGEEPA and its regulations assure people have access to environmental information and social participation is possible for the development of large-scale water infrastructures. However, the process is a failure because it is not appropriate to the Mexican social conditions. Legislation and regulations on social participation have been drafted with reference to people with high income, good quality of life, high levels of education and an entrepreneurial approach. For a country like Mexico, 63.2% of the population has an average income of less than $6.00 per day, 53% of the population live in poverty and the national educational average is primary school (Castelán, 2000a; INEGI, 2000). These figures are even worse for communities in rural areas, where dams are constructed which makes these communities extremely vulnerable. Thus, it is impossible to consider any real public participation by the affected communities due to dam construction. The general public simply do not have access to mass media, they do not know or trust the official institutions, they are not aware of the environmental legal framework, and they do not have funds to hire experts. In addition, they have to face a wide group of politicians, economically powerful groups with vested interests, and professionals who have worked for years to justify the projects.

In the final analysis, the resettled people must not bear the cost of the project; they must also benefit from it. The absence of legal tools and mechanisms to protect the rights and welfare of vulnerable groups by the construction of large-scale water projects can be construed to be a sign of the lack of political and administrative will to address fairly the social and environmental impacts of the projects, and to ensure that the disadvantage of vulnerable groups continue to pay for these projects with lower quality of life.

## CONCLUDING REMARKS - BUILDING THE SUSTAINABILITY OF DAMS PROJECTS

On the basis of the current evidence, it is clear that the dams have fostered the growth of the Mexican economy and the social welfare through a myriad of pathways, many of which are still not fully known or understood. Large and medium-size dams will be essential to meet the escalating water needs of Mexico,

where demands are growing steadily. The increasing need for water recognized even by those who are against the development of large dams. It is true that in the past the decisions to developed large-scale water projects were based almost exclusively on economic and technologic feasibilities. Consequently, many dams were built in the past with significant negative environmental and social impacts. This situation can be improved. Large dams are not necessarily bad *per se*. They are the result of a wide and complex planning process, where cultural, economical, social, political, and environmental issues must be considered concurrently, and where the specific weight of each element is defined by the objectives, priorities, and need of the people. Thus, it is the human factor that is decisive in the planning process. On the basis of the above analysis, the following major issues can be identified in order to ensure the environmental sustainability of the large-scale water developments projects of the future.

*Generation of Information*

Technical experts responsible for the construction of large dams must shoulder considerable blame for the present opposition to them. In Mexico, no serious studies were ever done, systematically and objectively, to documented the benefits and costs of the various dams, and the nature of their beneficiaries. Even fewer are comprehensive studies which access the major costs of the dams constructed. This is a serious failure since this knowledge base is essential to improve the future decision making process. Lack of information or poor quality of information, is likely to lead to erroneous decisions and inefficient allocation of financial resources. In addition, information on unsuccessful experiences would ensure that this knowledge is used to improve the future development projects.

*Capacity Building*

Capacity building and training programmes in water planning in Mexico are now an urgent necessity. It is now well know that the water professionals are not capable to adequately identifying and evaluating the potential social and environmental consequences of water development projects. This is primarily due to the lack of environmental expertise in the water sector. The social and environmental inter-relationships with water are complex, and thus water professionals need broader knowledge to understand these intricate inter-linkages. In the coming years, social and environmental assessments of water resources development projects will become significantly more difficult, time-consuming, and complex than they are at present. This means much higher levels of knowledge and expertise will be necessary from the analysts and planners. This can only be achieved if the current decision makers of the water sector in Mexico first realize that this expertise is basically missing at present, and then make a determined effort to build up the existing capacity to handle social and environmental issues.

*Social Participation*

The world is changing very fast, and the role of the various water management actors is changing as well. The participation of the different sectors of society has become so important that large-scale projects can no longer be developed unilaterally by anyone stakeholder alone, be it the government, the private sector, or the NGOs. Furthermore, individuals and institutions are increasingly becoming interested not only in management and operational aspects, but also in planning and operation of water-related activities (Castelán, 2000c). Thus, it will be necessary to develop effective ways of consultation, co-operation, co-ordination, and decision making by all the interested parties so that water projects and management policies and practices can be made acceptable to the vast majority of the concerned population. During this process, the governmental institutions will have to take special care of the vulnerable groups and, also establish adequate legal processes to protect them. The fundamental goal in the development of large-scale water infrastructure must be the enhancement of the general welfare of the people, and maintaining the environmental conditions.

*Political Will*

In the final analysis, water resources planning, project authorization, and its funding are all essentially political processes in all democratic countries. Accordingly, it is essential to generate and maintain political

support for the formulation and implementation of environmental policies which have a direct bearing on water management. In recent years, environmental and social implications of water management have received only limited support in the national political agenda in Mexico. The transition to environmentally and socially sound water management, however, will not be easy. This is because the governmental organizations have deliberately stayed away from the social and environmental considerations of large development projects, often because such issues have been considered to be politically sensitive. However, recent analysis (Castelán, 2001) indicate that only when senior management will have enough knowledge, understanding and appreciation of the importance and relevance of the environmental and the social issues from the very beginning of the planning cycle, can the quality of life of the population and the ecosystems be improved.

For a country like Mexico, where water availability and human activities are now inversely matched, there is no real alternative but to construct dams as and when essential. Without this, economic development of the country and improvement in the quality of life of the people would simply not be possible. Unquestionably, large dams have had direct negative impacts. However, it is should be noted that many of those negative impacts are the results of inefficient planning, inadequate expertise, and improper management. These major constraints can only be overcome if there is a revolution in the mind-sets of the senior managers who are responsible for the management and administration of the water sector. They must consider social and environmental issues properly, and not give only lip-service to it, as the case in the recent past. Otherwise, full benefits from the dams will never be realised. Hence, *the real question for Mexico is not whether dams should be constructed or not, but rather how should the dams be planned and managed so that the economic, social and environmental benefits to the society as a whole could be maximised and the costs could be minimised. On a long term basis, Mexico simply has no other alternative.*

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