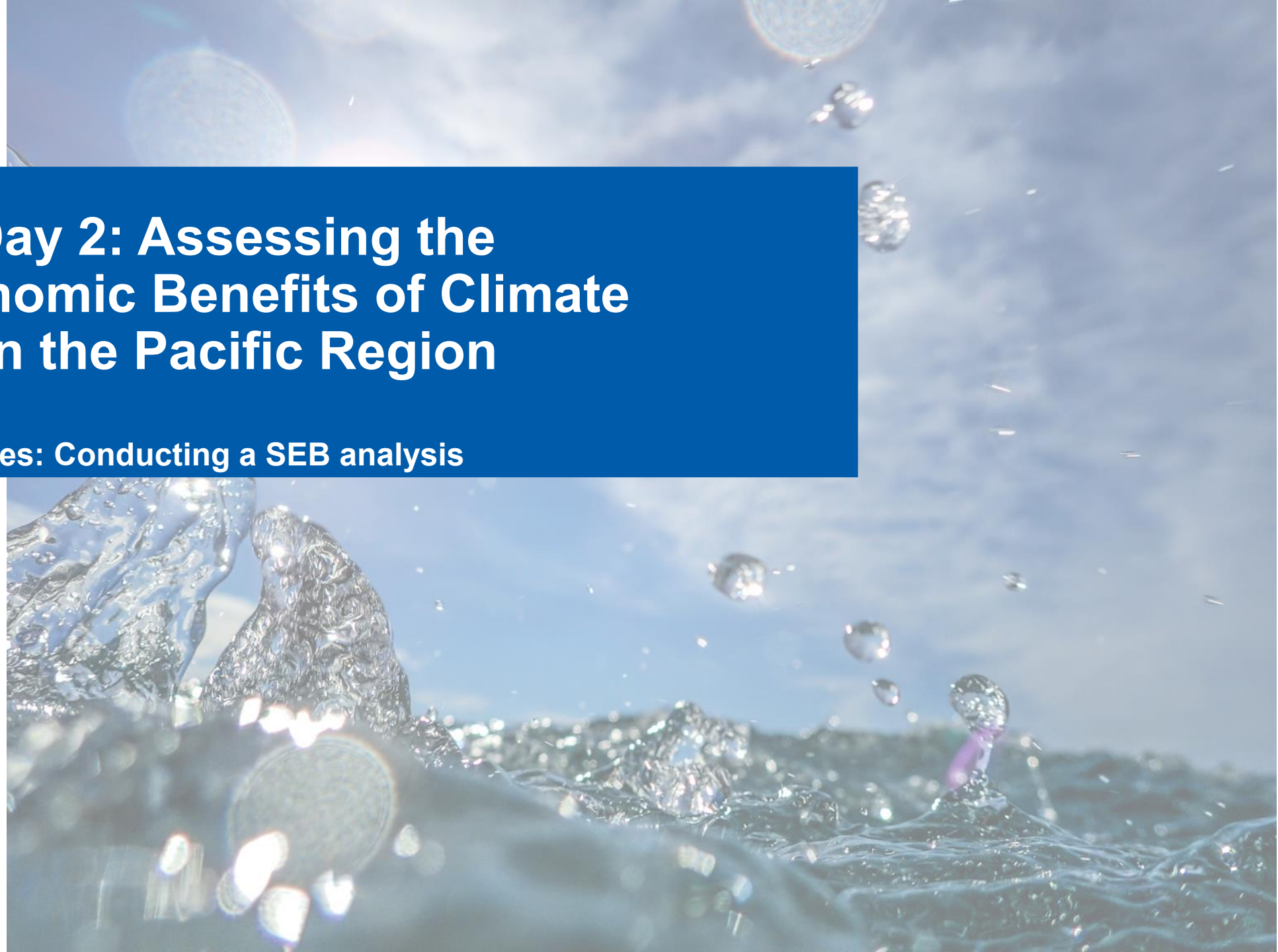
# Training Day 2: Assessing the Socioeconomic Benefits of Climate Services in the Pacific Region

## Practical Exercises: Conducting a SEB analysis



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# Welcome & Day 1 Recap

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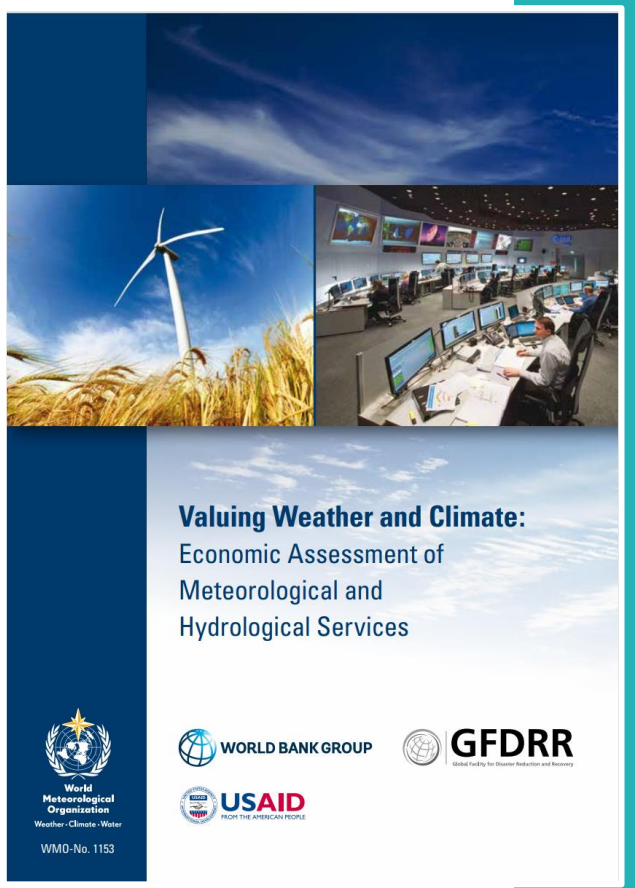
# Objectives

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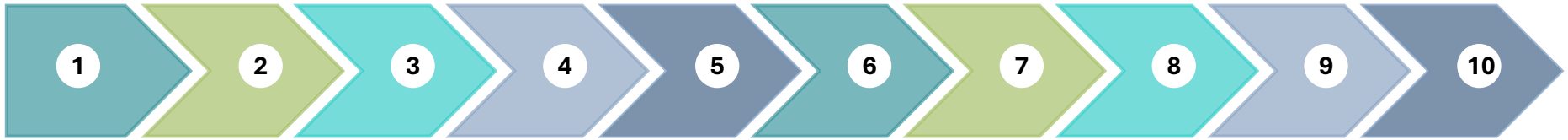
Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

# Communicating 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** (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.

