

Economic and social benefits of meteorology and climatology in Switzerland

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ABSTRACT: National Meteorological Services provide meteorological data, information, forecasts and various related products, which are important for the smooth functioning of many aspects in economy, administration and society. The merit of meteorological services cannot be deduced directly from the consumption of services. Rather, it emerges from the improvement of decisions by economic stakeholders thanks to weather and climate information. These services are purchased by users in order to be able to offer optimally or demand a certain service or, with respect to security, these services aim at helping to prevent damage from extreme events.

A rough estimate for a number of selected sectors shows that benefits from weather services in Switzerland are in the region of hundreds of millions Swiss Francs (1 Swiss Franc \sim €0.66, US\$0.83 as at 2008).

This pilot study shows that it is not possible to estimate one single figure representing the overall benefit from weather services in a country. Concerning the economic sector, a benefit analysis should therefore concentrate on those sub-sectors where weather services are particularly relevant, i.e. agriculture, construction, energy, insurance, telecommunication, tourism, transport, logistics and water availability. Analysis of benefits from climate data is of particular interest to MeteoSwiss since the Federal Office is the main source for climate data in Switzerland. Climate data form the basis on which climate change and possible climate threats can be detected.

This study estimates for the first time the socio-economic benefits of meteorological and climatic information in Switzerland as a small developed European country and gives an outlook of how a further study might be designed. Copyright © 2009 Royal Meteorological Society

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1. Introduction

The climate of Switzerland is strongly determined by the proximity of the Atlantic Ocean. The prevailing westerly currents transport mainly humid and mild sea air to Switzerland. In the summer this has a cooling effect, in the winter a warming one while all year round there is adequate precipitation in most areas. The Alps constitute a distinct climate divide between northern and southern Switzerland. The latter is mainly influenced by the Mediterranean and one of its chief features is considerably milder winters than those in the northern parts of the country.

In addition to their powerful impact as a climate divide between north and south, the Alps as a complex mountain range create several different climate zones. Inner Alpine valleys present a distinct climate of their own, since they are sheltered from precipitation both from the north and from the south. As a consequence, dry conditions prevail. Typical for this phenomenon are the Valais in South Western Switzerland and the Engadine in South Eastern Switzerland. While along the northern Pre-Alps, in the

Alps and in Southern Switzerland the average annual precipitation amounts to approximately 2000 mm, the Valais has a regional annual average of 500–600 mm, the Engadine of 600–700 mm and in the low regions north of the Alps the average annual precipitation amounts to approximately 1000–1500 mm. Precipitation amounts in summer are roughly double those in winter, with the exception of the Valais.

From an altitude of 1200–1500 m above sea level, precipitation mostly falls as snow in winter, often resulting in a complete snow cover for months. In comparison, snowfall is rare in the lower regions of western Switzerland (the Geneva area) and of northern Switzerland (the Basle area) as well as in the low regions in the far south of the country (Figure 1). Here winters without snow cover are quite common.

Air temperatures in Switzerland depend primarily on altitude. In the northern lower regions the average temperature in January is approximately 1 °C, in July approximately 17 °C. In the southern lower regions the equivalent average temperatures are about 2–3 °C higher.

A peculiarity of the climate in Switzerland is the well-known 'Foehn'. This wind, which traverses the Alps, generates extremely mild and dry conditions on leeward slopes. The South Foehn, blowing northwards from the

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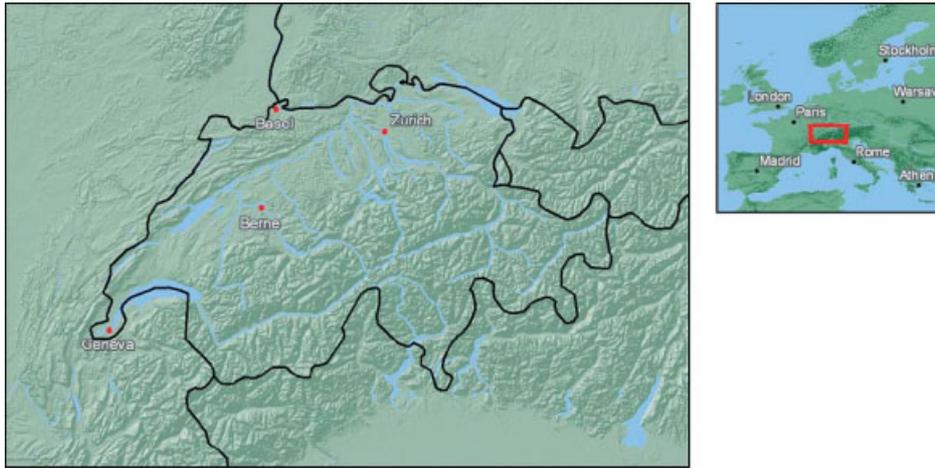


Figure 1. Locations in Switzerland and relative to Europe.

south, is often associated with events of high wind speed in the north and intense precipitation in the south. Foehn winds occur mainly from autumn to spring.

