

## Experimental service for high-resolution slipperiness risk forecasts in Finland

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### ABSTRACT

In February-April 2007, an experimental high-resolution road weather service called “Kelipilotti” was implemented between the cities of Turku and Pori in south-western Finland. The 140 km long route was divided into 11 smaller road stretches, for which the service generated once per hour detailed local forecasts of various weather parameters and slipperiness risks. The forecasts were shown for road users through the Finnish Road Administration’s public traffic information Internet service. This report analyses the functionality of the service, its ability to forecast slipperiness in various weather situations, and reviews the response from the users. In conclusion, the pilot service worked relatively well compared to the objectives set for the system. Second test period will run through winter 2007-2008.

**Keywords:** weather forecast, road conditions, slipperiness risk

### 1. INTRODUCTION

Weather and road condition forecasts for road users have traditionally been regional and not very detailed in time. The increasing use of Internet and mobile phones has also changed the delivery of these services. For the last few years in Finland, the on-line Internet service of the Finnish Road Administration FinnRA ([www.tiehallinto.fi/alk](http://www.tiehallinto.fi/alk)) has contained a six-hourly road condition forecast, which shows the situation on main roads and contains warnings for poor road conditions.

Due to rapid development of very-high-resolution weather forecasting models, it is now feasible to test much more accurate road condition forecasts and warnings. These can be generated for road stretches with spatial resolution of about 10 km, and temporal resolution of 1-2 hours. A test service was developed by the Finnish Road Administration and Foreca Ltd in autumn 2006. Service was called “Kelipilotti” (road weather pilot) and implemented on eleven road stretches on Main road 8 between Turku and Pori, some 140 kilometers apart. This road was chosen because it is known to have rapid changes in road conditions mainly due to its coastal position.

### 2. IMPLEMENTATION OF THE PILOT

Foreca Ltd is responsible for nationwide road weather services in Finland, which are delivered via FinnRA for road maintenance and other professional users. Road Weather Pilot forecasts were based on Foreca’s operational nationwide road weather service products, in particular on its very-high-resolution weather model. Road condition schemes used were developed during the national FITS programme in 2002-2003. System calculated every hour basic weather parameters (air temperature, road temperature, weather symbol, wind speed and direction) and any of the following four types of slipperiness warnings, if a pre-defined risk limit was exceeded: Risk for slipperiness due to hoar frost, snow fall, wet road surface freezing, or rain freezing to the cold road surface.

The web user interface was developed utilizing Flash/XML techniques. User received detailed forecasts and warnings in colour codes when rolling the mouse over the map of Main road 8. User interface included a help menu and a notice that no maintenance actions were taken into consideration when calculating the warnings. Thus the service showed such warnings that were valid if no maintenance was performed at all. A simple mobile version in text format was also developed.

Service was available and functioned technically well from 8<sup>th</sup> February to 30<sup>th</sup> April, 2007. Due to very good user feedback, service was opened again for the next winter season from November 2007 to April 2008.

Figure 1 shows the user interface of the Pilot. When a user first opens the web page, he sees a map of South-Western Finland and the Main road 8 from Turku to Pori, divided into 11 stretches. If the forecast is indicating

risk for slipperiness for any of the road stretches during the next 6 hours, the corresponding stretch is red with the common traffic warning symbol for slipperiness. If no risk is expected, the stretch is grey.

