Training Day 1: Assessing the Socioeconomic Benefits of Climate Services in the Pacific Region

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Mentimeter

1. How would you define climate services in one sentence?

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Agenda: Day 1

Timeline	Item
09:00-09:25	Welcome & Objectives
09:25-09:55	Introduction on Socioeconomic Benefit (SEB) Assessments
09:55-10:25	Evaluation Framework: The 10-Step Procedure
10:25-10:40	**COFFEE BREAK**
10:40-12:30	Step 1-3 in SEB Evaluation
12:30-13:30	**LUNCH BREAK**
13:30-15:00	Step 4-5 in SEB Evaluation
15:00-15:15	**COFFEE BREAK**
15:15-15:30	Exploring the Case Study Methodological Approach
15:30-16:15	Q&A Session
16:15-17:00	Closing Remarks and AOB

Agenda: Day 2

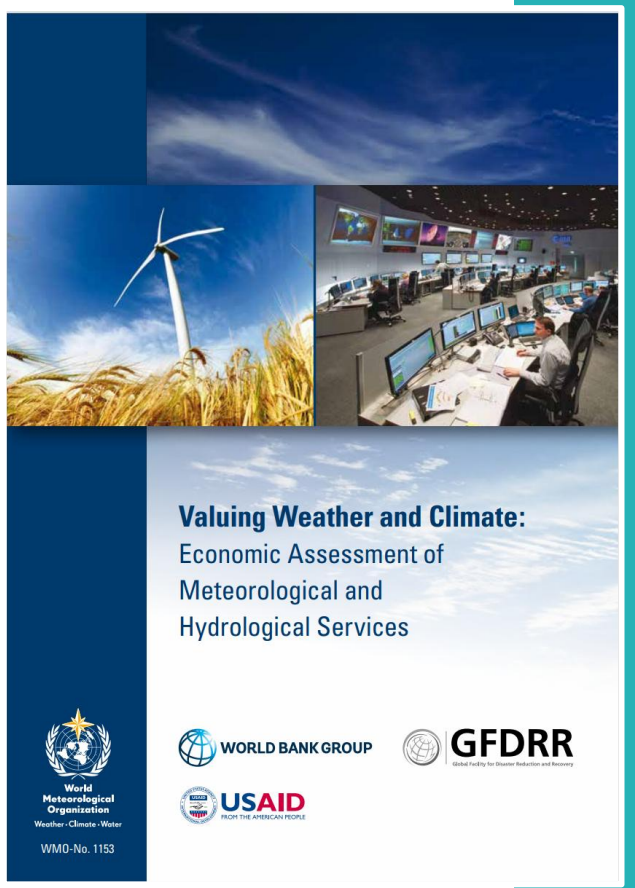
Timeline	Item
09:00-09:25	Welcome & Day 1 Recap
09:25-09:40	Day 2 Agenda
09:40-10:30	Step 6-7 in SEB Evaluation
10:30-10:45	**COFFEE BREAK**
10:45-12:00	Step 7-8 in SEB Evaluation
12:00-13:00	**LUNCH BREAK**
13:00-14:00	Step 9-10 in SEB Evaluation
14:00-14:45	Q&A Session
14:45-15:00	**COFFEE BREAK**
15:00-16:00	Practical Exercise: Conducting an SEB Assessment
16:00-16:30	Closing Remarks and AOB

Welcome and Objectives

Objectives

According to the results of the WMO Hydrology Survey 2020, **NMHSs have insufficient budget allocations and difficulties in attracting government funding.**

To incentivize governments to invest in NHSs operations, **SEB analysis of hydrological services is an effective tool** to support evidence-based decision-making.



EXPECTED OUTCOMES:

- Enhance understanding of SEB concepts and their application to hydrology.
- Gain practical knowledge of SEB tools and methodologies.

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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Round of Introductions

- Please share your **name**
- Tell us about your **current role/position**
- Which **country or organization** are you representing?
- What are your **expectations or goals** from this training?

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Introduction to Socioeconomic Benefit (SEB) Assessments

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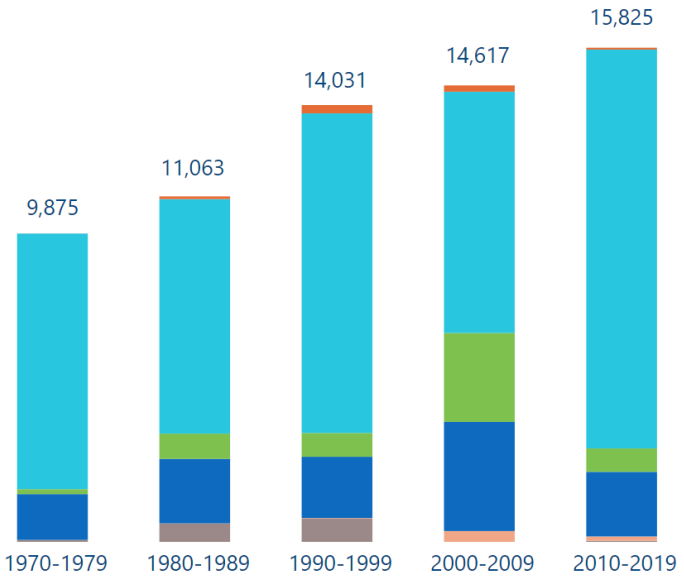
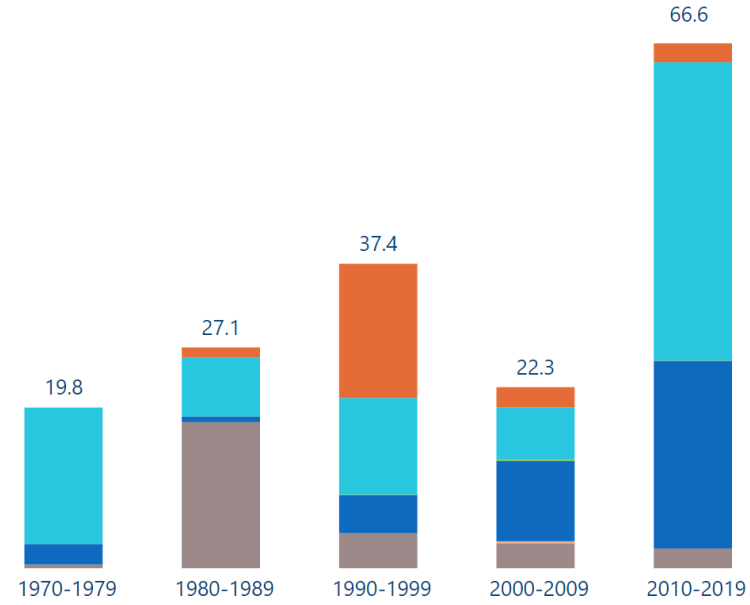
Impacts of extreme events in the South-West Pacific

Updated WMO Atlas of Mortality and Economic Losses (1970-2021)

Reported deaths by decade
Total: 66 951 reported deaths



Reported economic losses in US$ billion by decade
Total: US$ 185.8 billion reported economic losses



Drought Extreme temperature Flood Landslide Storm Wildfire

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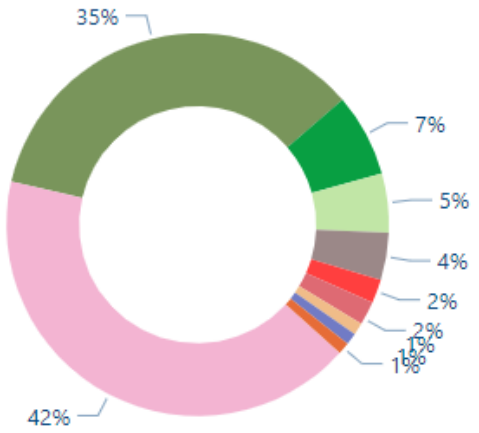
Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate, and Water Extremes (1970–2019) (WMO-No. 1267) 2022 update.
Note: * refers to the EM-DAT classification. Economic losses are reported in 2021 US$ values.

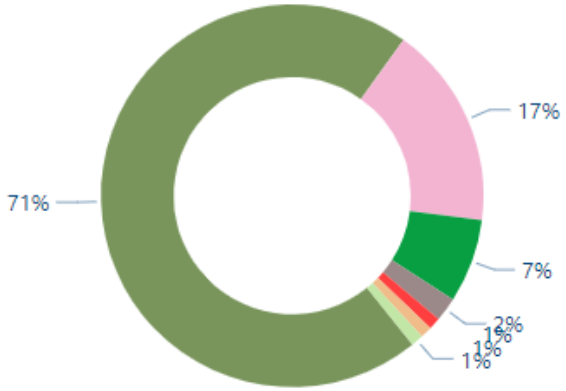
Severe impacts of floods and cyclones in the South-West Pacific

Updated WMO Atlas of Mortality and Economic Losses (1970-2021)

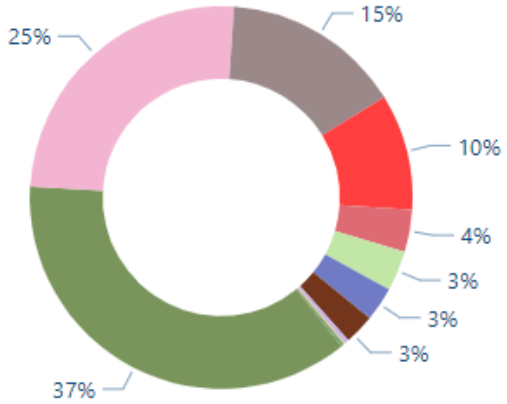
Reported disasters



Reported deaths



Reported economic losses



Avalanche · Cold wave · Drought · Extra-tropical storm · Flood (general flood, flash flood, riverine flood, coastal flood) · Forest fire · General storm · Hail · Heat wave · Land fire (Brush, Bush, Pasture) · Landslide · Lightning/Thunderstorms · Mudslide · Severe winter conditions · Tornado · Tropical cyclone · Winter storm/Blizzard

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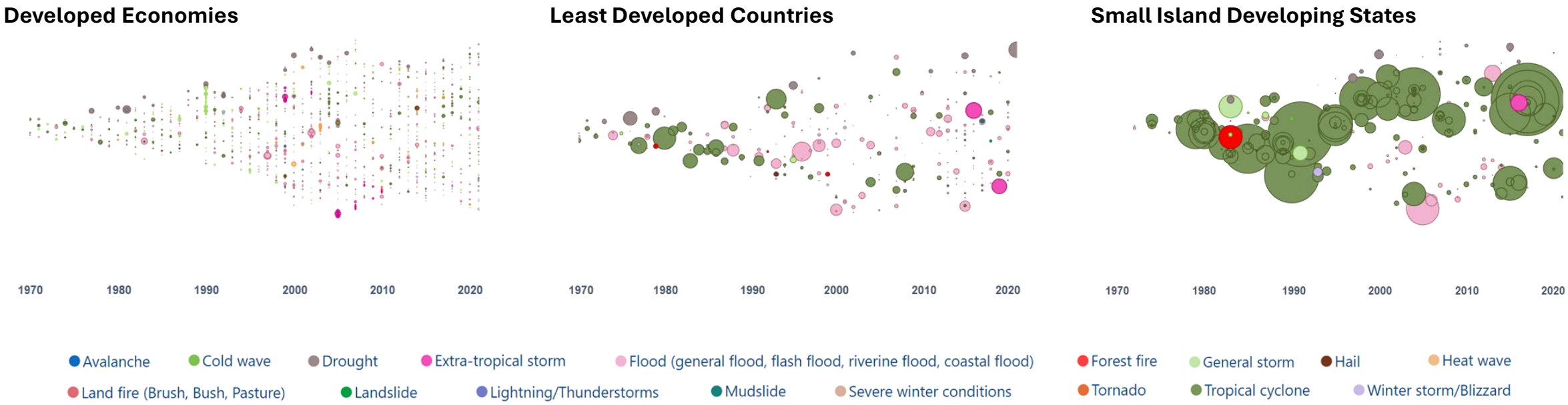
Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate, and Water Extremes (1970–2019) (WMO-No. 1267) 2022 update.
Note: * based on EM-DAT hazard type. Percentages may not total 100% due to rounding, deviation is within +/- 1%.