This short overview of the complex meteorological conditions in Switzerland gives a summary of conditions for the economic value and benefit of meteorological services.

There are only a few comprehensive studies of the economic value of various meteorological services to their users (Freebairn and Zillmann, 2002), although it is widely assumed that the benefits far exceed the costs. This economic value is also not known for Switzerland.

Additionally, there is even less information on the economic value to users of potential improvements or changes in the current meteorological services (Lazo and Chestnut, 2002).

Weather data and information are factors in the decision-making process that can be used to reduce uncertainty and improve economic and other decisions. In the case of storms or floods public emergency services, after having received timely and accurate warnings, can provide personnel and equipment to minimize damage. In each case, the economic value or benefit of the warnings, forecasts and climate information consists of the improvements in economic and related outcomes resulting from the use of these services.

In the case of government, several extreme events in the last two decades in Switzerland such as the floods in 1993, 1999, 2005 and 2007 have shown the enormous economic impact of such events. For example, in the case of the 1993 event the disastrous floods in the Valais and Ticino cantons resulted in economic damage of about 600 million Swiss Francs, the flood in 2000 resulted in damage of about 670 million Swiss Francs and the extreme event in 2005 resulted in a damage of about 2500 million Swiss Francs (BAFU, 2008). On the other hand, storm 'Viviane' in 1990 and storm 'Lothar' in 1999 both resulted in damage of about 500 million Swiss Francs (BAFU, 2008). Due to climate change such events are expected to happen more frequently in future. For example Rockel and Woth (2007) show that there will

be an increase of up to 20% in the frequency of extreme winds in the period 2071–2100 compared to the climate of 1961–1990. According to the Fourth IPCC Assessment Report (IPCC, 2007) extremes of daily precipitation are very likely to increase in northern Europe. Taking into account all these findings the economic impact of climate change might be enormous (Stern, 2007). In the case of Switzerland a study by Ecoplan (Arbeitsgemeinschaft ecoplan/Sigma-plan, 2007) has shown that the average economic damage due to climate change is expected to be around 1000 million Swiss Francs *per* year in the period 2005–2100.

In the case of individuals, households and companies the situation is quite different. Due to correct decisions weather forecasts often enable the users to make significant savings. For example, the rainfall forecast provided by the national meteorological service in Switzerland (MeteoSwiss) to the decision-making and planning process of farmers in Switzerland provides a basis for a change of the farmers' own subjective considerations. The value of rainfall information at the level of the individual farmer is then reflected in the change of the revenue generated from improved decisions associated with the additional meteorological and climatic information. This means that meteorological information acquires value when use of such information changes the behaviour of the user.

As well as forecasts, weather and climate data can act as planning and control tools for companies in the energy industry, helping them to optimize the generation, transmission and distribution of power or to estimate the energy demand accurately and in good time and finally also to optimize the heating/cooling of buildings. In the case of individuals, 1–5 day weather forecasts are valuable in helping plan outdoor activities.

The World Meteorological Organisation (WMO) and the World Bank have also recognized the importance of understanding how weather, climate and water information helps the various sectors of society to make decisions and reduce risks, as well as to outline what changes would be needed to improve decision making (WMO,

2003; World Bank, 2008). The aim is to increase further, in view of their growing value and impact, the utility of weather, climate and water knowledge for social and economic benefit. The realization of these goals will require a more effective use of weather, climate and water information. A process to raise awareness has been initiated regarding the issues at stake and it has created a dialogue among those involved: decision-makers at national level, users and the national meteorological services (NMSs).

An international conference in 2007 adopted a conference statement and action plan, the overall objective of which is 'to achieve, within 5 years, a major enhancement of the value to society of weather, climate and water information and services in response to the critical challenges represented by rapid urbanization, economic globalization, environmental degradation, natural hazards and the threats from climate change' (WMO, 2007).

2. Material and methods

There are different methodologies to measure the economic benefits of meteorological and climatic information. According to Gunasekera (2004) the most important models include the following elements.

