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# The National Drought Policy in Mexico

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*Abstract* -. **Traditionally, drought effects in Mexico have been attended through governmental reactive efforts directed to provide water and food, to assure health protection, and to restore economic impact once the phenomena occurred. The Mexican Government through National Water Commission (CONAGUA, for its acronym in Spanish), interested in changing the paradigm for preventive actions to cope with droughts in Mexico in the past, decided to launch in 2013 the National Program Against Drought (PRONACOSE, for its acronym in Spanish) and created the Intersecretarial Commission on Droughts and Floods (CIASI, for its acronym in Spanish) to take charge of coordinating, implementing and following-up of the PRONACOSE. This program has its main focus on reducing vulnerability through the implementation of planned preventive actions under a comprehensive and participative approach. As key part of the program, Programmes of Preventive and Mitigation Drought Measures (PMPMS, for its acronym in Spanish) for each one of the 26 river basin councils established in the country and for the principal cities of Mexico were developed. These programmes include the measures that can be implemented within the river basin councils and the cities to cope with drought in three ways: before the phenomenon occurs (strategic measures), when it is starting (tactical measures) or when it is already happening (emergency measures). Also, since 2014, the National Meteorological Service (SMN, for its acronym in Spanish) releases timely alerts and monitors the evolution of the drought including affected areas and level of severity of the phenomenon at a basin, state and municipality level. It is noteworthy that in all these activities the Mexican Institute of Water Technology (IMTA, for its acronym in Spanish) has played an important role, as this institute has provided the necessary technical support for the designing and implementation of the PRONACOSE. It is concluded that drought risk cannot be fully eliminated, nevertheless the actions that are implemented as part of this program are useful to mitigate its effects.**

*Keywords* – **river basin council, drought, planning, prevention, vulnerability.**

## I. INTRODUCTION

Drought is one of the most complex natural phenomena which affects a lot of people in the world [1]. Droughts in recent years have affected various socioeconomic sectors in Mexico, but especially the agricultural and livestock sectors as well as rural populations, leading to severe imbalances in the regional and national economies [2].

However, despite the frequency and recurrent droughts in Mexico, historically, attention to the effects of this phenomenon has been based on a reactive approach, where the primary importance has been the attention of crisis and not the risk management; in other words, in the last few decades have been implemented measures and response actions "emerging" only after is known each of the ravages caused by drought, without the time required to plan and properly assess the options and resources available to deal with the phenomenon [3].

In this context, the Mexican Government through the National Water Commission (CONAGUA), worried for the poor or rather the absence of preventive actions to face droughts in Mexico in the past, developed a comprehensive but practical structure of baseline measures, which included the necessary actions that would really help to minimize drought impacts, better than the costly traditional governments responses.

Due to the severity of last 2011-2012 drought, CONAGUA concluded by the end of 2012 this initiative in the form of Guidelines which would give to the 26 river basin councils, independent from CONAGUA, a direction on what, who, when, where and how, related to measures against possible next droughts. Such guidelines were officially issued on 22 November 2012.

The Mexican Federal authorities decided to give support to this initiative with the development of the National Program Against Drought (PRONACOSE), which ensures the framework for a comprehensive and participative implementation. The preparation of this Program was initiated by December 2012 under CONAGUA's leadership. By the time of the implementation kickoff of the Program, CONAGUA was invited to attend to Geneva, Switzerland, on March 13, 2013 for the High-level Meeting on National Drought Policy (HMNDP) to present how Mexico plans to face the drought phenomena. It is worth noticing that Mexico's National Drought Program meets several of the recommendations referred to during this important event.

Among its goals, the PRONACOSE aims to share the concepts and principles behind it as well as the implementation experiences to keep it on a permanent and dynamic improvement.

## II. BACKGROUND

Mexico has an area of 1,964,375 km² and 66% of its territory is classified as desert or semi-desert. It has a population of 120 million people and a large scattering of populations under 2500 inhabitants, which increases their vulnerability to drought.

The parallels 14°32'27" and 32°43'06" N limit southern and northern extremes of Mexico which also contain the greatest deserts of the world (Fig. 1). Mexico has a high recurrence of droughts and its history reveals some periods of water and food scarcity that have caused migrations like those of the Mayan and Teotihuacan civilizations [4]. In recent times, drought events have caused major impacts in hindering economic activities and sometimes affect the commitments established in the 1944 Water Treaty between Mexico and the United States.

With respect to the attention of drought (and of other natural phenomena) Mexico has "a wide gap between the total disbursement in reconstruction against the investment in prevention; and not investing in prevention lead to excessive economic and social costs which also compromise the sustainable development of the country" [5].

Traditionally, Mexico has acted with emergency assistance programs once the drought occurs to assure water and food supply, to keep proper health conditions, to restore affected economy (through financing and subsidies), and to promote projects or infrastructure for relief.

