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Socio-economic benefits of weather and climate services in Europe

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Abstract. There is a rising interest around the world for a better understanding of the economic and social value added of weather services. National hydro-meteorological services and international cooperative bodies in meteorology have ever more to justify their use of public budgets. Furthermore, the development of hydrological and meteorological services is to a large extent steered by expectations regarding the eventual benefits of the envisaged new developments. This article provides a compact overview of the impediments for uptake of socio-economic benefit (SEB) studies, methods and results of SEB studies to date. It also discusses some pitfalls and crucial steps to enhance a broader uptake of SEB studies.

1 Introduction

The national meteorological and hydrological services (NMHSs) in Europe have been steadily improving their forecast skills and expanding their environmental and climate services (Nurmi and Brockmann, 2007), but face nonetheless major challenges. Public budgeting is tight and only seems to get tighter. A growing range of media through which weather information is provided blurs the position of NMHSs in public and commercial weather service provision. Varying interpretations of free access to public information and competition promotion in weather service markets create uncertainty for the future scope of NHMSs, while technical and scientific progress create new resource demands as well as new service opportunities (World Bank, 2008).

To date all reviews of Socio-economic benefits (SEB) of hydro-meteorological services show very good benefit-cost ratios, i.e. in any country the benefits of these services for society are many times their costs (see Sect. 4). Yet, the sense of doing SEB studies from an NMHS perspective has more to do with systematic learning than with marketing splendid B/C ratios. The Task Team Socio-Economic Benefits (TT SEB) of the WMO Working Group on Public Service Delivery will soon publish a report on social-economic benefit assessment of weather services in which is explained what can be the purposes and approaches and how a SEB study can be organised. The main message of that report is to "*grasp the benefit of showing the benefits*". In this article, based on that report, we will briefly discuss impediments, methods and pitfalls, and results.

2 Developments in Europe

In the past ten years the WMO has been running several programmes with respect to SEB of hydro-meteorological services (WMO website, 2013). The 2007 WMO Madrid International Conference has been an important catalyst for interest in SEB studies. In September 2011 a survey was carried out regarding the interest for SEB assessment among WMO Regional Association Europe (RA VI) members. A summary of the results was presented at the WMO RA VI Conference on Social and Economic Benefits in 2011 in Lucerne, Switzerland (WMO, 2012).

Interest was wide spread, but so far only a minority has been carrying out such assessments. Lack of in-house knowledge on SEB studies, uncertainty regarding how to commission a meaningful SEB study, and doubts about adequate resourcing of SEB studies appeared to be important impediments.

The survey was carried through internet and addressed to the 50 WMO RA VI region member NMHSs. Answers from 25 NMHSs were received. The results of the survey denoted that:

- 21 (i.e. 84 %) of the responding NMHSs carry out (more or less regularly) user group surveys, such as fora or user consultations, which can be seen as a good start to map user needs and benefits.
  - 12 of the responding NMHSs (i.e. 57 % of those running surveys) try to estimate the user benefits regarding their meteorological services
- only 7 NMHSs (i.e. 28 % of the respondents) indicated that they have already experiences with SEB studies; among those 7 NMHSs 4 used cost-benefit based methods.

On the other hand 17 (43 %) of the responding NMHSs indicated that they plan to carry out SEB studies for several reasons, such as (it was allowed to tick more than one option):

- justify funding from the government (17);
- promote its services and attract new users (14);
- use results for decision support to prioritise their investment (11).

Out of the 25 responding organisations 17 NMHSs indicated to be interested in receiving additional guidance and advise on appropriate methodology. In addition, the respondents expressed their interest in sharing experience among NMHSs as regards SEB studies as well as related funding opportunities, e.g. through WMO supported projects.

