LBS in Weather and Geophysical Services

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Weather information carries little meaning unless it is related to a specific geographical location. Hong Kong Observatory (HKO), being responsible for issuing weather warnings and forecasts in Hong Kong, has a long tradition of using GIS in processing meteorological and other geophysical data spatially, and presenting them on geographical displays for both internal analysis and external service delivery.

The use of GIS at HKO, in its more primitive form, can be traced back to the 1980s when the first computer-based weather radar was implemented to replace the old analogue system. The display of radar return signals on top of a geographical map enabled weather forecasters to follow the movement and development of rain areas in a more efficient manner. As GIS technology advanced, conventional weather charts drawn manually by weather forecasters were replaced with computer-generated charts. The weather forecasters are thus free to switch between different weather elements on the same map or generate multiple overlays to suit his/her analysis needs.

The emergence of the Internet in the 1990s was another breakthrough which enabled HKO to expand its range of GIS-type products, from internal analysis for own use, to the delivery of services to external users. In addition to textual information, HKO disseminates through its own website weather observation and forecasts using GIS to enable the public to better appreciate the spatial and temporal evolution of weather situations.

In recent years, HKO also made use of Location Based Services (LBS) to increase the efficiency of work and enhance its public weather services. With the aid of LBS, new location-specific services were launched allowing the public to better integrate the weather information in their decision processes. Examples of the Observatory’s GIS and LBS applications will be discussed in the following sections.

**USE OF GIS TO ENHANCE EFFICIENCY**

GIS is especially useful when it comes to analysing and presenting a large volume of information that spans a wide area, such as data from radar or satellite. The rain areas detected by weather radar, presented in different colours according to the intensities, are overlaid on top of geographical maps to enable the weather forecasters to assess the location and intensity of rain areas. Furthermore, sophisticated GIS tool gives forecasters a cross-sectional view of the storm structure by just a mouse drag on the map. Figure 1 shows how a hail event was revealed from the radar image.

Over a wider range, weather-related phenomena such as cloud, fog, dust and aerosol as detected by meteorological satellites are presented to weather forecasters with the aid of GIS. The GIS display software is highly versatile in that it can ingest data from different meteorological satellites.

To facilitate analysis of different weather phenomena, satellite pictures can be enhanced by assigning different colours to signals detected by different channels and overlaying them on the same map. Figure 2 shows how duststorms are revealed from the satellite image. Besides applications on weather fore-
casting. GIS is also widely used by the HKO in other areas such as earthquake monitoring. An earthquake monitoring system empowered with GIS features displays earthquake information such as location and magnitude on a map, with visual and audio alarms available so that the Observatory’s personnel can respond immediately to the earthquake.

Just like other GIS tools with high portability, the earthquake monitoring software is shared for operational use by different countries, which can add to the maps their own geographic overlays such as local roads, bridges and facilities vulnerable to earthquake damage, thus facilitating rescue and rehabilitation work. Figure 3 is a sample screenshot of the earthquake monitoring system.

**USE OF GIS AND LBS IN THE INTERNET AGE**

Apart from using GIS to display weather information in such a manner that forecasters could assimilate it conveniently and effectively, the combined use of GIS and Internet had enabled HKO to expand and enhance its service to the public. With increasing bandwidth, weather forecast charts, previously only available to forecasters, are now available on the Internet, empowering citizens to make intelligent weather-related and location-specific decisions for themselves (Figure 4).

Another example is the Observatory’s lightning location information service provided to the public over Internet, freely. The service is well received, with millions of webpage hits per year. Locations of lightning strokes detected by the Observatory’s lightning location network are displayed in graphical form on the Observatory’s website and Personal Digital Assistant (PDA) website. With the service adopting GIS technology, users can interactively zoom in to their areas of interest and such geographic features as landmarks, highways, country parks and beaches can be switched on and off at the fingertips of users.

Another feature of the service involves the provision of a user-friendly decision support tool. Members of the public can select their own location of interest so that the webpage will automatically provide audio and visual alerts when lightning strikes are detected within a pre-set distance from the specified location (Figure 5). Besides the above, the lightning serv-
ice also provides spatial data analysis tools, so that user can retrieve the number of lightning strokes occurring in a selected area of interest over a period of time. For data sharing the same GIS platform, the development of new value-added products is much simplified. A good example is the overlying of radar images onto lightning data which enables user to appreciate which rain area bears lightning activities and which does not (Figure 6). Moreover, a film loop can be activated to track the movement of lightning alongside rain areas for assessing how the lightning develops or decays as the rain progresses.

**USE OF GIS AND LBS IN EMERGENCY RESPONSE**

In the event of a radiological emergency, a custom-fitted van with radiological measuring equipment on board is deployed to measure the background radiation level over the territory. To allow the decision maker at the Observatory headquarters to make an overall assessment of the situation and give appropriate commands to the survey team on the van, he/she has to be kept informed of the radiation level at every point along the survey route instantly. This is achieved by transmitting realtime radiological data measured en route automatically to the headquarters using wireless communication and displaying the track of the van and the measurement results in front of the decision maker, with the aid of sophisticated GIS tool as shown by the example in Figure 7.

Besides the above, the measurement of weather information in the event of a nuclear, chemical or biological attack is another example of the Observatory’s location-specific service. Since the attack can take place at any part of the territory, a portable automatic weather station is deployed to the affected site so that in situ wind and temperature information can be collected for identifying the area of downwind hazard. With the combination of mobile, GPS and GIS technology, weather information of the affected location can be displayed together with data of other fixed weather stations on a map (Figure 8) for analysis by the emergency response personnel of the Observatory and other operation departments.

**LOOKING AHEAD**

If we would just imagine, there are even more possibilities of using GIS and LBS to enhance public weather services. Once numerical weather prediction becomes more and more reliable, location-specific weather forecasts with fine time resolution, say less than an hour, may be provided to members of the public, facilitating them to make intelligent weather-related and location-specific decisions for themselves. For example, imagine someone caught in a rainstorm while travelling. If this person could use a mobile device to obtain information on when the rain will stop (Figure 9), he could make a decision as to whether he should proceed or seek a temporary shelter.

Another possibility of applying LBS is the provision of location-specific weather warning to the public, especially when there is no territory-wide warning in force but localised hazard may exist. For example, when there is a tropical cyclone in the vicinity of Hong Kong but winds generally over Hong Kong are not strong except for a certain region of the territory. If people in that region can obtain alert of the strong winds through mobile devices (Figure 10), it would on the one hand ensure safety of the public and at the same time minimises disruption to normal life caused by the issuance of warnings of higher winds.

Information technologies such as GIS and LBS advance rapidly and give us a lot of convenience in service delivery. Nowadays, many commercial GIS and LBS platforms are increasingly affordable. With the development of interoperability standards, software with GIS and LBS features conforming to these standards is now highly portable. All these serve to expedite the Observatory’s development of GIS and LBS applications for the public. The Observatory will continue to make good use of the technologies and at the same time enhance the content of the service itself, in terms of accuracy, diversity and usefulness of the weather information. There is no doubt therefore that GIS and LBS will become more and more widely used and will increasingly aid the mitigation of disasters caused by severe weather.

**REFERENCES**


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