INCA-CE Newsletter • Issue no. 2 • March 2011

Weather?

INCA-CE strives to improve European Road Safety

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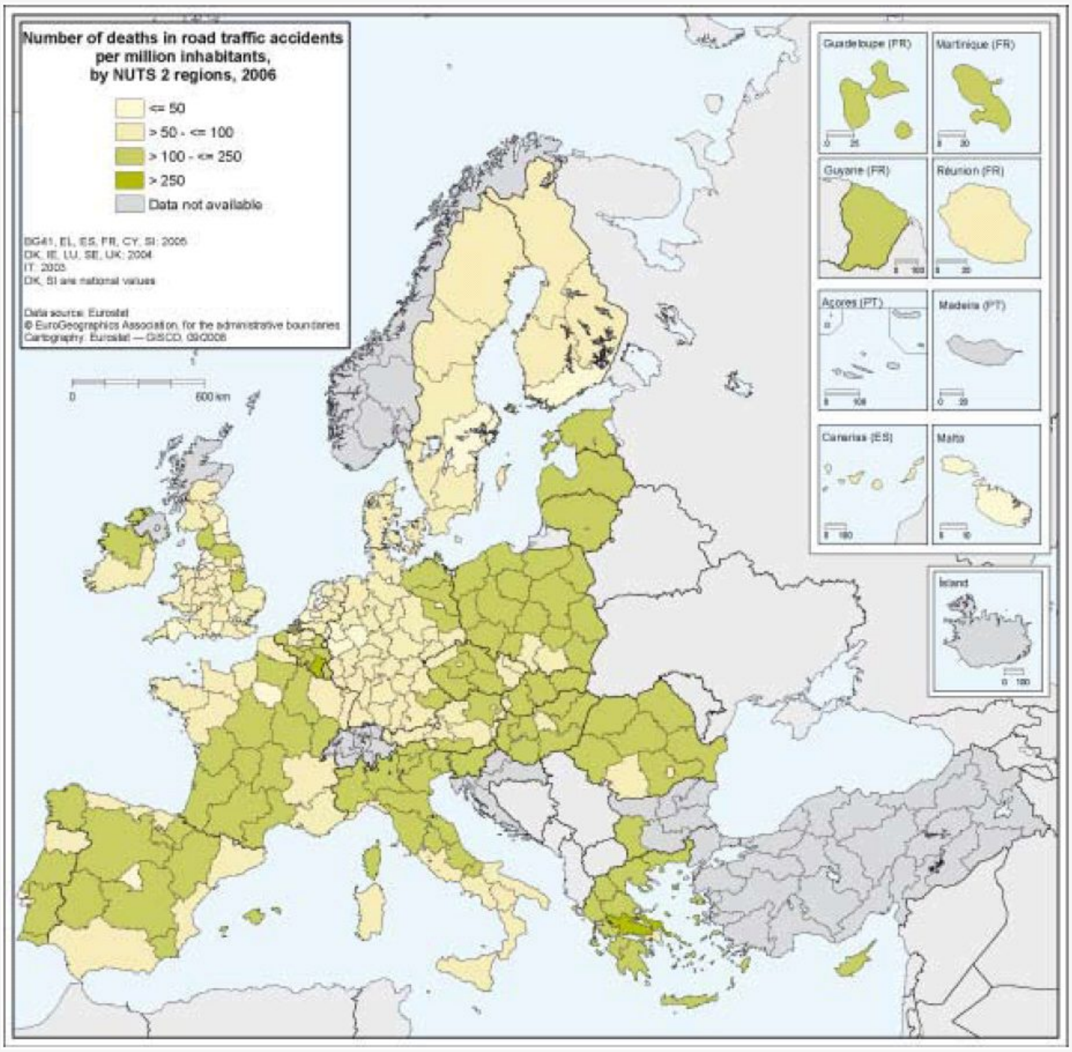
European Road Safety and INCA-CE

One of the goals of the INCA-CE project is to improve the safety and cost-efficiency of weather-sensitive activities. Three transregional working groups have been established, one of which is focusing on scientific and processual improvements in road safety.

The following lines are intended to briefly summarize some of the anticipated project activities as well as general road safety issues and their link to the INCA-CE project.

When looking at common statistics on European road safety, one quickly realizes that most of them include all kinds of critical incidents and do not necessarily focus on weather related accidents. According to the European Commission's Eurostat database (http://ec.europa.eu, http://epp.eurostat.ec.europa.eu), road mobility in the EU still comes at a high price in terms of lives lost. Although it has been possible to reduce the total road death toll by 44 % between 1991 and 2006, about 43,000 people died in road accidents in the EU in 2006. However, there is a strong regional variation in the risk of getting involved in some kind of road accident, as can be seen from Figure 1.