3 Methods

There is no unique method for assessing the social and economic benefits generated by a NMHS; it depends on the field of the activity within the NMHS (weather forecasting, climate services, warnings and emergency services, other environmental products, etc.) and on the sectors to which these services are oriented. Different market conditions affect the range of applicable methods, whereas also the precise questions to be answered has significant impact on what is a useful method. Any method chosen should somehow be capable of (1) identifying how the use of weather services makes a difference in the costs or revenues of a sector or company and (2) of estimating the size of the benefit attributable to the weather service by means of a formalized description of the differential effect on costs and/or revenues. Even though there is quite a choice of conditionally relevant methods, some general considerations can be made, such as outlining the steps along which the value added is created by the supply and use of weather services.

The creation of value added (VA) in the supply chain for weather services occurs in three phases (Fig. 1), being: (VA1) when combining data, models and expertise to generate weather forecasts and adjacent services, (VA2) when editing and distributing weather information through media channels and enabling the combination of information, and (VA3) when end-users interpret weather information and use it in decision making (to avoid damages and exploit weather related opportunities). The first phase of value added creation (VA1) represents the activities in the NHMSs and commercial weather service providers. VA2 represents the different media channels (TV, radio, newspapers, websites, mobile), which convey weather information alongside other information.

The third phase (VA3), in which the end-users use weather information to avoid damage or reap opportunities, represents by far the largest amount of benefits, i.e. $VA3 \gg VA1 + VA2$. The extent to which the potential value of VA3 is realized depends on the personal or collective capacity of the end user to interpret and use that information adequately.

The above explanation was intently focused on weather services. For traditional climate services (such as for hydropower and agriculture) the model as represented in Fig. 1 largely holds, even though such services are usually tailored for specific customers and not general public service. The newly emerging climate services aimed at adaptation support are as yet much less standardized and have also a larger variety of suppliers, whereas also the nature of the service can be quite different. As a consequence Figs. 1 and 2 are not necessarily straightaway applicable to adaptation oriented climate services, while the applicable evaluation methods are quite different as well, among others because the evidence of the benefits is either a projection or based on more rapidly realized side benefits, such as avoided road maintenance cost owing to new observation based asset management systems.

As stated above valuating the SEB of weather services requires the assessment of the *differential effect* of (improved) weather information on the value added of a sector, i.e. the difference in generated benefits owing to a difference in information level. It is important to understand that generating benefits through meteorological services depends on how this information is delivered, understood and how user decisions are taken. The information delivery process can also be understood as a process of *information decay* during subsequent steps of information distribution and uptake. Information decay refers to the fact that in subsequent stages of the weather service chain, some of the original value potential gets unattainable because timely access, use, comprehension,

