Dr. Michel Rosengaus Moshinsky
Head of the Unit
National Meteorological Service/SMN
National Water Commission
Mexico

Lauri Tuomaala
Product Line Manager
and
Hannu Kokko
Product Manager
Vaisala
Helsinki, Finland

Modernizing Weather Information Networks in Mexico

This article describes the measurement problems experienced at the National Meteorological Service (Servicio Meteorológico Nacional) of the National Water Commission of Mexico and how they can be solved utilizing the Vaisala Weather Transmitter WXT510, together with PDAs and some additional hardware. We also introduce another, more advanced solution - the Vaisala HydroMet™ Automatic Weather Station MAWS100, which incorporates the Vaisala Weather Transmitter WXT510.

Vaisala introduced the Vaisala Weather Transmitter WXT510 into the global market in October 2004. The WXT510's various interface options means that it can be easily integrated with data loggers, PDAs or machine to machine communication modules. It is especially suitable for dense measurement networks.

Case: National Meteorological Service of Mexico

The network of traditional climate stations (TCS's) in Mexico is a major source of climatological information in the country. Many governmental and private decisions are taken on the basis of data coming from these stations, e.g. identification of normal weather conditions, evaluation of potential extreme occurrences, daily follow-up of the water cycle, objective identification of draught conditions, adjustments to electricity fees, design of works and systems, etc. This is the data that is most frequently requested from Mexico's National Meteorological Service (SMN).

Presently, there are 3,200 stations in operation, with an average distance of 20 km between them. The maximum number of stations operating simultaneously was reached in 1980-1985, with approximately 4,200 stations. A human observer reads the results once a day (at 8:00 a.m., local time) and writes them down in a paper record. A subset of 900 stations are linked by radio or telephone and, apart from generating the paper records described above, these stations transmit their measurements once a day to a concentration point where they are captured and entered into a database. Paper records, once digitally captured, are sent to the SMN to be entered into the national weather database, which is currently managed through the WMO's CLICOM system. As of December 31st 2004, the historical database had 12'440,747 records, where one record represents one month (28 to 31 values) of one of the nine variables for one station.

Dr. Rosengaus verifying every detail of the tailored cut model.

Problems with the old network

The TCS network has considerable limitations:

- It does not provide practically any information about the diurnal cycle. There is a lack of proportion between the cost of operating the network and the quality of data obtained. The trips (ideally monthly) to collect data are very costly, while the amount of data collected at each site is very limited.
- Timeliness of data is poor. Except for the data coming from the subset of stations that report daily, data availability takes months (at times, even years) after this has been collected.
- Quality control is limited, especially because of the difficulty of managing a set of human operators, who are quasi-volunteers, broadly distributed across the country.

Vaisala Weather Transmitter WXT510.

- Operations in the stations are irregular, resulting in discontinuous records, a porous database and geographic density that is inconsistent in time.
- Some important variables (basically humidity and wind) are not measured.

After the introduction of the Vaisala Weather Transmitter WXT510, Mexico's SMN immediately identified that this kind of equipment could be the milestone of modernization for the network of climate stations in the country, providing several different options. To begin with, there is the possibility of recovering 1,000 stations whose operation had been lost since 1980-1985, at affordable prices. To this end, a pilot test commenced with 30 units operating for one year. Rossbach de México, Vaisala's exclusive representative in the country, is a key partner in this project.

The new station configuration

The subset of instruments consists of five modern sensors in a very compact package, similar in size to a coffee can: ultrasonic wind sensor (speed and direction), piezo electrical RAINCAP® sensor (accumulated rainfall, rain intensity and duration), temperature, humidity and atmospheric pressure - all protected from solar radiation but having an adequate flow of air from the ambient environment. The WXT510 is an intelligent multisensor that communicates with a data recorder through its serial interface. Individual characteristics of the instruments are excellent, certainly better than those of traditional instruments presently used in TCS's. Also, energy consumption is low enough to consider an autonomous installation, far from commercial electricity sources. Another important factor is that the package has no mobile parts.

The entire station does not attract attention to its state-of-the-art technology when installed within a traditional weather station. The concrete foundation is 60 cm deep, and weighs approximately 180 kg, which makes it very difficult to extract and move. The corrosion resistant mast, embedded in concrete, is installed from the beginning with a notch in the upper part, oriented in such a way that if the package of sensors has to be reinstalled, it is already properly oriented, which is essential for detecting the direction of the wind. There is a no-cups anemometer, an element which has historically been the object of vandalism. Another popular target, the solar panel, is not evident at a distance because it is attached to the upper part of the weather-proof box (on the mast, above the upper edge of the railings). External cables are not evident, nor is the internal electronic instrument visible. It is quite stable, not only against the wind but also against operators that may lean against the mast. The wind sensor is not subject to down wind trails from any other component of the traditional weather station.

There are no exterior nuts or bolts. It may only be disassembled with the access key. Even after cutting metal clamps on the mast, the box is not totally removed, because it has additional bolts at the center of the mast.

The data recording device is a palm computer running Windows CE. Batteries are found behind the metal plate that appears to be the background. Bolts to detach the whole box are also behind the plate. Normally the screen displays the last measurements taken for the benefit of the station's operator. When dealing with a station that reports daily, this data is transmitted by telephone or radio. By pressing one of the buttons, the operator is asked whether data should be downloaded to the removable memory card. It is enough to do this, extract the card, replace it with a blank card, take the said card to the data concentrating center and - using a simple computer with the proper card reader - copy the information to the hard disc.

