Assessing policy influences on people's relationship to water ecosystem services: The Mexican experience

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Report contributing to the scoping exercise managed by IIED to help develop a DFID research programme on water ecosystems and poverty reduction under climate change

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This work was completed as part of an International Institute for Environment and Development (IIED) assignment to scope a possible DFID Research Programme on Freshwater Ecosystem Services and Poverty Reduction.

Executive summary

As part of the scoping study into the freshwater ecosystems, poverty in the context of climate change, IIED commissioned five country reports on the policy and practice of water management. This report provides an overviews of the current status of water resources in Mexico, current water policy and the challenges faced from the introduction of payments for hydrological services (PSAH) that attempts to bridge forest and water legislation.

Even without the challenges of climate change Mexico faces growing water stress as a result of population and economic growth. Current water policy encourages irrigated agriculture but creates no incentive for the efficient use of that water. The state has also failed to protect freshwater ecosystems with only 10% of surface water being classed as unpolluted. Payments for hydrological services are made to land managers in areas that have been identified as critical for ground water recharge. The payments by government signal the first movement away from the dependency on supply side investments for water supply and management. The analysis shows that the nascent payment programme is facing numerous constraints, many of which stem from the contradictory government policy and opposition from within government and the private sector to the payment of 'subsidies'.

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1. Introduction and background

The International Institute for Environment and Development (IIED) has led a research scoping study on "water ecosystem services and poverty reduction under climate change" for the UK's Department for International Development (DFID). The study has two objectives:

- To identify the **key research areas and knowledge gaps** for improving the sustainability and equity of water provision and water ecosystem services management in the context of climate change in developing countries of Africa and Asia.

- To determine the **most effective means** by which research can contribute to achieving more sustainable and equitable water services and ecosystems management in these countries.

Three main tasks are identified:

1. Gather evidence from stakeholders by seeking views internationally based on in-depth interviews, informal discussion and a web-survey instrument;
2. Review the literature drawing key lessons from major bodies of work and less well-known material;
3. Conduct policy and practice analysis: identifying influences on water delivery in key developing countries.

Policy and practice analyses were conducted in Bolivia, India, Kenya, Mexico and South Africa. This report briefly reviews gaps between water policy and practice in Mexico. The report is in four sections. The hydrology and climate of Mexico (Section 1) is followed by a review of the impacts of climate change (Section 2). Section 3 considers water policy focusing on the challenges to the recently introduced payments for hydrological services. A summary and the conclusions are presented in Section 4.

1.1 Hydrology and climate of Mexico

Mexico has nearly 150 rivers, two-thirds of which empty into the Pacific Ocean and the remainder of which flow into the Gulf of Mexico or the Caribbean Sea. Despite this apparent abundance of water, water is unevenly distributed throughout the country. Five rivers, the Usumacinta, Grijalva, Papaloapán, Coatzacoalcos, and Pánuco, account for 52% of Mexico's average annual volume of surface water. All these rivers flow into the Gulf of Mexico. In contrast, northern and central Mexico, with 47% of the national area and almost 60% of Mexico's population, have less than 10% of the country's water resources.

The Tropic of Cancer effectively divides the country into temperate and tropical zones. Land north of the twenty-fourth parallel experiences cooler temperatures during the winter months. South of the twenty-fourth parallel, temperatures are fairly constant year round and vary solely as a function of elevation. Areas south of the twentieth-fourth parallel with elevations up to 1,000 meters (the southern parts of both coastal plains as well as the Yucatán Peninsula) have a yearly median temperature between 24°C and 28°C. Temperatures here remain high throughout the year, with only a 5°C difference between winter and summer median temperatures. Although low-lying areas north of the twentieth-fourth parallel are hot and humid during the summer, they generally have lower yearly temperature averages (from 20°C to 24°C) because of more moderate conditions during the winter.

Rainfall varies widely both by location and season. Arid or semi-arid conditions are encountered in the Baja California Peninsula, the north-western state of Sonora, the northern altiplano, and also significant portions of the southern altiplano. Rainfall in these regions averages between 300 and 600mm per year, although it is even less in some areas, particularly in Baja California Norte. Average rainfall is between 600 and 1,000mm in most of the major populated areas of the southern altiplano, including Mexico City and Guadalajara. Low-lying areas along the Gulf of Mexico receive in excess of 1,000mm of rainfall in an average year, with the wettest region being the south-eastern state of Tabasco, which typically receives approximately 2,000mm of rainfall annually.