Number of deaths in road traffic accidents per million inhabitants in 2006 (Source: http://epp.eurostat.ec.europa.eu).

According to the EC's CARE (Community Database on Accidents on the Roads in Europe) information platform, some recent absolute numbers for the INCA-CE partner countries are: the Czech Republic (901 fatalities per year), Germany (4,477), Italy (4,731), Hungary (822), Austria (633), Poland (4,572), Slovenia (171) and the Slovak Republic (384).

EU-wide, the lowest recorded relative numbers of road fatalities per million inhabitants are reported in the Netherlands (45), Switzerland (50), Germany (63 nationally - the regions in the west of Germany show a lower rate than those in the east), Sweden (49) and Norway (53). As for the major conurbations, the relative number of fatal road accidents at regional level is comparably low (Vienna (20 fatalities per million inhabitants), Berlin (22), Stockholm (31), Madrid (47) and Prague (58).

Nevertheless, the fatality rates in the more rural areas surrounding these cities are always significantly higher. The highest rates of road deaths are to be found in the eastern and south-eastern member states. Lithuania has the highest fatality rate (223 fatalities per million inhabitants), followed by Latvia (177), Estonia (164), Greece (159), Slovenia (140), Poland (137), Slovakia (130), Bulgaria (124) and Romania (115). Given the still lower level of vehicle ownership in most of these countries, the reasons behind these high values — compared to Western Europe — can probably be found in the quality of infrastructure supply and a less-developed awareness of road safety issues in some of these countries.

Together with factors like motorway density, vehicle safety standards, speed regulations and a general 'safety culture', the quality of the emergency and health systems, the proportion of public, bicycle or pedestrian traffic and physical geography might be other reasons for the differences in per-inhabitant fatality levels. Driving in mountainous regions like the Alps is probably more dangerous than in flat areas and, therefore, leads to an increased number of accidents and fatalities. In addition, these regions attract a high volume of tourist traffic, thus increasing local traffic and hence the number of reported accidents per inhabitant.

The influence of weather on the road safety is not directly derivable from those statistics. However, there is no doubt that weather conditions determine road conditions and influence the driver's behaviour. According to the Dutch National Road Safety Institute (SWOV), this influence is strongest for the conditions of precipitation (including snow and hail), fog, low sun, wind, ice forming, and hot temperatures. In a fact sheet, the SWOV summarizes the consequences of various types of weather events as follows:

Precipitation

- Motorists overtake less, drive slower and increase their following distance during showers. However, changes in driving behaviour are insufficient to compensate for the greater risk.
- Visibility can be reduced to approximately 50 meters during heavy rain or snow, and in thick fog. Clouded windows and windscreens as a result of high humidity during rain can also reduce visibility.
- Blinding can occur at night because the headlights of oncoming vehicles reflect in the water on the road surface.
- The more rain, snow, or hail falls, the less the friction of the road surface. Rain can lead to dynamic aquaplaning.
- When it has been dry for a long time, a drizzle can lead to viscous aquaplaning if drops of oil and dust, together with water, produce a thin liquid film on the road surface.

Claude Monet, Snow-Covered Road at Honfleur (1867); Source: www.wallpapers-free.co.uk. (40300 other hits on the internet...)

Fog

- Reduction in visibility because the light is diffused by fog droplets.
- People generally drive somewhat slower, but simultaneously keep a shorter following distance to the vehicle in front of them, which, in combination with the decreased field of vision, increases the risk of crashes.
- Fog can also cause viscous aquaplaning when water droplets provide a thin film on the road surface.

Wind

- Gusts of wind can push relatively high vehicles such as busses, delivery vans, camper vans, caravans, and lorries off the course and, under extreme conditions, can even cause them to roll over. This happens mainly on bridges and viaducts.
- Objects carried by the wind, fallen trees, and broken-off branches can also cause traffic disturbance.

Ice forming

- If a road surface has an open structure, such as porous asphalt, wet parts of the road surface will freeze quicker than surfaces with a closed structure.
- When there is black ice, a thin layer of ice forms so quickly on porous asphalt that it looses its friction.
- Roads that have just been laid also have a greater risk of slipperiness: the layer of black bitumen has a lower temperature and is thus more sensitive to wet parts freezing.

