

THE BENEFITS OF METEOROLOGICAL INFORMATION FOR TRANSPORT – A REVIEW AND CASE STUDIES

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ABSTRACT

The aim of the work was to study, what are the benefits of meteorological information in the field of transport and ITS. The work covered all modes of transport and all main effects on the transport system. Results presented in the paper are based on a literature study, internet searches, expert interviews and ongoing research related to ITS and meteorological information services in Finland and countries in South-eastern Europe. Most benefits of meteorological information and meteorological services in transport sector are related to improved safety, better quality of service and improved efficiency of maintenance operations.

KEYWORDS

ITS, transport, meteorological information, services, impacts

INTRODUCTION

During the last twenty years, there has been significant progress in the meteorological information and information services available to actors working with different modes of transport. As the quality and coverage of meteorological information services has improved, relatively little has been published on questions, how meteorological information is used in transport and ITS applications and what benefits it yields.

The objective of the work was to study, what are the benefits of meteorological information in the field of transport and ITS. The work covered all modes of transport and all main effects on the transport system.

The aim was to provide an overview on the subject on the basis of a literature study, expert interviews and ongoing research. Because of the width of the scope, detailed analysis on the benefits to different modes of transport is not included. In some cases, only the most significant benefits were included.

METHOD

Results presented in the paper are based on a literature study, internet searches, expert interviews and ongoing research related to ITS and meteorological information services in Finland and countries in South-eastern Europe. Results of the ongoing research used in the study are preliminary. Final results of the case studies made in Finland and South-eastern Europe will be published later in autumn 2007.

RESULTS

The results of review and case studies are preliminary and subject to further inspection and analysis. The paper covers all modes of transport – road traffic, railway traffic, maritime and aviation. Total benefits of meteorological information services to road transport, aviation, railways and maritime sector have been estimated to be at least 90-113 million euros in a year in Finland.

REVIEW

In many countries there are real-time information services targeted to road users. Usually they distribute information related to weather and driving conditions in addition to traffic-related events such as incidents and fluency of traffic. The effects of information service vary from one country to another. In addition to road users, traffic control centre can also benefit from meteorological information. For example, traffic control centre may decide to close a road or a bridge or lower the speed limit (1), if weather and driving conditions turn hazardous to road users.

It is well known that the free-flow speed on a highway drops when visibility drops because of snow or fog (2). The study also concludes that real-time visibility data allows the highway personnel to choose the most appropriate speed limit.

In many countries road winter maintenance organisations use weather forecasts and nowcasts when making their decisions on their operations (3-4). Meteorological information helps to choose appropriate strategy and make a decision to “do nothing” when appropriate. Avoiding unnecessary starts of winter maintenance operations means savings in materials, labour hours and fuel. Savings in materials, labour and fuel can also be achieved by better timing of maintenance operations. For example, if de-icing operations can be done proactively, less road salt is needed.

According to a study made in UK, many activities in railroad operations are weather-sensitive and many special short-term arrangements are activated by weather forecast information (5). A statistically significant decrease in punctuality of trains was found when temperature went down below 4°C. In case of Scotrail the most common weather-related incidents were found

to be switch failures related to frost and snow and frost affecting rolling stock. In this case the weather forecasts were not specifically tailored for use in railroad industry. According to a British study (6), 20 % of delays in rail transport are caused by weather conditions. In Finland, Finnish State Railways uses weather forecasts published in the mass media and contacts a meteorologist when needed to prepare for snowy days and minimize their impacts on railway traffic (7).

CASE STUDIES

In 2006 studies on the effects of meteorological information services were carried out in Finland (8) and in Croatia (9-10). Same kind of benefits could be found in both countries while there were also several differences. In both cases the most significant benefits were realised in aviation, marine sector and road traffic.

Modern aviation would not exist without meteorological information produced in standardised form, and the largest benefits are obviously related to improved safety. The benefits for increased flight safety are difficult to quantify, for Finland an estimate of savings around 46 million euros a year was calculated (8).

