GEONICA

COMPANY PRESENTATION

METEOROLOGY - HYDROLOGY
OCEANOGRAPHY
AND ENVIRONMENTAL MONITORING







QUALITY THROUGH INNOVATION AND DESIGN

GEONICA SYSTEMS & SOLUTIONS
SECTORS WE COVER

INDEX






1. Meteorology – HYDROMET System

Since 1974 **GEONICA** designs and manufactures a complete line of remote very low power Automatic Weather Stations (AWS), based on the field-proven and reliable Data Loggers, Acquisition and Transmission Units **METEODATA / HYDRODATA** Series.

Our Automatic Meteorological Stations or Automatic Hydro-Meteorological Stations can be configured according to any requirement for the measurement of all meteorological and hydrological parameters, such as precipitation, air temperature, relative humidity, dew point, atmospheric pressure, wind speed and direction, solar radiation, etc., as well as water level of rivers, river discharge (water flow), water velocity and currents.

Due to the very low power consumption of **GEONICA**'s solutions, our automatic Hydro-Meteorological stations can be installed at remote unattended sites, operated by the internal battery pack and charger and an external solar panel of reduced dimensions.

GEONICA offers a wide range of telemetry options for remote data collection and networking by GPRS/3G cellular Network; via Point-to-Point or Point-to-Multipoint Radio Link; as well as via Satellite (INMARSAT BGAN, INSAT, VSAT, IRIDIUM, etc.), allowing also mixed solutions and optional redundancy, in such a way to ensure communications in critical projects, as for example, in the case of early flood and heavy rain alert and warning systems and networks.

Our advanced and tested **GEONICA SUITE** Software Package installed at the Data Receiving Center (**GEO-DRC**) is ready to manage all the communications of any number of remote measuring stations of a complex network, as well as fully remote programming and data transmission, generating a database in SQL for subsequent analysis and additional data processing.

By means of our **WEBTRANS** ***Ubiquitas*** Internet Platform (WEB Posting Application), the users have access via Internet to all graphical and numerical information transmitted by the remote stations to the Server, and updated at programmable intervals from 1 to 60 minutes . Additionally, it is always possible to interrogate directly the remote stations at any moment, as well as to request real-time data.

Remote Automatic Rainfall Measuring Station

Electronic Weighing Precipitation Sensor Model DATARAIN-4000

2. Agro-Meteorology – AGROMET System

METEODATA / HYDRODATA - 3000CP

Our Automatic Agro-Meteorological Stations and Networks can be configured according to any requirement for the measurement of all agro-meteorological parameters, such as: precipitation, air temperature, relative humidity, dew point, atmospheric pressure, wind speed and direction, solar radiation, evapotranspiration, leaf wetness , soil temperature and soil humidity, etc.

GEONICA offers specific sensors for the measurement of all the agro-meteorological parameters. These sensors are connected directly to our data logger and data transmission unit Model **METEODATA**, which stores all the information and transmit data in real-time via GPRS/3G cellular Network, when a suitable GPRS/3G coverage is available at the remote site.

Alternatively data is transmitted via Radio Link Point-to-Point or Point-to-Multipoint, or through Satellite networks like INMARSAT BGAN, INSAT, VSAT, IRIDIUM, etc., allowing also mixed solutions.

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PTHR-4000 Multisensor

. Atmospheric Pressure
. Ambient Temperature
. Relative Humidity
. Solar Radiation
. Dew Point (calculated)

PTH-4000 Multisensor

. Atmospheric Pressure
. Ambient Temperature
. Relative Humidity
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3. Hydrology

The term Hydrology, is the scientific discipline concerned with the waters of the Earth including their occurrence, distribution, and circulation via the hydrologic cycle. Hydrology has as its primary objective the study of the interrelationship between water and its environment.

Therefore Hydrology Science is also fundamental for application in Flash Flood Early Warning Systems (EWS), as indicated in the Early Warning Sector.

As hydrology is mainly concerned with water close to the land surface, it focuses on those components of the hydrologic cycle that occur there, that is: precipitation, runoff, river discharge and the related water level and water velocity in the rivers, as well as the evapotranspiration, and groundwater.

The measurement of all these hydrological parameters is the primary objective of the **GEONICA HYDROMET System**. The different parameters are measured using specific sensors for determining the precipitation, runoff, river discharge, water level, water velocity, water currents, etc. all of them connected to our **METEODATA / HYDRODATA.** Remote low power Data Acquisition and Transmission Unit. Data transmission can be carried out via GPRS/3G cellular network, by Point-to-Point / Point-to-Multipoint Radio-Link or via Satellite, as well as mixing these communication ways.

Due to the very low power consumption of **GEONICA**'s solutions, our automatic hydrological stations can be installed at remote unattended sites, operated by its internal battery pack and charger, all under a compact mount in a weatherproof enclosure box, plus an external solar panel of reduced dimensions.

River discharge & level in Real-Time – HYDROMET System

River discharge at any given point is the volume of water flowing through a river channel and is normally measured in cubic meters per second.

GEONICA offers specific solutions for the continuous measurement of the river discharge (water flow) and level, with data transmission in real-time.

Water level sensors of different technologies such as: Non-contact RADAR, Ultrasonic, Hydrostatic, Bubbler-in, etc. can be connected to our **HYDRODATA** datalogger for continuous measurement of river level, storing all the level data in its internal memory.

HYDRODATA unit also allows the connection of RADAR Doppler water surface velocity meters, storing velocity data in its internal memory. In base of the averaged data of water level and surface velocity in programmable periods of time, it is possible to calculate the flow rate of the river in real-time by an equation adjusted for any specific moistened cross-sectional area of the river.

How the RADAR Doppler Velocity System Works

The flow velocity is measured using the Doppler effect. A radar signal with a frequency of 24 GHz is transmitted towards the water surface. The signal is partially reflected with a frequency change due to Doppler effect when water is moving. A spectral analysis is performed on the reflected signal and the water's surface velocity "Vs" is calculated. The radar signal has to be transmitted at an angle to the water surface. This angle is internally measured to automatically correct the calculated velocity.

How the river discharge is calculated

A commonly applied methodology for measuring, and estimating, the discharge of a river is based on a simplified form of the continuity equation. The equation implies that for any incompressible fluid, such as liquid water, the discharge (Q) is equal to the product of the stream's cross-sectional area (S) and its mean velocity (Vm).

So, the discharge "Q" is determined by the continuity equation:

$$Q = Vm \bullet S$$

The moistened cross-sectional area "S" as a function of the water level **(*S=f(l)*)**, is determined by the cross-sectional profile at the measuring point.

The RADAR system does not measure the mean velocity "Vm" but the surface velocity "Vs" , that is, the mean velocity is calculated with the conversion factor "k" , **as**:

$$Vm = Vs \bullet \text{“k”}$$

So according to the continuity equation:

River Discharge: $Q = Vs \bullet \text{“k”} \bullet S$

The k-factor can either be determined by a reference measurement, for instance by means of one Acoustic Doppler Current Profiler (ADCP) or by specific modelling. The surface level, the k-factor and the cross-sectional area are stored on the **HYDRODATA** unit, enabling it to calculate and output the discharge directly from the measured surface velocity of water and its level in real-time.

River Discharge in connection with Early Flood Alert Systems (EWS)

It is important to mention that the river discharge measurement in real-time is a fundamental input for **GEONICA RAINALERT Early Warning System (EWS)**, in combination with the implementation of a suitable rainfall network which must be installed upstream in the drainage basin.

This allows knowing in advance the corresponding rainfall intensity and duration to determine the volume of total rainfall in the basin during a certain period of time when the objective is to establish flood risk warning conditions to alert the population.

However, the prediction of the level of the river, not only depends on the intensity and amount of rainfall, but there are many other factors to be taken into account to adjust a predictive model for flood risk. Evapotranspiration and storage factors are well known, but also other factors affecting a river's discharge are indicated below:

- **Rock and soil type** (permeable or not rock and soils)
- **Land use** (urban or rural areas, vegetation cover, deforestation, ground saturation and surface run-off)
- **Rainfall** (type and intensity or accumulated)
- **Relief** (Steep slopes mean that rainwater is likely to run straight over the surface before it can infiltrate.
- **Weather and Climate conditions** (hot dry weather, evaporation, frozen ground)

Measurement of River discharge by means of Acoustic Doppler Current Profilers (ADCPs)

In recent years, advances in technology have allowed to make discharge measurements by use of an Acoustic Doppler Current Profiler (ADCP). An ADCP uses the principles of the Doppler Effect to measure the velocity of water in the whole cross-sectional area, but this procedure for measuring flow of a river is performed at a given moment, and consequently this is a single measurement, which does not allow obtaining continuous and real-time river discharge data.

In this method, the whole stream cross-section of the river is measured by means of a bottom tracking acoustic procedure and divided into numerous vertical subsections. In each subsection, its area "s" is pre-defined and its associated mean velocity calculated. The discharge in each subsection is computed by multiplying the subsection area by the measured individual velocities. The total discharge is then computed by integrating the discharge of all subsections of the whole cross-section of the river.

To make a discharge measurement, the ADCP is mounted onto a boat or into a small watercraft with its acoustic beams directed into the water from the water surface. The ADCP is then guided across the surface of the river to obtain measurements of velocity and depth across the channel.

The river-bottom tracking capability of the ADCP acoustic beams or a Global Positioning System (GPS) is used to track the progress of the ADCP across the channel and provide channel-width measurements. Using the depth and width measurements for calculating the area and the velocity measurements, the discharge is computed by the ADCP using also the equation Q= V x S, similar to the conventional current-meter method.

Horizontal water velocity profilers (H-ADCPs)

The ADCP is also available in a horizontal version (H-ADCP) and in this case can be connected to our **HYDRODATA** datalogger for real time measurements and data transmission.

The compact H-ADCP is a two-beam, horizontally oriented ADCP designed to obtain high accuracy velocity data at ranges up to 300 meters, utilizing 1 to 128 cells of data. Connected to our **HYDRODATA** Logger/Transmitter it allows to obtain unmatched data quality, even in low velocities and complex flows, where a single cell cannot provide enough information.

In connection to our **HYDRODATA** unit, our solution is ideally suited for use in rivers, streams, estuaries, open channels, sea ports and harbours for real-time measurements with data transmission via GPRS/3G, Radio Link, INMARSAT Satellite or connected to an existing fiber optic line available in the port.

4. Climatology & Climate Change - HYDROMET System

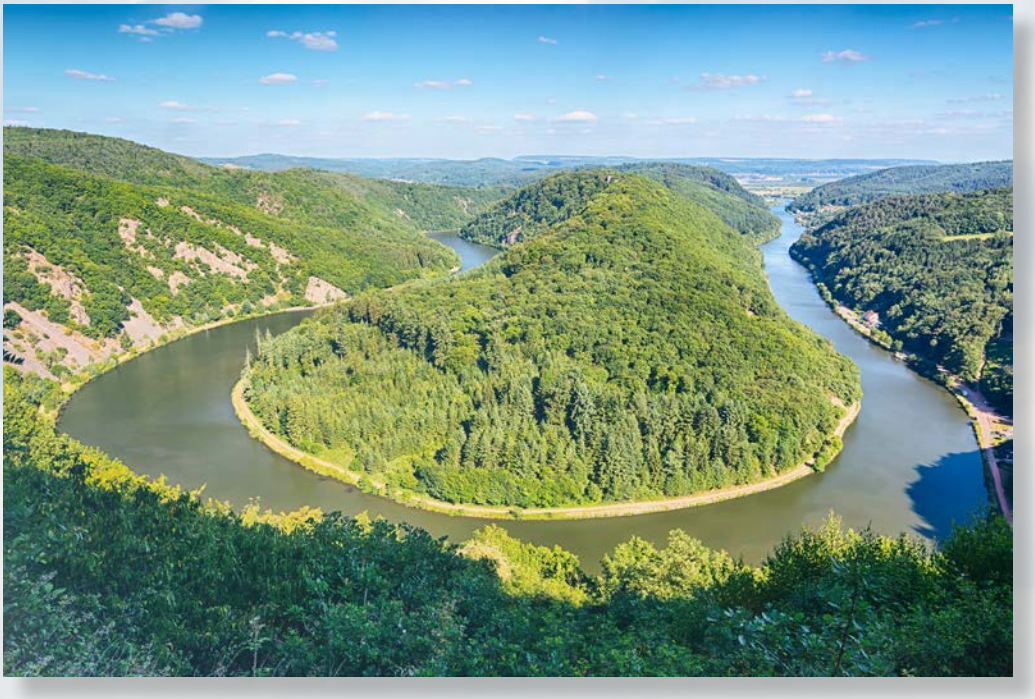
The climate system is a complex, interactive system comprising the atmosphere, land surface, snow and ice, oceans and other bodies of water.
But the atmospheric component of the climate system is what people refer to as Climate, which is described in terms of the mean and variability of three parameters: temperature, precipitation and wind over a period of time, ranging from months to millions of years, so it is often defined as 'average weather'.
The difference between Climate and Weather is really a matter of time. Weather is what happens over a short time, and Climate is the behaviour of the atmosphere over a longer period. A 30 year period is considered as the most adequate for comparison in climate behaviour.