Recent experience with the 2011-2012 drought, the most severe event of scarcity since 1941 in the North and Central Mexico affected (at different stages and levels) around 70% of the territory and has represented up to payments of almost US $6.5 million out of nearly US $47.5 million authorized from the Natural Disasters Fund (FONDEN) towards the alleviation in ten states.

There is a strong urgency to generate a radical change of strategy in the Mexican Government as well as in the society towards a stronger participation, clear definition of public frameworks for planning and investment, and real operational local drought preventive plans.

## III. DISCUSSION

### 3.1. TOWARDS A COMPREHENSIVE DROUGHT POLICY IN MEXICO

In December 2013, CONAGUA began to design and implement the National Program Against Drought, PRONACOSE, to face the drought with a comprehensive and participative approach. The goal is to identify all kind of actions which will allow timely, coordinated and efficient decisions for both drought mitigation and prevention, considering regional features and agreeing such actions with local authorities and water stakeholders.

PRONACOSE, was launched by the Mexican President in January 10, 2013 and within the CONAGUA on February 2013. The highlight of this initiative is that the 32 States and the Local Governments have a key role of the efforts, as well as all the water users through the 26 river basin councils which cover all the Mexican territory (Fig. 2).

PRONACOSE has a comprehensive and participative approach for the period 2013–2018 in several ways:

(a) It includes both: prevention and mitigation through respectively the estimation of needed resources, the definition of actions and the construction of a structure for the organization of stakeholders; and the reduction of impacts on people, goods, infrastructure, activities, as well as on the environment.

(b) It enhances: forecasting, early warning and data dissemination, which includes both: (i) the periodic collection and analysis of hydrometric and climatic data, and information of reservoirs and that of drought location or its levels or degrees of intensity; and (ii) the spreading of drought information so to guide the implementation of actions.

(c) It promotes: coordination of governments from the federal, state and municipal levels (for joint programs and resources) and water users involvement. The later includes training for the understanding the monitoring information and the options for user cooperation in water demand reduction actions and an efficient water use.

(d) It supports: a drought plan for each of the 26 river basin councils and drought plans for major water users. The first implies that authorities and users within their respective river basin council design and later implement their plan based on local features. The plans for major water users look for specific actions for them (major water utilities, irrigation districts or industrial facilities).

