

## SUSTAINABLE MANAGEMENT OF AQUIFERS IN MEXICO

### GESTION DURABLE DES AQUIFERES AU MEXIQUE

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#### ABSTRACT

Water being a nationally important and strategic resource in Mexico, the National Water Commission (Comisión Nacional del Agua, CONAGUA) promotes and encourages the water user organizations to establish regulatory mechanisms to resolve water-related problems faced by agricultural, urban and industrial water users. Agriculture is the largest water consumer (77%), followed by constantly growing urban areas with 15% and the industry with 8% which increasingly requires more water. Mexico has 6.4 million hectares (Mha) under irrigation, of which 3 Mha are classified as irrigation units, using mainly groundwater from aquifers for irrigation. Climate change and its impact on the variability and intensity of rainfall cause significant changes in the availability of water in aquifers; more than 100 aquifers are overexploited, mainly due to excessive withdrawals exceeding the recharge. CONAGUA envisages to embark upon a federal program through civil associations (CA) by forming Limited Liability Company (LLC) and Groundwater Technical Committee (Comite Técnico de Aguas Subterráneas, COTAS) for sustainable management of the aquifer. Optimization of water resources, leads to the use of "Sustainable Water Volume" defined as the annual average volume available in each aquifer (quality and quantity) according to the annual average recharge. This is considered as the maximum extractable groundwater from an aquifer and it has to be used equitable by the users of the aquifer water. To regulate, supervise and monitor the aquifer withdrawals, there has to be written agreement (called Concession Agreement) between the CONAGUA and the water users on the volume of water that the users can withdraw from the aquifer. To make this effective, monitoring of the aquifer water withdrawal through actual measurement is essential. CONAGUA places special emphasis on making the water users sensitive to the need to conserve water and penalize those who violate the set norms of groundwater extraction by overexploitation.

**Keywords:** Sustainable Water Volume, Law of National Waters, Concession agreement, Public Policy, Mexico.

#### RESUME

L'eau étant une ressource importante et stratégique au niveau national du Mexique, la Commission nationale de l'eau (Comisión Nacional del Agua, CONAGUA) favorise et encourage les organisations des usagers d'eau à établir les mécanismes de réglementation pour résoudre les problèmes liés à l'eau auxquels sont confrontés des usagers des eaux agricoles, urbains et industriels. L'agriculture est le plus gros consommateur de l'eau (77%), suivi de la consommation croissante par les régions urbaines (15%) et l'industrie (8%), ce qui nécessite plus d'eau. Le Mexique possède

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une superficie irriguée d'environ 6,4 millions d'hectares (Mha) de terre, dont 3 millions d'hectares est classifiée en tant que unités d'irrigation, en utilisant principalement les eaux souterraines des aquifères pour l'irrigation. Le changement climatique et son impact sur la variabilité et l'intensité des précipitations provoquent des changements importants dans la disponibilité de l'eau des aquifères; plus de 100 aquifères sont surexploités, principalement en raison de prélèvements excessifs dépassant le rechargement. Le CONAGUA envisage de lancer un programme fédéral à travers les associations civiles (CA) en créant la Société à responsabilité limitée (LLC) et le Comité technique des eaux souterraines (Comité Técnico de Aguas Subterráneas, COTAS) pour la gestion durable de l'aquifère. L'optimisation des ressources en eau conduit à l'utilisation du «Volume durable de l'eau», défini comme le volume annuel moyen disponible dans chaque aquifère (qualité et quantité) selon le rechargement moyen annuel. Ceci est considéré comme la nappe phréatique qui peut être retirée d'un aquifère et elle doit être utilisée de manière équitable par les usagers de l'eau de l'aquifère. Pour régler, surveiller et contrôler les prélèvements d'aquifères, il doit y avoir un accord écrit (appelé contrat de concession) entre la CONAGUA et les usagers de l'eau sur le volume d'eau que les utilisateurs peuvent se retirer de l'aquifère. Pour le faire de manière efficace, il est nécessaire de surveiller le prélèvement actuel de l'eau de l'aquifère. CONAGUA accorde une importance particulière sur la sensibilisation des usagers de l'eau en ce qui concerne la nécessité d'économiser l'eau et de pénaliser ceux qui violent les normes établies de prélèvement de l'eau souterraine par la surexploitation.