Disproportionate impacts on Small Island Developing States

Updated WMO Atlas of Mortality and Economic Losses (1970-2021)



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Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate, and Water Extremes (1970–2019) (WMO-No. 1267) 2022 update.

Note: the hazard classification is based on EM-DAT hazard type; the bubbles are event-specific; the size of a bubble relates reported economic losses from weather-, climate- and water-related extremes to countries' annual Gross Domestic Products.

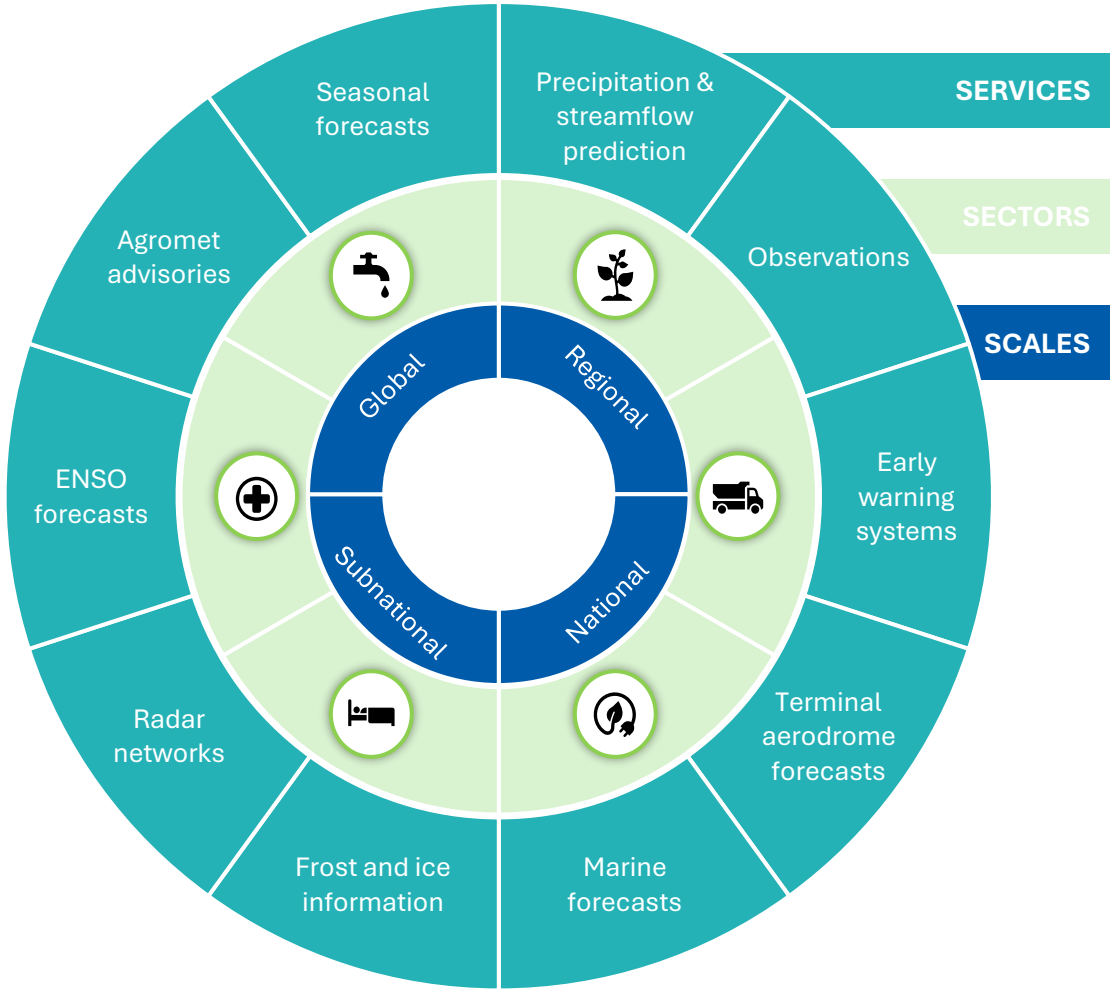
Socioeconomic benefits span across types of services, sectors, and scales

Economic efficiency
Reducing operational costs, optimizing logistics, and preventing service interruptions, contributing to more resilient and cost-effective systems.

Productivity gains
Supporting better agricultural planning, energy management, and financial outcomes for households and businesses.

Effective risk reduction
Helping to avoid damages and health impacts associated with extreme weather events.

Social and environmental benefits
Including improved livelihoods, targeted humanitarian interventions, and more sustainable use of natural resources.



Source: WMO Database of Socioeconomic Benefit Assessments, 2025.

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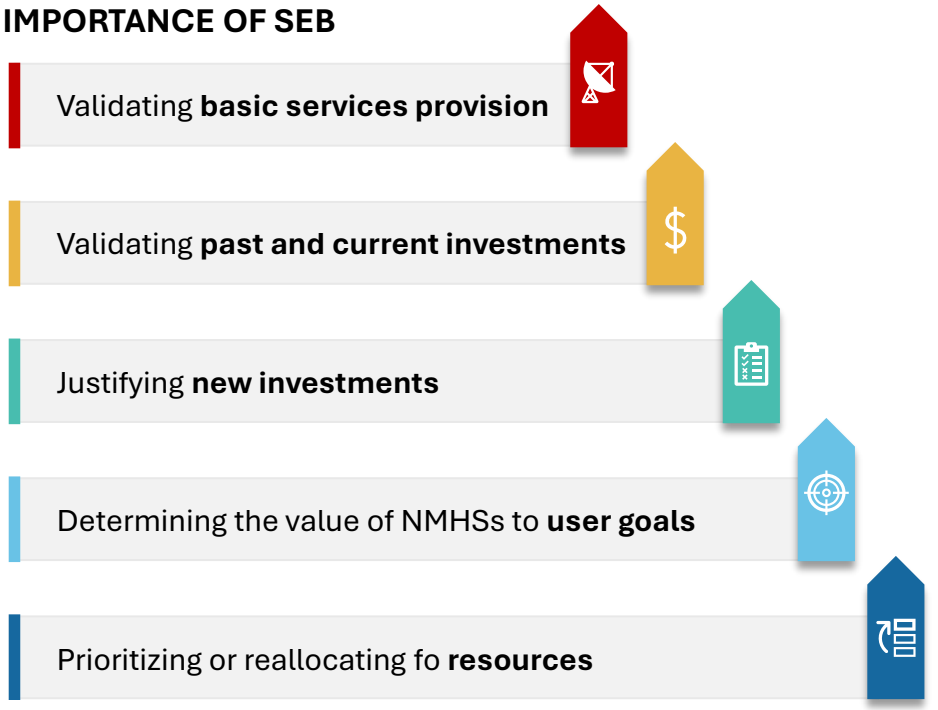
Socioeconomic benefit assessments and their importance

WHAT IS A SOCIOECONOMIC BENEFIT (SEB) ASSESSMENT?

Involves a **quantitative analysis of the benefits and costs (in monetary terms)** and a comparison of the benefits and costs derived from a project or investment in weather, climate and hydrological services, providing the basis for informed investment decision-making.

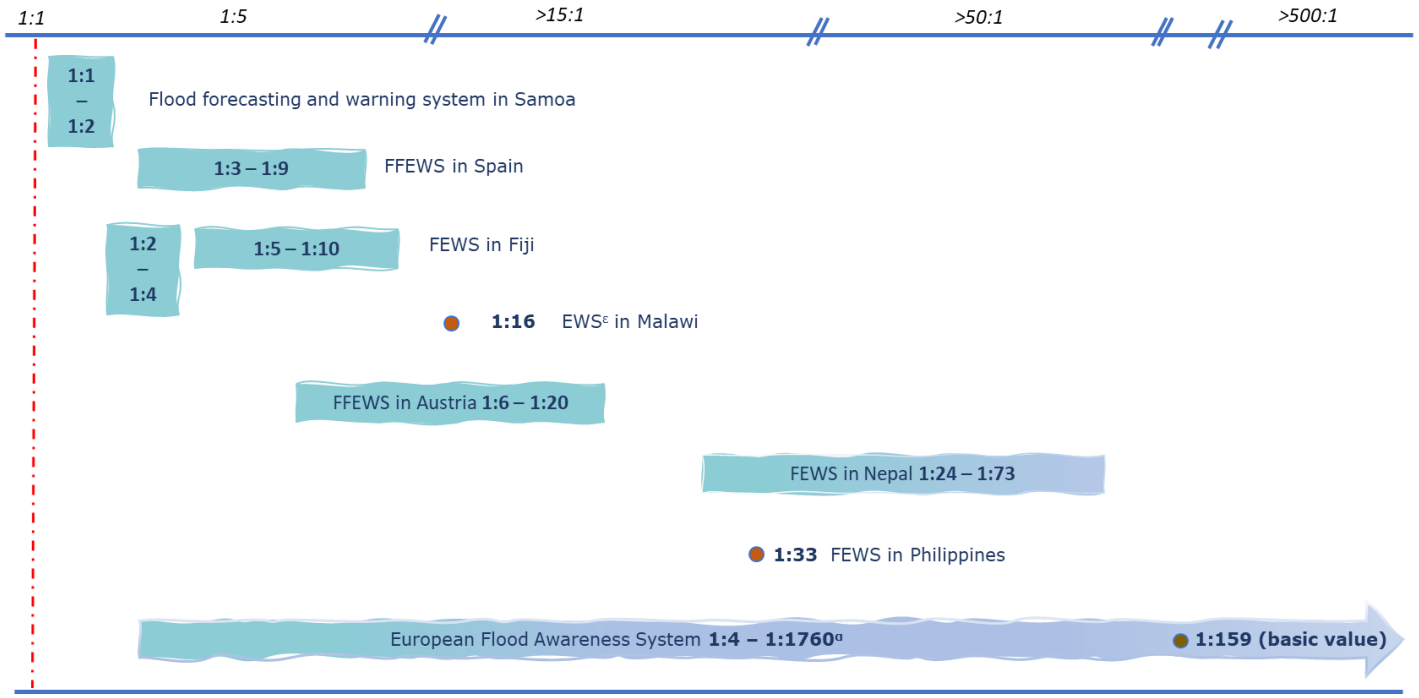
IMPORTANCE OF SEB



Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

SEB assessments demonstrate that investing in climate services makes economic sense

Cost-Benefit Ratios for climate services



Sources: Adopted from Woodruff, A., 2008; Schröter et al., 2008; Holland, P. , 2008; Arias et al., 2015; Pappenberger et al., 2015; Rai et al.; 2020; National Planning Commission et al., 2021.
Note: examples do not cover investments in structural protection measures; α study covers 19 scenarios; ε with a FEWS component

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Current status of SEB assessments across WMO Members

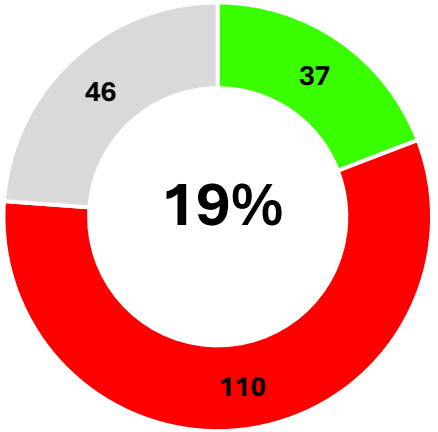
WMO Monitoring Data Collection Campaign (2022-2025)

The **WMO Monitoring System** reports on Members who have evaluated their services using SEB assessments in the past ten years.

