HEPEX WORKSHOP 2023
Forecasting across spatial scales and time horizons
Norrköping, Sweden

SONICS: A novel in-house development system for detection and forecasting potential river floods in Peru

Harold Llauca[1], Karen Leon[1], Waldo Lavado[1] & Oscar Felipe[1]

[1]**National Service of Meteorology and Hydrology of Peru (SENAMHI)**

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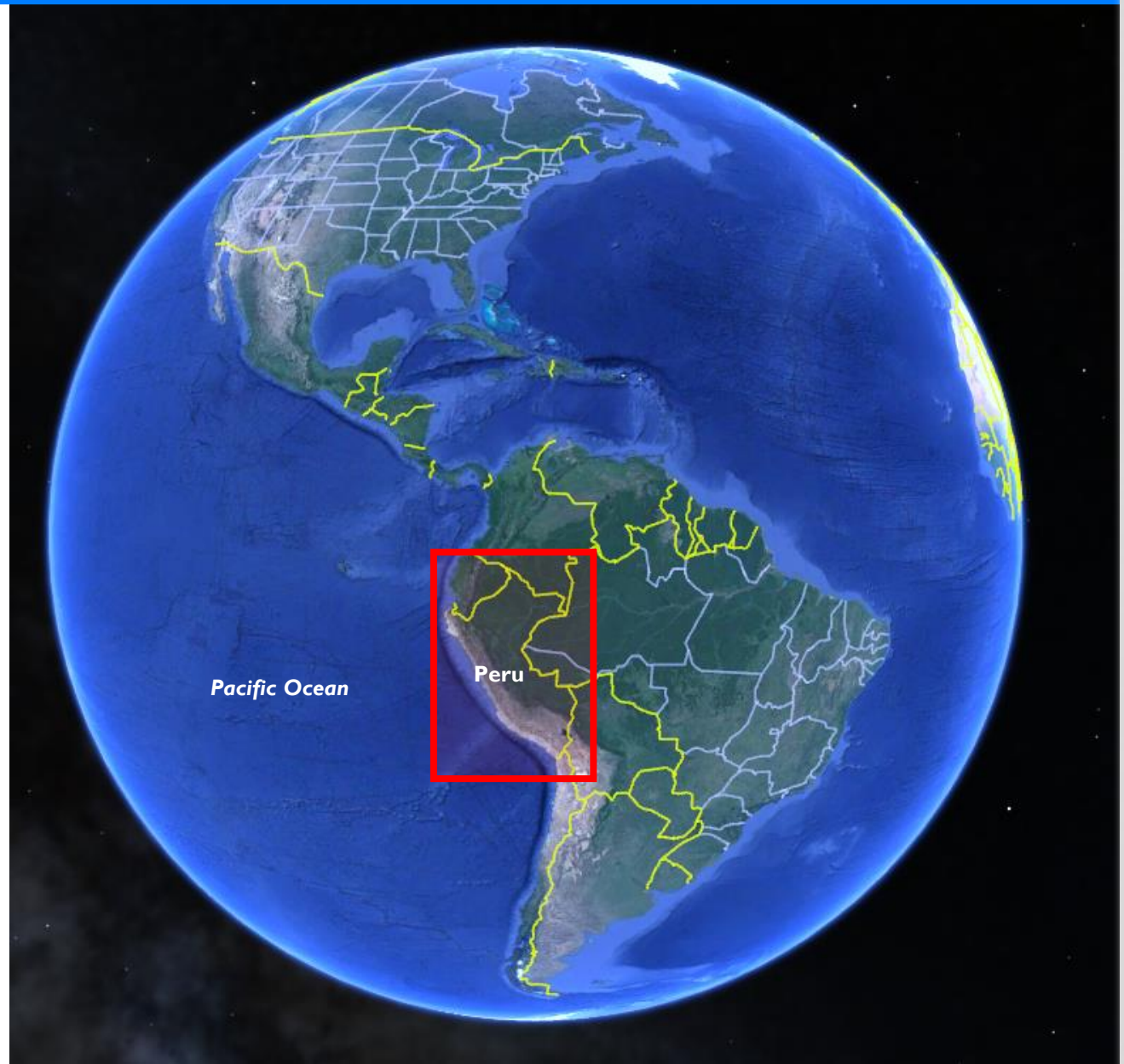
September 2023

PERU beyond Machu Picchu…

West coast of South America



Miguel Valenzuela (2021)

The Andes Cordillera

33.72 Million people

1.285 Million km²

Hydrological Hazards (HZ) in a very heterogeneous country

38 climates

SENAMHI (2020)