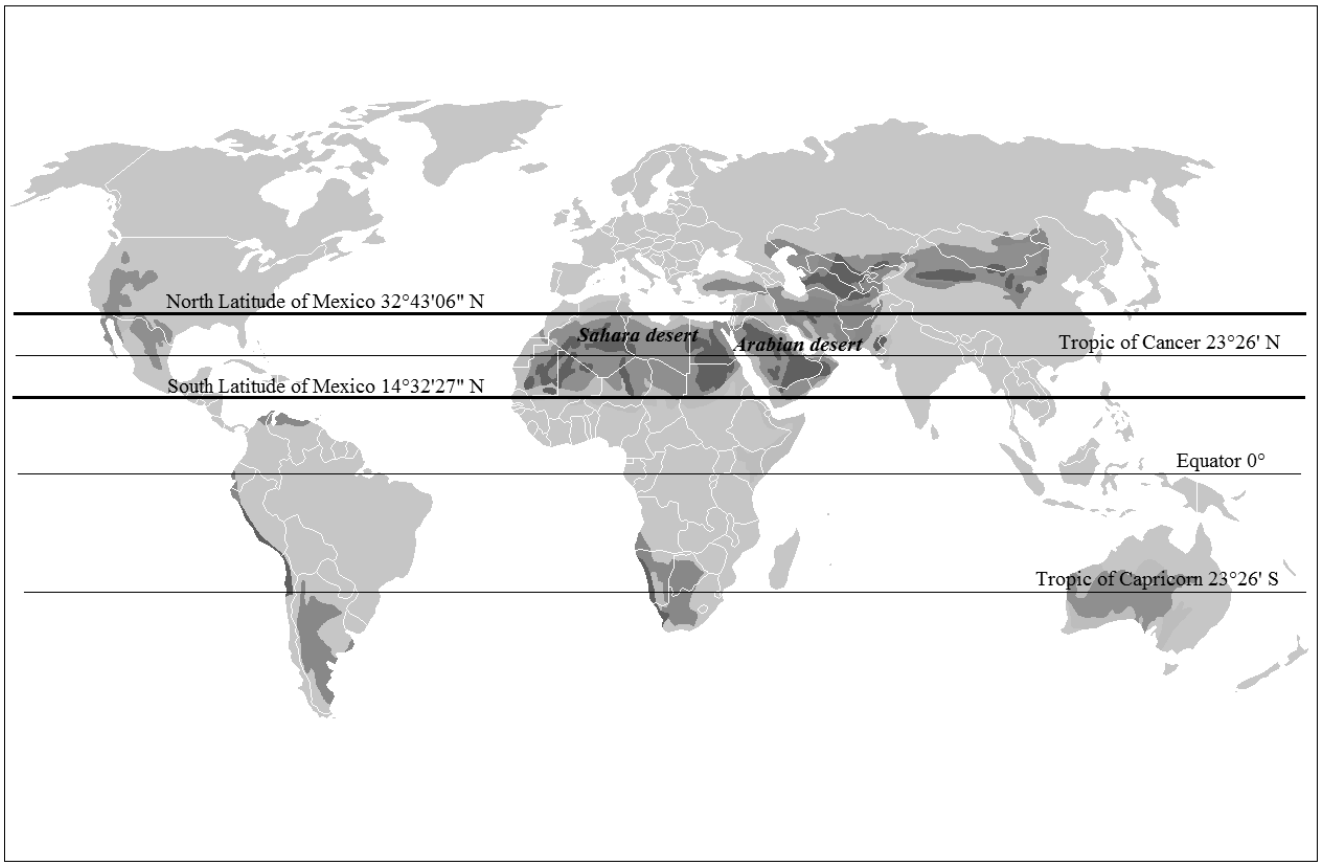


Fig.1, Location of Mexico regarding the greatest deserts of the world.

(e) The local implementation also implies that water users and authorities in the river basin council will define triggers to implement agreed actions based on official drought evolution information. Also they should agree on a range of voluntary. Measures which are expected to bring major water economies as well as mandatory measures.

A key principle is the development of such plans implies increasing complexity and improvement with time (a dynamic planning) but it is expected that an increasing involvement of stakeholders will come with the time of implementation as well as with evaluation and feedback (Fig. 3).

PRONACOSE will need the conjunction of existing federal programs and eventually their alignment with the basin plans. To reach this the Program considers an Interagency Commission and an Expert Committee. Both will review, inform, enrich and support the program, the implementation of the plan and the needed drought research. The Interagency Commission is composed by a total of thirteen Federal Agencies: CONAGUA, Interior, Environment, Agriculture and Rural Development, Economy, Energy, Health, National Defense, Marine, Education, Social Development, Land Use and Tourism. The Expert Committee considers researchers as well as high profile professionals from different parts of the country.

### 3.2. BASIS

CONAGUA started in 2009 the development of guidelines to deal with drought based on the California State's guidebook for urban zones [6] and other drought plans including a collection of experiences from many cities of the world. CONAGUA issued by 2012 the final document [7] based on Mexico's National Water Law.

The guidelines to deal with drought indicate: (i) how CONAGUA will announce the beginning and the ending of a Drought (at the severe stage), and (ii) recommendations on which are the desired characteristics for the actions that should be developed and adopted by the 26 river basin councils and by the major water users so that their territories could effectively face a drought, as well as evaluate their performance after the end of the event.

The document considers facing all stages or levels of a drought through actions before, during and after the occurrence. Before the drought level refers to the design of actions, quantification of necessary resources, and planning. During the phenomena level is related with the harmonic implementation of early planned actions. And after the occurrence level considers as necessary the evaluation, recovery of resources and improvements derived from learning.