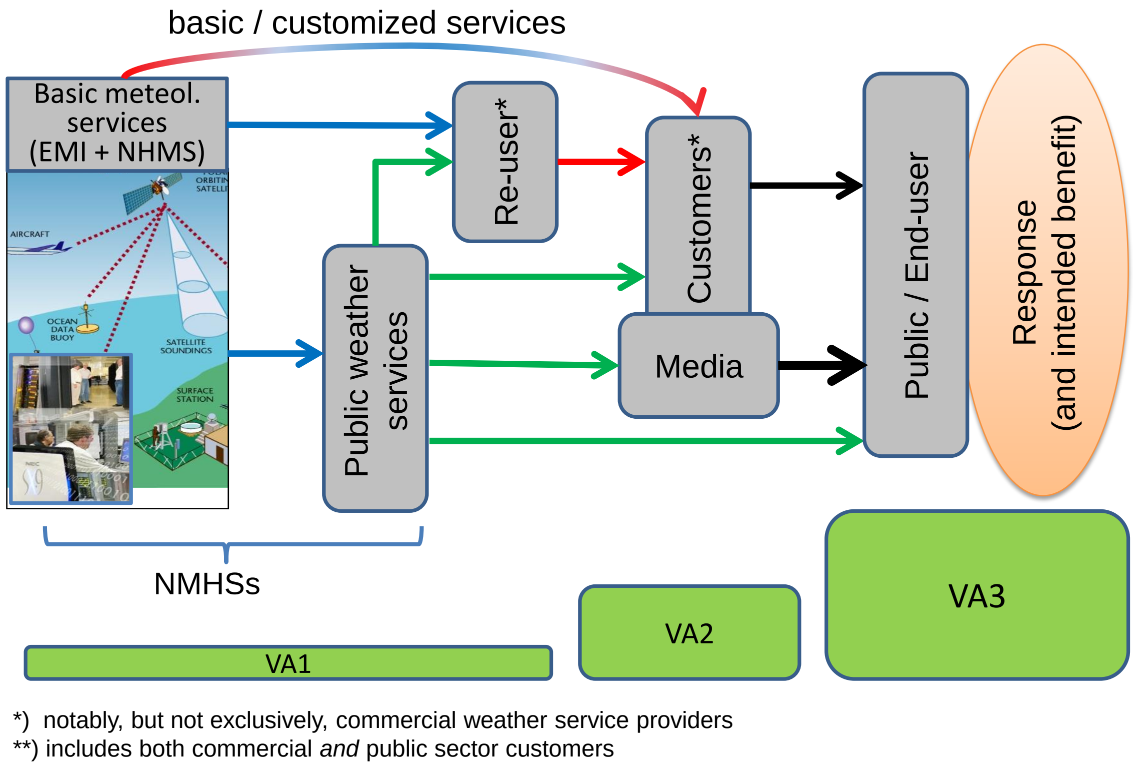

Figure 1. Principal stages in the provision of meteorological services and the related generation of value added by stage; VA = value added (by service stage 1, 2, 3).

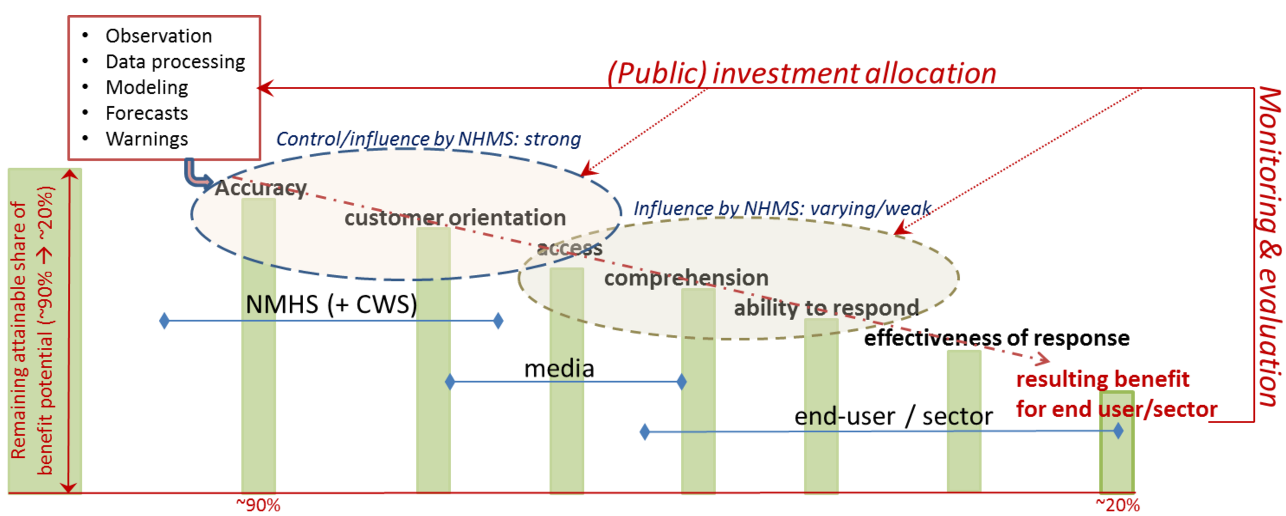

Figure 2. The weather service chain, its information decay and feedback possibilities for improving steps in the weather service chain; CWS denotes "commercial weather services".

etc. are not optimal. So, even the original forecast accuracy is 90 %, eventually only 20 % of the original value potential may get realized as the other steps (timely access, etc.) are not perfect (i.e. fractions varying between 80 % and 40 %, culminating in a compound fraction of 20 % or lower).