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

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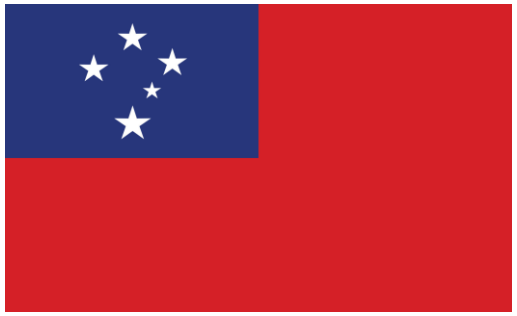
Source: WMO, World Bank, GFDRR and USAID, 2015: Valuing Weather and Climate Economic Assessment of Meteorological and Hydrological Services.

# Practical Exercise 1: SEB of climate services in Samoa

# Introduction and context



Based on a study that **analyses the economic profitability of climate services** in the Pacific region, with a **specific focus on Samoa**.

**Investments in these technologies in Samoa generate significant socio-economic returns** that far exceed the initial costs.

The study employs **a conservative methodology** that does not account for population growth or improvement of climate services, suggesting that the real value of these tools is likely higher than reported.

**Climate services**: the set of technologies, including Alarm systems, EWS and forecasting.

# Step 1: Establish the baseline

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

TC Evan was estimated to have cost at least **WST 465 million (USD 168,4 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

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# Step 2: Identify changes in NMHS services

Step 2 aims to **establish what is being valued**, **consider the primary options and** what reasonable or **potential alternatives** should be included in the analysis.

In the case of our study, we analyse the **socio-economic benefit of a climate service in Samoa with regard to the annual impacts of tropical cyclones** in the period **2025-2050.**

# Step 3: Identify full range of benefits and costs

## Benefits

There is **ample evidence** in the literature on the **benefits of climate services** related to reducing losses from climate disaster.

Benefits can be classified on **2 categories**:

1. **Avoided losses**.
2. **Increased productivity**.

| 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 |
| **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 |
| **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<br>15% of losses in Education<br>10% in Housing |

# Step 3: Identify full range of benefits and costs

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)

## Costs

The implementation of climate services **also entails costs**.

These costs v**ary 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.

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

# Step 4: Screen benefits and costs and select analytical approach

## BENEFITS RELATIVE IMPORTANCE

**Quantifiable 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** | Avoided 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 |

# Step 5: Quantitative analysis of benefits and costs

METHOD USED IN THE CASE STUDY → BENEFIT TRANSFER/AVOIDED COSTS

**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**

# Step 5: Quantitative analysis of benefits and costs

## Without system scenario (baseline)

| 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 |
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| Transport | 88,345.6 |
| **Cross-sectoral** | **72,649.0** |
| Environment | 72,649.0 |
| **TOTAL** | **465,146,9** |

## With system scenario (based on literature review)

| 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<br>15% of losses in Education<br>10% in Housing |

# Step 5: Quantitative analysis of benefits and costs

By **applying the benefits identified in the literature** in the ”with system” scenario **to the costs incurred in the baseline, we estimate the quantitative benefits** of the climate service.

| Sector | Total amount (USD million) | Amount per benefit (in USD million) |
|---|---|---|
| **Agriculture** | 6.17 | Avoided crop losses (0.21)<br>Avoided damage to agricultural equipment (0.33)<br>Avoided agricultural input losses (0.03)<br>Reduced costs of cultivation (2.52)<br>Irrigation optimization (0.58)<br>Reduction of labour hours (2.42)<br>Avoided livestock death (0.02)<br>Avoided damage to livestock infrastructure and equipment (0.06) |
| **Energy** | 0.19 – 0.96 | Prevention of power interruptions (0.1)<br>Improved hydropower energy production (0.09-0.86) |
| **Disaster risk reduction** | 7.4 | Avoided damages of tropical cyclones and floods on manufacturing, tourism and the built environment (7.1)<br>Avoided mortality from early warning systems (0.3) |

# Step 5: Quantitative analysis of benefits and costs

Calculate the **present value of benefits and costs.** The values have been calculated for the **period 2025–2050.**

## Benefits for the period

| BENEFITS | Baseline 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| Total Agriculture | 6.17 | 6.26 | 6.35 | 6.45 | 6.55 | 6.65 |
| Total Energy | 0.19 | 0.19 | 0.20 | 0.21 | 0.21 | 0.22 |
| Total DRR | 7.41 | 7.46 | 7.51 | 7.56 | 7.61 | 7.66 |
| **Total benefits in Sam** | **13.77** | **13.92** | **14.06** | **14.22** | **14.37** | **14.53** |

## Costs for the period

| Country / Region | Costs of climate services (in USD million/year) | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| Fiji | 3.86 | 3.9872376 | 4.1186694 | 4.2544336 | 4.394673 | 4.5395351 |
| Samoa | 0.62 | 0.64 | 0.65 | 0.67 | 0.69 | 0.70 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# Step 6: Qualitative analysis of benefits and costs