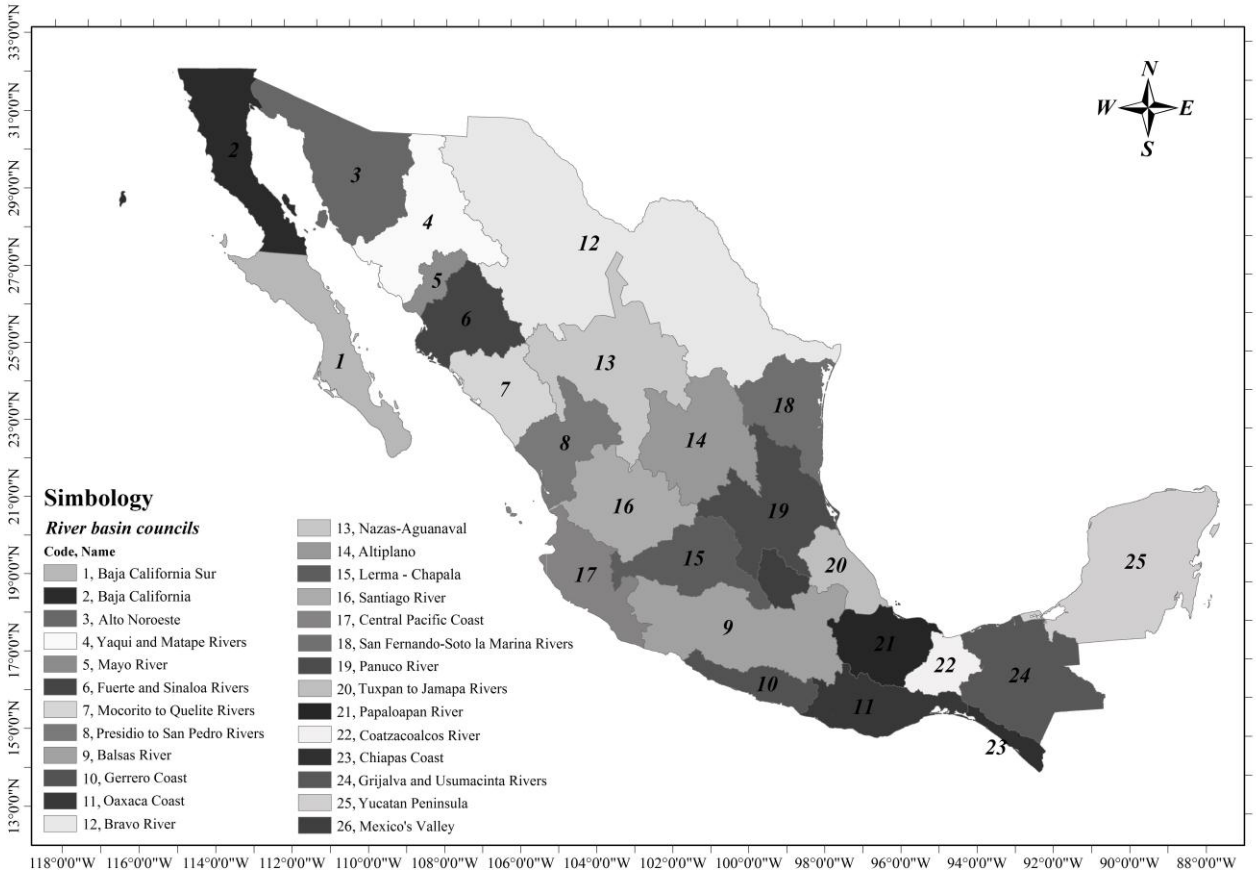


Fig. 2, Map of the 26 river basin councils covering the country in Mexico.

Although CONAGUA is interested in determining and announcing severe droughts to assure water supply to all the population, continuous monitoring and timely communication to society since first stages of droughts is part of the strategy, so that river basin councils could initiate their actions as agreed (Fig. 4). Information of stage and evolution of drought indexes for each river basin council is available at the official website of the National Meteorological Service (SMN) (smn.conagua.gob.mx).

The legal principles underlying the guidelines are derived from the National Water Law [8]. According to this Law, jurisdiction is given to the CONAGUA to regulate the exploitation and use of national water, as well as to control and to preserve water quantity and quality. Related to extreme weather events (such as droughts) that threaten people, productive areas or facilities, CONAGUA is responsible for issuing general regulations and supporting federal plans and programs directed to prevent and attend them as well as to take the necessary measures, usually transitory, to ensure domestic and public-urban supply. Besides, CONAGUA may support the organization and participation of water users, with the collaboration of state and local governments to improve water management to decide and to make commitments.

### 3.3. Steps and goals

During 2013 efforts were directed essentially for the development of the 26 river basin councils plans for droughts. Such plans define the basin drought features, vulnerability, triggers, actions and how they would be implemented and evaluated with the river basin council's participation and CONAGUA guidance. Later in the period 2014– 2018 the implementation of major actions supported by federal, state or local resources, or by funding from private sector or from international institutions will take place to improve the plans.

### 3.4. Components

There are two basic elements (Fig. 5) that comprise the National Program Against Drought: Prevention (monitoring-awareness, and basin plans and by major water user, evaluation and research), and Mitigation or Reactive Attention (action during and after the drought event).

The principles under the program have been planned and executed, not necessarily in order of importance, include:

(a) developing local capacity inside and outside CONAGUA to ensure the permanence of PRONACOSE past six years;

