Earth Sciences
Department

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# Information for Decision Making (I4D)

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Ramón y Cajal Fellow

Earth System Services (ESS) Group

# Research and Co-Dev Agenda

- Emphasis on demand-driven approach to identify predictands, calibration methods, ensembling, verification metrics, etc.

- From a collection of climate services to an ecosystem of climate services

- Financial instruments to transfer climate-related risk

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# Demand-driven approaches

**SCIENTIFIC REPORTS** natureresearch

OPEN **AeDES: a next-generation monitoring and forecasting system for environmental suitability of *Aedes*-borne disease transmission**

Á. G. Muñoz, X. Chourio, Ana Rivière-Cinnamond, M. A. Diuk-Wasser, P. A. Kache, E. A. Mordecai, L. Harrington & M. C. Thomson

Muñoz et al., 2020. https://doi.org/10.1038/s41598-020-69625-4

RESEARCH ARTICLE

**A demand-driven climate services for health implementation framework: A case study for climate-sensitive diseases in Caribbean Small Island Developing States**

Avriel R. Díaz[1,2*], Leslie Rollock[3], Laura-Lee G. Boodram[4], Roché Mahon[5], Sabu Best[6], Adrian Trotman[5], Cédric J. Van Meerbeeck[5], Chloe Fletcher[7,8], Willy Dunbar[9], Catherine A. Lippi[10,11], Daniela Lührsen[7], Cecilia Sorensen[12,13], Ángel G. Muñoz[7], Sadie J. Ryan[10,11], Anna M. Stewart-Ibarra[14], Rachel Lowe[7,15,16]

Díaz et al., 2024 https://doi.org/10.1371/journal.pclm.0000282

**On the NextGen-Chile forecast system: a calibrated multi-model ensemble approach for seasonal precipitation forecasts**

CLIMATE PREDICTION | CLIMATE SERVICES | FORECAST VERIFICATION/SKILL | MULTI-MODEL ENSEMBLE
SEASONAL FORECASTING

Diego A. Campos Díaz, Fernanda I Cabello, Ángel G Muñoz

Cite as: Diego A. Campos Diaz, Fernanda I Cabello, Ángel G Muñoz. On the NextGen-Chile forecast system: a calibrated multi-model ensemble approach for seasonal precipitation forecasts. Authorea. July 16, 2024.
DOI: 10.22541/au.172116352.28309402/v1

Non-exclusive
No reuse

**AeDES2.0: An enhanced climate-and-health service for monitoring and forecasting environmental suitability of Aedes-borne disease transmission in hotspots**

Javier Corvillo Guerra[1], Verónica Torralba[1], Carmen González Romero[1], Alba Llabrés-Brustenga[1], Ana Riviere-Cinnamond[2], and Ángel G. Muñoz[1]
[1]Earth System Services (ESS). Department of Earth Sciences. Barcelona Supercomputing Center (BSC). Barcelona, Spain
[2]Pan-American Health Organisation (PAHO). World Health Organisation. Panama Office. Panama.

Corvillo Guerra et al., 2024. https://doi.org/10.5194/ems2024-1061

**Lessons learned from the co-development of operational climate forecast services for vineyards management**

N. Pérez-Zanón[a,*], V. Agudetse[a], E. Baulenas[a], P.A. Bretonnière[a], C. Delgado-Torres[a], N. González-Reviriego[a,b], A. Manrique-Suñén[a], A. Nicodemou[a], M. Olid[a], Ll. Palma[a], M. Terrado[a], B. Basile[c], F. Carteni[c], A. Dente[d], C. Ezquerra[e], F. Oldani[f], M. Otero[g], F. Santos-Alves[h], M. Torres[e], J. Valente[h], A. Soret[a]

Pérez-Zanón et al., 2024 , https://doi.org/10.1016/j.cliser.2024.100513

**Standardisation of equitable climate services by supporting a community of practice**

Francisco J. Doblas-Reyes[a,b,*], Asun Lera St Clair[b,c], Marina Baldissera Pacchetti[b,d], Paula Checchia[b], Joerg Cortekar[e], Judith E.M. Klostermann[f], Werner Krauß[g], Ángel G. Muñoz[b], Jaroslav Mysiak[h,l], Jorge Paz[i,j], Marta Terrado[b], Andreas Villwock[e], Mirjana Volarev[k], Saioa Zorita[i]