METEODATA / HYDRODATA - 3000CM

GEONICA offers the necessary instruments for the measurement of all the parameters directly related with the Weather as: Temperature, Precipitation and Wind, but also for the rest of meteorological parameters such as Atmospheric Pressure, Solar Radiation, Relative Humidity, Dew Point, etc. **GEONICA** Automatic Weather Stations (AWS) or Automatic Meteorological Stations Model **METEODATA** are the most advanced technical solutions for such purpose.

Carbon dioxide (CO_2) is a strong attenuator of infrared radiation and is believed to be important in trapping heat in the lower atmosphere, contributing to global climate change. It is a matter of fact that carbon dioxide in the atmosphere is rising significantly, so **GEONICA** also offers suitable solutions for the CO_2 measurement in air and soils, as well as the NET carbon exchange, defined as the Gross Primary Production (GPP) minus the ecosystem respiration (R_{eco}). It is a key variable for understanding the carbon balance of an ecosystem.

Understanding how sources and sinks for CO_2 vary in both time and space can be important in evaluating the potential impacts of different land covers and management practices on the environment and human health. One approach to characterizing this variability is to integrate spatial data with concurrent observations of CO_2 concentrations and/or fluxes.



5. Solar Energy Resource Assessment - SEMS

Solar energy is certainly one of the most important renewable energies available, and we use it under two forms: thermal and photovoltaic.

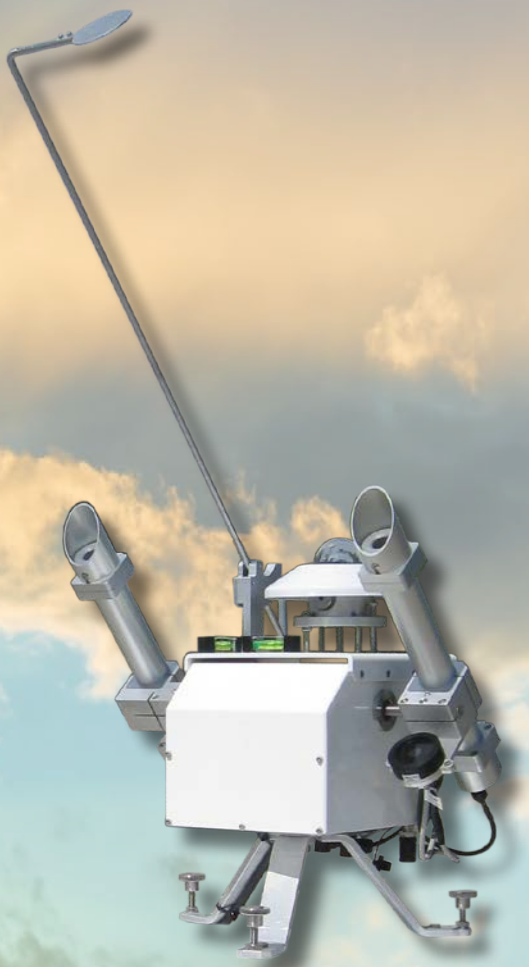
The Solar Energy Measurement System (SEMS) is the most advanced technical solution for the measurement of all the components of Solar Radiation:

- Direct Normal Irradiance (DNI)
- Global Horizontal Irradiance (GHI)
- Diffuse Horizontal Irradiance (DHI)
- Global Normal Irradiance (GNI)
- Solar Spectral Irradiance (SSI), plus AOD, Ozone and Water vapour columns

For solar energy resource assessment purposes and solar power plant monitoring, generally it is required to measure all the three components of the Solar Irradiance: DNI, GHI, DHI plus optionally GNI. This is made by the Remote Solar-Meteo Stations of the **SEMS System,** consisting of one **METEODATA** Datalogger, a **SUNTRACKER** with Shadow Arm/Disc, plus one or two Pyrheliometers and one or two Pyranometers.

For the measurement of the **Solar Spectral Irradiance (SSI)** it is required to use a **Solar Spectral Sensor** as the **Solar Spectral Meter** Model **GEO-SSIM**, which is the most advanced, unique, efficient and affordable technical solution to measure solar spectral irradiance and DNI in near real-time, when mounted on our **SUNTRACKER-2000 or 3000 Series**, as part of **SEMS System**.

The **GEO-SSIM** uses first quality silicon photodiodes, integrated with hard coated band-pass filters to measure the solar spectral irradiance in several narrow wavelength bands.



SUNTRACKER-2000

GEO-SSIM's proprietary software then uses these measurements to resolve the direct solar spectrum, in addition to major atmospheric processes, such as **air mass, Rayleigh scattering, aerosol extinction, ozone and water vapour absorptions**. This new approach has allowed us to dramatically reduce the cost of obtaining, precise, reliable solar spectral irradiance measurements in near real-time.

The **GEO-SSIM** is designed to provide the CSP, CPV and PV industries with a low-cost tool for accurately determining the solar spectra and DNI as part of on-site solar resource assessments and module performance characterization studies.

SUNTRACKER-2000

So the **GEO-SSIM** delivers the following information in real-time:

- Measuring range:
  280 – 4000 nm [W/m²/nm]
- Total column ozone content:
  cm (spectral ozone absorption optional)
- Total column water vapour content:
  cm (spectral water vapour absorption optional)
- Aerosol Optical Depth (AOD):
  at 500 nm (spectral aerosol extinction optional)

Additional meteorological sensors for the measurement of ambient temperature, relative humidity, wind speed and direction, atmospheric pressure, precipitation, etc., can be also connected to the same data logger of the **SEMS System**. The values of all these meteorological parameters are stored at the data logger and transmitted to a Central Receiving Station or SCADA via GPRS/3G, Radio-Link, Fiber Optic or through Satellite networks.

The **GEONICA SUITE** Software Package manages all the communications, data transmission, and remote programming, creating a database with all the information for subsequent data analysis. The information can be also WEB Posted by our **WEBTRANS** ***Ubiquitas*** Internet Platform.

In base of solar historical data Government agencies in many countries publish maps commonly collected together as a National SOLAR ATLAS, which serves to inform policy-making and encourage solar power development.

A good example of this is the Indian National Solar Network supplied by **GEONICA** to the C-WET Institution, consisting on more than 130 Remote Solar Meteo Stations configured by our **METEODATA** data logger, **SUNTRACKER-3000,** Solar Irradiance and other meteorological sensors, covering the whole Indian country, transmitting data in near real-time via GPRS/3G to the Central Receiving

Station. Numerical data and graphical information is WEB Posted by our Application **WEBTRANS** ***Ubiquitas*** Internet Platform (www.cwetsolar.com) In the Press Release No 9993.0023 is described this Network with more detail.

The thermal technology (CSP) concentrates sunlight, converts it into heat, and applies it to a steam generator or engine to be converted into electricity. Solar thermal works by using mirrors to concentrate sunlight. The concentrated sunlight is then used either directly as a source of heat, as in solar water heating, or to drive a heat cycle such as a sterling engine.

Concentrated Solar Power (CSP), also called **Concentrating Solar Power or Concentrated Solar Thermal** is using different types of concentrators such as: Parabolic trough, Enclosed trough, Fresnel reflectors, Dish Stirling and Solar power tower. For all these technologies **GEONICA** offers advanced remote Automatic Meteorological Stations for the measurement of the solar irradiance as well as the rest of meteorological parameters of interest.

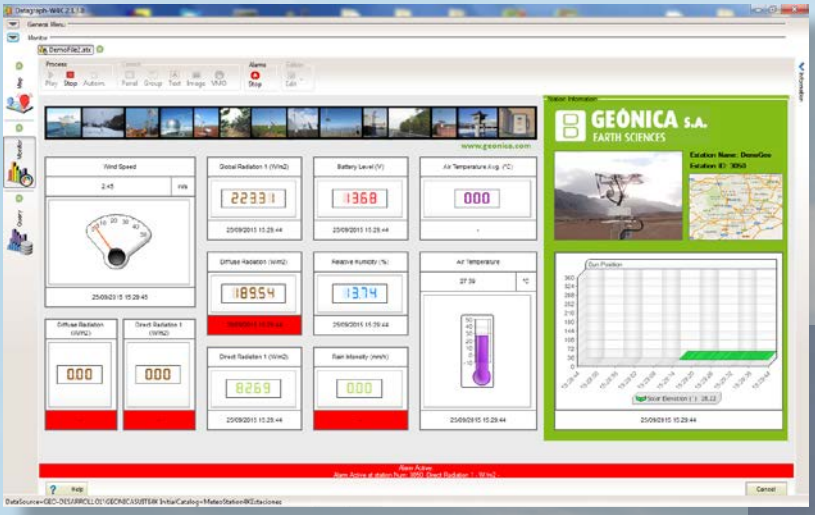
The Photovoltaic (PV) form of solar power produces electricity directly by means of generally static and sometimes moving solar panels.

Solar Irradiance monitoring at PV solar power plants is also carried out by means of solar radiation sensors plus additional meteorological sensors connected to our data logger Model **METEODATA** Series. Data is stored and transmitted to a local SCADA or to a distant Data Receiving Center, in which our **GEONICA SUITE** software package is installed for system management, remote programming and database generation.

Concentrating Photovoltaic (CPV) form of solar power produces electricity directly also by means solar panels. Concentrating photovoltaic systems use lenses or mirrors to concentrate sunlight onto high-efficiency solar cells. Concentrating photovoltaic technology offers a number of advantages as for example: efficiencies greater than 40%, near ambient temperature operation, fast response, etc.

As in the case of CSP solar power plants, at CPV plants it is essential to measure the Direct Normal Irradiance (DNI). This parameter has to be measured by means of a first class Pyrheliometer mounted on our **SUNTRACKER-2000** or **3000** Series and connected to our **METEODATA** datalogger for data recording and data transmission to a local SCADA or remote computer.
Concentrating thermal solar power (CSP) and Concentrating Photovoltaic (CPV) technologies are poised to take its place as one of the major contributors to the future clean energy mix.

SUNTRACKER-3000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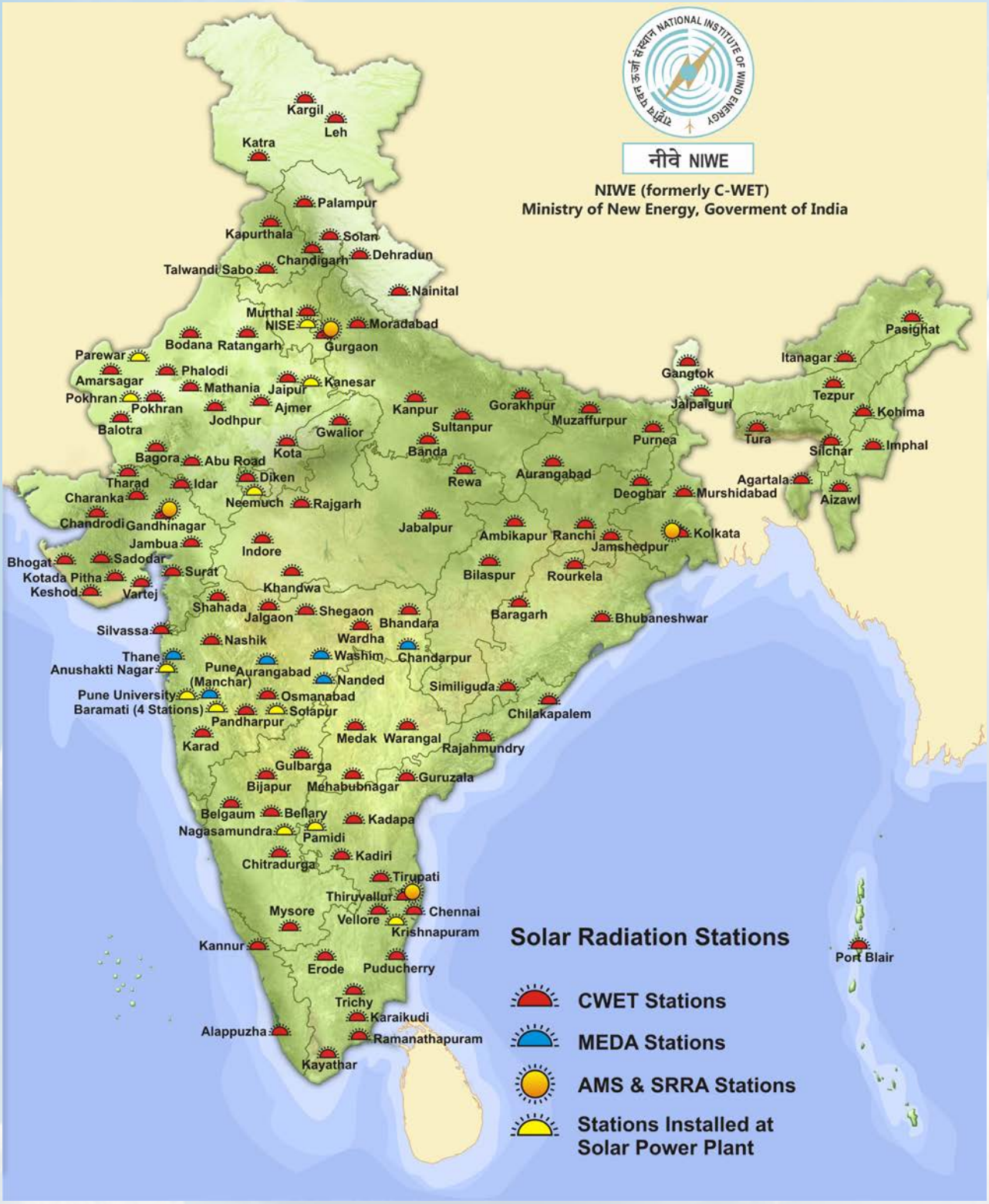


SOLAR RESOURCE ASSESSMENT NETWORK IN INDIA
(> 130 STATIONS)

6. Wind Energy Resource Assessment – WINDPOWER System

Wind resource assessment is the process by which wind power developers estimate the future energy production of a wind farm. Accurate wind resource assessments are crucial to the successful development of wind farms.

