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Benefits of meteorological services in South Eastern Europe

An assessment of potential benefits in Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova and Montenegro

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Title

Benefits of meteorological services in South Eastern Europe

Abstract

The study evaluated the impacts and potential benefits of meteorological and hydrological information services in Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova and Montenegro. The services were analysed for the sectors of transport, construction industry, energy production, flood protection and agriculture production. The study was part of a larger project for the development of weather and climate observation networks and meteorological services in South Eastern Europe countries.

In Albania advanced meteorological information services would produce annual savings worth 24 to 26 million €. In Bosnia-Herzegovina the potential annual benefits were estimated to be about 10 to 22 million €, in the FYR Macedonia 12 to 40 million € and in Moldova 12 to 19 million € per year. For Montenegro the data available did not enable the differentiation from Serbia for aviation and agriculture sectors. For road transport, construction industry and flood protection the annual savings resulting from better hydrometeorological information would be 1 to 3 million €.

Due to the lack of source information only part of the approximate potential benefits could be estimated at magnitude level, even though, the results show that hydrometeorological services are beneficial and worth developing further. The benefits are to a large extent due to higher predictability rates and better planning of operations as well as better preparedness for accidents and the reduction of human and material losses caused by these accidents.

The realisation of the potential benefits requires comprehensive development of the hydro-meteorological service systems. This means further development of observation infrastructure, data and transmission systems as well as service processes, operation models and know-how. Not only should the services be developed, but their availability and usability should be improved. The utilisation of communications technology should be enhanced and the awareness of the benefits of various services should be raised.

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Preface

This study evaluated the impacts and potential benefits of meteorological and hydrological information services in Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova and Montenegro. The study is part of a larger co-project between the FMI Finnish Meteorological Institute, Croatian Hydrological and Meteorological Institute DHMZ of Croatia and VTT Technical Research Centre of Finland on the development of weather and climate observation networks and meteorological information services in the above mentioned countries.

The study was funded by the FMI Finnish Meteorological Institute and FINNFUND Finnish Fund for Industrial Cooperation Ltd. The project management group consisted of Pekka Plathan (chair) and Bengt Tammelin of the FMI Finnish Meteorological Institute and Jorma Rytkönen and Raine Hautala of VTT.

The analysis work and reporting was performed by Raine Hautala (project manager at VTT), Pekka Leviäkangas, Jukka Räsänen, Risto Öörni, Sanna Sonninen, Martti Hekkanen, Mikael Ohlström and Pasi Vahanne from VTT Technical Research Centre of Finland and Bengt Tammelin, Seppo Saku and Ari Venäläinen from FMI Finnish Meteoroligical Institute. The authors of different sections are as follows:

- Raine Hautala: 1st editor, Introduction, Summary of results and discussion
- Pekka Leviäkangas: Railway traffic, Methods, 2nd editor
- Jukka Räsänen: Aviation, Methods
- Risto Öörni: Road traffic
- Sanna Sonninen: Maritime industry
- Martti Hekkanen: Construction industry
- Mikael Ohlström: Energy production and air quality
- Pasi Vahanne: Flood protection
- Bengt Tammelin: Introduction, Summary
- Seppo Saku: Agriculture production
- Ari Venäläinen: Agriculture production.

We would like to thank the national meteorological service organisations of the above mentioned South Eastern Europe countries for the co-operation and support. In particular, we would like to acknowledge the meteorological service organisations of Moldova and FYR Macedonia for their efforts that resulted in reasonable data for this study. Without the help from the representatives of these entities and without the help

from their partners and customers, the whole analysis would have suffered from a serious lack of input.

The quality assurance for this publication was done by Marja Rosenberg from VTT.

VTT Technical Research Centre of Finland, Espoo, September 2008

Raine Hautala

Contents

1. Introduction

1.1 Background

Reliable weather forecast and outlooks, functioning warning system for natural hazards, knowledge of weather, water and climate events, their extremes and their changes in the changing climate are necessary for sound and sustainable development of national socioeconomic and environmental programs in any country. The value of hydrometeorological data, good forecasting and scientific high quality R&D services is increasingly becoming better understood and appreciated by various sectors within the communities. (Figure 1.)

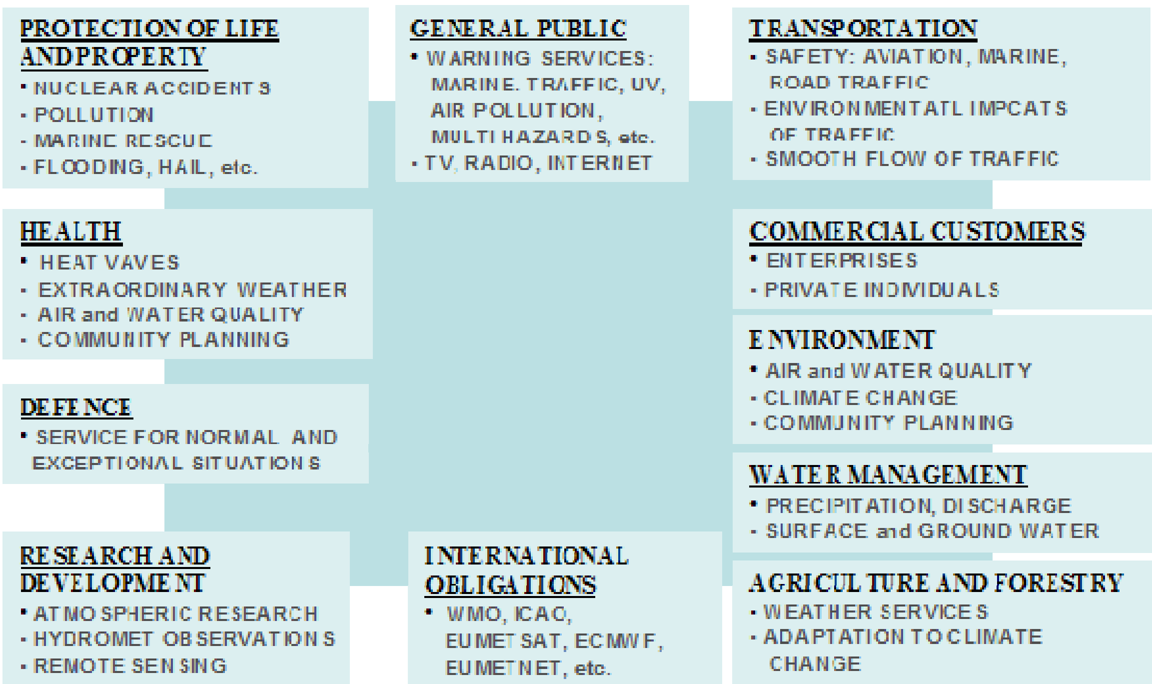

Figure 1. Typical socioeconomic sectors using hydrometeorological data and services (Tammelin 2007).

The expected role of the NHMSs (national hydrological and meteorological institute) is changing rapidly. Traditionally the public sector has formed the major customer and end-user group of hydrometeorological and environmental data and services. However, in the SEE (South Eastern Europe) countries the NHMSs are not the organisations responsible for production of services for the aviation sector, which is typically the profitable sector in terms of revenue for the European NHMSs. On the other hand, the legislative package concerning Single European Sky, adopted by the European Parliament and the Transport Council in March 2004, opened up the market to new service providers of national and international meteorological services for the European aviation sector.

Thus the future of each NMHS lies in its capability to develop and more effectively deliver hydrometeorological products and service outcomes which have a recognizable value to governments, different socioeconomic sectors for the protection of the environment.

In order to be able to improve the hydrometeorological services it is necessary to extend the on-line hydrometeorological observation network, to adopt state-of-the-art equipment and software, foster international cooperation and data sharing, and to introduce new public private partnerships on a national and international level.

In South Eastern Europe the national hydrometeorological services in Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Moldova, Montenegro and Serbia currently do not have the financial and human capacity to fully meet the international obligations and growing national needs and requirements for production of data and services, nor to adequately invest in their development in order to achieve the level of the Western European NHMSs.

Lack of governmental appreciation and adequate financing, together with unidentified customers and end-users along with undeveloped cooperation with the private sector has led to a situation where the NMHSs in the SEE countries have actually fallen into a trap of poverty, with very few possibilities to improve their technical and human preconditions in order to better promote the national development goals (Figure 2).

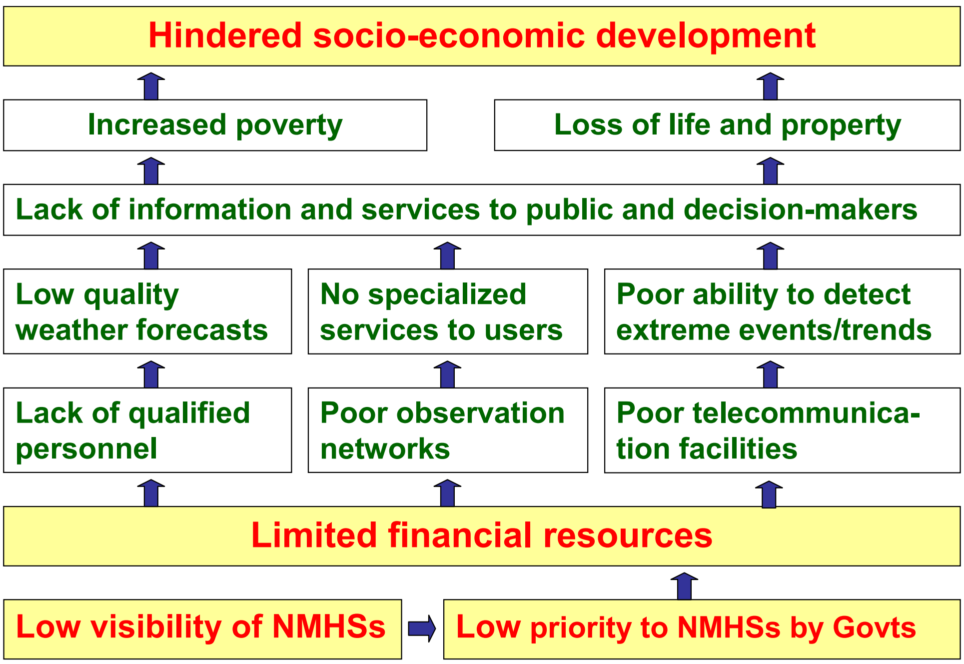

*Figure 2. Schematic presentation of the "poverty trap" of the NHMSs illustrated by P. Taalas/*WMO *(Tammelin 2007).*

However, by governments, and also by different economic sectors, strengthening of the NHMSs to promote their capability to produce better hydrometeorological and environmental (air quality and water quality) services, must not be seen as a national expenditure but as an investment in national and regional development.

There is a great need to demonstrate convincingly that meteorological services contribute to the well-being and safety of citizens and various organisations and to provide sustainable socio-economic development of the countries. It is important for national decision-makers and the public to appreciate that the services provided by national meteorological and hydrological services redound to the benefit of the communities they serve.

This benefit assessment study on meteorological and hydrological services is part of a larger project on the development of weather and climate observation networks and meteorological services in South-East European countries (Tammelin 2007). In addition to the scope of the observation network and technological solutions, the service system development also includes service supply architecture, operational models, enhancement of know-how and training. By developing their service systems the national actors can better prepare for international competition and market liberalisation and deliver meteorological services that are utilized more efficiently by different functions of society. For example, by making weather and road surface condition predictions more accurate, reliable and available will in turn improve road safety and the fluency and predictability of logistics. Meteorological warning systems can be utilised when preparing for emergencies and extreme phenomena (storms, floods, etc.) and decrease the damage brought on by them.

This assessment draws from the project started in 2006 where a development plan for the meteorological observation system, service system and organisation for Croatia was drafted and the impacts and potential benefits of meteorological services were assessed. This assessment also utilizes the experiences gained from the evaluation of the socio-economic benefits of the FMI Finnish Meteorological Institute services made within the information evaluation system development project (*EVASERVE, http://www.evaserve.fi/*).

1.2 Objectives and scope

The purpose of this study is to assess the impacts and potential benefits of meteorological and hydrological information services in Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova and Montenegro. This study assesses the socio-economic benefits generated by more advanced weather and climate observation networks and meteorological and hydrological information services, but does not include economic studies on more detailed project entities, such as investment profitability calculations of investments in particular equipment.

A rough target level for the developed service system is that of the Finnish meteorological service system, simply because the authors are most familiar with that system. The impacts of the information services are assessed for transportation, construction, energy production and from flood prevention point of view.

Both the availability and the quality of source information were generally poor. In most cases there was a need to supplement the information using public national and international statistics, which lead to varying levels of detail and accuracy, and even having to use somewhat outdated data in certain cases. Due to the quantity, coverage and quality of source information the overall accuracy of the assessment of the impacts and benefits is lower than planned.

2. Methods

2.1 General

Various methods have been used for measuring the economic benefits of meteorological services. For instance Freebairn and Zillman (2002a and b) have done salient research in this area and they have analyzed the applicability of various methodologies proposed for measuring the economic benefits of meteorological services. According to Gunasekera (2003) there is not just one method of assessing the economic value of meteorological services. A key concept is the crucial relationship between the economic value of the meteorological information and its impact on decision-making by users engaged in weather-/climate-sensitive activities.

Market prices can be used as a measure of the marginal benefits to users of meteorological information. In the case of private good meteorological information, such as special forecasts for particular purposes, users will purchase the information up to the amount where the marginal value to them equals the price. An advantage of market prices is that they explicitly reveal the value users place on, and are willing to pay for, particular categories of meteorological information (Freebairn and Zillman 2002a).

The most commonly used techniques to estimate the value of meteorological information are what are called normative or prescriptive models. The approach in these models is to view meteorological information as a factor in the decision-making process that can be used by decision-makers to reduce uncertainty. This approach is based on the Bayesian decision theory (Johnson and Holt 1997). The Bayesian approach takes explicit account of how forecast is utilized. It is both more rigorous and more realistic than the "easier" but misleading approach of equating forecast benefits with simple estimates of mitigated impacts. In these models, decision-makers choose actions that either maximize expected profits of minimize expected costs, under conditions of imperfect knowledge about weather and climate conditions.

Some analysts have been using the contingent valuation method which is a non-market valuation method. The contingent valuation method is based on survey techniques and hypothetical situations to elicit users' "willingness to pay" or their "willingness to accept" for hypothetical changes in the quantity of a non-market good such as public weather information (Mitchell and Carson 1989). Conjoint analysis is a method which has been used extensively in marketing and transportation research (Lazo and Chestnut 2002). It has been used increasingly in recent years, including the evaluation of meteorological information. Conjoint analysis is similar to contingent valuation in that it also uses a hypothetical context in a survey format involving the users of meteorological information. Conjoint analysis requires survey respondents to rank or rate multiple alternatives where each alternative is characterized by multiple attributes. The empirical application of conjoint analysis to meteorological information enables the estimation of the value that consumers derive from the various attributes of such information.

2.2 The carry-out of the study

The data of the study consisted of the answers to the questionnaire prepared for different sectors and sent to national hydrometeorological services of target countries, statistics available and literature. Additional information was attempted to be collected during the missions to the counries (Tammelin 2007). The study especially utilized the methods and experiences from the studies of the social benefits of the meteorological information systems in Finland and Croatia made in 2006 and 2007 and the evaluation tools developed in the *EVASERVE* project.

The original goal was to gather data for business specific evaluation, using a questionnaire sent to the national meteorological institutes (Appendix A). Due to the inadequacies of the answers, evaluations had to be based mainly on statistics and application of the experiences and results of previous studies. At the same time the evaluation point of view had to change to a more general level than planned. Due to the inadequacies of the answers for some sectors, only the qualitative impact could be evaluated, not the quantitative.

The business specific evaluations were all made as separate entities due to their distinct characteristics but adhering to a commonly agreed upon logic. Chapter 3 describes in more detail the data and methods used in the business specific evaluations.

The value of statistical life ($VOSL$) can be calculated as suggested by the High Level Group on Infrastructure Charging (Expert Advisors to the High Level Group 1999), based on Swedish practice in road infrastructure projects:

$$VOSL = WTP + NLP + HLC + ADM + PDV,$$

where WTP = Willingness to pay; WTP consists further of two components: "pure human value" and lost consumption

NLP = Net lost production

HLC = Hospital care cost

ADM = Administration cost

PDV = Property and material damage cost

The Finnish practice is identical (Finnish Road Administration 2006) to that above and is applied across the whole transport sector. Of these components, "pure human value" is the greatest and the lost consumption ranks second. $VOSL$ is not a uniform concept when it comes to injuries in different sectors because e.g. traffic accidents cause different types of injuries and damages than e.g. accident on construction sites. But since in the transport sector $VOSL$ is based on empirical analysis and thus represent a reliable cost estimate it has therefore been applied across this study assuming that the error of cross-application is far less than the error of excluding *VOSL* entirely. Furthermore, the difference in fatalities is less than the differences in pure injury accidents (i.e. accidents not leading to fatalities) and yet the greatest benefit comes from saving lives.

VOSL values applied in Finland can be exchanged using purchasing power parity adjusted ratios (see Leviäkangas et al. 2007). Doing this we assume that the *VOSL*s of Finland are equal to *VOSLs* of countries in question. This is of course very debatable, but on the other hand the error of neglecting the *VOSL*s is far greater than including them, even as very rough estimates.

The different trip purposes (leisure, business) and travellers (adults, children, retired, drivers, etc.) as well as trip length (local, inter-city and international) each have different preferences for time and thus different values. For this publication, the average time value per person per hour for inter-city public transport in Finland is used as a benchmark, adjusting the national values according to price level coefficients.

The price level coefficients for different countries are according to Table 1. The purchasing power parity (PPP) adjusted gross domestic product (GDP) per capita is the variable for the coefficient calculation. Purchasing power parities are received directly from the Statistics Finland databases. These parities might be slightly different depending on how the income and cost items are measured and weighed. However, these differences between parities are usually not relevant taking into account other possible sources of error.

Table 1. Price level co-efficients.