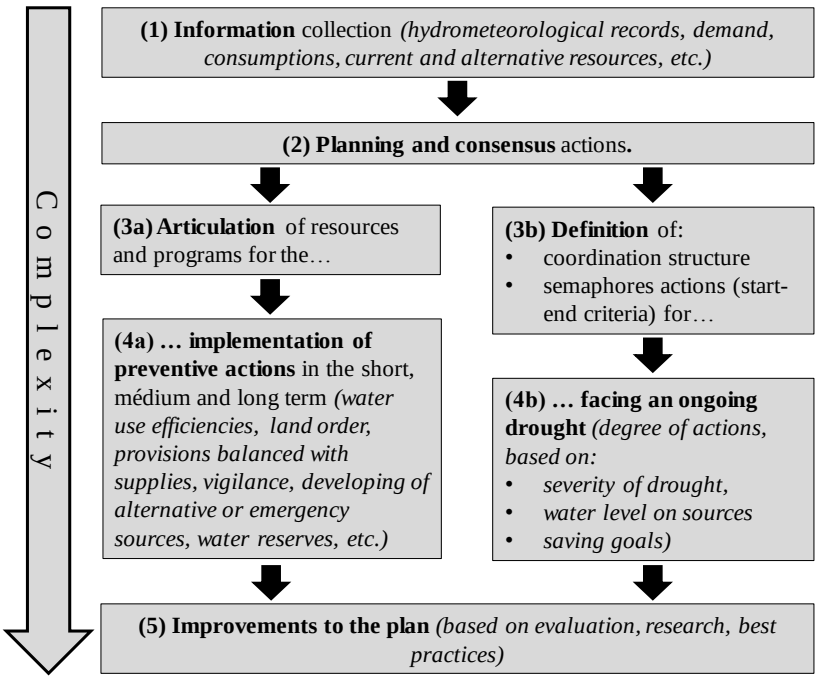


Fig. 3, Increasing complexity and involvement of stakeholders with time during the development of river basin council plans for drought.

(b) initiate an aggressive training program on basic concepts of drought and successful stories seeking to have the largest number of national and international experts on this issue both in the monitoring and evaluation;

(c) raising awareness on local water stakeholders initially through information occurrence and vulnerability to drought at the basin level (later at relevant water users in terms of use of water) and allow a first program of *ad hoc* preventive and mitigation measures at will and implementation possibilities for later evaluation, adjustment and improvement on the basis of the experience;

(d) coordinate and direct the programs of federal institutions supported by an interagency committee and working groups founded in law whose mission will be to guide and assess the PRONACOSE and fund the actions proposed by local stake- holders at the basin level;

(e) include the participation of experts and researchers to strengthen and link the solutions to the needs identified during the development of the programs of measures as well as to the general PRONACOSE implementation;

(f) ongoing communication and outreach program that emphasizes the concepts of occurrence, vulnerability, participation and prevention as well as understanding the evolution of drought; and

(g) an assessment of PRONACOSE indicators based on the implementation and impact of preventive measures reducing vulnerability to drought.

The program considers three main lines of action: (a) the formulation and implementation of preventive and mitigation programs (including monitoring and alerting), (b) acts of authority to ensure drinking water supply and (c) institutional coordinated attention based on prevention and mitigation. For the line of action (a), the PRONACOSE has five components: (1) formulation, implementation and evaluation of Programmes of

**Stakeholders will together:**

| Before drought | During drought | After drought |
|---|---|---|
| • Design the actions to reduce vulnerability<br>• Set a coordination structure to address drought | • Implement actions | • Evaluate to get a better plan, and restore conditions |

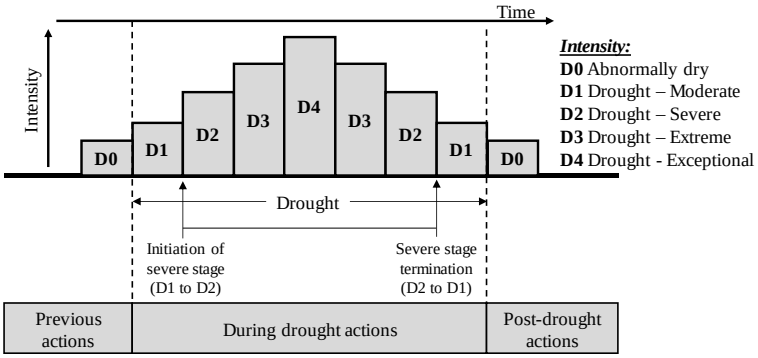


Fig. 4, Left: river basin council's stakeholders actions to face droughts; right: scheme of stakeholders actions according to drought intensity through time, highlighting severe stage initiation and termination which CONAGUA will announce.