GEONICA offers wind measurement systems (WINDPOWER System) specifically engineered for wind resource assessment, power curve measurement, and monitoring operational wind farms.

Our wind measurement systems have a wide range of options for measuring wind speed, wind direction, air density, and electric power. Real-time data are stored locally on our **METEODATA** datalogger, and can be transmitted via all standard communication methods such as via GPRS/3G, Radio-Link or through satellite networks.

GEONICA offers a variety of products that can be used to configure custom Wind Energy systems. Wind speed and direction sensors as the classical three cup anemometers and potentiometric vanes, or the new ultrasonic wind sensors with no moving parts, can be connected to our datalogger **METEODATA** for data storage and data transmission in real-time or delayed mode.

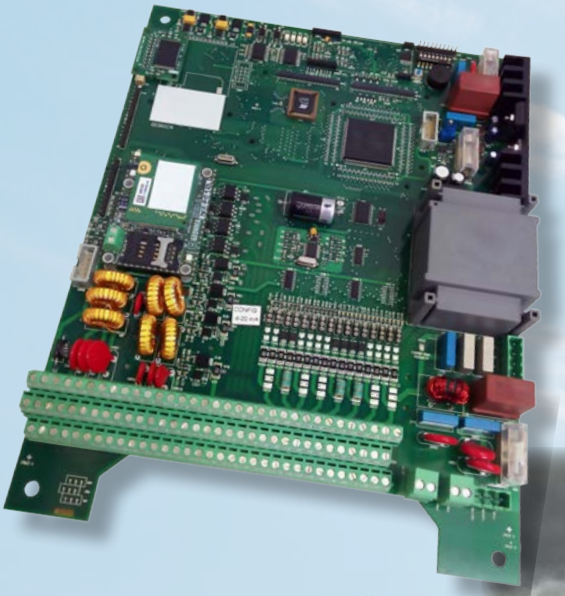
Our Wind Power Monitoring System (**WINDPOWER System**) has been designed by our experts for wind energy resource assessment and also for monitoring the performance of operational wind farms. It is designed around our rugged **METEODATA** data logger to which can be connected a variety of different technologies of wind sensors all under the management of our advanced **GEONICA SUITE** software Package.

GEONICA offers complete solutions for the installation of Wind Energy Resource Measuring Networks with data transmission to a Central Receiving Station. Having wind historical data Government agencies can publish a national WIND MAP of measured wind resources, which will facilitate and support private and public investors in their decisions oriented to wind power energy development.

Besides the classical solutions for wind energy measurement based on anemometers, ultrasonic or mechanical wind sensors, **GEONICA** also offers a very advance solution for wind energy measurement, based on LIDAR technology such as The ZephIR 300. This is a continuous-wave (CW) LIDAR system that provides remote wind measurements across ten user-defined heights from 10 m to 300 m. It is ideal for applications that require wind measurements at multiple heights, and for locations where the installation of a tall tower is difficult.

It is used worldwide for: site assessment, prospecting, and turbine micrositing, extreme flow conditions, power-curve assessment, permanent wind-farm anemometry and complex site analysis.

INSTALLATION, MAINTENANCE AND PRODUCTION



7. Upper Air Observations

It is well known that the information about the vertical profile of the atmosphere is essential for understanding atmospheric conditions and accurate weather forecasting.

GEONICA supplies to national weather services, universities and military forces advanced radiosondes and upper-air sounding systems for measuring atmospheric conditions from ground level up to the lower stratosphere, integrating also Automatic Meteorological Stations as ground reference. The radiosondes are designed to meet the specifications of the U.S. National Weather Service and the World Meteorological Organization.

403 MHz GPS Sounding Systems

- GEO-Met-3150: Low cost and ultra-portable for boundary layer and reduced range soundings
- GEO-Met-3050A: Compact, high performance, full-range sounding system for field research
- GEO-Met-3100M: Completely redesigned military sounding system for fixed and mobile applications
- GEO-Met-3200: Fixed installation synoptic system for maximum sounding range

Radiosondes and UAV Sensors

- GEO-Met-1: A complete family of 403 and 1680 MHz GPS and RDF Radiosondes
- GEO-Met-1-RS: Research Radiosonde for Ozone and Auxiliary Sensor Integration
- GEO-Met-X: PTU and Atmospheric Chemistry Sensors for UAV Integration

Additionally **GEONICA** offer others the following upper-air measuring products:

Micro Rain Radar MRR

The Micro-Rain-Radar MRR at 24 GHz is a unique meteorological radar profiler for Doppler spectra of HYDROMETeors in height ranges 15 m ... 6000 m. The high resolution in time and height enables the MRR to monitor the genesis of frozen HYDROMETeors, the melting zone (bright band) and the formation of rain drops. With the derived rain rate the MRR offers a calibration of weather radar. The MRR has been adapted even for monitoring of avalanches and volcanos.

Doppler SODAR
The Doppler SODAR measures vertical profiles of wind and turbulence, monitors inversion layers and derives stability classes in height ranges 15 m ... ≥ 1000 m.

RASS System
The Doppler SODAR system can be extended by radar components to a RASS system for vertical profiling of temperatures, temperature gradients and inversion layers synchronously with the SODAR profiling.

Cloud Ceilometer
The cloud ceilometer is a stand-alone instrument designed for fixed and mobile installations where accurate and reliable cloud height information is required. The design is based on the LIDAR principle.

DIGICAM 3K

8. Early Warning Systems (EWS)

An Early Warning System (EWS) is a major element of disaster risk reduction. It prevents loss of life and reduces the economic and material impact of disasters. To be effective, Early Warning Systems need to effectively disseminate alerts, and warnings. A complete and effective Early Warning System supports four main functions:

- Data collection by continuous monitoring and event detection
- Data Transmission to a Central Receiving Station
- Risk assessment based on data analysis by the Authorities
- Warning and Alerts dissemination

Risk analysis involves systematically collecting data and undertaking risk assessments of predefined hazards and vulnerabilities. Monitoring and warning involves a study of the factors that indicate a disaster is imminent, as well as the methods used to detect these factors. Dissemination and communication concern communicating the risk information and warnings to reach those in danger, in a way that is clear and understandable. Finally, an adequate response capability requires the building of national and community response plan, testing of the plan, and the promotion of readiness to ensure that people know how to respond to warnings.

GEONICA implements advanced early warning systems focused in the three following areas of risk:

- Flash Floods and Heavy Rains
- Lightning and Thunderstorms
- Environmental Gamma Radiation

Find below a brief description of three areas in which our Early Warning System is used.

8.1 Flash Floods and Heavy Rains - RAINALERT System

Flash floods are typically caused by torrential rainfall, but can also occur from a dam break, a levee break, or even ice jams in rivers during the winter and spring months. Urban flash flooding is a serious and increasingly common problem as cities grow and sprawl. Impervious surfaces like concrete or compacted bare soils, along with alterations to the natural drainages, create instant high energy runoff from heavy rainfall that can inundate roads and buildings very quickly.

GEONICA offers advanced Early Warning Systems (EWS) for Flash Floods alert to allow Civil Protection Authorities to take precautionary actions. The combination of new computer modelling, precipitation sensing and GPRS/3G / SATELLITE communication technology improvements, are making flash flood EWS increasingly affordable, effective and sustainable.

In fact **GEONICA** designs affordable flash flood early warning systems for heavy rain event detection via dense rainfall / stream flow gauge networks with data transmission in near real-time such as our **RAINALERT System**, with the ability to pinpoint the location and timing of small-scale heavy rain.

This solution can be combined with sophisticated forecasting schemes, employing dense rain gauge networks, radar coverage, satellite algorithms, high resolution computer models of atmospheric processes and distributed hydrologic models, but it is obvious that , it is beyond the state of the science to accurately forecast with effective lead time where flash flooding will occur from convective storms in some situations.

But now, flash-flood prone countries with vulnerable populations do have a range of options from **GEONICA** for creating local or regional early warning systems in base of our **RAINALERT System,** capable of providing a first level of protection from flash floods. This basic **RAINALERT System** can be complemented with Forecast Management, integrating in the solution a generation module forecasts based on the models MIKE RR (Rain Runoff - Hydrology), MIKE HD (Hydro Dynamic - Hydraulic) and MIKE DA (Data Assimilation), which through CUSTOMIZED MIKE Manager, help generate automatically forecasts and information from the network.

8.2 LIGHTNING ALERT

It is important to note that our **LIGHTNING ALERT System** can be also integrated as a part of the **RAINALERT System**. The **LIGHTNING ALERT** System is based on a device which measures the strength of electrostatic fields (high voltage gradients measured in Volt/m) produced in nature by the accumulation of electric charges in thunderclouds. When the voltage detector is installed outdoors connected to our **METEODATA** Logger/Transmitter, the system warn when sufficient electric charge has accumulated in an overhead cloud to create a lightning hazard, even before the first lightning occurs.
User defined thresholds can be established and monitored 24 hours/day 7 days/week automatically with values updated from the system virtually every second. Should alarm thresholds be attained, an alert message will be transmitted by SMS messages to a number of identified users.

Our **LIGHTNING ALERT System** is not working as a Lightning Detectors: but rather, it has been designed to determine when conditions exist where lightning is likely to occur in the local area. While using a “detector” is an ideal method to confirm that lightning has already occurred, it is often too late to be of real operational value especially if the first event occurs either nearby or at the place that is most vulnerable.

Main applications of our LIGHTNING ALERT System are:

- DOD / DOE Facilities
- Blasting Operations
- Aero Space
- Hazardous Materials Management
- Atmospheric Research
- Oil & Gas Storage and Handling Facilities
- Military/Commercial Ordenance & Munitions
- Airport FBO and Ground Operations
- Golf Courses and Swimming Pools
- Crane/Heavy Equipment Operations
- Construction Sites
- Public Events and Outdoor Recreation

8.3 Environmental Gamma Radiation Monitoring and Alert System - GAMMALERT System

Our **GAMMALERT System** measures radiation levels in the environment. It has been developed having in mind the importance of counting on a first quality early warning Gamma Ray Environmental Radioactivity Monitoring Solution with an extensive range of applications, such as in monitoring networks for early warning civil protection, with coverage of wide areas; hospital surveillance at radiation therapy wards; supervision at borders, airports, railway stations; accidental radiation generated by Nuclear Power Plants, storage and truck/train transportation of fusionable materials, etc.

The basic element of the **GAMMALERT System** is the remote measuring station Model **GammaDATA-3000**, a smart and low power consumption data logger and data transmitter. This unit allows the connection of different gamma sensors or detectors as the Model **GammaMETER-RS04** or Model **GammaMETER-GSP02** Gamma Spectrum Probe which permits In-situ isotope identification.

The **GammaDATA-3000** unit accepts the connection of additional meteorological sensors for the measurement of precipitation, wind, ambient temperature, relative humidity, solar radiation, etc. in order to give a complete picture of the environmental conditions.

Data and alerts are transmitted to a Central Receiving Station in real-time via, cable, GPRS, Radio-Link or Satellite. Dissemination of data and alerts can be carried out by our **WEBTRANS *Ubiquitas*** Internet Platform (WEB Posting). Also SMS messages can be transmitted in real-time to a number of mobile phones, as well as warning emails to Authorities and population.

9. Coastal Oceanography
Tides, Waves, Currents – SAFE PORT and DATAMAR Systems

Physical Oceanography is one of several sub-domains into which Oceanography is divided. Others include biological, chemical and geological oceanography.

Physical oceanography is the study of physical conditions and physical processes within the ocean, especially the motions and physical properties of ocean waters.
In particular, the term of Coastal Oceanography refers to the physical processes generated at the land-sea interface that are manifested in the form of currents, waves and tides induced by different agents such as wind or the gravitational action of the Sun and Moon phenomena.

As manufacturer and Systems Integrator, **GEONICA** offers advanced technical solutions for the measurement of currents, waves and tides, complemented by the measure of all the meteorological parameters of interest in order to know the environmental conditions affecting seaports.

