

Future direction 2022+, Socio Economic Benefits:

**EUMETSAT's SEB network/community of practice
incl. EUMETSAT's recent experience of assessing
SEBs for EPS-Aeolus and EPS-Sterna, the
limitations of the methodology and in particular
concerning gaps and areas of work**

Presented to CGMS-53 Plenary session, agenda item 5

Executive summary of the WP

Weather and climate services deliver substantial socio-economic benefits (SEBs) globally across all sectors of the economy. There is a growing body of supporting literature, demonstrating benefit-to-cost ratios ranging for 3:1 to more than 2000:1. Benefits can be increased through the provision of more, and better, observational data, which improves the accuracy of weather forecasts and the quality of services to users. However, it is more challenging to quantify the SEB impact of such improvements and few comprehensive studies are available in the literature.

In 2023 EUMETSAT commissioned a SEB study to support two proposed additions to its European Polar System: EPS-Sterna and EOS-Aeolus. The study used extreme event economic impact data and published sector-specific SEB studies to quantify the value of weather services, and NWP impact studies to assess the improvement in forecast accuracy from the proposed additions. By assuming a linear relationship between accuracy improvement and SEBs, the study determined a benefit-to-cost ratio of 33.

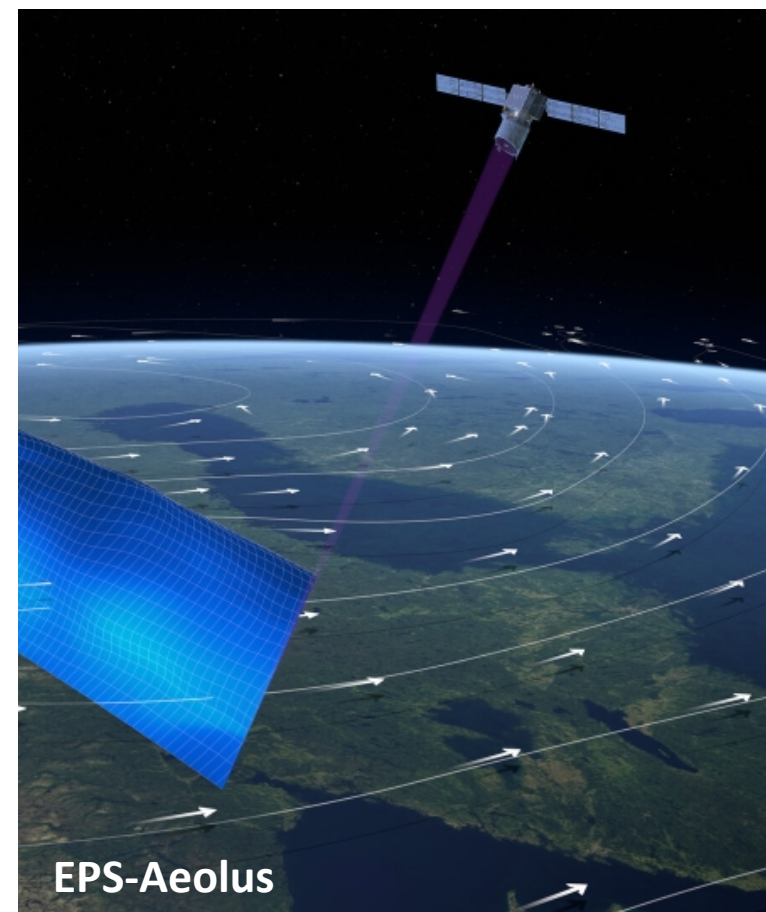
This study draws on the best available sources in the literature, as well as specially commissioned NWP impact experiments. However, the methodology revealed a lack of recent, applicable studies in key sectors, including flooding, energy and construction, and there is a need for more deep-dive investigations into how improved accuracy enhances business decisions. Such insights are especially relevant now, in a time of disruptive change being brought about by application of AI/machine learning to weather forecasting and climate modelling.

SEB evaluation of weather services is an area of growing interest among National Meteorological Services. WMO is developing a toolkit for weather and climate SEB studies, and has established an Economic Impacts Network to foster greater engagement and collaboration. Member States are encouraged to develop in-house skills and build co-operation with economists in governments, industry and academia, commissioning new research and supporting international collaboration.

Outline

Evaluating Social and Economic Benefits of weather satellites

- Why is this important?
- Recent experience at EUMETSAT
- Limitations and gaps
- Recent developments
- Priorities for the future
- Q & A



SEB evaluation: why is it important?

Major global investment

- Billions of Euros in new programmes

Global financial pressures

- Government budgetary constraints

Space industry investment priorities

- Exploration, Security, Comms, Weather, ...