**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.

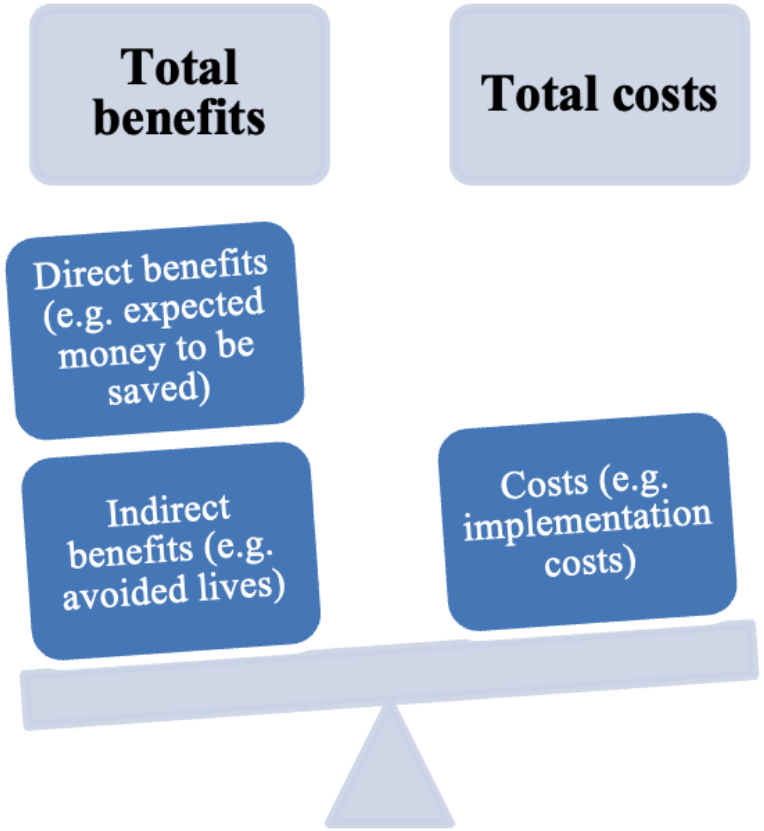
### Better planning of crop varieties

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




**Net Benefit**

The Decision Rule:

- **NPV > 0:**

The project adds value and is economically justified. **Proceed**.

- **NPV < 0:**

The costs outweigh the benefits. **Rethink**.

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# Step 7: Summarize and compare benefits and costs

| Costs of the project (million USD) | TOTAL | 2,025 | 2,026 | 2,027 | 2,028 | 2,029 | 2,030 |
|---|---|---|---|---|---|---|---|
| Period | | - | 1 | 2 | 3 | 4 | 5 |
| Project funds / Investment costs | - | | | | | | |
| Implementation (IE fees) | - | | | | | | |
| *Sub-total* | - | | | | | | |
| | | | | | | | |
| Operation and maintenance costs | | | | | | | |
| Operation and maintenance (adjusted by estimated growth) | 24.65 | 0.62 | 0.64 | 0.65 | 0.67 | 0.69 | 0.70 |
| *Sub-total* | *24.65* | *0.62* | *0.64* | *0.65* | *0.67* | *0.69* | *0.70* |
| | | | | | | | |
| **Total costs** | **24.65** | **0.62** | **0.64** | **0.65** | **0.67** | **0.69** | **0.70** |
| | | | | | | | |
| **Benefits derived from the project (million USD)** | TOTAL | 13.77 | 13.92 | 14.06 | 14.22 | 14.37 | 14.53 |
| *Total of benefits* | *424.47* | *13.77* | *13.92* | *14.06* | *14.22* | *14.37* | *14.53* |
| **Annual net benefits = (Benefits - Costs)** | | 13.15 | 13.28 | 13.41 | 13.55 | 13.68 | 13.82 |

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

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# Step 7: Summarize and compare benefits and costs

**Net present value (NPV):** Present benefits minus present costs. If the net present value is greater than 0.0, then the investment is considered economically effective.

**Benefit/cost ratio (BCR):** Present benefits divided by present costs. If the benefit/cost ratio is greater than 1.0, then the investment is considered economically effective.

| PV Benefits | PV Costs | NPV | BCR |
|---|---|---|---|
| 236.93 | 13.03 | 223.90 | 18.18 |

**NPV > 0**
**BCR > 0**

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# Step 8: List omissions, biases and uncertainties

## 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 5% 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

# Step 9: Conduct sensitivity analysis of key variable values

***Table: Variation in present values under different discount rates (lower bound).***

| Discounting rate | NPV |
|---|---|
| 0% | 399.8 € |
| 5% | 223.9 € |
| 7% | 185.3 € |
| 10% | 145.1 € |
| 15% | 105.2 € |
| 20% | 82.5 € |

In the study **5% discount rate** is applied.

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

Although the results vary based on the discount rate, **in all cases there is evidence of the efficiency of investing in climate services**.

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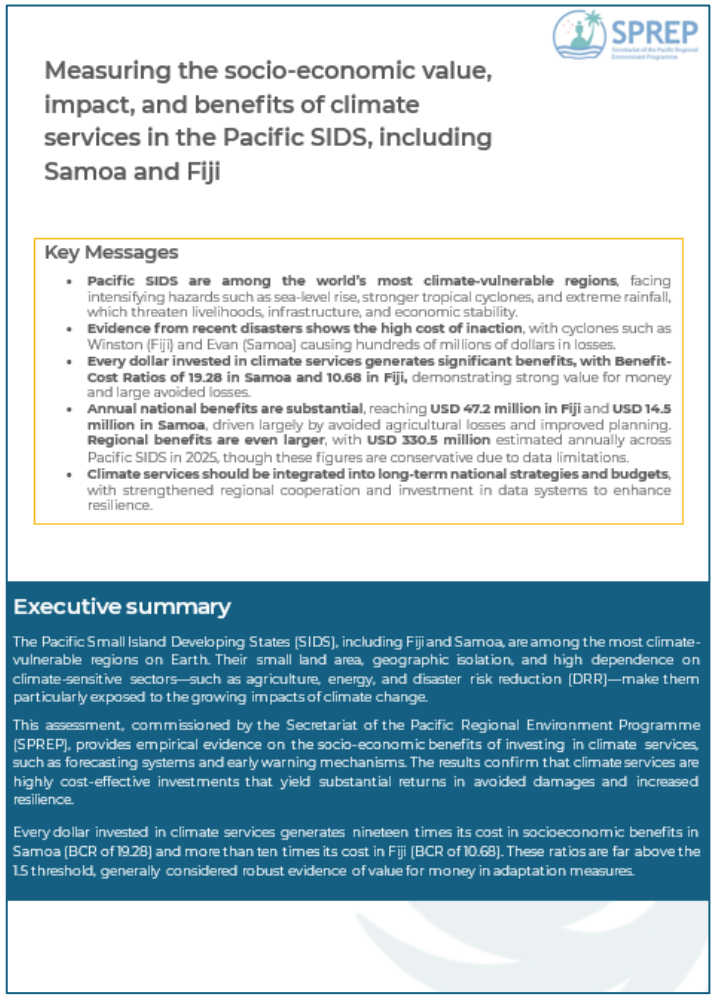
# Step 10: Formulate and communicate results

SEB study results can **guide NMHS decisions, strategies and actions**. It is therefore **important to communicate the results and conclusions effectively.** In our study in Samoa, in addition to the full report, we have produced a policy brief summarising the methodology used and an infographic showing the main results obtained.