Atlantic

97.27%

03 Main drainages areas

2.18%

Pacific

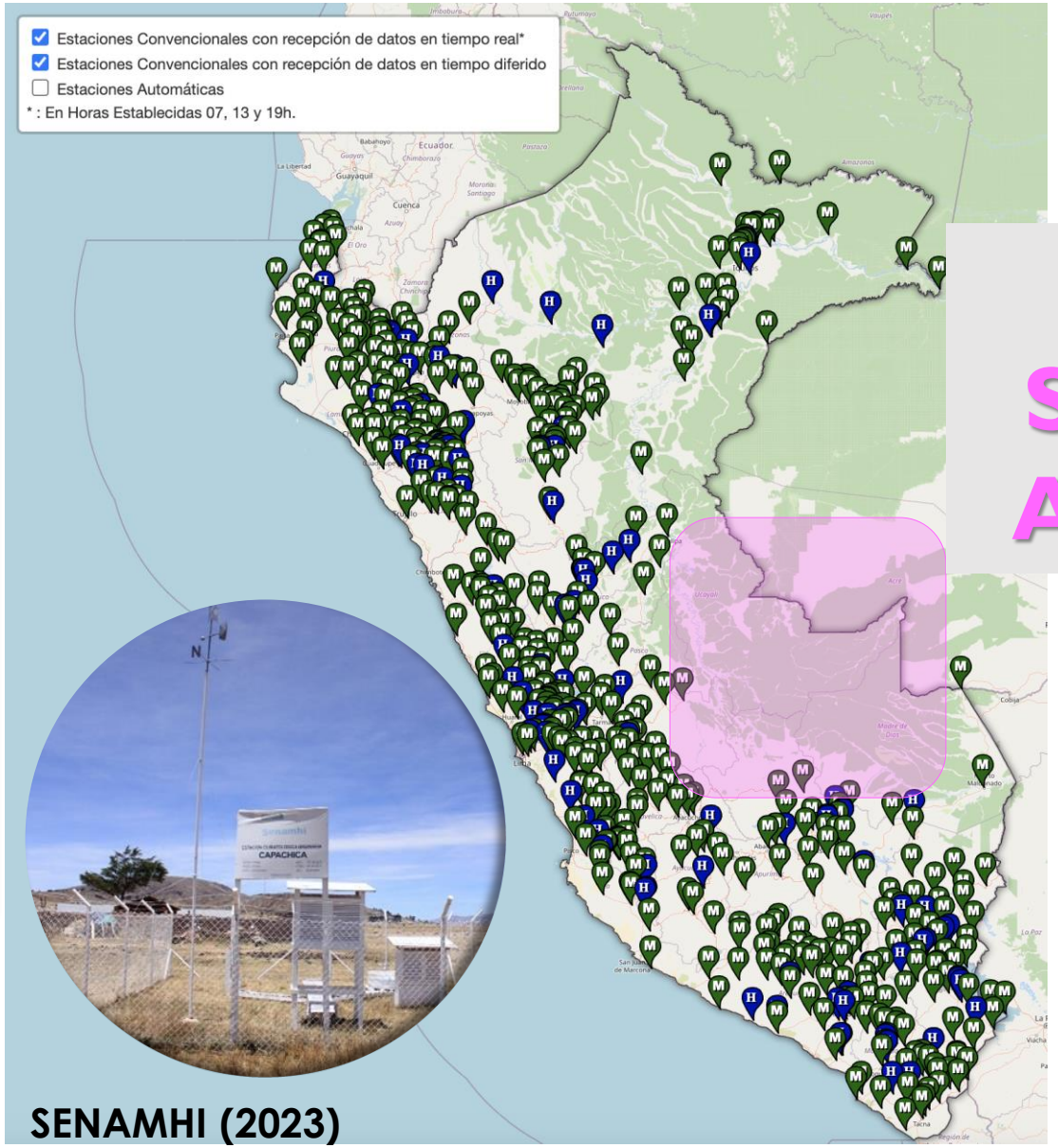
Titicaca

0.56%

Floods in the Northwest Coast of Peru (**March 2023**)

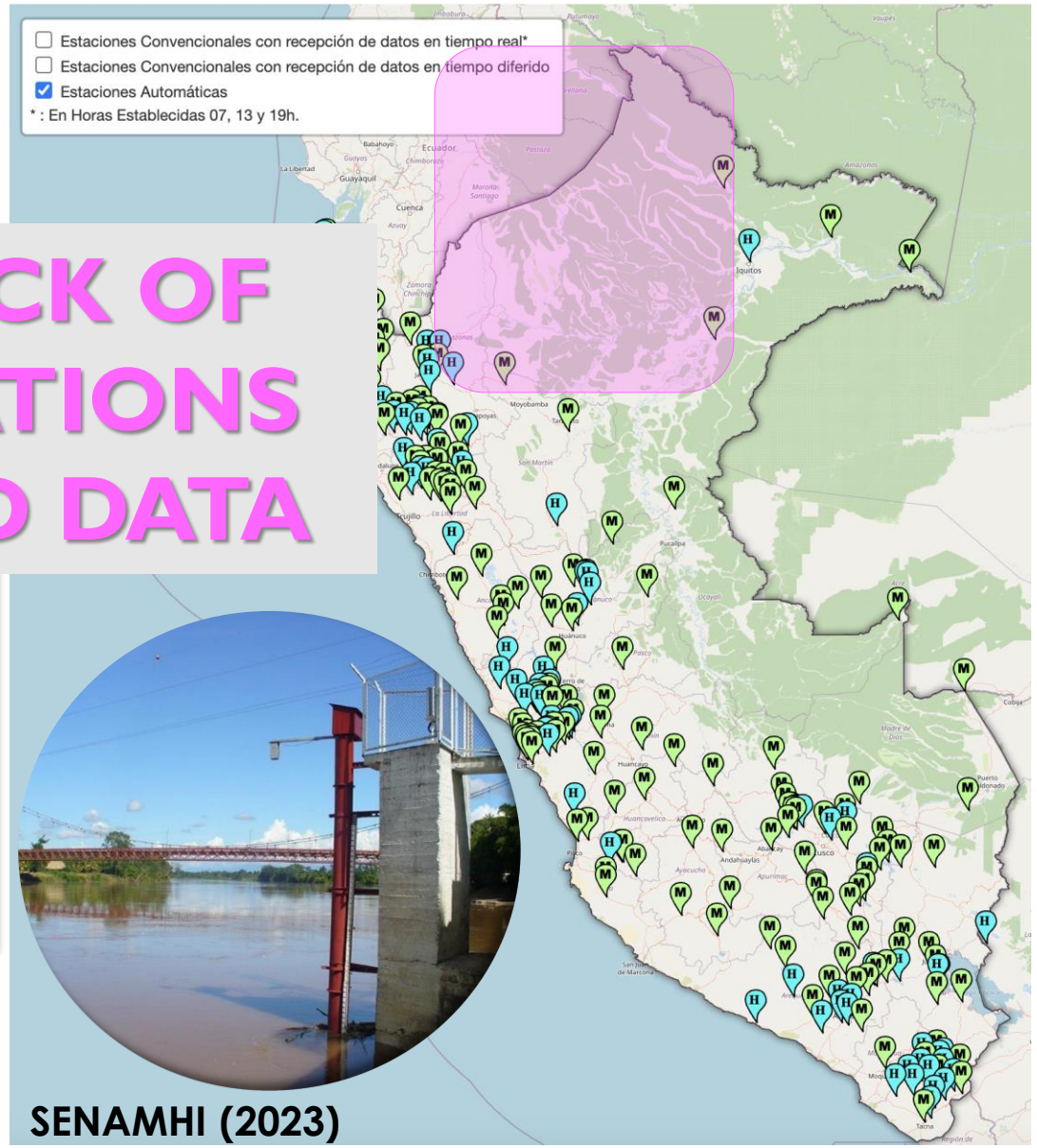
Monitoring HZ in a data-scarcity context