Country	PPP-adjusted GDP per capita, 2005	Price level coefficient (PLC)
Finland	32 678	1
Albania	5 302	0.162
Bosnia-Herzegovina	7 929	0.243
FYR Macedonia	7 221	0.221
Moldova	2 658	0.081
Montenegro	3 800	0.116

Using the PLCs we obtain the following table (Table 2) for unit values of time and life, using the Finnish base values for 2005 as a benchmark.

Table 2. PLC-adjusted values of life and time.

Country	VOSL; 1000 €/person	Average time value in inter-city public transport*; €/person/h
Finland	1 752	8.13
Albania	284	1.32
Bosnia-Herzegovina	426	1.98
FYR Macedonia	387	1.80
Moldova	142	0.66
Montenegro	203	0.94

* Time values of different trip purposes vary, e.g. leisure trips vs. business trips. A fixed ratio of trip types has been assumed here, as it is done normally in time value operationalisation.

3. Results by sectors

3.1 Road traffic

Objectives

The aim of the work was to study what the effects are of meteorological services and meteorological information on road traffic in South Eastern Europe. Five countries – Albania, Bosnia Herzegovina, FYR Macedonia, Moldova and Montenegro – were included in the study. In addition to road users, maintenance operations were also included in the study.

Methods

The results of the work are mainly based on earlier research on this subject, a survey targeted to experts in participating countries and statistical information related to the countries included in the study. In addition, some expert interviews were done. The unit cost values for effects on traffic safety are based on unit cost values estimated by the Finnish Road Authority. The Finnish unit cost values (Finnish Road Administration 2006) were scaled with the GDP adjusted with purchasing power parity to obtain unit cost values relevant to each country. The Finnish unit cost values include both material damage and costs caused by accidents and loss of welfare related to human injuries or fatalities.

The original plan was to gather as much information as possible by organising a survey targeted to meteorological institutes in South Eastern Europe. According to the original plan, national meteorological institutes would then seek answers to questions in the questionnaire and send completed questionnaires back by email. Unfortunately, only two countries – FYR Macedonia and Moldova – provided information related to the road sector in their answers.

Because only FYR Macedonia and Moldova provided information related to road transport during the survey, other sources of information were needed. In some cases, relevant information such as numbers of different types of road accidents could be found in international statistic handbooks. The values of different variables and their sources have been listed in Appendix B.

The effects of meteorological information and warning services on safety of road users has been estimated on the basis of available statistics, answers to the survey and expert interviews made in Finland. According to a Finnish expert interview, meteorological information and warning services offered to road users reduce by 1–2% the number of road accidents involving personal injury or death on public roads (Kulmala 2006) in Finland.

The previous estimate can not be generalised as such to other countries with different climate and different situations and strategies of traffic safety. The 1–2% effect on the number of accidents (r_{fi}) was scaled with the shares of accidents happening in adverse weather and road conditions. The mathematical model used to calculate the impacts and socio-economical benefits of meteorological information and warning services offered to road users has been described in detail in Appendix C. Intermediate results of the calculations have been listed in Appendix D.

Results

According to research made in Finland and in Croatia (Hautala and Leviäkangas 2007, Leviäkangas et al. 2007), meteorological information services have two main effects on road transport. At first, meteorological information is used in information and warning services available to road users. Secondly, meteorological information is used in the planning of road winter maintenance operations.

The ways the meteorological information is used in the road transport sector depends on the quality and coverage of services available, local climate and the organisation of meteorological services, information services to road users and road winter maintenance.

Weather-related information and warning services for road users

Because all countries didn't answer all the questions in the survey, statistical data had to be used to replace the missing values. Answers used to calculate the effects on road users and statistical data used to replace missing values have been documented in Appendix B. The method used for estimating the effects on weather-related information and warning services for road users has been described in the methods section and in detail in Appendix C.

The maximum and minimum values for the effects on the number of accidents and the monetary values of the effects have been shown in Table 3.

Table 3. The maximum and minimum values for the effects on the number of accidents and the monetary values of the effects (per year).

Calculated results (minimum)	Albania	Bosnia-Herzegovina	FYR Macedonia	Moldova	Monte-negro	Croatia
The impact of information services offered to road users on injury accidents (accidents)	0.30	7.29	4.60	4.69	2.15	25.8
The impact of information services offered to road users on fatal accidents (accidents)	0.27	0.23	0.14	1.80	0.06	0.60
The impact of information services offered to road users on injury accidents / M€	0.02	0.54	0.34	0.12	0.15	3.68
The impact of information services offered to road users on fatal accidents / M€	0.11	0.11	0.07	0.31	0.03	0.58
Socio-economical benefits of meteorological information services / M€	0.12	0.66	0.41	0.42	0.18	4.25
Calculated results (maximum)	**Albania**	**Bosnia-Hertzegovina**	**FYR Macedonia**	**Moldova**	**Monte-negro**	**Croatia**
The impact of information services offered to road users on injury accidents (accidents)	0.60	14.60	9.21	9.43	4.31	51.71
The impact of information services offered to road users on fatal accidents (accidents)	0.53	0.46	0.28	3.63	0.11	1.21
The impact of information services offered to road users on injury accidents / M€	0.04	1.09	0.69	0.24	0.30	7.37
The impact of information services offered to road users on fatal accidents / M€	0.21	0.23	0.14	0.61	0.05	1.15
Socio-economical benefits of meteorological information services / M€	0.25	1.31	0.83	0.85	0.35	8.52

Road winter maintenance

Meteorological information can in many cases support planning and decision-making in road winter maintenance operations. With better planning of operations, the amount of working hours, materials and fuel can be minimised. One of the most weather-sensitive operations in road winter maintenance is de-icing with road salt, which is usually sodium chloride. The cost of a ton of sodium chloride was assumed to be 100 €.

The amount of road salt used for de-icing roads in a year was asked in the questionnaire. Of all countries involved in the study only Moldova answered that question. According to their answer to the questionnaire, 1 000 tons of road salt is used every year on public roads in Moldova. In Finland, a 5% reduction in use of road salt was achieved because of better meteorological support to road winter maintenance operations (Rusanen 2006) after the beginning of 1990s. Reduction in costs was calculated by assuming that a 5% reduction in salt use could be achieved with meteorological information and alert services tailored to the needs of road winter maintenance. This means that cost savings of at least 5 000 € could be achieved in a year because of reduced use of road salt. In addition, spreading salt on roads incurs costs of which some are directly related with the tons of salt used (fuel, working hours of staff). For this reason, 10 000 € would be a better estimate of the potential cost savings in de-icing operations with better meteorological information services.

In the case of the other countries included in the study, the amount of road salt used in a year is not known. For this reason, it is not possible to give exact figures describing the potential benefits in road winter maintenance. However, almost all countries spend considerable amounts of money on winter maintenance of roads. If even a small cost reduction in percents could be achieved, the benefits would be considerable.

Discussion and analysis

The results are based on a model describing the impacts and socio-economical benefits of weather-related information and warning services targeted to road users. The model is rather crude and it gives only a guidance of the scale of the benefits. Numbers used as inputs for the model have been gathered with a survey, from statistics and from an expert interview.

Results calculated with the model are only as good as numbers inputted in the model. Because the accuracy of statistical data and numbers obtained by the survey vary between participating countries, the accuracy of results varies between countries. This means that great caution is needed when comparing results between different countries included in the study.

In South East European countries, no cause-effect relationship could be concluded on the basis of the results because present detailed information and warning services targeted to road users or their usage statistics was not available. It is better to say that the figures obtained in the study represent potential effects, which can most probably be achieved with information and warning services delivered via the mass media such as radio and TV.

In future, more localised and personalised weather-related information and warning services will be available to road users. According to an expert interview, their impact to the number of accidents will be about twice as large (24%) as the impact of present information and warning services delivered via mass media (Kulmala 2006). According to an earlier study made with the same method, the benefits of weather-related information and warning services to road users have been estimated to be between 3.0–6.0 million € in a year in Croatia (Leviäkangas et al. 2007). These figures are smaller than benefits estimated for Croatia in this study. The difference is explained by the different ways to deal with differences in purchasing power.

The potential for reduction in the number of injury accidents is largest in Bosnia-Herzegovina according to the results of the study (7.3–14.6 accidents in a year). The potential to reduce fatal accidents seems to be largest in Moldova (1.8–3.6 accidents in a year). The results obtained with the model are quite sensitive to the shares of different types of accidents happening in adverse weather and road conditions.

In all the countries involved except Moldova, percentages calculated from Croatian statistics had to be used when estimating the shares of different types of road accidents happening in adverse weather and road conditions. The reason behind this was the lack of answers to the survey. The use of Croatian figures instead of figures obtained from studied countries has to be remembered when using the results and considering the reliability of the results.

The difference in accident reduction between different countries is also related to differences in the number of road accidents in a year between different countries. In Croatia the amounts of injury accidents and fatal road accidents on public roads in a year are larger than in other countries involved in the study.

The difference in the monetary value of benefits is also affected by differences in purchasing power between studied countries. For example, the gross domestic product per capita adjusted with purchasing power is significantly higher in Croatia than in other countries included in the study. This partly explains the large difference in monetary values of benefits between Croatia and other studied countries.

The effect of meteorological information and warning services on road maintenance operations was hard to estimate on the basis of available information. Of the studied countries, only Moldova provided information related to road winter maintenance in the questionnaire. In the case of Moldova the benefits of meteorological information to road winter maintenance were estimated to be at least 10 000 € in a year. However, this is considerably less than estimate of benefits related to improved traffic safety in Moldova (0.42–0.85 million €). The same kind of relationship between those figures can also be expected in the other countries studied.

3.2 Railway traffic

Introduction

In the following assessment, the benefits of meteorological information services to railways are described. The services considered are mainly daily, routine services, but with an emphasis on more efficient delivery and utilization rate. The term appropriate in this context is "potential benefits", meaning that when the services and their delivery are developed to meet more precisely the needs of the users, the benefits will increase. Naturally, the "potential" also includes quality improvements of the end products (i.e. service) and their procession.

The railways of the Balkan play an important role in the region's economy and exchange of goods. The railways have experienced much of the same restructuring process as the other European railways, i.e. separation of infrastructure from operations and more market-oriented corporate structure.

The volumes[1] as well as some basic data on rail transport in the five countries are shown in Table 4.

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1 Various sources used: UIC statistics, direct information from the questionnaire replies, and information provided by the web-sites.

Table 4. Railway sector key figures and facts.

Country	Railway and infrastructure companies, 2006	Freight volume 2006 million tn-km *million tonnes*	Passenger volume 2006 million p-km *million passengers*	Track length 2006 km
Albania	Hekurudha Shqiptare, HSH, is the integrated railway of Albania.	na	na	677
Bosnia-Herzegovina	Two companies, ŽFBH (Federation of Bosnia and Herzegovina) and ŽRS (Republic of Srpska); both provide transport services and manage the rail infrastructure.	ŽFBH – 682 *6.6* ŽRS – 407 *0.4*	ŽFBH – 682 *0.4* ŽRS – 407 *0.8*	na
FYR Macedonia	Infrastructure and transport entities have been separated into two companies from the Railways of Former Yugoslav Republic of FYR Macedonia (RFYROM).	614 *3.8*	105 *1.0*	925
Moldova	Integrated railway	3 656 *11.1*	471 *5.3*	1 153
Montenegro	Divided into infrastructure and transport companies (ŽCG-Infrastruktura d.o.o. and ŽCG-Prevoz d.o.o.) operating under one holding company (ŽCG Crne Gore a.d.).	182 *na*	112 *na*	328

na = Not received from the questionnaire or not found.

The impact mechanism of meteorological information

Meteorological information has an impact on the transportation system at different levels:

- strategic information, such as climate change, will give transportation system planners valuable inputs how to set standards for the infrastructure and how to prepare for exceptional weather phenomena
- operative information, which is used on a daily basis, when the operators of transport and infrastructure use meteorological information to optimize their daily work, including the short-term planning of the work.

In this analysis, the focus is on an operative information level, mainly meaning the daily and weekly forecasts and nowcasting. The use of strategic impact has a huge impact on infrastructure and operation costs but these savings are far in the future and their present value, if one wants to discount them as usual, might be lower than anticipated.

The operative information is expected to have at least the following beneficial impacts:

- maintenance of tracks can be proactive and just-right-time maintenance operation, such as snow removal and subsystem (e.g. train control systems) maintenance; this should give significant possibilities to improve the reliability of train movements and enable the maintenance operator to plan their activities to be performed optimally in terms of man power and equipment

- more efficient maintenance and better preparedness should improve the safety of rail transport resulting in savings in terms of human lives[2] and material damages.

Figure 3 illustrates the logic of impact mechanisms.

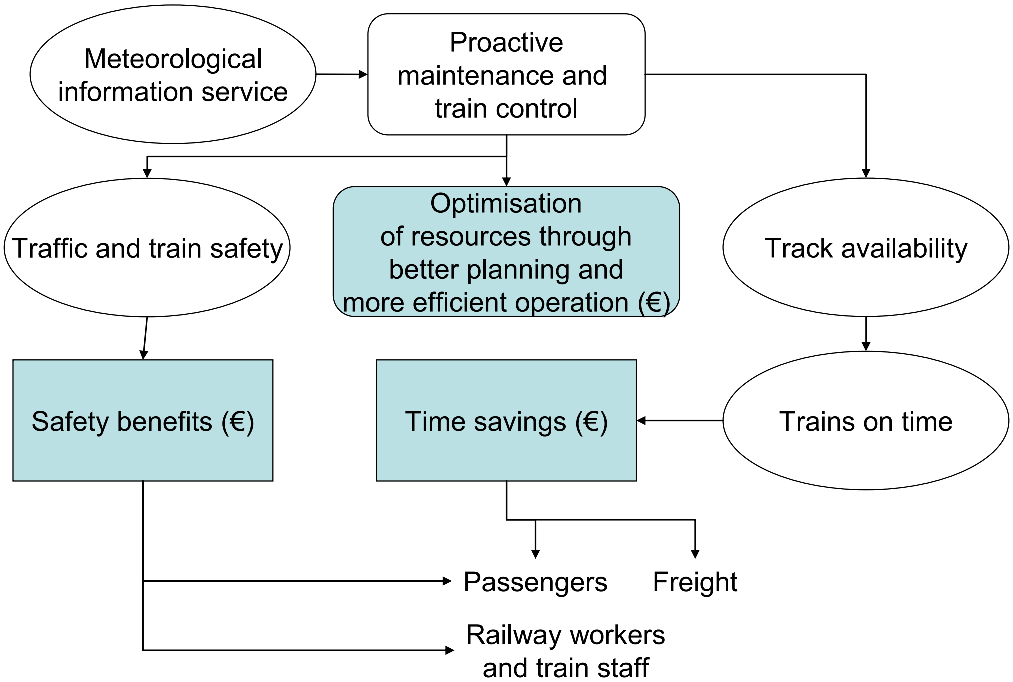

Figure 3. Impact mechanism of meteorological information.

Benefits with current and "perfect" information

To assess the benefits resulting from the utilization of met-information services there are two important aspects that need to be considered. First, there are the benefits coming from the utilization of current information, i.e. from the information services as they are today. The other aspect is considered when we assume that there is "perfect" information to be utilized in the best possible manner. Of course, the second aspect represents the ideal situation which will never materialize, but with today's technology it might be considered an option not too far away. Personalized mobile devices and sophisticated forecasting and nowcasting techniques enable the critical information to be available when most needed and in a suitable format. If we further assume that this information is used by operative managers in the best possible way, we might consider this as the ideal

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2 The value of human life has been discussed in e.g. Leviäkangas et al. (2007). This analysis relies on the same assumptions.

situation. At least, the latter situation is what should be pursued by met-service providers and their customers.

The data basis for assessment

From the five countries, some data was gathered through a questionnaire. The aim of the data was to enable a benefit assessment concerning the meteorological information supplied for the railways. The data received was inadequate for a proper assessment and the analysis that continues from hereon is heavily relying on previous studies from Croatia (Leviäkangas et al. 2007) and particularly from Finland (Hautala and Leviäkangas 2007).

The data requested was mainly concerning rail traffic safety (benefits of increased safety), track maintenance (savings in operative maintenance) and time reliability of trains (time savings of passengers and freight). The data coverage was according to Table 5.

Table 5. Rail transportation key figures.

Country	Rail traffic reliability (% of departures and arrivals on time)	Reliability problems due to weather conditions	Safety of rail transport (no. of accidents)	Weather-related accidents	No. of casualties and injured in the accidents
Albania	na	na	na	na	na
Bosnia-Herzegovina	na	na	na	na	na
FYR Macedonia	Severe problems in reliability*	None reported	83 accidents in 2006	2	7
Moldova	Departures ca 98%, arrivals ca 90% on time	None to be reported	na	na	26 in 2000**
Montenegro	Passenger trains: departures ca 90%, arrivals ca 20% on time; Freight trains: ca 20% of departures and ca 5% of arrivals on time	Some part of the deviations of scheduled times are weather-related	56 in 2005	1	270***

na = No answer or no data available.

* 0% was reported as the reliability indicator; either there are severe problems as it was interpreted (i.e. all the trains experience time reliability problems) or the question was misunderstood.

** Source: Moldovan Railways Restructuring, SCR-E/111005/CSV/MD, Safety and Environmental Considerations, October 2002 (NEI B.V., DE-Consult, ARRC & VTT).

*** One major accident occurred where the majority of injuries and casualties were experienced.

The impression from the questionnaire was that the data from Montenegro and FYR Macedonia was quite reliable and further assessment is based on the data from those countries. The FYR Macedonian figures also corresponded exactly to the figures of UIC (International Union of Railways).

The time reliability of the railways seems to be somewhat of a problem in the countries covered. Since at least one response (Montenegro) was given where the weather conditions were blamed for part of the delays, we must assume that this represents approximately the situation across the countries. In the UK, some 20% of the delays in departures and arrivals were estimated to be weather-related (Thornes and Davis 2002). This would mean that e.g. in Montenegro 2% of departing and 16% of arriving passenger trains are delayed because of bad weather or due to damages or difficulties caused by bad weather. For freight trains the corresponding percentages would be 16% and 19%. If we roughly generalize, we could assume that some 10% of the trains deviate from the timetable due to bad weather conditions. The question is that whether this share can be reduced and by how much if improving the meteorological information services and their utilization rate. We shall make an assumption that 1% of the trains will improve their timetable performance if the met-information services are better and more efficiently used.