According to the SWOV, a recent study of the relation between weather and road crashes on Dutch national state roads showed that there was an increase in the

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number of accidents of between 25% and 182% when it rained. Ice forming on the road surface even led to an increase of between 77% and 245%. However, ice forming is far less frequent than rain, and thus has a smaller impact on the total number of crashes.

The main focus in the INCA-CE project has been laid on road safety issues connected to precipitation events. As for the Austrian road management authorities, high resolution INCA analyses and forecasts of precipitation intensity and type and other crucial parameters like temperature are already produced and submitted in real time. Nevertheless, there are improvements that should be made. Amongst others, these improvements include:

- optimizing the nowcasting range;
- optimized cell tracking algorithms for precipitation nowcasting;
- enhancing the reliability of consecutive analyses and forecasts;
- including cell life cycle into nowcasting algorithm: initiation, intensification, and weakening;
- refinement of the surface temperature;
- development of a separate module for the estimation of fog and visibility.

Special attention and testing will be performed for the INCA surface temperature forecast. Assessment of using this INCA parameter for the purposes of road winter service on road sections where special road model is not applied will be introduced.

References:

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php

http://ec.europa.eu/transport/road_safety/specialist/statistics/index_en.htm

http://www.swov.nl/rapport/Factsheets/UK/FS_Influence_of_weather.pdf

Foto: Andrej Beden, CGS plus

Winter Road Maintenance

Road travel has become an essential component of daily life for many people throughout the world. The presence of adverse weather conditions, most notably during the winter, has a dramatic effect on road safety and delays. The winter climate in many countries necessitates significant investment for the prediction and subsequent prevention of snow and ice formation on highways. The total annual global expenditure on the winter maintenance of roads is about €10 billion. The benefits of winter maintenance have been estimated to be about eight times the cost.

Efficient ice control and snow removal are two basic challenges to road winter services. There are two main approaches towards ice control; known as anti-icing (precautionary or pre-salting) and de-icing. Anti-icing involves the application of chemicals to the road in order to prevent forming and developing the bond between the ice and road surface. By contrast, de-icing is an after-the-event action that involves spreading salt or other chemicals onto the road to break the bond of already bonded ice and snow, i.e. to melt the existing ice and snow.

Pre-salting technique is becoming increasingly popular from the economical and environmental points of view. Studies have shown that it should take place not more than 1–2 hours before snowfall. Smaller amount of salt (5–10 g/m²) is usually applied compared to the de-icing technique. In case of a big snowfall, a snowless roadway is not possible. A small amount of salt stops the freezing of snow on the road surface and allows easier snow removal with snow plough in the next circulation. A good short-term weather forecast (nowcast) is needed for efficient pre-salting.

Dry and wet salt and brine are generally spread on roads that must be fully cleared of snow and ice due to a high volume of traffic. Managers faced with major snowfalls or long cold periods also use abrasives (sand or a mix of sand and salt) on mountain and rural roads. Sodium chloride (NaCl - rock salt, sea salt, evaporated salt and brine) remains the basic de-icing product, probably due to its high level of cost effectiveness. Calcium chloride (solid or brine) and magnesium chloride are used less, usually to dampen the sodium chloride, among other things.

Studies have shown that salt-spreading has significantly lower environmental emissions than gritting of roads with average daily traffic of more than 3,000 vehicles. Therefore, grit is regularly used on low traffic roads and salt is used on roads with high traffic. In addition, the risk of an accident on gritting-routes with higher traffic volumes is higher than on salting-routes. From the environmental point of view, wet-salt technology is preferred to dry salt.

For efficient road winter maintenance, most current weather information and weather forecasts are essential (i.e. time and duration of precipitation, amount of snow, freezing drizzle, fog). A crucial factor affecting road condition is the road surface temperature. You can read more about this in the next article.

References:

Snow and Ice Databook 2010 (PIARC): http://publications.piarc.org/en/search/detail.htm?publication=6904

A Guide to Road Weather Systems (SIRWEC): http://www.sirwec.org/documents/rwis_web_guide.pdf