Approximately 12% of the country is is classified as arable land. Permanent pasture (39%) and forests and woodlands (26%) are the two largest land classes. Mexico faces a number of severe environmental issues, including; dwindling supplies of freshwater together with increasing pollution from industrial waste and urban effluent. The availability and access to water is closely related to topography and rainfall. For example in the humid states of Veracruz, Tabasco, Oaxaca and Chiapas run off is the equivalent of 10,000 litres per capita per annum. Conversely in the semi-arid southern states like Baja California, Baja Californa Sur or Coahulia, run off is not more than 200 litres per person.

2. Climate Change Scenarios for Mexico

Making projections regarding any aspect of life is associated with uncertainty. In the case of climate change there is little doubt that the world will experience higher temperatures and a changing water cycle. However, the magnitude of such changes and the specific regional impacts remain uncertain. It is for this reason that, in generating future climate scenarios, integrated models need to be considered that would contemplate both the future generation of greenhouse gases from economic development and the planet's own climate feedback systems.

The IPCC has projected different emissions scenarios and greenhouse gas concentrations in order to estimate the changes in the planet's climate. This series of emissions scenarios is known as the Special Reports on Emissions Scenarios (SRESs) (IPCC, 2000), and is based on different hypotheses regarding the planet's aggregate social and economic development paths. These are:

High Emissions	A1B
Medium-High Emissions	A2
Medium-Low Emissions	B2
Low Emissions	B1

In Mexico, various climate models from the large weather climate centres of the world were used and future climate scenarios were generated for each of those SRESs. Each 'climatology' is constructed using the average conditions over thirty years (i.e. 2010-2039; 2040-2069 and 2070-2099). They are referred to as the 2020, 2050 and 2080 'climatologies'.

If a set of projections from the General Circulation Models (GCM) and the dispersion in temperature and precipitation projections for the 2020, 2050 and 2080 climates are considered, it is found that, in general, the climate of Mexico will be warmer (by 2 to 4 °C) around 2050. The results indicate that the most continental part of northern Mexico is the region that will experience the greatest increases in temperature. During the first decades of the 21st century, there are no marked differences if the emissions follow scenario A2 or B2. But after the 2050 climate, the differences will become more pronounced. These scenarios highlight the importance of promoting global mitigation strategies (INE, 2006a).

Changes for winter rains indicate a decrease in precipitation fluctuating between 0 and 0.6 mm/day. This value indicates reductions of up to 15% in regions in central Mexico, and of just under 5% in the coastal area of the Gulf of Mexico, with the smallest reductions in precipitation being reached with scenario A2 in climate intervals around 2080. It should be mentioned, however, that the projected changes vary between models. There are some models that project slight increases in precipitation while others project drastic decreases.

Extreme events, such as hurricanes and cold fronts ("nortes"), require special consideration in the case of the rainfall projections for Mexico. It is possible that these cold fronts may become less frequent. It is uncertain to what degree this decrease could affect precipitation, but according to certain scenarios, these will tend to diminish mainly in the Gulf of Mexico basin.

In the case of tropical hurricanes, it is considered that, on the average, they will increase in intensity, with a decrease occurring in the average central pressure of the system of approximately 14%, with increases of 6% in the wind intensity and an increase in precipitation of approximately 18%, within a 100km radius from the centre of the hurricane. Such projected changes can be difficult to detect in present data, since the uncertainty involved in a small sample obscures the indication compared to the large, well-known inter-annual and inter-decadal variations.

Finally, the theories suggest that, because the water cycle will become more intense, the number of severe storms would be expected to increase, but there could also be more extreme and more prolonged periods of drought. Observations over the last few years in Mexico seem to agree with this position.

The change in water availability throughout the various seasons of the year is a very important problem, because the change from dry periods to periods of flooding has become more common. The cycle of alternating drought and abnormal rains, reflecting natural climate variability, frequently translates into disasters because of Mexico's high level of hydrological vulnerability. Part of the problem is that climate information is not or cannot yet be used to prevent disasters. These problems could become more accentuated under climate change conditions. Undoubtedly, in the face of a hotter climate with greater variability, adaptation actions will be required, including the utilization of climate information. In Mexico, some steps have already been taken in that direction. But the greatest challenge is still for scientists, government authorities, and other stakeholders to share climate information and to increase capacity for generating and interpreting climate forecasts. The uncertainty associated with climate forecasts requires interpretation in terms of risk management, a capacity that should be developed in each sector.