As to safety, we will make a modest assumption that each year one person in each country is saved due to better maintenance and thus improved safety on tracks. Accidents occur rarely, but every now and then major accidents take place and some of them are more or less weather-related. Annual statistics are fairly unreliable unless they are gathered from several countries that are not very different from each other.

Material damages are difficult to assess, although the information is surely available within railways. For example, the insurance compensations are a very good estimate for material losses due to accidents, but this information is naturally confidential and not published in any format.

Track and fleet maintenance costs were reported by FYR Macedonia and Montenegro. In Montenegro it was estimated that bad weather conditions could take the costs up by 20% to 30% of the standard cost. However, what share of these extra costs could be avoided remained unclear. But evidently weather conditions do have a great impact on costs of maintenance, especially those of tracks. We shall assume a 1% reduction potential in the total track maintenance costs that could be achieved by better weather information services and better utilization of weather information. For fleet maintenance, to be on the safe side, we will not assume any savings potential when making the aggregate benefit assessment for railways.

Benefit estimates

Time savings

The time savings come from the improved time reliability of trains. To estimate the savings, we need to assess the following parameters:

- the improvement rate of the time reliability of trains; we assumed earlier based on questionnaire answers that some 10% of all the trains might experience time delays due to bad weather conditions. The improvement rate could prove possible to eliminate at least 10% of the delays due to improved proactive track, fleet and equipment maintenance as far as there are weather-prone elements. This would mean that about 1% improvement in the total reliability of trains.
- the amount of average delay that is eliminated; in one of the questionnaire answers, an average delay of 30 minutes was mentioned. We take this as a representative average delay across the countries.
- the average amount of passengers experiencing the time savings; a straightforward assumption is that 1% of the reported passengers experience the improvement.

These assumptions holding, we can estimate the time savings with the help of unit values of time. Hence, the estimates are as follows:

- Albania: na
- Bosnia-Herzegovina:
  0.5 h × 0.01 × (800 000 + 400 000) passengers × 1.98 €/passenger/h ≈ 12 000 €
- FYR Macedonia: 0.5 h × 0.01 × 1 000 000 passengers × 1.80 €/passenger/h ≈ 9 000 €
- Moldova: 0.5 h × 0.01 × 5 300 000 passengers × 0.66 €/passenger/h ≈ 17 500 €
- Montenegro: na

Savings in maintenance costs

The maintenance cost data is poorly available. However, the questionnaire answers from Montenegro provided some data on which to build an estimate. The annual cost of track maintenance was about 2 200 € per track kilometre. With the help of PLCs we can roughly estimate the unit maintenance costs per year. Also, we earlier assumed that at least 1% of the total costs could be reduced by better utilisation of weather information. With these assumptions the annual savings, based on 2006 price level, would be as shown in Table 6.

Table 6. Track maintenance cost savings.

Country	Estimated annual unit cost of track maintenance; €/track-km	Track length; km	Total annual savings (1%); €
Albania	3 100	677	21 000
Bosnia-Herzegovina	4 600	na	
FYR Macedonia	4 200	925	39 000
Moldova	1 500	1 153	17 000
Montenegro	2 200	328	7 200

The above estimates do not take into account the scale economies which are important also in track maintenance. But since we neglected any potential savings in fleet maintenance we can assume that these errors partly eliminate each other. Furthermore, even if the estimates are based on unit values of Montenegro Railways, the differences in track length are not that radical and the scale factors must be modest, because day-to-day track maintenance costs are not highly capital intensive in the long run.

Safety benefits

It was assumed earlier, that improved maintenance of tracks and fleet in terms of weather-prone elements will result in some safety benefits. It was further reasoned that on average roughly 1 casualty or severe injury could be avoided per year in each country. The *VOSL*s presented earlier form explicitly the estimated benefits per annum:

- Albania: 284 000 €
- Bosnia-Herzegovina: 426 000 €
- FYR Macedonia: 387 000 €
- Moldova: 142 000 €
- Montenegro: 203 000 €.

Aggregated results

Adding up the estimated benefits, results in a formidable value for the improved meteorological information services. It is noteworthy that these benefits accrue year after year, thus justifying considerable investments. For example, if we assume that the required pay-back time for the investment is five years, we can multiply the annual benefits by five to assess the justified investment level.

The results must be seen as very crude estimates, but pointing in the right direction. Meteorological services will affect the functions of society in many beneficial ways. Railways are just one example of those functions. Furthermore, the assessment of potential benefits was mainly based on improved day-to-day services of meteorological information providers and the sub-functions (e.g. rail track maintenance) studied were day-to-day operations as well. The aggregated potential savings are shown in Table 7.

Disaster prevention services, special warnings and other services dealing with exceptional situations will produce benefits too. These benefits can be substantial even though the likelihood of occurrence is low. These benefits must be assessed separately but added, nevertheless, to the benefits assessed here.

Table 7. Aggregate potential benefits for rail sector.

	Albania	**Bosnia-Herzegovina**	**FYR Macedonia**	**Moldova**	**Montenegro**
Safety of rail transport	284 000	426 000	387 000	142 000	203 000
Time savings of passengers	na	12 000	9 000	17 500	na
Savings in track maintenance	21 000	na	39 000	17 000	7 000
Total per annum	**305 000**	**438 000**	**435 000**	**177 000**	**210 000**

3.3 Maritime industry

Objectives

This study focused on the potential socioeconomic benefits of meteorological services gained by different actors in maritime industry in the South Eastern Europe countries of Albania, Bosnia Herzegovina, FYR Macedonia, Moldova and Montenegro. One of the aims of the study was to identify the potential benefits that could be gained by enhancing the present meteorological services.

Methods

The starting point for the evaluation was the studies of the socio-economical impact of meteorological services made in Finland and in Croatia. These evaluations included literature reviews, expert interviews and statistical analysis and a strong methodology development aspect. Thus the methodology for evaluation of socioeconomic benefits gained in the South Eastern Europe countries is based on the method developed during these studies (Hautala and Leviäkangas 2007, Leviäkangas et al. 2007). The maritime industry domains (safety of human lives, environment, materials and economy) and related activities that are evaluated in the SEE projects were identified from literature and their selection verified with expert judgement. The use of questionnaires was selected as the method for collecting country-specific basic data from these domains. Questionnaires covering the information needed for the evaluation were prepared and sent to the relevant stakeholders in target countries. The aim was to identify the potential users, to list the services they use and to which activities these services have an impact, to receive evaluations on the benefits of the services and to gain supporting statistical information for the estimations on the values of the benefits.

Results

No answers to the questionnaire related to maritime traffic were received from the target countries. A concise literature review was made to examine if sufficient information for a general evaluation could be gathered. The information available was, however, not adequate and thus the evaluation is based on the previous work in Finland and Croatia and it merely outlines the potential benefits to maritime industry without any reference to the national circumstances in the target countries.

The utilisation of meteorological information is traditionally self-evident in seafaring but also in other fields of maritime industry. Meteorological information affects a significant part of decision making onboard, but the demands for meteorological information vary among the different user in maritime industry. Information is used e.g. in the planning of routes, loading, cargo lashing and securing, maintenance and repair work, predeparture preparations and chartering. To some of the activities in maritime transport the impact of the meteorological information is difficult to evaluate. It can be observed to be positive or negative, in fact invariably positive, but to achieve quantitative benefits a comprehensive analysis and expert judgements of subject matter expert group is always needed.

To gain the potential benefits the meteorological and hydrological services should provide for the activities of:

- shipping companies and their vessels and the shipping industry in general
- search and Rescue (SAR) organisations
- organisations responsible for pollution mitigation at sea (oil combating etc.)
- maritime safety authority / organisations
- harbours, ports and terminals
- fishing and fisheries
- tourism
- boating and other recreational use of sea
- ship building
- off-shore industry

These organisations and actors generally utilise both basic and special meteorological services. According to the studies made (Hautala and Leviäkangas 2007, Leviäkangas et al. 2007) the basic meteorological services are widely used by the maritime industry and the typically contractual special meteorological services are used by a small part of the industry e.g. shipping companies, ports, terminal and marinas and shipyards.

According to the reference studies in Finland and Croatia (Hautala and Leviäkangas 2007, Leviäkangas et al. 2007), all actors that were considered in the evaluation had gained benefits from meteorological services. The positive impact of the services was evaluated to be overextended and to some of the actors even a necessity for up keeping safe and cost-effective operations. The importance of accurate, short term and medium term forecasts was emphasised. These services were estimated to enhance the safety and efficiency of operations the most. The benefits gained with different services are, however, dependable on the type of business and nature of operations: traffic area of fleets i.e. ocean-going versus short-sea-shipping, scheduled liner traffic or tramp ships etc.

It can be inferred that the activities to which the benefits of the meteorological services are easily observed are search and rescue, oil combating, the planning and optimisation of freighting and the ship operation during sea voyage. Also the value of the benefits is the most obvious and measurable in these activities. It should be noted that in addition to the daily decision making, the benefits of the services are highlighted in incident management.

Discussion

Sufficient amount of information for the estimation of comprehensive economic benefits of meteorological services was not provided by the target countries. One of the reason for this is that not all of the target countries have waterborne, neither sea nor inland traffic. Often the related organisations do not compile statistics required for the estimations and some of the activities under consideration are handled by several organisations making it very difficult to evaluate the total impact of services. As an example of the potential benefits that can be gained in future with the implementation of enhanced meteorological services, the summary of the benefits to maritime activities that are estimated to benefit the most from the meteorological information services in Finland and Croatia can be considered. The estimated benefits in these countries are shown in Table 8.

Table 8. Summary of estimated benefits per year of Croatia DHMZ information services to maritime industry derived from corresponding Finnish estimations (Leviäkangas et al. 2007).

Activity	Finland	Croatia DHMZ
Number of boats	420 000 [1]	200 000
Annual number of boating accidents at sea	700	1 000
Fatalities in weather related accidents	–	3–7
Fatalities saved due to delivered met-information	10–20	5–10 [2]
Value of lives saved per annum	17.5–35.0 M€	3.6–7.2 M€
Number of rescue missions avoided	34	17 [3]
Savings in rescue mission costs per annum	0.24 M€	0.05 M€ [3]
Number of port calls	44 988	5 806
Planning and conducting of oil combating per annum	12.1 M€	0.64 M€ [4]
Total benefits per annum (million €)	**29.8–47.3 M€**	**4.3–7.9 M€**

1) The number of all boats in Finland (including boats without motor) is approximately 737 000.

2) The number of boats in Croatia is approximately 50% of the (motor) boats registered in Finland but the annual boating season in Finland is on average 4–5 months whereas in Croatia the weather enables boating all year round. In Finland boating is mainly done with one's own boat in fairly familiar waters and conditions whereas in Croatia, boating tourism includes rented boats and are therefore used by people unfamiliar with the waters, which is very popular. Based on this information it is (conservatively) assumed that the number of fatalities saved with the utilisation of meteorological services is about half of the lives saved in Finland and multiplying the Finnish value of statistical life (VOSL) with Price Level Coefficient 0.41: e.g. 17.5 million € × 0.5 × 0.41 = 3.59 million €.

3) The number of rescue missions avoided with the use of meteorological services is expected to be half of the corresponding figure in Finland as was the number of lives saved. Then the monetary value of rescue mission savings is multiplied with the PLC: 0.5 × 0.41 × 0.24 M€ = 0.049 M€.

4) Year 2004 was the reference year for number of port calls. During this year there were altogether 204 362 port calls in Croatia of which the great majority was made by vessels in domestic traffic and only 5806 by foreign vessels. Most of the domestic vessels are small vessels travelling between the islands and main land. Though these vessels may naturally also cause oil pollution, the major accidents are caused by tankers and larger vessels with a lot of bunker fuel. Also the larger vessels use environmentally more dangerous heavy fuel oil whereas the smaller vessels often run with light fuel oil. To make conservative assumptions, only the number of foreign traffic vessels was chosen to represent the potential for oil pollution. The benefit of meteorological information was evaluated from Finnish value of benefit. First the monetary benefit calculated in Finland was divided with number of port calls. This number was then multiplied with PLC and then multiplied with the number of foreign vessels port calls in Croatia: 267 €/port call × 0.41 × 5806 port calls = 0.64 M€.

The reference study made for the Finnish Meteorological Institute included the evaluations of a wider range of activities than what is shown in Table 8. A comprehensive list of evaluated activities and the estimated benefits are shown in Table 9. As mentioned earlier, such evaluation was not possible to be conducted for the meteorological services in South Eastern Europe countries due to the lack of basic information. However, the example of benefits gained in Finland (Table 9) summarising those activities where potential economic benefits could be found also in the South Eastern Europe countries.

The following are the short general summaries about the significance of maritime industry in order to outline the future potential of meteorological and hydrological services and support resource allocation.

Albania:

Tourism is on the rise, especially near Corfu. The large amount of coastline suggests that the increase of both passenger and freight maritime transports is possible. Oil and chromium are important exports with Durrës as the greatest cargo port. Meteorological services have development potential.

Bosnia-Herzegovina:

One sea port and several inland ports on the Sava river. Both the sea and the inland ports can be developed. Maritime tourism does not have as significant development in sight as Albania because the own archipelago and coastline is significantly smaller. Meteorological services do, however, have development potential.

FYR Macedonia:

No ports or significant inland waterway transport (the river Vardar runs through the land). No significant development potential in sight for meteorological services.

Moldova:

Only inland waterway ports (424 km of waterways). No significant development potential in sight for meteorological services.

Montenegro:

The country has some coastline but a very small fleet and only one significant port. The development of the fleet and seaports seem, however, possible. Tourism seems to have development potential due to the coast and already there are boating services. The most significant port is Bar. Meteorological services have development potential.

Table 9. Economic benefits of meteorological information services in Finland and the share of Finnish Meteorological Institute of the total benefits (Hautala and Leviäkangas 2007).

Personal safety	**Economic benefits (M€)**
Improved safety of boating and recreational use of water areas – reduction of accidents – reduction of accidents with personal injuries	17.5–30.04
Fatigue prevention (SAR personnel and ship crews)	
Anticipation and prevention of threats to personal safety (passengers, SAR personnels and ship crews)	
Environment	
Planning and conducting of oil combating	12.10
Estimation of the spread of dangerous goods in accident situations	
Material	
Prevention of damage to materials – damages to equipment and hull – planning and execution of salvage operations	0.10
Maintenance and repair planning	
Prevention of material losses including cargo damages and damages caused by ice	0.05
Shipbuilding	
Economic	
Savings in SAR operation costs resulting from the reduced number of accidents	0.24
Evaluation of required human resources, facilities, equipment and material	
Planning and scheduling of transportation routes – route planning for single passage – fleet transportation routes – speed optimisation – reduced bunker consumption (single passage)	0.9
Planning and execution of icebreaking services	
Marketing of sea voyages (passenger vessels seasonal traffic)	
Prevention of costs and penalties of delays in scheduled traffic or tramp shipping (breach of contract, planning of chartering agreements)	0.07
Economic benefits in total	**30.9–48.5**
Share of Finnish Meteorological Institute of the production of meteorological services to maritime traffic	**80%**
Million € per annum	**24.7–38.8**

3.4 Aviation

Objectives

This study focused on the potential socioeconomic benefits of meteorological services gained by different actors of the aviation sector in the South Eastern Europe (SEE) countries of Albania, Bosnia Herzegovina, FYR Macedonia, Moldova and Montenegro. One of the aims of the study was to identify the potential benefits that could be gained by enhancing the present meteorological services.

Methods

The aviation sector is still quite modest in the countries under discussion. The number of flights, trips and volume of air freight is however anticipated to grow. The estimates of current savings shown below (Table 10) are mainly based on the number of passengers, freight and flights per year on 2005–2006 level, compared to Croatian and Finnish numbers. For Moldova it was also possible to calculate some additional ratios. Unfortunately it was not possible to treat Serbia and Montenegro separately. The main shortcoming in the input data concerning all countries was the lack of comparable accident data, so it was in general assumed that the safety situation is on a European average level, even though the current situation may be somewhat worse.

The benefits are scaled down using Purchasing Power Parity comparisons collected by the Finnish statistical agency. About two thirds of the impacts (like accident costs and labour) were scaled using PPP ratios, but for fuel costs, prices of aircraft, etc. international values were seen appropriate.

Future development and potential total savings are mainly based on the assumption that the number of weather related accidents will decrease due to better production, distribution and use of meteorological information.

Results

Table 10 presents the estimated current benefits for aviation, and a rough estimate of the level of benefits that can be achieved if all potential of meteorological information is taken to use in the SEE countries. This especially involves improvement of safety. It has to be remembered that the calculations are based on current volumes.

Table 10. Benefits of meteorological services for aviation in selected SEE countries in 2005.

Benefits of meteorological services for aviation	Current savings million €/year	Potential benefit million €/year
Albania	2–4	6.5
Bosnia and Herzegovina	0.5	1
FYR Macedonia	2–3.5	5.5
Moldova	2–4	6
Serbia and Montenegro	5.5–10	16
Croatia	12	15

Discussion

The main shortcoming of the project was lack of detailed up-to-date data. The parties involved did their best in achieving the information required for estimations, but a lot of information was not received. Therefore many local circumstances have been ignored, and many figures are based in direct comparisons to neighbouring countries, especially Croatia, to international average figures, and to the situation of the Finnish aviation sector.

The calculations shown here are based on current volumes. As aviation (flights, passengers and freight) is growing, also the benefits will raise approximately at the same rate.

The economies of the countries are also growing. This means that the Purchasing Power Parities will gradually approach the European averages, which also increases the socio-economic benefit further.

3.5 Construction industry

Objectives and methods

This study focused on the potential socioeconomic benefits of meteorological services on the construction sector in South Eastern Europe countries of Albania, Bosnia Herzegovina, FYR Macedonia, Moldova and Montenegro. The scope was the whole construction sector including all activity in the gross national product (new building, renovation, and civil engineering). The potential benefits of the maintenance phase were not evaluated as the data of the maintenance part of the gross national product was unavailable.