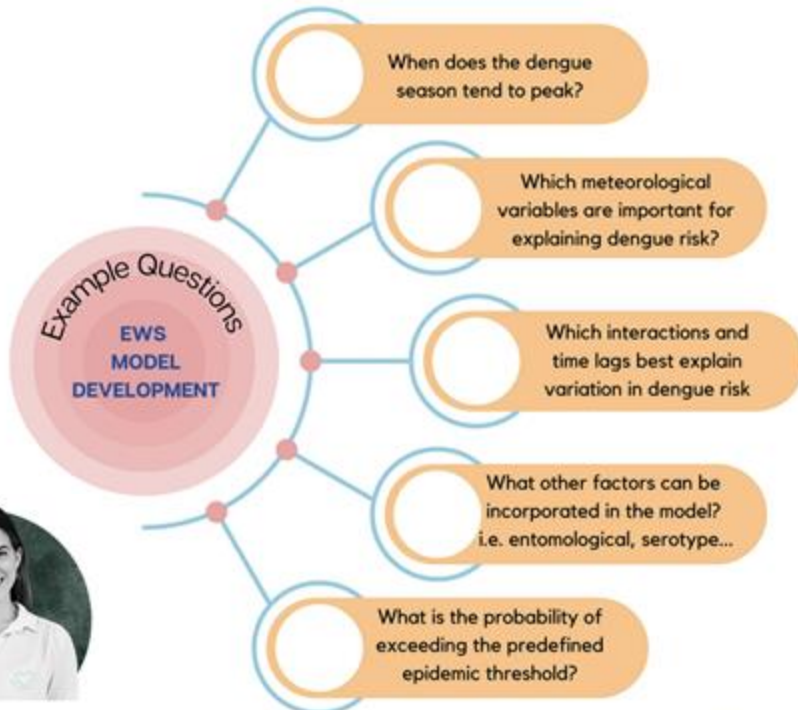Doblas-Reyes et al., 2024. https://doi.org/10.1016/j.cliser.2024.100520

# Demand-driven approaches



Fig 5. Example of guiding questions used to create predictive models for the climate-driven Dengue EWS in Barbados by Lowe et al. 2018 [9].
https://doi.org/10.1371/journal.pclm.0000282.g005

RESEARCH ARTICLE

## A demand-driven climate services for health implementation framework: A case study for climate-sensitive diseases in Caribbean Small Island Developing States