Observation of Current Weather and Road Surface Conditions

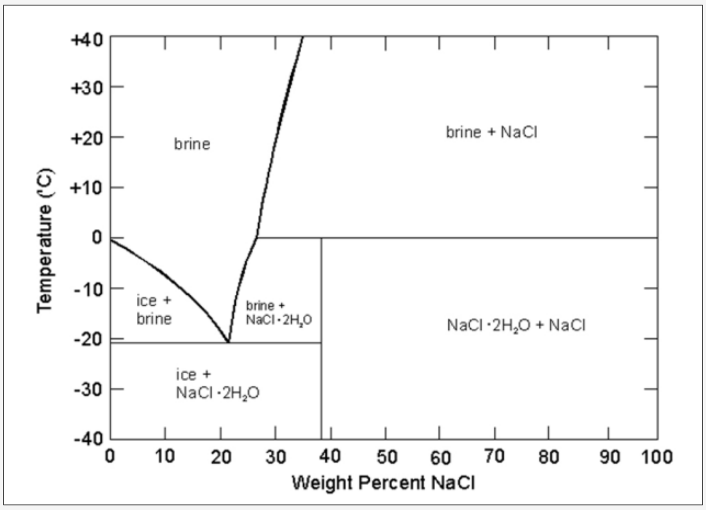
Weather information is important in supporting a variety of winter maintenance operations; however, more detailed weather information, such as road surface temperature and condition, is needed to support anti-icing and ploughing/de-icing operations. For this purpose, road weather information systems (RWIS) were developed and are nowadays a critical component of winter maintenance decision-making.


Foto: CGS plus

A component of the RWIS that collects weather data and makes observation of the current weather and road surface conditions is a road weather station (RWS). The most important RWS sensor is the so-called road sensor, which measures surface temperature, sub-surface temperature, surface condition (dry, wet, frozen), the thickness of water film, the amount of de-icing chemical on the road (salt concentration) and the freezing temperature of the road surface.

A common approach used in road surface sensors is monitoring of road surface conductivity, which changes as road surface conditions change. Where anti- or de-icing chemicals are used, surface conductivity is also an indication of the concentration of chemicals on the road. This is a vital information, since the presence and concentration (known as residual salinity) affects the actual freezing temperature of the road surface.

Other possibility is to use non-intrusive technology - remote sensors which use infra-red, microwave radar or laser techniques by either mounting the sensor above the road or by bouncing a signal across a road from a transmitter to a receiver. The spectroscopic measuring principle enables accurate measurement of the surface state, thickness of moisture, and grip or road friction. Water and ice are measured



Source: A Guide to Road Weather Systems (SIRWEC)

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independently of each other, enabling sensor to accurately report the surface state.

RWS are generally equipped also with meteorological sensors for measuring the air temperature and relative air humidity, precipitation, solar radiation, wind speed and direction and the depth of snow cover, and with digital cameras.

All collected data are transferred to control centre using state of the art telecommunications technology (GSM/GPRS/3G, land line or optic data transfer). In some rural area, where even mobile network is not perfect, online data transfer is a challenge.

Road Weather Information Systems (RWIS)

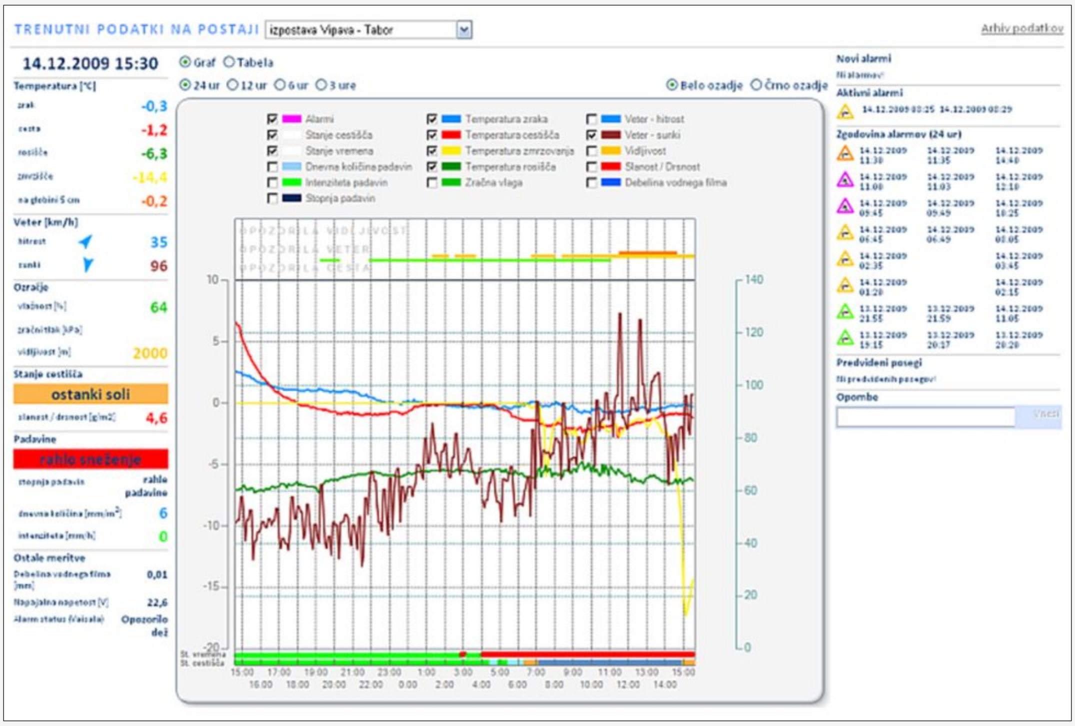
Starting in the 1990s, several countries in Europe have deployed weather information gathering systems nationwide to assist snow and ice control managers in making sensible salting decisions.