Answers to questionnaire studies (Appendix A) were only received from Moldova. The evaluation based on application of cost model developed on earlier studies (Hautala and Leviäkangas 2007, Leviäkangas et al. 2007) and statistics. The federal construction profiles were unavailable. The only available figure was the percentage of construction of the gross national product. This figure was available for FYR Macedonia, Moldova and Montenegro (WIIW 2006). The figure is unavailable for Albania and Bosnia. The gross national product percent of construction varied between 3% and 5%. The evaluation used country specific data for FYR Macedonia, Moldova and Montenegro. For Albania and Bosnia the estimated value of 4% was used. In the cost model the gross national product percent of construction is shown as the variable BV (building volume).

Results

In target countries the following factors can cause problems for construction:

- severe winds from the sea or the mountains
- sudden snowfall
- heavy rains.

Weather can cause hazards and additional costs for construction at the earth work, foundation and framework stages. In addition weather causes the risk for damp damages in the mounting of moisture barriers and heat insulation especially in roofing. The costs of earth work, foundation and framework, and external surface structures represent about a third of the construction project costs. In the cost model the symbol used for the variable is y (relation of building costs).

The quantity of the weather risk is difficult to estimate. It depends greatly on the starting time of the construction and on the preparedness to elimination of risks due to weather at the site. There is no research available on the quantity of weather risks in the target countries. The cost model assumes that the risk is as great in all the countries and accounts for 3% of the earth work, foundation and framework and external surface structure installation costs. In the cost model the symbol used for the variable is z (risk for additional costs).

The savings of using the weather services were estimated using the above-mentioned three variables as

$$S = BV \times y \times z \tag{1}$$

where S = the potential savings of using the weather services

BV = building costs that can be affected by the weather services (the potential savings percent, 33.3% in all the countries)

y = the potential savings percentage of earth work, foundation and framework and external surface structure installation costs (% BV)

z = the quantity of weather risk of earth work, foundation and framework and external surface structure installation (% y)

Table 11 shows the weather related additional costs for construction.

Table 11. The cost risks due to weather in the South Eastern European countries (2005 price level).

	Variable	Albania	Bosnia-Hertzegovina	FYR Macedonia	Moldova *)	Montenegro
2	GDP (M€ 2005)	6 724	9 878	4 634	2 400	1 642
3	GDP/PPP (M€, EU25)	15 189	22 978	12 227	6 900	3 494
4	Population	3 143 000	3 844 000	2 035 000	3 386 000	622 000
5	Shares of GDP					
6	– agriculture, fishing, forestry			10.8	18.0	10.8
7	– building	4.0	4.0	4.9	4.0	3.1
8	– transport and telecom.			8.1	12.0	10.3
9	Mean monthly income			21 330		
10	– (€)			*346*		326
12	Percentage of construction with weather risk, %	33.3	33.3	33.3	33.3	33.3
13	Construction value (2 × 7)	268.96	395.12	227.07	96.00	50.90
14	Percentage of construction with weather risk (12 × 13), M€	90	132	76	32	17
15	Weather risk z; %	3	3	3	3	3
16	Potential additional costs due to weather (14 × 15)	**2.7**	**3.9**	**2.3**	**1.0**	**0.5**

*) mean from several sources

The use of weather services can yield about 25–50% savings in additional costs. Risks due to weather can not be totally eliminated even with highly sophisticated weather services.

It is most sensible to begin the elimination of weather risk project wise. In larger construction projects the establishment of a weather service should be included in the organisation plan.

The construction sector will develop strongly in all target countries. This clear market potential should be utilized by hydrometeorological service providers.

3.6 Energy production and air quality

Objectives and methods

The aim of the work was to study, what the effects are of meteorological services and meteorological information on energy production and air quality in South Eastern Europe. Five countries – Albania, Bosnia Herzegovina, FYR Macedonia, Moldova and Montenegro – were included in the study.

However, answers to questionnaire studies (Appendix A) were only received from FYR Macedonia, Moldova, and Montenegro. In addition, FYR Macedonia and Montenegro did not provide any data on costs. This means that even rough benefit/cost ratios could not be calculated for these countries. Furthermore, all these countries import a big share of their electricity, so the national benefits of meteorological data in the energy sector will be a bit lower than in the case of 100% own energy production.

To summarise, only qualitative results and (highly speculative) comments are presented in this study concerning the energy production sector.

Qualitative results

Moldova

The Moldovan energy sector and weather services

State enterprise "Moldelectrica" produces, buys and sells electricity of which 3/4 is imported (even the gas pipeline network is partly owned by Russian Gazprom). The main challenge in Moldovan energy sector is to create its own energy production facilities. This would need some private companies with an ability to make big investments. Then, privatisation of the energy sector would also be easier.

However, Moldelectrica estimates that even 90% of damages caused by bad weather conditions could be prevented by tailor-made weather services. There are already some weather services for the energy sector produced by SHS (State Hydrometeorological Service), but the quality and lead time of data could be better. There is a lack of technologies to improve the weather service system. SHS mentions season weather forecasts as future demand of weather services.

SHS has also estimated that 5 million leu and 5 (15→10) human lives could be saved by using weather information in energy sector. The costs of tailor-made weather services would probably be much lower than the monetary value of these savings. In other studies, benefits/costs (B/C) ratios of 3–7 have been reported in international studies. For example, on the basis of our study in Finland (Hautala and Leviäkangas 2007), the benefits were assessed as factor of three (at least) for energy weather services provided by the Finnish Meteorological Institute (FMI).

Montenegro

In Montenegro, also state owned (mainly) enterprise Elektroprivreda Crne Gore AD (EPCG) dominates the national energy sector. Hydro power is a very important source (nearly 2/5) of all electricity in Montenegro (Table 12). However, 38% of electricity consumed is imported. Less than a quarter of electricity is produced by conventional thermal facilities.

Table 12. Historical summary of Montenegro's annual electricity generation and consumption in GWh/a.

	2002	**2003**	**2004**	**2005**	**2006**	
Net generation					GWh/a	%
- hydroelectric	1095	1533	2231	1857	1743	38.5
- conventional thermal	1099	1074	955	890	1076	23.8
Imports	2037	1786	1324	1587	1707	37.7
Total electricity consumption	**4231**	**4393**	**4510**	**4334**	**4526**	100.0

According to EPCG, the main weather impacts are damages to the electricity transmission network. Drought/flood/dam control is important due to the high share of hydro power production. Meteorological and hydrological data is already used in hydro power production for dam controlling and production planning is provided by Hydro-meteorological Institute of Montenegro.

EPCG stresses that it is needful to get good information about Met-forecasts and hydrological data in order to plan electricity consumption and production as well as control the production facilities. It is also necessary to improve collection of hydrological data and flood forecasts. In addition, they have a need for historical meteorological data. EPCG would also be willing to invest some money to get tailor-made weather services especially concerning:

- communication on expected extraordinary hydrological conditions for the next 1–3 days
- flood warnings, hydrological forecasts, on-line hydrological data
- season weather forecasts.

FYR Macedonia

The answers from FYR Macedonia were very minor. The following weather services were mentioned as present services:

- precipitation, wind and air temperature forecasts
- flood warnings
- hydrological forecasts
- availability of historical meteorological data.

Any required new services were not mentioned.

The meteorological and hydrological services needed in energy sector

Assessment of the services needed in studied countries (Moldova, FYR Macedonia, Montenegro) is based on earlier studies in Finland (Hautala and Leviäkangas 2007) and in Croatia (Leviäkangas et al. 2007).

Plenty of weather information is needed when power plants and electricity grids are operated optimally and as planned. Security of energy supply is usually the most important thing in energy production and distribution. This is even more important when speaking of industrial customers and their production facilities. Even short power failures could harm the industrial activity and are costing much. That's why energy producers have to foresee possible threats that e.g. changing weather conditions may cause.

The use of tailor-made meteorological and hydrological services (forecasts, warnings etc.) is one of the key things to be in control of in order to track changing weather conditions and keep the electricity grid stabilised at all hours. The main problems created by exceptional weather conditions in electricity supply are (according to questionnaires):

- power supply failures
- damage to buildings and plants
- non-completion of planned work and generation shortfalls
- increase in maintenance costs for buildings and plants
- increased energy consumption
- overflows.

The main impacts of these problems caused by bad weather conditions are:

- interruptions in electricity supply to industry, households and other consumers
- destruction of the transmission network (towers/lines) due to wind/ice
- lock-out of switches and puncture of insulation caused by salt sediments on cross-island connections and in the littoral part

- damage to embankments and rock-fill dams caused by ice and waves as a result of prolonged low temperatures and strong winds
- draught/flooding have an adverse impact on the implementation of generation plans, i.e. the pace of completion of works related to the construction and maintenance of plants.

Monetary values of these impacts are not separately specified. However, costs could be reduced by additional weather/hydrological information services that could help overcome such damages. These are for example:

- precipitation, wind and air temperature forecasts for plant locations
- communication on expected extraordinary meteorological and hydrological conditions for the next 1–3 days
- season weather forecasts
- on-line hydrological data
- availability of historical meteorological data
- hydrological forecasts.

Some recommendations

According to the results of this questionnaire (Table 13) and previous studies (Hautala and Leviäkangas 2007, Leviäkangas et al. 2007), it seems to be very profitable to develop some tailor-made weather and hydrological services by national meteorological/hydrological institutes for the energy sector. Some examples of these could be:

- "energy weather" service (for different time-scales from 12h warnings to one month or seasonal forecasts); especially 1–3 day's warnings and forecasts
- storm/thunder/lightning warnings
- on-line hydrological data and flood warnings.

Air quality

Environmental and health impacts of polluted air can also be reduced (including environmental accidents) with reliable and well-timed weather information, by measuring air quality and by using e.g. dispersion models for predicting the transportation of emissions. Air quality forecasts and warnings could be developed further in the near future by national meteorological institutes to reduce adverse health impacts (e.g. fine particles cause pulmonary diseases and deaths especially for asthmatics and older people). Especially, in the case of possible serious environmental accidents the possible evacuations (e.g. by the national rescue operation authorities) could be done with the help of real-time dispersion models even saving human lives.

It is difficult (and perhaps no need) to calculate the cost/benefit ratios of these kinds of services. But when speaking of human lives the benefits are obvious.

Table 13. The main results of questionnaires.

Industry / Sector	Main impact mechanisms	Main benefits	Current annualised value
Energy production (provided already)	Energy production forecasts (operation control); Security of supply (operation, maintenance, damage prevention); Infrastructure (electricity grids); Hydro power (dam controlling, overflows);	Prediction of power demands; Power failure reduction; Savings in material (damages) and working time (repairing, maintenance costs); Prevention of damage to buildings and plants; Avoiding generation shortfalls and overflows; Energy savings	1. Electricity production: – Moldova: 0,3 M€ (1 (5 MDL) and 5 human lives – FYR Macedonia: n.a. – Montenegro: n.a.
		Reducing adverse health impacts; Saving human lives in possible environmental accidents (evacuations)	2. Other energy (heating plants, oil and gas production etc.): unknown
Air quality monitoring and warnings (in the future)	Air quality forecasts and warnings (in future); Health impacts (fine particles causing pulmonary diseases and deaths)		3. Air quality (dispersion models): 0 M€/a at the moment, some future potential; very useful for the authorities

1) Source: http://www.finpro.fi/NR/rdonlyres/6136480A-D447-45C6-A5EC-7EA5008C4BBD/9952/DRFMaaprofiiliMoldova080503sspf1.pdf (Finnish) accessed May 2007.

3.7 Flood protection

Objectives and methods

This study focused on the socioeconomic benefits of meteorological services gained by different national stakeholders. The aim of the work was to assess potential benefits within the field of flood protection. The following countries in South Eastern Europe were included in the study: Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova and Montenegro.

The results of the study are based on a survey targeted to experts in participating countries, personal interviews and statistical information related to the countries. Questionnaires covering the information needed for the evaluation were prepared and sent to the relevant stakeholders in target countries. The aim was to identify the availability of different weather service types, the need for improved services, potential benefits of improved services and to gain statistical information for the estimations on the values of the benefits.

The main source of information was The International Disaster Database. In order for a disaster to be entered into the database at least one of the following criteria has to be fulfilled:

- 10 or more people reported killed
- 100 people reported affected
- a call for international assistance
- declaration of a state of emergency.

Results

Only a few answers were received to the questionnaire, mainly from Bosnia-Herzegovina and Moldova. That is why this study is based almost completely on the statistical data available in the International Disaster Database. The information available was, however, not adequate for a complete analysis of the values of benefits gained by improved meteorological services. Thus, the evaluation merely gives a general idea of the types of benefits and their economical value.

The damages caused by the floods concerns many different sectors in the target countries. Damages are evident within the sectors of agriculture, infrastructure, construction, energy production and so on. However, it is not possible to assess current losses and potential benefits by sectors due to scarce basic data. The number of people affected by single floods easily reaches tens of thousands, in some cases even hundreds of thousands, in case of disastrous floods. The amount of people killed is usually less than 10 during disastrous floods but have reached 15 in worst cases. The value of material losses caused by a single flood may be hundreds of millions US$.

The ratio between human losses and material losses varies not only with the quality of existing meteorological services and warning systems but it is also strongly related to the development phase of the country. Wherever development (increase of GNP) takes place, the shift from loss of human life to increased economic losses is evident. This well known fact could not be exploited in this study due to lack of relevant background data and that is why only the economical benefits related to material losses were estimated. Table 14 presents the summary of these results.

Table 14. Socioeconomic benefits of meteorological and hydrological services for flood protection in selected SEE countries.

	Albania	Bosnia-Herzegovina	FYR Macedonia	Moldova	Monte-negro	Croatia
GDP M€*	6 724	9 878	4 634	2 400	1 642	30 949
GDP/PPP M€*	15 189	22 978	12 227	6 900	3 494	50 831
PPP USD*	5 302	7 929	7 221	2 658	3 800	13 342
Benefits MUSD/year**	0.07	3.03–9.09	2.52	1.22	0.3	2.0 ***
Benefits MUSD/average flood**	0.35	5.0-15.0	5.05	3.05	3.05	–
Benefits MUSD/maximum flood**	1.75	–	35.0	9.0	–	–
Estimated socioeconomic benefits MUSD/year	**0.07–1.75**	**3.0–15.0**	**2.52–35.0**	**1.22–9.0**	**0.3–3.05**	**2.0*** **

* 2005

** Benefits caused by improved weather services for flood protection

*** M€

– no data available

The baseline facts and results of the study are presented in the following paragraphs for each of the target countries.

Albania

In Albania rivers are subject to sudden spates in rainy periods (winter and spring). The consequences of floods are considerable, especially in the low-land regions. Warning systems are in place. Flood protection works consist solely of maintenance. The annual budget for maintenance has been US$ 0.3 million/year during the last 10 years.

The list of ten most serious natural disasters during the period 1967–2005 includes 3 floods (if sorted by numbers of people killed), 4 (if sorted by numbers of total affected) and 4 (if sorted by numbers of economic damage costs). The portion of the occurrence of floods of all natural disasters has been 35% during the period 1967–2005 and 47% of weather dependent natural disasters. A summarized table of floods in Albania from 1967 to 2005 is presented below (Table 15) (EM-DAT).

Table 15. Floods in Albania from 1967 to 2005.

# of events / average per year	Killed / average per event	Injured	Homeless	Affected	Total affected / average per event	Damage US$*/ average per event
7 /0.2	19/3	0 *	0 *	116 384	116 384 /16 626	24 673 000/ 3 525 000

Total affected = Sum of injured, homeless and affected

* Data base defective

If a conservative estimate of 10% reduction in flood related losses is used, it means that potential savings are about US$ 352 500 per event (major floods). However, the last major flood in 2002 caused damage worth of US$ 17 500 000, potential savings would then be US$ 1 750 000 (1 407 000 €) per similar event.

If potential savings are estimated on a yearly basis, it would mean that US$ 70 500 (about 56 700 €) would be saved annually.

Bosnia-Herzegovina

The responsibility for flood protection in Bosnia-Herzegovina is in the Federation and Canton levels. On a Federation level the responsible authorities are the Government of Bosnia-Herzegovina, Federal Ministry of Agriculture, Water management and Forestry, Public Water Management Enterprise Watershed Sava River, Public Water Management Enterprise Watershed Neretva River, Federal Hydrometeorological Institute and Federal Civil Protection. On the Cantons level the responsibility is on cantonal ministries, municipalities and towns, Civil protection and Public Communal Enterprises. Some type of flood warning system is available by the Federal Hydrometeorological Institute. The amount of money spent annually for flood protection is about 2.0–2.5 million €.

According to Public Water Management Enterprise Watershed Sava River approximately 30 to 40% of the damages could be prevented if NM-services were improved and used for flood protection. The current level of lead time for standard/tailored forecasts does not meet the needs of flood protection. Early warnings and exact forecasts (new forecast models) are needed. Contradictory comments were received concerning the use of hydrometeorological services in strategic and annual work planning and budgeting within the flood protection sector. The flood protection sector seems to be willing to invest in the strengthening and operation of the relevant agencies in order to promote provision of better and tailored products and services.

The list of nine most serious natural disasters during the period 1999–2005 includes 4 floods (if sorted by numbers of people killed), 4 (if sorted by numbers of total affected) and 4 (if sorted by numbers of economic damage costs). The portion of the occurrence of floods against all natural disasters has been 36% during the period 1999–2005 and 36% of weather dependent natural disasters. A summarized table of floods in Bosnia-Herzegovina from 1999 to 2005 is presented below (Table 16) (EM-DAT).

Table 16. Floods in Bosnia-Herzegovina from 1999 to 2005.

# of events / average per year	Killed / average per event	Injured	Homeless	Affected	Total affected / average per event	Damage US$/ average per event
4 /0.6	0	0 *	0 *	290 000	290 000 /72 525	–

Total affected = Sum of injured, homeless and affected

* Data base defective

– No data available

In Bosnia-Herzegoniva potential savings in material losses could be 30% (this figure is based on the returned questionnaires). If average damage per event is in the same magnitude as in FYR Macedonia, it means potential savings of about US$ 15 000 000 per event. However, if a conservative estimation is used (10%), potential savings would be US$ 5 000 000 (4 020 000 €) per event.

