MEXICAN EXPERIENCES TO CONTROL GROUNDWATER USE IN AGRICULTURE

EXPERIENCES AU MEXIQUE SUR LA GESTION DES EAUX SOUTERRAINES DANS L'AGRICULTURE

Waldo Ojeda-Bustamante[1];Juan Manuel González-Camacho[2];Luis Rendón Pimentel[3];

ABSTRACT

The irrigated agriculture in arid and semiarid areas of Mexico supplied by groundwater sources in the past 50 years has brought social and economic benefits; however, groundwater overdrafthas induced depletion of aquifers and water salinization. In this paper, some strategies implemented by the Mexican government are described to manage groundwater extraction focusing not only to increase water productivity with an ambitious plan for irrigation modernization, but also, a better planning and supervision with the incorporation of legal aspects to adequate water rights to reality. The establishment of a legal framework, the participation of organized water users, complemented with a process of awareness about preserving groundwater resources and the modernization of irrigation districts reducedthe deficit of the recharge-extraction of important aquifers that supply important irrigation districts in Northwest Mexico. However, coordinated efforts, among federal, states, and local governments, with strong participation of irrigation users are required to improve the groundwater managementand sustainability at long term.

RÉSUMÉ

L'agricultureirriguéedans les zones arides et semi-arides du Mexiquealimentés par des sources d'eausouterraine,dans les derniers 50 ans a apporté des beneficessociaux et économiques; Toutefois, la surexplotation des eauxsouterrainesa occasionéun épuisementdes aquifèreset la salinisation des eaux. Dans cette communication, quelques stratégies mis en œuvre par le gouvernement Mexicain sont décrits pour gérer l'extraction des eaux souterraines et améliorer la productivité de l'eau avec un plan de modernisation de l'irrigation;au meme temps, il a eté mis en oeuvre, une meilleure planification et supervision avec l'incorporation des aspects legaux de droit de l'eau adaptés à la réalité actuelle. La mise en place d'un cadre juridique, la participation organisée des usagers de l'eau, accompagnée par un processus de prise de conscience concernant la préservation de la ressource en eau souterraine et la modernisation des périmetres irrigués a permis de réduire le deficit de la recharge-extraction de deux importants aquifères qui alimentent les périmètres irrigués au Nord Ouest du Mexique. Toutefois, des efforts coordonnés, entre fédéral, régions, et gouvernements locaux, avec une forte participation des usagers de l'eau d'irrigation sont nécessaires pour améliorer la gestionet d'assurer la durabilitée de l'eau souterraine à long terme.

[1]*Irrigation engineering submanager. InstitutoMexicano de Tecnología del Agua. PaseoCuauhnáhuac 8532, Colonia Progreso, Jiutepec, Morelos, México. 62550. E-mail: wojeda@tlaloc.imta.mx;*
[2]*Professor. Colegio de Postgraduados. Posgrado en Socioeconomía, Estadística e Informática. Montecillo, Texcoco, Estado de México, México. 56230. E-mail: jmgc@colpos.mx;*
[3]*Mexican ICID CommitteePresident. ComisiónNacional del Agua. Insurgentes Sur 2416 Col. Copilco El Bajo, DelegaciónCoyoacán, México D.F. 04340.E-mail: luis.rendon@conagua.gob.mx.*

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1. INTRODUCTION

Mexico is a highly variable country in terms of water resources, in time and space. Two thirds of the country is classified as arid or semiarid where most of the population and economic growth is concentrated. The southeastern region of the country is humid, where 72% of thesurface water flow occurs, but only,provides 16% of economic output.Average annualrainfall is 772 mm;however 67% of rainfall is highly concentratedin three months, from June to September(CONAGUA, 2012**).**

37% of annual used water volume 79 800 hm^3 comes from groundwater. Groundwater recharge (natural and induced) in Mexico is as big as total used volume, about 80 000 hm^3. Although total groundwater recharge almost doubles groundwater extraction, 16% of 653 Mexican aquifers are marked as overexploitedwith static water levelsdeclining very rapidly mainly due toagricultural activity intensification..53% of total groundwater used comes from overexploited aquifers (CONAGUA, 2012). Almost 70 aquifers are close to be considered overexploited and 16 aquifers have severe seawater intrusion. One third of concessioned volume (61 200 hm^3) for agricultural uses, main water user, comes from groundwater sources. On the contrary, two thirds of concessioned volume (11 200 $hm^{3)}$ for urban uses comes from groundwater.In many arid and semiarid areas, groundwater is the only available water source, therefore, groundwater management is a field where this is urgent need. Aquifer depletion is becoming an increasingly serious problem in many aquifers that support agricultural, industrial and urban activities.

Most Mexican irrigation districts supplied by groundwater have faced severe declines in pumping levels and in consequence there is a need for regulation of groundwater pumping. Reductions in irrigated area and farmer revenue have caused considerable economic impacts on these irrigated areas because farming is the major activity. As a consequence, substantial irrigation water management changes are needed to balance irrigation requirements with available supply (Pereira et al. 2002).

The regulation of groundwater pumping has been applied in several agricultural areas by the government. However, its implementation has been very difficult,even though groundwater is of critical importance to their regional economies.