Weather infrastructure investment priorities

- Research, Observations, NWP, Services...

EUMETSAT priorities



SEBs of weather services

Growing library of SEB studies

– Regional, national, sector specific

BCRs 3:1 to more than 2000:1

Problem: how to quantify SEBs
from increasing forecast accuracy?

World Bank (Kull et al., 2021)

– BCR >25:1 from investment
in surface-based observations

SEB study	Location	BCR
PWS (1998)	Sydney	4:1
Value of forecasts (2002)	USA	4:1 +
Drought early warning and response system (2012)	Ethiopia	3:1 to 6:1
Philadelphia Heat Watch/ Warning System (2004)	Philadelphia, USA	2 000:1 +
ENSO early warning (2003)	Mexico	2:1 to 9:1
Hurricane forecasts for oil and gas producers (2004)	Gulf of Mexico	2:1 to 3:1
NMHS modernization (2008)	Europe and Central Asia	2:1 to 14:1
Improving met/hydro services (2012)	Developing countries	4:1 to 36:1
Avoided costs of met/ hydro services (2009)	Finland	5:1 to 10:1
Enhanced weather services (2011)	Nepal	10:1
Benefits of meteorology and climatology (2010)	Switzerland	5:1 to 10:1
Improved met/hydro Services (2014)	Bhutan	3:1

SEBs of EUMETSAT MISSIONS

LEO satellites

- SEB valuation based on NWP skill impact
- Quantified using OSSE techniques – this is unique

GEO satellite

- EUMETSAT does not perform SEB studies
- most benefits are related to saving of lives

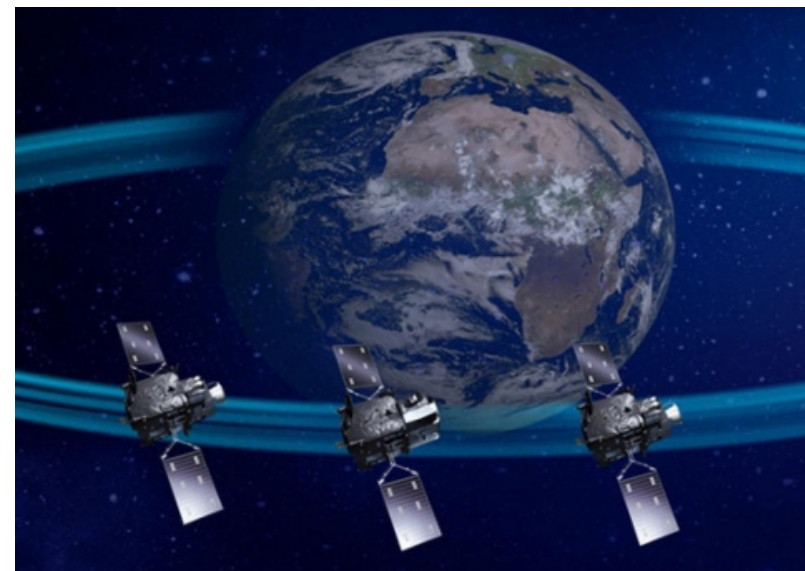
Oceanography missions

- we did try recently (Q2/2025)
- not possible to quantify the link to the Blue Economy

When not possible to do SEB studies

- we present Benefit papers without numbers

EUMETSAT intend to continue to publish such studies, and to update them in the course of implementation of the programme



Recent experience at EUMETSAT

2023 SEB valuation for two new additions

- EPS-Aeolus and EPS-Sterna
- Improved forecast accuracy
- Combined EUMETSAT lifetime cost ~€2bn

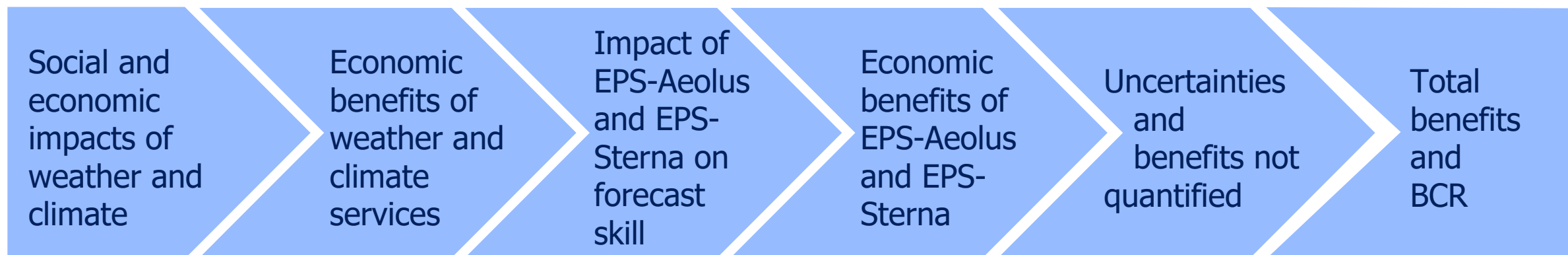
Problem: how to quantify the benefit to MSs

