



GIS AND INTEGRATED WATER RESOURCE MANAGEMENT IN MEXICO

IN 2012, THE NATIONAL WATER COMMISSION OF MEXICO CONTRACTED GEOTECHNICAL SPECIALIST ARGEOMÁTICA SA DE CV TO SUPPLY SOFTWARE AND SERVICES FOR A NATIONWIDE GIS THAT WOULD HELP TO ALLEVIATE CONFLICTS OVER WATER BROUGHT ABOUT BY UNCONTROLLED DEVELOPMENT. RICHARD SPOONER REPORTS ON THE PROJECT AND ITS PROGRESS TO DATE

According to the National Water Commission of Mexico (Comisión Nacional de Agua or Conagua), water is 'a strategic element essential for national security'. The country is situated at the same latitude as the Sahara and Arabian deserts, and two-thirds of the territory of Mexico is considered arid or semi-arid, with annual precipitation of less than 500mm.

However, it isn't simply that not enough rain falls on Mexico: some parts receive over 1,500mm per annum (see Figure 1). The problem Mexico faces is that its water resources are unevenly distributed, in both time and space. This is compounded by uneven economic development: 69 per cent of renewal water resources

are in the south and south-east, where only 23 per cent of the population live and 13 per cent of GDP is generated; 77 per cent of the population is concentrated in the north, centre and north-west, which accounts for 87 per cent of GDP, but has only 31 per cent of the country's renewal water resources.

Compounding these geographic variations in supply and demand is the fact that most of the rainfall in Mexico occurs between June and September, very often torrentially and often causing severe flooding – no wonder Tlaloc, the Aztec god of rain, fertility and water, was regarded as both a benevolent god and one that was to be feared for his ability to invoke violent storms.

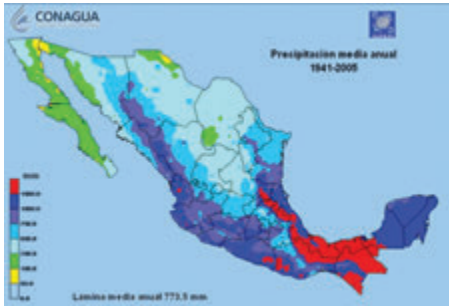


Figure 1: Average annual precipitation in Mexico

According to the National Population Council, Conapo, the population of Mexico quadrupled between 1950 and 2005, and went from being predominantly rural (57.4 per cent) to mainly urban (76.5 per cent). The population is forecast to increase by a further 16 million people by 2030, at which point 82 per cent of the population will be living in urban areas, many of them in regions where water stress is already high. Despite considerable improvements, in 2007, 10 per cent of the population still had no access to drinking water and 14 per cent had no access to sanitation.

Water stress isn't confined to urban areas. The demands of crop irrigation mean that agriculture is the country's greatest consumer of water. Indeed, Mexico has the sixth largest amount of land devoted to irrigation of any country in the world. In many cases, demand for irrigation water can only be fulfilled by

drawing water from aquifers, which are not being replenished.

A policy shift

Over the past century, Mexico's response to its water problems has changed markedly. At the start of the 20th century, the imperative was to increase the supply of available water by building reservoirs, irrigation systems, aqueducts and water supplies. As a result, Mexico has become renowned throughout the world for its expertise in hydraulic engineering. However, from the 1980s onwards, government policy began to shift more to controlling demand, rather than increasing supply. The government devolved responsibility for providing drinking water, sewerage, sanitation services and management of irrigation systems to the municipalities. It also created Conagua as an overarching body and gave it a mission to manage and preserve the country's water resources.