Avriel R. Díaz[1,2*], Leslie Rollock[3], Laura-Lee G. Boodram[4], Roché Mahon[5], Sabu Best[6], Adrian Trotman[5], Cédric J. Van Meerbeeck[5], Chloe Fletcher[7,8], Willy Dunbar[9], Catherine A. Lippi[10,11], Daniela Lührsen[7], Cecilia Sorensen[12,13], Ángel G. Muñoz[7], Sadie J. Ryan[10,11], Anna M. Stewart-Ibarra[14], Rachel Lowe[7,15,16]
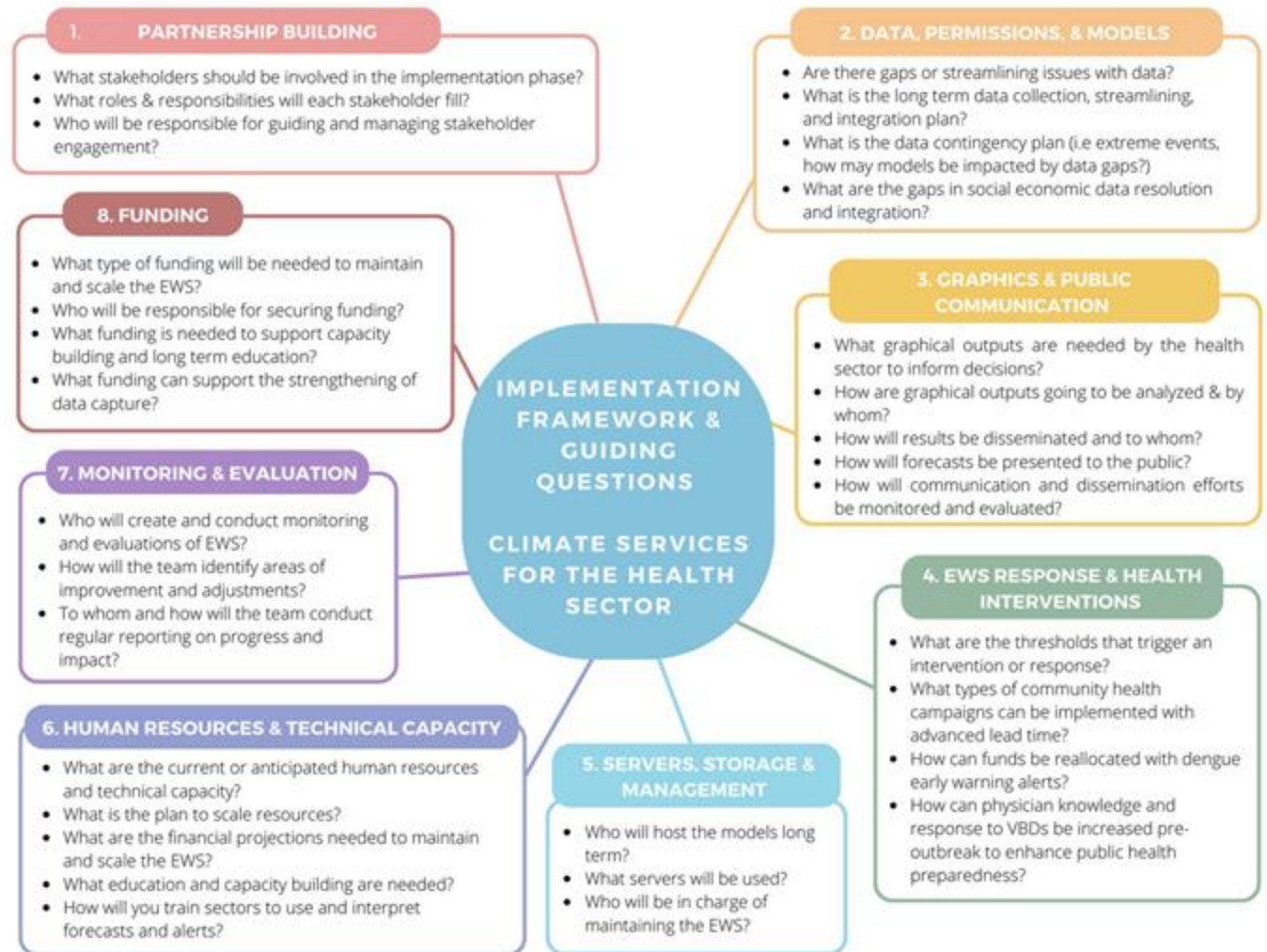
Fig 7. Visual representation of implementation framework and guiding questions for climate services for the health sector. See S1 Annex for extended list format.

https://doi.org/10.1371/journal.pclm.0000282.g007

# Ecosystem of Climate Services

## Climate Services Ecosystems: an opportunity to increase optimization

**Carmen Gonzalez Romero**, Angel G. Muñoz, Lisa Goddard, Asuncion Ledas St.Clair, Francisco Doblas- Reyes, Marta Terrado, and Dragana Bojovic

Barcelona Supercomputing Center, Barcelona, Spain (carmen.gonzalezromero@bsc.es)

González Romero et al., 2023. https://doi.org/10.5194/egusphere-egu23-14170.

## Climate Services Ecosystems: more bang for the bucks

Carmen González Romero[a,b]    Ángel G. Muñoz,[a]  Dragana Bojovic,[a]  Asunción Lera-St. Clair,[c,a]

Lisa Goddard[d] †

Gonzalez Romero, et al (2024). https://doi.org/10.5281/zenodo.13847725
Gonzalez Romero, et al (BAMS, sub judice).