3. The Water Sector in Mexico

Most of Mexico receives a monsoon-type climate with rains in the summer. This results in semi-arid conditions in the northern part of the country and tropical conditions in the southern part. Of total precipitation approximately 75% is lost through evapo-transpiration while just 5% enters and recharges aquifers, the main source of water. At present the average water availability is approximately 4,000 m^3/capita/annum. As in many countries, this figure is deceptive as a measure of the real water availability for most Mexicans due to the extreme regional variations. Although this value is higher than 1,000 m^3/capita/annum, considered to be the threshold that defines water shortage, several regions in the centre and north already have levels lower than 2,500 m^3/capita/annum as a result of the growing demands due to the increasing population. In particular, in the regions of the Baja California Peninsula, the Río Bravo (Grande) and the watersheds in the north, water availability for the year 2020 is predicted to be less than 1,000 m^3/capita/annum.

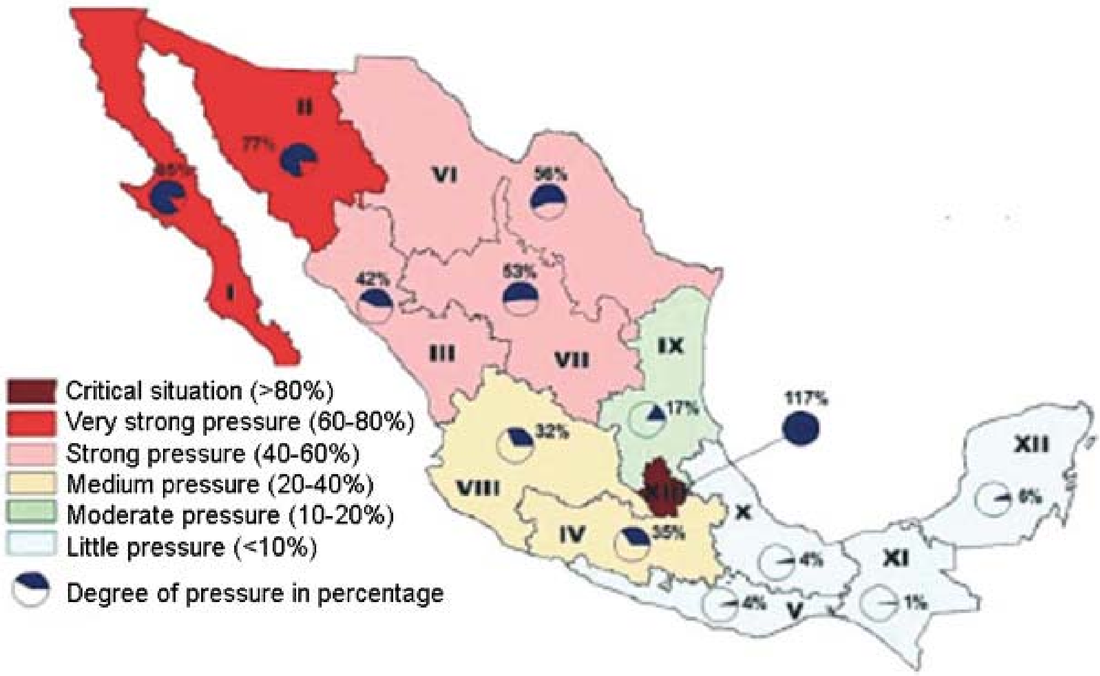
Almost 75% of the water consumed in Mexico is for agricultural purposes (CAN, 2004). Domestic use is responsible for 14% and the remaining 11% is for industrial use (op. cit). However, water use is very inefficient. In agriculture, 55% of the total amount of water extracted is wasted, because of leaks and over-irrigation, among other causes. In the urban sector water loses amount to 43% of the total abstracted. While the losses from industry and the service sector are minimal, both sectors contribute strongly towards water pollution.

3.1 Vulnerability to climate change

Uncertainty and the regional variations in climate make it difficult to assess the impacts of climate change. In the northwestern part of Mexico, increasing temperatures will cause evapo-transpiration to increase and soil moisture to diminish. Initially, this will lead to a higher demand for water as farmers seek to compensate with irrigation. Reduced soil moisture will lead to vegetation stress so that, with the current slash and burn practices, the frequency and severity of forest fires will increase. Changes in structure of the ground cover will result in changes to the quantity, quality and seasonality of surface and ground water. Thus while farmers are attempting to compensate the effects of climate change with increased water extraction and use the availability of surface and ground water may decrease by between 5 and 15%, depending on the region (INE, 2006a).