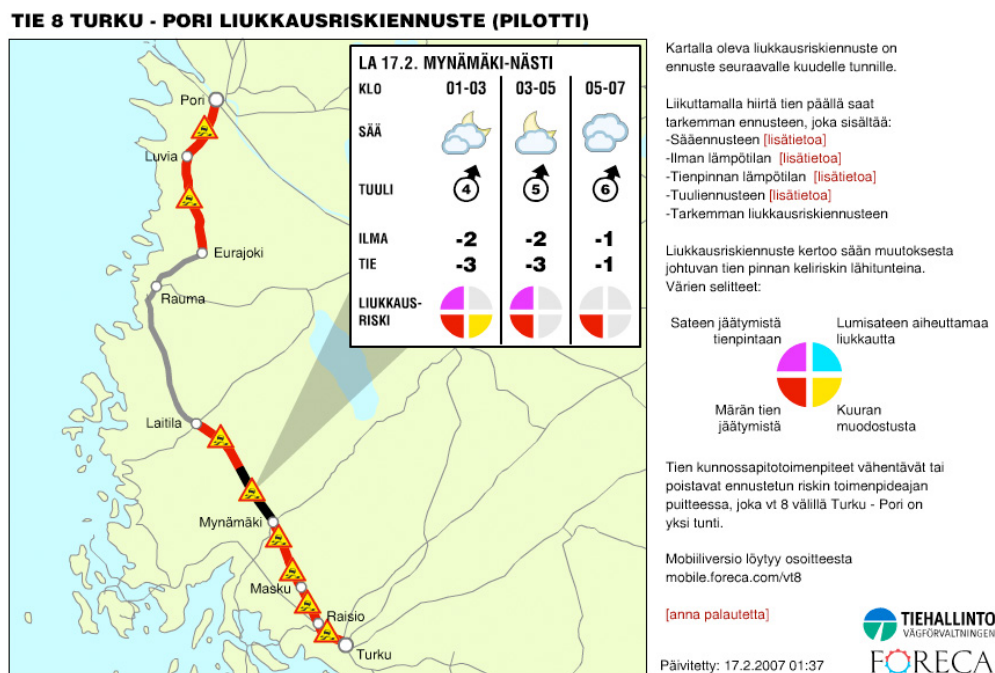


Fig. 1. User interface for the Road Weather Pilot. Road stretches with risk for slipperiness are indicated with red colour and the warning symbol.

Scrolling the mouse over the road, a pop-up window is generated on the upper-right corner with a detailed weather and road condition forecast for the corresponding road stretch:

- The issuing time of the forecast and the road stretch
- The three two-hourly time intervals when the forecast is valid
- Weather type shown with a symbol
- Wind direction and speed (m/s)
- Air and road surface temperature
- Slipperiness risk indicated with a colour code

The four classes and corresponding colour codes for slipperiness risk are:

- Rain freezing on the road surface (violet)
- Slipperiness due to snowfall (blue-green)
- Wet road surface freezing (red)
- Hoar frost (yellow)

The service had also help links with additional information, and a feed-back link. Road maintenance actions were not taken into account, and thus the services indicated the worst scenario what would be the case without any road maintenance. This was indicated to the users.

### 3. WEATHER SITUATIONS AND FORECAST ACCURACY

Weather was not very cooperative for the test period because there were very few really bad road condition situations and the spring season started early. Nevertheless, interesting cases were found and analysed. Two cold spells with  $-20$  degrees temperatures did occur in February, in March the temperature was generally over zero and in April it was already full spring time, as can be seen in Fig. 2 temperature observations from Turku and Pori during the pilot test.