Maritime ports for commercial, fishing and water sports purposes play an important role of great economic importance in the development of a country. For this reason, port management should always seek the **highest levels of safety and effectiveness.**

Well aware of this fact and with an Engineering Department that boasts the necessary experience and knowledge in the fields of oceanography, meteorology and data transmission solutions, **GEONICA** has developed the **SAFE PORT System.** Said system integrates the most advanced instrumentation for the measurement of all the meteorological, oceanographic and hydrodynamic parameters of interest, such as tides, waves and currents, complemented by the appropriate telemetry network. In summary, the **SAFE PORT System** constitutes a tool of tremendous value to those who are responsible of port management, Port Authorities and all potential users of the port infrastructures including: ships of all kinds, fishing boats, yachts, recreational vessels, etc.

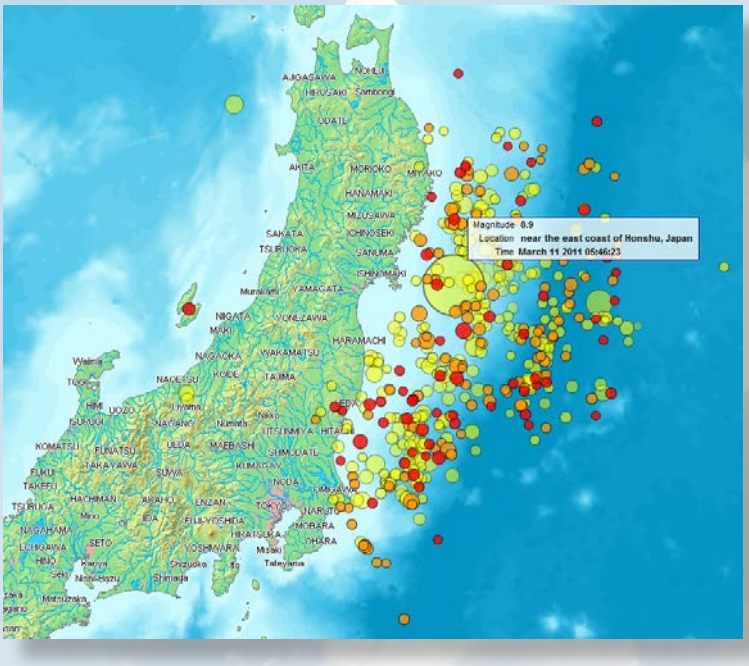
DATAMAR 2000C RADAR Tide Gauge designed by **GEONICA**, based on the latest electronic technology, is the ideal solution for measuring, recording and transmitting tide level data, not only due to its high-level features and advanced technical characteristics, but also due to its great versatility and cost effective.
It is important to mention that the Measuring Stations of SAFE PORT System and Datamar allow for an integrated AIS AtoN (Aids to Navigation) transponder. It provides accurate and real time information of the AtoN to all vessels and shore stations in range.

SUCCESS STORY: Peru Navy Tide Gauge Network developed by GEONICA recorded neatly the 2011 Japan tsunami

BACKGROUND

The Directorate of Hydrography and Navigation of Peru (HIDRONAV), dependent of Peru Navy, has acquired from **GEONICA** a System consisting of **12 Tide Gauges Stations including redundant communications using 3G/GPRS and INMARSAT Satellite (bidirectional, real-time, essential for warning systems), still images cameras and 1 Control Center** which are, nowadays, totally functional.

Hence, the Peru Nation has been provided by a Tide Gauge Registration, Storage, Transmission and Monitoring System along the entire coast and, most importantly, has been set with a Prevention and **Early Warning System (EWS)** against possible oceanographic natural disasters.



2011 JAPAN TSUNAMI

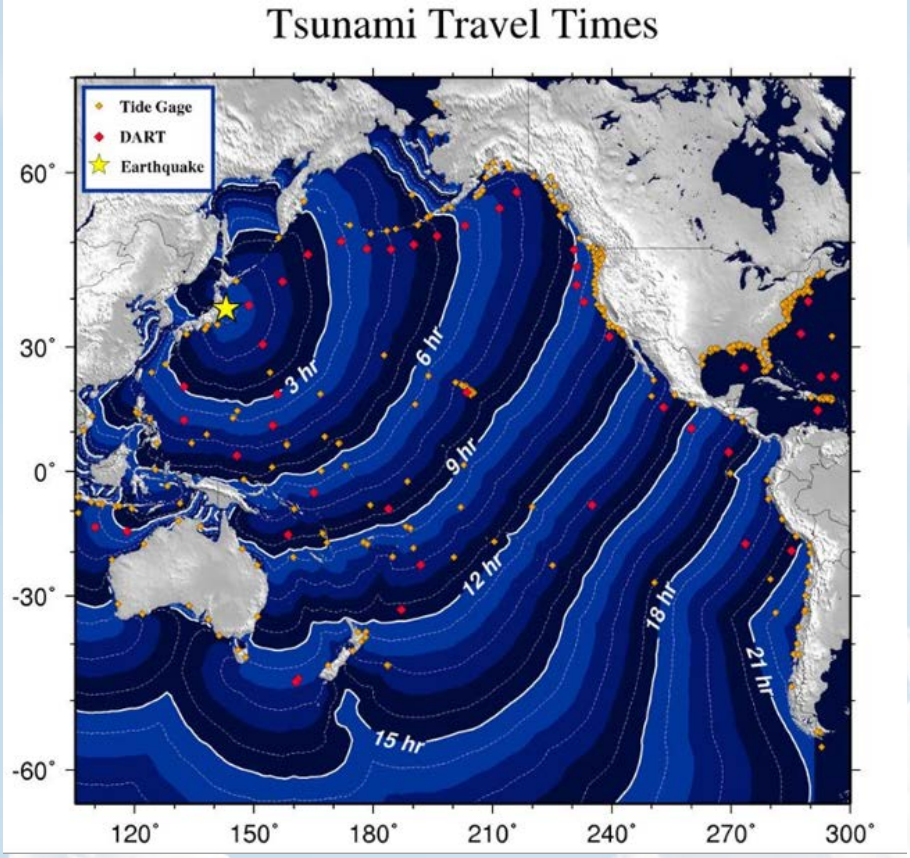
The 2011 Japan earthquake of 9.0 MW1 magnitude generated up to 10m tsunami waves. The earthquake took place at 14:46:23 local time (5:46:23 UTC) on Friday 11th March, 2011. The epicenter was located in the sea, off the coast of Honshu, 130 km east of Sendai, in Miyagi Prefecture, Japan.

After the quake, a tsunami warning has been triggered for the Pacific coast of Japan and other countries, including New Zealand, Australia, Russia, Guam, the Philippines, Indonesia, Papua New Guinea, Nauru, Hawaii, Northern Mariana Islands, United States, Taiwan, Central America, Mexico and South America, Colombia, Peru, Ecuador and Chile.

TSUNAMI ARRIVAL TO PERU

Given that the distance between the epicenter and the coast of Peru is approximately 15,200 km, and that the propagation speed is 724 km/h, the estimated time of arrival of the tsunami to the shores of America is just about 21 hours after the quake, as shown in the following diagram.

The tsunami took place at 5:46:23 UTC on 11th March; its arrival to the Peruvian coast was expected at 2:46:00 UTC on 12th March. Taking into account that the time zone of Peru is UTC-5, the tsunami appeared at the shores of Peru at around 21:46:00h local time on 12th March.

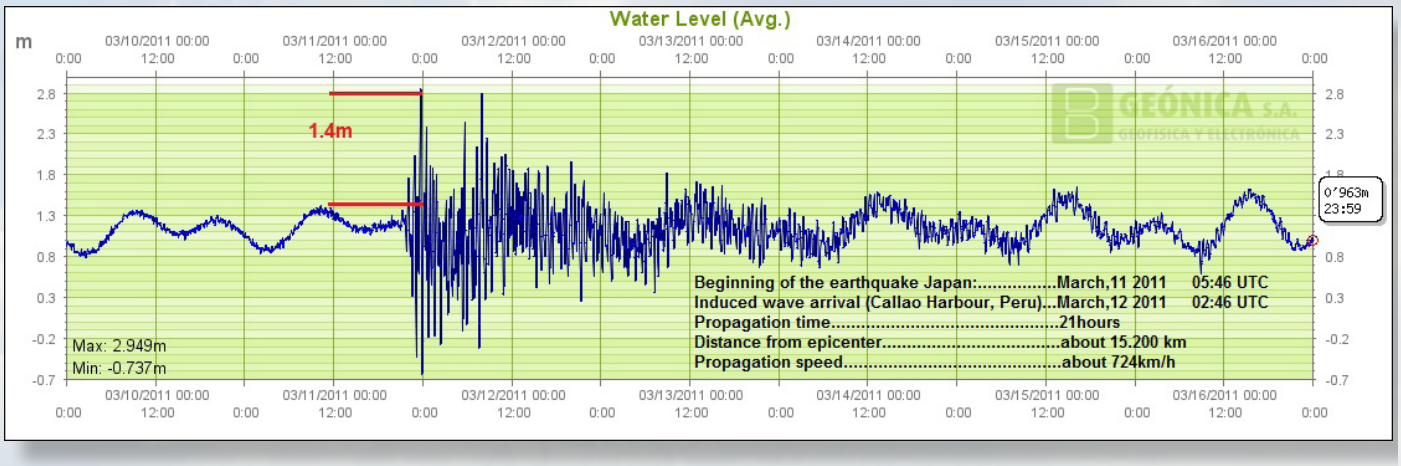


HOW DATAMAR TIDE GAUGE NETWORK REGISTERED THE TSUNAMI

The following chart is taken from data provided between 10 and 16 March 2011 by the gauge located at the Port of Callao. It shows clearly that the estimates made a priori were fulfilled.

The most relevant data collected were:

- The tsunami front stroke at the estimated time.
- The tidal range reached maximum amplitude of approximately 1.4 meters with a total swing of almost 3 meters.
- In the 12h that followed the tsunami, the tidal cycles remained barely imperceptibles.
- The ripple persisted in samples received even on 16th March.



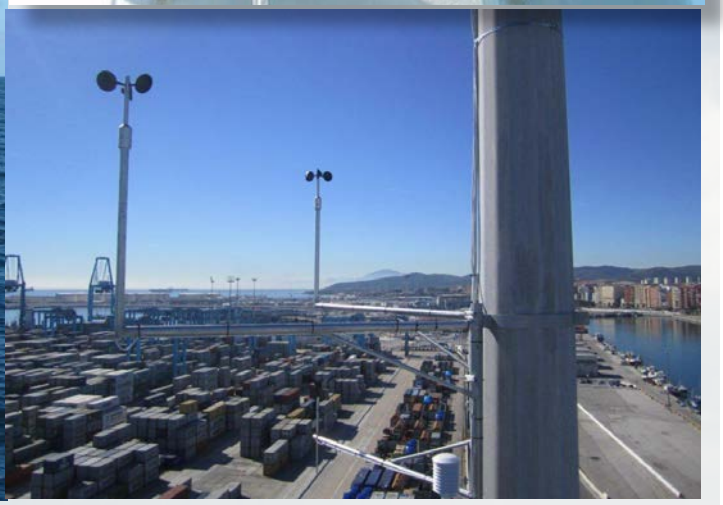
10. Coastal Meteorology

Coastal meteorology encompasses phenomena that extend from about 100 km offshore to 100 km inland. Thus understanding the meteorology of the coastal zone combines knowledge of the interaction of marine and land atmospheric boundary layers, air-sea interaction, large-scale atmospheric dynamics, and the circulation of the coastal ocean.

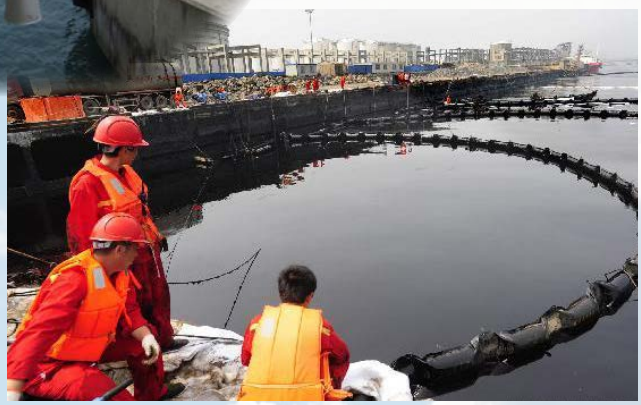
Most coastal environments are modified by the adjacent ocean, the coastal topography and the land-sea thermal contrast. Complex feedbacks occur between the atmosphere, ocean and land.