Current analyses suggest a very high degree of pressure on water resources in the northwest part of the country, and a critical degree in the Valley of Mexico basin (Figure 1). In the latter case, the volume commissioned is even greater than the average natural availability of the resource, so that water must be brought in from other hydrological regions. The degree of pressure is high in the northern part of the country, medium-high in the region of Lerma Chapala, and moderate or low in the southern part of the country, where the resource is abundant.

Figure 1: Degree Of Pressure On Water Resources (Source: Adapted from the CNA (2004) estimate for defining "very strong" and "critical" degrees of pressure)



3.2 **Future Demand for Water**

The demand for water can be modeled by considering future

- population growth scenarios;
- economic growth GDP growth scenarios[1]
- agricultural scenarios, and
- changes in water management efficiency .

Source: Fundación Gonzalo Río Arronte-Fundación Javier Barros Sierra (FGRA-FBS, 2004)

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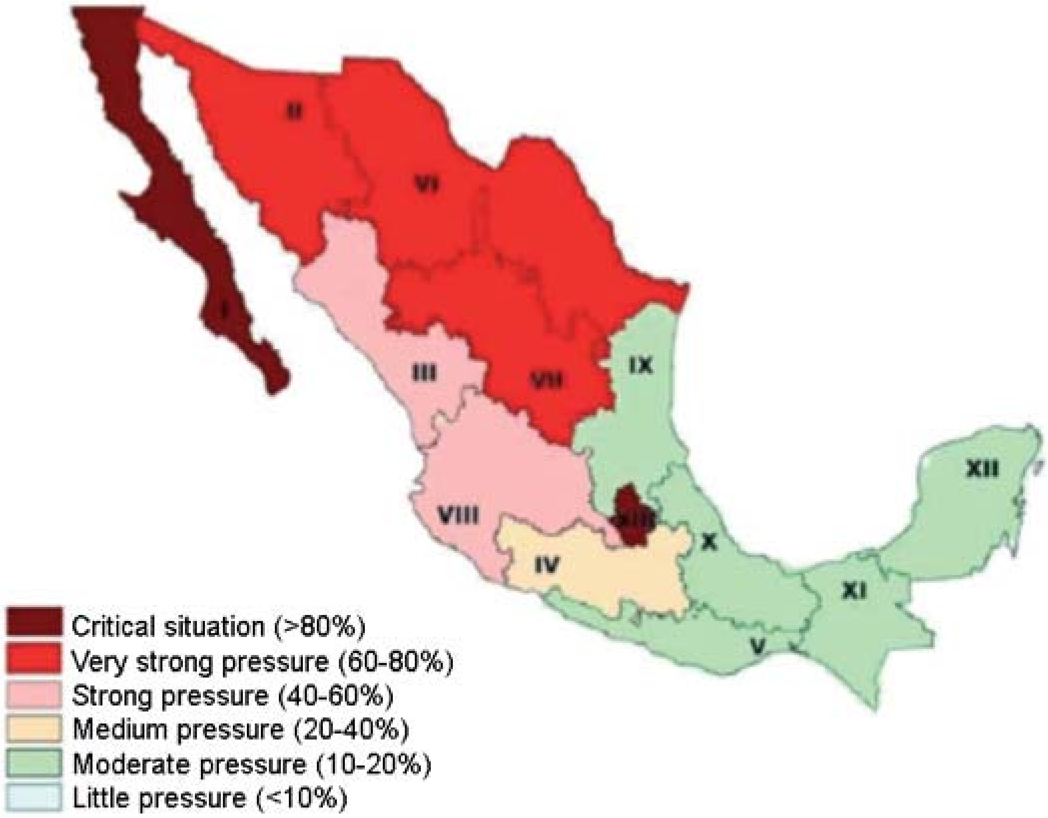
[1] Various scenarios are considered. The first is that GDP per inhabitant doubles in 30 years with respect to 2000 (3.3% annually). The second that is that GDP triples between 2000 and 2030 (4.7% annually). There are also regional variations in which there is more dynamic economic development in the regions of the northern border and the peninsula of Yucatan, and a slower one on the high plateau, in the coastal area of the Gulf of Mexico and along the southern border (Fundación Gonzalo Río Arronte-Fundación Javier Barros Sierra (FGRA-FBS, 2004)