Conventional stations



LACK OF STATIONS AND DATA

Automatic

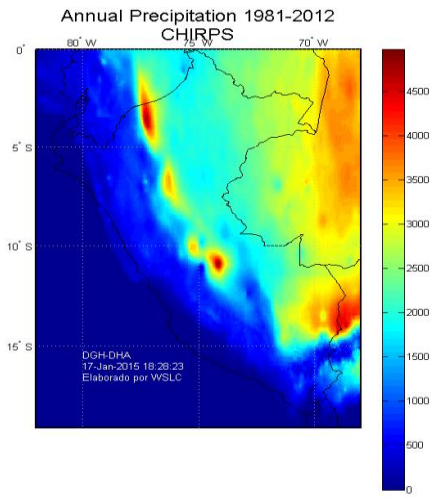


Building new hydrometeorological gridded data

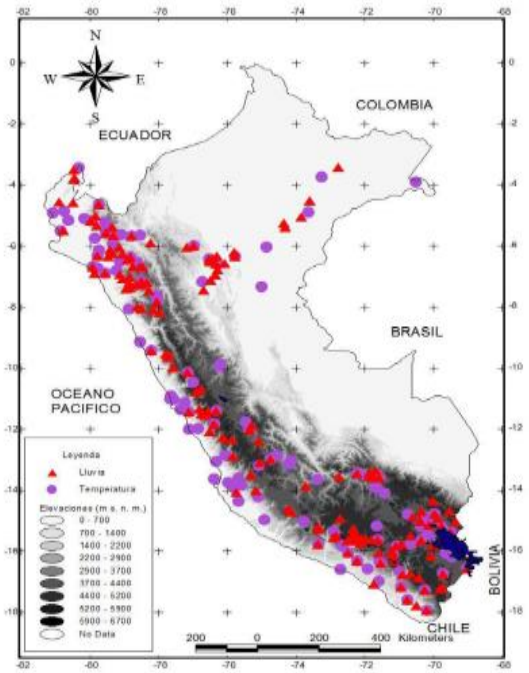
PISCO

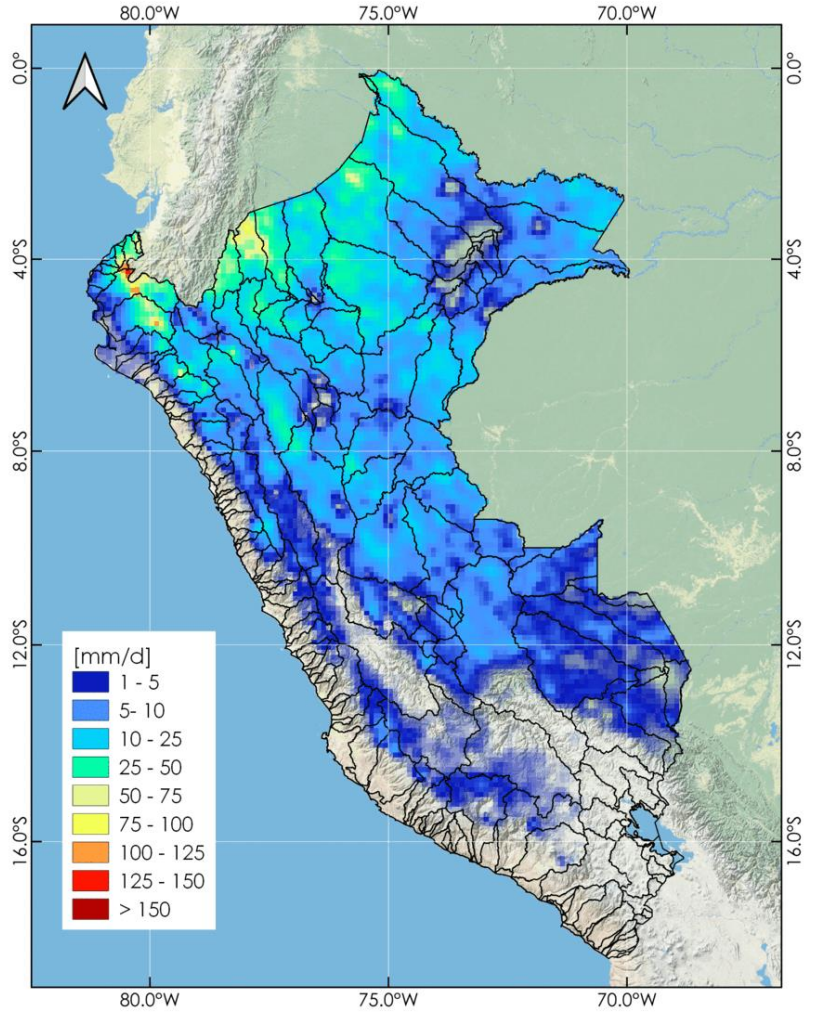
Peruvian Interpolated data of SENAMHI's Climatological and Hydrological Observations

~ 10 km



MERGING





- Precipitation (pr), Maximum (tx) and minimum (tn) air temperature, Potential evapotranspiration (pe).
- Daily and monthly time steps. Preparing hourly products.
- Dynamic versions → PISCOpr v2.1, PISCOtx v 1.2, PISCOtn v1.2 and PISCOpe v1.2

Some PISCO related papers (from SENAMHI's research group)

HYDROLOGICAL SCIENCES JOURNAL
2020, VOL. 65, NO. 5, 770–785
https://doi.org/10.1080/02626667.2019.1649411

IAHS AISH

Taylor & Francis
Taylor & Francis Group

SPECIAL ISSUE: HYDROLOGICAL DATA: OPPORTUNITIES AND BARRIERS

Check for updates

Construction of a high-resolution gridded rainfall dataset for Peru from 1981 to the present day

Cesar Aybar[a], Carlos Fernández[a,b], Adrian Huerta[a], Waldo Lavado[a], Fiorella Vega[a] and Oscar Felipe-Obando[a]

[a]Servicio de Meteorología e Hidrología del Perú (SENAMHI), Dirección de Hidrología, Lima, Perú; [b]Potsdam Institute for Climate Impact Research, Potsdam, Germany

scientific data

Check for updates

OPEN

DATA DESCRIPTOR

PISCOeo_pm, a reference evapotranspiration gridded database based on FAO Penman-Monteith in Peru

Adrian Huerta[1], Vivien Bonnesoeur[2,3], José Cuadros-Adriazola[2,3,4], Leonardo Gutierrez[1], Boris F. Ochoa-Tocachi[3,4,5,6], Francisco Román-Dañobeytia[2,3] & Waldo Lavado-Casimiro[1]

Nat. Hazards Earth Syst. Sci., 23, 1191–1206, 2023
https://doi.org/10.5194/nhess-23-1191-2023

Natural Hazards and Earth System Sciences — Open Access — EGU

Rainfall thresholds estimation for shallow landslides in Peru from gridded daily data

Carlos Millán-Arancibia[1,2] and Waldo Lavado-Casimiro[1,2]

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[2]Department of Water Resources, Universidad Nacional Agraria La Molina (UNALM), Lima 15012, Peru

water

MDPI

Article

PISCO_HyM_GR2M: A Model of Monthly Water Balance in Peru (1981–2020)

Harold Llauca [1,*], Waldo Lavado-Casimiro [1], Cristian Montesinos [1], William Santini [2] and Pedro Rau [3]

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[2] Laboratoire GET (IRD, CNRS, UPS, CNES), Institut de Recherche pour le Développement, 31400 Toulouse, France; william.santini@ird.fr
[3] Centro de Investigación y Tecnología del Agua (CITA), Departamento de Ingeniería Ambiental, Universidad de Ingeniería y Tecnología (UTEC), Lima 15063, Peru; prau@utec.edu.pe
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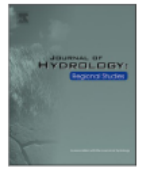

Construction of a daily streamflow dataset for Peru using a similarity-based regionalization approach and a hybrid hydrological modeling framework