## (1) Elaboration of a policy brief



SPREP

Measuring the socio-economic value, impact, and benefits of climate services in the Pacific SIDS, including Samoa and Fiji

Key Messages

- **Pacific SIDS are among the world's most climate-vulnerable regions**, facing intensifying hazards such as sea-level rise, stronger tropical cyclones, and extreme rainfall, which threaten livelihoods, infrastructure, and economic stability.
- **Evidence from recent disasters shows the high cost of inaction**, with cyclones such as Winston (Fiji) and Evan (Samoa) causing hundreds of millions of dollars in losses.
- **Every dollar invested in climate services generates significant benefits, with Benefit-Cost Ratios of 19.28 in Samoa and 10.68 in Fiji,** demonstrating strong value for money and large avoided losses.
- **Annual national benefits are substantial**, reaching **USD 47.2 million in Fiji** and **USD 14.5 million in Samoa**, driven largely by avoided agricultural losses and improved planning. **Regional benefits are even larger**, with **USD 330.5 million** estimated annually across Pacific SIDS in 2025, though these figures are conservative due to data limitations.
- **Climate services should be integrated into long-term national strategies and budgets**, with strengthened regional cooperation and investment in data systems to enhance resilience.

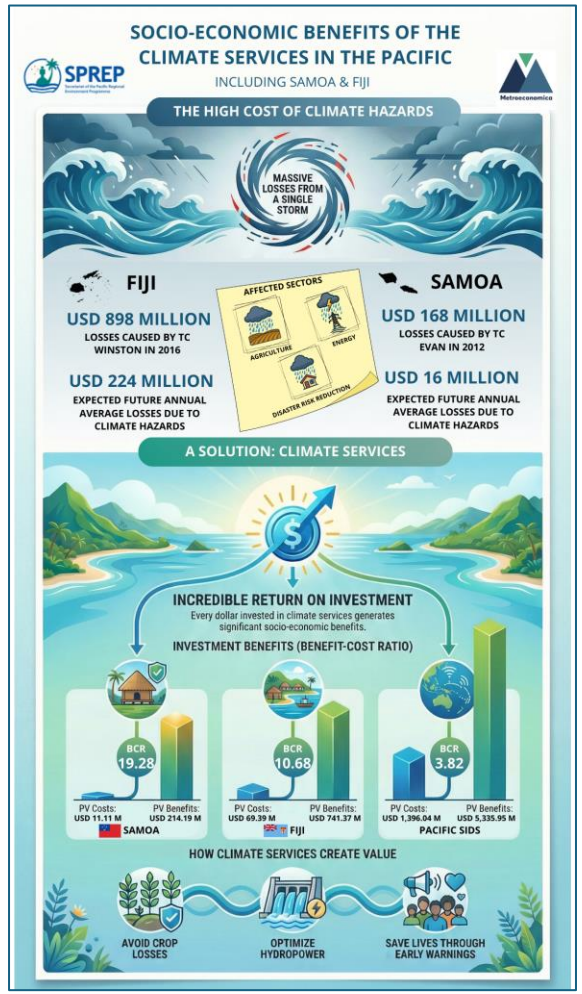
Executive summary

The Pacific Small Island Developing States (SIDS), including Fiji and Samoa, are among the most climate-vulnerable regions on Earth. Their small land area, geographic isolation, and high dependence on climate-sensitive sectors—such as agriculture, energy, and disaster risk reduction (DRR)—make them particularly exposed to the growing impacts of climate change.

This assessment, commissioned by the Secretariat of the Pacific Regional Environment Programme (SPREP), provides empirical evidence on the socio-economic benefits of investing in climate services, such as forecasting systems and early warning mechanisms. The results confirm that climate services are highly cost-effective investments that yield substantial returns in avoided damages and increased resilience.

Every dollar invested in climate services generates nineteen times its cost in socioeconomic benefits in Samoa (BCR of 19.28) and more than ten times its cost in Fiji (BCR of 10.68). These ratios are far above the 1.5 threshold, generally considered robust evidence of value for money in adaptation measures.

## (2) Design of an infographic



# Practical Exercise 2: SEB of climate services in Lake Chad Basin

# Introduction and context

**Analysis of the socio-economic benefits of improved climate services in the Lake Chad Basin.**

**Main Result:** Investing 1 USD in hydrometeorological services and early warning systems (EWS) results in 2 to 36 USD in socioeconomic benefits.

| Country | GDP (USD; million) | Reference year |
|---|---|---|
| **Cameroon** | 45,338.28 | 2021 |
| **Central African Republic (CAR)** | 2,516.50 | 2021 |
| **Chad** | 11,779.98 | 2021 |
| **Niger** | 14,915.00 | 2021 |
| **Nigeria** | 440,833.58 | 2021 |
| **Total (Lake Chad Basin)** | 515,383.34 | 2021 |

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# Step 1: Establish the baseline

The economic assessment of the climate service is **based on total loss (USD million) for the main hydrometeorological hazards in the 5 countries of the Lake Chad Basin from 1960 to 2022 .**

| Country | TOTAL Loss (USD million) |
|---|---|
| **Cameroon** | 28.39 |
| **Central African Republic (CAR)** | 0.402 |
| **Chad** | 676.95 |
| **Niger** | 372.89 |
| **Nigeria** | 5,751.75 |
| **Total (Lake Chad Basin)** | 6,815.39 |

# Step 2: Identify changes in NMHS services

Step 2 aims to **establish what is being valued**, **consider the primary options and** what reasonable or **potential alternatives** should be included in the analysis.

In the case of this study, the implementation of a **socio-economic benefit of a climate service in Lake Chad basin with regard to the annual impacts of main hydrometeorological related hazards** in a 10-year period**.**

# Step 3: Identify full range of benefits and costs

## Benefits

Considering the limited data availability, Hallegatte (2012) methodology has been applied in this study, classifying benefits in two categories:

1. Benefits from **reduced disaster losses**.

2. Benefits from **increased production**.

## Costs

For this project, there is an estimated regional cost of **10.62 million USD**, of which 3.750 million USD are for regional activities and management.

These activities relate to aspects that all five countries face, and therefore joint capacity building will reduce the total cost of ownership.