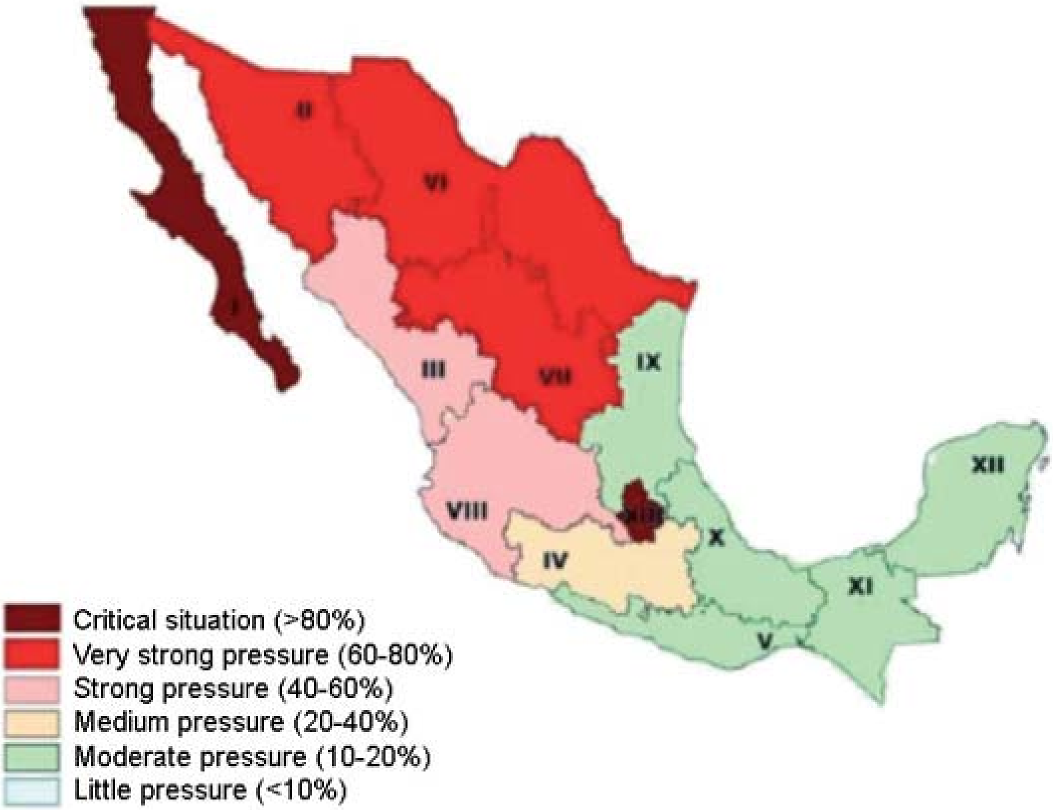
The baseline FGRA-FBS scenario does not consider climate change. The scenario shows that in almost all hydrological-administrative regions, the degree of pressure on water resources will rise. In Baja California the degree of pressure will increase from high to critical, and in the northern states, the pressure on water resources will reach very high levels. The Lerma Santiago Hydrological Region VIII will begin to experience high degrees of pressure in view of the growth projections for the agricultural sector.

FIGURE 2: Future baseline changes in water availability by 2030 (no climate change) (Source: Fundación Gonzalo Río Arronte-Fundación Javier Barros Sierra (FGRA-FBS, 2004))



The severity of these scenarios increases when the current climate change projections are introduced. Taking the scenarios for the 2020 climatology, it is estimated that the natural availability of water will diminish because of the increase in temperature and evapo-transpiration. Scenarios for 2020 with climate change show that both Baja California and Sonora will reach a critical situation in the pressure on water resources (Figure 3). The region of Sinaloa and the Lerma Hydrological Region will reach a high degree of pressure on this resource. Areas in southern Mexico and the Peninsula of Yucatan could even begin to experience a medium to high level of pressure on this resource. This indicates that the increases in the degree of pressure on water resources due to climate change effects could be as great as those of a socio-economic nature for the next two decades.