## Ecosystems of Climate Services in Latin America: examples from Guatemala and Chile

Ángel G. Muñoz[1], **Carmen González Romero**[1], Alan García[2,3], Diego Campos[1], and Zain Alabweh[3]

[1]Barcelona Supercomputing Center, Earth Sciences, Barcelona, Spain (angel.g.munoz@bsc.es)
[2]Department of Earth and Environmental Sciences (DEES). Columbia University. New York, NY. USA
[3]The International Research Institute for Climate and Society (IRI). Climate School. Columbia University. New York, NY. USA

Muñoz et al., 2024 https://doi.org/10.5194/ems2024-965

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# Ecosystem of Climate Services

- **(Optimal) Orchestration of climate services**
- **Early warning systems**
- **Maximise resilience**
- **Context, monitoring, predictions, risk transfer**



**Dengue predictions**

Muñoz et al., (2020)



**Climate predictions in context**
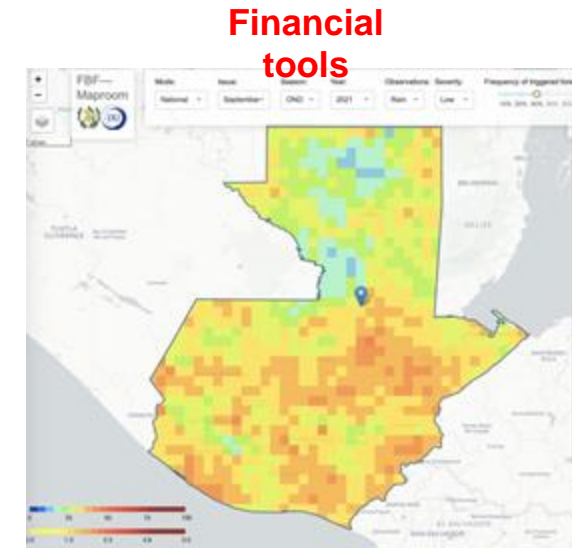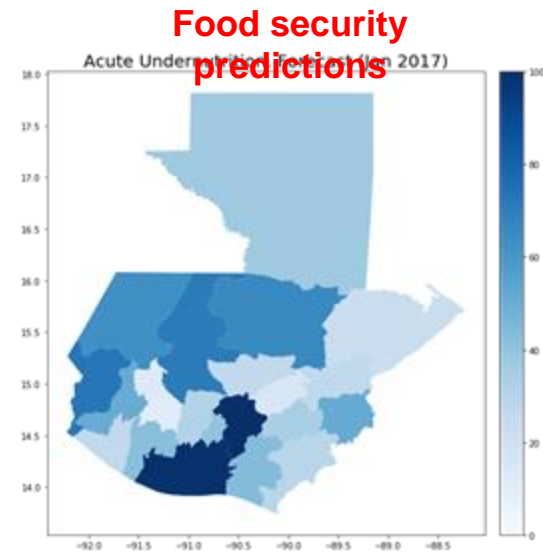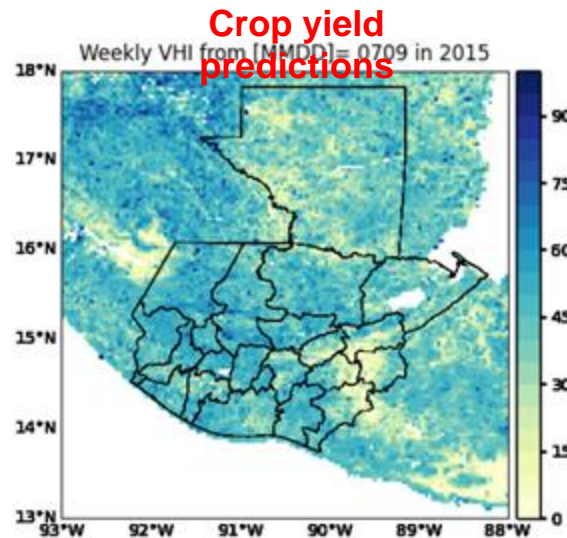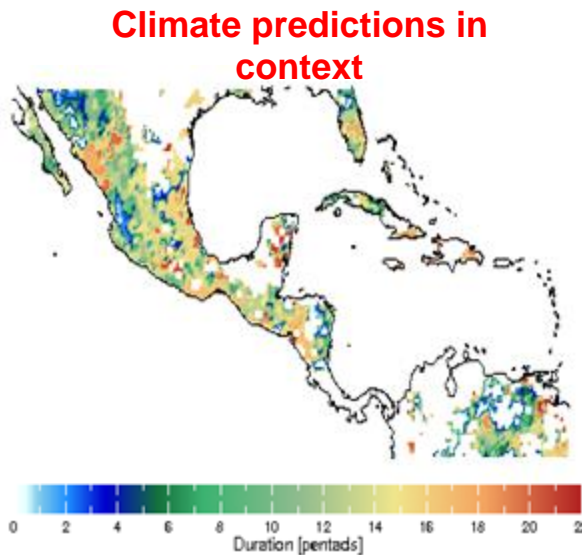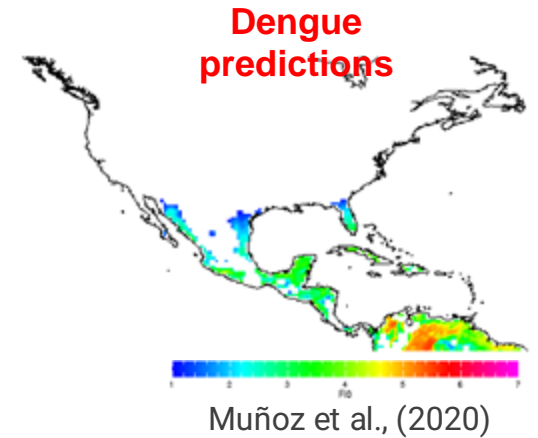
Rainfall, frequency of rainy days, onset, duration, demise, etc.
(Muñoz et al., 2019)