# Step 4: Screen benefits and costs and select analytical approach

## Benefits from reduced disaster losses

Hallegatte (2012) found that on average, well-functioning, modern **climate services reduce disaster-related asset damages by between 0.003 percent and 0.017 percent of GDP**.

The **potential benefit of an investment in EWS is the difference between the current protection provided by the existing systems and the potential reduction in asset damages if the systems are modernized**.

Under this benchmarking methodology, the **Lake Chad Basin countries would be considered as countries with relatively modest systems**, assuming that **their system currently capture only 20%** of the benefits.

# Step 4: Screen benefits and costs and select analytical approach

## Benefits from Increased production

Hallegatte (2012) finds that about **25 percent of the world GDP is generated in weather-, water- and climate-sensitive sectors**. **Modernized hydromet** and warning systems can benefit these sectors in many ways.

A conservative global benchmark is that modern hydromet services **add value of 0.1 percent to 1 of the GDP of those sectors.**

In the **Lake Chad Basin countries, weather-, water-, and climate-sensitive sectors represent at least 25 percent** of the countries' economies for agriculture.

Applying the Hallegatte (2012) benchmarking approach to the Lake Chad Basin, **the benefits from increased production will be calculated as the 0.1% of the weather-, water- and climate-sensitive sectors (25% of total GDP).**

# Step 5: Quantitative analysis of benefits and costs

**The benefit is the sum of benefits from reduced disaster losses and increased production..**

1

## Reduced disaster losses

Benefits thus are calculated as **the potential reduced losses** (between 0.003% and 0.017% of GDP) **multiplied by the effectiveness of the climate services**, which in this case would be 20% of that value.

*Estimated anual benefits (lower bound) = GDP*0.003% * 20%.*

+

2

## Increased production

**Increased production is calculated as their added value** (0.1% - 1% of GDP) **multiplied by the GDP generated in weather-, water- and climate-sensitive sectors** (25% of GDP) which would translate into gains of approximately 0.025 percent and 0.25 percent of regional GDP.

# Step 5: Quantitative analysis of benefits and costs

## Benefits from reduced disaster losses

The results for the Lake Chad Basin **range from 3.09 to 17.52 million USD** in average annual reduced losses.

To avoid double-counting, the lower end of the range is used in this analysis.

## Benefits from increased production

Applying the Hallegatte (2012) approach, **annual benefits in production are 128.85–1,288,46 million USD per year**.

To avoid double-counting, the lower end of the range is used in this analysis.

# Step 6: Qualitative analysis of benefits and costs

**Qualitative benefits are not included in this study.**

Some examples (mentioned in the previous exercise) would be:

**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.

**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.

**Potential use of other local warnings**

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

# Step 7: Summarize and compare benefits and costs & Step 9: Sensitivity analysis

**Net present value (NPV):** Present benefits minus present costs. If the net present value is greater than 0.0, then the investment is considered economically effective.

**Benefit/cost ratio (BCR):** Present benefits divided by present costs. If the benefit/cost ratio is greater than 1.0, then the investment is considered economically effective.

| A1.4.1a Proposed Regional Investment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Net present value (million USD) | | | | Benefit/cost ratio | | | |
| **Discount rate** | **0%** | **5%** | **10%** | **15%** | **0%** | **5%** | **10%** | **15%** |
| **Benefits** | 619 | 395 | 264 | 184 | 35 | 28 | 24 | 20 |

Although the results vary based on the discount rate, **in all cases there is evidence of the efficiency of investing in climate services**.

**NPV > 0**
**BCR > 0**

# Practical Exercise 3: An economic analysis of flood warning in Navua, Fiji

# Introduction and context

## EU-SOPAC PROJECT

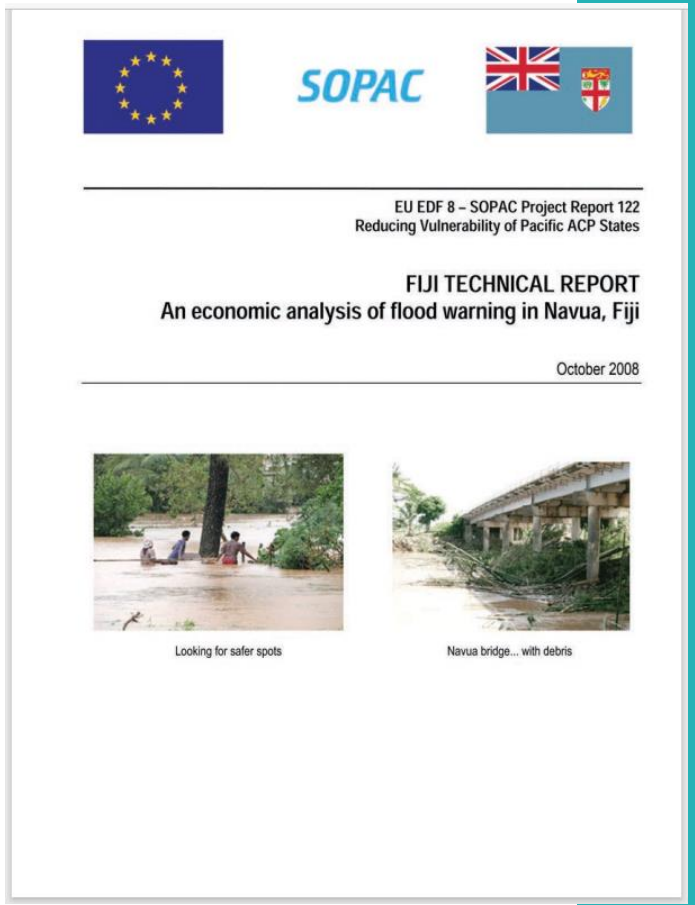
Under the European Development Fund (EDF) project **“Reducing Vulnerability in Pacific ACP States”**, SOPAC worked with the Government of Fiji to establish a flood warning system for the town of Navua and nearby communities.

## FOCUS

Focused on the **town of Navua, Fiji, and surrounding areas** – a highly flood-prone area subject to flooding about once every 7 year.

## OBJECTIVE

Aimed to **evaluate the potential economic return of investing in the Navua flood warning system** to support the Government of Fiji in its deliberations over securing financial support for the scheme.