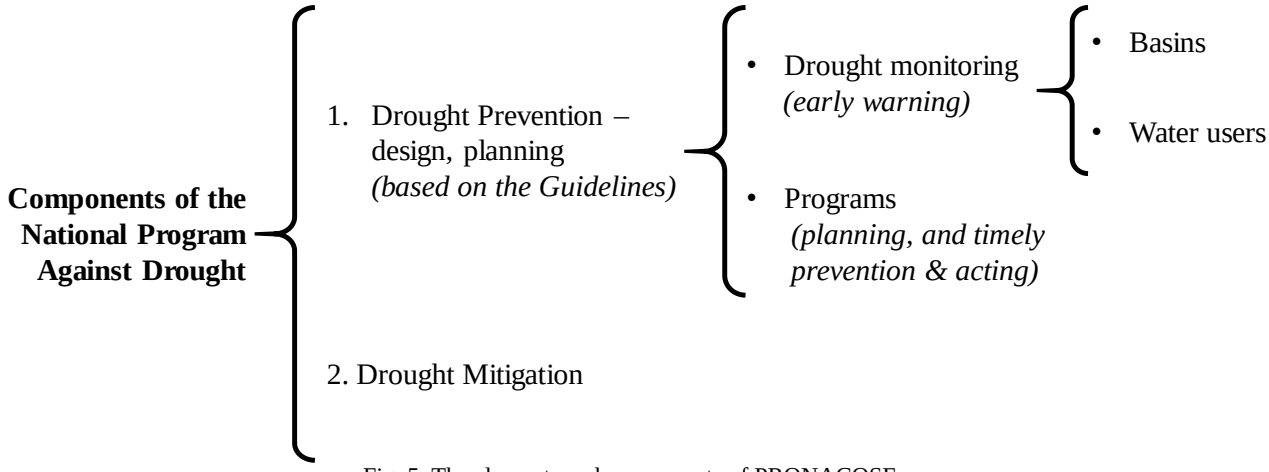


Fig. 5, The elements and components of PRONACOSE.

Preventive and Mitigation Drought Measures; (2) drought alert and monitoring; (3) development and strengthening of the institutional framework for dealing with drought: establishment of the Inter-ministerial Commission for the attention of droughts and floods and committees or working groups to inform, support, guide and evaluate the program; (4) research; and (5) training, communication and dissemination.

For the line of action (b), there are two components: (1) the establishment of administrative legal protocol and (2) the publication and implementation of the overall arrangements to guarantee the supply of water for human consumption as long as the drought reaches the severe degree or higher status and remains in it.

The final line of action (c) has two components: (1) the coordination with the National Natural Disasters Fund and the other federal government agencies programmes, (2) ongoing review of these programs and their operation rules for an effective and efficient way to mitigate the effects of drought.

CONAGUA is also conducting the visit from different world drought experts so that they can review and offer recommendations on plans design, drought analysis, and on the use of information. Efforts are also being carried out to develop a formal coordinated platform in charge of the investigation on defined lines for drought applied studies.

Decentralized attention of drought will nest the development of local capacities. In this sense, local universities are to be the coordinators within each river basin council for the elaboration of drought plans containing prioritized actions based on the guidelines published by CONAGUA some weeks before (22 November 2012) the initiation of the PRONACOSE.

### 3.5. The Programmes of Preventive and Mitigation Drought Measures (PMPMS)

The PMPMS has the general objective of minimizing social, economic and environmental impacts of possible drought situations and have been conceived as planning instruments that will serve as the basis for the right decision making within the river basin councils about the drought in the different sectors of the water users. The process for the elaboration of each one of the 26 PMPMS was formed of eight steps (Fig. 6): 1) the program objectives and the guiding principles were established within the river basin councils; 2) the characterization of the historical droughts and their impacts is carried out; 3) the evaluation of the current vulnerability to droughts was executed; 4) the

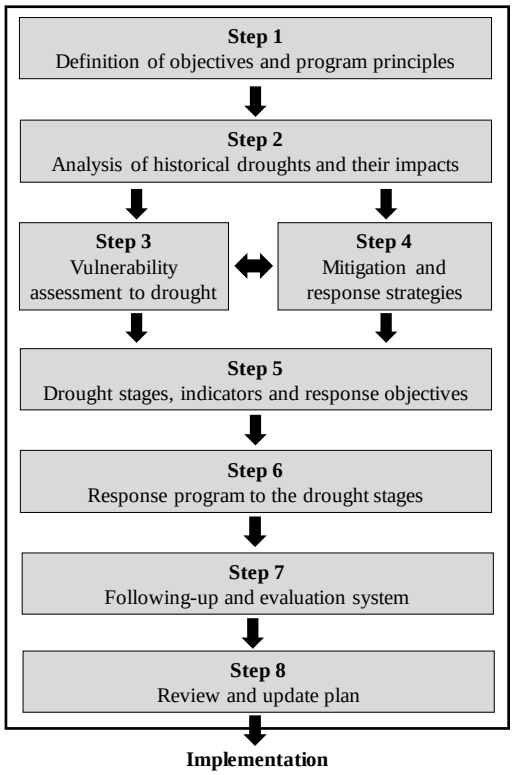


Fig. 6, PMPMS elaboration process development chart.

strategies of mitigation and response to a drought were specified; 5) the identification of the different stages of the drought and the corresponding signs and response objectives was performed; 6) a detailed program on the responses for each stage of the drought was fulfilled; 7) an indicators system for the following-up and evaluation of the program was prepared; 8) a reviewing and updating plan of the document was determined.