The purpose of road weather information systems (RWIS) is to assimilate the influence of the meteorological and road data to develop a picture of how road surface temperature changes at a given site. The actual data from the local climate and roads can be incorporated into road weather models to forecast the road conditions.

The RWIS comprises RWS in the field, a communication system for data transfer, and central systems to collect field data from numerous RWS. From the RWS logger, the measurements are transferred by different telecommunication technologies to the central database of the RWIS, which is usually a web-based application offering various displays of current weather conditions at RWS locations, displays of the archived data and the metadata on stations and sensors. The application can also trigger alarms. Although real-time weather information is important, the greatest benefits of RWIS are accrued through the use of tailored forecasts, such as those aimed at supporting maintenance operations.

The most common approach to forecasting road conditions is the energy-balance model based on a one-dimensional diffusion equation. Physical models can predict the road surface temperature, which is the most important parameter for determining the state of a road surface (i.e. dry, wet, ice, snow). Sometimes such models show a high degree of error at sites where the environmental conditions are too complicated to be simulated correctly. To solve this problem, physical models can be combined with statistical approaches or neural networks. An accurate prediction of road weather conditions is important in cutting the winter road maintenance costs, reducing the environmental damage from over-salting and providing safer roads.

Data gathered from the RWIS is used for monitoring and planning operations such as personnel scheduling, selecting the roadway control materials and deploying the equipment as cost-effectively as possible (the so-called Maintenance Decision



Detailed overview of events at a chosen Road Weather Station. (Source: DARS d.d., Slovenia)

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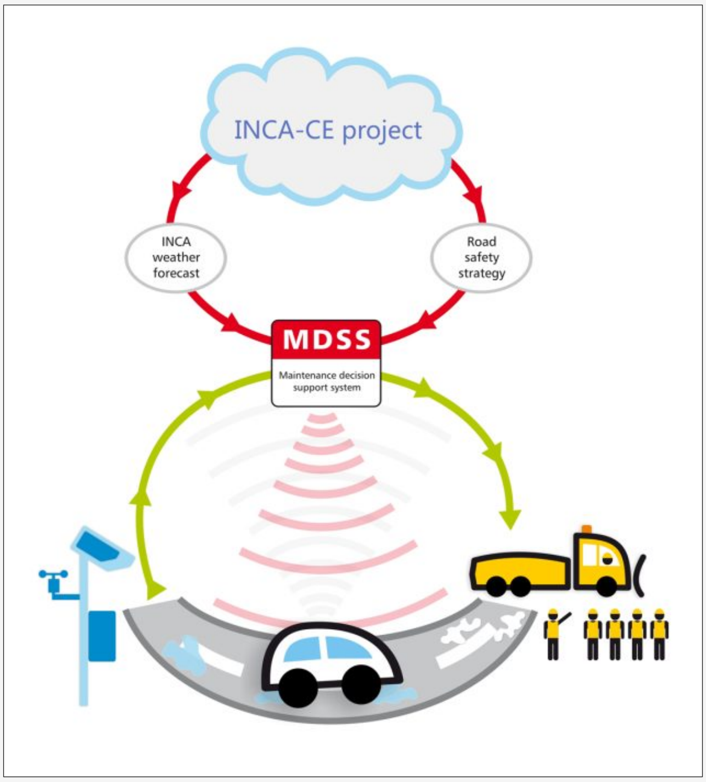
Support Systems – MDSS). With advances of technology in surface transportation, environmental data is now being disseminated to a wide range of transportation users and operators, including the travelling public, traffic managers, incident management teams and emergency response personnel.

And how will the road sector benefit from the INCA-CE project?