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# Step 1: Establish the baseline

*Table 16. Estimated economic losses to Navua of the 2004 floods.*

| Item | National cost | Navua value | Comment |
|---|---|---|---|
| Household losses * | | 67 45 228 | |
| Business losses | | 2 980 837 | Probable underestimate |
| Agricultural and fisheries losses | | 832 388 | Agriculture component possible overestimate |
| Government losses: | | | |
| ▪ Replacement of destroyed lean tos | | 34 800 | |
| ▪ Infrastructure rehabilitation | | 400 000 | Underestimate |
| ▪ Medical services | | 2 000 000 | |
| ▪ Education | | 25 625 | Underestimate |
| ▪ Provision of water tanks | | 0 | |
| ▪ Provision of emergency clothing | | 1000 | |
| ▪ Provision of food rations and disaster sundries | | 10 908 | |
| ▪ Coordination by government | | Not known | |
| Humanitarian aid valued: | | | |
| ▪ Australian High Commission | 150 000 | 1560 | Underestimate |
| ▪ French Embassy | 20 000 | 208 | |
| Unvalued humanitarian aid: | | | |
| ▪ Blankets | Not known | Not known | |
| ▪ 10000 oral dehydration salts | * | Not known | |
| ▪ 2400 litres bottled water | * | Not known | |
| ▪ 11 cartons Fiji water | * | Not known | |
| ▪ Red Cross provisions | Not known | Not known | |
| Other losses | | | |
| ▪ Early school break for Catholic primary School due to need for fresh water | Not known | Not known | |
| ▪ Volunteers to government and NGOs | Not known | Not known | |
| ▪ Trauma and irreplaceable items | Not known | Not known | |
| ESTIMATED TOTAL (not including 'unknown' values) | | 13032554 | |

* Household losses estimated from Mataki et al. (2006).

The economic assessment of the flood warning system is **based on losses estimates from the 2004 floods** in Navua.

The 2004 floods were estimated to have cost at least **FJ$13 million**, causing losses to households, business, government, etc.

**COUNTING THE COST TO CALCULATE THE BENEFIT**

BENEFITS = What **proportion of the 2004 losses could be avoided** if a flood early warning system operated successfully in the future?

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# Step 2: Identify changes in NMHS services

Again, Step 2 aims to **establish what is being valued**, **consider the primary options and** what reasonable or **potential alternatives** should be included in the analysis.

In the case of this study, the implementation of a **Flood Warning System** in Navua (Fiji) **is assessed.**

# Step 3: Identify full range of benefits and costs

## Benefits

*Table 6. Potential benefits from a warning system.*

| Type of benefit of the warning system | Type of cost |
|---|---|
| People have time to evacuate the area and avoid injuries from flood exposure | Immediate medical costs |
| People have time to move more personal possessions and moveable business and/or government assets (e.g. computers, electricals, clothing, vehicles, livestock) to higher ground or protect them | Personal and commercial financial costs |
| People avoid later sickness by having the time to store clean water, medical provisions and tarpaulin etc. in readiness | Subsequent medical costs |
| People potentially able to reduce days lost resulting from injury by having time to flee floods (but unlikely to be able to get to work any faster as infrastructure damage unavoidable) | Lost income (due to business damage, inability to get to work because of infrastructure damage etc.) |
| People suffer reduced stress and trauma as they have time to protect more possessions and avoid injury | Trauma from flooding, loss of personal possessions, pets, records etc. |
| Reduced harm and losses to families means that the government and humanitarian agencies need to provide less medical, food or other assistance and/or have to spend less time coordinating efforts | Government and humanitarian assistance |

# Step 3: Identify full range of benefits and costs

## Costs

*Table 7. Costs of flood warning systems.*

| Establishment costs | Operational costs |
|---|---|
| ▪ Equipment (e.g. transmitters, river gauges, rainfall gauges) | ▪ Maintenance |
| ▪ Software (e.g. flood prediction models) | ▪ Awareness raising |
| ▪ Technical advice and training on how to use the system | |
| ▪ Communications systems to alert people | |

# Step 4: Screen benefits and costs and select analytical approach

**BENEFITS RELATIVE IMPORTANCE**

Table 17 (Column 2- Impact) classifies the magnitude of benefits the warning system could deliver in reducing the respective losses

**NON-QUANTIFIABLE BENEFITS:**

- Reduced lost education opportunities;
- Savings in terms of volunteer labour;
- Reduced trauma;
- Potential use of the warning system for other local warnings; and
- Lessons to other warning systems across the Pacific.

*Table 17. Assumed benefit rates from the warning system.*

| Item | Impact |
|---|---|
| | |
| *Personal losses* | |
| ▪ Immediate medical costs | High |
| ▪ Loss of personal possessions such as televisions, clothing, vehicles | Medium |
| ▪ Subsequent medical costs | Medium to high |
| ▪ Lost earnings | Negligible |
| ▪ Reductions in evacuation costs | Nil |
| *Business losses* | |
| ▪ Large companies (Bus.A) | Limited |
| ▪ Medium size companies (Bus. B) | Limited |
| ▪ Small companies | Limited |
| *Primary production* | |
| ▪ Agricultural land | Nil |
| ▪ Boats and engines | Low to medium |
| *Government losses* | |
| ▪ Buildings (e.g. lean tos) | Nil |
| ▪ Infrastructure rehabilitation | Nil |
| ▪ Medical services | Low |
| ▪ Education services | Low |
| ▪ Clothing | Nil |
| ▪ Food rations and sundries | Low to moderate |
| ▪ Coordination by government | Moderate |
| *Humanitarian aid* | Nil |
| *Other losses* | |
| ▪ Lost education opportunities | Nil |
| ▪ Volunteers | Low to medium |
| ▪ Trauma from flooding, loss of irreplaceable items. | Medium? |
| ▪ Use of warning system for other local purposes | ? |
| ▪ Environmental management | ? |
| ▪ Lessons to other warning systems in the Pacific | ? |