If potential savings are estimated on a yearly basis, it would mean that US$ 3 000 000 – US$ 9 000 000 (2 412 000–7 236 000 €) would be saved annually.

FYR Macedonia

The list of ten most serious natural disasters during the period 1993–2006 includes 4 floods (if sorted by numbers of people killed), 7 (if sorted by numbers of total affected) and 4 (if sorted by numbers of economic damage costs). The portion of the occurrence of floods against all natural disasters has been 54% during the period 1993–2006 and 54% of weather dependent natural disasters. A summarized table of floods in FYR Macedonia from 1993 to 2006 is presented below (Table 17) (EM-DAT).

Table 17. Floods in FYR Macedonia from 1993 to 2006.

# of events / average per year	Killed / average per event	Injured	Homeless	Affected	Total affected / average per event	Damage US$*/ average per event
7/0.5	2/0	0 *	150	111 250	111 400/ 15 914	353 600 000/ 50 514 000

Total affected = Sum of injured, homeless and affected

* Data base defective

Potential savings in material losses are US$ 5 051 400 per event (10%). The flood in 1995 caused damage worth of US$ 350 000 000, potential savings would then be US$ 35 000 000 (28 140 000 €) per similar event.

If potential savings are estimated on a yearly basis, it would mean that US$ 2 525 700 (about 2 030 700 €) would be saved annually.

Moldova

The Republic of Moldova suffers from flooding almost every year. There is an early warning system available for natural disasters, including flood warnings, run by the Department of Emergency Situations. The same department is also responsible for flood protection. Even though flood protection activities depend totally on relevant hydro-meteorological information, hydro-meteorological services are not taken into account in the strategic planning, annual work plan or budgeting within the flood protection sector. However, the willingness to invest in the strengthening and operation of the relevant service producer in order to promote provision of more accurate and tailored products and services is negligible.

The list of nine most serious natural disasters during the period 1994–2006 includes 5 floods (if sorted by numbers of people killed), 5 (if sorted by numbers of total affected) and 5 (if sorted by numbers of economic damage costs). The portion of the occurrence of floods against all natural disasters has been 50% during the period 1992–2006 and 50% of weather dependent natural disasters. A summarized table of floods in Moldova from 1994 to 2006 is presented below (Table 18) (EM-DAT).

Table 18. Floods in Moldova from 1994 to 2006.

# of events / average per year	Killed / average per event	Injured	Homeless	Affected	Total affected / average per event	Damage US$/ average per event
5 /0.4	24/5	0 *	849	25 243	26 092 /5 218	152 584 000/ 30 517 000

Total affected = Sum of injured, homeless and affected

According to State Hydrometeorological Service (SHS) flooding caused damages worth of 2 850 000 US$ during 2005–06. They have also estimated that 1/3 of the damages could be prevented by using improved NMS-services. The current level of the lead time of standard/tailored forecasts is very poor compared to the needs of the flood protection sector. Future needs consist of improvement of lead time and forecasting accuracy.

In Moldova savings in material losses could be at least 10%, meaning about US$ 3 051 700 per flood. The flood in 1994 caused damage worth of US$ 90 000 000, potential savings would then be US$ 9 000 000 (7 236 000 €) per similar event.

If potential savings are estimated on a yearly basis, it would mean that US$ 1 220 600 (about 981 400 €) would be saved annually.

Montenegro

The nearby areas of River Zeta, River Tara and Lake Skadar suffer from floods. Montenegro has special procedures for flood protection activities and applying of measures.

The list of ten most serious natural disasters in Serbia-Montenegro during the period 1992–2006 include 2 floods, if sorted by numbers of people killed or by numbers of total affected or by numbers of economic damage costs, which occurred in Montenegro. The list of major floods in Yugoslavia during 1964–1990 includes 2 floods which occurred in Montenegro. A summarized table of floods in Montenegro from 1979 to 2006 is presented below (Table 19) (basic data from EM-DAT, adapted, some of the floods occurred during the former Yugoslavia).

Table 19. Floods in Montenegro from 1979 to 2006.

# of events / average per year	Killed / average per event	Injured	Homeless*	Affected	Total affected * / average per event	Damage US$/ average per event
4 /0.1	23/6	–	6 000	21 000	27 000 /6 750	–

Total affected = Sum of injured, homeless and affected

* Data base defective

– No data available

In Montenegro potential savings in material losses could be 10%. If average damage per event is in the same magnitude as in Moldova, it means potential savings of about US$ 3 051 700 (2 453 600 €) per event.

If potential savings are estimated on a yearly basis, it would mean that US$ 305 100 (245 300 €) would be saved annually.

Discussion

Weather forecasts are the most important basis of the human adjustment exercise. Evacuation of people and property, river protection works and societal activities themselves are dependent on the availability of relatively accurate and timely weather and flood forecasting. For predicting floods, the integration of atmospheric processes with hydrological processes, especially land surface processes, is indispensable (Takeuchi 2001). However, one of the main problems in flood forecasting and early warning is to determine how much warning is enough. Using a system that has an effective warning rate of say 70% may cause a reduction in flood related losses of 40%, whereas a 90% effective system may only reduce losses by 43% (NBCBN 2005).

The ratio of material losses to number of deaths (caused by flooding) is clearly different in developing countries and developed countries. The shift from loss of human life to increased economic losses is evident wherever development is taking place. Moreover, various flood control measures have shifted flood losses to a large extent from human casualties to economic losses (Takeuchi 2001). For catastrophic floods in developing countries, material losses per one fatality can be as low as US$21 000, while in developed countries they can be up to US$ 400 million (Kundzewicz and Takeuchi 1999). The ratio of material losses to number of deaths (in simple words, material losses per one death) as a function of GNP per capita is presented in an illustration in Appendix E.

It is extremely difficult to ascertain the impacts of improved technologies in hydrologic forecasting and the emergence of the automated local flood warning systems. Similar floods of magnitude and frequency do not necessarily equate to identical benefits. However, in general, hydrologic forecasts together with automated local flood warning systems and flood-control structures accomplish their intended purpose to reduce damage and loss of life from flooding. There are several examples of reported economic benefits associated with advanced hydrologic forecasts (AHPS). In Iowa AHPS forecasts reduced annual flood damages by 35% when compared to non-AHSP forecasts. In North Carolina a flash flood occurred in 1990. As a result of flash warnings and subsequent actions, no lives were lost. It is reasonable to assume in similar flash flood events that over 20 people would have drowned (National Hydrologic Warning Council 2002).

Forecasting and warning, when coupled with effective response plans, enable citizens and public servants to act to protect people and property before floodwaters reach critical levels. With sufficient warning, for example, actions like temporary removal of property from flood plains can be taken. If suitable actions are taken in a timely manner, tangible benefits accrue, especially in terms of inundation damages being reduced (National Hydrologic Warning Council 2006). Day (1970) proposed the function shown in Appendix E to estimate the value of the damage prevented as a function of warning time increase. With this, it can be predicted, for example, that if the warning time increases from 0 to 4 hours with data collection, evaluation, notification, and response, damage incurred would be reduced by about 10%. Similarly, if the warning time is increased from 4 to 12 hours through addition of features or enhancement of the warning system, Day's curve predicts an incremental decrease of 12% in the annual damage. The Day curve also suggests that no matter how great the warning time, the maximum possible reduction is about 35% of the total damage due to the flood. This is logical, as some property, including most structures, simply cannot be moved. According to Institute for Water Resources (USACE 1994) the Day's methodology is perfectly applicable today. However, it suggests that the curve should be calibrated to account for the differences in the contents of residential structures of 1970 and the present and for other regional and system differences.

Many studies indicate a 12.5 to 43% reduction in flood damage due to short-term hydrologic forecasts. The U.S. Weather Bureau in its summary report estimated a ten percent reduction of flood damage using hydrologic forecasts for short-term events. 10% was selected as the conservative estimate. It still seems to be a viable and conservative estimate (National Hydrologic Warning Council 2002).

Besides socioeconomic benefits related to flood protection, improved meteorological and hydrological services also constitute important input for many other water resources systems, e.g. irrigation (agriculture), hydropower generation (energy) and water supply.

Main uncertainties and problems in this study were the following:

- The basic data relies practically on one reference, The International Disaster Database, which has its own faults and limitations
- The incidence of floods varies irregularly and considerably
- Data concerning other than disastrous floods was not available
- The assessment of the reduction potential of material losses is possible at a general level; however, in the future material losses will grow even though improved meteorological services were available
- Due to insufficient country specific data, it was not possible to assess the number of human lives which could be saved in each of the target countries if improved meteorological services were available
- Material losses are based on individual floods, as the yearly losses are not known; the yearly savings (benefits) were only estimated.

3.8 Agriculture production

Objectives

The most weather prone sector in our societies is agriculture. Land use, crop selection, and farming practices are all directly dependent on the prevailing local climate. Major parts of the farming products are very vulnerable for unfavourable weather conditions and thus the value of the use of meteorological information can be considered substantial. Climate variability and climate change have large impacts in crop growth and development, crop yields, and activities such as shift in cropping periods, crop rotations, and modifications of cropping systems. We are facing new threats through deforestation, wind erosion and water erosion, more agricultural use of sloping lands, migration into vulnerable areas, and new insect pests. Climate variability and change, in all contexts, represents a factor of risk, which can have the dimensions of disaster in fragile and more vulnerable environments. Agro-meteorology can help us cope with these environmental hazards and mitigate their negative impacts.

The importance of weather services to agriculture

Given the fact that weather affects every stage of farming activities in one way or the other the benefits gained by the specialized weather forecasts for farmers are quite obvious. The benefits may be directly economic in production costs, for instance through preventing crop losses by sprayings. Reliable and frequently updated weather forecasts also make decision-making and planning of the farming activities a lot easier.

Weather forecasts ranging from a few hours up to seasonal forecasts have a great importance in various phases of agricultural activities. At the beginning of the growing season correct timing of sowing is essential for the yield of spring grain. Successful plant protection of spring cereals and sugar beet calls for exact and correct timing. Five-day weather forecasts are then of crucial importance for work planning; the time of e.g. surface harrowing is vitally dependant on the rain, air temperature and air humidity expected. In the dry early summers, irrigation has proved to produce substantial increase in yield as well as improvement in quality of yield. Reliable weather forecasts are also crucial for the quality and quantity of the yield during harvesting.

Typically agro-meteorological services are provided by National Meteorological and Hydrological Services (NMHS) as part of their daily operational service. This service includes meteorological information given on radio, television and in daily newspapers. Meteorological services for agriculture are also available on Internet web sites maintained by NMHS respectively.

The meteorological information is needed to guarantee that the agricultural production is as effective as possible and to ensure high quality of agricultural products. The benefits that can be gained by effective agro-meteorological services encourage to maintain and to further develop these services. An effective use of meteorological information helps to optimize the use of fertilizers and pesticides, which benefits in lower costs for farmers but it has highly favourable effects on environmental protection too.

Earlier studies

The UK Met Office has increased the economic benefit to the user by providing a package of weather information tailored to their business activities. They have shown that an understanding of the market place and business practice is essential to those who provide meteorological information. In the process of increasing benefits the industry must also be educated in the need to use weather information in the decision-making process. Studies by Met Office have provided information on quantitative benefits for specific services. For example one of the companies had estimated potential annual savings from meteorological service to be in the order of £700 000, with a benefit-cost ratio of about 30. The studies have also shown the importance of qualitative benefits to industry. Most participants in the study perceived the main benefits as being the usefulness of the forecast in supporting and aiding management planning (Ballentine 1994).

A research study of enhanced cottonfields weather service was carried out 1997 in Australia. The analysis of this survey revealed that annual gross benefits were about A$397’150 for cotton production only. The total annual costs incurred by cotton producers for the use of the service were A$31 590. Hence the benefit–cost ratio of this specialized weather service was 12.6 (Anaman et al. 1997). The majority of the users of this weather service indicated that it provided them with some non-financial benefits too. About one third of the users reported that the service assisted them in their general household planning and decision making. Planning of outdoor and recreational activities was identified as the second most important non-financial benefit of the service.

In Finland a survey research was carried out during the development of farmers’ weather service (Ansalehto et al. 1985). This study was carried out in 1983–1984 in a local area in Southern Finland; 230 farmers participated in this study. Farmers were offered weather forecasts specifically tailored to agricultural purposes through an automatic answering machine five days a week from May to September during the research period. Farmers were presumed to be able to make good use of the specialized meteorological information on their own and they were not given any training for utilization of the meteorological information. The evaluation of the research was done by questionnaires mailed to the farmers participating in the project. The study revealed that it was very difficult for many farmers themselves to assess the amount of the economic benefit gained from the specialized meteorological services. The economic benefits were then summed up from the assessments made by the farmers with the help of agro-meteorological experts. Results of the study revealed that the economic added value benefits given by the specialized weather services (taking into account the change in the cost-of-living index from 1984) for 2006 in Finland for the main sectors of farming activities were:

– sowing	12 million € / a
– spraying and protection	8 million € / a
– harvesting	12 million € / a
– other actions	2 million € / a
Total	34 million € / a

An estimate of economic benefits gained by agro-meteorological services in South Eastern European countries

To be able to estimate potentials in the added value economic benefits of specialized meteorological services in the South Eastern countries of Europe we have used the results found in the Finnish study as a template for our assessment. By assuming that the benefits of well organized agro-meteorological services in Finland are 34 million €/year and the value of agricultural production in Finland is 6 876 million US$[3] we end up with a conclusion that the ratio between the agricultural production and benefits is approximately 0.005. By multiplying the value of agricultural production in each of the South Eastern European countries with this figure we get estimates on how large the benefits can be gained by well organized meteorological services (Table 20).

Table 20. The estimated added value of economic benefits that can be gained by agro-meteorological services in the South Eastern European countries. GNI values of various countries are taken from the statistics provided by the Ministry for Foreign Affairs of Finland[4].

	Albania	Bosnia-Hertzegovina	FYR Macedonia	Moldova	Serbia / Montenegro	Croatia
GNI 2004 in million constant 2004 $US	6 600	8 000	4 900	2 600	21 800	30 300
GNI 2004 in million constant 2004 $US by Agric	3 366	960	588	728	4 360	3 030
Economic benefits of met.serv. M€	16.6 (20$US)	4.7 (5.74$US)	2.9 (3.5 $US)	3.6 (4.3 $US)	21.6 (25.9$US)	15.0 (18$US)

3 http://global.finland.fi/public/default.aspx?nodeid=32367&contentlan=1&culture=fi-FI

4 http://global.finland.fi/public/default.aspx?nodeid=32367&contentlan=1&culture=fi-FI

The costs caused by unfavourable weather conditions on agriculture in the South Eastern countries of Europe are also substantial. Thus there lie potentially additional economic benefits through enhanced weather forecasts in preventing, at least partially, the damage caused by hail, frost, drought and floods. For instance in Croatia the costs for damage caused by these unfavourable weather events are annually on average (avg. 1995–2005):

– hail 42.7 million € / a
– frost 16.5 million € / a
– drought 50.6 million € / a
– floods 19.8 million € / a

Closing remarks and recommendations

It is recognised that there is some awareness of the impact that National Weather Service can bear upon various elements that contribute to socio-economic well-being, through the provision of information, products and services. However, what appears to be lacking is a clear and precise understanding of this impact. There is a need to provide quantitative assessments of this impact. This could be considered as one of the urgent tasks of the NMHSs, as well as those who collaborate with the role of NMHSs, such as the national planning offices. This can lead to an even greater appreciation of their role, a better definition of their capability, a consequently greater possibility of additional resources for the strengthening of the national meteorological services, and additional benefits to society.

The estimates presented in this publication are the first possible estimates taking into account the information available. The figures given are an estimate of the situation in such a case where agro-meteorological services are well organized. Even this short analysis demonstrates the large importance of meteorological services.

4. Summary of results and discussion

4.1 Benefits of hydrometeorological services

This chapter summarises the sector-wise results of the previous chapters. The main potential benefits of hydrometeorological services for transport, construction, energy production, flood protection and agriculture are shown in Table 21. The weights of different benefits are different in the countries involved (Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova and Montenegro). The impacts shown for each country represent the potential benefits, assuming that the services and information production are on the contemporary European level, and the information is accepted and utilised in all the sectors covered. This requires that the observation network, technological solutions, services, business models, know-how and training are all taken care of.

Table 21. The main qualitative benefits and impacts of meteorological and hydrological information services in general level.

Sector / industry	Main benefits and impacts
Road traffic	Accident reduction, savings in material and working times (road maintenance)
Railway traffic	On-time arrivals (time value), savings in passenger and working times (railway maintenance)
Maritime industry	Reduction of accidents and environmental damages, fuel savings, more efficient rescue operations
Aviation	Reduction of accidents and emissions; savings in fuel, passenger times, materials and working times (airport maintenance)
Construction production	Possibility to eliminate serious construction problems beforehand (risk controlling system)
Energy production	Prediction of power demands, power failure reduction, savings in material and working times (maintenance), energy savings
Air quality monitoring and warnings	Reducing adverse health impacts; saving human lives in possible environmental accidents (evacuations)
Flood protection	Savings in human lives and material damages, more efficient rescue operations
Agriculture production	Plant protection, crop dusting, right timing of harvesting

Table 22 presents the socioeconomic value of the benefits, covering the items that were possible to appraise based on the limited data available. The sectors concerned are transport (excluding maritime), construction industry, flood protection, and agriculture.

For energy production, only Moldovan data was available. Table 22 also shows Croatian estimates for comparison. Country by country figures are collected below.

In Albania advanced meteorological information systems would produce annual savings worth 24 to 26 million €. The main beneficiaries are agriculture and aviation.

In Bosnia-Herzegovina the potential annual benefits are about 10 to 22 million €. The most important sector making use of the meteorological services is flood protection. Additionally agriculture and aviation can benefit considerably.

Also, in the FYR Macedonia, flood protection would gain the most revenue from better hydrometeorological information, and aviation is the second largest benefiting sector. Total value of the benefits were estimated to be between 12 and 40 million € per year.

In Moldova the potential benefits of enhanced meteorological services were estimated to 12–19 million € per year. Aviation and flood protection would generate the most of these cost savings.