Harold Llauca*, Karen Leon, Waldo Lavado-Casimiro

National Service of Meteorology and Hydrology of Peru, Lima 15072, Peru

The new PISCO_HyD_ARNOVIC dataset

Journal of Hydrology: Regional Studies 47 (2023) 101381

Contents lists available at ScienceDirect

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Construction of a daily streamflow dataset for Peru using a similarity-based regionalization approach and a hybrid hydrological modeling framework

Harold Llauca *, Karen Leon, Waldo Lavado-Casimiro

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ARTICLE INFO

Keywords:
Peru
Hydrological regionalization
National hydrological modeling
PISCO dataset

ABSTRACT

Study region: A total of 11,913 sub-catchments in Peru and transboundary catchments with neighboring countries in South America.
Study focus: This paper aims to develop a national hydrological model using physiographic and climatic characteristics to identify donor and receptor sub-catchments (sub-zones). Therefore, we use the hydrometeorological PISCO dataset (0.1° x 0.1°) to drive a sub-catchment conceptual rainfall-runoff (ARNO/VIC) model and a river-routing (RAPID) model in thousands of river reaches. We identify 43 hydrological zones (with 122 sub-zones) to run the hybrid hydrological modeling framework (ARNO/VIC | RAPID) with previously calibrated and validated parameters with 43 fluviometric stations for 1981–2020. Simulated flow series show a higher performance at daily scale (KGE ≥ 0.75, NSEsqrt ≥ 0.65, MARE ≤ 1, and −25% ≤ PBIAS ≤ 25%) for catchments located at the Pacific coast and the Andes-Amazon transition, and good representation (R≥0.75) of seasonal and interannual variability.
New hydrological insights for the region: Increasing hydrological hazards such as floods highlight the importance of a systematic hydrological analysis and modeling at national level in gauged and ungauged catchments in Peru. This study introduces a new hydrological dataset of simulated daily flow series. The results are helpful for short-term flood risk scenario simulations and long-term water resource planning as the outcomes can provide valuable information for hydrologists and water resource managers in Peruvian regions with limited or no access to in-situ networks.

11913

Sub-catchments and river reaches

43

Fluviometric stations

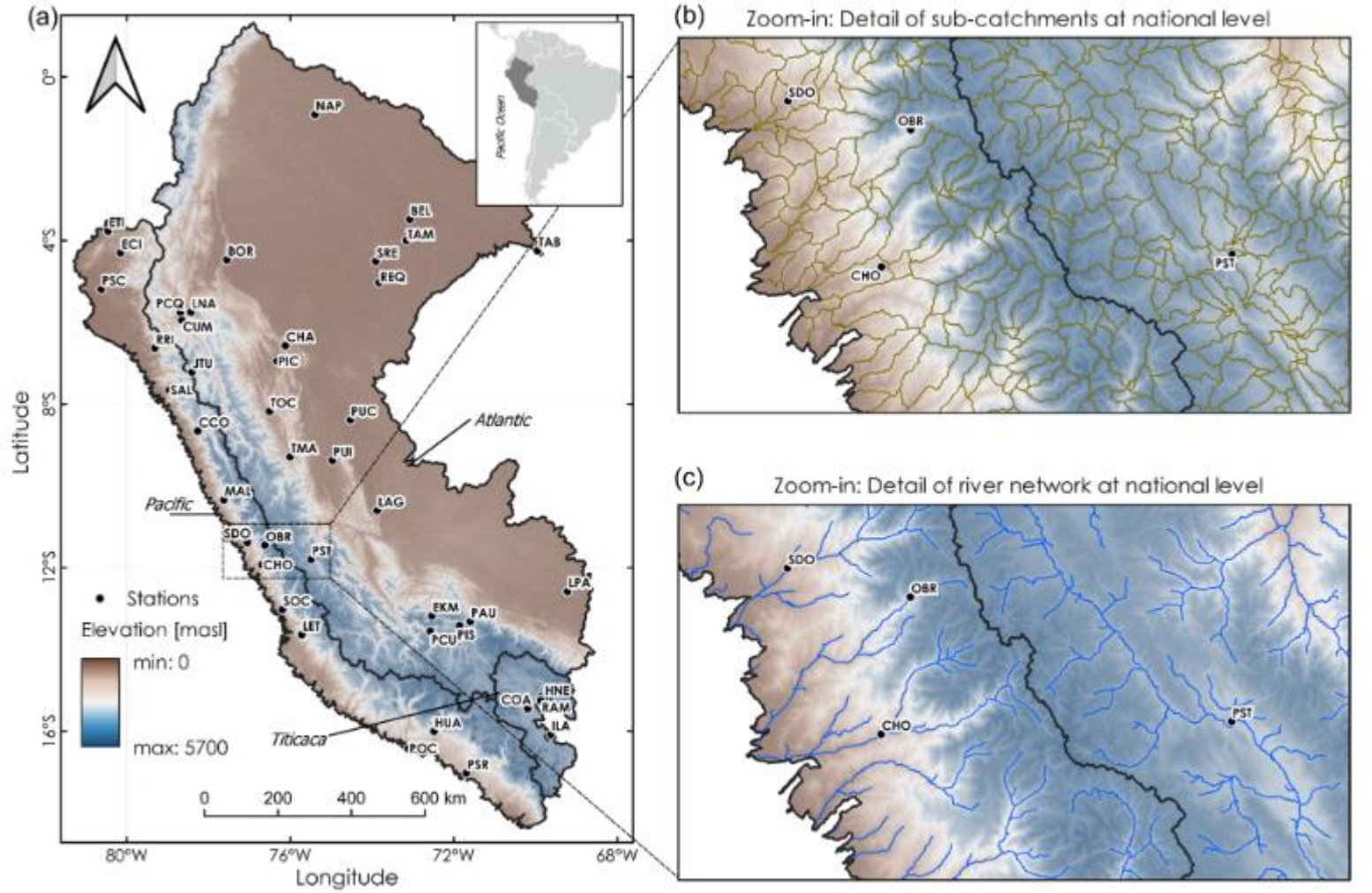


Fig. 1. (a) Study domain boundaries that consider all catchments in the Pacific, Atlantic, and Titicaca slopes in Peru, and transboundary catchments with neighbors' countries. Fluviometric stations are shown on the map as black dots. Zoom-in panels show (b) detail of sub-catchments employed for rainfall-runoff modeling, and (c) the river network used for river routing modeling.