*Table 21. Total costs of the warning system.*

| Item |
|---|
| Fixed costs |
| *Software and hardware (NIWA) NZ$* |
| ▪ Sabata flow station (establish) |
| ▪ Nakavu flow station (upgrade) |
| ▪ Equip Public Works Hydrology unit in Suva |
| ▪ Establish second base station |
| ▪ New rainfall station at Tikitura |
| ▪ Upgrade Nabukelevu and Wainimakutu rainfall stations |
| ▪ Upgrade Cabe, Namuamua and Wainikavika rainfall stations |
| ▪ Basic flood modelling |
| ▪ Flood modelling using flow and rainfall data |
| ▪ Public river display |
| ▪ Training workshops (how to use hard and software), reporting etc. |
| *In-kind and financial contributions from the Government of Fiji FJ$* |
| ▪ In-kind contributions from Department of Public Works (labour and building materials)** |
| *Communications and dissemination activities FJ$(SOPAC)* |
| ▪ Workshops with community leaders and local government officials |
| ▪ Exercise to test and review system |
| ▪ Implementation of public awareness system |
| ▪ In-kind contributions and training from SOPAC FJ$ |
| ▪ Radio services from local supplier (SOPAC/EDF) FJ$ |
| Variable costs (VC annual) |
| *In-kind and financial contributions from the Government of Fiji FJ$* |
| ▪ Physical maintenance of the monitoring system including travel and man power (15% of NIWA infrastructure) |
| ▪ On-going awareness raising |

# Step 5: Quantitative analysis of benefits and costs

**The benefit is the avoided cost of flooding**, calculated by comparing the scale of losses with and without the flood warning system over a given period.

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

**RECALL THE BASELINE:**
The 2004 Navua flood is taken as the reference event = the "without system" scenario.

*Estimated 2004 flood losses ≈ FJ$13 million.*

2 **Estimate the expected flood frequency**

Estimate **how many floods of the 2004 magnitude are likely to occur** during the system's 20-year lifetime.

*Assumed a major flood happens only once every 20 years or as much as once every 10 years.*

3 **Establish the "with system" scenario**

**Through stakeholder consultations**, determine the % of avoidable losses with the warning system in place.

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

**Un-discounted benefits = 2004 flood losses (baseline) x expected frequency of similar floods x % avoidable losses with the system**

# Step 5: Quantitative analysis of benefits and costs

1

**Establish the "without system" scenario**

*Table 16. Estimated economic losses to Navua of the 2004 floods.*

| Item | National cost | Navua value | Comment |
|---|---|---|---|
| Household losses * | | 67 45 228 | |
| Business losses | | 2 980 837 | Probable underestimate |
| Agricultural and fisheries losses | | 832 388 | Agriculture component possible overestimate |
| Government losses: | | | |
| ▪ Replacement of destroyed lean tos | | 34 800 | |
| ▪ Infrastructure rehabilitation | | 400 000 | Underestimate |
| ▪ Medical services | | 2 000 000 | |
| ▪ Education | | 25 625 | Underestimate |
| ▪ Provision of water tanks | | 0 | |
| ▪ Provision of emergency clothing | | 1000 | |
| ▪ Provision of food rations and disaster sundries | | 10 908 | |
| ▪ Coordination by government | | Not known | |
| Humanitarian aid valued: | | | |
| ▪ Australian High Commission | 150 000 | 1560 | Underestimate |
| ▪ French Embassy | 20 000 | 208 | |
| Unvalued humanitarian aid: | | | |
| ▪ Blankets | Not known | Not known | |
| ▪ 10000 oral dehydration salts | * | Not known | |
| ▪ 2400 litres bottled water | * | Not known | |
| ▪ 11 cartons Fiji water | * | Not known | |
| ▪ Red Cross provisions | Not known | Not known | |
| Other losses | | | |
| ▪ Early school break for Catholic primary School due to need for fresh water | Not known | Not known | |
| ▪ Volunteers to government and NGOs | Not known | Not known | |
| ▪ Trauma and irreplaceable items | Not known | Not known | |
| ESTIMATED TOTAL (not including 'unknown' values) | | 13032554 | |

* Household losses estimated from Mataki et al. (2006).

# Step 5: Quantitative analysis of benefits and costs

*Table 17. Assumed benefit rates from the warning system.*

| Item | Impact | % Assumed benefits | | |
|---|---|---|---|---|
| | | Worst case | Most likely | Best case |
| *Personal losses* | | | | |
| ▪ Immediate medical costs | High | 10 | 30 | 50 |
| ▪ Loss of personal possessions such as televisions, clothing, vehicles | Medium | 20 | 40 | 55 |
| ▪ Subsequent medical costs | Medium to high | 0 | 5 | 10 |
| ▪ Lost earnings | Negligible | 15 | 20 | 30 |
| ▪ Reductions in evacuation costs | Nil | 0 | 0 | 0 |
| *Business losses* | | | | |
| ▪ Large companies (Bus.A) | Limited | 10 | 30 | 50 |
| ▪ Medium size companies (Bus. B) | Limited | 20 | 30 | 40 |
| ▪ Small companies | Limited | 20 | 40 | 60 |
| *Primary production* | | | | |
| ▪ Agricultural land | Nil | 0 | 0 | 0 |
| ▪ Boats and engines | Low to medium | 0 | 10 | 20 |
| *Government losses* | | | | |
| ▪ Buildings (e.g. lean tos) | Nil | 0 | 5 | 10 |
| ▪ Infrastructure rehabilitation | Nil | 0 | 5 | 10 |
| ▪ Medical services | Low | 25 | 40 | 50 |
| ▪ Education services | Low | 25 | 40 | 60 |
| ▪ Clothing | Nil | 50 | 70 | 90 |
| ▪ Food rations and sundries | Low to moderate | 25 | 50 | 75 |
| ▪ Coordination by government | Moderate | 30 | 60 | 90 |
| *Humanitarian aid* | Nil | 10 | 30 | 50 |
| *Other losses* | | | | |
| ▪ Lost education opportunities | Nil | 0 | 0 | 0 |
| ▪ Volunteers | Low to medium | ? | ? | ? |
| ▪ Trauma from flooding, loss of irreplaceable items. | Medium? | ? | ? | ? |
| ▪ Use of warning system for other local purposes | ? | ? | ? | ? |
| ▪ Environmental management | ? | ? | ? | ? |
| ▪ Lessons to other warning systems in the Pacific | ? | ? | ? | ? |

3

**Establish the "with system" scenario**

# Step 6: Qualitative analysis of benefits and costs

**A subset of benefits from the Navua flood warning system are not amenable to quantitative analysis.**

### Volunteer labour savings

Volunteers may still needed to distribute materials and assist businesses and families for recovery, but fewer and for shorter durations.

### Reduced trauma

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

### Potential use of other local warnings

The Navua flood warning system – if successful – could be used as part of a broad community warning system.

### Lessons to other systems in the Pacific

With advanced flood forecasting and radio transmitted automatic warnings, the Navua system could offer design and operational lessons for warning systems in the region.