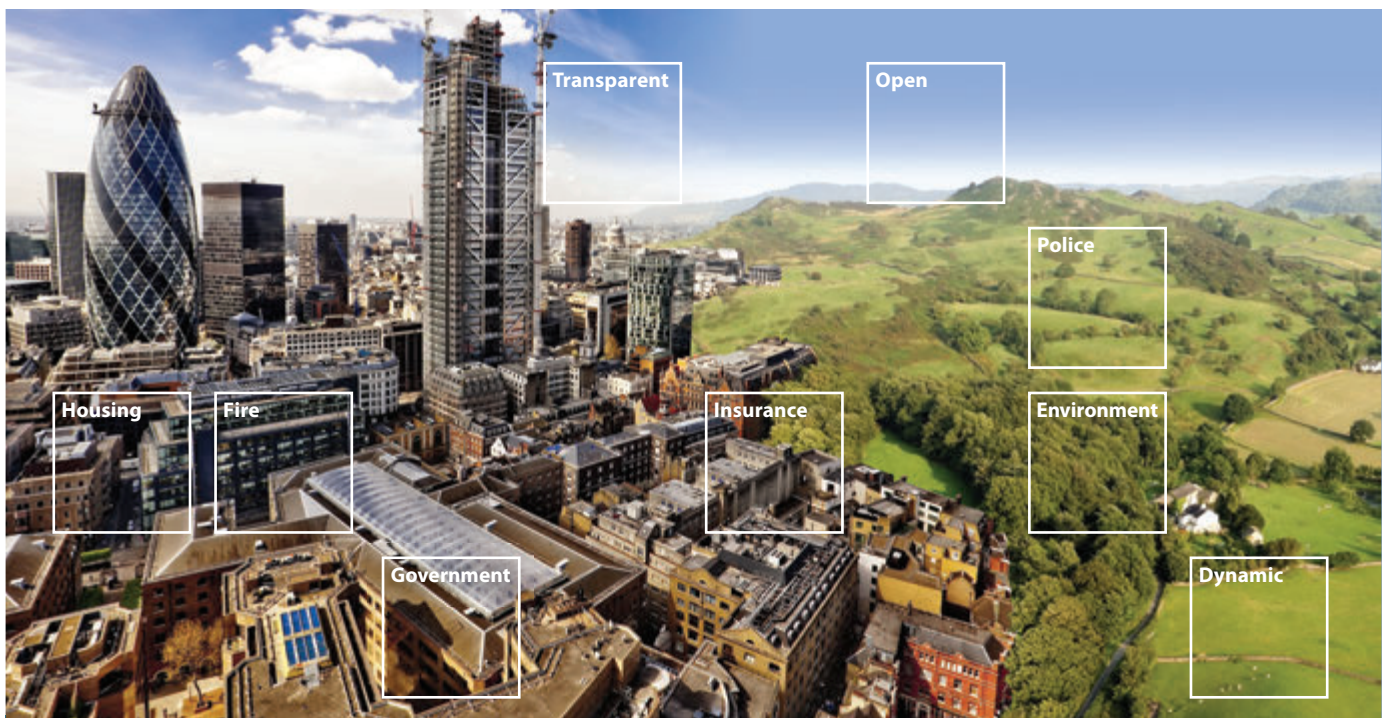
In the 21st century, water policy has entered a third phase that focuses on water sustainability. Attention is being directed much more towards normative and legislative vehicles to encourage changes in behaviour, such as the creation of water banks to manage the transfer of water entitlements between users; the introduction of measures to promote the treatment of wastewater; the reuse of water; and the application of more efficient practices in agriculture.



Figure 2: The main screen of the application developed by Argeomática SA de CV for Conagua, showing the Query, Receipt, Management and Topography modules



Figure 3: The planning portal is for recording planning applications and objections. The image shows an application to build a soccer pitch for community use, close to a river within the 'Federal Zone'



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The project

Jaime Montesinos, general manager of Argeomática, explains the role of GIS technology in terms of Conagua's sustainability agenda. "Sustainability involves environmental, economic and social considerations. GIS is perhaps most easily identifiable with the environmental ones. Water sustainability requires, for example, that aquifers are not overexploited, that flows of surface water bodies are respected, and that water pollution is monitored and controlled. We are using Cadcorp SIS combined with our surveying expertise to build up a comprehensive picture of what is happening on – and in – the ground."

Argeomática has used components of the Cadcorp Spatial Information System (Cadcorp SIS) suite to develop four interrelated applications for Conagua.

Módulo Recepcion (see Figure 3) is a planning portal for recording building applications and appeals. The module has been designed to categorise development applications from government agencies and individuals, and to quantify any potential flood damage that might arise from development.

Módulo Consulta (see Figure 4) is an application for querying a building permit and cadastral database. It is used to indicate whether properties are located on federal land. It also returns the name of the occupants from the Public Registry of Property, as well as the property's cadastral key. It allows both buildings and their occupants to be queried on a range of variables.