Llauca et al. (2023)

The new PISCO_HyD_ARNOVIC dataset

National hydrological modeling using the ARNOVIC+RAPID modeling framework

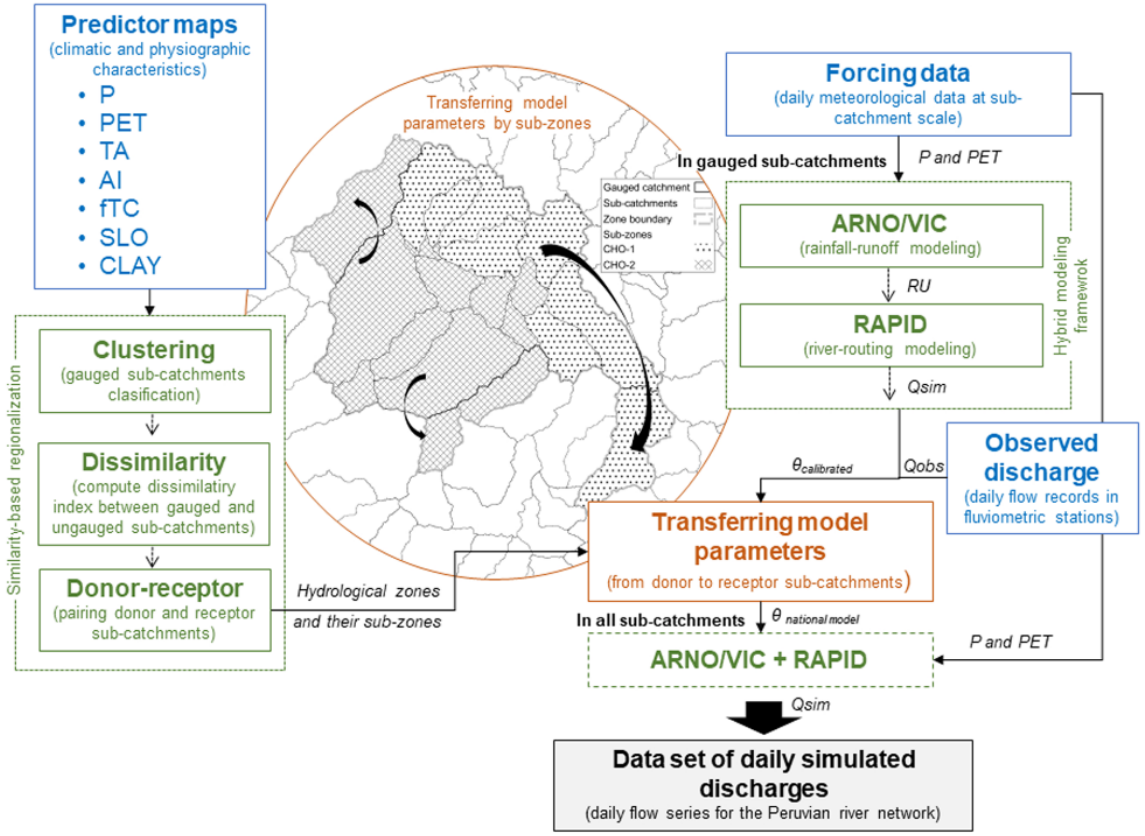
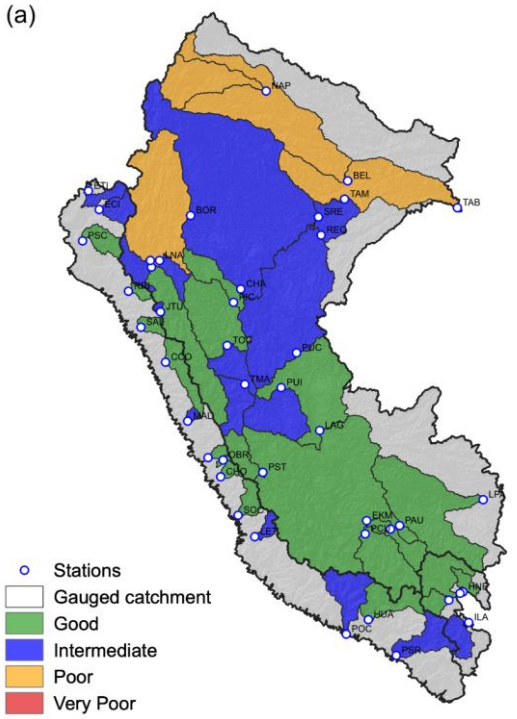
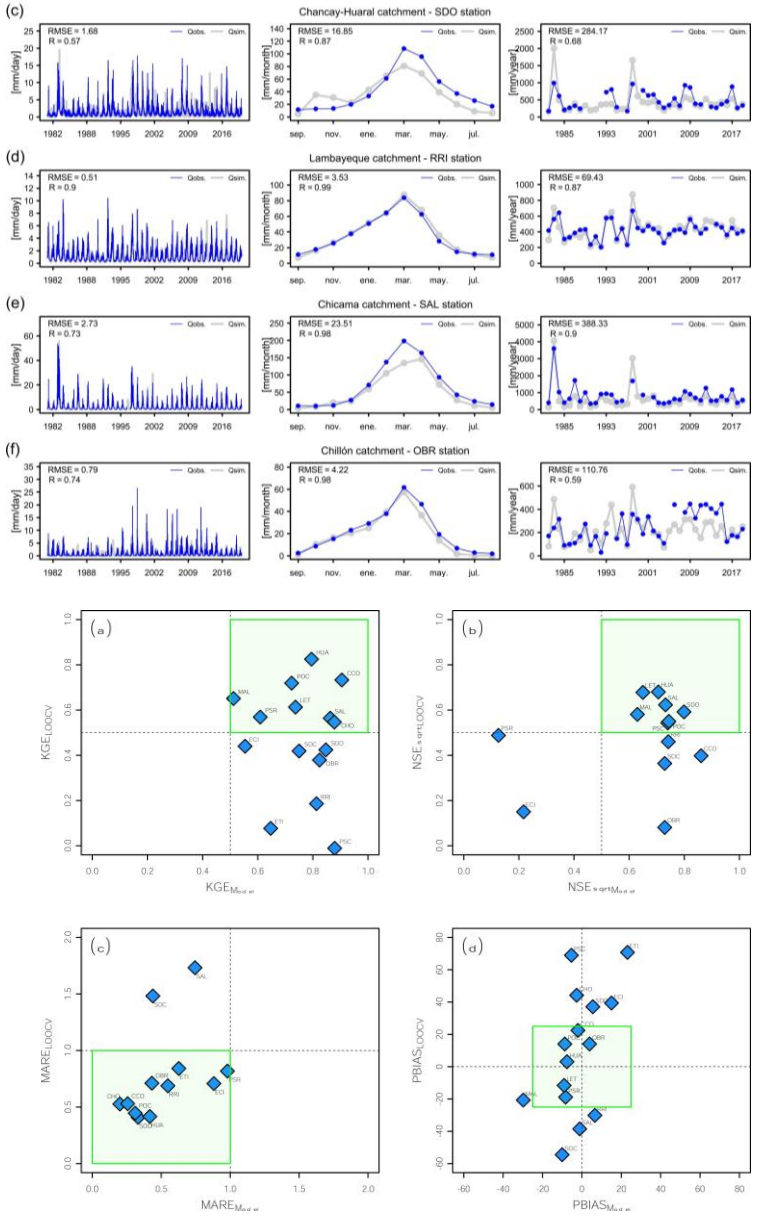


