Monitoring the Weather – More Relevant than Ever

Weather and rainfall monitoring networks are becoming increasingly important in today's world, as they are essential for our understanding of climate change and indeed for our very survival. Because food and water resources are powerful determinants of how economies develop, accurate observations of weather and climate are of vital importance.

Although both weather and climate affect every aspect of our daily lives, the two terms should not be confused. Weather is the state of the atmosphere at a given time and place, with respect to variables such as temperature, precipitation, wind velocity, and barometric pressure, whereas climate is the overall average of the prevailing meteorological conditions in a particular area, incorporating its variations over time.

The effects that natural disasters such as volcanic emissions can have on economies and infrastructures cannot have escaped notice recently. The use of satellite imaging and data is vital for severe weather situations, especially in rapidly occurring explosive events, such as the recent volcanic eruptions in Iceland, during which pollutants were discharged into the upper atmosphere. In this instance, it was vital to use all the latest satellite visualisation images and upper atmosphere measuring technologies in order to map and model the dispersion of volcanic ash across Northern Europe.

Basic monitoring

Instruments have been available for measuring weather parameters since Victorian times. Much of this equipment, such as copper rain gauges and thermometers, was manually read and was historically used to measure trends so that long term data could be analysed.

Data continues to be collected in this manner and these 'old fashioned' instruments are still used in great numbers, especially, owing to lack of power and financial constraints, in developing countries. The data obtained from these simple devices is still valuable today, as it represents the local conditions for the site and for the user, provides reliable 'ground truth' data for modelling, and forms the backdrop for many larger modern meteorological monitoring networks worldwide.

Automated monitoring

However, the manual equipment at these local sites is labour intensive and does not provide real-time data. In order to obtain information more quickly, many stations are now automated, with links to data transmission systems, removing the operator from the equation and allowing systems to be deployed in the remotest areas on earth. Most government ministries now set up and run whole networks of ground stations, the statistics from which can be accessed and then used and analysed by powerful computers to devise climate models. Using the internet, this critical data, which can provide instant displays of extreme weather events either locally, or available via live satellite images of earth from space, can now be accessed in real time.

Extensive networks of automatic meteorological monitoring stations are to be found around the world today, most with remote solar powered operation, on-board data-logging capabilities and access to real-time data transmission networks.

As weather knows no boundaries, many of these networks are combined into national networks operated as National Meteorological and Hydrological Services (NMHS) under the auspices of bodies such as the World Meteorological Organisation (WMO), which oversees and collates global information from around 10,000 land stations, 3,000 aircraft, 1,000 upper air stations and 1,000 ships.

Information provided around the clock from both ground-based and space-based systems giving early reliable warnings of severe weather, poor air quality and other climatic events, allows decision makers to be better prepared. These systems help to save lives, protect property and infrastructures, preserve resources and support socio-economic growth.

The Global Earth Observation System of Systems (GEOSS) interconnects a diverse and growing array of instruments and systems for monitoring and forecasting changes in the global environment. In addition, there are many hundreds of other weather monitoring stations which are operated by governments, the military, local authorities, highway departments, industries, organisations and private individuals.

The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) delivers weather and climate-related satellite data, images and products 24 hours a day, 365 days a year. This provides extremely valuable figures on factors such as rainfall and temperatures to areas that have limited land-based monitoring capabilities.

For many natural disasters such as forest fires, floods and chemical spills the collection of localised 'ground truth' data from manual synoptic climate classification and networks of automatic weather stations and observers is essential. Normal everyday data is also important for transport, shipping, farming and construction.

Avoidance of disaster

According to the WMO, approximately 90 per cent of all global disasters are related to weather, climate, or water, affecting, or even halting, sustainable development in many countries. Disaster risk reduction programmes offer many challenges and are also a major driver for the establishment of weather monitoring networks. A number of countries, including many in Europe, have already well-established hydrological and rainfall monitoring networks that provide real-time early warning data, allowing authorities to implement appropriate flood management plans and deploy disaster preparedness teams and facilities.

Flooding

Water is the most important resource on earth, with global distribution and demand for it rapidly and constantly changing. Patterns of rainfall are altering – even in the UK more extreme high intensity rainfall levels are being noted, resulting in increased sewage outfall back-ups and the risk of flash flooding. Globally, coastal areas will also experience increased incidents of flooding due to rising sea levels, especially around large deltas, many of which are populated.

In the UK, the Department for Environment, Food and Rural Affairs (DEFRA) has recently allocated over £10m to local authorities that are most at risk to help them monitor and tackle surface water flooding. Following many instances of extreme flooding in the UK in 2007, the independent Pitt Review suggested a raft of urgent measures which need to be put in place to prepare for similar events in the future, owing to the escalating risk of flooding. Many countries also have waste water flood management plans in order to help cope with excessive rapid increases in waste water.