For Montenegro the data available did not enable the differentiation from Serbia for aviation and agriculture sectors. For road transport, construction industry and flood protection the annual savings resulting from better hydrometeorological information would be 1 to 3 million €. When looking at Serbia and Montenegro as one, aviation and agriculture would benefit up to 38 million € per year, out of which most would concern Serbia.

The scientific and technical improvements in monitoring, modelling and production of customer orientated services do not alone give added value to hydrometeorological services. Services have value only when the data and information are properly disseminated to the customers and end-users in an understandable form and further intercorporated in the decision making process of different socioeconomic sectors in order to foster their productivity and human safety.

It is estimated that the potential average annual economic effect of establishing good hydrometeorological services for agriculture, the transportation sector, the construction sector and for electricity production, combined with reduced costs in flood protection, could be around 140 and 200million € in total for the SEE countries including Croatia (Table 22). However, it is unrealistic to expect that these countries would achieve 100 per cent of potential benefits within the project window, as they will have to make and adjust too many changes in their hydrometeorological service production first. Assuming a conservative learning curve for improvement of services and exploitation of them among the economic sectors (ramping up to 75 per cent of the perfect level by the end of the fifth year, and up further from there as illustrated in Figure 4), it could be expected that a total effect over 10 years could be between 450 and 800 million €.

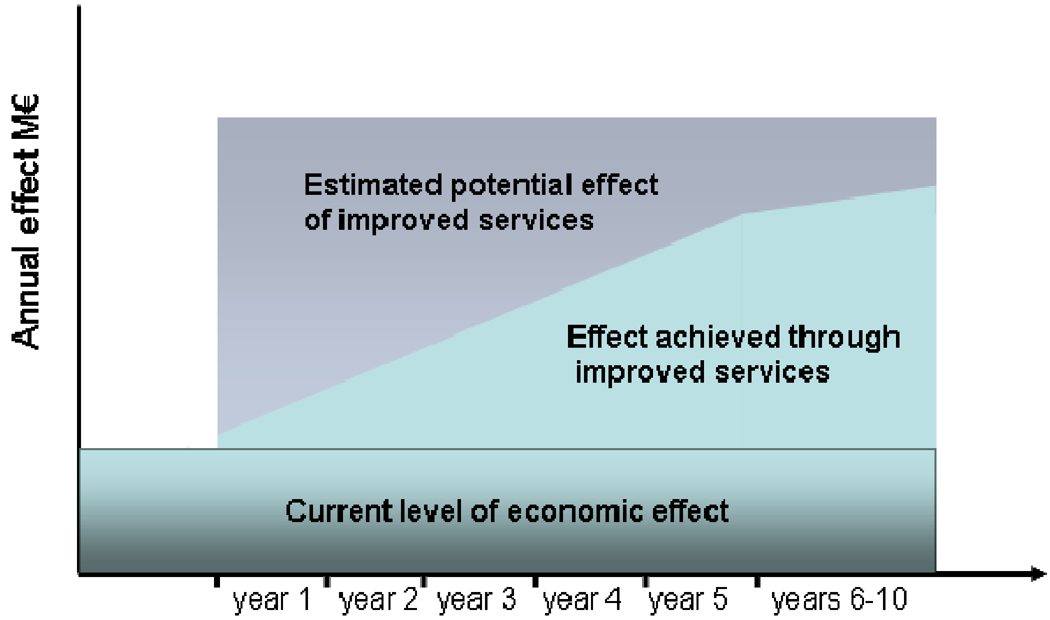

Figure 4. Schematic illustration of relationship (principle) between current economic effect, potential economic effect and estimated economic effect to be achieved (Tammelin 2007).

It is not possible to make all the required investments and strengthening of the human resources within one year. Thus, the investment and operation costs during the 10 year period depend much of the timing of big investments like weather radars. On the other hand it was shown by Tammelin (2007), that improved regional cooperation and data sharing would reduce the investment and operation costs by around 30% compared to the situation where hydrometeorological services were strengthened separately in each country.

The proposal to strengthen the hydrometeological services to an adequate level included modernization of communication systems, data management, meteorological and hydrological network, remote sensing network (weather radars, lightning detection and upper air observations), automation of the forecasting system, training, human resources and memberships of EUMETNET, EUMETSAT and ECMWF. The ratio of investments to benefits for the SEE countries commonly could be higher than the general 1:7 value given by WMO; in the long run (1–10 years) it could run from around 1:6 to 1:20. The calculated ratio varies widely from country to country. In some cases the ratio is lower; due for example to the small size of the national economy, or to the lack of beneficiary information from different sectors. However, if the NHMSs in the countries were strengthened individually as "stand-alone projects", the ratios are much lower.

Table 22. Potential socioeconomic benefits (million €/a) of meteorological and hydrological services in South Eastern Europe.

	Albania	**Bosnia-Herzegovina**	**FYR Macedonia**	**Moldova**	**Montenegro 1)**	**Serbia and Montenegro 1)**	**Croatia**	**Nota bene**
Road traffic	0.12–0.25	0.66–1.31	0.54–0.96	0.44–0.87	0.18–0.35		5.0–10.3 (current 3.1–6.2)	(basic public services)
Railway traffic	0.31	0.44	0.44	0.18	0.21		0.15	
Maritime industry	?	?	?	not relevant	not relevant		not assessed (current 4.3–7.9)	no input received
Aviation	6.5 (current 2.0–4.0)	1.0 (current 0.5)	5.5 (current 2.0–3.5)	6.0 (current 2.0–4.0)	?	16.0 (current 5.5–10.0)	15.0 (current 12.2)	Serbia and Montenegro
Construction production	0.68–1.35	0.98–1.95	0.58–1.15	0.25–0.50	0.13–0.25		1.5 (current 0.5)	
Energy production	?	?	?	current 0.3 (5.0 mill. MDL)	?		not assessed (current 2.0)	input received only concerning Moldova
Flood protection	0.06–1.41 (0.07–1.75 M$US)	2.41–12.06 (3.0–15.0 M$US)	2.03–28.13 (2.52–35.0 M$US)	0.98–7.23 (1.22–9.0 M$US)	0.24–2.45 (0.3–3.05 M$US)		2.0	1USD = 0.804 € (average rate 2005)
Agriculture production	16.6 (20 M$US)	4.7 (5.7 M$US)	2.9 (3.5 M$US)	3.6 (4.3 M$US)	?	21.6 (25.9 M$US)	15.0 M€ (current 5–10)	Serbia and Montenegro 1 USD = 0.833 €
Total potential benefits	24.3–26.4 M€/a	10.2–21.5 M€/a	12.0–39.8 M€/a	11.8–18.7 M€/a	0.8–3.3 M€/a	37.6 M€/a	43.0–53.9 M€/a	
Nota bene	Without railway, maritime and energy sectors	Without railway, maritime and energy sectors	Without railway, maritime and energy sectors	Without railway and maritime sectors	Inc. road traffic, construction and flood protection sectors	Inc. aviation and agriculture sectors	Maritime industry and energy production: current benefits	

4.2 Comparison to the Croatian study

When comparing the estimated benefits for Albania, Bosnia-Herzegovina, FYR Macedonia, Moldova, and Montenegro to the previous study done for Croatia, there are several aspects which have to be taken into account. The amount, accuracy and level of detail of available information were better in Croatia for most sectors. The benefits became higher, as in Croatia transport volumes are generally higher, the society relies more heavily on transport (phase of industrial development), and also maritime transport was included.

None of the countries currently studied was able to provide input concerning maritime transport. It is though evident that Albania could show considerable benefits from this sector, as well as Bosnia-Herzegovina with its one seaport. In the future, as transport and tourism will grow, Montenegro may also need better hydrometeorological services for maritime industry. FYR Macedonia and Moldova have only inland waterways, which were not covered in this study.

4.3 Estimate of source information and result reliability

Estimating the impacts of hydrometeorological services, their benefits, and the value of the information proved to be especially challenging in the area under consideration. The availability of information was generally poor. Only Moldova answered the questionnaire well, covering most sectors and aspects. In most cases there was need to supplement the information using general national and international statistics, which lead to varying levels of detail and accuracy, and in some cases even having to resort to use years old sources. Due to this, the overall accuracy of the results is somewhat lower than was planned, though the magnitude is correct.

Country-wise monetary values were not available. Therefore the values are based on Croatian, European, and Finnish valuations, which have been converted using Purchasing Power Parities.

Currency is euro (€), but as some input was received in US dollars ($), the amounts were converted using 2005 average (1 US$ = 0.804 €), except for agriculture, where 2004 exchange rate 0.833 was applied. The possible inaccuracy due to the need to convert figures using average exchange rates is not significant, taking into account the general level of the results.

4.4 Conclusions and recommendations

The benefits of meteorological services are largely based on better anticipation and planning of actions, better provision for different damages and accidents and decreasing the disadvantages due to them. Although in this study the lack of source information meant that only part of the potential benefits of meteorological services could be valuated at magnitude level for the studied fields of activities, the results show that these services are socially beneficial and worth developing. When studying the results one should note that a lot of actions and fields of activities implementing meteorological services were left outside the study.

As the community structure and operation processes of the countries develop, also the implementation need of meteorological services increases as the normal social functions are intensified. For future significance, impressiveness and benefits of hydro-meteorological services will probably still increase if the exceptional weather phenomena and as their result great natural disasters increase. The current conception is that these extreme events will increase due to climate change.

The realisation of the potential benefits requires comprehensive development of the hydrometeorological service systems. This means the development of observation infrastructure, data and transmission systems as well as service processes, operation models and know-how.

Not only should the services be developed, but their availability and usability should be improved, communications technology should be developed and awareness of the benefits of various services should be increased.

Increased awareness about the benefits and possibilities of the services will further the demand for the services and at the same time increase the impressiveness of the services and the implementation of the potential benefits. Current clients and other potential users should thus be made better aware of the possibilities of hydrometeorological services in the development of their operations. Client co-operation should also be exploited more efficiently in the identification of needs taking into consideration the different fields of operation and user groups.

The above also enables the obtaining of a better source of data for a more comprehensive and detailed evaluation of impacts and exploitation possibilities. The carrying out of these evaluations is recommended as part of a comprehensive development of the hydrometeorological service systems in order to realize them at a level whereby meeting the growing national needs, international demands and co-operation needs.

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Appendix A: Inquiry on social and economic benefits of national hydrological and meteorological services in South-eastern European countries

1. SEE Project – Common questions

Country: ______________________________

Respondent: ______________________________
e-mail: ______________________________
Organization: ______________________________

1. Please mark the meteorological and hydrological services that are available in your country at present. Please mark also the service provider with a letter:

M: national meteorological institute

P: some other public sector organisation

E: a private enterprise

X: some other organisation, please describe ______________________________

	Short-term forecasts published on mass media (for example, Radio, TV, teletext)	Short-term warnings distributed via mass media (for example, Radio, TV, teletext)	Forecasting and warning services via Internet (web pages)	Tailored forecasting and warning services distributed directly to end-users (e.g. by phone, telefax or email)
Road traffic				
Aviation				
Maritime				
Rail road				
Energy				
Construction and facilities				
Flood protection				

2. Which radio stations, television channels and web pages distribute weather-related warnings and forecasts in your country? Please write the channels of information (radio and TV stations and web pages) in the first column in the left and mark in the table the services they provide.

Information channels (below)	General short-term forecasts and nowcasts	Warnings on hazardous weather condition (public safety)	Weather-related warnings to road users	Weather-related warnings and forecasts targeted to maritime users	Weather-related warning and forecasts tailored to the needs of agriculture	Something else, for example mobile services (please describe)

3. Which of them (TV and radio channels and web pages, see question 2) use warnings and forecasts produced by national meteorological organisation?

4. What are the shares of different sectors in national economy (% of GDP at constant prices excluding taxes) for year 2005?

Sector	%
Road traffic	
Aviation	
Maritime	
Railroad	
Energy	
Construction and facilities	

Further information regarding the common questions of this questionnaire can be addressed to:
raine.hautala@vtt.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

2. SEE Project – Questions related to road traffic

Country: ____________________

Sector: **Road traffic**

Respondent: ____________________

e-mail: ____________________

Organization: ____________________

The following questions cover many aspects of road traffic (traffic safety, road winter maintenance etc.) as well as the operation of related organisations and relevant authorities. Please answer all questions that You have knowledge on. *If You don't have exact information on some of the asked matters, please do provide an estimation based on Your expertise.* Your input is extremely important for our study and we appreciate Your effort very much.

Questions related to road traffic can, for example, be forwarded to the organisations responsible or associated with the following issues and to the organisations named in the following lists:

Issues:
– Winter maintenance operators/contractors
– Authorities responsible for traffic information and road winter maintenance
– Authorities responsible for traffic safety
– Road safety organisations

Organisations:
– Meteorological and hydrological information / services provider(s)
– Ministry responsible for transport
– Ministry of internal affairs
– National road authority

1. What was the number of following traffic accidents in your country in 2005 (or the latest data available)?

	on public roads	on city streets and arterials
accidents involving death		
accidents involving personal injury only (no fatalities)		
accidents involving property damage only		

2. How large share of following traffic accidents happened in adverse weather and road conditions (snow, sleet or fog)?

	on public roads	on city streets and arterials
accidents involving death		
accidents involving personal injury only (no fatalities)		
accidents involving property damage only		

3. **What weather-related information and warning services are available to road users in your country (please select from list)?**

___ a) Forecasts and warnings to road users on TV

___ b) Forecasts and warnings to road users on radio

___ c) Forecasts and warnings distributed via Internet (if yes, please write down the URLs)

___ d) Weather-related information services in mobile terminals (such as mobile phones)

___ e) Something else (please describe in your own words)

4. **Which of them are most popular? (See question 3.)**

---

5. **What is the amount of road salt used in a year on public roads in your country (in tons)?**

---

6. **Are meteorological information or warning services used to support decision-making in road winter maintenance? How they are used at present?**

---

7. **What are the most serious needs for the future development of meteorological information, services and data on road sector?**

---

8. **Are there other relevant issues related to meteorological information, services and data on road sector in your country (if yes, please describe)?**

Further information regarding the road traffic part of this questionnaire can be addressed to:

risto.oorni@vtt.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

3. SEE Project – Questions related to railway traffic

Country: ________________________________
Sector: **Railways**

Respondent: ________________________________
e-mail: ________________________________
Organization: ________________________________

The following questions cover many aspects of railway traffic (safety, reliability etc.) as well as the operation of related organisations and relevant authorities. Please answer all questions that You have knowledge on. *If You don't have exact information on some of the asked matters, please do provide an estimation based on Your expertise.* Your input is extremely important for our study and we appreciate Your effort very much.

In the following questions, indicate always, whether the information is based on statistics (e.g. statistics of railway companies) or whether it is an estimate. Also indicate always the year that the information is referring to.

SAFETY & RELIABILITY

1. **What are the volumes of railway transport in your country? Indicate most recent figures (indicate the year too) for the following:**
   - passenger kilometres per year ____________________
   - tonne kilometres per year ____________________
   - train kilometres per year ____________________

2. **Indicate the reliability of railways by stating:**
   - share (%) of passenger trains in time, i.e. share of departures and arrivals in time ____________________
   - share (%) of freight trains in time, i.e. share of departures and arrivals in time ____________________
   - the criteria when the train is in time or late/early in departure or arrival (e.g. in time if within ± 5 min compared to schedule) ____________________

3. **What is the impact of weather conditions in the time-reliability of railways? What is the share (%) of arrivals and departures not in time that is a result of bad weather conditions? What are the most typical poor weather conditions that result in deviations from schedules?**

   ____

4. **Indicate the safety of railways by stating (Note! Do not count accidents involving road vehicles that crash with trains):**
   - number of train accidents per year ____________________
   - number of injured persons in train accidents per year
     *number of casualties in train accidents per year ____________________

5. **Are any train accidents resulted in by bad weather conditions, so that the weather conditions are a clear contributing factor to the accidents? How many of these type of accidents have occurred on average per year in recent years?**

---

6. **Are there any dedicated services for railways provided by your country's meteorological institute (and hydrological if hydrology is included in the institute)? If yes, what are they? (Please specify as accurately as you can) MAINTENANCE OF TRACKS AND FLEET (in the following questions, please exclude building of new tracks or heavy upgrading of old tracks)**

---

7. **What is the annual cost of day-to-day maintenance of rail tracks in your country?**

---

8. **Please describe the typical problems resulted in by bad weather that make track maintenance more difficult and/or inefficient.**

---

9. **How much is it affecting the maintenance operations in money terms, i.e. what are the extra costs for maintenance resulted by bad weather?**

---

10. **How do you take into account changing/poor weather conditions in fleet (wagons and locomotives) maintenance? Please describe as well as you can.**

---

11. **What is the annual cost of maintenance of rail fleet?**

---

12. **Does the meteorological institute (include hydrology, if appropriate) provide any dedicated services for track maintenance units of railways? If yes, please describe them the best you can.**

---

13. **Does the meteorological institute (include hydrology, if appropriate) provide any dedicated services for rail fleet maintenance units of railways? If yes, please describe them the best you can.**

---

14. **What is the type of meteorological (and hydrological) services that you think would most benefit railways? How do you see that the benefits would materialise? Please explain as well as you can.**

Further information regarding the railways part of this questionnaire can be addressed to:
pekka.leviakangas@vtt.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

4. SEE Project – Questions related to maritime industry

Country: ____________________

Sector: **Maritime**

Respondent: ____________________

e-mail: ____________________

Organization: ____________________

The following questions cover many sectors of maritime industry and inland waterways (shipping, leisure boating, waterborne tourist activities, fishing, etc.) as well as the operation of related organisations and relevant authorities. Please answer all questions that You have knowledge on. *If You don't have exact information on some of the asked matters, please do provide an estimation based on Your expertise.* Your input is extremely important for our study and we appreciate Your effort very much.

Questions related to maritime industry can, for example, be forwarded to the organisations responsible or associated with the following issues and to the organisations named in the following lists:

Issues:
– Maritime safety authority / organisations (sea and inland waterways)
– Search and rescue
– Oil combating (pollution prevention)
– Tourism (e.g. national tourism centre)
– Boating associations, yacht clubs, etc.
– Harbours, ports and terminals
– Marinas
– Shipping companies
– Fisheries, fishing companies
– Ship building
– Marine insurance (companies)
– Off-shore industry

Organisations:
– Meteorological and hydrological information / services provider(s)
– Ministry responsible for shipping
– Ministry responsible for tourism
– Ministry responsible for fishing

Answer questions 1–4 and 7 to the tables bellow these questions. If some important sector is missing from the questions please do add it in.