2. CASE STUDY:IRRIGATION DISTRICT 037 ALTAR-PITIQUITO, SONORA, MEXICO

The irrigation district 037 (ID 037) located in the northern part of the state of Sonora, Mexico will be the study case. This irrigation district is one of the driest in México.The ID 037 is located in the Sonoran desert with an average annual rainfall of 140 mm and a reference evapotranspiration of 1888 mm. Its irrigation development began in 1949 and in 1964 it was created asan irrigation district. Irrigable land is about 60,000 ha with 844 pumping wells. Data from last three decades shows that peak irrigation cropping area was 55000 ha and peak aquifer extraction was 760 hm3. However due to overpumping, the irrigated area has been stabilized to about 20000 ha, 795 pumping wells and 300 hm3 as Figure 1 shows. Most of the crop are perennial irrigated micro-sprinkler or drip irrigation systems. Pumping levels vary from 150 m to 120 m, increasing at a rate of one meter per year at the beginning of this century. In 2003, 30 pumping wells were cancelled when the program Water Rights Use Adequacy was applied in this irrigation district. Aquifer recharge (natural and induced) was estimated of about 212.9hm3.Assuming an annual water extraction of about 308 hm3 results a deficit of 94.7 hm3. Control groundwater use in ID 037 has a long history since in 1962 new pumping wells were prohibited. In order to stabilize the aquifer, irrigable area was estimated in about 12,000 ha with an irrigation efficiency of 90%.

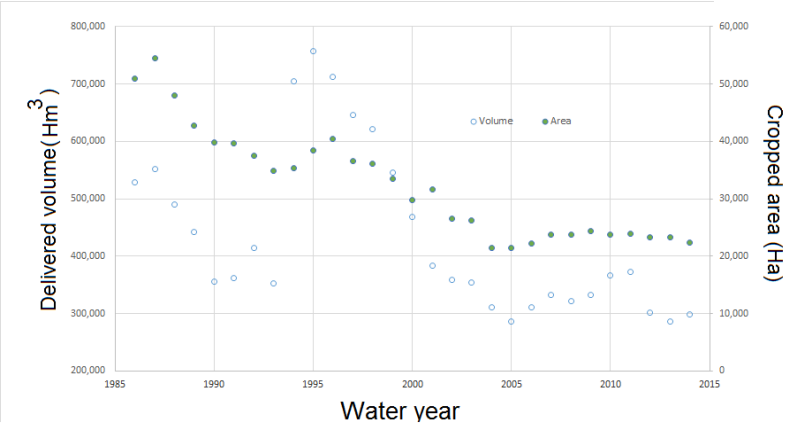

Figure 1Annual variation of cropped area in ha and delivered volume in hm^3 at Irrigation District 037, Altar-Pitiquito, Sonora, Mexico

The combination of long-term groundwater extraction to supply increasing agricultural demands and arid climate led to over-extraction exceeding aquifer recharge in the ID037.Several actions were proposed to stabilize thisaquifer (IMTA, 2012):

i. Cropping area reduction to 12,000 ha.
ii. Cropping pattern conversionto increase water productivity.
iii. Modernization of irrigation districts with conversion of surface irrigation to pressurized irrigation systems.
iv. Reduction groundwater extraction to 150 hm3.
v. Adequate water rights to actual conditions, leaving operating 501 pumping wells and canceling 329 pumping wells.
vi. Rehabilitate operating pumping wells and install water measuring devices in each well.

3. MEXICAN CONTROL POLICIES

Water use in Mexico is managed through concessions allocated by the federal government which are registered in the public registry of water rights known as REPDA. Exploitation and water use is made through concessions.

Due to groundwater overexploitation in several irrigation districts supplied by subterranean sources, the federalgovernment through the Ministry of Agriculture in Mexico implemented the program Water Rights Use Adequacy and Resizing of Irrigation Districts (PADUA). Itsobjective was to buy back permanent water rights to maintain and improving the water productivity and competitiveness in critical irrigation districts. This program was operated from2004 to 2006. It had a unitary cost of 243 USD per thousand cubic meters of groundwater. The ID 037 was the first district where the PADUA program operated.

The establishment of a legal framework, the participation of organized water users, complemented with a process of awareness about preserving groundwater resources and the modernization of irrigation districts reduced the deficit of the recharge-extraction of some important aquifers that supply important Northern Mexico irrigation districts. However, coordinated efforts, among federal, states, and local governments, with strong participation of irrigation users are required to improve the groundwater management and control aquifer over-extraction in the medium term(Burchi and Mechlem, 2005).

4. CONCLUSION

The analysis of the permanent buy back of water rights in Mexico showed that this policy had a positive effect on water resource conservation in most irrigation districts where was applied. However, due to higher return in irrigated agriculture supplied by groundwater sources than in those supplied by surface source, the buyback price of water rights set by the federal government was no an incentive to sell water rights by well owners. In consequence, the water rights buyback program is now applied mainly in irrigation district supplied by surface sources.

Groundwater governance for agricultural use is complex and require participation at different levels: producers, local and federal government. Several actions have been applied to control groundwater extractions in Mexico:

- Frequent estimation of cropped area and volume withdrawn for each pumping well.
- Strict supervision of pumping wells with over-extraction above concessioned volume.
- Annual estimation of static water levels during a non-pumping period.
- Analysis of critical zones where water levels are beyond expected.
- Frequent update of aquifer water balance to improve understanding of the magnitude of the recharge and discharge components using new data from pumping wells. The water balance of an aquifer system is dynamic which changes seasonally and yearly.
- Enforcement of water law and regulations.
- Apply governmental programs to improve operation and efficiency of wells, irrigation modernization, groundwater monitoring and control, and permanent buyback of water rights.

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