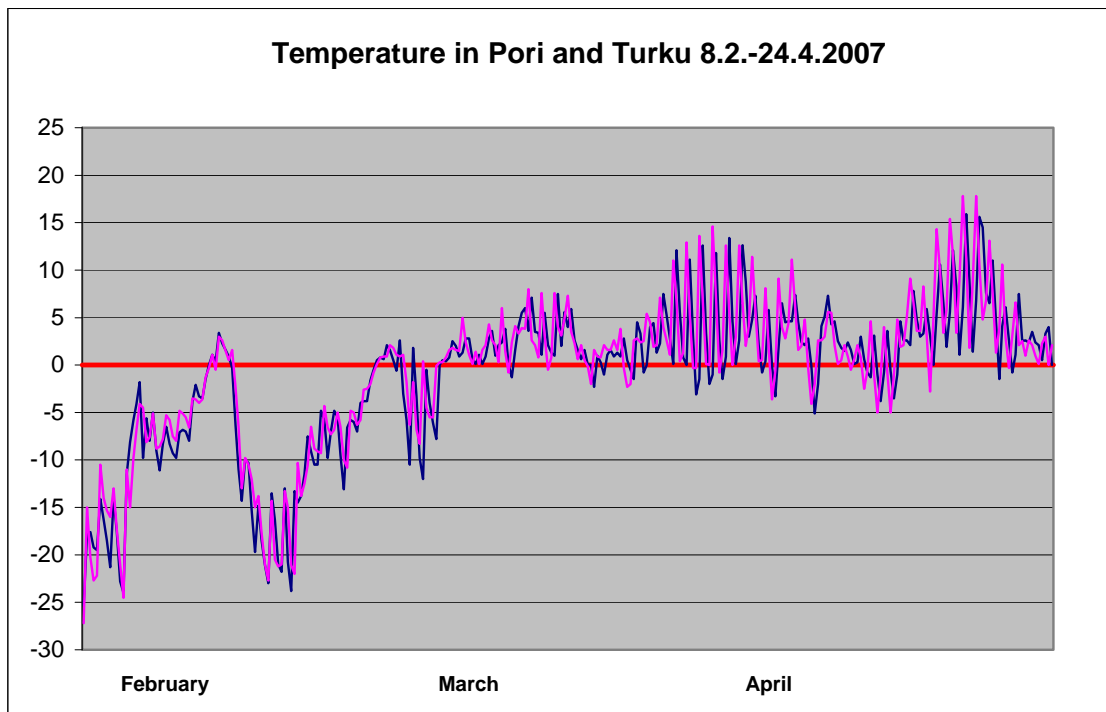


Fig. 2 Observed air temperature in Turku and Pori during the pilot.

For each of the eleven road stretches, altogether 5904 forecasts of 0-2, 2-4 or 4-6 hours ahead were made, which makes the total of about 65000 forecasts. Table 1 shows some statistics of these forecasts. Mean temperatures show that the climate gets noticeably colder towards north even though the distance from Turku to Pori is only about 140 km. The risk for hoar frost is largest on the two northernmost stretches 10 and 11. The most northern Luvia-Pori stretch had more than 10% of forecasts with a hoar frost warning. Stretch number 5 had also an elevated slipperiness risk. We can conclude that there are distinct differences between the stretches even in this very dense 10 km spatial resolution, and thus the pilot service model is considered valid.

Table 1. Average temperature and warning amounts for each road stretch.

Road stretch	Mean air temp	Mean road temp	Hoar frost risk	Snow fall	Wet road freezing	Freezing rain	Hoar frost risk	Snow fall	Wet road freezing	Freezing rain
	°C	°C	#	#	#	#	%	%	%	%
1 Turku-Raisio	-0,54	0,71	418	444	197	3	7,08 %	7,52 %	3,34 %	0,05 %
2 Raisio-Masku	-0,54	0,54	419	457	191	0	7,10 %	7,74 %	3,24 %	0,00 %
3 Masku-Kaitarainen	-0,53	0,61	397	453	168	0	6,72 %	7,67 %	2,85 %	0,00 %
4 Kaitarainen-Mynämäki	-0,49	0,8	370	467	181	0	6,27 %	7,91 %	3,07 %	0,00 %
5 Mynämäki-Nästi	-0,53	0,74	515	511	288	9	8,72 %	8,66 %	4,88 %	0,15 %
6 Nästi-Laitila	-0,67	0,99	416	462	231	2	7,05 %	7,83 %	3,91 %	0,03 %
7 Laitila-Ihode	-0,75	1,29	326	437	188	0	5,52 %	7,40 %	3,18 %	0,00 %
8 Ihode-Rauma	-0,78	1,17	382	361	191	0	6,47 %	6,11 %	3,24 %	0,00 %
9 Rauma-Eurajoki	-0,94	1,01	273	384	198	0	4,62 %	6,50 %	3,35 %	0,00 %
10 Eurajoki-Luvia	-1,06	0,61	468	433	279	0	7,93 %	7,33 %	4,73 %	0,00 %
11 Luvia-Pori	-1,16	0,12	610	438	336	0	10,33 %	7,42 %	5,69 %	0,00 %
Total	-0,73	0,78	4594	4847	2448	14	7,07 %	7,46 %	3,77 %	0,02 %

Warnings for slipperiness due to snowfall and hoar frost were most common (7,46% and 7,07% of forecasts). The verifications with observed values showed that in general, the model predicted well the elevated risks for both hoar frost and snowfall, in time and space. But as there was no measure of intensity of the phenomena included, the pilot service issued these warnings too easily, especially during the spring nights when road surfaces were dry. Thus it is the most important development need to fix the warning generation schemes to avoid warnings with very low risk, as it is not preferred to warn users too often if there is no real risk for slipperiness. There should be also a way to tell the intensity of the slipperiness risk to the users.

The test phase had only two cases with rain freezing on the road surface, and just fourteen out of the total of 65000 forecasts included that warning. In both cases the warnings were very valid and necessary. Warnings for wet road surface freezing were issued in 3,77% of the forecasts.