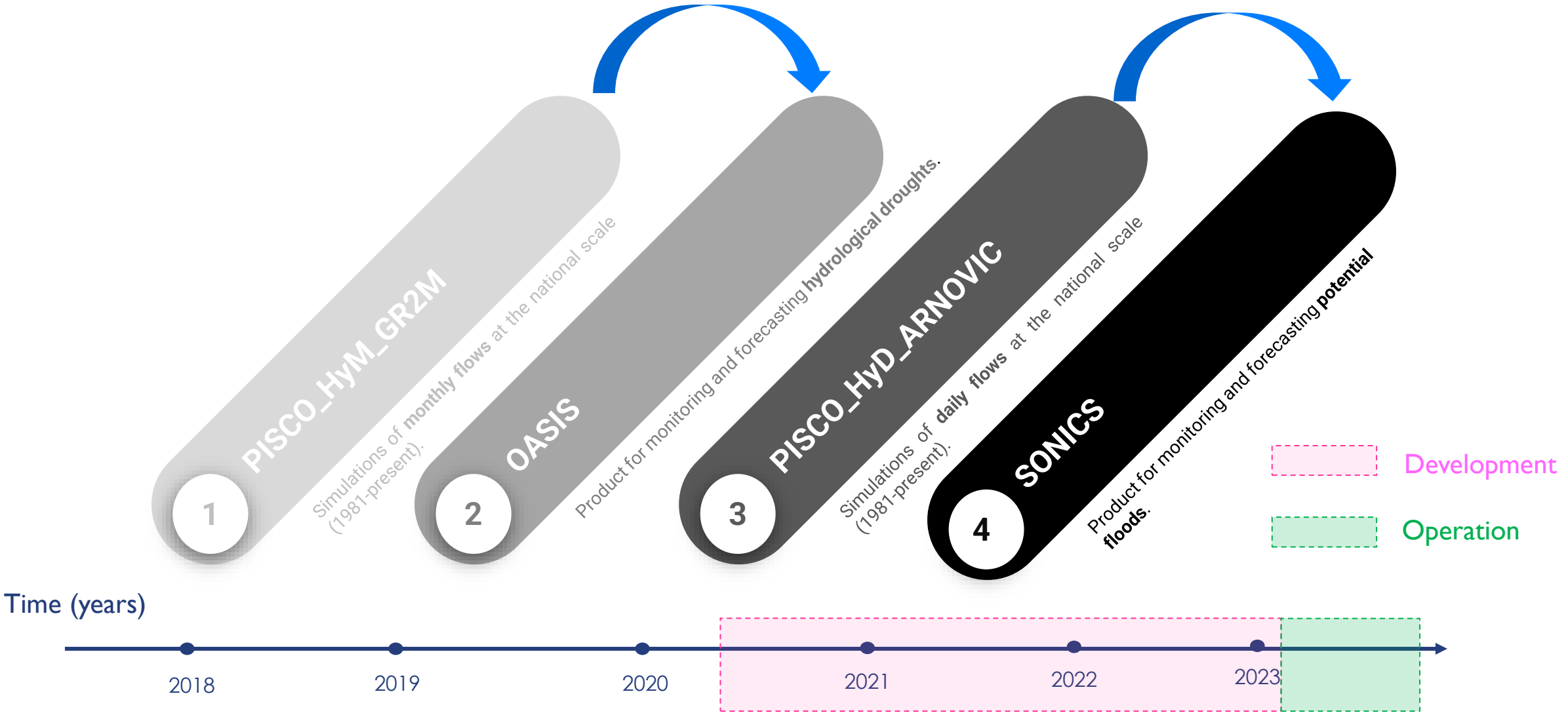
Fig. 2. Framework for the sub-catchment national simulation of daily flow series applying a similarity-based regionalization to identify hydrological zones and sub-zones, and a hybrid modeling framework for parameter calibration and streamflow simulation across the whole Peruvian river network. P: precipitation; PET: potential evapotranspiration; TA: air temperature; AI: aridity index; SLO: surface slope; CLAY: soil clay content; fTC: fraction of tree cover; RU: runoff; Qsim: simulated streamflow; Qobs: observed streamflow; θ: model parameters.





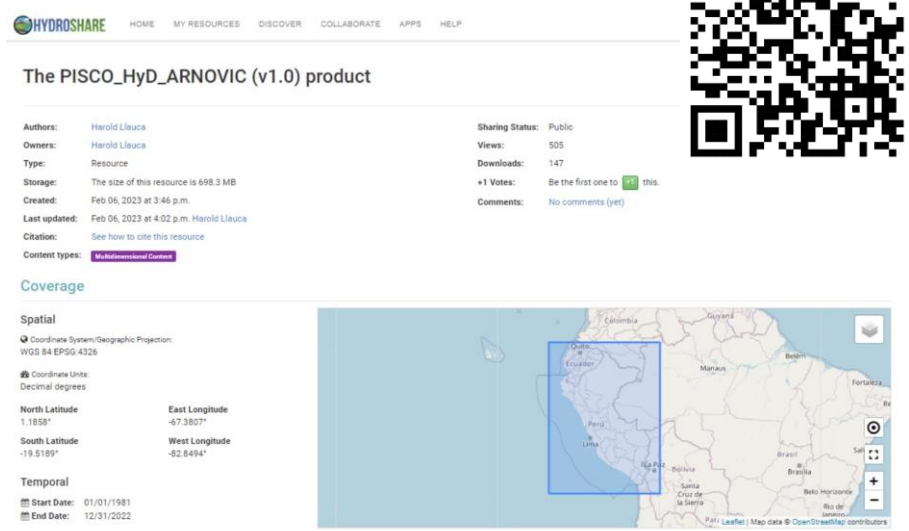
Llauca et al. (2023)