**Mots clés :** Le volume d'eau durable, le Droit sur les eaux nationales, le contrat de concession, la politique publique, le Mexique.

## 1. Introduction

Mexico has 6.496 million hectares (Mha) of Irrigated area, one-third of which is irrigated with groundwater extracted from 653 aquifers and distributed throughout the country. There are 115 overexploited aquifers. Presently, the extraction and use of 29,784 hm<sup>3</sup> of groundwater is agreed. Of this amount, 68.5% is used for agriculture, urban use is 23.9%, industrial use is 4.85% and the rest 2.8% is for other uses.

Climate change and its impacts on the variability and intensity of rainfall is inducing significant changes in the availability of water in aquifers, decreasing the volume significantly coupled with excessive extractions, causing decline of the static water level, and increasing extraction costs and in many cases, abandonment of wells due to lack of water in them. Water is a strategic resource, especially in the central and northeastern Mexico with lower rainfall. Moreover, users mostly do not measure and control of the extractions, and in most cases, using higher volume than permitted in the concession agreement. The hazard with overexploitation of water in terms of deterioration of the quality of the extracted water necessitates establishing optimal policies for operation and management in groundwater extraction that would stop overuse and restore the aquifers to a sustainable condition.

## 2. Governance of water resources

Studies performed worldwide show that water problem lies in inadequate resource management. This problem is addressed through increasing emphasis on water governance on the basis of studies and framing strategies to resolve this problem. This new vision of water governance should focus on achieving a change in the hierarchical control of decisions, allowing a balance between government and civil society, who should be involved in solving the problem by including diverse points of

view, interests and obligations for a water resource shared between the public and private sector.

From this viewpoint, water governance is a means that allows achieving different objectives, where the different stakeholders are involved and in a participatory approach between the water managers and the water users.

The different federal institutions individually and collectively responsible to ensure equitable and sustainable use of the water resources should collaborate with a new way of structuring and conducting water management, where the relationship between State and society assumes more importance than the unilateral approach either by the government or the users of both surface water and groundwater.

### 3. Public Policy on groundwater resources in Mexico

The situation of aquifers in Mexico should be carefully analyzed, especially with respect to the type of management and the volumetric supply given to users who currently have a Concession Agreement. Therefore, a Public Policy must be implemented to provide a system of sustainable water balance for aquifers, allowing to stop and regain the recharge in due course, in the case of overexploited aquifers, and prevent aquifers with positive balance to retain their potential available in the future.

The proposed Public Policy in this regard is focused on establishing a co-responsible water management between the federal government, specifically through institutions such as CONAGUA-CFE-SAGARPA and users of each aquifer. This involves developing a comprehensive management scheme where the aim is to optimize economically the use of groundwater resource. This implies technologically refocussing investments and move from what is now the aim in modernization of agriculture i.e., to optimize economically the use of water in a sustainable manner.

A new term that should be coined in groundwater management in the Concession Agreements is "**Sustainable Water Volume**", which is defined as ***annual average volume available in each aquifer (quantity and quality), depending on the annual average water recharge, which can be extracted and distributed among the various water users.*** The importance of water available in the aquifers of the country, and overexploitation done by some users is linked to the use of electrical energy consumed by pumping equipment; therefore, CFE must be integrated into this Public Policy, helping in delivering (kWh) only the amount required by the groundwater pumping equipment, with a view to restricting it to the water use as indicated in the Concession agreement.

Moreover, SAGARPA should only help users in making payments to CFE limited exclusively to the energy consumed in kWh by each extraction team, owned by users possessing a Concession agreement. This Public Policy will benefit all participants, as the institutions like SAGARPA will save billions of pesos by scrapping subsidy to the energy cost for groundwater pumping. Thus, CFE will ensure non-overexploitation of aquifers, CONAGUA will promote stabilization of aquifers and sustainable use of water, and finally, the users under a scheme of modernization of the countryside, raise the productivity of land and water and ensure a higher income for their families.