Figure 3 shows the forecast chart for rainfall type in the case of freezing rain on February 17<sup>th</sup>, 2007. The area of freezing rain is shown in red. The weather situation was such that warm and moist air was advecting over Finland from the west. Southern Finland was in the warm sector and observing stations reported occasionally on freezing drizzle.

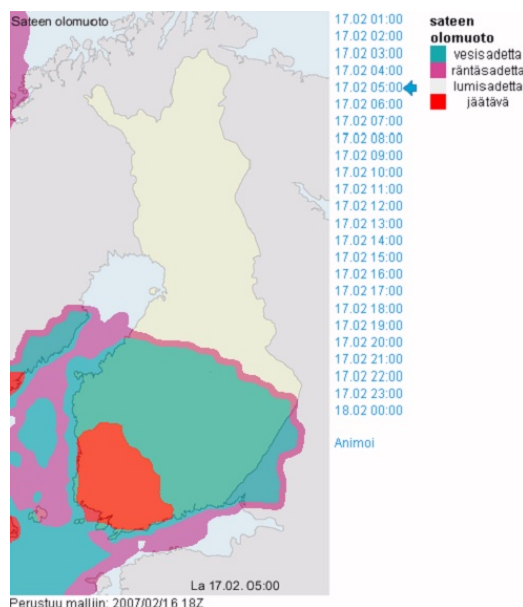


Fig. 3 Rain fall type forecast on 17<sup>th</sup> of February, 2007. Red area indicates freezing rain.

On the second case during the early hours of 10<sup>th</sup> of March 2007, a warm rainfall area was approaching south-western Finland from the west. Road surface temperatures on the mainland were still well below zero, and thus in this situation too, the warnings were very justified.

#### 4. COMPARISON TO THE CONVENTIONAL SERVICE

The Pilot was compared to the traditional six-hour road weather forecast (see Figure 4) in different weather disturbance situations which were verified from accident and other incident records [1]. It was found that the forecast accuracy of both services was roughly at the same level. By analysing the Pilot's slipperiness warning data it was detected that the pilot logically generated more warnings during the night than during the day, and in February more warnings were generated in the southern stretches of the test road than in the northern stretches. In particular, towards the end of the winter, the Pilot generated more warnings than the traditional six-hour road weather forecast, which is probably due to the fact that the pilot did not have access to information about winter maintenance (see Figure 5).

The Pilot generated a number of slipperiness warnings that only applied to one particular stretch of the road, which can be interpreted as the program utilising the stretch of road division quite efficiently.

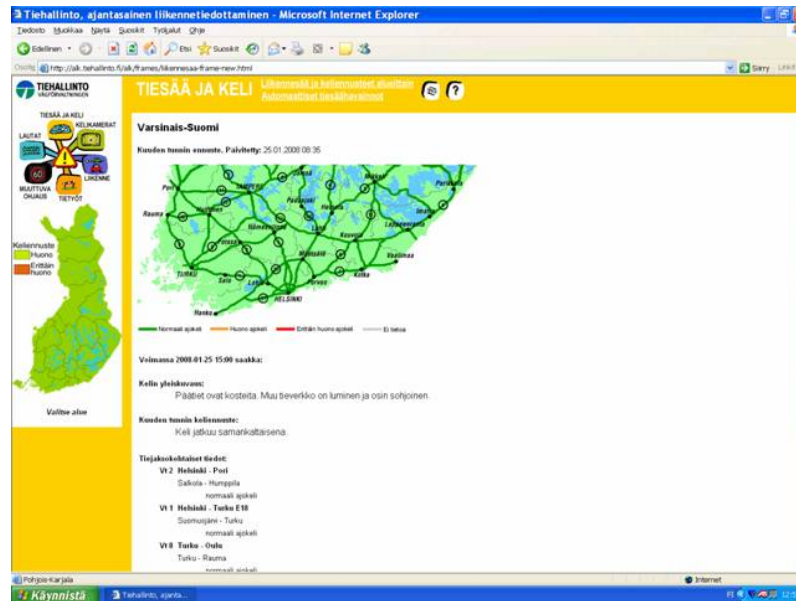


Fig. 4 Six-hourly road weather forecast on FinnRA’s web service. The main roads are coloured green, yellow or red depending on the risk level due to road conditions