Módulo Topografía (see Figure 5) uses Cadcorp SIS technologies and products to support a range of tasks associated with land survey and spatial analysis. These include: topographic, photogrammetric, bathymetric, GPS, LIDAR (Light Detection And Ranging) and satellite surveying; soil surveys; 3D visualisation; integration with hydraulic modelling applications; and the production of ortho-rectified photos, maps and plans.

The last application, Módulo Gestión (see Figure 6), manages the collection of fees associated with building permits and applications to develop land in the Federal Zone around a river.

The result

Already, the system is showing its worth. Argeomática's Jaime Montesinos says: "We are also using Cadcorp SIS to support the economic dimensions of sustainable water management. For example, the revenue collected using our Gestión application is used to fund water management initiatives."

Montesinos also points to the social dimension of sustainable water management, which the project builds on. "It provides a very transparent vehicle – the geospatial planning portal – for involving local communities in deciding the building developments they want in their localities.

A central role for GIS

Conagua has been at the forefront of promoting the development of information systems since its formation in 1989. In its 2030 Water Agenda (http://www.conagua.gob.mx/english07/publications/2030_water_agenda.pdf), it makes the case for developing regional GIS that will contain 'inventories of infrastructure and national assets, the configuration of catchments and their social, economic and environmental characterization, as well as the outline, location and names of rivers, streams, water bodies and aquifers, the location of the flood risk zones and the climate and hydrometrical information that contributes to planning their prevention'.

Conagua makes it clear that the information is to be collected not for its own sake, but to inform the planning process: 'Equally important is the systematization and making accessible of the information consultations of all those who are involved in water management, to facilitate the analysis and interpretations, as well as the elaboration of diagnosis and the generation of indispensable indicators for the very formulation of the planning process at the regional and national levels.'

WE ARE USING CADCORP SIS COMBINED WITH OUR SURVEYING EXPERTISE TO BUILD UP A COMPREHENSIVE PICTURE OF WHAT IS HAPPENING ON – AND IN – THE GROUND

It is this emphasis on the gathering and presentation of information to inform planning that underlies the 'Delimitation of Federal Zones in Rivers Project' that Argeomática is delivering on behalf of Conagua.

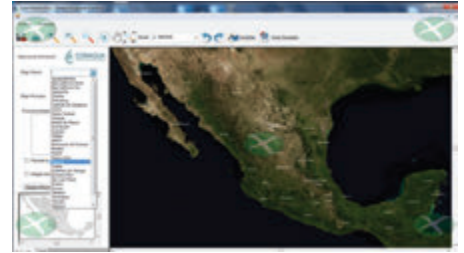


Figure 4: The Query Module links to a spatial database indicating whether properties are located on federal land. It also returns the name of the occupants from the Public Registry of Property, as well as the property's cadastral key. Buildings and their occupants can be queried on a range of variables

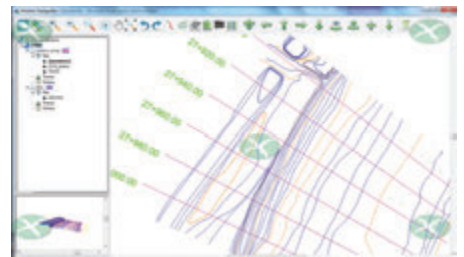


Figure 5: The Topography Module provides the means to model and analyse river basins in Mexico. The module, which meets the national standards set for geodetic surveying, collates data from multiple sources including topographic, photogrammetric, bathymetric, GPS, LIDAR and satellite surveys. The resulting spatial database supports a range of analytical activities including the building of cross-sectional profiles, 3D visualisations and hydraulic modelling.



Figure 6: The Manager Module allows users to collect fees associated with building applications

In fact, one of the central reasons we deployed Cadcorp SIS in the project is that the software suite not only provides the powerful geo-processing functionality that we require as geotechnical professionals to support our work in creating and analysing spatial information, it also allows us to share the spatial information we have generated with those agencies, organisations, and individuals that have an interest in sustainable development – not least the local communities.

Richard Spooner is marketing manager at Cadcorp (www.cadcorp.com) Argeomática SA de CV (www.argeomatica.com) is a Mexican company and Cadcorp business partner specialising in photogrammetry, geomatics and GIS Images reproduced with the permission of Conagua