In many cases a hypothetical benefit potential (i.e. avoided cost based on ideal conditions) can be estimated thanks to available statistics on accidents, damage claims, etc. Subsequently, the degree of information decay in the weather service chain (Fig. 2) can be analysed so as to approximate the current level of realized benefits in the considered sector. Information on the sources of information decay can be used to improve steps in the weather service chain. The approach, denoted as weather service chain analysis (WSCA; Nurmi et al., 2012), can be quite generally applied in combination with various methods, including so-called Cost-Loss analysis which has been widely applied in appraisal studies in the weather service sector (Katz and Murphy, 1997). Essentially WSCA is an analysis of a product sum (eventual share of the benefit potential realized) and its constituent arguments (fractions). The consecutive arguments (fractions) can be assessed by means of underlying estimated functions, with variables representing abilities, propensities or proneness with respect to the considered fraction (Nurmi et al., 2012; Perrels et al., 2012).

4 Results

Studies in various countries, most of them industrialized, have shown that the cost/benefit ratio of a national meteorological service is around 1 : 3 to 1 : 10 as described in Table 1. However, there are only a few more or less comprehensive studies available and in many studies cost of media and of the end-users are not considered. Some studies have been estimating avoided cost (or deviation from maximum revenue), which relates to *realized* value added in an economy. Such an approach is useful if one wishes to answer how beneficial the weather services (and its public funding) actually have been for the national economy. In practice it means that the effect on value added of a bundle of closely related weather services used in a certain sector is analysed. The incremental contribution of one specific service product (via one particular media) in a considered bundle is often hard if not impossible to assess in this approach.

Other studies are based on willingness-to-pay (WTP) analysis. WTP studies give an indication of the potential market value of a particular weather service product, as they indicate the propensity to pay for the service in relation respondent's characteristics as well as the share of the potential user population which is prepared to pay a positive price. WTP studies can be applied to existing public services that are available free of charge (even though their use will require some kind of effort) as well as to new – not yet provided – services. In the latter case the product characteristics and its potential usefulness should be unambiguous to the respondents.

5 Discussion

We are still far away from having a comprehensive understanding of social economic benefits of weather and climate services within Europe, but the results are so far encouraging. The available study results indicate – practically unanimously – favourable cost-benefit ratios. However, in many cases these ratios represent the overall bundle of public and private weather services taken together. For the NMHSs it would be helpful to clarify also what are the contributions of basic meteorological services, as well as what are the benefit-cost ratios of public weather services. In the WMO TT-SEB study (Perrels et al forthcoming) is in fact emphasized that the demonstration of good benefit-cost ratios should not be seen as the main output of SEB studies. Instead, SEB studies should be seen as a valuable source of information regarding (1) improvement of the effectiveness of current weather services in all phases of the weather service chain and (2) prioritizing focal areas of innovation of weather services. This does require however that SEB studies are repeated from time to time and are supported by regular monitoring for service use and user satisfaction. In turn this also implies an integration of the SEB studies, monitoring and exploitation into the management cycles of the NMHS.