National hydrological simulations and products

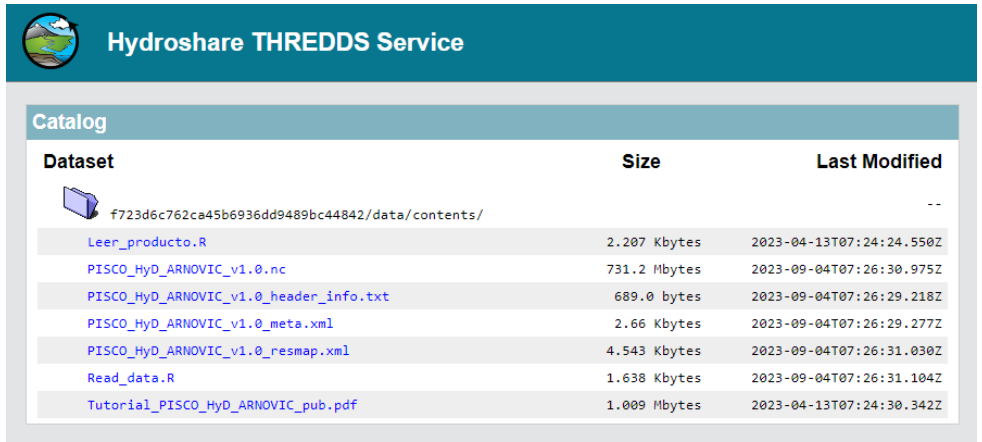


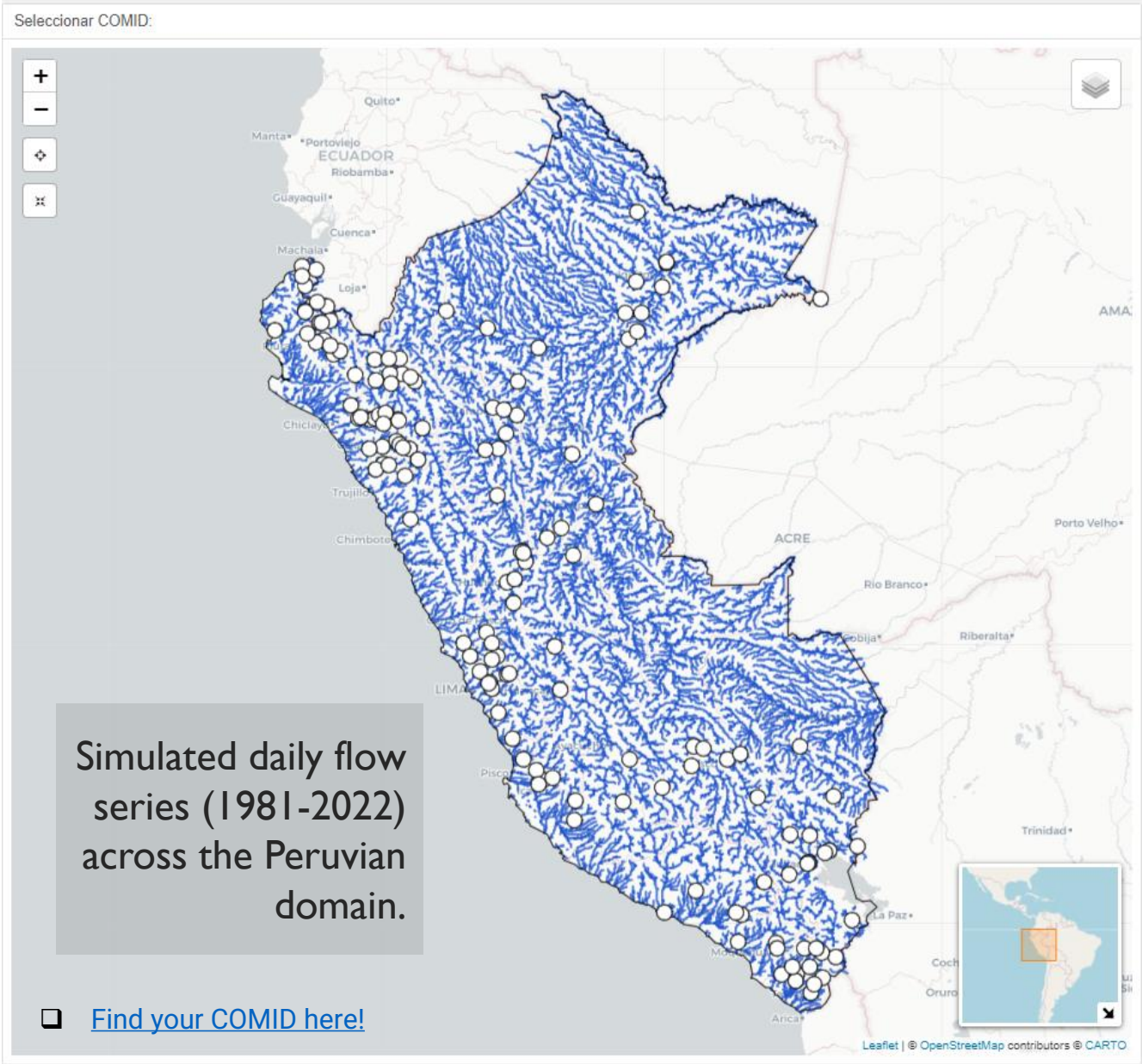
How accessing to the PISCO_HyD_ARNOVIC dataset?