**Crop yield predictions**

Weekly VHI from [MMDD]= 0709 in 2015

Vegetation Index Health, crop yield (e.g coffee), etc.
(Pons et al., 2020)



**Food security predictions**

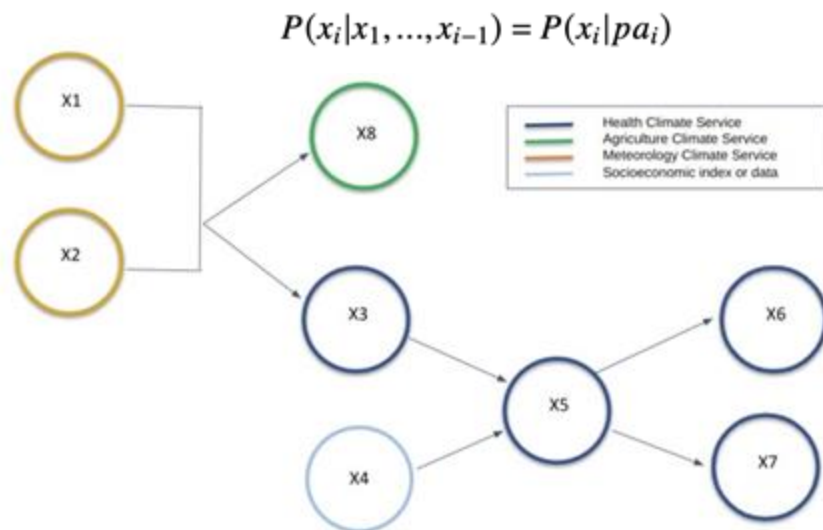Acute Undernutrition prediction (Jan 2017)

Acute undernutrition for kids under 5 yr
(González Romero et al., 2020; White et al., 2022)



**Financial tools**

Index-based Insurance, Forecast-based financing, Forecast-based Actions

ACToday (2022)