In the EU, the Floods directive 2007/60/EC aims to help reduce and manage the risks that floods pose to human health, cultural heritage and economic activity. All EU member states must carry out a preliminary assessment by 2011 to identify river basins and coastal areas at risk of flooding, draw up flood risk maps by 2013 and establish flood risk management plans focused on prevention, protection and preparedness by 2015. Water and rainfall monitoring is an essential part of this process.

Climate change

Even in developed countries, the effects of extreme weather are on the increase every year. Recent research and modelling from the Meteorological Office for the Association of British Insurers, The Financial Risks of Climate Change, found that, based on a four degree rise in global ambient temperatures, average UK annual insured flood losses could rise by 14% to £633 million, wind losses could rise by 25% to £827million, and losses from typhoons in China could increase by 32% to £345million.

Approximately 700 million people in Africa depend on farming for their livelihood, most of which is totally dependent upon rainfall. Changing weather patterns due to climate change have meant that original knowledge and data is now becoming obsolete, creating a greater need for higher density of monitoring, preferably via automated networks which can transmit data on a real-time basis.

A network of weather monitoring stations is planned in some African countries in order to provide effective data for crop protection insurance

programmes. The recommended density of stations for weather and rainfall is 20km, so that they will need to be powered in ways other than by mains electricity such as solar power. These stations will also have to have the capability to transmit records via mobile data services such as GSM or GPRS in real time in order to offer early warning of extreme weather or rainfall events.

The collection of sound, reliable meteorological data is imperative for continued sustainable development. Many industries, such as health, tourism, agriculture and energy, depend on such information. Monitoring networks, which can help reduce the vulnerability of agricultural systems and study illness outbreaks, are critical to logistics operations including those at airports and harbours.

Water stress

Water stress – lack of good quality fresh water – is a major problem that is driving the growth in water, rainfall and precipitation monitoring networks around the world. According to the UN's Intergovernmental Panel on Climate Change (IPCC), 1.5 billion people currently live in water-stressed regions, and this will be exacerbated by the growth in populations, which is estimated to raise this number to 7 billion by the mid 2000's, with ever more competition for this essential resource.

High water stress and the need for food security are also forecast to lead to major shifts in population and increased migration. The Environmental Justice Foundation estimates that there could be 150 million refugees by 2050 owing to the effects of dramatic weather and flooding. Forecasting such changes is extremely difficult, but the impacts of climate change must take into account changes to societies and how they will adapt to these changes.

A new report from the conservation organisation WWF and insurers Lloyd's 360 Risk Insight, Global water scarcity: risks and challenges for business, explores the increasing threat to business from water scarcity, as populations grow and climate change takes hold. It says that businesses will have to address and manage the risk of water scarcity in the future if they are to survive.

Looking at weather systems as local environmental monitoring systems means the data can be incorporated to give global pictures. Increasing numbers of applications such as industrial processes now have requirements to monitor local conditions to help check emissions of pollutants, or chemical spills, from their site boundaries.

Everything we do is dictated by the weather, so that monitoring conditions with accuracy will require a much higher level of investment in National Meteorological and Hydrological Networks (NMHN) to ensure that risks from disasters can be minimised, weather models improved, and local facts and figures made available to all governmental departments, industry and farmers. Data from these Networks will also help bodies such as the Met Office Hadley Centre, the UK's most important climate change research centre, to provide more accurate modelling software to help plan out infrastructure development plans for the next few years.

Recently, the UK's Department for International Development (DFID) and the World Health Organisation (WHO) undertook modelling exercises up to 2030 to look at the viability of current and planned technologies to provide water supplies and sanitation. This in turn will allow them to identify research needs in technologies and regions that are the most appropriate.

Need for investment

We now have the technology to monitor weather conditions in great detail, while the extensive modelling packages that are now available allow us to attempt to predict what may happen in the future. This equipment is becoming more affordable, even for the poorest countries of the world, and every piece of monitoring helps assess the overall picture, so that the necessary action can be taken.

However, many areas of the world still do not have enough capacity in their monitoring capabilities. In countries such as Africa, increased investment of meteorological services is vital. The Environment Minister for Kenya recently demonstrated this by stating: "Weather shocks have devastated food security. Deforestation, soil erosion and land degradation have wiped out thousands of acres of land while water borne diseases continue to claim hundreds of lives."

With the all too obvious results of climate change around us every day, it is now even more vital that regions and countries continue to invest in the development and expansion of their weather and rainfall monitoring networks in order to help study the overall changes in climate.

According to the WMO, science-based disaster risk reduction offers a high return on investment, since every dollar invested pre-disaster in risk reduction can save seven dollars' worth of disaster-related economic losses. As its factsheet on climate information for reducing disaster risk concludes: "More accurate weather and climate forecasts and warnings play a key role in anticipating risk to lives and property."

AUTHOR DETAILS

Gary Noakes
Market Manager
Casella Monitor
Regent House, Wolseley Road,
Kempston, Bedford
MK42 7JY
Tel: 01234 844100
Fax: 01234 841490
email:
garynoakes@
casellameasurement.com
www.casellameasurement.com