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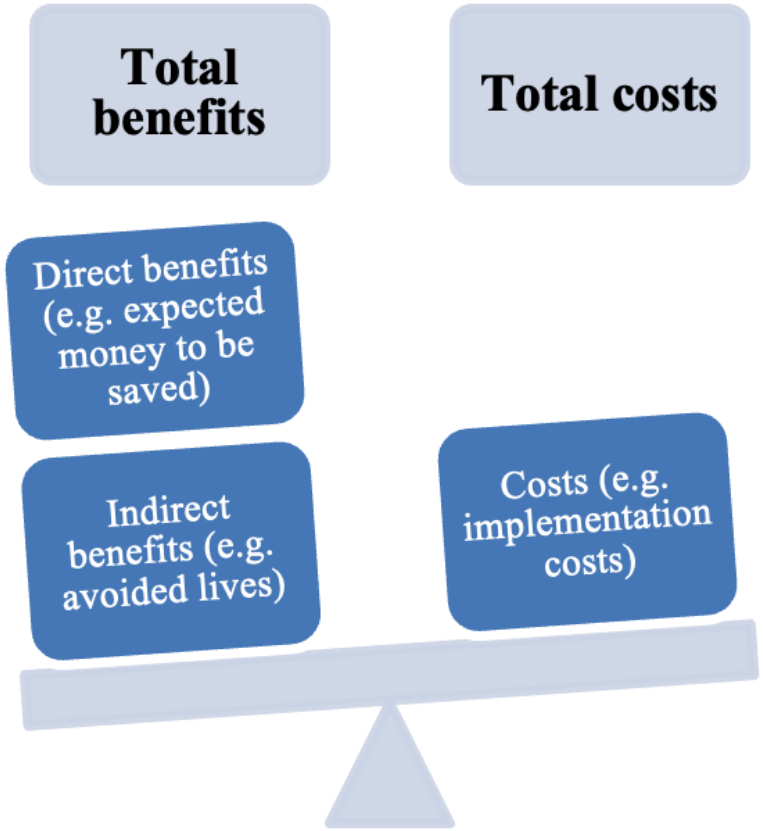
# Step 7: Summarize and compare benefits and costs




**Net Benefit**

The Decision Rule:

- **NPV > 0:**

The project adds value and is economically justified. **Proceed**.

- **NPV < 0:**

The costs outweigh the benefits. **Rethink**.

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# Step 7: Summarize and compare benefits and costs

**ADJUSTING BENEFITS OF THE NAVUA WARNING SYSTEM TO PRESENT VALUES**

**Present values were estimated using a 10% discount rate** – consistent with Asian Development Bank (ADB) guidelines and the most commonly used for environment and development projects in the Pacific.

*Table 18. Most likely gross value of benefits (10 per cent discount rate).*

| Item | Minimum of 1 major flood | Minimum of 2 major floods |
|---|---|---|
| ▪ Immediate medical costs | 14 | 28 |
| ▪ Loss of personal possessions such as televisions, clothing, vehicles | 1 262 703 | 2 525 407 |
| ▪ Subsequent medical costs | 1 | 2 |
| ▪ Lost earnings | 314 | 628 |
| *Business losses* | | |
| ▪ Loss of assets such as computers, electricals, vehicles | 419 510 | 839 020 |
| *Government losses* | | |
| ▪ Buildings (e.g. lean tos) | 986 | 1972 |
| ▪ Infrastructure rehabilitation | 9365 | 18730 |
| ▪ Medical services | 374 597 | 749 194 |
| ▪ Education services | 4800 | 9599 |
| ▪ Coordination by government | 0 | 0 |
| ▪ Clothing | 328 | 656 |
| ▪ Food rations and sundries | 2554 | 5108 |
| ▪ Primary production | | |
| – Agricultural land | 0 | 0 |
| – Boats and engines | 891 | 1782 |
| *Humanitarian aid* | | |
| ▪ Other valued aid | 248 | 497 |
| ▪ Unvalued aid | unknown | unknown |
| *Other losses* | | |
| ▪ Lost education opportunities | unknown | unknown |
| ▪ Volunteers | unknown | unknown |
| ▪ Trauma from flooding, loss of personal possessions, pets etc. | unknown | unknown |
| ▪ Use of warning system for other local warnings | unknown | unknown |
| ▪ Lessons to other warning systems in the Pacific | unknown | unknown |
| TOTAL | 2 076 311 | 4 152 622 |

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# Step 8: List omissions, biases and uncertainties

## 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 5% 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

# Step 8: List omissions, biases and uncertainties

## OMISSIONS

**Benefit estimates likely to be an under-estimation as values did not include benefits arising from:**

- Reduced lost education opportunities;
- Savings terms of volunteer labour,;
- Reduced trauma;
- Potential use of the warning system for other local warnings; and
- Lessons to other warning systems in Fiji and across the Pacific.

## ASSUMPTIONS

**The evaluation of the Navua flood warning system made estimates based on various assumptions:**

- Major floods happen only once every 20 years or as much as once every 10 years;
- 10 per cent discount rate (highly conservative and reflecting that this is the value most commonly used in the Pacific); and
- Worst case, most likely case and best case scenarios.

# Step 9: Conduct sensitivity analysis of key variable values

A **10 per cent discount rate** is the applied in this study, which is consistent with Asian Development Bank (ADB) guidelines.

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

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

| Minimum 1 major flood | Minimum 2 major floods |
|---|---|
| **10% discount rate** | |
| 2 076 311 | 4 152 622 |
| **7% discount rate** | |
| 2 513 025 | 5 026 050 |
| **3% discount rate** | |
| 3 352 803 | 6 705 606 |

**Based on Tables 18, 19, 20 of the report.*

# Q&A Session

# TAKE HOME MESSAGES

1. Useful to better understand the importance of the Climate Services and economic case to (increase) investments.
2. Necessary to bridge between technical experts and decision makers, other departments, stakeholders, etc.
3. The 10 steps procedure is a good guideline.
4. Careful with details:
   - Consider the value of the future (discount rate)
   - Consider differences in cost of living between countries (Purchasing Power Parity).
   - Consider differences in currencies (Exchange rate).
   - Consider differences in years (Inflation rate, CPI).
5. Account for qualitative information.
6. Be honest (transparent) with uncertainties, limitations and biases.
7. Disseminate and make good use to engage with stakeholders.

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