- Market prices can be used for services on the market which are offered in competition. An advantage of market prices is that they explicitly reveal the value users are willing to pay for.
- Commonly used techniques to estimate the value of meteorological information fall within the category of normative or prescriptive models. The approach in normative or prescriptive decision making models is to view meteorological and climatic information as a factor in the decision making process that can be used by decision makers to reduce uncertainty.
- Descriptive behavioural response methods are based on the notion that the value of meteorological information is dependent on their influence on the decisions of users engaged in meteorologically sensitive activities.
- Most of the meteorological and climatic information products are not traded in a market (public goods). Some of them are often available as free access' or are just priced with a legal fee. Therefore some analysts have used non-market valuation methods to estimate the value or the benefits of such information products. The contingent valuation method is based on survey techniques and hypothetical situations to elicit users' willingness to pay or their willingness to accept hypothetical changes in the quantity or quality of a non-market good such as public weather and climate 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. The conjoint analysis requires survey respondents to rank or rate multiple alternatives.
- A useful tool for economy-wide analysis of the value of meteorological information is a general equilibrium

model. General equilibrium models incorporate production of goods and services in an economy at a level of aggregation that permits the analysis of various structural and policy changes.

In the present pilot study results from the literature are used and the values of the economic benefit of meteorological services for the situation in Switzerland (Infras, 2008) extrapolated. The results are shown in Table I. The economic benefit for aviation and the climate data in Switzerland are not included in this pilot study.

3. Results

Probably the largest customer of meteorological products is the 3.1 million Swiss households who regularly consult different meteorological products. The MeteoSwiss annual total budget (weather and climate services as well as international contributions) is about 77.3 million Swiss Francs (2006). The average Swiss household, therefore, pays about 25 Swiss Francs a year for the weather and climate services of MeteoSwiss.

Taking into account the 7.5 million Swiss people this means that each inhabitant paid about 10 Swiss Francs in 2006 for the services of the Federal Office for Meteorology and Climatology.

Indeed the cost is even lower for the Swiss people, since some 38% of the budget is funded by professional users (2006).

Besides MeteoSwiss there are also several private providers of meteorological services, of which four are of some importance in Switzerland (Meteotest, Meteomedia, Meteonews, SF Meteo). The total costs of their weather services (radio, TV, press, internet) are estimated at 18 million Swiss Francs or, as there are about 3.1 households in Switzerland, approximately 6 Swiss Francs *per* household. When the costs of MeteoSwiss (77.3 million Swiss Francs) and those of the private providers of meteorological services are added the total is approximately 100 million Swiss Francs. This amount has to be compared with the overall benefits resulting from the weather and climate services, estimated to be in the range of several hundred million Swiss Francs.

Table I gives a summary of the findings regarding the economic benefit in Switzerland as a rough estimate. Aviation and climate data are not included in this rough estimate, since these markets will be studied in a follow-up study. This short overview allows estimation of the benefits from weather services in Switzerland to be in the range of hundreds of millions Swiss Francs. This study shows that roughly the costs of the meteorological services in Switzerland amount to about one-fifth of the revenues of all providers of meteorological services in Switzerland but omits economic sectors such as insurance, telecommunication, tourism, transport and logistics.

One of the main challenges is to identify the fraction of the total benefits from weather services that is attributable to the national meteorological service MeteoSwiss. This

Table I. Summary of chosen results for Switzerland.

Client	Service	Benefit model	Basic value	Reference	Projection parameter	Reference value for extrapolation in Switzerland	Estimated benefits obtained from extrapolation
Households	Free access information	Willingness to pay	30–200 CHF Person ⁻¹	Anaman and Lellyett (1996) Brown (2002) Lazo and Chestnut (2002)	Number of households in Switzerland	2.2 million	US\$54–362 million
Agriculture: granoculture	Seasonal forecasts and climatology	Normative, decision-making model	13 CHF ha ⁻¹	Abawi <i>et al.</i> (1995) Hill <i>et al.</i> (2000) Messina <i>et al.</i> (1999)	Cultivated area in ha	90 838 ha	US\$1 million
Agriculture: orchard	Short-term weather forecast	Normative, decision-making model	7 674 CHF ha ⁻¹	Adams <i>et al.</i> (2004) Katz <i>et al.</i> (1982)	Orchard	6636 ha	US\$42 million
Agriculture: total	Seasonal forecasts and climatology	Welfare	1% GDP US agriculture	Adams <i>et al.</i> (1995) Chen <i>et al.</i> (2002) Solow <i>et al.</i> (1998)	GDP Swiss agriculture	5.1 billion CHF	US\$42 million
Energy: water	Climatology	Normative, decision-making model	1% GDP Gas and electricity	Hamlet <i>et al.</i> (2002) Maurer and Lettenmair (2004)	GDP Swiss category of goods (41/40)	11.7 billion CHF	US\$98 million
Energy: electricity	Short-term weather forecast	Normative, decision-making model	0.08 CHF (MW h) ⁻¹	Teisberg <i>et al.</i> (2005)	Megawatt hours of consumption	59 421 GW h	US\$4 million

CHF = Swiss Franc (1 Swiss Franc ~ €0.66, US\$0.83).