Improved INCA forecast will provide a high resolution (1km) and a very short-range (nowcasting range of up to +4 h) weather forecast. The improvement of weather information accuracy is critical to achieving safety on roads and more savings in winter maintenance. A road safety strategy will be set up in accordance with the needs and priorities of the meteorological information in road maintenance service.



INCA-CE and Road Safety

One of the important tasks of the INCA-CE project is to prepare a transregional strategy for the use of nowcasting data in road safety. For this purpose, the Road Safety Group prepared a questionnaire for each INCA-CE country. Not every country responded completely but the answers received were quite informative and provided a satisfactory picture of the current situation and the needs for systems and nowcasts to provide safer roads.

The answers show that the organisation of winter road maintenance is typically level-based. For example, in Hungary there is a two-level organisation (state and local roads). Slovenia has three levels, Slovakia four, and Germany four. In Austria, roads are administrated by regions. Dissemination of the road weather information is provided by media (internet, radio, television) and on electronic boards on roads. However, the type and amount of information varies considerably by countries.

All countries have established a network of road weather stations (RWS). According to the questionnaire, the approximate numbers of RWSs are: Germany 1,000, Austria 370, Hungary 360, the Czech Republic 310, Slovakia 130, and Slovenia 100. In general, the RWS measurements are provided through road weather information systems (RWIS). In addition to the current and historical RWS data, the RWIS also shows weather forecast and road forecast (road surface temperature and state), provided by meteorological agencies and special physical models (i.e. IceBreak, METRo), respectively.

According to the questionnaire there are only pilot implementations of the Maintenance Decision Support Systems – MDSS (i.e. in the Czech Republic). Expectations of such advanced systems are described below.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MDSS requirements expressed in the INCA-CE questionnaire

General:

- web-based and mobile application;
- flexible integration with existing systems;
- customizable presentation of desired information;
- SMS alerts for user-defined parameters and areas;
- also suitable for the road network without road weather stations.

Weather:

- accurate and reliable short-term forecast (high event probability $\approx$90%);
- high time resolution ($\approx$15 minutes) and spatial resolution (5 km and less for diverse topography);
- meteorological radar image with road network map (without blind spot – i.e. in valleys);
- infrared satellite image with a road network map;
- forecasts for: air temperature, dewpoint, wind, cloudiness, precipitation (type and amount with the probability);
- detailed forecasts for special events: freezing drizzle, snowfall, drifting snow, wind gusts, fog.

Road:

- current and historical data of road and weather parameters measured on RWS;
- road weather forecast:
- based on a special prediction model,
- point (on the location of the RWS) and route based (on the whole road network),
- prediction of the road surface temperature and road surface condition (also with slippery road surface probability, amount of snow on the road).

Maintenance:

- warnings for severe forecasts on the road network: ice, frost, heavy rain and snowfall, wind gusts, fog (coloured road network map in accordance with the level and type of hazard);
- automated maintenance vehicle location reporting with route optimisation;
- route-specific road treatment recommendations with the selection of de-icing/anti-icing chemicals;
- "what-if" analysis for different road maintenance scenarios.

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Extreme Weather Events in Winter 2010-2011

Slovenia

Chain Collision on the Dolenjska Motorway on 27 November 2010

On 27 November 2010, a most horrible traffic accident occurred on the Dolenjska motorway in Slovenia. There was a chain collision involving 36 vehicles. Three people died.

In between two weather fronts there was an intermediate clearing up period that intensified radiation cooling and local fog formation. In some areas there were very thick mists bands present where the visibility dropped rapidly on very short distances and that was one of the main reasons for the accident of such extend.

Source: www.siol.net (Slovenia)

Poland

Two persons killed in a motorway accident near Gliwice on 4 January 2011

On 4 January 2011, in the area of Gliwice (South Poland), dense fog caused a multiple motorway accident. According to the police sources, the series of accidents started when a TIR truck entered a foggy area and started to slow down due to reduced and glazed road surface. Other cars hit the rear of the long vehicle, in total 42 on both lines. A deadly combination of glaze and fog, which is often recorded in this area, took the lives of two people.

The weather forecast for the 4th of January said that the region of Slask Voiwodship laid in the area of high atmospheric pressure, in a cold air mass of arctic origin. Normal road conditions would be strained due to the drop in temperature to -10° C during the night, while during the day, the temperature would increase close to 0° C. Low clouds covering the sky would break during the day.

None of the available numeric models predicted fog and ice at that time. The satellite data sources could not provide appropriate information because of densely overcast sky. Such an event proves that numerical prediction tools like the INCA model are urgently needed.