The survey of 2011 and also the abundant attendance of the 2011 SEB conference showed that there is a wide spread interest for SEB studies. At the same time the lack of in-house knowledge seems to be a significant obstacle for getting a useful SEB study commissioned. Therefore the sharing of information and experiences across WMO members merits to be promoted, both with respect to carrying out such studies and regarding the uptake of the SEB study outcomes in the NMHS organisation. Twinning and pilot projects – in a WMO framework – for countries and NMHSs with a need for SEB studies but lack of know-how will also help to stimulate wider application of SEB studies. These twinning and pilot projects taken together should cover a wide variety of services and issues, such as (1) the sensitivity of various sectors as well as national economies as a whole, (2) the direct and downstream impacts of the various kinds of natural disasters, from short-lived storms to protracted droughts and (3) the likely social and economic impacts of long-term climate change on societies and economies.

Another important factor for greatly enhancing the societal value of, and benefits from, meteorological services is the establishment of much closer dialogue and sense of partnership between the provider and user communities at all levels.

There are still challenges with respect to applying the different methods, not the least due lacking data. In this respect a better monitoring of customers of weather services would help. This would be also a first advice to NMHSs that

Table 1. Overview of published cost-benefit analysis within different weather services, based on avoided costs unless otherwise stated.

Country	economic sector	cost-benefit ratio	Reference
Australia	general public (willingness to pay analysis) in Sydney	1 : 4	Anamann and Lellyett (1996)
Croatia	overview of all sectors	1 : 3 (at least)	Leviäkangas et al. (2008)
Denmark	overview of all sectors, 3 case studies	Many detailed examples with good net benefits; aggregate picture lacking	The Ministry of Transport and Energy (2006)
Finland	overview of all sectors	1 : 5	Leviäkangas and Hautala (2009)
	transport	1 : 10 and higher	Nurmi et al. (2012) internal FMI study (on-going for other sectors)
Nepal	mainly agriculture; transport and hydropower also considered	around 1 : 10	Perrels (2011)
Russia	overview of all sectors	1 : 3–1 : 4	Bedritsky and Khandozko (2001)
Switzerland	overview, all sectors	1 : 5	Frei (2010)
	transport sector	1 : 10	Frei et al. (2012)
United Kingdom	general public (willingness to pay analysis)	1 : 7	Met Office (2007)
	meteorological infrastructure – satellite	1 : 5–1 : 20	Joo et al. (2011)
USA	transport sector (winter road maintenance)	1 : 2–1 : 3	Ye et al. (2009)
	general public (willingness to pay analysis)	1 : 6	Lazo et al. (2009)

contemplate the commissioning of SEB studies. By means of user surveys a NHMS should first obtain an impression of how, for what precise purpose, and to what extent various user groups use the weather information. Such a survey assists to focus the SEB study and provides indispensable information to conduct it.

Some appraisal methods need further development to make them particularly suitable for economic assessment of weather and (traditional) climate services. This calls for intensifying co-operation with economic researchers. Furthermore, as regards the newly emerging adaptation oriented climate services standardisation of its economic evaluation practices is called for, but this requires also fundamental economic research work considering that a good part of the targeted benefits is supposed to realize in the (distant) future. This feature differs greatly from weather services or traditional (i.e. seasonal) climate services, for which evidence is produced within a year and partly within a week.

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References

Anaman, K. A. and Lellyett, S. C.: A Contingent Valuation Study of the Public Weather Service in the Sydney Metropolitan Area, Economic Papers: A Journal of Applied Economics and Policy, 15, 64–77, 1996.

Bedritsky, A. I. and Khandozko, L. A.: The economic benefits of hydrometeorological services, WMO-Bulletin, 50, 219–224, 2001.

Frei, Th.: Economic and social benefits of meteorology and climatology in Switzerland, Meteorol. Appl., 17, 39–44, 2010.

Frei, Th., von Grünigen, S., and Willemse, S.: Economic benefit of meteorology in the Swiss road transportation sector, Meteorol.

Appl., doi:10.1002/met.1329, in press, 2012.

Joo, S., Eyre, J. R., and Marriot, R. T.: The impact of Metop and other satellite data within the Met Office global NWP system, using and adjoint-based sensitivity method, Forecasting Research Technical Report 562, Met Office, UK, 2011.