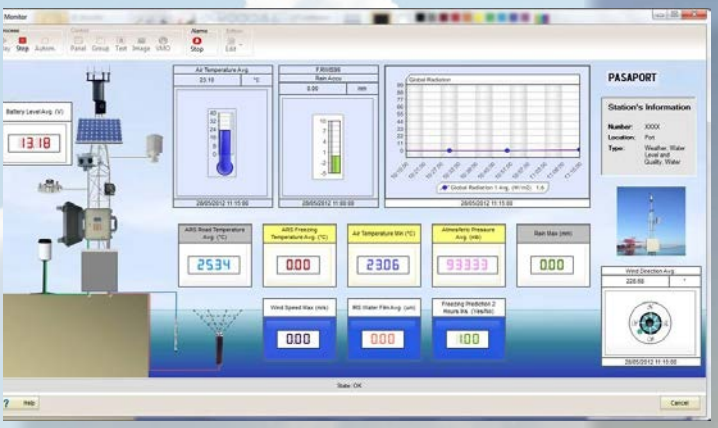
GEONICA offers the necessary instrumentation for the measurement of all the meteorological parameters in the inland zone, as described in the SECTOR of Meteorology at this site, as well as for the measurement of the offshore meteorological conditions, which require the use of meteorological buoys, or floating structures, where to mount the corresponding measuring sensors, including the data logger and data transmission devices.

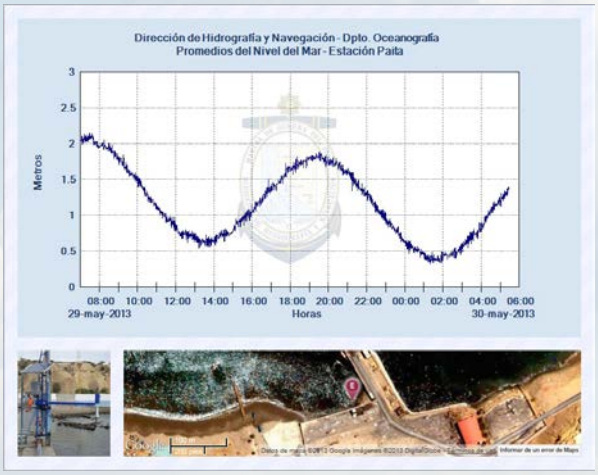
Our coastal weather buoys (**GEONICA** MetBuoy Series) are ready to measure the meteorological parameters close to the sea surface, but can also be equipped for measuring water quality parameters using the appropriated water quality sensors, as well as water currents, and scalar or directional waves in base of Acoustic Doppler Current Profilers (ADCPs).




GEÓNICA




PASAPORT
Station's Information


Dirección de Hidrografía y Navegación - Dpto. Oceanografía
Promedios del Nivel del Mar - Estación Paita
Metros
Horas
29-may-2013
30-may-2013

11. Airport and Heliport Weather Observation (AWOS)

GEONICA's Airport Weather System (Automatic Weather Observation System - AWOS) deals with measuring all the meteorological parameters of airports, aerodromes, heliports, etc., providing data already processed to the Meteorological Center for distributing them to the aircraft pilots and Authorities responsible for air traffic safety, using different communication ways.

Besides the aviation market, **GEONICA AWOS Systems** are also implemented at small public-use airports, heliports, seaplane bases, crop duster operations and private landing strips providing high quality, up-to-the-minute weather conditions to ground personnel and pilots.

Depending on the category of the airport, or if a heliport with smaller requirements is to be implemented, the parameters to be measured can vary considerably. Below we have listed all those that should be considered in any of the possible cases:

- Wind speed and direction
- Air temperature
- Relative Humidity of the air
- Dew point
- Precipitation
- Atmospheric pressure (QFE-QNH)
- Solar Radiation
- Visibility (MOR Meteorological Optical Range)
- Present weather (Intensity and type of precipitation: rain, snow, hail, etc.)
- Cloud base height
- Sky condition
- Thunderstorm detection (via a cloud-to-ground lightning detector)
- Vertical visibility
- Turbulence in altitude
- Runway surface condition

GEONICA integrates complete Automated Weather Observing Systems (AWOS) for all airport categories, according to the needs of each specific project, providing accurate and reliable data to ensure airport safety and operational efficiency.

AWOS systems disseminate weather data in a variety of ways:

Weather reporting (voice messages)

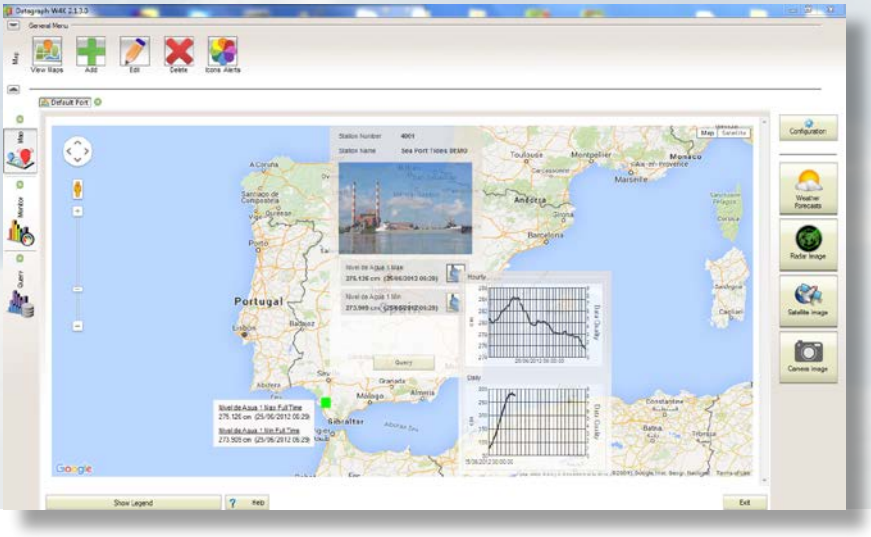
AWOS system disseminates weather data via a computer-generated voice message which is broadcast via radio frequency to pilots in the vicinity of an airport. The message is updated at least once per minute, and this is the only mandatory form of weather reporting for an AWOS.

The aviation weather report also may include a section containing the trend forecast, which indicates the forecast change in meteorological conditions in the next two hours.

AWOS Reports

METAR is an aviation routine weather report that is issued at hourly or half-hourly intervals. It is a description of the meteorological elements observed at an airport at a specific time.

SPECI is an aviation special weather report issued when there is significant deterioration or improvement in airport weather conditions, such as significant changes of surface winds, visibility, cloud base height and occurrence of severe weather. The format of the SPECI report is similar to that of the METAR and the elements used have the same meaning. The identifier METAR or SPECI at the beginning of the weather report differentiates them.



12. Road Weather Information System (RWIS)
SAFE ROAD System

GEONICA's SAFE ROAD System is a Road Weather Information System (RWIS) offering accurate environmental data for road traffic safety purposes used also by road operators and maintainers to support decision making.

The Road Weather Information System (known as RWIS system) is comprised by a number of in the field Remote Environmental Monitoring Stations (REMS), to which are connected several types of sensors for the measurement of three types of road weather data : Atmospheric data, Pavement data, and Water Level data.

Atmospheric data include:

- Air temperature and Relative Humidity
- Visibility distance
- Wind Speed and Direction
- Precipitation type and rate
- Cloud cover
- Waterspout occurrence
- Lightning
- Air quality

Pavement data include:

- Pavement temperature
- Pavement freezing point
- Pavement condition (e.g., wet, icy, flooded)
- Pavement chemical concentration
- Subsurface soil temperature

Water level data include:

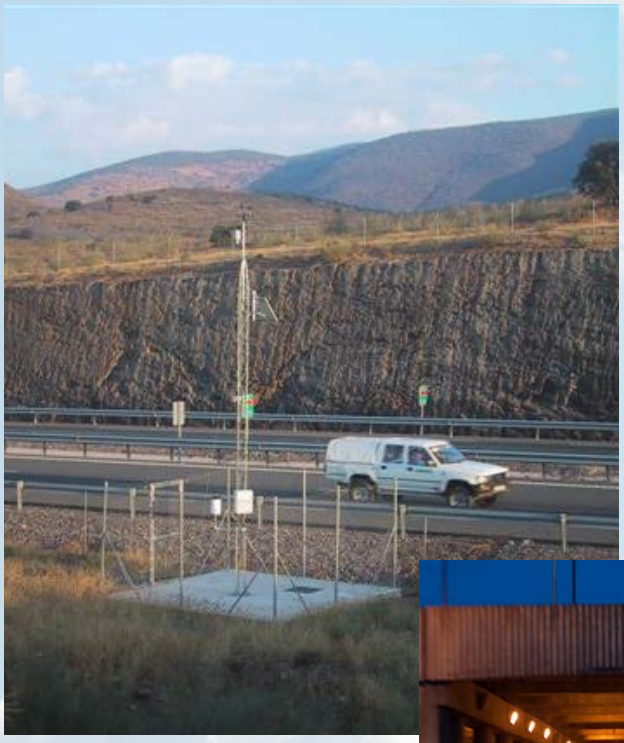
- Water level in streams or rivers near roads

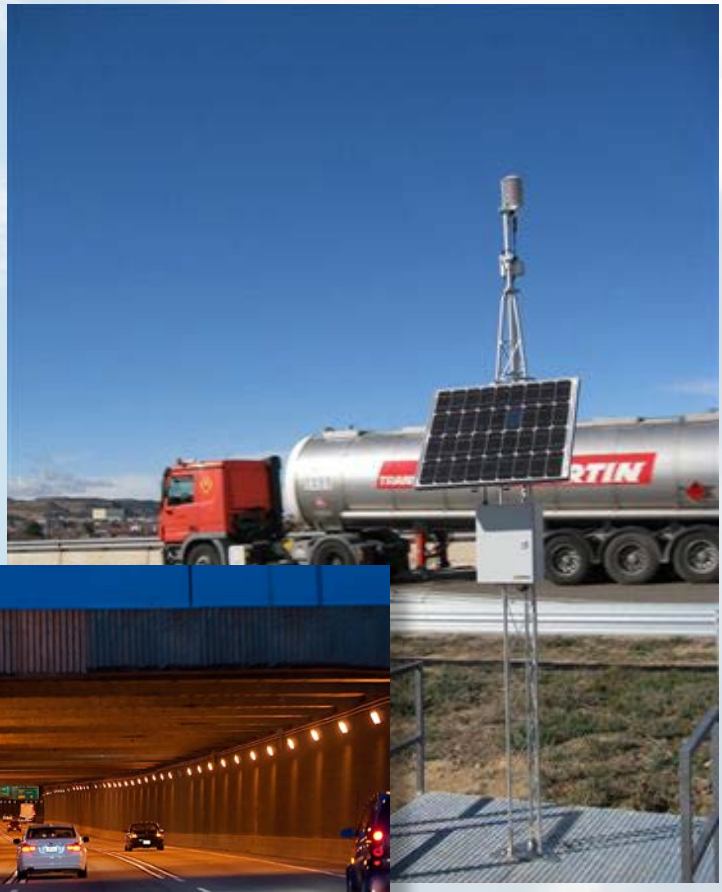
All the information generated by the REMS is transferred to the Central RWIS Station via GPRS/3G, Radio-Link, Satellite or via a physical fiber optic link, where by means of a specific software, data is processed to develop nowcasts or forecasts, and display or disseminate road weather information in a format that can be easily interpreted by a manager.

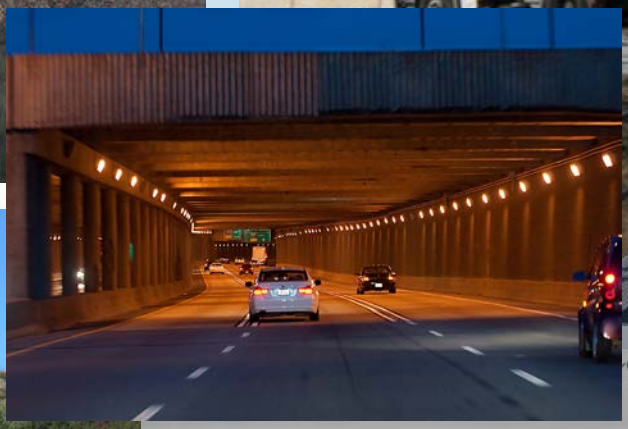
Transportation managers utilize roadway warning systems, and web sites to disseminate road weather information to travellers in order to influence their decisions. This information allows travellers to make choices about travel mode, departure time, route selection, vehicle type and equipment, and driving behaviour.

Data communications of **GEONICA** RWIS System is supported by different standard communication protocols such as NTCIP, DGT, etc.

The REMS stations of **GEONICA** RWIS system are based on the **METEODATA** Data Acquisition and Transmission Unit. This is a very advanced data logger which allows the connection of almost any type of environmental sensors, allowing also data transmission via different communication ways.







13. Road Traffic Information – SAFE ROAD and DATACAR Systems

GEONICA offers advanced Road Traffic Information Systems as our **SAFE ROAD System** specifically designed with the aim of improving safety and reduce congestion for ground transport. Road Traffic Information is a fundamental part of Intelligent Transportation Systems (ITS) that improve traffic flow, increase road safety, help to protect the environment and enhance public security.

The **SAFE ROAD System** incorporates diverse types of traffic detectors, for vehicle count and classification and vehicle velocity monitoring, these being of tremendous utility for the authorities and those responsible for road and motorway management and conservation.