In summary, each one of the PMPMS includes the following: the physical and socioeconomical characterization of the basin at issue; the analysis of the historical droughts and their impacts; the evaluation of the current vulnerability to droughts; the stages and signs of the drought and the measures that can be implemented within the river basin councils to face the drought in three ways: before the phenomenon occurs (strategic measures), when it is starting (tactical measures) or when it is already happening (emergency measures), such as it is described below [9]:

a) Strategic measures. These types of measures mean actions taken in a long term (having a duration of more than two years) and they normally have an institutional and infrastructural nature that are part of the hydrological planning. For example: the building of infrastructure to keep water or the agreement and regulations development for its distribution amongst the various catchment users.

b) Tactical measures. They are short-term actions (with a duration going from some months up to two years) that are planned and validated early within the drought program. They shall be activated at yellow and red alerts. For example: when there is an increase in water prices or the reutilization of grey waters for garden irrigation or any other non-priority uses.

c) Emergency measures. They are actions taken in a very short-term (with a duration of weeks or months) and their objective is that of facing the water deficit caused by a drought when it is already there or when it is already at an advanced stage and they will vary according to its seriousness and the level of effects in the catchment. For example: water distribution through tankers amongst the population or its rationing and reduction for certain purposes.

It is important to mention that the distinction between the strategic measures, the tactical measures and the emergency measures depends on the synchronization and the manner that each river basin council implements them. For instance, the wells renovation (that is, the restoration of the water production in the wells to its most efficient manner through various treatments and methods), it can be considered as a strategic measure if it is done on an everyday basis to assure that the wells are in good working conditions when there is a drought or it can be also a tactical measure in case it is done after a drought declaration. Ultimately, it can also be an emergency measure if it is carried out when the drought is in an advanced stage and it is required to extract water from the subsoil urgently.

In addition to the above, in each one of the PMPMS are specified a basis for the implementation of actions, distinguishing between the supply side (offer of water), related to construction and distribution systems; and on the demand side that impact the use and consumption by users. This is known as the management or operation of supply and demand for water in drought conditions. As well, in the following tables are presented some examples of preventive and mitigation drought measures proposed for each of the major sectors of water users: municipal water systems (Table 1); the hydro-agricultural sector (Table 2); and the residential, industrial and commercial uses (Table 3).

TABLE 1, EXAMPLES OF PREVENTIVE AN MITIGATION DROUGHT MEASURES FOR MUNICIPAL WATER SYSTEMS

| Objective | Measure | Type* | | |
|---|---|---|---|---|
| | | S | T | E |
| Improve the water distribution service in municipal systems | Increase of water rates depending on the consumption | | x | x |
| | Repair of leaks | x | x | |
| | Install or replace measurement systems | x | | |
| | Implement distribution water systems | | x | x |
| | Replace obsolete pipelines | x | | |
| | Build wastewater treatement plants | x | | |
| | Distribute water in tank cars | | | x |
| | Make agreements with bottlers | | x | x |
| | Make a resource inventory | x | x | |
| Create new water supplies, preserve or extend existing ones | Find new water sources | x | | |
| | Drill deep wells | x | x | x |
| | Enable deep wells | x | x | x |
| | Build rainwater harvest systems | x | | |
| | Recharge aquifers by storm sewers | x | | |

*Types: S = Strategic measure; T = Tactic measure; E = Emergency measure.

TABLE 2, EXAMPLES OF PREVENTIVE AN MITIGATION DROUGHT MEASURES FOR HYDRO-AGRICULTURAL SECTOR

| Objective | Measure | Type* | | |
|---|---|---|---|---|
| | | S | T | E |
| Improve the water use efficiency in irrigation | Coating of main channels | x | | |
| | Coating of secondary channels | x | | |
| | Dam operation policies | x | x | |
| | Curves of guarantee from users | x | x | |
| | Water volume measurement | x | | |
| Create new water supplies, preserve or extend existing ones | Drilling deep wells | x | x | x |
| | Deep wells rehabilitation | x | x | x |
| | Storage dams | x | | |
| | Water treatment | x | | |
| | Recharge aquifers through drainage | x | | |
| | Runoff management systems | x | x | |
| | Cleaning sewer lines, canals and dams | x | x | |

*Types: S = Strategic measure; T = Tactic measure; E = Emergency measure.

TABLE 3, EXAMPLES OF PREVENTIVE AN MITIGATION DROUGHT MEASURES FOR RESIDENTIAL, INDUSTRIAL AND COMMERCIAL USES

| Objective | Measure | Type* | | |
|---|---|---|---|---|
| | | S | T | E |
| Reduce water consumption in household | Installation of water saver devices | x | | |
| | Replacement of traditional systems for efficient technologies | x | | |
| | Reuse of gray water for garden irrigation | | x | x |
| | Leak repair in hydraulic installations | | x | x |
| | Reduction in use of air-conditioning systems | | x | x |
| | Restriction of garden irrigation with drinking water | | | x |
| | Restriction of car washing with drinking water | | | x |
| | Restriction of sidewalk washing with drinking water | | | x |
| | Restriction of swimming pools filling | | | x |
| | Restriction of new gardens planting | | | x |

*Types: S = Strategic measure; T = Tactic measure; E = Emergency measure.