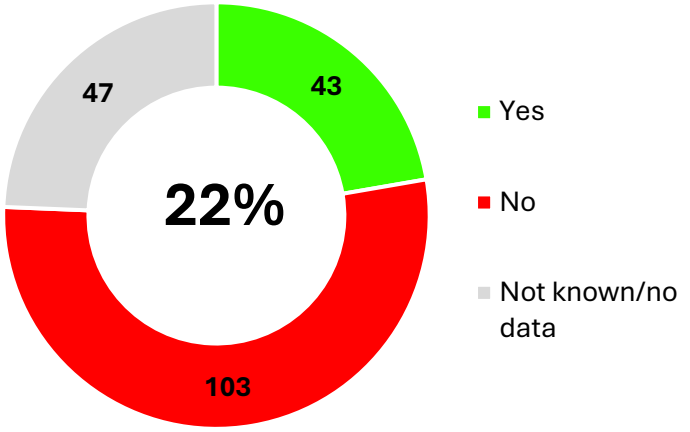
Since 2022, the proportion of WMO Members conducting these assessments has increased from **19% to 22%.**

As challenges persist, there is an **urgent need to accelerate progress** through a coordinated global effort to enhance SEB methodologies and promote their widespread adoption.

WMO Members reporting to have conducted SEB assessment in the last 10 years, as of Aug 2022



WMO Members reporting to have conducted SEB assessment in the last 10 years, as of July 2025



Source: WMO Monitoring System 2022-2025.

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Evaluation Framework: The 10-Step Procedure

10-step procedure for conducting a SEB assessment

1. **Establish the baseline**

   Refers to the current situation and provides a point of reference to evaluate service changes.

2. **Identify changes in NMHS services**

   Refers to changes from new services, expanded geographic coverage of services, service improvements etc.

3. **Identify full range of benefits and costs**

   Enumerate benefits to user communities and costs incurred under different scenarios.

4. **Select analytical approach**

   Select the analytical approach, accounting for cost, time and data constraints.

5. **Conduct quantitative analysis of benefits and costs**

   Assess the benefits and costs in monetary terms, if feasible.

6. **Conduct qualitative analysis of benefits and costs**

   Describe the benefits and costs for which quantification is not appropriate or feasible.

7. **Summarize and compare benefits and costs**

   Determine if the change in services results in benefits that are greater than costs.

8. **List omissions, biases and uncertainties**

   Supports understanding of limitations and uncertainties inherent in assumptions and future values.

9. **Conduct sensitivity analysis of key variable values**

   Present the results for benefits and costs for a range of assumptions on uncertain variables.

10. **Formulate and communicate results**

    Review and formulate results to be shared with stakeholders and decisionmakers.

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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Coffee Break

We will re-convene in 15 minutes.

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Illustrative Case Study

Socio-economic Benefits (SEB) of Climate Services in the Pacific SIDS, including Fiji and Samoa.

A socio-economic assessment os climate services in agriculture, energy and disaster risk reduction sectors.

Work carried out by:

SPREP
Secretariat of the Pacific Regional Environment Programme

Metroeconomica

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Case Study: Background

SPREP-Metroeconomica

Under the ClimSA project **“Measuring the Socio-Economic Value, Impact and Benefits of the Climate Services in the Pacific SIDS, including Fiji and Samoa”**, Metroeconomica worked with SPREP to develop and implement a methodology to assess the SEB of climate services in Pacific SIDS, including Fiji and Samoa.

FOCUS

Focused on **agriculture, energy and DRR sectors in Fiji, Samoa and Pacific SIDS** as a whole.

OBJECTIVE

Aimed to **evaluate the potential economic return of investing in climate services** to support the National Meteorological and Hidrological Services of Fiji and Samoa in its deliberations over securing financial support for the scheme.

Step 1: Establish the baseline

1

HOW TO ESTABLISH THE BASELINE?

The baseline for the study is the **current situation** and provides a **point of reference** for changes in the met/hydro services to be evaluated.

To establish the baseline, the study team characterizes the services that are **currently offered**, and the **outcomes observed** for the current situation.

It is important to **define the scale and timing of the impacts of the baseline**, articulate what problems the proposed programme is intended to resolve and be explicit about assumptions.

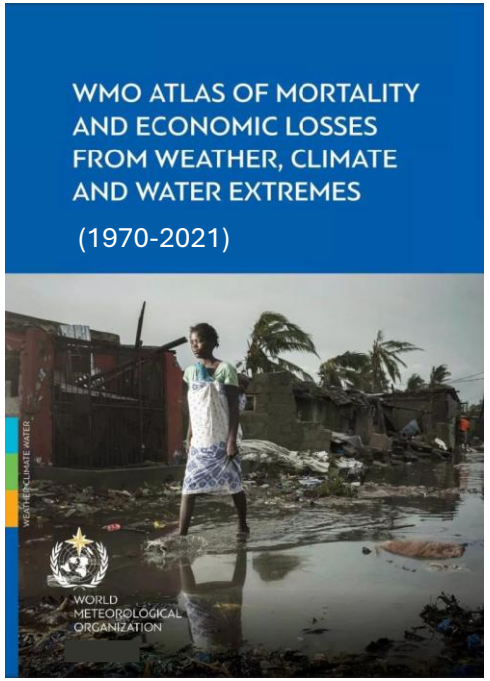
POTENTIAL DATA SOURCES TO ESTABLISH THE BASELINE:

- CRED Emergency Events Database (EM-DAT)
- Post-Disaster Needs Assessments (PDNA)

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

1 Examples of resources to establish the baseline

UPDATED WMO ATLAS OF MORTALITY AND ECONOMIC LOSSES (1970-2021)



Between 1970 and 2021, **11 778** disasters were attributed to extremes, resulting in **2 087 229** deaths and **US$ 4.3 trillion** in economic losses.

Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate, and Water Extremes (1970–2019) (WMO-No. 1267) 2022 update.

EARLY WARNINGS FOR ALL IN FOCUS: HAZARD MONITORING AND FORECASTING

Reported disasters (1970-2021) in the EW4All countries caused **1 260 816 deaths** – accounting for **60% of globally reported deaths** over the 51-year period.

Source: WMO, 2023: Early Warnings for All in Focus. Hazard Monitoring and Forecasting, https://wmo.int/files/early-warnings-all-focus-hazard-monitoring-and-forecasting -

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Step 2: Identify changes in NMHS services

To determine what is being valued, consider the primary options and what reasonable or potential alternatives should be included in the analysis. **Options often of interest to NMHSs include changes or improvements in:**

- Observation systems
- Data assimilation
- Forecasting models
- Computer facilities and capacity
- Forecast dissemination

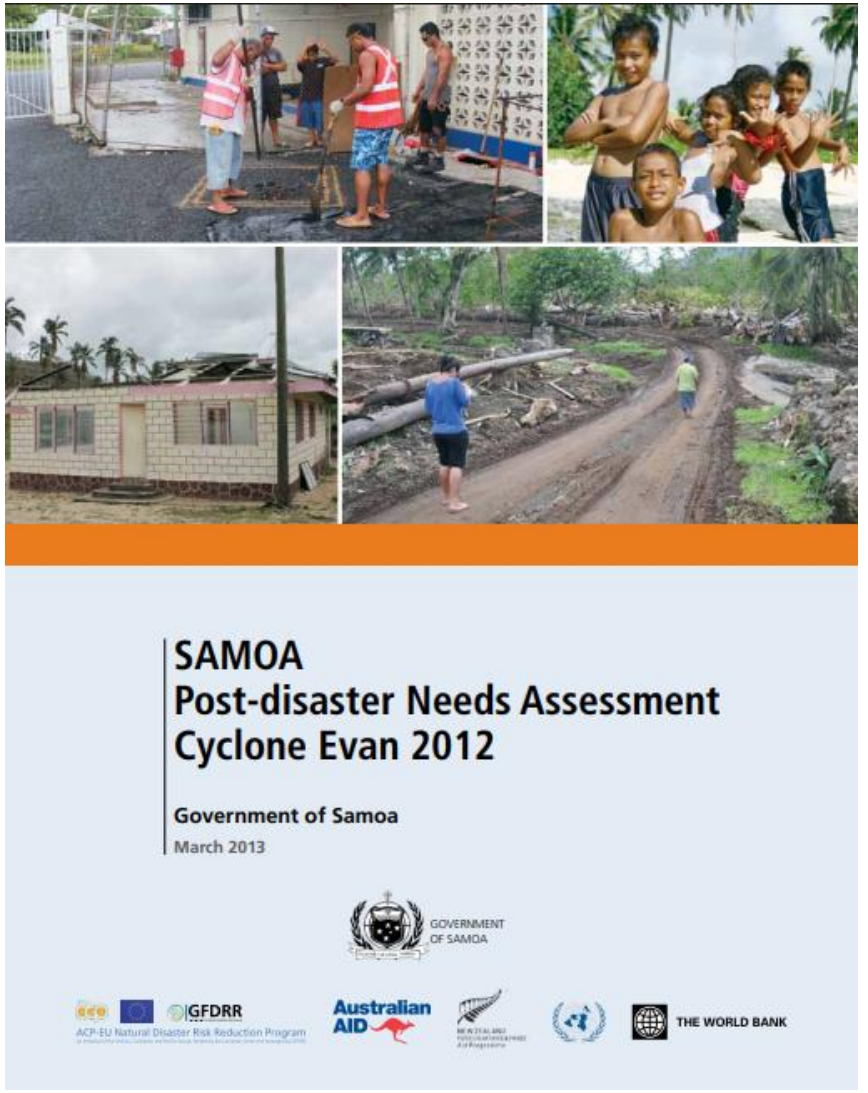
Extending the traditional realm of many NMHSs may involve **improvements or implementation of new or better uses and responses to information**, including improved:

- Forecast communication
- Development of decision support tools
- Emergency response activities for severe weather

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Case Study: Resources used to establish the baseline.

The economic assessment of the climate service is **based on loss estimates from the 2012 Tropical Cyclone (TC) Evan in Samoa.**



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Case Study: Losses from Tropical Cyclones in Samoa as the Baseline

TC Evan was estimated to have cost at least **WST 465 million (USD 103,3 million)**, causing losses to crops, livestock, energy infrastructure, households, business, government, etc.

COUNTING THE COST TO CALCULATE THE BENEFIT

BENEFITS = What **proportion of the losses were avoided** thanks to the climate services?

Sector	Losses (In WST thousands)
Productive sectors	**163,727.6**
Agriculture	52.695,5
Livestock	4,250.0
Fishery	7,562.0
Manufacturing	21,845.7
Commerce	17,194.9
Tourism	49,909.5
Social sectors	**57,769.7**
Education	7,850.1
Health	5,565.1
Housing	43,354.5
Infrastructure	**172,000.6**
Electricity	70,973.7
Water and sanitation	12,671.3
Transport	88,345.6
Cross-sectoral	**72,649.0**
Environment	72,649.0
TOTAL	**465,146,9**

Source: Post-disaster Needs Assessment of the Government of Samoa

Step 3: Identify full range of benefits and costs

1 2 3

Weather, climate and hydrological services can deliver a diverse array of benefits, including those that can be quantified and monetized and those that are more amenable to qualitative evaluation.