In addition to safety, savings in fuel consumption can be realised. According to the study made in Finland, the amount of extra fuel for unexpected situations can be optimised on the basis of weather conditions. When a flight is planned, the pilot has to define one or more alternate airports which can be used in case the original destination cannot be reached for some reason or another. If weather conditions in several airports are known, the pilot can choose the most suitable alternate airports and take less reserve fuel for flight. The reduced weight of the plane has a cause-effect relationship on reduced fuel consumption. In Finnish context, the benefits related to better choice of alternative airports have been estimated to amount 3 million euros in a year.

Meteorological information also allows the pilot and the flight control to choose the most energy-efficient route and height for his or her flight. For example, the pilot may try to find tail wind and avoid flying against contrary wind. The benefits for choosing more fuel-efficient routes have been estimated to amount about 2 million euros in a year in Finland. In addition to fuel savings, short term weather forecasts are used to support the winter maintenance and de-icing operations at airports.

Maritime transport was one of the first users of meteorological information and meteorological services. According to a case study made in Finland, largest benefits of meteorological information in commercial maritime transport are related to oil combating and pollution prevention. The planning of oil combating on sea is largely based on measured meteorological information and weather forecasts. Measured data and short-term forecasts on direction and speed of wind are used to determine, where and how the oil in sea can be collected. A common objective in oil combating is to collect the oil on sea before it washes ashore and causes larger environmental damage. The amount of oil transported on the Gulf of Finland has been increasing in recent years, which has underlined the need to manage the related environmental risks.

In addition to oil combating, weather data and forecasts are used to support rescue operations on sea, icebreaking and route choices of ships.

Weather information and weather forecasts also improve greatly the safety of recreational boating. According to a Finnish expert interview, the number of fatalities in boating accidents in a year in Finland would increase by 10-20, if no meteorological information services were available. This means that the benefits of meteorological information in recreational boating are at least 17,5-35 million euros per year in Finland.

Especially in Northern Europe weather affects road traffic in many ways. Snow, fog or heavy rain reduces visibility. Snow or ice on road surface also reduces the friction between car tyre and road surface. In winter changes in temperature or rain on icy road surface can make roads more slippery than usual. To improve road safety, drivers are warned via mass media, when driving and road conditions are turning or will turn hazardous. The objective is to make drivers aware of the situation and change their behaviour.

In Finland a significant share of road accidents happen in adverse driving conditions. According to an expert interview, present information and warning services reduce the number of road accident involving personal injury or death by 1-2 %. The effect can be explained by both increased vigilance of the driver and lower speed. Road users may also change their routes, times of departure or cancel their trips. The benefits of present information and warning services available to road users have been estimated to be 16-32 million euros in a year in Finland (8). These figures include only reduction in accidents involving personal injury or death. Benefits related to reduction of accidents involving only material damage have been estimated to be considerably smaller.

Because of differences in climate, this effect is considerably smaller in Croatia. Because a smaller share of road accidents happens in adverse weather conditions, the effect of meteorological information and warning services to road users and number of accidents is most probably smaller than in Finland. Present meteorological information and warning services available to road users have been estimated to reduce the number of fatal road accidents by 0,11-0,23 % and the number of injury accidents by 0,17-0,34 % in Croatia. The benefits of meteorological information and warning services to road users have been estimated to account 3-6 million euros in a year in Croatia.

Nowcasts and short-term forecasts are also used to support road winter maintenance operations. If an accurate short-term forecasting and warning service is available, maintenance organisations can operate proactively before the ice forms or snow falls on the road surface and eliminate unnecessary maintenance operations. According to an expert interview, Finnish road enterprise Destia has achieved a 2,25 million euros reduction in costs of road winter maintenance operations. These cost savings have been achieved through eliminating unnecessary maintenance operations and reducing number of late starts of operations, for example when temperature drops below zero and ice forms on the road surface.

In Croatia, a lot of meteorological information is collected. The challenge seems to be analyzing in and refining it to services. In Croatia, the use of meteorological services in traffic and transport applications seems to be concentrated on nowcasting and short-term forecasts. Only few warning services tailored to specific user groups are available and a clear need for them exists. The previous findings apply to all transport modes.