DATACAR, as a part of the **SAFE ROAD System** or as an independent system, is a specific solution for vehicle count and classification, as well as for vehicle velocity monitoring. **DATACAR** consists of autonomous remote measuring stations based on the **METEODATA** datalogger plus a multilane vehicle detector, offering real-time data transmission to a Central Station, so allowing complete traffic information of the whole road network of a country or region, including main and secondary roads.

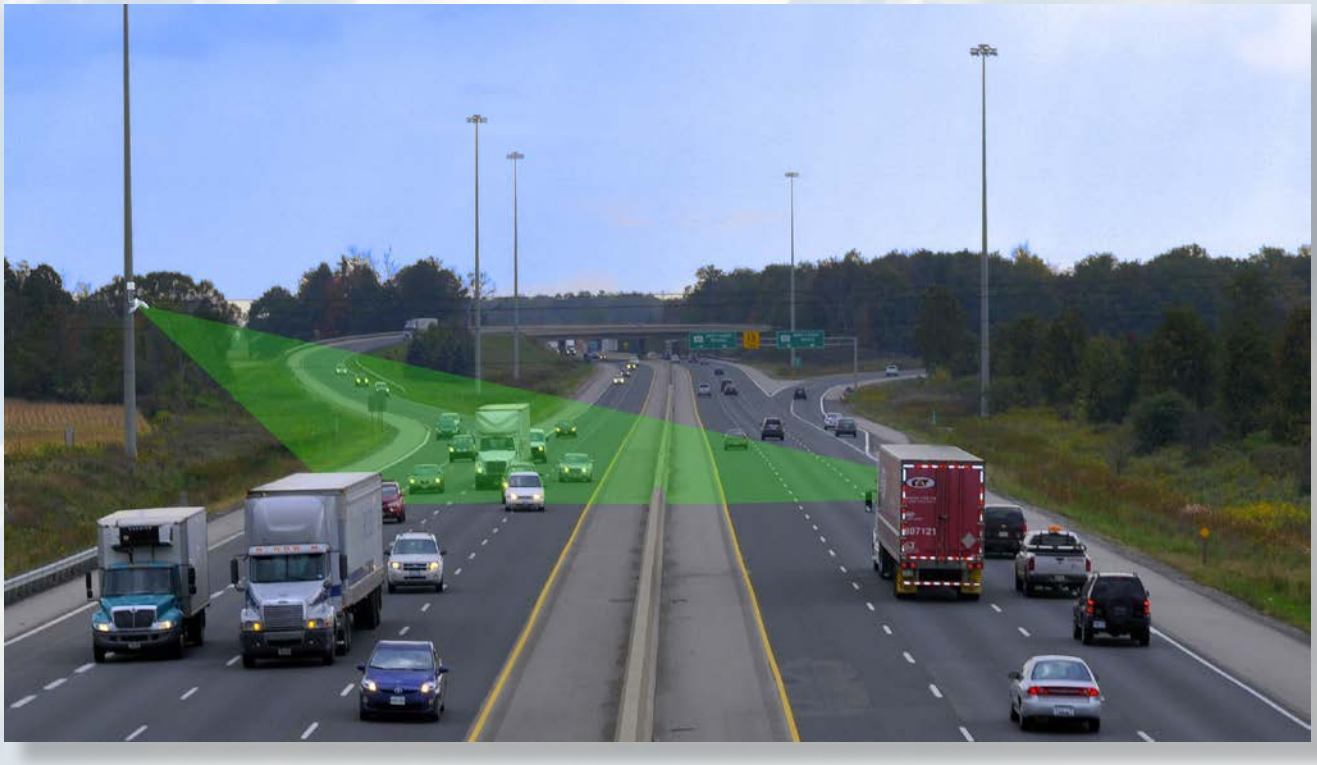
The **SAFE ROAD System** can integrate also road weather information as our RWIS system, in such a way to optimize the measuring networks, incorporating also pavement status conditions and environmental data as visibility, in a mixed or combined road traffic/weather information solution.

DATACAR System has been designed to detect, track and classify all traffic (multilane traffic detector). The system implements the newest RADAR technology and it can be used for permanent or temporary installations.

DATACAR System may include other sensors and detectors for complementing the traffic information such as:

- Meteorological Sensors (e.g. Wind Speed and Direction, Air Temperature and Relative Humidity, Precipitation)
- Noise detectors: for real time environmental noise .monitoring, establishing the correlation between traffic and noise.
- Still image cameras: for real time site visualization of traffic status.

Of course, both **SAFE ROAD** and **DATACAR** systems can be combined according to customer needs.



All our **METEODATA** in-field remote data acquisition and transmission units have been designed having in mind the need of reducing power requirement to a minimum, in such a way that our road monitoring stations can operate connected to the mains of an existing lighting pole or autonomously, by means of the internal battery pack and an external solar panel; so they can be installed at any isolated secondary road without the need of mains availability at the remote site.

These secondary roads form an important part of all the national route networks, and it is precisely in this type of roads where most accidents occur, in contrast to motorways, highways or main roads. So with our Road Weather and Traffic Information solutions it becomes now possible to provide traffic information and road environmental conditions in all types of roads to improve road safety and reduce the number of accidents, on the main roads and particularly on secondary roads.

Ground transport is essential to every country's economic and social well-being and therefore the responsible authorities are required to implement the solutions that current technology offers in order to try to reduce the accident rate on the roads, increasing motorist safety, mobility and energy efficiencies.

In **SAFE ROAD System** data collected from all the meteorological sensors, pavement status sensors, vehicle detectors and still images captured by suitable cameras, etc. is stored in the Data Acquisition and Transmission Unit model **METEODATA**.

All the information is transmitted in real-time to a central computer through diverse methods that are available (radio, optical fiber, GPRS/3G, INMARSAT Satellite Network or through the Internet), where said data is finally processed, and published on a **WEBTRANS** for general or restricted user access.

Data communications of **GEONICA** Road Traffic Information System is supported by different standard communication protocols such as **NTCIP, DGT,** etc.

14. Lateral Wind at Roads – WINDALERT System

The effect of wind on the stability of vehicles is an important safety consideration as in many cases lateral wind is the reason of accidents. Variables that contribute to vehicle rollovers can be divided into several categories: vehicle characteristics, road features (short radius curves on highway ramps, high bridges across deep valleys between mountains, etc.), excessive speeds, human factors and, of course, the intensity of lateral winds.

So the risk of vehicle over turning depends on many factors but heavy crosswinds has been noted to be a critical safety factor in areas with frequent high winds, or in areas prone to strong gusts.

Over the years the effects of high winds on road and railways have become of increasing concern to transportation system operators. Cars, high-sided lorries and high speed trains can be at risk of a wind-induced accident on exposed sites such as embankments or long span bridges.

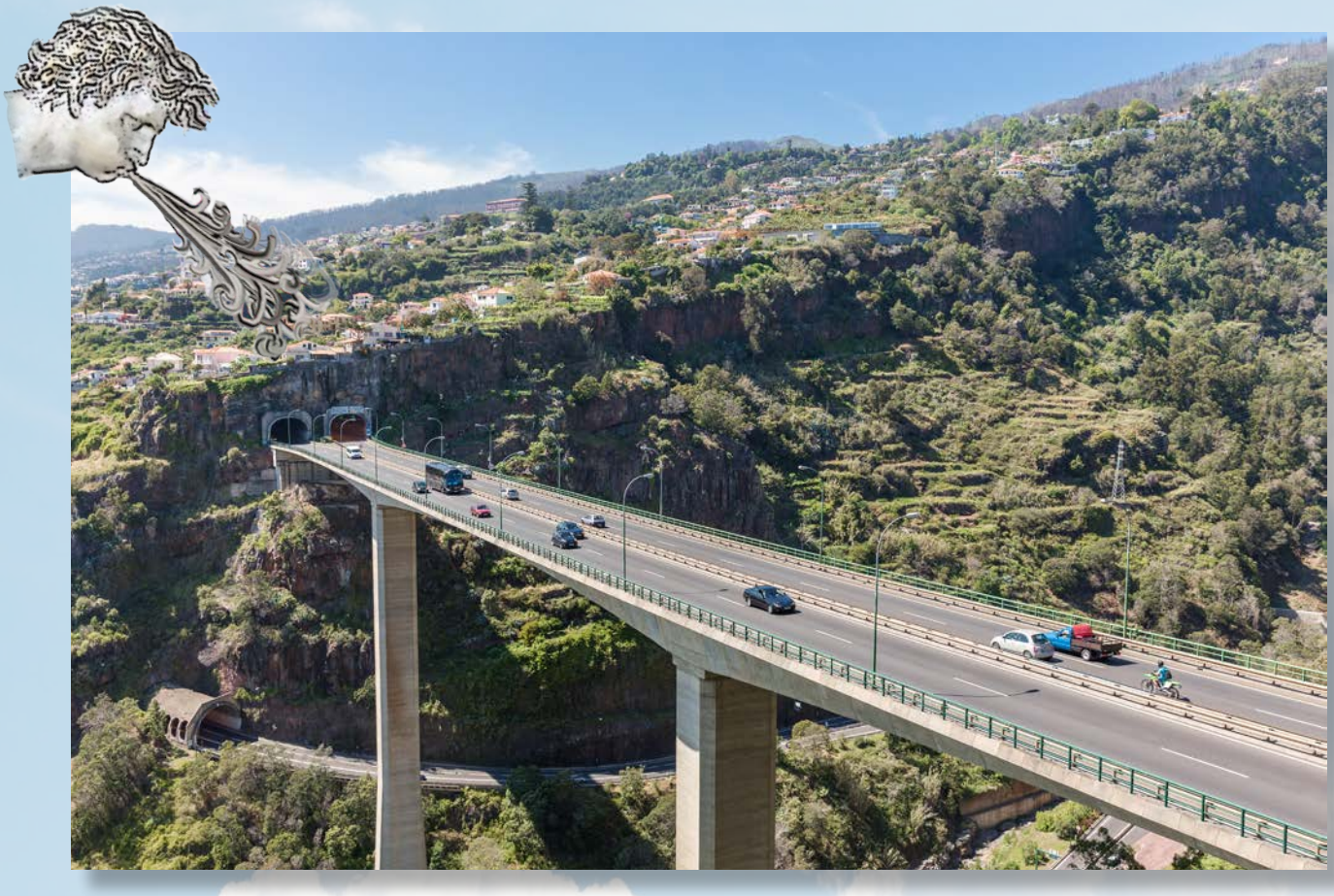
GEONICA offers our advanced **WINDALERT** System for Road Traffic Safety, strongly recommended in the case of heavy lateral winds be expected at any site along the roads. The basic system consists in one or more Wind Meteorological Stations installed at the points of interest, for example at the exit of a tunnel which is followed by a bridge located between two mountains, over a deep valley, because in these conditions the winds are concentrated and intensified, thereby causing a great risk of overturning, as the vehicle passes from not suffering any lateral wind inside the tunnel to have to face a strong crosswind just outside the tunnel.

According to the characteristics of the terrain and other factors, the Critical Wind Curves are calculated previously for each specific site and used by the Wind Meteorological Stations for alerting if such CWC have been exceeded at any moment. This information can be transmitted automatically to a Variable Message Sign (VMS) located inside the tunnel or at any suitable point of the road, for alerting the drivers about a certain level of overturning risk.

The same information can be also transmitted to a Central Receiving Station which also can disseminate the alerts to the drivers by other ways as radio broadcast or controlling remotely the VMS.

Since 2004, **GEONICA** along with other prestigious European companies and Universities aware of the gap between end-users requirements and existing technologies, cooperate in the European "WEATHER" Project, putting together their experience and know-how on wind modelling, risk analysis, data-logger manufacturing, wind sensors, communications technologies, environmental monitoring and road surface state measurement, in order to develop a turnkey wind alarm system for road and rail managers.

The W.E.A.T.H.E.R. Program *(Wind Early Alarm System for Terrestrial Transport Handling Evaluation of Risks)* *http://cordis.europa.eu/project/rcn/86545_en.html* was a Cooperative Research Project of the European Community, of a great interest for Road Traffic and High Speed Trains safety.



As an active and proprietary participant in the WEATHER Project, **GEONICA**, in cooperation with the Coordinator METEODYN, has developed the **WINDALERT** System as a very advanced solution for preventing the accidents caused by heavy lateral winds in the roads, alerting in advance to the drivers about the presence of strong winds on the road, at the exit of tunnels, or when driven on high bridges or in areas of strong and frequent gusts.

So the **WINDALERT** System is the resulting practical solution for road traffic application of the "WEATHER" Project, developed by **GEONICA** in cooperation with the firm METEODYN. The **WINDALERT System** for roads is now also available as a second version for application in high speed railways (see SECTOR Lateral Wind at High Speed Railways).

15. Lateral Wind at High Speed Railways – WINDALERT System

The high speed train is inevitably exposed to natural winds when running on the open track. The side force and lift force increase sharply when subjected to strong crosswinds, which drastically deteriorates the operational safety of high speed trains.
Lateral wind is one of the most important influencing factors on high speed trains running performance. As in the case of road traffic safety, the Characteristic Wind Curve or Critical Wind Curve (CWC) is used to evaluate the operational safety of the high speed trains exposed to crosswinds.

