

Economic benefits of weather forecasting in some Member States of ECMWF

J.A. Woods

Research Department

November 1983

This paper has not been published and should be regarded as an Internal Report from ECMWF.
Permission to quote from it should be obtained from the ECMWF.



European Centre for Medium-Range Weather Forecasts
Europäisches Zentrum für mittelfristige Wettervorhersage
Centre européen pour les prévisions météorologiques à moyen

TABLE OF CONTENTS

Federal Republic of Germany.....	2
France	3
Ireland	6
Italy	8
Austria	9
Finland	10
Sweden	16
Turkey	18

INTRODUCTION

Information on the economic benefits of weather forecasting in the various Member States is of great interest to the Centre, and also to the Meteorological Services of the Member States. Information on this topic in the Meteorological Services of the Member States was requested, typed on A4 size paper within an area 16cm x 25cm to facilitate direct reproduction. Quantitative economic estimates (benefits or costs or benefit/cost ratios) were requested where possible. The contributions are based mainly on information already existing within the Meteorological Services. The information concentrates on, but is not necessarily restricted to, medium-range forecasts. Areas where economic benefits are gained include:

- ship routing
- agriculture
- energy
- public services (including the leisure sector of the economy)
- construction or other civil engineering
- industry and commerce (including retailing)

The information so submitted is included in this Report. It is expected that it will provide a useful reference source for the Centre and for the Member States.

ECONOMIC BENEFITS OF WEATHER FORECASTING IN THE FEDERAL REPUBLIC OF GERMANY

Benefits of the German Weather Service (DWD) estimated for 1983

	DM million
Transport	147
Agriculture	532
Construction	590
Energy	246
Total	1515

Figures for "public services" and "industry and commerce" are not available.

The above estimates include all types of services, i.e. forecasts, investigations; provision of raw data or expert advice etc. No assessment is made about the percentage to be allocated to medium range forecasts.

ECONOMIC BENEFITS OF WEATHER FORECASTING IN FRANCE

INTRODUCTION

This note on economic benefits has been limited to the three areas in which the Centre's products have the greatest impact: agriculture, energy and public works. The figures given are an estimate of the benefits derived generally from meteorological assistance.

To give a precise account of the part attributable to the Centre's products would require a study in depth which would be difficult to carry out, since the products are not necessarily communicated directly to the users, but are adapted to their needs. However, even if we were to estimate arbitrarily that as little as 5% of the economic benefits derived from meteorological assistance in France within the three areas considered are attributable to information received from the Centre, their amount would certainly be several times greater than the financial contribution paid by our country.

IMPACT OF THE METEOROLOGICAL INFORMATIONRELEASED BY THE EUROPEAN CENTRE

The economic impact of meteorological information is obvious for all forecast days, and also where climatology is concerned.

The various products of the European Centre contribute to this impact by noticeably extending the forecast periods (including general forecasting and statistical adaptation). In view of the resources and research efforts applied at the national level, information disseminated by the Centre is particularly useful where it concerns the medium and long ranges of the forecast (beyond 96 hours). This category of information is very much sought after for planning activities.

Agriculture

The planning of agricultural activities is directly dependent on the weather. This requires forecast periods shorter than 2 or 3 days in the case of phytosanitary treatments and sowing, but is more demanding where crops are concerned. The latter is where a risk of great agricultural losses lies.

The importance of meteorological information for agriculture is shown by the following figures (year 1982):

The vegetable sector of agricultural production amounted to 102,000 million francs and the animal sector to 125,000 million francs. To obtain this production, it is estimated that the total consumption of goods and services amounted to 114,000 million francs.

By combining the possibilities of improvement offered by the Centre and meteorology, we can estimate that

- agricultural losses account for 10 to 15% of the vegetable production: these can be decreased by one to five points according to the quality of the information. There is probably a close relation with animal production but this is still to be demonstrated.
- intermediate consumption of petroleum products (7,000 million francs), fertilizers (21,000 million francs), phytosanitary products (11,000 million francs) can be reduced by at least 10% in the first two instances and by 20% in the third.

Detailed knowledge of local climates and reliable forecasts to five days or more will make it possible to gain up to 5,000 million francs in production and to save 5,000 million francs on intermediate products. Potential gains thus amount to 10,000 million francs; they are at present of 1,000 million francs only.