There are **two types of benefits**: (1) Benefits from **reduced disaster losses** - e.g., avoided crop losses; and, (2) Benefits from **increased productivity** - e.g., irrigation optimization.

NMHS staff should consider how the services will be used and **how the use of the service will change outcomes** associated with a specific decision or action (vis-a-vis the value chain).

The **triple bottom line (TBL) benefits approach** is recommended to identify the full suit of economic, social and environmental benefits.

TRIPLE BOTTOM LINE BENEFITS APPROACH

- Economic benefits
- Social benefits
- Environmental benefits

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

3

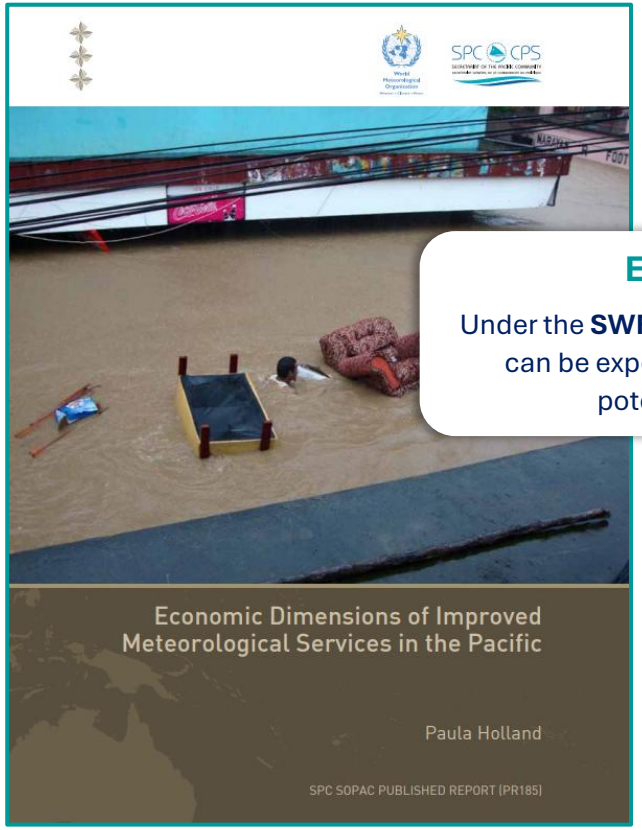
Resources to identify full range of benefits

WMO CATALOGUE OF SOCIOECONOMIC BENEFIT (SEB) STUDIES

A preliminary literature review of SEB assessments of weather, climate, and water services and related infrastructure identified **over 170 existing SEB studies**.

The catalogue provides **an introduction to case studies that have already estimated the benefits** in the South-West Pacific and other regions.

Source: WMO (2024): Catalogue of Socioeconomic Benefit (SEB) Studies.



EXAMPLE:

Under the **SWFDDP,** improved warnings can be expected to generate high potential benefits.

Source: Holland, P., 2014: Economic Dimensions of Improved Meteorological Services in the Pacific.

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3. What socioeconomic benefits do you associate with climate services?

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Step 3: Triple bottom line benefits approach

Based on the WMO SEB Database

ECONOMIC BENEFITS

- Avoidance of agricultural losses
- Increased crop and livestock production
- Reduced damages caused by floods
- Reduced fuel consumption for airlines
- Minimization of losses from flight deviations and suspensions
- Minimization of road maintenance and road closure costs
- Minimization of evacuation costs
- Avoidance of foregone drilling for offshore oil and gas operations
- Avoidance of weather damage to personal property
- Increased energy production and revenues
- Increased profits gains
- Avoidance of government spending

SOCIAL BENEFITS

- Avoidance of loss of life
- Reduced heat-related hospitalizations
- Safety of the travelling public from reduced transport accidents
- Reduced health impacts
- Enhanced humanitarian interventions
- Avoided loss of education
- Improved household welfare

ENVIRONMENTAL BENEFITS

- Water savings
- Reduced pollution from fertilizer runoff
- Enhanced ecological services
- Reduced tree mortality and enhanced tree growth

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Sources: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

WMO, 2025: Catalogue of Socioeconomic Benefit (SEB) Studies.

Case Study: Potential benefits of the climate services

In the case study, numerous existing studies in the current literature were used, highlighting the following studies:

Progress in Disaster Science 2 (2019) 100034

Contents lists available at ScienceDirect

Progress in Disaster Science

journal homepage: www.elsevier.com/locate/pdisas

Benefits of economic assessment of cyclone early warning systems - A case study on Cyclone Evan in Samoa

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ABSTRACT

Samoa is extremely exposed to natural hazards, particularly tropical cyclones and earthquake-generated tsunami. Some studies have put forth the position that adequate investment in early warning systems can contribute to the social and economic well-being of countries. However, in spite of these research findings there is still a lack of understanding on how to measure effectiveness that leads to limited investment. Cost-benefit analysis (CBA) is a tool used in this study to summarize the value for money in terms of investment to enhance an early warning system. This paper aims to summarize the benefits of adopting early warning systems and its effectiveness against the investment required and its value proposition. Data from the 'Samoa Post-Disaster Needs Assessment of the Cyclone Evan event in 2012' have been used to assess damage information, and stakeholders consultations and interviews were carried out for cost-benefit analysis. We have conducted quantified CBA of early warning services for cyclone hazards and the results have shown that for every USD 1 invested, there is a return of USD 6 as benefit. This paper suggests that economic assessment of early warning services could help in quantifying pre-impact assessment to demonstrate to policy makers the economic benefit of disaster risk reduction (DRR).

1. Introduction

Pacific Island countries are exposed to frequent and damaging natural hazards ([1,2,26]). Samoa comprises two large volcanic islands (Upolu and Savai'i) and several smaller islands with a total land area of approximately 2935 km^2. The islands lie in the southwest Pacific within an exclusive economic zone of 120,000 km^2. The population of Samoa is approximately 196,440 [29]. Samoa experiences high vulnerability to disasters and external economic and trade developments [3,4]. These disasters include tropical cyclones, prolonged periods of drought, extreme flooding, pest infestation and sudden disease-outbreaks, storm surges, and sea level rise, all of which affect the natural-resource dependent economy of the islands. Further, it is clear that Samoa (and the Pacific Island Region in general) is highly vulnerable to hazards that will be influenced by climate change, (such as sea level rise, flooding from storm surges, and coastal inundation) [5–8]. Climate related hazards are the greatest challenges that Samoa faces, affecting all aspects of life. In addition to Cyclone Evan in 2012, there were other severe cyclones in the successive seasons of 1989–90 (Ofa) and 1990–91 (Val) and recently cyclone Gita (2018), all of which caused massive damage to infrastructure and other assets ([9,10,30]. Tropical cyclones produce extreme winds, tornadoes, storm surges, wave action and heavy rainfall. The main damage from tropical cyclones results from severe wind and associated storm surges. Cyclones have occurred more frequently in El Niño years [11]. The average number of cyclones per year varies from 0 to 5 in a La Niña season, whereas approximately 52 tropical cyclones pass within 400 km of Apia during an El Niño year (IUCN 2011, [11,31,32]).

The institutional arrangement for DRM is well structured at a national level, with clear policy in place for disaster management. However, there is a complex relationship between hazard detection and disaster management, with various organisations responsible for detection of hazards and notification to the disaster management office. Disaster management in Samoa is administered under the Ministry of Natural Resources and Environment (MNRE), via the Disaster Management Office (DMO) under the mandate set out in the Disaster and Emergency Management Act 2007 [33], and the National Disaster Management Plan (NDMP) 2017–2021 [34].

There are several tools available to evaluate risk reduction measures such as cost benefit analysis (CBA) used to compare costs and benefits of a one specific measures or a set of alternative measures over a period of time. CBA assesses the measure(s) mainly based on the efficiency criterion. Cost effective analysis (CEA) has most of the features of CBA, but does not require the monetization of either the benefits or the costs (usually the benefits). Multi Criteria Analysis (MCE) is a tool that allows comparing alternative measures on multiple criteria. In contrast to CBA, MCE allows the

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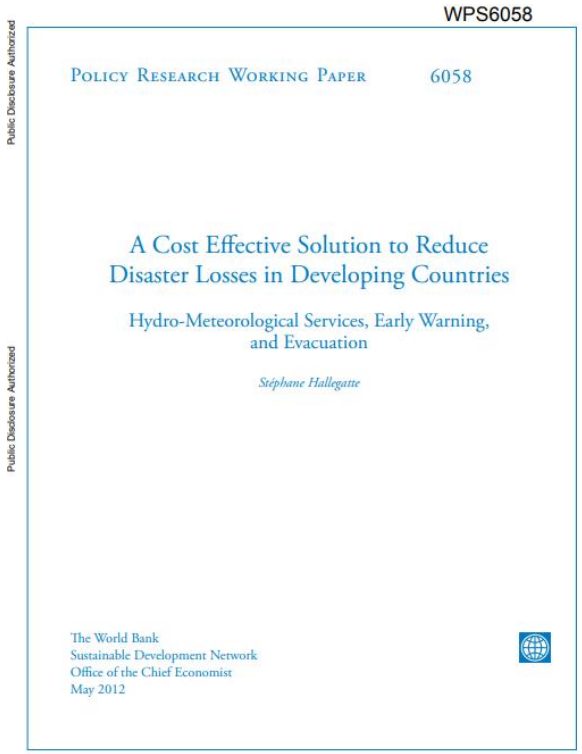
E-mail address: bhakhruddin@tonkintaylor.co.nz. (B.S.H.M. Fakhruddin).