Figure 3: Future changes in water availability with climate change (Source: Fundación Gonzalo Río Arronte-Fundación Javier Barros Sierra (FGRA-FBS, 2004))



The IPCC socio-economic scenarios indicate that Mexico is one of the regions that will require special attention, mainly toward the western, northwestern and northern zones. Perhaps the only socio-economic scenarios that could reduce future deterioration in the water sector are those in which policies of sustainability are prioritized, and where the work begins as of now.

3.3 Policies affecting the management and access to water

Under the Mexican Constitution, water is a national property or asset. That means that is a public good, for which the State has the responsibility to preserve, allocate user rights and ensure that it is used for the common benefit of all.

However water management in Mexico has been difficult due to deforestation, aquifer overexploitation and water pollution. The increase of population and economic activity has exerted more pressure on the scarce water reserves. The abstraction of water from aquifers exceeds natural recharge in some parts of the country. The situation is worst in those areas such as the north-east where precipitation is low and there is strong economic activity.

Federal government policy for water scarcity consists mainly in the expansion of physical infrastructure for water management and supply. Infrastructure has been financed by general taxes complemented by revenues from water users in the industrial and service sectors. Recently some municipalities have actually started to pay, albeit low, tariffs for the water delivered. The major problems are as a result of water used by farmers and ranchers. Aquifers are over-exploited because abstraction limits are not enforced, water is free and there are extensive electricity subsidies given to this sector for pumping water out of the aquifers (Munoz, 2005). It is estimated that two thirds of the 188 most important aquifers in the country suffer from over-exploitation (Diario Oficial de la Federación, DOF: 2003).

In Mexico, the market mechanisms, such as prices and rates are a recent innovation and to manage the demand for water. Faced with water stress, the preferred strategy to date has been to invest in supply side solutions with large amounts of water infra-structure. Only when scarcity has persisted, has the government used mechanisms to either ration water or limit demand (such as fees). This has resulted in perverse outcomes especially with respect to the costs of water and water use. For example, a family without easy access to potable water service uses 7,000 litres per month and pays about US$28 dollars for water [at a cost of US$0.004 per litre]. In contrast, a family with access to potable water, pay 10 times less (U$2.8) for approximately 14,000 litres of water per month [at a cost of US$0.0002 per litre] (National Water Commission (Comisión Nacional de Agua*:* CNA).

Current Government policy has largely failed to protect freshwater ecosystems. Most of the surface water is polluted because of limited water treatment and sanitation plants causing environmental damage and limitation on the direct use of the resource. Despite recent increases in the proportion of waste treatment, only 10% of the surface water is good quality, 65% medium and 25% is poor quality. Most of the waste-water comes from urban and industrial sources. Much of the discharge is directly into water bodies and irrigation channels. Health problems are exacerbated by the use of contaminated water in irrigation systems.

3.4 Policies affecting development of water ecosystems services

The importance of environmental services in general and in water environmental services in particular is increasing within the federal environmental policies. The national and general laws have been reformed and the definition of environmental services has been included.

The federal policy to develop water ecosystems services has been playing an important role since 2000 with the promotion of forest environmental services, based on the water service. The Sustainable Forestry Development General Law (LGDFS) created the trust fund, the Fondo Forestal Mexicano (FFM) for the promotion, conservation, sustainable use and restoration of the forestry resources and associated resources. The trust fund facilitates access to financial services, promotes projects which contributes to the integration and is developing payment mechanisms for environmental services (LGDS: 2003). The importance of the FFM is that it is a financial instrument for the environmental sector that allows the entrance of federal, local, private and international resources (Braña y Zorrilla: 2005).

The National Water Law (LAN) presents a definition of water environmental services as those benefits of ‘social interest generated by watersheds and its components’, such as climate regulation, conservation of hydrologic cycles, mitigation of erosion, mitigation of floods, recharge of aquifers, management of natural filtration for water quality and quantity, soil creation, sinks for greenhouse gases and conservation and protection for biodiversity. The application of this concept has to be taken in close relationship with forestry.

Federal Government has recognized the importance of environmental services through both the National Water Law (LAN) and the Sustainable Forestry Development General Law (LGDFS). Implementing the provisions of these laws is constrained by the lack of strength and skills in the local and municipal capacities to develop these services. For example: there are insufficient skilled people who understand the roles of ecosystem services and too few who can use the tools (such as geographical information systems) to develop the necessary information for each ecosystem. But even with these constraints some local NGOs and communities have found ways to identify the water ecosystem service that can be the object of a trading agreement as the Copalita and Scolelte cases (Burstein, 2000).