#### **4. Regulation, supervision and monitoring of the groundwater resource**

The methodological framework for implementing Public Policy is based mainly in next steps:

Formalizing Civil Associations (CA) for each aquifer, formed by the different users (agricultural, urban and industrial users), hydrographically delimited by the basin of each aquifer, integrating many CAs in multi-locations, as users require. The formalized CA should be the team that will integrate with the board of the Technical Groundwater Committees (Comité Técnico de Aguas Subterráneas, COTAS) of the aquifer represented.

Establishing mechanisms to keep track of monitoring and location of all equipment and pumping systems, determine the *Sustainably extractable Water Volume* and extractions performed by each team regarding the time, measured volumetrically with installed measuring equipment and/or indirectly supported through indirect measurement of the Energy Index (kWh/m<sup>3</sup>) determined for each team and pumping system.

Structure and develop the Aquifer General Regulations

Training for the technical staff of support to users, allowing to continue the optimal and sustainable use of water and land. Integrate efforts and resources of CONAGUA, CFE, SAGARPA and users to focus on the canalization of the federal support for the benefit of users, with the aim of increasing rural productivity, optimize economic resources and make sustainable resources available in the Mexican aquifers.

#### **5. Operating Platform and technology in data management.**

The large amount of information on extraction equipment, supervision and monitoring of cumulative volumes and comparison with the Sustainable Water Volume of each Concession agreement implies a permanent and reliable monitoring system, which requires a friendly platform for integrating, structuring and developing database, and easily and transparently analyze the information collected from all pumping systems, monthly or quarterly volumes provided by users and the indirectly information of support taken monthly through energy indices.

#### **6. Institutions involved, integration and functions to be performed**

Institutions such as CONAGUA, SAGARPA and CFE have encouraged and supported rural areas with their programs. Supports are specified in different programs, administratively regulated by the rules of operation implemented by each institution, and their respective operating manuals, allowing an appropriate use of federal resources and schemes that arise from their use in all states of the country.

Therefore, the volumetric measurement required under the Law of National Waters and specified in the Concession Agreement of each user of the agricultural area, clearly indicates that a volumetric meter should be installed at the discharge of the pumping system and share such information with the CONAGUA, who in turn must keep track of the extracted water volume and in the near future, in all cases, ensure that the *Sustainable Water Volume* is not exceeded.

The operational management of the large amount of the generated information shall be operated through a platform already available in the Mexican Institute of Water

Technology (Instituto Mexicano de Tecnología del Agua, IMTA). The system takes data provided by users from reading their meters; verify the power consumption of each power unit installed in the extraction site, study the water extraction status aquifer-wise and take necessary action which indirectly through its Energy Index, allows to obtain the volume pumped at each pumping system.

## **7. Conclusions**

The proposal for the sustainable management of aquifers in Mexico represents a new prospective vision of the rational use of available and biddable groundwater. The scheme should be implemented in all aquifers in the country; however, this should be mostly applicable in those aquifers that are already overexploited.

The conditions required in this proposal involve the proactive participation of different institutions, but especially SAGARPA, CFE and obviously CONAGUA as the leader in the water sector, to support a public policy for the sustainable management of water available in aquifers in a participatory mode with the water users.

The organization of users in Civil Associations and the integration into a Limited Liability Company, and the integration of these users into the Groundwater Technical Committee for each aquifer, are the main and most important parts in this project. This action would provide security to the implementation of the agreements to achieve an economically sustainable use of the aquifer.

CONAGUA should give greater legal security to COTAS to enforce its regulations and support their establishment and ongoing training, as established by the Law of National Waters. It is also necessary to provide them with technical tools and mechanisms to enable gathering information of water extractions in each well, aquifer-wise. Analysis of such information would and suitable action taken on the basis of the analysis results would benefit all users and achieve sustainability of the water resource use, economically optimizing its availability.