Fakhruddin & Schick (2019)



WPS6058

Public Disclosure Authorized

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POLICY RESEARCH WORKING PAPER 6058

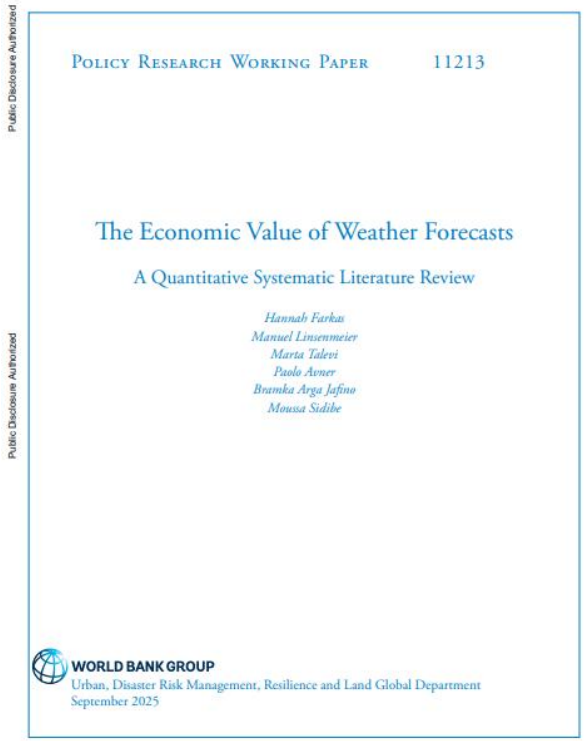
A Cost Effective Solution to Reduce Disaster Losses in Developing Countries

Hydro-Meteorological Services, Early Warning, and Evacuation

Stéphane Hallegatte

The World Bank
Sustainable Development Network
Office of the Chief Economist
May 2012

Hallegate (2012)



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POLICY RESEARCH WORKING PAPER 11213

The Economic Value of Weather Forecasts

A Quantitative Systematic Literature Review

Hannah Farkas
Manuel Linsenmeier
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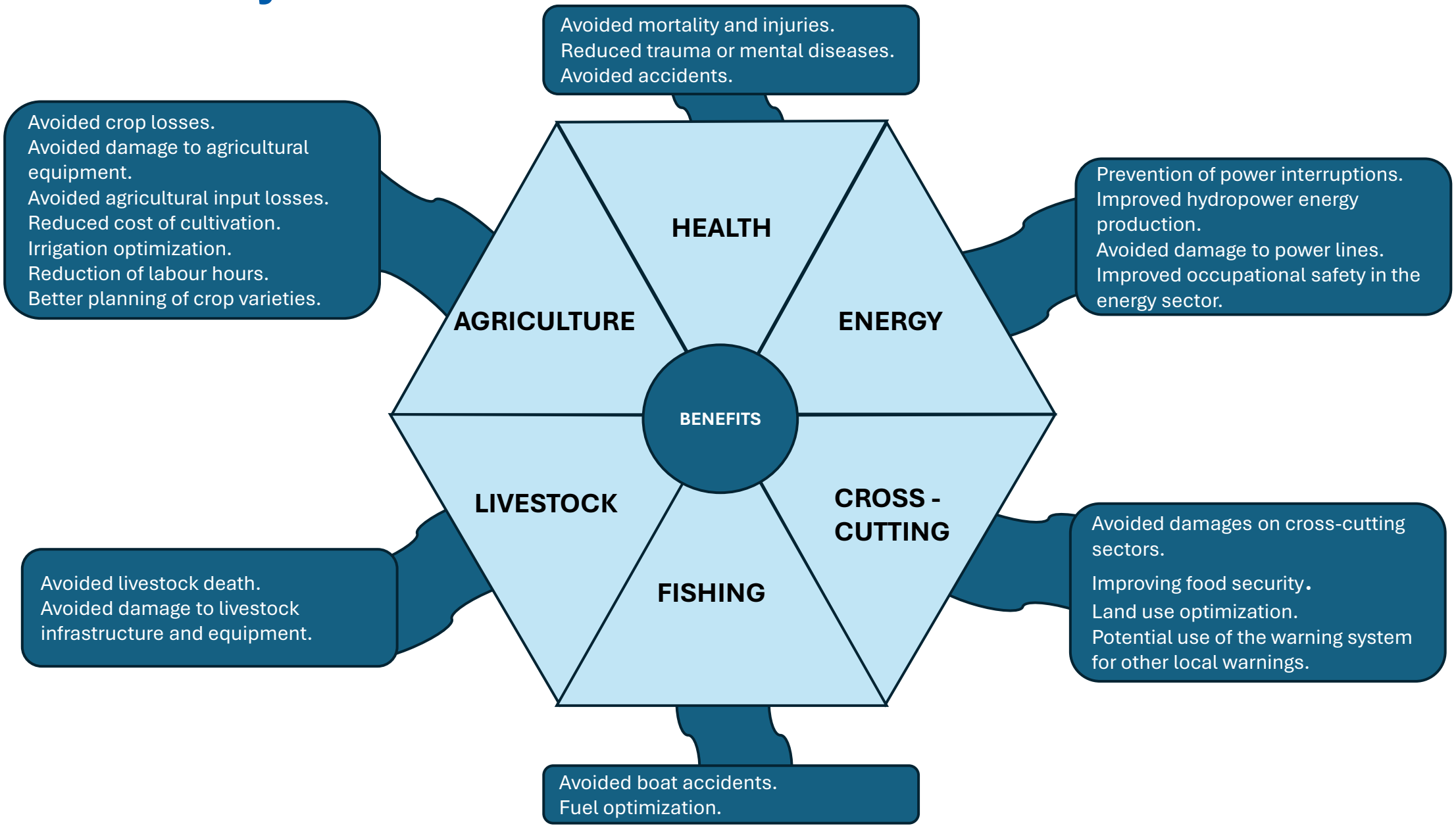
WORLD BANK GROUP
Urban, Disaster Risk Management, Resilience and Land Global Department
September 2025

Farkas, et al. (2025)

Case Study: Potential benefits of the climate services



Case Study: Potential costs of the climate services

The implementation of climate services also entails costs.

These costs vary depending on the scope, scale, and level of service provision, but they typically fall into fixed (F) and variable costs (V). Fixed cost can be disaggregated into three cost categories (Fakhruddin and Schick, 2019):

(1) **Scientific costs (S):** Costs related to generating forecast information).

(2) **Institutional costs (I):** Costs of training and capacity building.

(3) **Community costs (C):** costs to enable users to adopt forecast information and responses.

$$C = F_c + V_c = S_c + I_c + C_c + V_c$$

The estimated **cost of providing climate services in Samoa** over ten years amounted to approximately USD 5.12 million, i.e., **USD 0.5 million per year** (Fakhruddin & Schick, 2019)

Lunch Break

We will re-convene in 1 hour.

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Step 4: Screen benefits and costs and select analytical approach

SCREENING BENEFITS

Determine benefits relative importance (for example in terms of magnitude).

Identify data gaps that may limit the monetization of specific benefits.

Assess which benefits are most likely to be **amenable to quantitative assessment** and those that will be difficult to assess, except in qualitative terms.

SCREENING COSTS

The **purpose of the study** should serve as the starting point in screening costs.

In "**whole of services**" studies, the full range of costs for providers and users will likely be considered.

In studies assessing **changes in existing services or new services**, only the incremental costs to produce and disseminate the improved or new services will be considered.

ANALYTICAL APPROACH SELECTION

Based on whether the benefits and costs are amenable to quantitative or qualitative assessment, the **methods for assessing benefits can be selected**.

Data needs and availability would be determined as required for the estimation method selected.

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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Case Study: Screening the benefits and costs of the climate services in Samoa

BENEFITS RELATIVE IMPORTANCE

Table included in the slide shows the quantificable benefits the climate services could deliver in reducing the respective losses.

NON-QUANTIFIABLE BENEFITS:

- Land use optimization.
- Improving food security.
- Avoided boat accidents at sea.
- Reduced trauma and mental diseases.
- Avoided accidents.
- Better planning of crop varieties.
- Potential use of the warning system for other local warnings.

Sector	Quantificable benefits
Agriculture	Avoided crop losses
	Avoided damage to agricultural equipment
	Avoided agricultural input losses
	Reduced costs of cultivation
	Irrigation optimization
	Reduction of labour hours
Livestock	Avoidead livestock death
	Avoided damage to livestock infrastructure and equipment
Energy	Prevention of power interruptions
	Improved hydropower energy production
	Avoided damage to power lines
Health	Avoided mortality and injuries
Cross-cutting	Avoided damages of tropical cyclones and floods on cross-cutting sectors

Mentimeter

4. Are you familiar with the methods used for socioeconomic benefit analysis?

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Step 5: Quantitative analysis of benefits and costs

1 2 3 4 5

VALUATION METHODS

NON-MARKET VALUATION

Directly asking users of the information to subjectively assess the value of the data (**stated preference**).

Inferring the value of the service based on observations of people's behaviour and the costs they voluntarily bear (**revealed preference**).

ECONOMIC MODELLING

Formulating mathematical relationships to examine decisions/supply-demand changes and the of value (or cost) outcomes that result, both with and without information.

AVOIDED-COST ASSESSMENT

Analyzing historical records or conducting surveys to determine the actual difference made by the information in terms of avoided costs of weather and climate events.

BENEFIT TRANSFER

Transferring of existing economic values estimated in one context or study to estimate economic values in a different context.

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Step 5: Advantages and disadvantages of valuation methods

Non-market valuation

ADVANTAGES

Stated preference: Estimates use and non-use values; incorporates hypothetical scenarios that closely correspond to policy case.

Revealed preference: Uses observed data to conduct ex-post analyses; tailored to specific policy case.

DISADVANTAGES

Stated preference: Time intensive and expensive to implement; challenging to frame survey questions that elicit valid responses; potential response biases.

Revealed preference: Measures use values only; collecting adequate data is often expensive and time intensive.

Benefit transfer

ADVANTAGES

Relatively simple and inexpensive.

Accepted as a suitable method for estimating order-of-magnitude values for use and non-use benefits, in ex-post and ex-ante analyses.

DISADVANTAGES

Can generate potentially inaccurate and misleading results.

Limited number of original studies.

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Step 5: Advantages and disadvantages of valuation methods

Economic modelling

ADVANTAGES

Decision analysis: Useful to examine decisions and expected outcomes at household or firm level.

Equilibrium modelling: Useful to examine benefits of met/hydro services for a specific sector.

Econometric modelling: Uses observed data to conduct ex-post and ex-ante analyses.

DISADVANTAGES

Time and data intensive.

Expensive to implement.

Requires significant expertise.

Avoided-cost assessment

ADVANTAGES

Can be applied in ex-post and ex-ante analyses.

Relatively easy to implement.

DISADVANTAGES

Only represents partial value (for example, it does not take into account benefits of met/ hydro services associated with increased productivity and enjoyment).

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

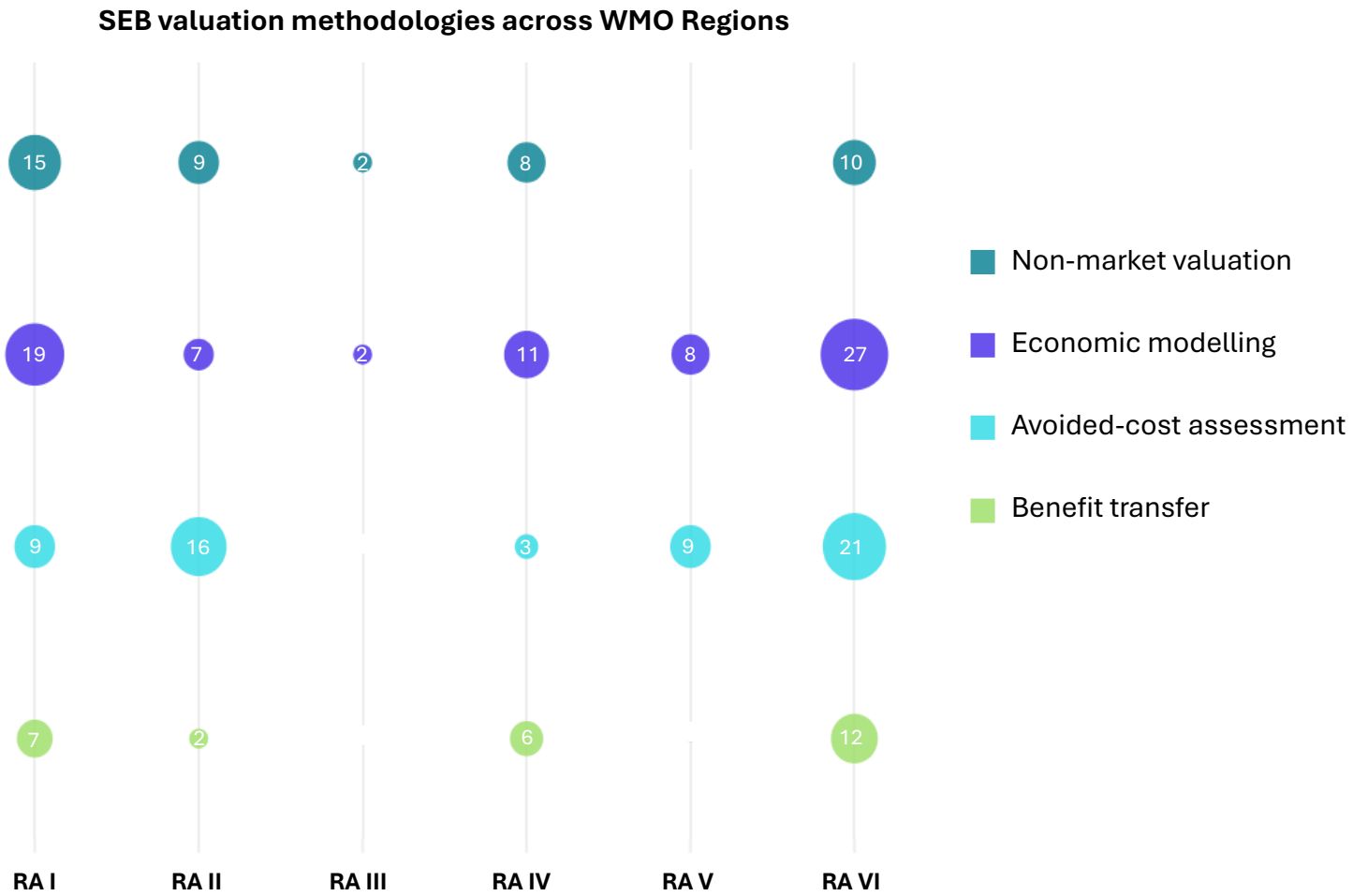
Step 5: Valuation methods across WMO regions