There are also contradictions. For example, the Mexican forest policy consists of a series of programmes that subsidize plantations and other commercial forestry, help build capacities among poor forest-owning communities so they can have their own community forestry firms, and directly invest in reforestation. However, plantations can have a negative effect on surface and ground water (Calder, 2005).

The programme for Payment of Hydrological Environmental Services (PSAH is its acronym in Spanish) seeks to become an interface between the forestry and water policy. It was designed to complement both policies by providing economic incentives to avoid deforestation in areas where water problems are severe, but where in the short or medium term there is no way in which commercial forestry could cover the opportunity cost of switching to agriculture or cattle ranching (Munoz, 2005).

Payments for hydrological services are a very recent development, however there are already a number of criticisms of the approach, these include:

- **Payments for hydrological services are a subsidy**: Despite the government interest to support water environmental services their policies has been criticized because the payments made under the PSAH are a subsidy.

- **Payments for hydrological services are politically vulnerable**: It is also considered to be vulnerable because the payments are coming from sectoral policy rather than from general public policy. This policy cannot get any conscience in the sellers and the buyers of the service. The civil society has to be the one to make this compensation programmes to get a fair redistribution of costs and benefits (Giner, 2007).

- **Payments for hydrological services do not have government and private sector support:** While Mexican law permits the marketing of environmental services, there are lacunae in the legal framework that limit the development of the strategy. Furthermore, the extension of the strategy depends on a level of demand that can only occur with large-scale government action. In essence, the environmental movement and some parts of the bureaucracy are up against the financial/ business sector and the rest of the bureaucracy in which there is likely to be no contest (Burstain, Jhon, 2005).

- **There are insufficient skills to value hydrological services:** Another problem of the water ecosystem services is that even given the obligation established by law to the Environmental Ministry for developing valuation methodologies for water environmental services, the reality is that they do not exist, because the lack of budget to generate the information. That makes it more difficult to determine a price that represents the amount to pay.

- **Water is considered a free good**: For farmers, water is free except for the costs of abstraction. In most of the medium cities only 30% of the population pays for water. In addition, the high levels of water pollution and the inequality associated with the provision of water make it very difficult to convince people that they should pay for the maintenance of watershed and freshwater ecosystems.

- **Policy contradictions**: While the PSAH is acting to form a bridge between water and forestry legislation there are other major policy conflicts. For example, agro-chemicals that are a significant source of pollution are tax free as a result of an agreement negotiated between the Ministry of Agriculture and the Ministry of Finance. Similarly, recent changes to legislation have made it easier for the financiers and developers of tourist facilities to remove and modify wetlands. This is a good indicator to know that the water ecosystem services still not been valued enough by the stakeholders.

4. Summary and Conclusions

Currently Mexico is characterised by considerable diversity in water resources between the largely arid northern areas of the country and the much better and well watered southern states. The bulk (75%) of the water is used for agriculture. Because water is considered a national good farmers are only required to pay for the costs of abstraction. Large quantities of water are wasted because there are few, if any incentives to use it efficiently. Mexico's water resources have suffered from the discharge of industrial waste, urban effluent and non-point pollution from agro-chemicals to the point that only 10% of water supplies are considered to be 'good quality' or unpolluted.

Even without the impact of climate change, water resources in Mexico will come under enormous stress from economic growth, population growth and the increased use of water for agriculture. Climate change will exacerbate these projections as surface and ground water diminishes and farmers try to compensate with higher levels of irrigation. Indirect effects of land use change such as deforestation will impact on water quality, water quantity and seasonal flows. Climate change projects also indicate that Mexico will bear the brunt of the increase in frequency and severity of extreme events – particularly hurricanes.

To date, Mexican Water policy has been dominated by government expenditure on supply-side investments. Recently through the Payment of Hydrological Environmental Services (PSAH) the government has sought to build bridges between the water and forestry sectors. Under the PSAH Programme government is a buyer of watershed services from land managers in areas that are known to be critical for aquifer recharge[2]. The fledgling experiments with payments for hydrological services have been met with substantial criticism and face numerous challenges. These include pressure from other sectors of government and the private sector who view the PSAH as a subsidy and therefore oppose it.

[2] Recent changes to the programme are also intended to focus the payments on the poorest land managers (Munoz, personal communication).

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