Motorway accident near Gliwice on 4 January 2011 (Poland)

Italy

A very rare situation in the Friuli Venezia Giulia region on 17 December 2010

On 17 December 2010, a cold front from the North-Atlantic crossed the Friuli Venezia Giulia (FVG) region. Snow started to fall during the afternoon also on the plain and the coastal parts, while during the night, the snowfall become more intense, in particular in the eastern part and in the mountains.

Friuli Venezia Giulia region on 17 December 2010 (Italy)

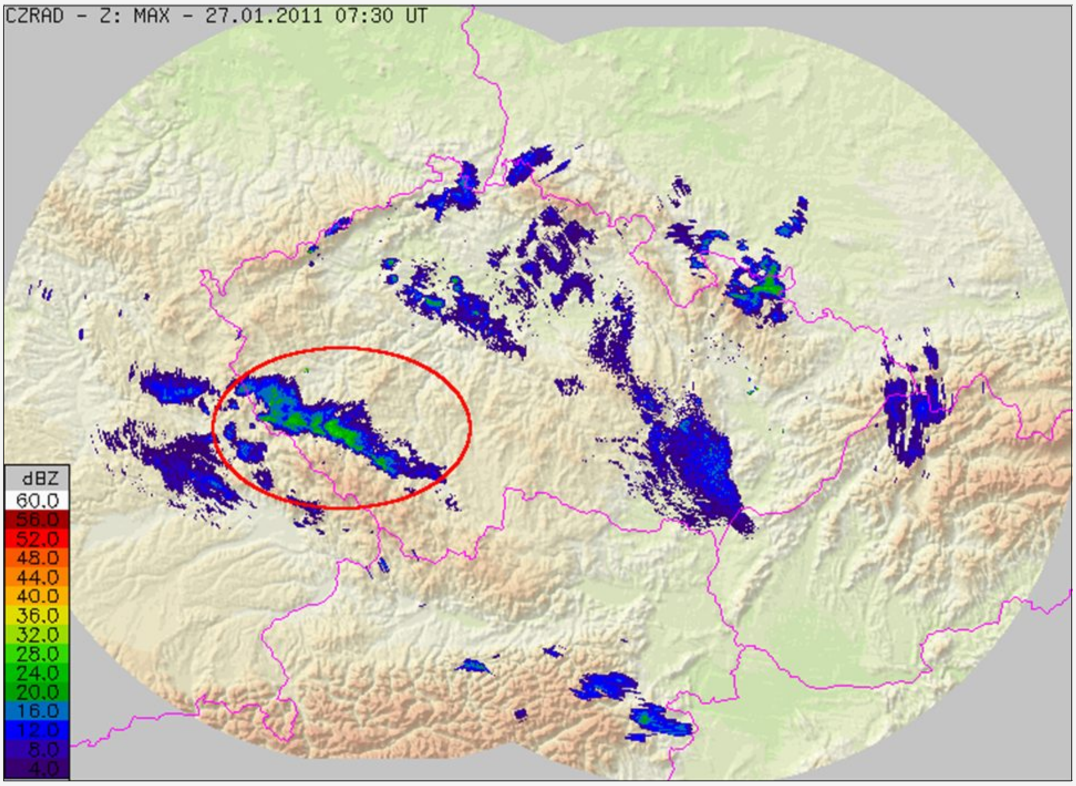
The snow was very cold and dry and it did not melt on the ground. At the end of the event, there were up to 20 cm of snow, while in the mountains there were no more than 10 cm.

The sequence of events (cold period since 13 December, snowfall on the plain and frost during the following night) was exactly the same as a year before, in December 2009, which is a very rare situation in the FVG region.

Czech Republic

Interesting snow event in the Šumava mountain range on 27 January 2011

In morning hours of 27 January 2011, an interesting situation occurred on the foothills of the Šumava



Radar Image of the Šumava mountain range (Czech Republic)

mountain range (see the radar image). The situation was characterized by a moist, easterly to northeasterly wind of up to 700 hPa with moist adiabatic lapse rates in this layer per 06 UTC rawinsonde data from Kuemmersbruck. As a result of low-topped convection, a mesoscale band of moderate to heavy snow formed, lasting more than two hours and delivering 5 to 25cm of fresh snow in only two hours. Unforeseen by numerical weather prediction models, this was an unpleasant surprise to drivers, the road-maintenance service and the forecasters of the Czech Hydrometeorological Institute.

Austria

Snowfall in Lower Austria on 14 and 15 December 2010

The maximum snowfall in high mountain regions of the south-west-Lower Austria was 40cm and there was about 25 cm of snow in the "Waldviertel" region in the north-west-part of Lower Austria.