Katz, R. W. and Murphy, A. H. (Eds.): Economic Value of Weather and Climate Forecasts, Cambridge University Press, Cambridge, 1997.

Lazo, J., Morss, R., and Demuth, J.: 300 Billion Served – Sources, Perceptions, Uses, and Values of Weather Forecasts, B. Am. Meteorol. Soc., 90, 785–798, 2009.

Leviäkangas, P. and Hautala, R.: Benefits and value of meteorological information services – the case of the Finnish Meteorological Institute, Meteorol. Appl., 16, 369–379, 2009.

Leviäkangas, P., Hautala, R., Räsänen, J., Öörni, R., Sonninen, S., Hekkanen, M., Ohlström, M., Venäläinen, A., and Saku, S.: Benefits of Meteorological Services in Croatia, Research Notes 2420, Finnish Meteorological Institute, Helsinki, 2008.

Met Office: The Public Weather Service's contribution to the UK economy, Met Office UK, www.metoffice.gov.uk/media/pdf/h/o/PWSCG_benefits_report.pdf, 2007.

Ministry of Transport and Energy (Denmark): Meteorology – a Revenue Generating Science; A mapping of meteorological services with an economic assessment of selected cases, Ministry of Transport and Energy, Copenhagen, http://www.wmo.int/pages/prog/amp/pwsp/documents/Meteorology_Revenue_Generating_Science.pdf, 2006.

Nurmi, P. and Brockmann, M.: A quarter century of operational end forecast verification, EMS Annual Meeting Abstracts, Vol. 4, FW4, P0102, EMS2007-A-00345 (San Lorenzo de el Escorial, Spain), http://meetings.copernicus.org/ems2007, 2007.

Nurmi, V., Perrels, A., Nurmi, P., Seitz, D., Michaelides, S., Athanasatos, S., and Papadakis, M.: Economic value of weather forecasts on transportation – Impacts of weather forecast quality developments to the economic effects of severe weather, EWENT report D5.2, http://ewent.vtt.fi/Deliverables/D5/D5_2_16_02_2012_revised_final.pdf, 2012.

Perrels, A.: Social economic benefits of enhanced weather services in Nepal – part of the Finnish Nepalese Project (FNEP), MFA intervention code: 79811801, Helsinki, 2011.

Perrels, A., Nurmi., V., and Nurmi, P.: Weather service chain analysis (WSCA) – An approach for appraisal of the social-economic benefits of improvements in weather services, SIRWEC Conference, Helsinki, 23–25 May 2012, paper 0081, http://www.sirwec2012.fi/Extended_Abstracts/002_Perrels.pdf, 2012.

World Bank: Weather and Climate Services in Europe and Central Asia, World Bank Working Paper No. 151, Washington DC, http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/0,,contentMDK:22000203~pagePK:146736~piPK:146830~theSitePK:258599,00.html, 2008.

WMO: Socio-Economic Benefits of Meteorological and Hydrological Services and Information: Madrid Action Plan, World Meteorological Organisation, Geneva, http://www.wmo.int/pages/themes/wmoprod/documents/madrid07_ActionPlan_web_E.pdf, 2007.

WMO: Proceedings of the WMO Regional Association VI (Europe) Conference on Social and Economic Benefits of Weather, Climate and Water Services, Lucerne, Switzerland, 3–4 October 2012, PWS-23/ROE-1, ftp://ftp.wmo.int/Documents/PublicWeb/dra/eur/SEB_Conf_Oct2011/PWS_23_ROE-1_en.pdf, 2012.

WMO website – Public Weather Programmes: http://www.wmo.int/pages/prog/amp/pwsp/SocioEconomicEventsandReports.htm, last access: 2 May 2013.

Ye, Z., Strong, C., Fay, L., and Shi, X.: Cost Benefits of Weather Information for Winter Road Maintenance, Western Transportation Institute, Montana State University, USA, 2009.