Energy industry:

Long-range forecasts are of interest mainly to Gaz de France, where serious problems occur in the control of gas stocks. For example, in the Paris region alone, a temperature difference of 1°C brings about a difference in consumption of 1.3 million cubic metres of gas. This applies also to fuel oil and, to a lesser extent, to electricity, which cannot be stored. Stock optimisation is undoubtedly profitable, but difficult to translate into figures as fuel distribution is carried out at a great number of distribution points.

To give an idea, we would say that the total absence of weather forecasts used to cause a 10% shortage in production for the French electricity and gas industries alone, i.e. about 1,500 million francs annually. Savings on storage alone through consumption planning could amount to up to 1,000 million francs for all energy distributing industries (electricity, gas and petroleum products).

Building and public works

As in the case of agriculture, the planning of construction work depends to a large extent on the weather; both climatological and medium-range (under 4 days) information are important and medium-range forecasts contribute to the smooth running of building sites (problems associated with rainfall, temperature, etc.). On average, it can be estimated that the savings which can be achieved on a well planned site (commencement of work, earthwork, hiring of heavy equipment, availability of manpower, etc.) could be around 5 to 6% of the total cost of the work, but this percentage could probably be increased if the forecast period were lengthened.

This evaluation is far from all-embracing but it is a fact that availability creates demand and if it were possible, through the intermediary of the European Centre, to get away from the 10 day + statistical adaptation, other trade sectors might show interest. This is so for the catering industry and commerce (guarantee of a period of dry weather, of a spell of fine weather, etc.).

Economic Benefits of Weather Forecasting in Ireland

Information on the benefits of weather forecasting in Ireland is very difficult to gather mainly because of the problem of establishing a reasonable basis on which to quantify the benefits. However two studies have been made which may be of some interest.

1. 1974 Study

This study tried to quantify the benefits to particular areas of agriculture, industry etc., and took account only of those areas where a plausible basis for the estimation of benefits could be established. Other areas were omitted entirely even though it was obvious that they also derived considerable benefit from weather forecasts.

The conclusion was that for these quantifiable areas the total benefit was in the ratio 3 : 1 to the total cost of the Meteorological Service.

The breakdown of benefits was as follows:-

Agriculture and Fisheries	36%
Energy	2%
Public Services	21%
Construction and Civil Engineering	17%
Aviation	24%

While no distinction was made between short range and medium range forecasts it is likely that most of the benefits to agriculture derive from medium range forecasts, public services would be equally divided between short range and medium range, while the remaining benefits would largely be associated with the short range forecasts.

These figures should be regarded as being very tentative having regard to the limited scope of the study. Developments since then would also alter the situation. There has been a significant increase over the last ten years in the awareness of potential customers of the value of good forecasts, notably in industry and agriculture. Since 1974 offshore oil and gas exploration has increased a great deal and the use of natural gas has made the energy sector more sensitive to the use of weather forecasts in predicting consumption.

2. 1983 Study

This study confined itself to agriculture and concluded that benefits to agriculture alone, when related to the entire budget of the Meteorological Service, produce a benefit/cost ratio of 2 : 1.

Three areas of benefit were considered, and they are listed below together with the benefit as a percentage of the total.

- | | |
|---|-----|
| (a) Crop Spraying Programmes: | 30% |
| (b) Livestock Disease Control (e.g. Liver Fluke): | 35% |
| (c) Grass Production: | 35% |

Again medium range forecasts would be the main source of these benefits.

ECONOMIC BENEFITS OF WEATHER FORECASTING IN ITALY

It is generally felt in Italy that ECMWF products are of great value to the national community.

About ten years after the previous economic study which opened the way to the foundation of the ECMWF, it is the opinion of the Italian Meteorological Office that a new benefit/cost estimate should be carried out as soon as possible by proper experts, based on the large experience acquired by users on a 4-year use of ECMWF products.

Such an estimate would be a powerful instrument for the Council and the Meteorological Offices of the Member States.

The suggestion is that an effort in this direction should call for serious economists and the proposed organisation to do the job could be the EEC.

ECONOMIC BENEFITS OF WEATHER FORECASTING IN AUSTRIA

A cost-benefit estimate has not been made and even does not seem to be possible. There is only one quantitative hint made by a regional producer of electricity (SAVE): A temperature forecast for the communities in the Salzach Valley with a precision of $\pm 1K$ during wintertime would save about 10 millions of Austrian Shillings compared to the present situation. It was not possible to receive similar statements from other energy companies neither from agriculture nor building industry. Two transportation companies stated that one fruit transport lost by weather influences would cost about 500.000 AS, the re-loading of humidity-sensible freights on account of (not foreseen) bad weather would cost about 20.000 AS. Unfortunately we cannot offer more information to this subject.