In addition to preventive and mitigation measures that are listed in Tables 1, 2 and 3, in the PMPMS are proposed others of general nature, with long-term trend (strategic measures), which can be implemented at national level, for example:

- In terms of governance, promote monitoring of strict observance of the National Water Law (NWL) and the application of sanctions for non-observance.
- Respect and enforce the agreements of the Technical Committee of Hydraulic Works Operation, in regard to the annual volumes assigned to draw from the dams for different water uses.
- Implement a payment program for hydrological services of CONAGUA (soil conservation to maintain its infiltration capacity) similar to the payment for environmental services of the National Forestry Commission (CONAFOR).
- Establish agreements of water distribution inside of each basin, and agreements for water transfers between neighboring basins, when drought conditions so require.
- Promote that CONAGUA assume operational and financial control of the operator agencies of drinking water and sanitation.
- Promote the modification of the Mexican Official Standard NOM-011-CNA-2000 in order to improve the estimation of water availability from aquifers be calculated with real data of extracted volumes, and not based on concession volumes.
- Implement mechanisms in the existing legislation to enable that CONAGUA could count with water volumes reserved for use in times of drought.

Finally, it is noteworthy that in all activities mentioned before, the Mexican Institute of Water Technology (IMTA) has played an important role, as this institute has provided the necessary technical support for the designing and implementation of the PRONACOSE.

### 3.5. CHALLENGES

Among the main challenges for the National Drought Program development and implementation is the adoption of a new water culture and strategy by water users and government agencies which comprises the prevention, planning and evaluation of the drought plans as the main asset to face a recurrent natural phenomena. Also the alignment of the federal, state and local fund programs to the directives of the drought plans is critical due to a very long history of a reactive approach. It is well known that

droughts occur in Mexico but it is not well assimilated that it should be considered as the present and future natural occurring condition in a climate change scenario and that should be the baseline for the National Development Plan and the framework for a new National Civil Protection System. The funds to reduce the present vulnerability are high and the possibilities to get the financing are opposite. Thus another challenge is the funding of Mexico's vulnerability reduction to drought. An option is to access the world Climate Change Adaptation Funds. Finally, a drought communication strategy from the beginning is also critical for the acceptance of the drought measures and for the real evaluation of the success or failure of the Program.

### 3.6. Main interests in Mexico

There are three main interests in Mexico with regard to its National Program Against Drought:

- To guarantee the permanency of the drought planning and implementation for the future;
- To manage real social involvement in the development and implementation of the drought measures on a permanent basis; and
- To ensure that the reduction of drought vulnerability is one cornerstone of the Mexican strategy for climate change adaptation in compliance with the Climate Change General Law and the National Water Law.

## IV. Way forward

The first planning phase of the Program was completed in 2013 but the implementation evaluation during the following four years will lead to another planning exercise and the issuing of new developed and improved basin and major water users plans for 2018 and onwards. The first phase effectively concluded with 26 completed plans for river basin councils which were analyzed by four international experts from USA, Spain and Brazil; they enriched the elaboration of the plans and shared comments for possible collaboration for drought monitoring and analysis.

Points to be properly addressed during the first four years are: the carrying out of the planned prioritized action with convergent resources, the development and testing of protocols for coordinated actions prior to the occurrence of a real drought, and the communication of plans out of the river basin councils looking for public appropriation.

Since the very beginning of the conception of CONAGUA's guidelines in 2009, decentralization of drought attention was considered as a key issue to maintain efforts beyond administrative changes. The complement of this key issue is the effective appropriation of plans by citizens.

Directions for basin councils through local universities were given to ensure, as far as possible, attention to social, financial and environmental aspects (especially water issues). Future versions of plans will improve such considerations.

A natural path to maintain the drought plans in place and keep them ongoing is to support them in a new National Civil Protection System and with the Climate Change and Water Laws mechanisms and instruments. This will give them financial support as well.

## V. Conclusion

Mexico is enveloped in a transition process that is going from a reactive approach centered in the management of the crisis caused by droughts to a preventive approach focused on the risk management. The aim of the National Program Against Drought is that of anticipating droughts by foreseeing solutions to satisfy the demand by avoiding situations of water shortage and conflicts between users for its use. The comprehensive vision of this program includes preventive and mitigation measures; improvements in knowledge generation and sharing of usable information for coordinated actions among stakeholders; and local conception and implementation of measures in each of the 26 river basin councils that integrate the Mexican territory. Drought risk can't be completely eliminated but this program is useful to mitigate its effects.

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