Development and Use of the Swedish Road Weather Information System

by

Lennart Axelson
Director at the International Secretariat
Swedish National Road Administration
SE-781 87 Borlänge, SWEDEN

Introduction

1972 witnessed the first attempts in Sweden at constructing simple stations that could be contacted via the telephone network for icy road warnings. This was the beginning of the present-day Swedish road weather system, which now incorporates about 650 stations spread geographically from north to south throughout the entire country. Although these are most highly concentrated in the central and southern parts of Sweden, there is also a large number located further to the north.

Historically speaking, we have seen a development from the simple analogue measurement system that existed at the end of the seventies to a custom-designed single board computer, which in turn evolved into the PC-based system that was introduced at the beginning of this decade. Input from new and improved sensors, better weather and road surface condition prognoses, radar-, satellite- and video images and a clear presentation in a PC-environment have all served to enhance the system. This has meant that while the system offers more comprehensive coverage, it has also become multi-functional, being used for purposes other than strictly road weather surveillance. The Swedish RWIS has been accessible on the Internet since 1998, which has also served to increase its general availability.

From the very beginning, the stations have been equipped with sensors for determining road surface temperatures, air humidity, and depending on the geographical position, even the wind direction, velocity and a simple yes/no regarding precipitation. For many years, such sensors constituted the basic equipment at the field stations, from which data was transmitted to 24 measurement centres. From there it was sent on to a central processing unit at the Swedish National Road Administration (SNRA) Head Office where the raw data was processed before being transmitted back to the regional measurement centres. Nowadays, there is direct telecommunication between the central processing unit and the 650 stations with information being sent every half-hour, around the clock. All data from the field stations has been saved since 1992 and is being used today to further improve and develop the road weather information system.

RWIS key factors

When a decision was made at the SNRA to invest in a RWIS, it was considered very important to define the system requirements, set up objectives, design a pilot project and implement it. This was carried out in one Swedish county, where the system proved very successful and subsequently led to its being extended to cover basically the entire country.

As the system was being put into action, it was essential that it be accepted and assessed on the basis of its inherent capacity. This demanded a number of important activities, such as:

- **Internal marketing**

It was considered extremely important that all conceivable users be given the opportunity to influence and take active part in the development of the project. Those who participate are generally more highly motivated to accept the changes in the way of working that would inevitably result from an implementation of a RWIS. Supervising the road network within a geographical area with the aid of a road weather information system was an entirely new idea. Feelings of confidence in the system is necessary, as well as the ability to realise the advantages of not having to be physically out on the roads in order to be able to supervise and have control over the situation. Participation in the project was a crucial factor in gaining acceptance for this new way of working.

- **Multi-source input**

Gathering input from several different sources, such as in our case from weather and road condition prognoses and from radar and satellite images in addition to the abundance of raw data from the field stations (sometimes even supplemented with video images), produces a great variety of basic data. This provides users with a comprehensive system with the best prerequisites for making correct decisions concerning good winter road maintenance.

- **Thermal mapping**

The climatic variations along a stretch of road are affected by many factors in the surrounding terrain, amongst which is the topography. It is therefore of utmost importance that every individual field station is set up at places where it can be expected that the ice, wind, snow or low temperature parameters are characteristic for that specific area. When users know this, as well as what the site and the topography are like, it is considerably easier to evaluate the output data and decide upon the action to take. Thermal mapping is used to find these specific sites. The maps are studied and then compared with first-hand knowledge about these selected geographical locations based on the experience of those who have previously been engaged in road maintenance in the area. The results from the thermal mapping indicating where the stations should be sited are generally corroborated by this previous experience. However, it is normally more often the case that there are several places along a stretch of road where conditions can become perilous. When, for financial and practical reasons, only one station can be set up, it is the result of the thermal mapping that is decisive.

- **Open-system architecture**

The open system architecture that we have chosen in Sweden enables us to engage different consultants / suppliers, meaning that we are not bound to any one in particular. This gives us greater flexibility concerning different types of transmitters and sensors so that we can purchase what we consider to be best rather than what any individual supplier can or wants to deliver. One inherent disadvantage might be that customised development is more expensive, at least in the short run.