1. Which of the following are the most important sectors of maritime industry and inland waterways in your country and what is their share of the Gross National Product (GDP)?

Maritime sector	High importance (put X if yes)	Low importance (put X if yes)	No meaning or industry not exists (put X if yes)	Percentage of this sector of the GDP (monetary value in euros)
Shipping (in general)				
Passenger ship traffic				
Leisure boating				
Waterborne tourist activities				

Maritime sector	High importance (put X if yes)	Low importance (put X if yes)	No meaning or industry not exists (put X if yes)	Percentage of this sector of the GDP (monetary value in euros)
Fishing / fisheries				
Inland water transportation				
Ship building				
Off-shore industry				
Name others?				

2. **How big a part (%) of the activities in the listed sectors depends on hydro-meteorological conditions and need (at least from time to time) relevant meteorological and hydrological information? What are the main activities where information is needed (name 1–4 activities)?**

Maritime sector	Part of the sector using hydro-met. information (in %)	1. Main activity	2. Main activity	3. Main activity	4. Main activity
Shipping (in general)					
Passenger ship traffic					
Leisure boating					
Waterborne tourist activities					
Fishing / fisheries					
Inland water transportation					
Ship building					
Off-shore industry					
Search and Rescue (SAR) organisations					
Pollution mitigation at sea (oil combating etc.)					
Others? (add at least the sectors added to question 1.)					

3. **Please describe what basic and special meteorological services (meteorological and hydrological information, services and data) are available to the listed sectors.**

Services / Maritime sector	Basic meteorological services	Special meteorological services
Shipping in general		
Search and Rescue (SAR) organisations		
Pollution mitigation at sea (oil combating etc.)		

Services / Maritime sector	Basic meteorological services	Special meteorological services
Fishing and fisheries		
Boating, tourist activities and other leisure use of sea		
Inland waterways		
Other relevant sectors?		

4. **How many maritime and inland waterways accidents happen annually and how many lives are lost in these accidents? In how many accidents a significant cause to the accident was weather? Estimate how many accidents are annually prevented by use of meteorological and hydrological services / information?**

Services used / Maritime sector	Average number of annual accidents	Lives lost in the accidents (number)	Annual number of accidents where weather significant cause to accident	Average financial loss in weather related accidents (€)	Amount of accidents prevented by use of hydro-meteorological information (%)
Shipping (in general)					
Passenger ship traffic					
Leisure boating					
Waterborne tourist activities					
Fishing / fisheries					
Inland water transportation					
Ship building					
Off-shore industry					
Others? (add at least the sectors added to question 1.)					

5. **What are the maritime industry and inland waterways related accidents and incidents of which claims on damages caused by weather have been filed in to your national insurance companies and what it's the annual number of these claims? (List accident and incident types and the annual amount of claims in each type.)**

6. **What is the estimated annual financial value of these claims per accident/incident type?**

7. **How many oil spills and spills of other dangerous substance have happened annually during the last years at the sea/inland water areas that are included to the national oil combating responsibility area?**

Polluted water area	Annual number of oil spills (10 yrs average)	Average annual amount of spilled oil (10 yrs average)	Average cost of cleaning oil spills (€ per volume unit spilled oil)	Annual number of other dangerous substance spills (10 yrs average)	Average annual amount of other dangerous substances spilled (10 yrs average)	Average cost of cleaning spills of other dangerous substances (€ per volume unit spilled oil)
Spills at sea						
Spills at inland waters						

8. **Is there any previous research available on the economical benefits of meteorological and hydrological information to the operation of maritime industry and related organisations including relevant authorities?**

9. **Are there other relevant issues related to meteorological and hydrological information, services and data on maritime industry and inland waterways in your country (if yes, please describe)?**

10. **List the greatest national benefits that are gained by the maritime industry and inland waterways by utilisation of meteorological and hydrological information?**

11. **What are the most significant deficiencies in the current basic and special meteorological and hydrological services?**

12. **What are the a) present and b) future needs of maritime industry and related organisations / authorities for meteorological and hydrological information, services and data that are not fulfilled with the currently available services?**

a)

b)

13. **Provide the following shipping industry information and figures:**

    1. What are the main national sea and inland ports, terminals and marinas?
    2. How many port calls are there annually in each these ports?
    3. What is the amount of dangerous cargoes handled in these ports?
    4. How many boats are there registered in your country?

5. How many a) fishing boats and b) leisure boats (both motor and sailing boats) are there in your country?

6. Who is responsible for search and rescue and who for pollution prevention in your country?

Further information regarding the maritime part of this questionnaire can be addressed to:
sanna.sonninen@vtt.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

5. SEE Project – Questions related to aviation

Country: ____________________

Sector: **Aviation**

Respondent: ____________________

e-mail: ____________________

Organization: ____________________

The following questions cover aviation sector, its operation, related organisations and relevant authorities. Please answer all questions that You have knowledge on. *If You don't have exact information on some of the asked matters, please do provide an estimation based on Your expertise.* Your input is extremely important for our study and we appreciate Your effort very much. If possible, use your contacts to aviation authorities, airport officials and/or aviation companies to complete the questionnaire!

1. Please, fill in the following tables 1 to 3:

Table 1. Main background data concerning aviation.

Basic data	**Scheduled**	**Charter**	**General**	**Military**
Number of flights per year (national/international)				
Flight kilometres and/or flight hours per year)				
Number of passenger trips per year (national/international)				
Passenger kilometres and/or passenger hours per year				
Air freight tonnes per year				
Air freight tonne-kilometres per year				
Number of airports				
Other, what?				
Related statistics and other information sources?				

Table 2. Main problems caused by weather and their monetary values (on national or on corporate level).

Main problems (total / caused by weather)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, amounts per year, average rate per 5 years, etc.)
Aviation safety, fatalities (scheduled/ charter/ general/ military)			
Aviation safety, other personal injuries (scheduled/ charter/ general/ military)			
Aviation safety, lost/damaged aircraft (scheduled/ charter/ general/ military)			
Delays (delayed flights, average delays per flight)			
Energy consumption and environment, benefits and costs for flights concerning reserve fuel, flight time, etc.			
Airport maintenance, costs, operational delays, short term planning costs/savings			
Other, what?			
Related statistics and other information sources?			

Table 3. Availability and demand of different weather service types, and their monetary values and/or potentials (on national or on corporate level).

Weather service types	Available / in use already (put X, if yes)	Who produces/ offers the service	Not yet available / in use, but there is a demand (put X, if yes)	Not needed at all	Amount (e.g. service potential, willingness to pay etc.) (monetary values, e.g. M€/a or €/customer etc.)
Standardised weather data for aviation (now-casting, short-term forecasts)					
Tailored weather services for special user groups, like military and general aviation					
Precipitation, snowfall, wind and air temperature forecasts for airports					
Communication on expected extraordinary meteorological and hydrological conditions for the next hours / 1-3 days					
- storm / thunder / lightning warnings					
- flood warnings					

Weather service types	Available / in use already (put X, if yes)	Who produces/ offers the service	Not yet available / in use, but there is a demand (put X, if yes)	Not needed at all	Amount (e.g. service potential, willingness to pay etc.) (monetary values, e.g. M€/a or €/customer etc.)
Other, what?					
availability of historical meteorological data					
Other, what?					

ADDITIONAL QUESTIONS:

2. **If there are several providers of meteorological data for aviation, who they are and what kind of services they provide? What are their market shares?**

3. **Can you estimate what is the share of aviation related services in your institute (person-months per year, €/year, % of the turnover, etc.)?**

4. **What sources are there available for general statistical data concerning aviation, aeroplanes, flights, etc?**

5. **Are there any former studies about these subjects or related subjects?**

Further information regarding the aviation part of this questionnaire can be addressed to:

jukka.rasanen@vtt.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

6. SEE Project – Questions related to construction and facility management

Country: ____________________

Sector: **Construction and facilities**

Respondent: ____________________

e-mail: ____________________

Organization: ____________________

The following questions cover different aspects of construction and facility management. Please answer all questions that You have knowledge on. *If You don't have exact information on some of the asked matters, please do provide an estimation based on Your expertise.* Your input is extremely important for our study and we appreciate Your effort very much.

1. **What is the monetary value of building construction in your country at this moment (% from gross national product or million euros per year)?**

2. **What is the relation between building construction and civil engineering in your country?**

3. **What is the annual production of apartments in your country?**

4. **What is the prediction of building sector growth till 2015?**

5. **Are meteorological services widely used in construction and facility management sector in your country? If yes, are they special services tailored to construction and facility management or general forecasts and warnings available to the public?**

6. **What are the most serious needs for the future development of meteorological information, services and data on construction and facility management sector?**

7. **Are there other relevant issues related to meteorological information, services and data on construction and facility management sector in your country (if yes, please describe)?**

Further information regarding the construction and facilities part of this questionnaire can be addressed to: *martti.hekkanen@vtt.fi*

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

7. SEE Project – Questions related to energy

Country: ______________________

Sector: **Energy**

Respondent: ______________________

e-mail: ______________________

Organization: ______________________

Please do answer all questions You have knowledge on. *If you do not have any exact information* on some of the asked matters, *please do provide estimation based on Your expertise*. Your input is extremely important for our study and we appreciate Your effort very much!

1. Please, fill in the following tables 1–4:

Table 1. Main problems caused by weather and their monetary values (on national or on corporate level).

Main problems (caused by weather)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, e.g. M€/a)
Power supply failures			
Damage to buildings and plants			
Non-completion of planned work and generation shortfalls			
Increase in maintenance costs for buildings and plants			
Increased energy consumption			
Overflows			
Other, what?			

Table 2. Main impacts/damages caused by weather and their monetary values (on national or on corporate level).

Main impacts/damages (caused by weather)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, e.g. M€/a)
Interruptions in electricity supply to industry, households and other consumers			
Destruction of the transmission network (towers/lines) due to wind/ice			
Lock-out of switches and puncture of insulation			
Damage to embankments and rock-fill dams caused by ice and waves as a result of prolonged low temperatures and strong winds			
Draught/flooding (adverse impact on the implementation of generation plans, i.e. the pace of completion of works related to the construction and maintenance of plants)			
Other, what?			

Main impacts/damages (caused by weather)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, e.g. M€/a)

Table 3. Main benefits achieved by the use of different weather services, and their monetary values (on national or on corporate level).

Main benefits (by use of weather services)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, e.g. M€/a)
Security of energy supply			
Prediction of electricity market prices and power demands			
Savings in material (damages)			
Savings in working time (repairing)			
Reduction of emissions and their health effects			
Evacuation needs in chemical or nuclear accident			
Other, what?			

Table 4. Availability and demand of different weather service types, and their monetary values and/or potentials (on national or on corporate level).

Weather service types	Available / in use already (put X, if yes)	Who produces/ offers the service	Not yet available / in use, but there is a demand (put X, if yes)	Not needed at all	AMOUNT (e.g. service potential, willingness to pay etc.) (Monetary values, e.g. M€/a or k€/customer etc.)
Precipitation, wind and air temperature forecasts for plant locations					
Communication on expected extraordinary meteorological and hydrological conditions for the next 1-3 days					
- Storm / thunder / lightning warnings					
- Flood warnings					
- Other, what?					
Season weather forecasts					
On-line hydrological data					

Weather service types	Available / in use already (put X, if yes)	Who produces/ offers the service	Not yet available / in use, but there is a demand (put X, if yes)	Not needed at all	AMOUNT (e.g. service potential, willingness to pay etc.) (Monetary values, e.g. M€/a or k€/customer etc.)
Hydrological forecasts					
Availability of historical meteorological data					
“SERVICE PACKAGES” like “energy weather” service (for different time-scales from 12h warnings to one month or seasonal forecasts)					
Other, what?					

ADDITIONAL QUESTIONS:

2. **Is the electricity grid privatized and how is it operated?**

3. **Is meteorological data already used in the grid operation and maintenance (e.g. thunder warnings etc.)?**

4. **Is meteorological/hydrological data already used in hydro power production (dam controlling, flood protection etc.)?**

5. **Are there any icing problems (electricity grid) or pipe breakages (e.g. district/central heating) due to the (cold) weather?**

6. **Are there any warnings for floods (e.g. for hydro power plants and for condensing power plants)?**

7. **Who is responsible for power failures in Your country? (Power companies or some other organisation(s)?)**

8. **Are there any sanctions/compensation fees due to longer power failures? (if yes, amounts?)**

9. **How the maintenance of electricity grid (power cables etc.) is arranged when storm or icing has caused power failures? Are they using weather forecasts beforehand to get quickly enough maintenance people for possible power failure repairing?**

10. **How would you think that energy companies would benefit from met-services? Give some examples. (Are (e.g. hydro and wind) energy companies using weather services in their power plant operation control?)**

---

11. **What are the most vulnerable weather/climate related activities in respect of electricity production in your country?**

---

12. **List what are the main impacts / damages for energy production, transportation and transmission caused by harmful weather and their monetary values?**

---

13. **How big part of the impacts and damages caused by unfavourable weather could be prevented?**

---

14. **What are the future needs in the energy sector concerning the national and international hydro-meteorological information, services and data?**

---

15. **Are there other relevant issues related to meteorological information, services and data on energy sector in your country (if yes, please describe)?**

---

16. **Which organisations are responsible for air quality warnings and who makes possible evacuation orders?**

---

17. **Are there any dispersion models in use for air emissions or for potential radioactive leakages?**

---

18. **Are there any former studies about these subjects or related subjects?**

Further information regarding the energy part of this questionnaire can be addressed to:
mikael.ohlstrom@vtt.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

8. SEE Project – Questions related to electricity production

Country: ______________________

Sector: **Electricity/Energy**

Recipient: ______________________

e-mail: ______________________

Organization: ______________________

Please do answer all questions You have knowledge on. ***If you do not have any exact information on some of the asked matters, please do provide estimation based on Your expertise.*** **Your input is extremely important for our study and we appreciate Your effort very much!**

1. Please give the historical summary of your country's Total Primary Energy Production (TPEP) and Consumption (TPEC) in Quands (1 Quand = 1 quadrillion Btu; see: DOE/EIA).

	2002	2003	2004	2005	2006
TPEP					
TPEC					

2. Please give the historical summary of your country's annual electricity Generation and Consumption in GWh.

	2002	2003	2004	2005	2006
Net generation					
- hydroelectric					
- nuclear					
- conventional thermal					
- biomass					
- wind					
- geo					
- solar					
- others					
Net consumption					
Imports					
Exports					

3. Does you country have a national development programme for renewable energy sources (biomass, wind, etc.)?

____

4. What are the most vulnerable weather/climate related activities in respect of electricity production in your country?

____

5. **List what are the main impacts / damages for energy production, transportation and transmission caused by harmful weather and their monetary values?**

6. **How big part of the impacts and damages caused by unfavourable weather could be prevented?**

7. **Does the current level of the lead time of standard/tailored weather forecasts meet the expectations of the energy sector in general?**

8. **Does the current level of the lead time of standard/tailored weather forecasts meet the expectations of the electricity sector?**

9. **Have you or has your sector received relevant information of impacts of climate change on your sector?**

10. **What are the future needs in the energy sector concerning the national and international hydro-meteorological information, services and data?**

11. **Is exploitation of hydro-meteorological services taken into account in the strategic planning and in the annual work plan and budget within your sector?**

12. **Is the sector willing to invest in strengthening and operation of the relevant agencies in order to promote provision of better and tailored products and services for your sector in the near future?**

13. **Are there other relevant issues related to meteorological information, services and data on energy sector in your country (if yes, please describe)?**

Further information regarding the flood protection part of this questionnaire
can be addressed to *Bengt.Tammelin@fmi.fi*

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

9. SEE Project – Questions related to flood protection

Country: ______________________

Sector: **Flood protection**

Respondent: ______________________

e-mail: ______________________

Organization: ______________________

Please do answer all questions You have knowledge on. ***If you do not have any exact information on some of the asked matters, please do provide estimation based on Your expertise.*** **Your input is extremely important for our study and we appreciate Your effort very much!**

1. Who is responsible for flood protection in Your country?

____

2. Table 1. Availability of different weather service types for flood predictions in Your country?

Weather service types	Available (put X, if yes)	Who produces / offers the service?	Chargeable (put X, if yes)
Availability of historical meteorological data			
General short-term weather forecasts and nowcasts			
Mid-term weather forecasts			
Long-term weather forecasts			
Tailored weather services for special user groups, like rescue authorities			
Communication on expected extraordinary meteorological and hydrological conditions:			
- Rainstorm warnings			
- Heavy wind warnings			
- Flood warnings			
- Discharge warnings			
- Water level warnings			
- Other, what?			

3. How big part (%) of the activities in flood protection depend on hydro-meteorological conditions and need (at least from time to time) relevant hydro-meteorological information?

____

4. List what are the main impacts / damages caused by flooding and their monetary values?

____

5. **How big part of the impacts and damages caused by flooding can be prevented?**

6. **How much money You country uses annually for flood protection?**

7. **How much of impacts and damages caused by flooding can be prevented using improved NMS services?**

8. **Does the current level of the lead time of standard/tailored forecasts meet the expectations of the flood protection?**

9. **What are the future needs in the flood protection concerning the hydro-meteorological information, services and data?**

10. **Is exploitation of hydro-meteorological services taken into account in the strategic planning and in the annual work plan and budget within the flood protection sector?**

11. **Is the sector willing to invest in strengthening and operation of the relevant agencies in order to promote provision of better and tailored products and services for your sector in the near future?**

12. **Are there other relevant issues related to meteorological information, services and data on flood protection sector in your country (if yes, please describe)?**

Further information regarding the flood protection part of this questionnaire can be addressed to *hanna-kaisa.huhta@vtt.fi*

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

10. SEE Project – Questions related to agriculture

Country: ______________________________

Sector: **Agriculture**

Recipient: ______________________________

e-mail: ______________________________

Organization: ______________________________

Please do answer all questions You have knowledge on. ***If you do not have any exact information on some of the asked matters, please do provide estimation based on Your expertise.*** **Your input is extremely important for our study and we appreciate Your effort very much!**

1. **What are the most vulnerable activities (e.g. sowing, spraying, harvesting) in respect of agriculture in Your country?**

____

Table 1. Main problems caused by weather and their monetary values (on national or on corporate level).