GEONICA offers our advanced **WINDALERT** System which represents a complete solution for the measurement of winds at high speed railways by means of a number of meteorological stations installed alongside the entire track, distributed according to specific scientific studies. As per the characteristics of the terrain and other factors related to the type of trains, the Critical Wind Curves are calculated previously for each specific site and used by the Meteorological Stations for alerting if such CWC have been exceeded at any moment. This information is automatically transmitted to the Traffic Processing Center.

Each meteorological station installed alongside of the high speed railway is configured by a Data Acquisition Unit or data logger Model **METEODATA**, to which are connected normally a set of three redundant wind sensors for wind speed and wind direction measurement. By means of a proprietary firmware the signals of all the three wind sensors are processed in real-time by the meteorological station in order to record reliable data of both parameters, wind speed and wind direction. As indicated this information is transmitted in real-time to the Traffic Processing Center.

Besides wind speed and direction sensors, these meteorological stations of the **WINDALERT** System can also be configured to measure other important meteorological parameters, such as Ambient Temperature, Relative Humidity, Atmospheric Pressure, Rain or Snow Precipitation, Snow Level, etc. of a great interest for completing the knowledge of the environmental conditions along the entire route.

16. Smart Cities - GEOcityQUAL System

Towards the end of the last decade, our planet achieved two remarkable feats. First, our human population crossed the seven billion mark and for the first time in history, 50% of the world's population was living in urban areas and this is expected to accelerate to 60% before 2025.

As we further congregate in cities, it has become more important to make cities not only green, but also efficient and safe. It can be identified a variety of key sectors that define a Smart City which are part of **GEONICA GEOcityQUAL** solution:

- Smart Traffic Information (traffic count and classification)
- Smart Traffic Control
- Smart solutions for Air Quality Monitoring
- Smart Noise Monitoring Systems (real-time noise maps)
- Smart Civil Protection and Alert Systems (early flood warning)

As a Smart City Project Integrator, **GEONICA** brings together various sectors of the smart city through pre-packed platforms, thereby providing a unified holistic and end-to-end integration of multiple sectors by means of our **GEOcityQUAL** System.

17. Water Quality Monitoring – AQUALERT On-Line System

GEONICA is offering our advanced **AQUALERT On-Line** Water Quality Monitoring System, ready to measure all the key constituents and Physico-Chemical parameters of water such as:

Dissolved Oxygen • Conductivity • Salinity • Temperature • pH • ORP • Turbidity • Nitrate • Ammonium • Chloride • Rhodamine • Blue-Green Algae • Chlorophyll • Biological Oxygen Demand (BOD) • Chemical Oxygen Demand (COD) • Total Organic Carbon (TOC) • Total Suspended Solids (TSS) • Spectral Absorption Coefficient (SAC254) • Polycyclic Aromatic Hydrocarbons (PAH) • Aromatic Hydrocarbons (BTX) • Crude Oils • Refined Fuels • Metals • Toxicity.

The **AQUALERT On-Line** water quality monitoring analyser operates in a continuous mode installed as a fix station, recording all measures and transmitting data in real-time via GPRS/3G cellular Network, INMARSAT Satellite or by Radio-Link to a Central Receiving Station. Also it can be connected to a local SCADA via Ethernet/Fiber Optic link.

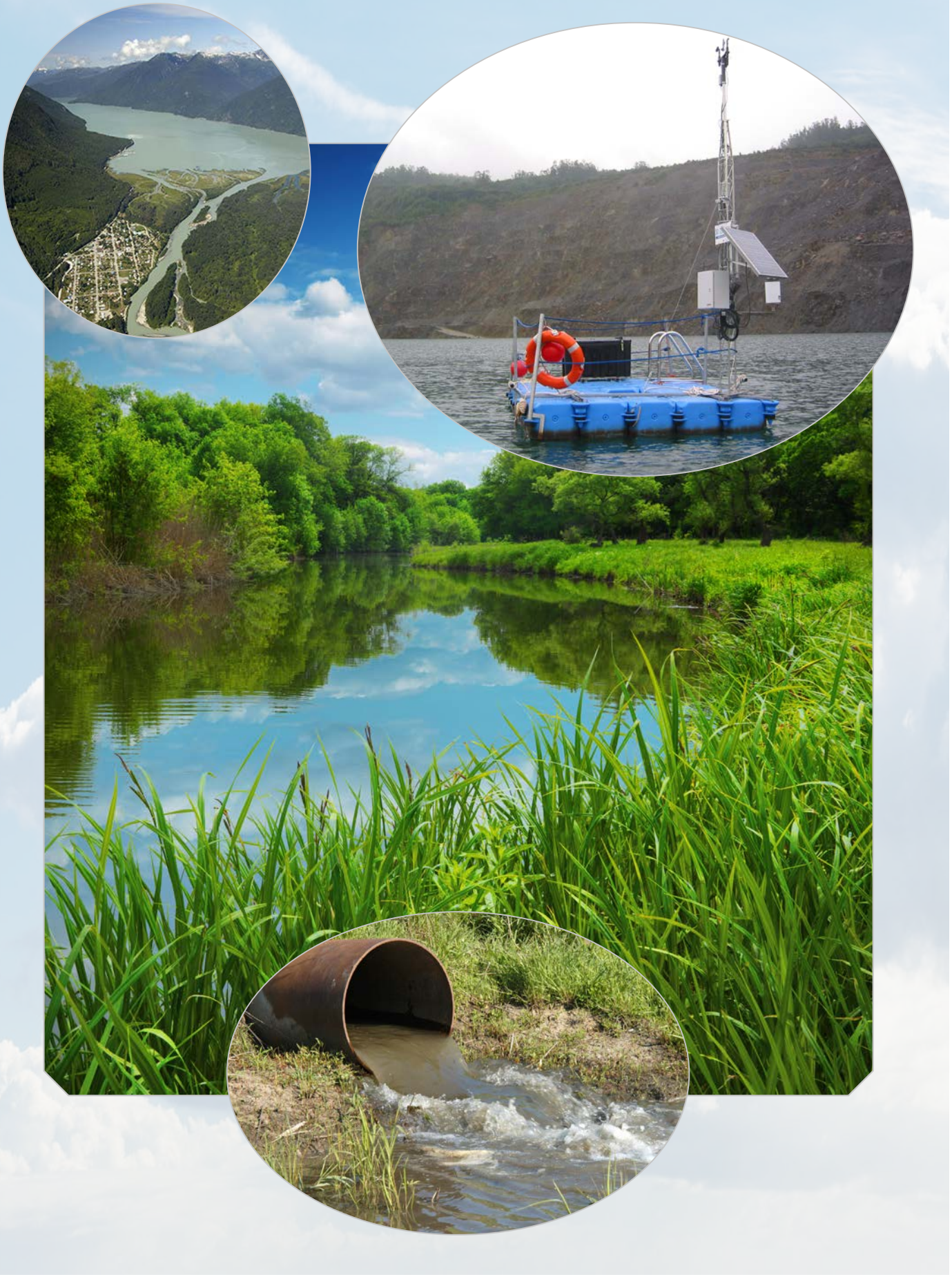
Typical applications of the **AQUALERT On-Line** System are:

- Water quality monitoring of Industrial Effluents
- Wastewater Treatment Plants
- Water quality monitoring of rivers, lakes, reservoirs and estuaries

Central Pollution Control Authorities of countries and regions have now the possibility of implementing efficient water quality monitoring networks for real-time control of water discharges into rivers and lakes by industrial plants or sewage treatment plants. Also to gather information to design specific pollution prevention/remediation programs, to characterize waters and identify changes or trends in water quality over time or for responding to emergencies, such as spills and floods.

Data collected by state, local and federal agencies and private entities are needed to build the assessments needed to make better pollution control decisions. Without data, simply it is not possible to know where pollution problems exist, where it is required to focus pollution control energies, or where progress in water quality has been effective.

Multiparameter Water Quality Probe Model GEO-AQUpro



18. Air Quality Monitoring – AQMS System

GEONICA designs and integrates complete Air Quality Monitoring Stations and Networks for the measurement of inorganic gases and Volatile Organic Compounds where parts per billion (ppb) detection is required, as well as optical aerosol/ particulate monitors for PM1, PM2.5 and PM10.

Our current technologies include Electrochemical, Catalytic, Optical, including NDIR & PID Semiconductor / metal oxide and Spectroscopy and we continue to explore the integration of new technologies for the benefit of our customers.

The measurement of gaseous pollutants in air is a sensitive and priority issue as it has large impact on human health and environment. Vehicle emissions remain a major contributor to air pollution in cities worldwide so it is fundamental to implement sustainable air quality monitoring networks due to the fact that current reference air quality monitoring systems based on gas analyser technology are expensive in cost and maintenance and, therefore, the number of such type of monitoring stations is obviously limited by budgetary reasons. Our Air Quality Monitoring System does not have among its objectives to replace the measurement networks based on sophisticated gas analysers, but to complement them.

Some of the advantages of our Air Quality Monitoring Stations with respect to the gas analysers are summarized below:

- Much lower cost and minimum maintenance requirements, so it is possible to install more dense networks with much larger number of measuring points.
- Much lower power consumption, operating by means of internal battery and solar panel.
- Reduced size and weight.
- Better temporal response for the measurement of air traffic peaks, as analysers normally log only every 30 or 60 minutes.
- Possibility of incorporating additional noise and meteorological sensors.
- Data Transmission in real-time via GPRS/3G cellular Network or Radio-Link to a Central Receiving Station.
- Web Posting by our advanced WEBTRANS ***Ubiquitas*** Internet Platform.

GEONICA Air Quality Monitoring Station 4000 Series (AQMS-4000) is a robust remote fixed site air quality station designed to be exposed to outdoor environments twenty-four hours a day, seven days a week, ensuring longer term reliability. Our Air Quality Monitoring System (AQMS) is used to determine compliance with clean air standards, assess the nature of air pollution in cities and for measuring the exposure of humans to airborne pollutants as:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Nitric Oxide (NO)
- Sulfur dioxide (SO_2)
- Ozone (O3)
- Hydrogen Sulfide (H_2S)
- Volatile Organic Compounds (VOC)
- Particulate Matter (PM1, PM2.5 and PM10)

GEONICA Air Quality Monitoring System and Networks can work as a low cost but efficient solution for real-time and long-term measurement at urban areas, along roadside for targeting of hotspots and at airports, combined with environmental noise monitoring, meteorological conditions and even traffic data.

GEONICA Air Quality Monitoring System (AQMS) is used to determine compliance with clean air standards, assess the nature of air pollution in in cities and assess the exposure of humans to airborne pollutants.

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas emitted from combustion processes. Nationally and, particularly in urban areas, the majority of CO emissions to ambient air come from mobile sources. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death.

EPA first set air quality standards for CO in 1971. For protection of both public health and welfare, EPA set a 8-hour primary standard at 9 parts per million (ppm) and a 1-hour primary standard at 35 ppm.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is one of a group of highly reactive gasses known Nitrogen dioxide (NO_2) is one of a group of highly reactive as “oxides of nitrogen,” or “nitrogen oxides (NOx).” Other nitrogen oxides include nitrous acid and nitric acid. EPA’s National Ambient Air Quality Standard uses NO_2 as the indicator for the larger group of nitrogen oxides. NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system.

EPA first set standards for NO_2 in 1971, setting both a primary standard (to protect health) and a secondary standard (to protect the public welfare) at 0.053 parts per million (53 ppb), averaged annually. The Agency has reviewed the standards twice since that time, but chose not to revise the annual standards at the conclusion of each review. In January 2010, EPA established an additional primary standard at 100 ppb, averaged over one hour. Together the primary standards protect public health, including the health of sensitive populations - people with asthma, children, and the elderly. No area of the country has been found to be out of compliance with the current NO_2 standards.

Sulphur Dioxide

Sulphur dioxide (SO_2) is one of a group of highly reactive gasses known as “oxides of sulphur”. The largest sources of SO_2 emissions are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of SO_2 emissions include industrial processes such as extracting metal from ore, and the burning of high sulphur containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system.

EPA first set standards for SO_2 in 1971. EPA set a 24-hour primary standard at 140 ppb and an annual average standard at 30 ppb (to protect health). EPA also set a 3-hour average secondary standard at 500 ppb (to protect the public welfare). In 1996, EPA reviewed the SO_2 NAAQS and chose not to revise the standards.

In 2010, EPA revised the primary SO_2 NAAQS by establishing a new 1-hour standard at a level of 75 parts per billion (ppb). EPA revoked the two existing primary standards because they would not provide additional public health protection given a 1-hour standard at 75 ppb.

Ozone

Ground level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapours, and chemical solvents are some of the major sources of NOx and VOC. Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems.

Particulate Matter

Particle pollution (also called particulate matter or PM) is the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.

Particle pollution includes "inhalable coarse particles" with diameters larger than 2.5 micrometres and smaller than 10 micrometres and "fine particles," with diameters that are 2.5 micrometres and smaller. How small is 2.5 micrometres? Think about a single hair from your head. The average human hair is about 70 micrometres in diameter – making it 30 times larger than the largest fine particle.