- **User training**

Training is a necessity for users to be able to interpret and make the most of all the information obtained from a road weather system. An understanding of how the weather and weather fronts can affect road conditions is needed, even for site supervisors with many years of practical experience. Courses in meteorology and climatology are therefore required. Without this knowledge, there is a risk that the system could be used as an ”extremely expensive thermometer ” instead of as a tool for making the right decision about the operational measures to be undertaken. If this system is to be put to the best possible advantage, it is therefore essential that every single user is given the opportunity to learn more about utilizing and interpreting the data provided by the road weather system.

	**RWIS**-site with sensors for wind-speed and wind-direction, the Optic-Eye for precipitation. Camera and Infrared floodlight for pictures.

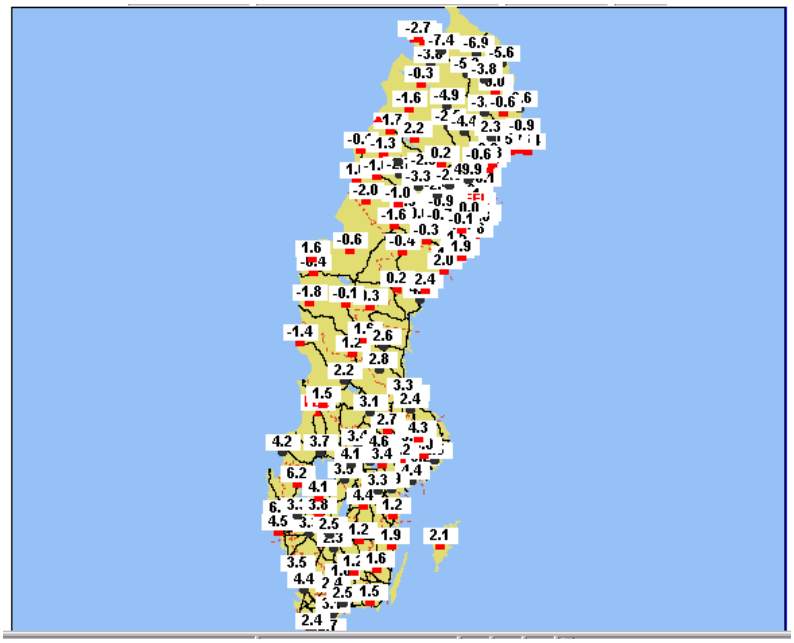
The Swedish RWIS

The Swedish system works in such a way that the data from the 650 field stations, three weather satellites and 21 weather radar stations are processed in a central computer. This input data is also processed in prognosis models that present four-hour road surface temperatures forecasts. Weather prognoses arrive every other hour from SMHI (the Swedish Meteorological and Hydrological Institute) and are also presented in the system. All information is processed and transmitted to all system users through the regular network. Moreover, the RWIS can also be accessed on the Internet at home through stating an ID code and password. This flexibility means that on-call surveillance duty does not have to be tied to any specific work location.

The system can issue different types of alert triggered by a drop in temperature, precipitation, risk of frost, etc. Often, the alert can indicate that it is time to carry out preventive salting before icy conditions can actually start to prevail. This leads to a calmer traffic rhythm, fewer accidents or incidents and is favourable to the environment. Preventive salting means less salt consumption due to the fact that it takes less salt to prevent water or moisture from freezing to ice than to thaw a layer of ice that has already formed. When a snowfall is forecast, ploughing and any possible skid control measures can be prepared for ahead of time by choosing the most relevant equipment for the expected weather situation and getting the machinery set up for action.

During an average winter in Sweden there are about 20 snowfalls, each of which lasts an average of six hours, has an average intensity of about 1 cm per hour and the number of occasions of treacherous

slippery conditions is between 80 and 120. There is money to be saved through a sound organization entailing the right equipment, carrying out the right measures, at the right time. RWIS provides us with this opportunity; i.e., reliable information at the right time so that the right action is taken.