Hours with warnings in relation to all hours

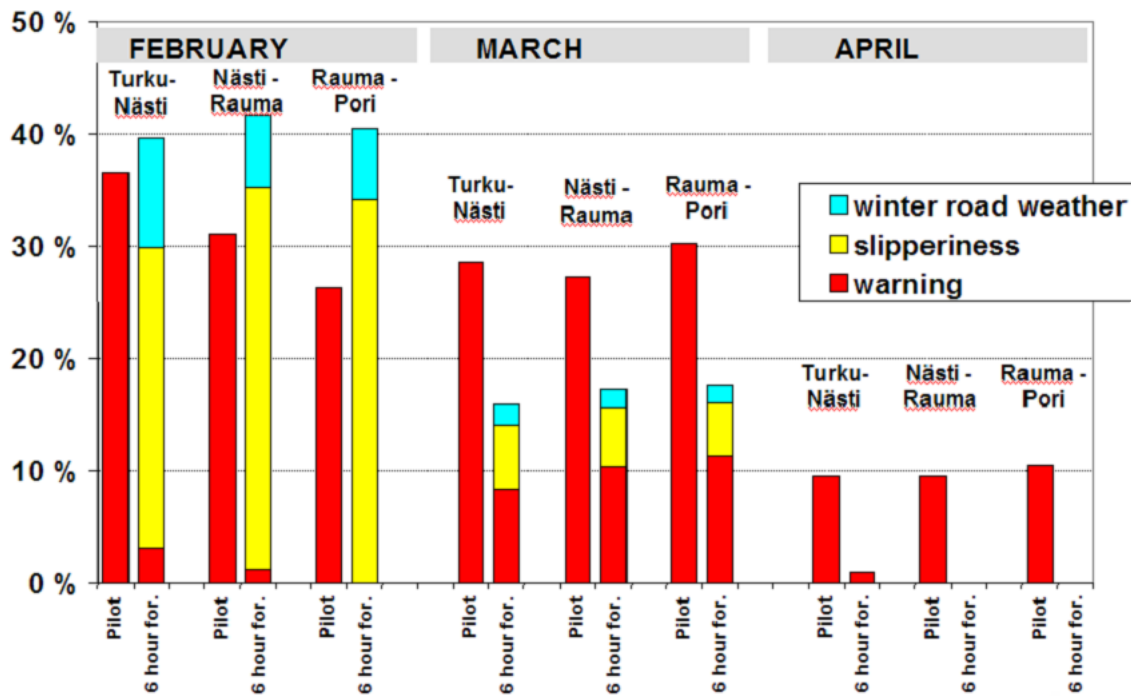


Fig. 5. Pilot and conventional warnings compared. Red columns on the left show all Pilot warnings combined. Columns on the right show the conventional road condition warning with three severity levels [1].

## 5. USER FEEDBACK

Four traffic and weather duty officers, four snow plough/salting truck drivers, three radio reporters and 15 professional motorists, who all used the test road, were interviewed both before the launch of the Pilot and afterwards. In the interviews that were conducted before the launch it was found that in particular the traffic and weather duty officers responsible for the six-hour road weather forecasts wanted some automatically updated weather forecasts. In the interviews after the use of Kelipilotti it was found that only four of the 26 interviewees actively utilised Kelipilotti during the test period, which may partly be due to the non-risky weather during most of the pilot period.

In addition to the interviews, feedback on Kelipilotti was collected using a Web feedback form on the pilot page. The response was very positive. Ninety-two per cent of the 34 people who sent feedback felt that the Pilot was better than the traditional six-hour road weather forecast.

## 6. CONCLUSIONS

It can be concluded that the Road Weather Pilot worked technically well and in particular compared to the objectives set for the system. Warnings were justified in most of the cases, and especially in the most dangerous weather situations. The variability of the warnings from each hourly forecast to the next was sometimes large, which made the trip planning difficult. The user interface was clear and users liked it very much. It was recommended that the Pilot development should be continued on the current basis, taking the level of risk also into account in the final product. Finally, there should be more comparison friction measurements along the roads, as it is hard to define the real risk inherent in warning cases, taken into consideration effects of maintenance actions.

## 7. REFERENCES

- [1] Mikko Malmivuo: Liukkausriskiennustepalvelun kokeilu. Seurantatutkimus. (Trial for slipperiness risk forecast service. Follow-up research). Helsinki 2007. Finnish Road Administration. Finnra reports, 48 p. + app. 41 p.

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