Based on the WMO SEB Database: 181 identified case studies

Methods employed to conduct SEB analysis **vary across regions**.

SOUTH-WEST PACIFIC (RA V)

In the South-West Pacific, **avoided-cost assessment and economic modelling** are the most common methods employed.



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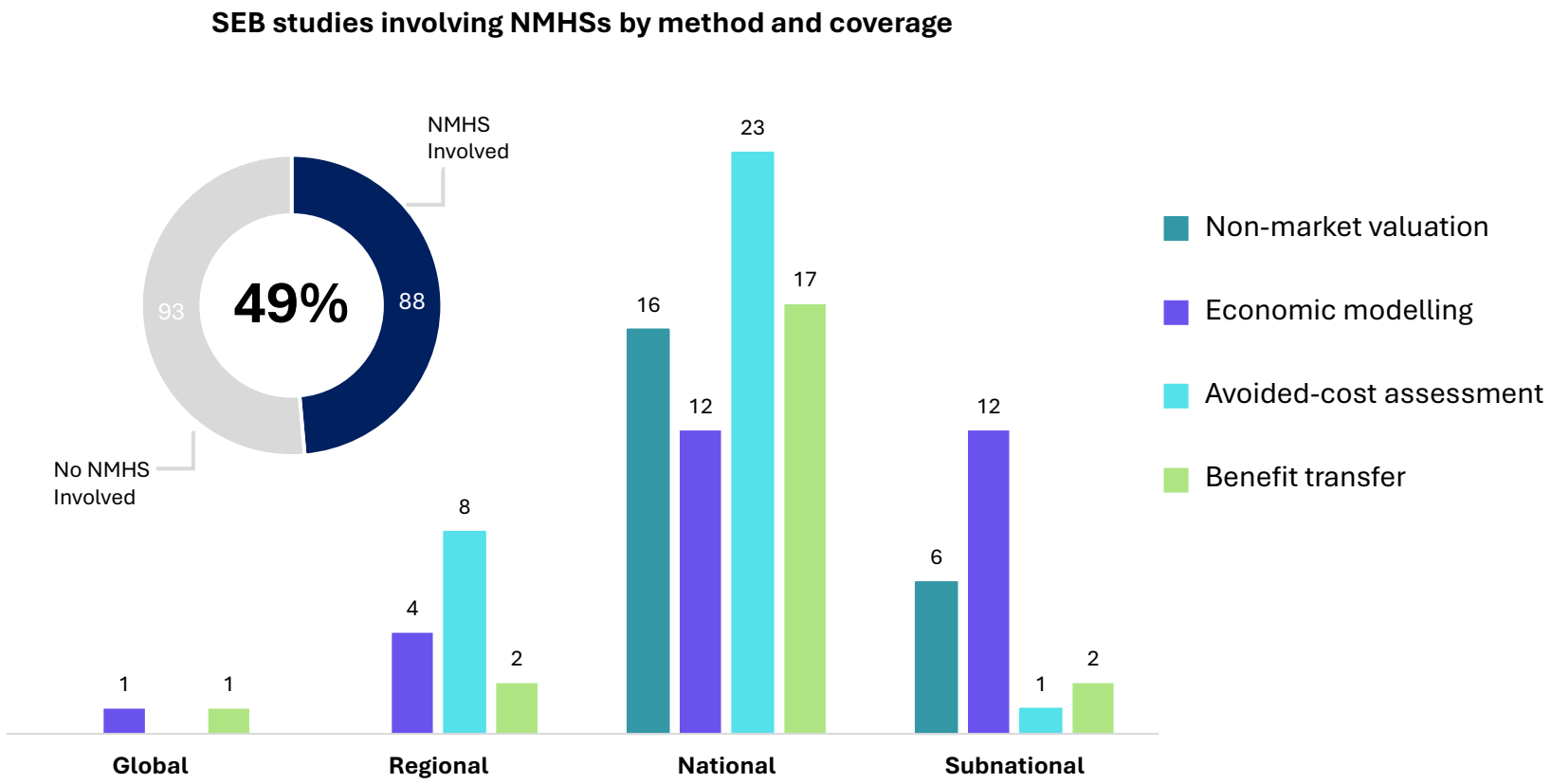
Step 5: Valuation methods in SEB studies involving NMHSs

Based on the WMO SEB Database: 88 identified case studies involved NMHSs

Avoided-cost assessment dominates national SEB studies conducted with NMHS involvement.



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5

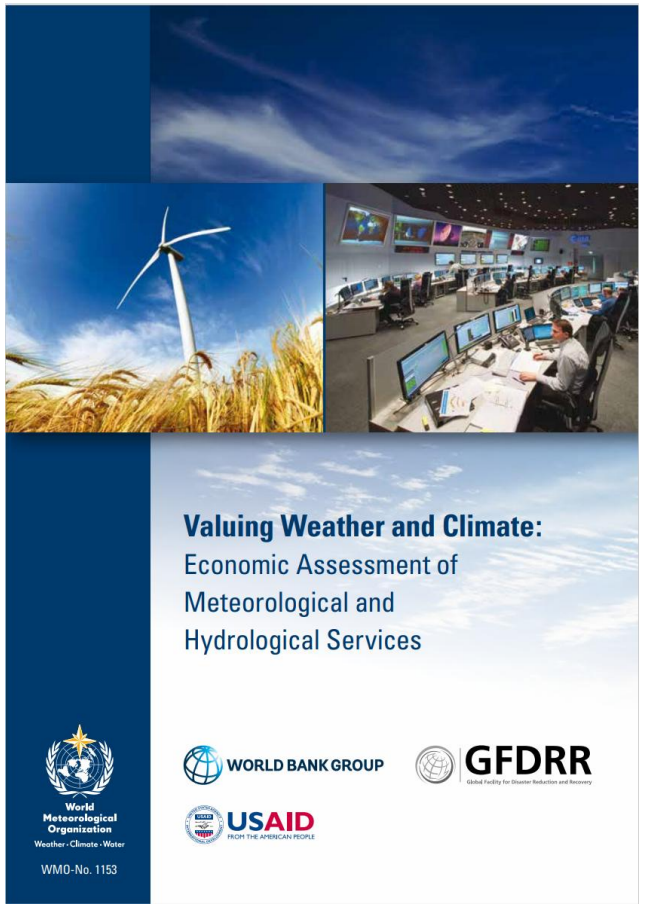
Resources to conduct quantitative analysis of benefits

WMO-WB-GFDRR-USAID VALUING WEATHER AND CLIMATE

The *Valuing Weather and Climate* publication provides **an introduction to the various methods** that can be used to quantitatively assess benefits.

The **methodological variety is a challenge** in closing the gaps in socioeconomic benefit assessment.

- **Non-market valuation**
- **Economic modelling**
- **Avoided-cost assessment**
- **Benefit transfer**



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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Mentimeter

5. What method would you use for the case study?

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Case Study: Applying Benefit-transfer in Samoa

METHOD USED IN THE CASE STUDY ⟹ BENEFIT TRANSFER

Benefit transfer method transfers the results obtained from study site to policy site by modifying them based on different macroeconomic (e.g., GDP per capita adjusted at Purchasing Power Parities) or socioeconomic (e.g., Total agricultural area) data.

In principle, the values at the policy site may differ from those of the study site for two reasons: (1) differences in the characteristics of the environmental features being valued; and, (2) differences between the populations valuing the resource change (e.g., differences in income, tastes, preferences, and other relevant socio-economic characteristics). Therefore, during the transfer process, **values must be adjusted** to reflect these two types of differences.

Case Study: Example of Benefit-Transfer

Hallegate (2012) → **Climate services prevent the 10% of crop losses**

Table 7. Agriculture Sector Damage and Loss (thousand SAT)

	Disaster effects		
Sector/subsector /component	Damage	Loss	Total
Crops	4,905	58,061	62,966
Livestock	3,516	800	4,316
Fisheries	2,084	5,493	7,602
Total	**10,505**	**64,354**	**74,884**

Government of Samoa published that **TC Evans caused nearly WST 63 million losses** due to crop losses.

How much can be avoided?

Type of Benefit	Description	Unit value	Benefit (2016)	CPI 2016-2025	Benefit (2025)
Avoided crop losses	10% of crop losses	WST 63 million	WST 6.3 million	30.85%	WST 8.4 million

Coffee Break

We will re-convene in 15 minutes.

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Exploring the Case Study Methodological Approach

Case Study: Assessing socio-economic benefits in Samoa

The benefit is the sum of avoided costs of TC and optimization of certain services/processes (such as irrigation or energy production). Avoided costs are calculated by comparing the scale of losses with and without the climate service.

1

Establish the "without system" scenario

RECALL THE BASELINE:
The expected annual losses from TCs is taken as the reference event = the "without system" scenario.

Estimated anual losses ≈ WST 43.7 million.

2

Establish the "with system" scenario

Through literature review (using Benefit-transfer methods) and stakeholder consultations, determine the % of avoidable losses with the climate services in place.

Under worst case, most likely case and best case scenarios.