ON COSTS AND BENEFITS IN FMI WEATHER SERVICE

1. General

Information on costs and benefits of FMI weather service are available on the following service units:

- Road weather service (a report enclosed)
- Railway weather service
- Icebreaker wind service
- Weather service for
 - timber tugging on inland waters (Lake Saimaa)
 - Peat digging industry
 - Ship routing

In addition, there are several other studies of costs and benefits of special weather services at the moment going on, such as

- an experiment of special service for three biggest peat digging firms by using national videotex system
- further service trials and their success for railway traffic
- preliminary study of needs and basic benefits of special weather service for construction industry
- an extensive collaboration project including several special weather service trials for agriculture.

More information on these should be available within a year (autumn 1984.)

2. Road weather service

The ministry of Communications directed the steering committee and its ancilliary working group to investigate the development and organization of road weather service in Finland in April 1980. During the development and research work several practical experiments were conducted. First, in 1980 - 1981 a trial consisted of cataloguing experiences and establishing the starting points was run in the Helsinki capital area. In the next winter, a more extensive experiment was run in the Helsinki area, where road maintenance personnel, local radio and mobile police were provided with special weather service by a real time automatic viewdata transmission system

controlled by the FMI. Third, in the Turku trial of 1980 - 1981 the requirements for a separate road weather service unit and influence of a tailored weather service on road maintenance, road conditions, and traffic were elucidated. Fourth, survey of needs by the motorists was made by a questionnaire and a selected sample of road masters in the whole country were questioned after having given them special service in the winter of 1981 - 1982 by aviation weather services using telephone answering device.

In all these trials costs and benefits of road weather service were studied. The cost-benefit ratio differed from 1 to 3 to 1 to 9 depending on the level of the service and on the possible future organization and establishment of service routine, among other things.

The development project was ended in autumn 1982 when the final report was written* and the results were handed over to the Minister. Now the service is operating in routine, according to the trials conducted in 1981 - 1982, but the final road weather organization will be built according to the area weather service plan of FMI in this decade.

3. Railway weather service

District offices of the railways in Finland have been given weather service in a very inconsistent way in the past, occasional phonecalls from and to the meteorologist.

In 1982, an investigation was made, where the benefits of the organized weather service for the railways were studied, and a plan for service experiment for the winter 1982 - 1983 was proposed. The trial organization, which was then defined, include three different ways of giving weather service. First, in Helsinki area, the aforementioned road weather service viewdata system was used (real time observations, forecasts and warnings), in southern coast regions the Post Office viewdata system was used (similar to Prestel) and in other parts of the country, the telephone answering device were used (updated forecasts twice a day). The final cost-benefit calculations are yet to be made, but following reasoning was made in cooperation with the railway authorities.

* Copy available on request from ECMWF.

The benefits of better weather service (compared to nationwide radio- and TV forecasts) can easily be seen in reduced costs of warming up the switches. The warming must be done for melting the snow and ice off of the switches. For example, during the winter of 1981 - 1982 the Finnish railways had 1600 switch units which are using electricity as the warming energy - and the amount is still increasing. The average power of these is 7.5 kW, so that the maximum consumption is 12 000 kW/hour, and the costs for electricity is thus 3 300 FIM/hour. One switch unit is warmed about 1500 hours/year (the warming can be regulated by using 1/2 power or 3/4 power instead of full power).

By a more tailored and efficient weather service the time of warming can be reduced and optimised. The costs of the weather service experimented in 1982 - 1983 could be met by only 40 to 50 hours saving in warming time per switch unit, which is only 3 % of the total amount. The warming practice has hitherto been very extravagant, so that it is reasonable to expect the cost-benefit ratio to be favourable.