The file is in ASCII text format. Therefore, while traditionally a visit to the station was to collect paper records, now memory cards will also be collected, regional data will be concentrated and sent via electronic means to central offices and entered into the corresponding databases. It is not necessary to shut down the equipment in the weather station in order to change cards and indeed, it does not interrupt measurement taking during that time. The person collecting the data does not have to do anything special to produce a continuous long term record because it is easy to link together the text files of two consecutive collection trips; the moment that the last data transfer to the removable memory card occurred is automatically marked. The data file has an identifier to avoid any confusion in case the cards from several stations are mixed, even if they do not have an outside identifier.

The pilot test

The pilot test, planned as the operation of 30 multi-sensors for a whole year (January 1st to December 31st 2005) under 100% operational conditions, is necessary because this is the first time that such equipment is used, except for internal tests carried out by the manufacturer. Before investing large amounts of money in a true modernization of the network of weather stations, there must be evidence of the correct operation of the instruments and the data collecting and concentrating system, as well as durability of the devices, and incidence of vandalism, etc. Moreover, the pilot test will allow for necessary modifications before starting a massive modernization program. A relatively small area close to the Valley of Mexico was chosen as the test site, to enable the specialized personnel from the SMN to perform close monitoring tasks. As of December 1st 2004, 100% of the stations were already installed and the personnel fully trained.

Since they are co-located with 30 TCS's presently operating, instantaneous (08:00), maximum and minimum temperatures as well as rainfall may be checked against traditional instruments. This is particularly important in the case of rainfall because of the revolutionary measuring device (impact drum).

New possibilities

The system is likely to improve the reliability of climatological measurements in Mexico, significantly improve its temporal resolution and even open the possibility to recover points of measurement that have been lost in recent years. It will also allow for humidity, wind and pressure measurements with adequate density on Mexico's geography.

The results of this pilot program for modernization will be available not only for Mexico's National Water Commission (CNA), but for similar efforts in developing countries in Central America and the Caribbean (WMO's RA-IV), South America (WMO's RA-III) and other interested nations. We are thankful to all who have helped us in this significant modernization project. ●

Left: Data recording device.
Right: Inside the weather-proof box.

Vaisala HydroMet™ Automatic Weather Station MAWS100 Incorporating the Vaisala Weather Transmitter WXT510.

Together with the Vaisala Weather Transmitter WXT510, the Vaisala HydroMet™ Automatic Weather Station MAWS100 extends the field-proven quality and reliability of the Vaisala HydroMet systems to new applications. The MAWS100 is a compact system for hydrometeorological monitoring when a small number of sensors is required. It brings data logging, in-situ calculations and data quality control, additional sensor interfaces, cellular telemetry and versatile powering options to the system incorporating the WXT510.

Sensors

The basic sensor suite measures wind speed and direction, pressure, temperature, relative humidity and precipitation. Optional sensors can be added to measure water level, soil/water temperature, global and net solar radiation, for example. Generic and configurable 16 bit A/D conversions are also provided in case the user wants to interface to their own sensors. The high accuracy of meteorological data is ensured by factory calibrated A/D conversion and advanced data quality control and validation software.

Power

The MAWS100 is a low power device. The basic system is powered using mains power or a small 6 W/6 VDC solar panel and 1.3 Ah back-up battery. The 5 Ah battery and 12 W panel support the systems with telemetry and extended back-up time.

Telemetry

- TCP/IP: The MAWS100 can be connected directly to a LAN network using the DXE421 ComServer module. The module converts a standard RS-232 port to a 10/100Base-T Ethernet connection making MAWS systems Internet-enabled devices. The DXE421 is a compact module installed on the DIN -rail inside the enclosure.

- PSTN: Connection to Public Switched Telephone Network(s) (PSTN) is made via an industrially hardened DXM421 modem, which has been designed for demanding environments and is rated for - 40 to +60 C operating temperatures. The modem has a low power consumption and includes both data compression and data correction functions. The maximum data rate is up to 57.6 kbits/second with an excellent in-built line protection.

- GSM/GPRS: The GSMTC35T-M3 is a dual band GSM terminal especially designed for demanding professional use. The data modem is small, has low power consumption and an extended operational temperature range. The tri-band model is available for cellular networks in the USA. The GPRS (General Packet Radio Service) service offers continuous and high-speed connectivity to the GSM network. In addition to the standard GSM operation, this option offers additional functions, which greatly facilitate data collection. Data transmission via GPRS can be initiated by the MAWS100 using FTP (File Transfer Protocol). The MAWS100 acts as an FTP client placing a file on the FTP server's hard disk at user configurable intervals, when a user set alarm condition is detected by the MAWS100 and/or when the daily log file(s) are completed. In practice, GPRS connectivity means the MAWS100 is online all the time and data is available immediately when required at a very low operating cost. Together with the Vaisala MetMan™ Network Software, mesoscale or national environmental monitoring networks can be easily and economically set up as a complete turnkey solution.

Flexible sensor and telemetry interfacing, advanced statistical calculations, extensive data logging on a compact flash memory card and versatile data reporting functions allow the MAWS100 and WXT510 to be customized to a large variety of applications. ●