DISCUSSION

Most benefits of meteorological information and meteorological services in transport sector are related to improved safety, better quality of service and improved efficiency of maintenance operations.

The timeframe for decision-making in most cases in transport sector is quite short: from seconds in real-time systems to a couple of days, when planning maintenance operations or preparing for adverse weather conditions. This means that nowcasting and short-term forecasting services are most useful for use by different modes of transport and ITS (table 1).

Mode of transport	Historical data and climatological effects	Nowcasting and warning services	Daily forecasts (12 h–2 days)	Medium-term forecasts (3–5 days)	Medium-term forecasts (5–10 days)
Road traffic		XX	X		
Maritime transport		XX	XX	X	X
Aviation	X	XX	X		
Railway s		X	X	XX	X

Table 1. Time scale and usefulness of meteorological services used by different modes of transport (X = useful, XX very useful) (8).

Different ITS applications use meteorological information to implement or improve their functionalities. It is easy to see that user requirements and needed functionalities differ from one application to another. For some applications the accuracy of forecast or measured data is more critical than others. For example, inaccurate data used in safety-related services may turn the situation more hazardous to end-users. In other cases, perfect or near perfect accuracy is not needed, but there are other requirements to be taken into account such as length of forecasting period or timeliness of the delivery of information.

Because information on weather and driving conditions is usually only one component of an information service, studying effects of meteorological information may be challenging. The potential applications of meteorological information in ITS are not limited to warning and information services. Meteorological information can be used also in other applications such as traffic control and supporting maintenance operations. Meteorological data may also be used as an input for real-time traffic models.

Meteorological information is a prerequisite for several ITS services. It can also contribute to the quality and accuracy of other ITS services. In many cases new ITS applications can be implemented and the quality and accuracy of existing applications improved without collecting any new raw data for the purpose. Naturally, relevant interfaces for exchanging

data and arrangements between organisations are needed before the benefits of meteorological information in ITS can be realised.

Meteorological information services will become more and more important in the future, because the climate change increases the severity and frequency of extreme weather conditions. This means also that benefits for transport sector and ITS will increase over time.

In future, more localized and customized real-time meteorological will be developed. The whole value chain from raw data to services offered to end-users has to be able to respond to these challenges. The benefits of meteorological information increase when more sophisticated services are developed (see figure below). The impacts and socio-economical benefits of meteorological information services are largely defined by the quality of services and the number of users.

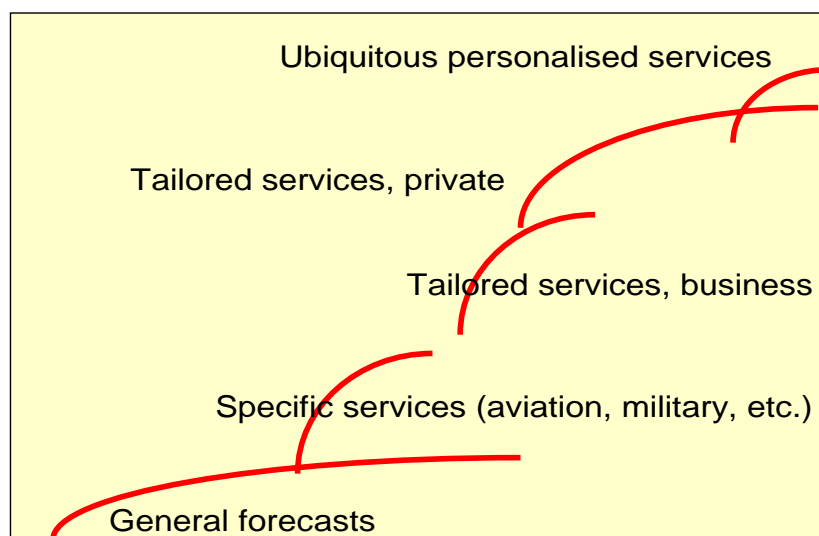


Figure 1. Benefits increase with more sophisticated services and increasing number of users (8).

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