Un-discounted benefits = Expected annual losses (baseline) x % avoidable losses with the system

Case Study: Assessing socio-economic benefits in Samoa

1 **Establish the "without system" scenario**

Sector	Losses (In WST thousands)
Productive sectors	**163,727.6**
Agriculture	52.695,5
Livestock	4,250.0
Fishery	7,562.0
Manufacturing	21,845.7
Commerce	17,194.9
Tourism	49,909.5
Social sectors	**57,769.7**
Education	7,850.1
Health	5,565.1
Housing	43,354.5
Infrastructure	**172,000.6**
Electricity	70,973.7
Water and sanitation	12,671.3
Transport	88,345.6
Cross-sectoral	**72,649.0**
Environment	72,649.0
TOTAL	**465,146,9**

2 **Establish the "with system" scenario**

Sector	Type of benefit	Benefit
Agriculture	Avoided crop losses	10% of losses
	Avoided damage to agricultural equipment	70% of losses
	Avoided agricultural input losses	80% of losses
	Reduced costs of cultivation	5% of cultivation costs
	Irrigation optimization	15.92 USD/ha
	Reduction of labour hours	20 USD/ha
Livestock	Avoidead livestock death	50% of losses
	Avoided damage to livestock infrastructure and equipment	40% of losses
Energy	Prevention of power interruptions	USD 0.1 million
	Improved hydropower energy production	5%-10% of increased production
Health	Avoided mortality and injuries	WST 0.52-2.65 million
Cross-cutting	Avoided damages of tropical cyclones and floods on cross-cutting sectors	25% of losses in Tourism and Manufacturing 15% of losses in Education 10% in Housing

Q&A Session

Closing Remarks

Training Day 2: Assessing the Socioeconomic Benefits of Hydrological Monitoring in the Pacific Region

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Agenda: Day 2

Timeline	Item
09:00-tbc	Welcome & Day 1 Recap
tbc	Day 2 Agenda
tbc	Step 6: Qualitatively Describing Key Benefits and Costs (Qualitative Analysis)
tbc	Step 7: Summarizing and Comparing All Benefits and Costs
tbc	Step 8: Listing All Omissions, Biases, and Uncertainties
12:30-13:30	**LUNCH BREAK**
tbc	Step 9: Conduct Sensitivity Analysis of Key Variables Values
tbc	Step 10: Formulating and Communicating Results to Decisionmakers and Stakeholders
tbc	Q&A Session
tbc	**COFFEE BREAK**
tbc	Practical Exercise: Conducting an SEB Assessment
tbc-16:00	Closing Remarks

Welcome & Day 1 Recap

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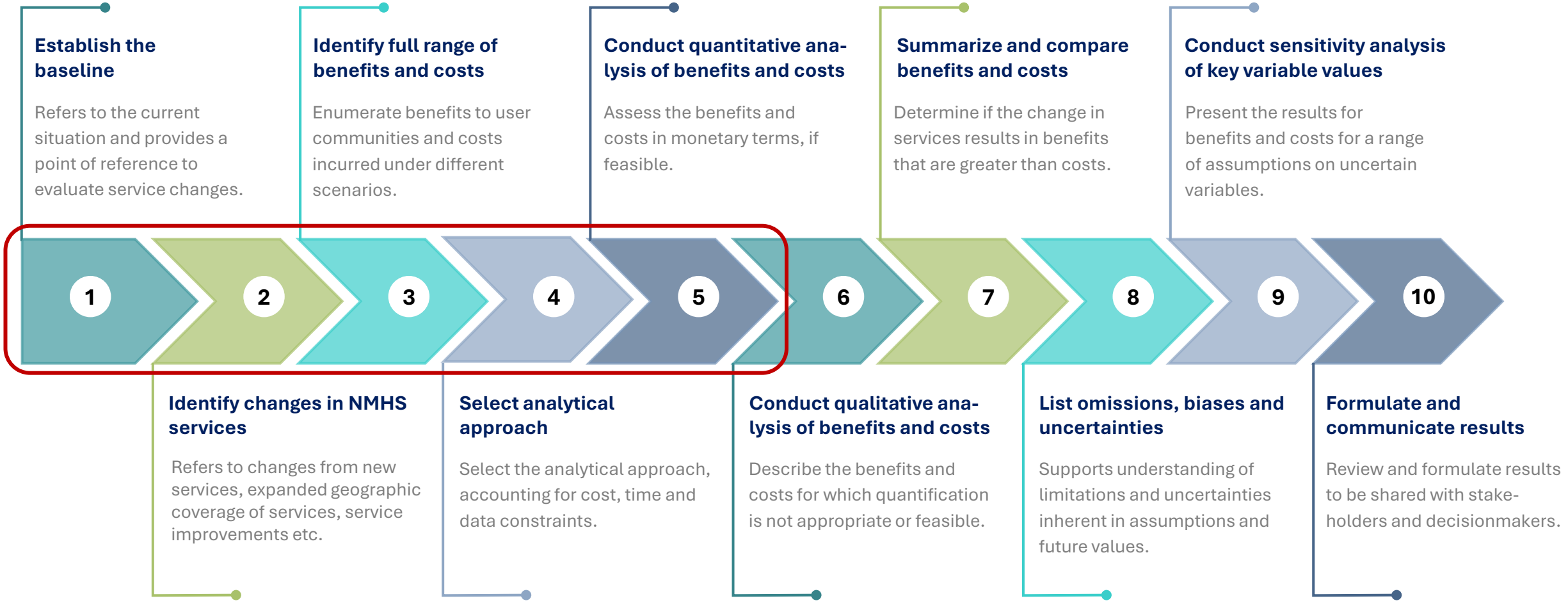
Day 1 Recap: Step 1-5 of the evaluation framework



Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

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6. **Day 1 Recap Quiz –** Step 1-5 of the evaluation framework

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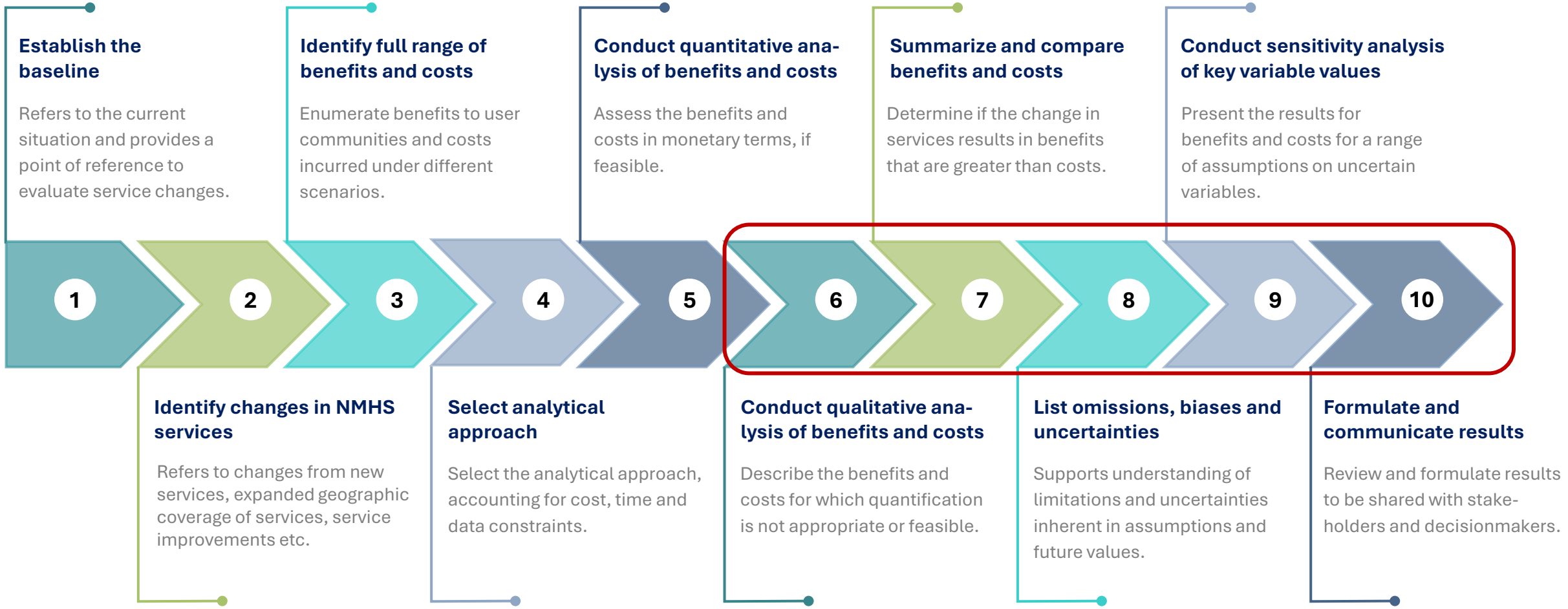
Day 2 Agenda

Agenda: Day 2

Timeline	Item
09:00-09:25	Welcome & Day 1 Recap
09:25-09:40	Day 2 Agenda
09:40-10:30	Step 6-7 in SEB Evaluation
10:30-10:45	**COFFEE BREAK**
10:45-12:00	Step 7-8 in SEB Evaluation
12:00-13:00	**LUNCH BREAK**
13:00-14:00	Step 9-10 in SEB Evaluation
14:00-14:45	Q&A Session
14:45-15:00	**COFFEE BREAK**
15:00-16:00	Practical Exercise: Conducting an SEB Assessment
16:00-16:30	Closing Remarks and AOB

Day 2: Step 6-10 of the evaluation framework



Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

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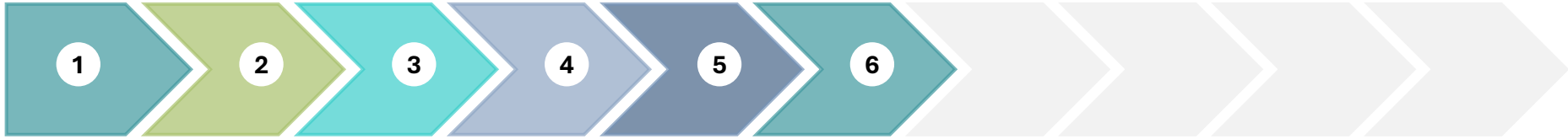
Step 6: Qualitative analysis of benefits and costs



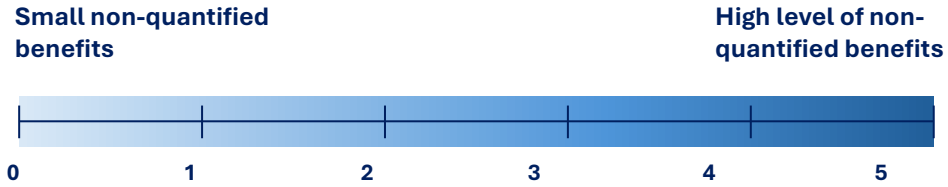
WHAT IS A QUALITATIVE ANAYLSIS?

While the value of **some benefits cannot be expressed in quantitative or monetary terms**, it remains important to describe these non-quantified benefits in a meaningful, qualitative manner.

A qualitative approach to assessing benefits is to **use a scale** indicating likely impact on net benefits, with the qualitative rating accompanied by descriptions of the impact.

CONDUCTING A QUALITATIVE ANALYSIS

For example, an NMHS can qualitatively rank impacts on a five-point scale to reflect non-quantified relative outcomes that span from relatively very small to very positive.



Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Illustrative Case Study

Socio-economic Benefits (SEB) of Climate Services in the Pacific SIDS, including Fiji and Samoa.

A socio-economic assessment os climate services in agriculture, energy and disaster risk reduction sectors.

Work carried out by:

SPREP
Secretariat of the Pacific Regional Environment Programme

Metroeconomica

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Case Study: Qualitative benefits from climate services in Samoa

A subset of benefits from climate services are not amenable to quantitative analysis.

Avoided boat accidents

Scientific literature estimates that the provision of climate services can reduce the 53% of accidents involving ships on the high seas.

Reduced trauma

Warnings can lessen disaster-related trauma by preventing injuries and loss of irreplaceable possessions, but assigning a monetary value is challenging.

Improving food security

Empirical evaluations show that when farmers have access to season-ahead rainfall forecasts, a substantial share adapt their cropping decisions, resulting in reduced crop failure rates and improved food availability.