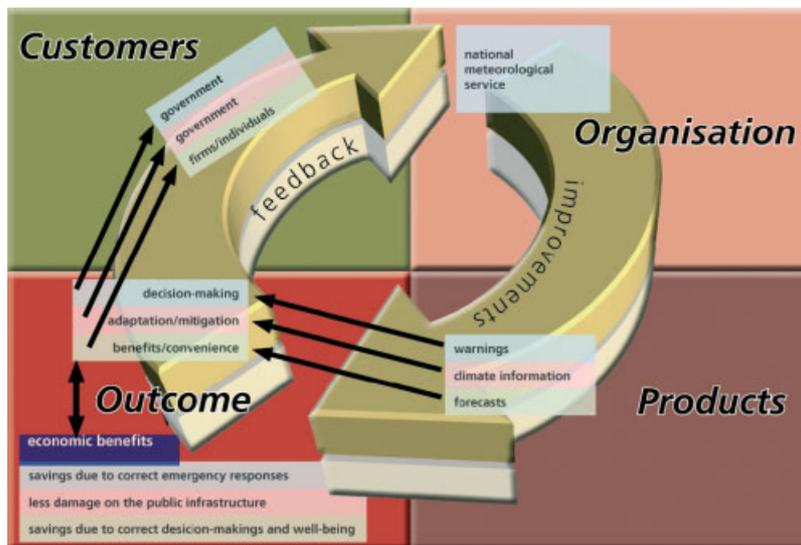


Figure 2. Economic benefits of the national meteorological service and its products, outcomes and customers.

problem is difficult since the services of private weather companies and MeteoSwiss are strongly interrelated on the one hand, whilst on the other hand both competitors offer similar products to users.

Economic value and benefit are a result of a continuing improvement process. Correct and decision-makings in time generate valuable economic values. The feedback and improvement loop for the national meteorological service and its products is shown in Figure 2.

4. Conclusions and outlook

The utility of timely and accurate weather and climate information to society cannot be overstated. Each day, people, in all walks of life, make decisions that involve information about the weather and climate from simple personal actions regarding appropriate clothing to complex actions that affect energy markets or aviation for example. Managing risk is important for everyone and better-informed decisions reduce risks and increase opportunities.

As governments respond to ensure public safety or to improve public health, there is growing recognition that weather and climate information have an increased impact on civil society and economies. There is also greater awareness that it is possible to make more effective use of weather and seasonal forecast information to mitigate some of the adverse consequences of the weather and to increase the positive benefits. Due to climate change (IPCC, 2007) and its impact on the economy (Stern, 2007) meteorological and climatic services become even more important.

The most weather sensitive sectors of the economy in Switzerland are agriculture, construction, the energy sector, insurance, telecommunication, tourism, transport (aviation, road, and railway) as well as logistics and water availability. The public sector profits in the areas of preparedness for storms, flooding and forest fires, avalanche

warnings and, as far as climate change is concerned, in effective adaptation and mitigation measures.

This pilot study has shown that it is hardly possible to estimate one single figure representing the total benefit from weather services in Switzerland. However, it is possible to work out specific answers concerning particular aspects of the benefits from weather and climate information by studying specific economic sectors.

Governments urge the national meteorological services to make maximal use in terms of services and products to its citizen and customers. This is also the case in Switzerland and, therefore, the results of this study are important to know. By paying about 31 Swiss Francs *per* year for all weather and climate services every household receives the relevant information. This study shows for the first time that in Switzerland the costs of MeteoSwiss and the other major providers of meteorological services very roughly amount to about one-fifth of the revenues of all providers of meteorological services in Switzerland. Not included in this estimation are the economic sectors that are users of meteorological services such as insurance, telecommunication, tourism, transport and logistics. Bearing in mind that Switzerland as an alpine country is particularly affected by climate change the cost/benefit ratio will increase in future (Arbeitsgemeinschaft Ecoplan/Sigmaplan, 2007; BAFU, 2008; EC, 2008).

Studies in other industrialized western countries have shown that the cost/benefit ratio of a national meteorological service is around 1:4 to 1:6 (Anaman *et al.*, 1995; Lazo and Chestnut, 2002; Leviäkangas *et al.*, 2008). It is highly probable that the ratio for Switzerland is about 1:5, but this estimation will have to be determined more precisely in a future study.

A possible design for a future main study should deal with the benefits for private households and economic sectors, not only as far as weather information is concerned, but also, particularly, with regard to climate data.

Analysis of benefits from climate data are of particular interest to MeteoSwiss, since the Federal Office is the main source for climate data in Switzerland. Climate data form the basis on which climate change and possible threats can be detected. Their benefits will materialize mainly in a distant future when – thanks to climate data – adaptation and mitigation measures will have been taken and hence climate costs will be smaller.

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