Solution: comprehensive SEB impact study

- NWP studies to quantify accuracy impact
- Economic benefit evaluation



Building the SEB case



Inputs:

EM-DAT, CATDAT (RiskLayer), NatCatSERVICE (Munich Re)

Published and commissioned SEB studies

Specially commissioned NWP accuracy impact studies

Case for EPS-Aeolus and EPS-Sterna

	EPS-Aeolus	EPS-Sterna	EPS-Aeolus and EPS-Sterna
Operational lifetime	2032-2042	2029-2042	
Lifetime net present costs	688	641	1,329
Lifetime net present benefits	13,600	32,700	44,200
Benefit to cost ratio	20	51	33

Summary of lifetime net present costs, net present benefits (million Euros at 2024 e.c.) and benefit-to-cost ratios for EPS-Aeolus and EPS-Sterna.

Limitations and gaps

Lack of recent sector-specific SEB studies

- Recent aviation and general public valuations (UK)
- Older studies used: Floods (2004), Rail (2012), Road (2011 and 2012), Retail (2016)

Important sectors lack comprehensive studies

- Energy, Construction, Water Resources

Need for more deep-dive investigations

- is the accuracy-value relationship linear?
- how does improved accuracy enhance business decisions?
- e.g. Molina, R and Rudik, I (2024),

The Social Value of Hurricane Forecasts

The Social Value of Hurricane Forecasts

Renato Molina and Ivan Rudik*

February 22, 2024

Abstract

What is the impact and value of hurricane forecasts? We study this question using newly-collected forecast data for major US hurricanes since 2005. We find higher wind speed forecasts increase pre-landfall protective spending, but erroneous under-forecasts increase post-landfall damage and rebuilding expenditures. Our main contribution is a new theoretically-grounded approach for estimating the marginal value of forecast improvements. We find that the average annual improvement reduced total per-hurricane costs, inclusive of unobserved protective spending, by \$700,000 per county. Improvements since 2007 reduced costs by 19%, averaging \$5 billion per hurricane. This exceeds the annual budget for all federal weather forecasting.

JEL: Q54, Q58, C53

Keywords: extreme weather, natural disasters, hurricanes, tropical cyclones, forecasts, information, climate change

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Recent developments

Increased requirement from EUMETSAT MSs

Growing SEB focus to support capacity development

WMO Economic and Societal Impacts Office

- *Valuing Weather and Climate* (WMO-No. 1153), 2015
- New toolkit for weather and climate SEB studies

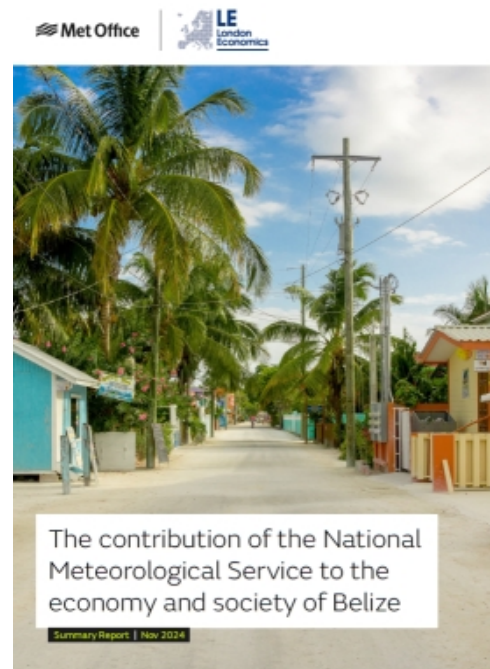
Economic Impacts Network

- Argentina, Australia, Canada, Denmark, Finland, Germany, Netherlands, South Africa, Spain, Sweden, UK

New economic research commissioning

- e.g. UK study on the SEB of improved flood forecasting

Transformational impact of AI on weather forecasting and climate projections



Priorities for the future

- ✓Develop in-house skills and understanding
- ✓Build co-operation with economists in industry and academia
- ✓Strengthen dialogue with Finance Ministry economists
- ✓Commission new research to fill gaps
- ✓Support international collaboration and knowledge sharing

To be considered by CGMS:

- Presentation and supporting paper for consideration by the CGMS-53 Plenary
- Questions and comments welcome now or afterwards direct with the speaker

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