# Ecosystem of Climate Services



Fig. 5. Example of a simplified CSE involving health and agriculture. See Figure 5 and main text for details.
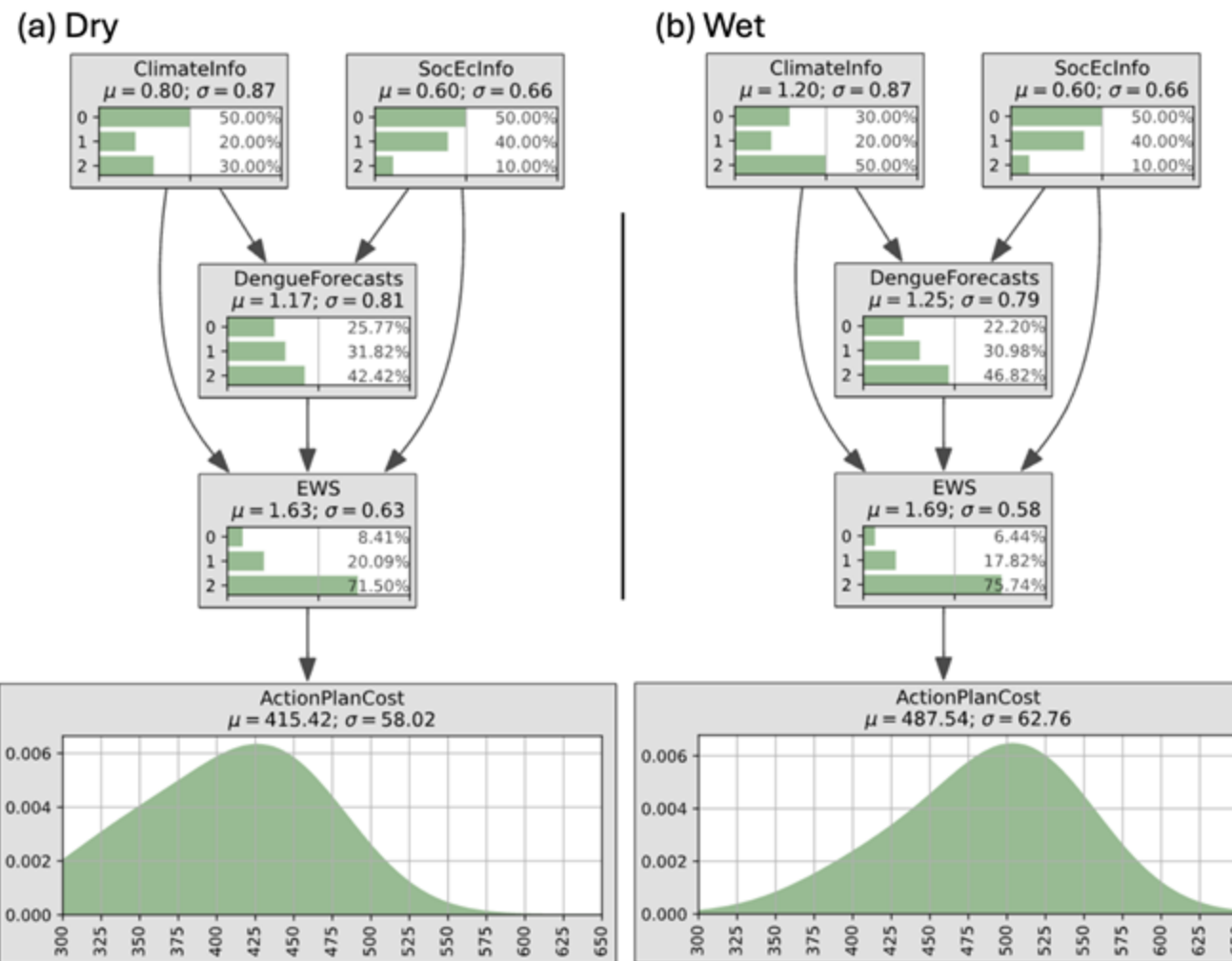
$$P(x_i|x_1, \ldots, x_{i-1}) = P(x_i|pa_i)$$

Legend:
- Health Climate Service
- Agriculture Climate Service
- Meteorology Climate Service
- Socioeconomic index or data

TABLE 2. Table with an example of the explanation of variables for a simplified CSE for health and agriculture.

$U_n$ represents the errors due to omitted factors and random errors.

| Sector | Node | Function | Description |
|---|---|---|---|
| Climate | $X_1$ | $X_1 = f_1(\text{seasonal model output}, U_1)$ | Seasonal forecast system for precipitation |
| Climate | $X_2$ | $X_2 = f_2(\text{subseasonal model output}, U_2)$ | Subseasonal forecast system for precipitation |
| Health | $X_3$ | $X_3 = f_3(X_1, X_2, U_3)$ | Dengue forecast system |
| Health | $X_4$ | $X_4 = f_4(\text{socioecon data}, U_4)$ | Socioeconomic index or data |
| Health | $X_5$ | $X_5 = f_5(X_3, X_4, U_5)$ | Early Warning System (EWS) |
| Health | $X_6$ | $X_6 = f_6(X_5, U_6)$ | Action-based protocol |
| Health | $X_7$ | $X_7 = f_7(X_5, U_7)$ | Climate and health bulletin |
| Agriculture | $X_8$ | $X_8 = f_8(X_1, X_2, U_8)$ | Index-based insurance |

c. Case study: How much those Priority Interventions cost? A cost assessment example