4. Icebreaker wind service

In the beginning of 70's a project was conducted at FMI where a statistical-dynamical model for predicting winds for the sea areas around the Finnish coast was developed. The wind forecasts are based on numerical model run at FMI and it is run for 36 hours four times a day. The forecasts are then checked by the meteorologist on duty and telexed to the coast radio stations and further to the icebreakers. The costs of this service are minimal (if the development costs are not included, and they cannot, because marine weather service is regulated by laws) and the benefits vary greatly depending on the severeness of winter, the decisions made by the captains, the value of the cargos and ships aided through the ice and so on. The hazards in the icebreaker traffic are caused by wind (almost entirely because other parameters have no effect on such huge constructions). It is essential to know if the wind will push the ice rafts together so that the ship cannot move or gets damaged, and the icebreaker must come to aid. Or the icebreaker captain must know how many ships it can take to escort to and from the harbour, which is dependent on the direction of wind (again, if the wind will close the opened rift too soon).

It is clear that the damages can be millions of FIM if the accurate wind information is not available. Also, any additional manoeuvre the big icebreaker must make is very expensive.

5. Weather service for timber tugging on inland waters

The biggest timber tugging lake in Finland is Lake Saimaa, which has vast open areas and narrow sounds alternating. The lake is instrumented by 5 automatic weather stations erected to the most difficult spots. They are measuring air temperature, humidity and wind and the measurements are collected to the FMI every three hours. The captains of the tug boats get weather service through their local radio station, and the forecasts are given from FMI. The costs of the service include the investment of the AWS's (appr. 200 000 FIM) and annual costs of forecasts (appr. 24 000 FIM/year). The managing director of the tuggers on Saimaa stated the benefits as follows:

- one timber float has the value 4 to 7 million FIM
- if the float breaks away in the storm, but all of it can be put together again (the gathering expences are 50 FIM/m³) the amount of damage is from 1 to 1.75 million FIM
- if the float breaks, but only, say, 2/3 can be gathered, 1/3 is totally missed (which is normally the case) then the damage amounts to 2 to 3 million FIM
- even if only 100 timber bunches (a float is made of bunches) out of the total amount of the tugging season - which is 250 000 to 300 000 bunches - could be saved by a better special weather service, the savings would be 300 000 FIM
- crossing the biggest open areas in the lake takes 10 to 12 hours (the speed of the tug boat + float is 2 km/h). Because of bad weather tug boats must stay on shore 4500 hours per season. If the so called weather windows could more efficiently be used, then the lay days could be reduced at least with 500 hours, which will amount to savings of 125 000 FIM per season.
- the stress of the tug boat captains in deciding weather sensitive actions will greatly be reduced.

6. Weather service for peat digging industry

One of the domestic energy sources in Finland is peat. The State Peat Digging Plant has made preliminary calculations of the benefits of tailored weather service. The results indicate the following.

Peat production is totally dependent on evaporation situations. It is essential to know the weather accurately for the next two or three days for management of the production and decision making of site activities. If the forecasts are not accurate enough losses may be caused in input costs for the production, eg. when the rain falls earlier than predicted. On the other hand, when the forecast is tailored and available, the costs can be reduced, because some of the phases in production can be postponed, left out or speedied up.

An example: One production unit is about 150 hectares. The input costs for cutting the moss and turning the peat during one production phase is 10 000 to 30 000 FIM. If heavy rain falls just before the peat digging, that amount of money is lost. If the rain is not so heavy, half of that amount is lost.

If the timing of the rain would have been known, the digging of peat would have been started earlier or a part of the work should have been left undone.

If in the production such an unnecessary loss could only once be avoided, the total seasonal gain in the total production area (30 000 hectares) of the Plant would be 2 to 6 million FIM.

It is thus reasonable to assume that the costs of rain service needed here will be much lower than the calculated benefits.

7. Weather service for ship routing

Many ships and cargo companies must nowadays study ways to reduce travelling costs. One possibility is to reduce driving speeds, when the fuel consumption is much lower. On certain prevailing winds it is even wiser to choose a longer route than normally. Handling of the cargo is a big cost component, for example: can deck cargo be taken, and how much, (say, 400 cars, and how to fasten them for the trip). Not small is also the concern of the passenger comfort onboard. All these components

must be taken care of without risking security on sea. Finnish cargo ship companies struggle with following questions, which depend on weather forecast during the trip:

- loading ship, deck cargo, fastening cargo
- fuel consumption, economical drive
- passenger comfort
- use and need of hired men power
- security on sea.

It is essential to stay on schedule, because this has influence on new costs which may be born of the waiting time of the pilot and the hired men and harbour expences, eg. dock charge.

Straightforward cost-benefit calculations are impossible since the big ships will traverse no matter what is the weather. Biggest savings can be gained, when hazardous weather can be predicted in due time, and the decisions needed can be made and the whole manœuvre succesfully executed.