Potential use of other local warnings

Climate services – if successful – could be used as part of a broad community warning system.

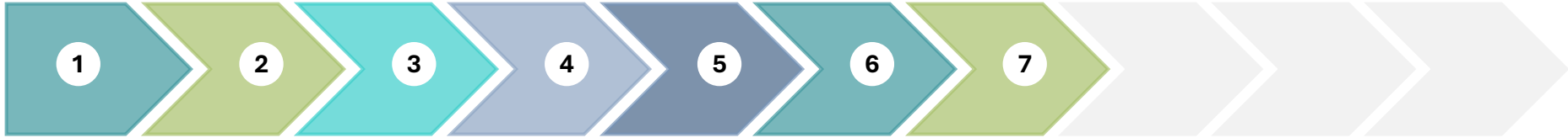
Better planning of crop varieties

Some studies show that 75% of farmers in Rwanda used climate services to make decisions on the types of crops to grow and the timing of planting and land preparation.

Land use optimization

Identifying areas prone to flooding, drought, or soil degradation allows decision-makers to allocate land to the most suitable uses and promote sustainable agricultural development

Step 7: Summarize and compare benefits and costs



Summarizing and comparing benefits and costs involves 2 steps of calculations:

STEP 1: **Adjusting and aggregating all costs and benefits into present value (PV) terms**

Most investments or planned expenditures will involve costs that vary from year to year and an uneven stream of benefits.

Whether a single investment, or multiple investments with varying temporal profiles of costs and benefits are to be evaluated, the discount rate is used to adjust future values to the present to determine the investment's PV of costs and benefits.

STEP 2: **Compare PV terms, calculating Net Present Value (NPV) or benefit-cost ratio (BCR)**

NPV = PV *benefits* – PV *costs*

Assessment of NPV of different projects allows direct comparisons of project values regardless of possible differences in the timing of benefits and costs for each project.

BCR = PV *benefits*/ PV *costs*

A decision rule for use of BCR is that any project with a BCR larger than 1.0 is worth undertaking, but the BCR does not indicate the magnitude of the investment.

Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Coffee Break

We will re-convene in 15 minutes.

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Case Study: Adjusting benefits of the climate services in Samoa

Present values were estimated using a **5% discount rate,** consistent with central estimates in assessments in developing-country contexts

Sector	Type of benefit	Benefit (In WST million)
Agriculture	Avoided crop losses	0.58
	Avoided damage to agricultural equipment	0.91
	Avoided agricultural input losses	0.08
	Reduced costs of cultivation	6.96
	Irrigation optimization	1.60
	Reduction of labour hours	6.68
Livestock	Avoidead livestock death	0.06
	Avoided damage to livestock infrastructure and equipment	0.17
Energy	Prevention of power interruptions	0.28
	Improved hydropower energy production	0.25 – 2.37
Health	Avoided mortality and injuries	19.60
Cross-cutting	Avoided damages of tropical cyclones and floods on cross-cutting sectors	0.83

Case Study: Calculating returns on investment to beneficiaries of climate services

Different stakeholders stand to benefit from the climate services:

International-level
Donors/development agencies

National-level
Government agencies
(NDMO, Departments, Ministries)

Community-level
Families and businesses operating around Navua

Sector	Type of benefit	Benefit (In WST million)
Agriculture	Avoided crop losses	Households, companies
	Avoided damage to agricultural equipment	Households, companies
	Avoided agricultural input losses	Households, companies
	Reduced costs of cultivation	Households, companies
	Irrigation optimization	Households, companies
	Reduction of labour hours	Households, companies
Livestock	Avoidead livestock death	Households, companies
	Avoided damage to livestock infrastructure and equipment	Households, companies
Energy	Prevention of power interruptions	Government
	Improved hydropower energy production	Government
Health	Avoided mortality and injuries	Households, government
Cross-cutting	Avoided damages of tropical cyclones and floods on cross-cutting sectors	Households, government, companies

Case Study: Results of the study

Country: Samoa
Discount-rate: 5%
Socio-economic scenario: SSP2 (intermediate)

Benefit range	PV Benefits	PV Costs	NPV	BCR
Lower bound	236.92	13.03	223.90	18.18
Upper bound	253.11	13.03	240.08	19.43

Benefit range	Country	PV Benefits	PV Costs	NPV	BCR
Fiji	Lower bound	664.63	81.84	582.79	8.12
	Upper bound	876.43	81.84	794.59	10.71
Pacific SIDS	Lower bound	4496.65	1639.12	2857.53	2.74
	Upper bound	6288.52	1639.12	4649.40	3.84

The analysis was also conducted for **Fiji and the Pacific SIDS** as a whole.

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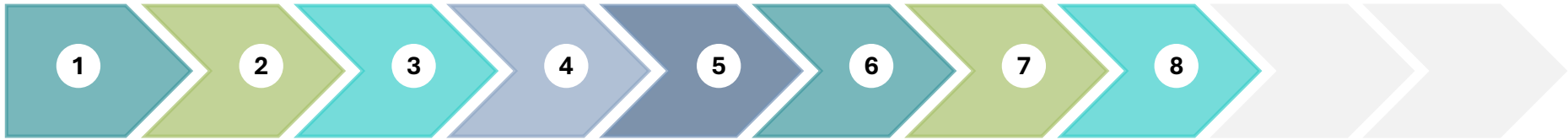
Step 8: List omissions, biases and uncertainties



OMISSIONS

Omissions: A subset of user communities for which benefits and costs have not been quantified.

It is useful to list such omissions and the types of decisions and actions these communities might take in response to service information.

BIASES

Examples:

Non-market valuation: May be subject to systematic biases that are difficult to test for and correct (potential response biases).

Avoided cost assessment: Reliance on expert opinion for sector-specific and benchmarking approaches can be subject to potential biases and knowledge limitations of involved experts.

UNCERTAINTIES

Assumptions, omissions, and biases engender uncertainty about the magnitude of benefits and costs estimates.

An analysis may be provided indicating whether different uncertainties are likely to result in underestimates or overestimates of the benefits and costs.

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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Mentimeter

7. Which of the following are examples of uncertainty in the case study?

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Case Study: Uncertainties in the SEB of climate services in Samoa

LIMITATIONS

Benefit estimates likely to be an under-estimation due to:

- Limited country-specific data.
- Limited evidence on the effectiveness of climate services.
- Uncertainty in climate and hazard projections
- Last-mile delivery constraints.
- Exclusion of intangible and non-monetary benefits.

ASSUMPTIONS

The socio-economic benefit assessment of made estimates based on various assumptions:

- The cost-benefit analysis uses growth rates from the SSP2, middle-of-the-road scenario as the central case.
- The analysis adopts a 7% discount rate, consistent with central estimates in assessments in developing-country contexts
- Costs are projected forward using the aforementioned SSP2 scenario.
- The analysis assumes fixed levels of effectiveness over time, without accounting for potential improvements in forecast quality, institutional capacity, or user learning, which may change actual outcomes

Lunch Break

We will re-convene in 1 hour.

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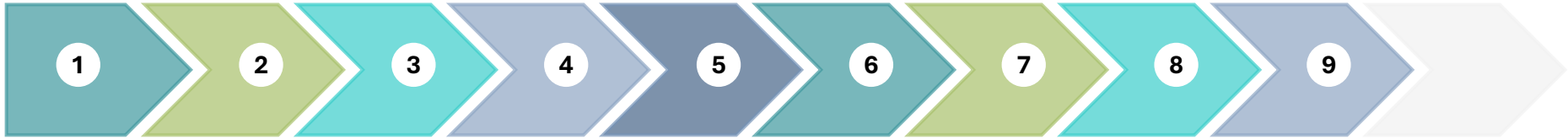
Step 9: Conduct sensitivity analysis of key variable values



WHAT IS A SENSITIVITY ANALYSIS?

Identifies which **assumptions or uncertainties that have the largest impact on the analysis outcome.**

Often performed by **varying a particular input** by equal amounts greater to and less than the current value.

Representing estimates as range values instead of just a single value **avoids perceptions that the analysis is tilted towards a desired outcome**. It will also help to indicate how certain NMHSs are about the results of the analysis.

EXAMPLES OF UNCERTAINS OR KEY ASSUMPTIONS

- Choice of **discount rates**
- Use of **benefit transfer**-based estimates
- Use of a particular **source of data**

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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Case Study: Estimating benefits of climate services in Samoa using various discount rates

A 5 per cent discount rate is applied.

However, discount rates for Pacific environment and development projects have ranged from 3%-12%.

Due to uncertainty over the appropriate rate, the Navua analysis uses 0%, 3%, 5%, 7%, and 10% for comparison.

Table: Most likely total gross value of benefits; varying discount rate

Discount-rate	PV Benefits	PV Costs	NPV	BCR
0%	455.09	24.65	430.44	18.46
3%	313.89	16.48	297.40	19.04
5%	253.11	13.03	240.08	19.43
7%	214.19	11.11	203.08	19.28
10%	169.46	8.69	160.78	19.51

Case Study: Estimating benefits of climate services in Samoa using various SSP

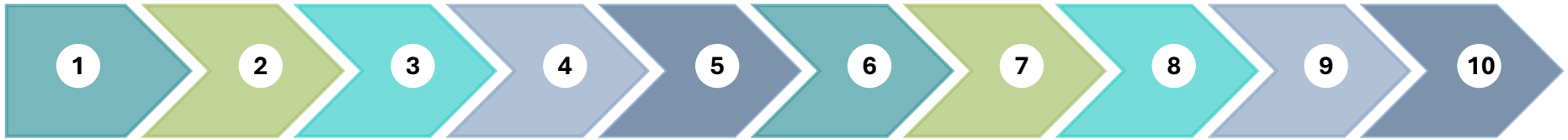
A SSP2 escenario is assumed in the study.

Due to uncertainty over the socioeconomic scenarios, the analysis SSP1, SSP2, SSP3, SSP4 and SSP5 for comparison.

Table: Most likely total gross value of benefits; varying discount rate

Scenario	Benefit range	PV Benefits	PV Costs	NPV	BCR
Central estimate SSP2	Lower bound	236.92	13.03	223.90	18.18
	Upper bound	253.11	13.03	240.08	19.43
SSP1	Lower bound	239.79	13.55	226.24	17.70
	Upper bound	256.62	13.55	243.07	18.94
SSP3	Lower bound	234.73	12.63	222.10	18.58
	Upper bound	250.42	12.63	237.78	19.83
SSP4	Lower bound	234.78	12.64	222.14	18.57
	Upper bound	250.48	12.64	237.84	19.82
SSP5	Lower bound	241.62	13.88	227.74	17.41
	Upper bound	258.86	13.88	244.98	18.65

Step 10: Formulate and communicate results



INTEPRETING & TRANSLATING RESULTS

SEB study results can **guide NMHS decisions, strategies and actions**. There are a number of means to best utilize the results when discussing with external audiences, for example:

- Elaborating the **case for resources**;
- Advocacy to the **public**;
- Advocacy to **key users**;
- Advocacy to the **aviation community**.

TARGET AUDIENCE

- Public authorities;
- Regulators;
- Service users;
- Funding authorities;
- Media partners;
- Emergency managers;
- Civil society.

DISTRIBUTION CHANNELS

- News media
- Television/internet;
- Electronic/social media/blogs.

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Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

Q&A Session

Coffee Break

We will re-convene in 15 minutes.

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Excel-Based Practical Exercise

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8. How do you think the quality and utilization of SEB analysis can be strengthened?

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Closing Remarks