Main problems (caused by weather)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, e.g. M€/a)

2. **What are the critical hydro-meteorological parameters and/or services needed for your sector?**

____

3. **What basic hyrological and/or meteorological services are used in your sector?**

____

4. **What additional special (e.g. chargeable) hydrological and/or meteorological services do you use?**

____

5. **Do you provide any value added hydro-meteorological or other products based on hydro-meteorological data and information?**

____

6. **List what are the main impacts / damages caused by harmful weather and their monetary values?**

---

7. **How big part of the impacts and damages caused by unfavourable weather could be prevented?**

---

8. **Is meteorological information used for example for crop prediction or irrigation planning?**

---

9. **Does the current level of the lead time of standard/tailored forecasts meet the expectations of agriculture?**

---

10. **What are the future needs in the agriculture concerning the hydro-meteorological information, services and data?**

---

11. **Is exploitation of hydro-meteorological services taken into account in the strategic planning and in the annual work plan and budget within the agricultural sector?**

---

12. **Is the sector willing to invest in strengthening and operation of the relevant agencies in order to promote provision of better and tailored products and services for your sector in the near future?**

---

13. **Are there other relevant issues related to meteorological information, services and data on agricultural sector in your country (if yes, please describe)?**

Further information regarding the flood protection part of this questionnaire can be addressed to Ari.Venalainen@fmi.fi

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

11. SEE Project – Questions related to tourism

Country: ______________________

Sector: **Tourism**

Recipient: ______________________

e-mail: ______________________

Organization: ______________________

Please do answer all questions You have knowledge on. *If you do not have any exact information on some of the asked matters, please do provide estimation based on Your expertise.* Your input is extremely important for our study and we appreciate Your effort very much!

1. Please give the historical summary of international tourist visiting your country, and the total number of overnight stays

	2002	2003	2004	2005	2006
Number of international tourists					
Total number of overnight stays					
The monetary volume/value (in M €) of tourism					

Table 1. Availability and demand of different weather service types, and their monetary values and/or potentials (on national or on corporate level).

Weather service types	Available / in use already (put X, if yes)	Who produces/ offers the service	Not yet available / in use, but there is a demand (put X, if yes)	Not needed at all	Amount (e.g. service potential, willingness to pay etc.) (monetary values, e.g. M€/a or €/customer etc.)
Standardised climate data for touristic resorts					
Standard weather forecasts for touristic resorts					
Tailored weather services for special user groups, like military and general aviation					
Precipitation, snowfall, wind and air temperature forecasts for resorts					
Communication on expected extraordinary meteorological and hydrological conditions for the next hours / 1-3 days					
- Storm / thunder / lightning warnings					
- Flood warnings					
- Other, what?					
Availability of historical					

Weather service types	Available / in use already (put X, if yes)	Who produces/ offers the service	Not yet available / in use, but there is a demand (put X, if yes)	Not needed at all	Amount (e.g. service potential, willingness to pay etc.) (monetary values, e.g. M€/a or €/customer etc.)
meteorological data					
Other, what?					

2. What are the most vulnerable weather/climate related activities in respect of tourism in your country?

Table 2. Main problems caused by weather and their monetary values (on national or on corporate level).

Main problems (caused by weather)	**SIGNIFICANT** (put X, if yes)	**SMALL/SLIGHT** (put X, if yes)	**AMOUNT** (Monetary values, e.g. M€/a)

3. How big part of the impacts and damages caused by unfavourable weather could be prevented?

4. Is the weather/climate information provided for various types of touristic resorts adequate?

5. If not, please indicate the main lacks?

6. Is your organization well informed about local weather phenomena that might be dangerous for tourists?

7. Are the tourists well enough informed about local (dangerous) weather phenomena and their annual/monthly appearance?

8. **Are the hotels (and tourists) well enough informed by the (Early) Warning System in case of dangerous weather phenomena?**

---

9. **Does the current level of the lead time of standard/tailored weather forecasts meet the expectations of the tourism sector in general?**

---

10. **Does the current level of the lead time of standard/tailored weather forecasts meet the expectations of the tourism sector?**

---

11. **Has you sector received adequate data/information on climate variability in your country?**

---

12. **Have you, or has your sector, received relevant information of impacts of climate change on your sector?**

---

13. **What are the future needs in the tourism sector concerning the national and international hydro-meteorological information, services and data?**

---

14. **Is exploitation of hydro-meteorological services taken into account in the strategic planning and in the annual work plan and budget within your sector?**

---

15. **Is the sector willing to invest in strengthening and operation of the relevant agencies in order to promote provision of better and tailored products and services for your sector in the near future?**

---

16. **Are there other relevant issues related to meteorological information, services and data on energy sector in your country (if yes, please describe)?**

Further information regarding the flood protection part of this questionnaire can be addressed to *Bengt.Tammelin@fmi.fi*

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!

Appendix B: Figures from survey and statistical data used as the basis for analysis (Section 3.1 Road traffic)

Statistics	Albania	Bosnia-Herzegovina	FYR Macedonia	Moldova	Monte-negro	Croatia	Finland
Number of accidents involving personal injury on public roads (in 2005)			2 698	1 000	1 264	15 149	
Number of accidents involving personal injury on public roads in adverse weather and road conditions (in 2005)				100			
Number of accidents involving death on public roads (in 2005)			123	330	49	530	
Number of accidents involving death on public roads in adverse weather and road conditions (in 2005)				40			
The share of fatal accidents happening in adverse weather and road conditions						2.54%	
The share of injury accidents happening in adverse weather and road conditions						3.64%	
GDP (M€ 2005)	6 724	9 878	4 634	2 400	1 642	30 949	157 000
GDP/PPP (M€, EU25)	15 189	22 978	12 227	6 900	3 494	50 831	139 332
Population	3 143 000	3 844 000	2 035 000	3 386 000	622 000	4 439 000	5 255 000
Number of fatalities in road accidents in a year	264	227					
Number of injuries in road accidents in a year	248	5 989					

References	Albania	Bosnia-Herzegovina	FYR Macedonia	Moldova	Monte-negro	Croatia	Finland
Number of accidents involving personal injury on public roads (in 2005)			survey	survey	4)	3)	
Number of accidents involving personal injury on public roads in adverse weather and road conditions (in 2005)				survey			
Number of accidents involving death on public roads (in 2005)			survey	survey	4)	3)	
Number of accidents involving death on public roads in adverse weather and road conditions (in 2005)				survey			
The share of fatal accidents happening in adverse weather conditions						3)	
The share of injury accidents happening in adverse weather conditions						3)	
GDP per capita (2005)	1)	1)	1)	1)	1)	1)	1)
GDP/PPP (M€, EU25)	1)	1)	1)	1)	1)	1)	1)
Population							
Number of fatalities in road accidents in a year	2)	2)					
Number of injuries in road accidents in a year	2)	2)					

1) WIIW. 2006. Handbook of Statistics.

2) UNECE. 2003. Statistics of Road Accidents in Europe and North America.

3) Bulletin of road traffic safety in 2005. 2006. Ministry of the Interior Affairs, Zagreb.

4) Statistical Office of Montenegro. 2006. Montenegro in Figures. http://www.monstat.cg.yu/. Accessed 24th September 2007.

Appendix C: The method used to calculate reduction in fatal and injury accidents (Section 3.1 Road traffic)

The 1–2% effect on the number of accidents (r_{fi}) was scaled with the shares of accidents happening in adverse weather and road conditions. The formulas for reduction of fatal and injury accidents in percents are presented below:

$$r_{n(fatal)} = r_{fi} \times \frac{a_n}{a_{fi}} \qquad \text{(C1)}$$

$$r_{n(injury)} = r_{fi} \times \frac{b_n}{b_{fi}}\,. \qquad \text{(C2)}$$

In the previous formulas a_n is the share of fatal road accidents happening in adverse weather and road conditions in the country being analysed, b_n is the share of fatal road accidents happening in adverse weather and road conditions. Constants a_{fi} and b_{fi} are the same percentages in Finland.

The original plan was to calculate a_n by dividing road accidents that happened in adverse weather and road conditions on public roads by all road accidents that happened on public roads in the country to be analysed. This approach was used with Moldova. In the case of FYR Macedonia, the numbers of fatal and injury accidents were available from the survey while the numbers of accidents in adverse weather and road conditions was not available. For this reason, Croatian ratio between accidents in adverse weather and road conditions to all accidents was assumed in FYR Macedonia:

$$a_{FYR\ Macedonia} = a_{croatia}$$

$$b_{FYR\ Macedonia} = b_{croatia}$$

The previous equality was also assumed for Albania and Bosnia-Herzegovina:

$$a_{albania} = a_{croatia}$$

$$b_{albania} = b_{croatia}$$

$$b_{bosnia} = b_{croatia}$$

$$a_{bosnia} = a_{croatia}$$

In case of Albania and Bosnia-Herzegovina, a few more assumptions were needed, because no answers from the survey were received and incompleteness of statistical data. Only the numbers of fatalities and the injured were available while the numbers of accidents involving fatalities or human injuries could not be found. To overcome this problem, the ratio between injured persons and injury accidents (l_{fi}) as well as the ratio between fatalities and fatal accidents (k_{fi}) were assumed to be same as in Finland:

$c_{fatal(albania)} = f_{(albania)} \times k_{fi}$

$c_{injury(albania)} = i_{(albania)} \times l_{fi}$

$c_{fatal(bosnia)} = d_{(bosnia)} \times k_{fi}$

$c_{injury(bosnia)} = i_{(bosnia)} \times l_{fi}$

In previous equations c represents the numbers of different types of accidents on public roads, f the number of fatalities and i the number of injured persons. Constants k and l have been calculated by the author on the basis of Finnish statistics (Finnish Road Administration 2006).

The reduction in the number of fatal road accidents was calculated with formula

$$x_n = \frac{1}{1 - r_{fi} \times \frac{a_n}{a_{fi}}} \times c_{n(fatal)} - c_{n(fatal)} = \frac{1}{1 - r_{n(fatal)}} \times c_{n(fatal)} - c_{n(fatal)} \qquad \text{(C3)}$$

in which $c_{n(fatal)}$ is the number of fatal road accidents in a year on public roads. The reduction in injury accidents was calculated in a similar way with formula

$$y_n = \frac{1}{1 - r_{fi} \times \frac{b_n}{b_{fi}}} \times c_{n(injury)} - c_{n(injury)} \qquad \text{(C4)}$$

in which $c_{n(injury)}$ is the number of injury accidents in a year on public roads.

All the countries included in the study have been assumed to have basic information and warning services for road users. If those services did not exist, the formulas for x_n and y_n would become slightly different:

$$x_n = r_{fi} \times \frac{a_n}{a_{fi}} \times c_{n(fatal)} = r_{n(fatal)} \times c_{n(fatal)} \qquad \text{(C5)}$$

$$y_n = r_{fi} \times \frac{b_n}{b_{fi}} \times c_{n(injury)} = r_{n(injury)} \times c_{n(injury)} \qquad \text{(C6)}$$

However, the results of Formulas (C3) and (C5) and Formulas (C4) and (C6) are quite similar, when $r_{n(fatal)} << 1$ and $r_{n(injury)} << 1$. Fortunately, this is true with all the countries studied and all types of accidents. Formulas (C3) and (C4) were used instead of (C5) and (C6), because a conservative estimate was considered more credible than too positive one.

Appendix D: Intermediate results calculated on the basis of statistical data, figures from surveys, literature survey and expert interviews (Section 3.1 Road traffic)

Calculated intermediate results	Albania	Bosnia-Herzegovina	FYR Macedonia	Moldova	Monte-negro	Croatia
GDP/PPP per capita / €	4 833	5 978	6 008	2 038	5 617	11 451
The share of injury accidents happened in adverse weather and road conditions	missing	missing	missing	0	missing	missing
The share of fatal accidents happened in adverse weather and road conditions	missing	missing	missing	0	missing	missing
The share of injury accidents happened in adverse weather and road conditions (assumed)	3.64%	3.64%	3.64%	10.00%	3.64%	3.64%
The share of fatal accidents happened in adverse weather and road conditions (assumed)	2.54%	2.54%	2.54%	12.12%	2.54%	2.54%
Unit cost for a road accident involving personal injury / €	60 148	74 399	74 781	25 363	69 915	142 521
Unit cost for a fatal road accident / €	401 897	497 118	499 673	169 470	467 157	952 300
Effect of the information services offered to road users on the number of injury accidents on public roads (minimum)	0.17%	0.17%	0.17%	0.47%	0.17%	0.17%
Effect of the information services offered to road users on the number of injury accidents on public roads (maximum)	0.34%	0.34%	0.34%	0.93%	0.34%	0.34%
Effect of the information services offered to road users on the number of fatal accidents on public roads (minimum)	0.11%	0.11%	0.11%	0.54%	0.11%	0.11%
Effect of the information services offered to road users on the number of fatal accidents on public roads (maximum)	0.23%	0.23%	0.23%	1.09%	0.23%	0.23%

Appendix E: The ratio of material losses to number of deaths as a function of GNP and a curve for estimating flood warning benefit (Section 3.7 Flood protection)

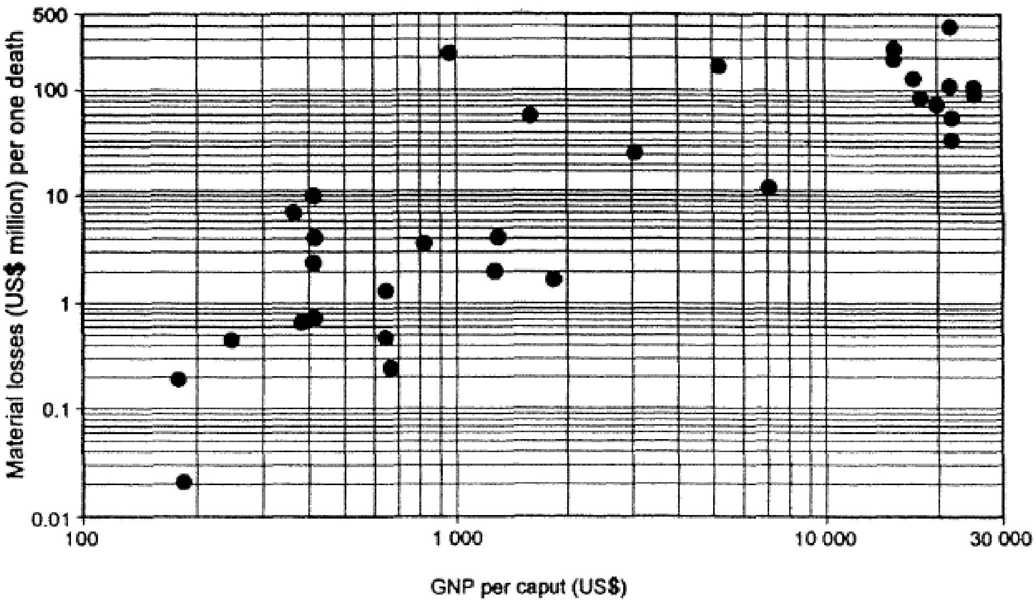

Figure E1. Relationship between the ratio of material losses in million US$ to number of deaths and GNP per capita, in US$, without taking account of the severity of particular floods (Munich Reinsurance Company 1997. Flooding and insurance. Munich, Germany).

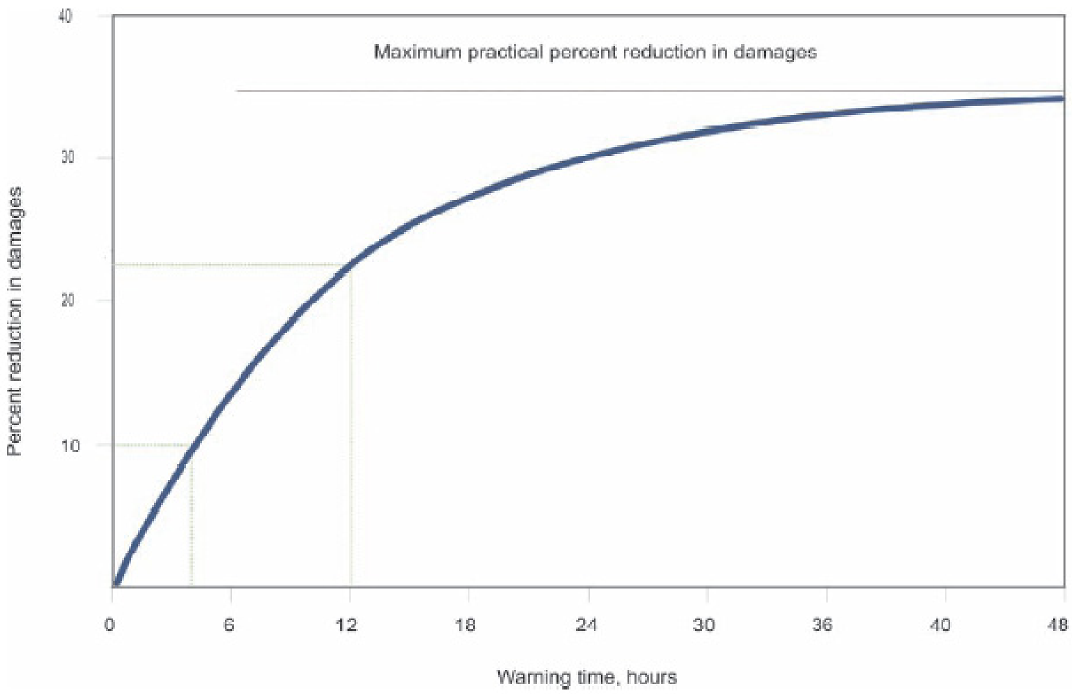

Figure E2. A curve for estimating flood warning benefit (National Hydrologic Warning Council 2006).

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