There were also high snow drifts in some sections with the height of up to 70 cm.

On that day, about 4,000 tons of salt and 6,500 tons of grit were needed for gritting.

Snowfall in Lower Austria on 14 and 15 December 2010 (C) *NÖ Straßendienst*

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Trucks required chains at more than 20 locations.

The temperature was very low (down to -11°C) and it was difficult to clean the roads.

Hungary

Car accident at Kiskorpád on 24 January 2011

During the 2010/2011 winter in Hungary, severe weather was mostly caused by large-scale cyclones and well expressed frontal systems (as was the snowfall accompanied by strong wind on 25/26 December 2010).

Besides, several cases of light to moderate snowfall were related to small scale and shallow precipitation bands, which are usually difficult to forecast (but also important from the road safety point of view). An example of a road accident in such situations occurred at Kiskorpád (southwest Hungary) on 24 January 2011, which could have been influenced by the meteorological conditions (snow and slippery road surface). This was also indicated by the temperature and precipitation forecasts of the numerical model WRF (the model predicted a possibility of weak snowfall during the night time and melting of snow prior to the accident). However, the precision of the spatial distribution of the forecasted precipitation, which is crucial for road safety, could be further improved by the INCA system during the nowcasting period (0-2 hour forecasts).

Car accident at Kiskorpád on 24 January 2011 (Hungary)

Project Outlook

In the next few months, first pilot systems will be installed in all partner countries which will include nowcasting products and applications in road safety, hydrology and civil protection. These systems are elaborated together with the partners and stakeholders from road management services, hydrological and civil protection agencies.

Moreover, a web portal will be set up to serve as a data dissemination platform for meteorological products. The partners from the application side as well as the general public will have access to relevant nowcasting information.

Upcoming Events

Progress Meeting 2: PM2 will be held from 4 to 6 May 2011 in Kutna Hora (CZ) and hosted by CHMI (PP4).

EGU 2011: Two INCA-CE contributions are scheduled for the European Geophysical Union general assembly from 4 to 8 April 2011 in Vienna (AT).

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Past Events

Progress Meeting 1

PM1 was hosted by the Fraunhofer Institute IOSB (PP16) in Karlsruhe, Germany from 2 to 4 November 2010. The project partners presented their work during the project's start up phase and discussed the ongoing and future actions. Specifically, the WP3 (Transregional strategy development) and WP4 (Refinement of nowcasting system INCA) were the key points as the actions therein play a central role in the current stage of the project.

Progress Meeting 1 (Photo: IOSB)

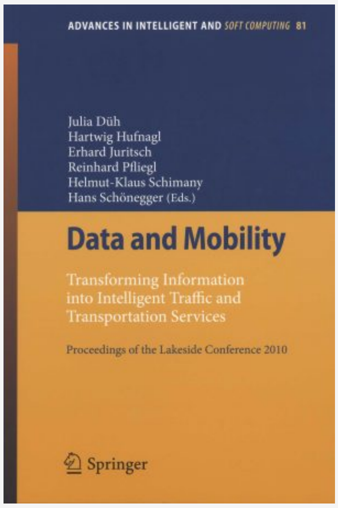
10th Slovenian Road and Transportation Congress

The Road and Transportation Research Association of Slovenia organised its jubilee, 10th Road and Transportation Congress in the congress centre of the Grand Hotel Bernardin at Portorož in October 2010. The INCA-CE project introduced its 'ROAD exhibition' to the audience of more than 500 participants from Slovenia and eight other EU countries.

INCA-CE project presented at 10th Slovenian Road and Transportation Congress in Portorož (Photo: CGS plus d.o.o.)

The Lakeside Conference

The 3rd Lakeside Conference took place in Villach, Austria from 6 to 8 October 2010 with the theme: "Data and Mobility" – transforming information into intelligent traffic and transportation services. Besides technical issues on information technology, road weather information and short-term forecast systems were presented. A presentation of INCA-CE with a focus on road safety was given, which resulted in an article published in the conference proceedings "Data and Mobility", which can be downloaded from www.inca-ce.eu.



Project Identity Card:

Title: INCA-CE — Integrated Nowcasting System for the Central European Area
Acronym: INCA-CE
Programme: Central Europe
Duration: 1 April 2010 – 30 September 2013 (42 months)
Partnership: 16 partners from 8 Central European countries
Lead Partner: Central Institute for Meteorology and Geodynamics (ZAMG)
Webpage: http://www.inca-ce.eu/

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