These particles come in many sizes and shapes and can be made up of hundreds of different chemicals. Some particles, known as primary particles are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires. Others form in complicated reactions in the atmosphere of chemicals such as sulphur dioxides and nitrogen oxides that are emitted from power plants, industries and automobiles. These particles, known as secondary particles, make up most of the fine particle pollution in the country.

Particulate matter (PM) is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulphates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. EPA is concerned about particles that are 10 micrometres in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. EPA groups particle pollution into two categories:

- “Inhalable coarse particles,” such as those found near roadways and dusty industries, are larger than 2.5 micrometres and smaller than 10 micrometres in diameter.

- “Fine particles,” such as those found in smoke and haze, are 2.5 micrometres in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

19. Environmental Noise Monitoring – NOISE MAPPER System

Noise pollution adversely affects the lives of millions of people. Studies have shown that there are direct links between noise and health. Problems related to noise include stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity. Noise Induced Hearing Loss (NIHL) is the most common and often discussed health effect, but research has shown that exposure to constant or high levels of noise can cause countless adverse health affections.

Consequently Noise Abatement is a fundamental task to be taken into account by the various health and municipal authorities, today reflected in a variety of regulations and directives adopted by almost all countries.

The source of most outdoor noise worldwide is transportation systems, including motor vehicle noise, aircraft noise and rail noise, but there are also other sources as car alarms, emergency service sirens, machinery, construction work, and even noisy people that have to be taken into account.

For Environmental Noise Monitoring we offer our **NOISE MAPPER** System which has been designed to monitor in real-time the environmental noise or acoustic contamination produced by road traffic in cities and roads, airplanes and railway traffic, or noise produced in construction sites. It applies to the monitoring of any other source of noise disrupting the welfare of the inhabitants.

NOISE MAPPER System is a versatile network solution for continuous permanent or semi-permanent monitoring of environmental noise in urban areas, from airports, industries, roads, etc. and in high noise sites (hot spot points), or in very quiet areas where noise may be a major concern.

Our Environmental Noise Monitoring System (ENMS) consists of the following parts:

- Remote Stations or NOISE MAPPER Remote Terminals (NMrt)
- Central Receiving Station or Environmental Noise Management Center (ENMC)

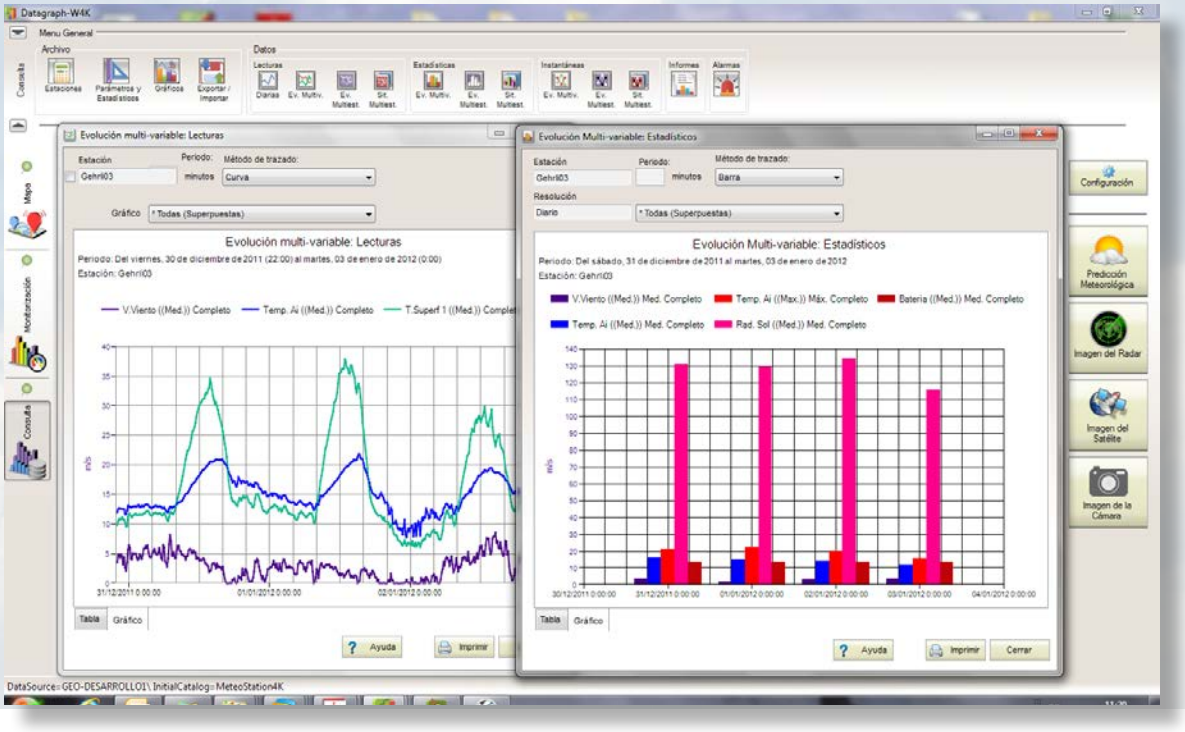
Remote Stations or NOISE MAPPER Remote Terminals (NMrt)

Our Environmental **NOISE MAPPER System** includes any number of autonomous NOISE MAPPER Remote Terminals (NMrt), deployed in such a way to cover the area of interest, as part of a noise monitoring network. Each NMrt includes its own weatherproof microphone (noise sensor), a very powerful Noise Processor, a Data Logger with very high capacity internal memory for data recording, as well as several optional data transmission capabilities vía GPRS/3G networks, radio-link, Ethernet, Wi-Fi, etc.

The NMrt, also allows the connection of other optional meteorological sensors for the measurement of wind, precipitation, air temperature, relative humidity, etc., and even sensors for air quality monitoring or vehicle traffic count and classification. Weather, air quality and traffic data are stored by the NMrt in the same manner as the noise measurements, but using a lower sampling rate, according to the different variability of the meteorological, air quality and traffic parameters. The Remote Terminals are offered with an optional built-in GPS receiver for automatic positioning.

Central Receiving Station or Environmental Noise Management Center (ENMC)

The Central Receiving Station or Environmental Noise Management Center (ENMC) would receive and store in a database all data transmitted by the NOISE MAPPER remote terminals in near real-time. Network Management is carried out by our **GEONICA SUITE** Software Package to be installed at the Central Server or Central Computer.
The Central Server also allows the installation of our **WEBTRANS** ***Ubiquitas*** Internet Platform (an advanced WEB Posting solution), which allows direct access to all numerical data and graphical information via Internet to all authorized users.



20. Data Transmission and M2M Communications

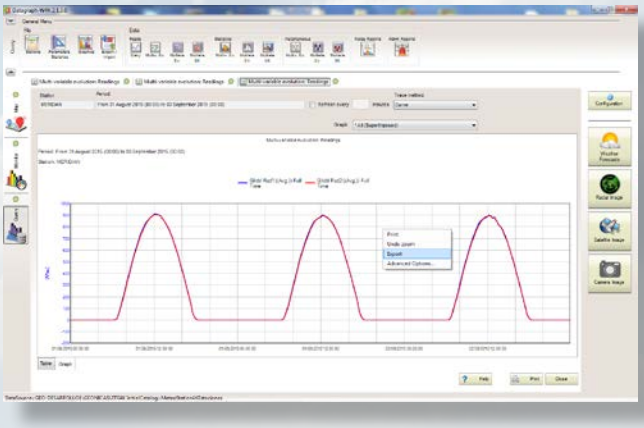
Hardware manufacturers are embedding wireless capability into a wide variety of devices. Wireless-enabled data transmission have never been more important to Industry and Environmental Monitoring sectors for numerous business and consumer applications to connect increasing numbers of networked devices.

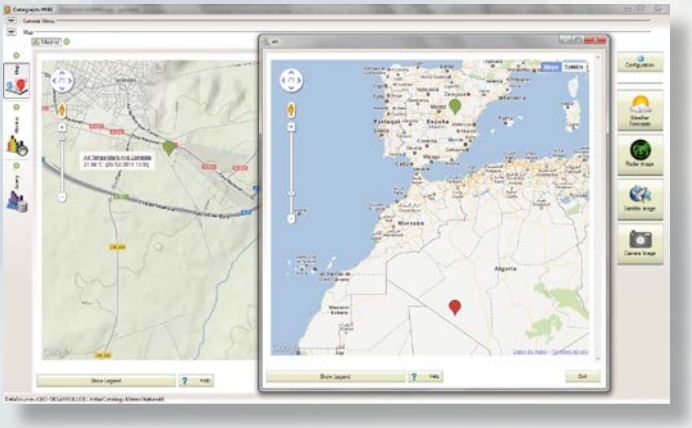
M2M communications are similar in some ways to cellular or Internet services. However, instead of phones and PDAs making calls, sending emails or texts, or surfing the "net," M2M intelligent "black box" devices (as our Dataloggers **METEODATA**), are equipped with cellular radio-based modules that collect information from remote locations and transmit it to a central location. This is similar to how remote PCs and laptops connect to the servers in a company's IT department. M2M communications are conducted via broadband/wireless connections in order to access and process the gathered data.

The essential difference with M2M is that on their own, with no human intervention, compactly packaged remote devices "sense" changes in location as wind speed, temperature, precipitation, solar radiation, water level, and the like, then issue an alert and transmit important data about environmental conditions or specific events.

For a little well over two decades, **GEONICA** has been offering advanced solutions for data transmission and M2M communications in the sector of the Earth Sciences including the Meteorology, Hydrology, Oceanography and for Environmental Monitoring in general.

The use of M2M technology in these areas and in environmental monitoring has begun to significantly expand as wireless technology applied to increasingly more monitoring applications as those included in our portfolio:





- Meteorological and Hydrological Networks
- Rainfall and Heavy Rains Networks
- Early Flood Management and Alerts
- Solar and Wind Energy Resource Assessment
- Water Quality in rivers and wastewater treatment plants
- Water Management in rivers and lakes
- Air Quality Monitoring
- Gas and pollutant levels in landfills
- Environmental Noise in urban areas, roadside and airports
- Road Weather Information
- Road Traffic Management
- Etc.

For all these applications, **GEONICA** offers M2M wireless networking to communicate in real-time remote measuring stations with SCADAs and Central Receiving Stations. Analogue and smart digital measuring sensors are integrated with our data loggers in such a way that all the information is transmitted to a Central Receiving Station in which is installed our **GEONICA SUITE** Software Package, allowing bidirectional communications, remote programming, Network Management and database generation.

For such purpose we use the following single or mixed M2M communications ways:

- GPRS/3G Cellular Networks
- INMARSAT BGAN bidirectional with global coverage
- Physical Interconnections as fiber optic cables
- Wi-Fi
- Point–to-Point (PTP) Radio-Links
- THURAYA Satellite Network (GmPRS)
- INSAT Satellite Network (unidirectional)
- GOES Satellite Network (unidirectional)
- IRIDIUM Satellite Network

GEONICA Suite 4K

As per our technical opinion, we have a clear recommendation on priorities for the use of the different M2M communication ways available: first we recommend GPRS/3G modem whenever there is coverage in remote location. Second we recommend INMARSAT BGAN satellite communications where there is no GPRS/3G coverage, or when the system criticality merits data communication redundantly, for instance, GPRS/3G and INMARSAT simultaneously or alternately.

GEONICA has more than 44 years of experience in remote control systems. Our design and engineering are constantly evolving, providing maximum satisfaction to clients. Our equipment is installed in remote and isolated areas; therefore, reliability, minimum maintenance and low power consumption are the strengths of **GEONICA**'s designs. Actually, **GEONICA** provides full compatibility to a wide variety of communication networks in order to entirely adapt to each system's requirements.

Applus+

CERTIFICATE

Number EC-8310/15

LGAI Technological Center, S.A. (Applus+)
certifies that the Quality Management System of the organization:

GEONICA, S.A.

GEONICA, S.A.
C/Alejandro Rodríguez, 22
28039, Madrid (Madrid)

For the following activities of:

DESIGN, MANUFACTURE, MARKET, INSTALLATION AND MAINTENANCE OF MEASURING EQUIPMENTS, SYSTEMS AND INSTRUMENTATION NETWORKS.

ENAC CERTIFICACIÓN Nº 02/C-SC032

is in accordance with the requirements of the standard ISO 9001:2015

INITIAL CERTIFICATION DATE: 17/07/2015
EFFECTIVE FROM: 17/07/2018
THIS CERTIFICATE IS VALID UNTIL: 16/07/2021

General Director
Applus+ Certification, B.U.

Juan Sendín Caballero

Technical Director
Applus+ Certification, B.U.

Cristina Bachiller Martínez

This certificate will be regarded as valid provided that all the contract conditions for which it is part of were be fulfilled
LGAI Technological Center, S.A. (Applus+) Campus U.A.B., Ronda de la Font del Carme s/n, 08193 Bellaterra, Barcelona

more than 40 years

GEÓNICA
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