An example: When there is light wind aft the route can be chosen between Helsinki and Luebeck so that the wind will help 20 tons of fuel to be saved. In winter conditions information on the positions of the rifts, (e.g. from satellite pictures) can cause 40 tons of fuel to be saved on the same route. The time of arrival to the harbours in Baltic sea indicates the amount of unloading personnel to be available so being late always causes delays and costs. One forecast for the cargo ships costs 100 to 200 FIM, which vary from 12 hour to 48 hour forecasts. The ships also make observations abroad for the use of forecasters. Depending on hazards avoided and fuel saved the cost-benefit ratio of weather service is estimated to be 1 to 50 or more.

ECONOMIC BENEFITS OF WEATHER FORECASTING IN SWEDEN

Some comments on economic benefits of weatherforecasts (SMHI)

The main end users of medium range weather forecasts in Sweden are given in the list below.

Users	Season	Frequency weekly	Period days	Note
Swedish Radio	whole year	2	5	for the general public
Swedish Television	whole year	2	5	for the general public
Newspapers	whole year	variable	3,5	for the general public
Energy companies	variable	variable	5	
Building-industry	winter	2	5	
Land-surveying authorities	summer	2	5	airphoto activity
Ice breaking service	winter	7	5	10-day forecasts twice a week
Harbours and shipyards	winter	variable	5	mainly wind
Shipping	variable	variable	5	mainly wind
Agriculture	summer	5-7	3,5	
Swedish Railways	winter	1	3	snow-clearance
Local snow-clearance authorities	winter	1	3	roads and streets

The forecasts are in many cases given for each day in the forecast period up to five days, in some cases for the five day period as a whole. The forecast parameters are in most cases wind, cloudiness, precipitation and temperature. Maximum and minimum temperatures are important as well as daily mean temperature. Snow-clearance authorities are interested in forecasts of new-fallen snow cover.

The weather forecast is a highly significant factor in the planning and executing of many operations in sectors of economy, and of course for the Community as a whole. As a measure of the value of the weather forecast (in many cases tailor made), we can mention that for the last 3 years the net income to SMHI from the Customers that buy specialized forecast products, has increased with 43% (excluding inflation). One can say these circumstances is a reflection of the fact that different sectors of the Society find it economic profitable to buy tailor made forecasts, in a severe economic situation.

In the majority of cases, however, it is difficult to evaluate economic benefits.

There is also the fact that those directly concerned are sometimes reluctant to provide the information requested, either because they fear that if they admit to deriving significant benefit, the Meteorological Services might increase their charges, or because they hesitate to reveal too many details concerning their finances.

That means that we unfortunately have no recent benefit/cost ratio to publish.

1983-07-01

Rune Joelsson

ECONOMIC BENEFITS OF WEATHER FORECASTING IN TURKEY

1. Agriculture

a. Forecasts for cultivation and harvesting

Medium and short-range weather forecasts have been prepared and broadcast. This is quite useful for farmers, allowing them to choose a convenient date for cultivation and harvesting.

b. Frost warnings

Frost warnings have been prepared as medium and short-range forecasts and transmitted to the users by TV, radio broadcast, meteorological bulletins and press, allowing them to take necessary measures.

c. Agricultural control and quarantine studies

Medium and short-range weather forecasts have been studied by the users for applying insecticides in suitable weather conditions.

d. Combating forest fires

Special weather forecast reports are prepared for combating forest fires; they are quite useful for taking measure.

It has been estimated that the benefit/investment ratio may be approximately 30/1 for agriculture.

2. Transportation: (highway, railway)

a. Highway

The contributions of meteorological support to highway transportation are remarkably high. Especially in winter, severe weather conditions such as snow and fog and icing on highways have been reported as short and medium-range forecasts. To draw the user's attention to forecasts is an important step for them to take necessary measures.

b. Railway

Weather forecasts also contribute to the railway transportation. It may be estimated that benefit/investment ratio is approximately 25/1 for transportation.

3. Ship routing

Mariners are informed previously about storm warnings which are prepared as medium and short-range forecasts. In addition, routine weather reports concerning navigational conditions are very important in performing navigational transportation, leading to better time-keeping, increased confidence and reduced prices. On the other hand, forecasts and warnings are important support services for fisheries.

It is estimated that benefit/investment ratio is approximately 25/1 for ship routing.