RWIS-sites in Sweden

Cost elements and cost benefits

During the winter, snowstorms, black ice and hoarfrost create road conditions that are extremely costly to society. Such conditions, to which road-users are ”caught unawares”, generally cause major problems within the road transport system entailing increased societal costs ensuing from the ensuing accidents, delays, increased maintenance needs and detrimental impact on the environment.

RWIS has been seen to help reduce these costs to society. During the winter of 1994/95, the European Space Agency (ESA) conducted a study on the value of weather prognoses with respect to winter road maintenance in Sweden. This study was carried out in an area in southern Sweden where it had been shown that a snowstorm costs society an average of SEK 11 million.

Through charting weather systems, anticipating the ensuing road conditions and taking the appropriate action, all with the assistance of our RWIS, we at the SNRA were able to save SEK 700,000 in this particular geographical area. Relevant SMHI weather prognoses helped us save an additional SEK 500,000 per snowfall.

If this experience in southern Sweden concerning snowfalls is used as a basis for estimating the cost benefit to the country as a whole, it is estimated that taking advantage of the meteorological information obtained from RWIS and SMHI would result in an annual saving of SEK 860 million. (Reference: Professor Allan Murphy, Bramshill Consultancy Limited, USA 1994).

No cost benefit analysis has been conducted for icy road conditions, making it difficult to calculate savings within this area. However, through providing maintenance staff with road weather information, the RWIS facilitates the potential for preventive salting, which benefits road-users. This prevention of treacherous slippery road conditions leads to fewer accidents, better accessibility and less salt

consumption, which is environmentally advantageous. Less salt means less vehicle corrosion and is less detrimental to watercourses and vegetation.

Other applications of RWIS

From the very outset, the information retrieved from the road weather system has been used to inform road-users about prevalent conditions within the road network. The presentation technique has been steadily improved, and today, road-users can call the SNRA central or regional traffic information centres to learn about the up-to-the-minute status of the road network. It is also possible to visit the SNRA home page on the Internet to seek the road and road weather information that could be of assistance when planning a journey.

The system is also used to inform road-users about road works, such as where pavement works are in progress or where roads have been closed to traffic. Road weather information is also sent several times a day to those contractors carrying out such road works.

Transport companies' queries concerning the best route for different types of transports are also answered with the help of the RWIS presentation.

It is also quite possible to use the RWIS for all kind of data-collection such as information from environmental-sensors, sensors for vehicle control, sensors for traffic flow variations etc.

In Sweden, basically all maintenance and operation works are contracted through competitive bidding, meaning road maintenance as well. This entails the examination of different remuneration models in order to be able to pay contractors for their work according to the requirements specified in the contracts negotiated. The payment schedule represents another area in which RWIS plays an important part due to the fact that the number of icy road occasions is information that can be retrieved from the system. As regards precipitation, the "Optic Eye" precipitation meter provides information about the type and amount of precipitation that has occurred. This information is currently used in connection with contractor remuneration.

The RWIS world situation

Today there are different road weather information systems in approximately 25 countries, with some 3000 stations having been installed. These systems are being developed all the time. Many of those countries where a RWIS still has not been implemented have come quite far along in their plans for either buying, or possibly developing, their own national system. There are currently about 20 RWIS suppliers who sell their own systems – and their ranks are constantly expanding.

What I see as most promising about the development of road weather information systems is the growth in the number of users. The information that the systems can offer to different elements in society, and to those of us who use the road transport system as a means of transportation, can be vital. Choosing the right route, cancelling a proposed journey, leaving earlier or later are examples of decisions that could mean avoiding major problems. I therefore firmly believe that the future for RWIS information lies with all road-user categories that benefit from the road transportation system and not only with us winter road managers. By making the right decision, we can all contribute to reducing the risk of weather-related accidents by keeping well informed about the road weather conditions and other information about the most recent situation within the road network.