(a) Dry

ClimateInfo
$\mu = 0.80; \sigma = 0.87$
| 0 | 50.00% |
| 1 | 20.00% |
| 2 | 30.00% |

SocEcInfo
$\mu = 0.60; \sigma = 0.66$
| 0 | 50.00% |
| 1 | 40.00% |
| 2 | 10.00% |

DengueForecasts
$\mu = 1.17; \sigma = 0.81$
| 0 | 25.77% |
| 1 | 31.82% |
| 2 | 42.42% |

EWS
$\mu = 1.63; \sigma = 0.63$
| 0 | 8.41% |
| 1 | 20.09% |
| 2 | 71.50% |

ActionPlanCost
$\mu = 415.42; \sigma = 58.02$

(b) Wet

ClimateInfo
$\mu = 1.20; \sigma = 0.87$
| 0 | 30.00% |
| 1 | 20.00% |
| 2 | 50.00% |

SocEcInfo
$\mu = 0.60; \sigma = 0.66$
| 0 | 50.00% |
| 1 | 40.00% |
| 2 | 10.00% |

DengueForecasts
$\mu = 1.25; \sigma = 0.79$
| 0 | 22.20% |
| 1 | 30.98% |
| 2 | 46.82% |

EWS
$\mu = 1.69; \sigma = 0.58$
| 0 | 6.44% |
| 1 | 17.82% |
| 2 | 75.74% |

ActionPlanCost
$\mu = 487.54; \sigma = 62.76$

# Financial Climate Services



Sheetal Saklani

Nadia Milders

Pedro Reca



'Ready-Set-Go!" optimisation: Towards an ecosystem of cross-timescale financial services to transfer climate risk

Ángel G. Muñoz, **Sheetal Saklani**, Carmen González Romero, and Albert Soret

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Muñoz et al., 2024 https://doi.org/10.5194/ems2024-885



PIISA

Piloting Innovative Insurance Solutions for Adaptation

# Financial Climate Services
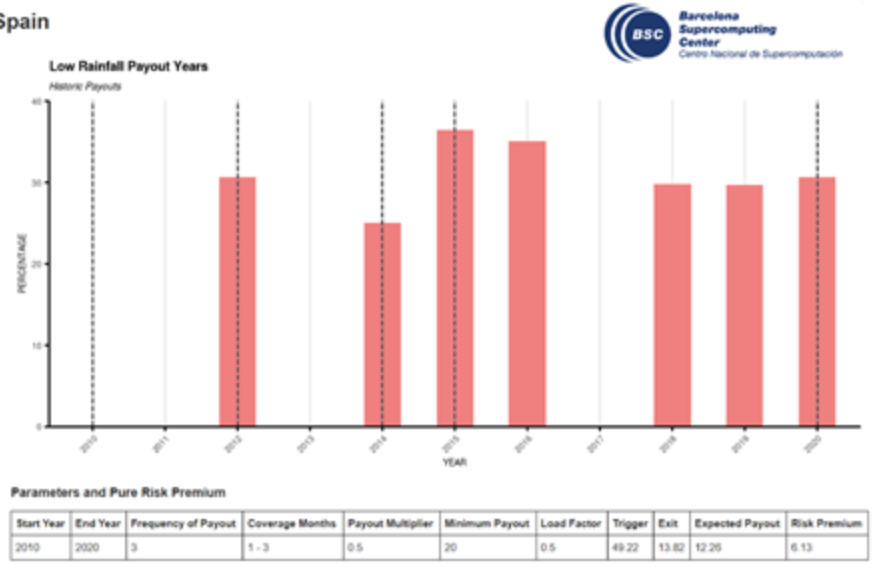


Parametric Insurance for Olive Farmers in Spain

Index-based insurance instrument co-design tool

Sheetal Saklani

Nadia Milders

Pedro Reca

"Ready-Set-Go!" optimisation: Towards an ecosystem of cross-timescale financial services to transfer climate risk

Ángel G. Muñoz, **Sheetal Saklani**, Carmen González Romero, and Albert Soret
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Muñoz et al., 2024 https://doi.org/10.5194/ems2024-885

PIISA
Piloting Innovative Insurance Solutions for Adaptation

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