- HYDROSHARE



- Thredds Data Service

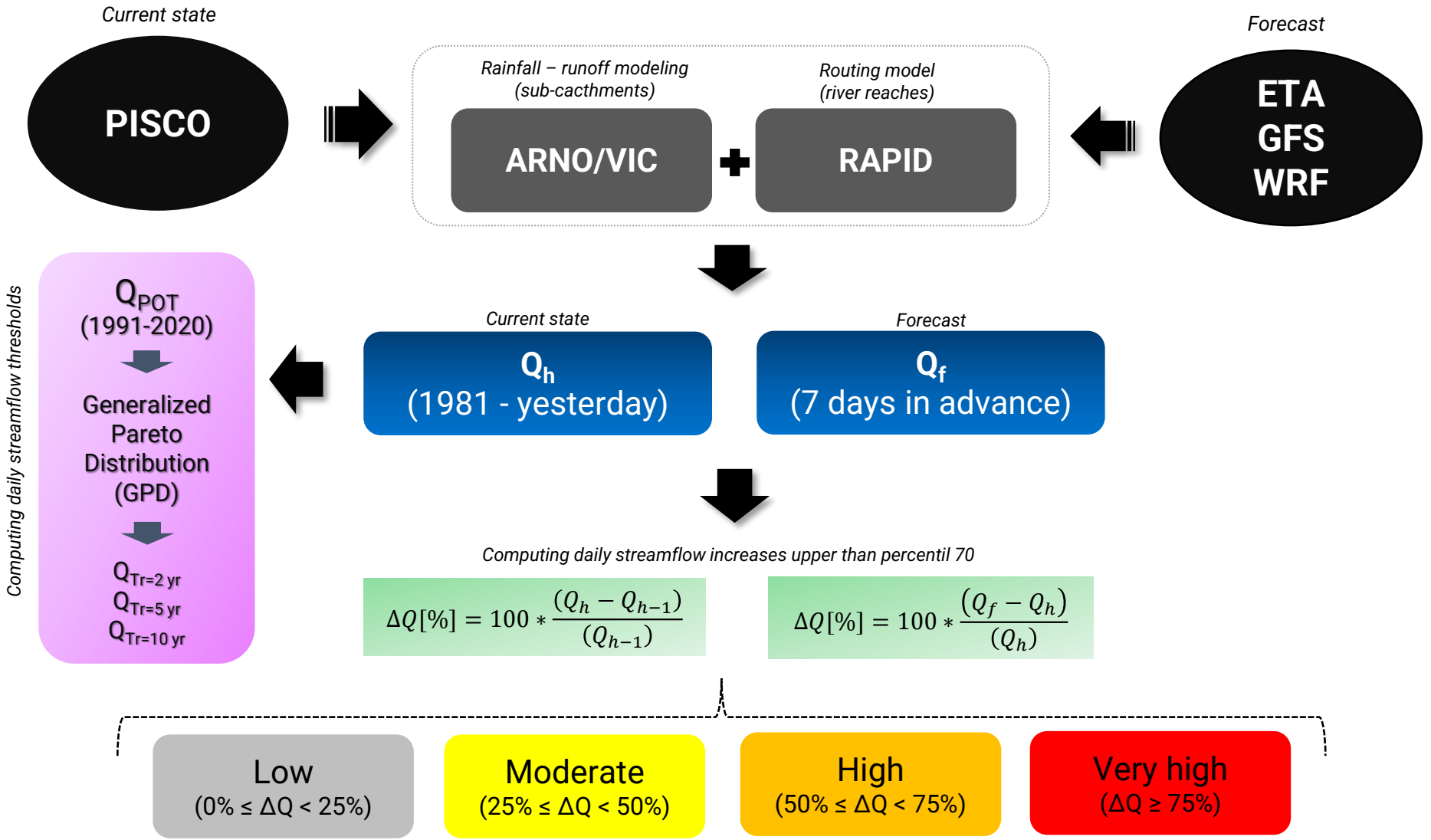




Simulated daily flow series (1981-2022) across the Peruvian domain.

- Find your COMID here!

The SONICS framework



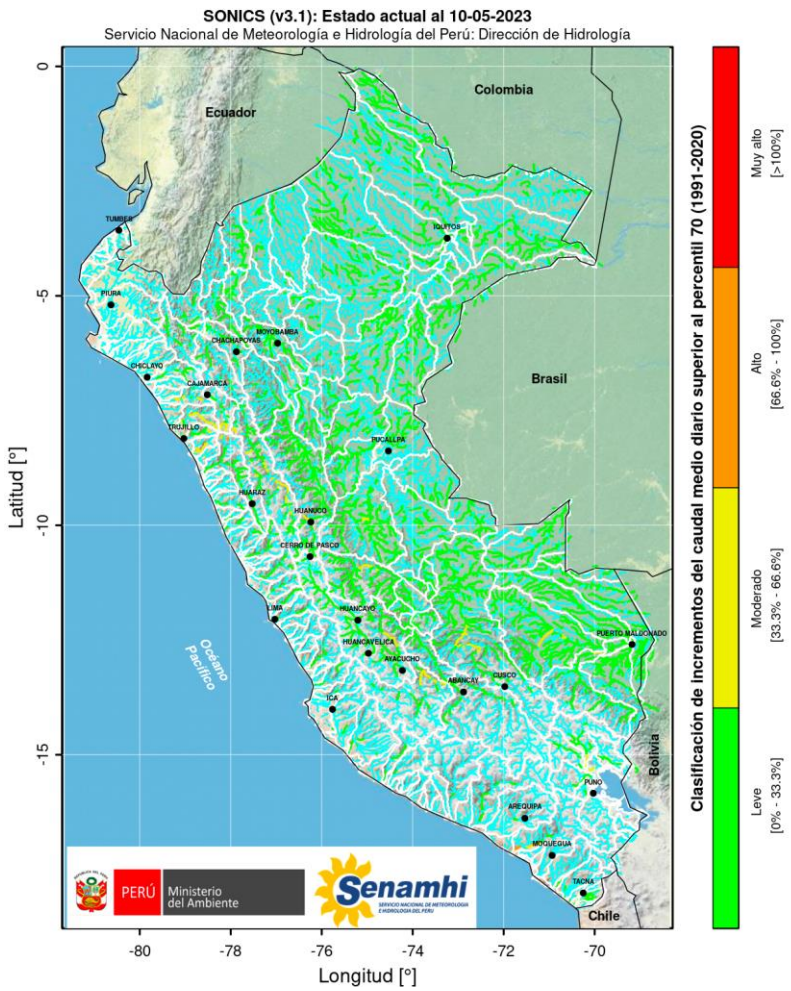
Llauca et al. (in prep)

River flood forecasting with SONICS

Daily flow simulations at the current state and forecasts (from 1 to 7 days)

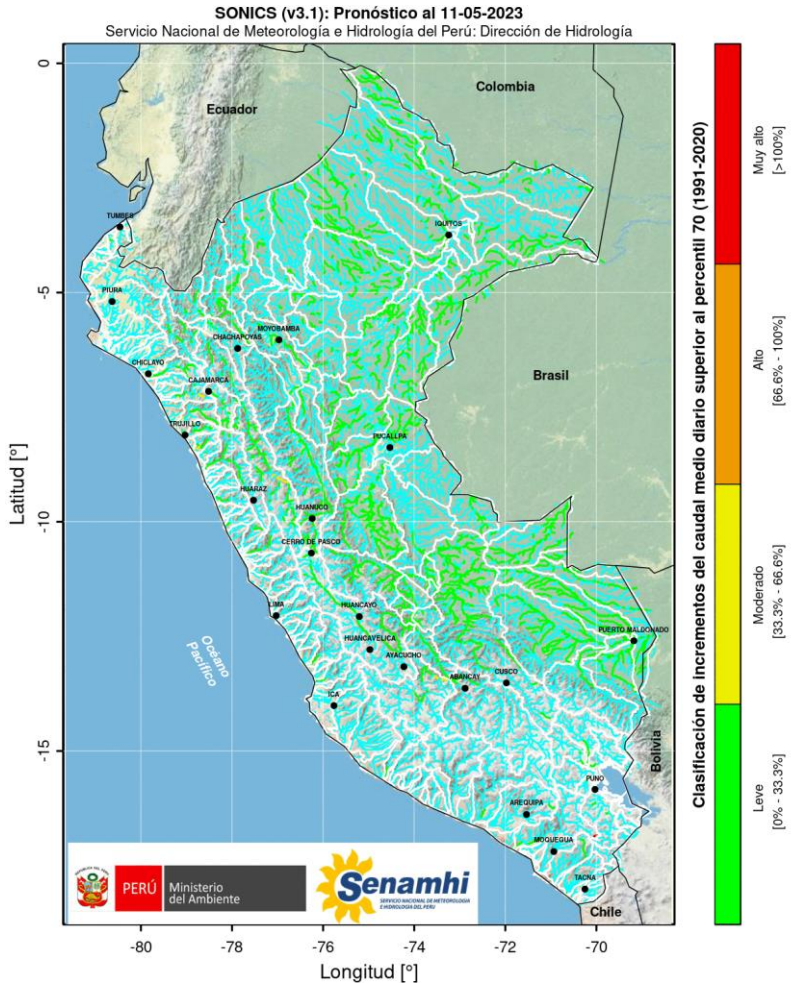
Current state

Yesterday



Forecasting

Today → Day 7



Llauca et al. (in prep)

SONICS as a climate service for river flood forecasting

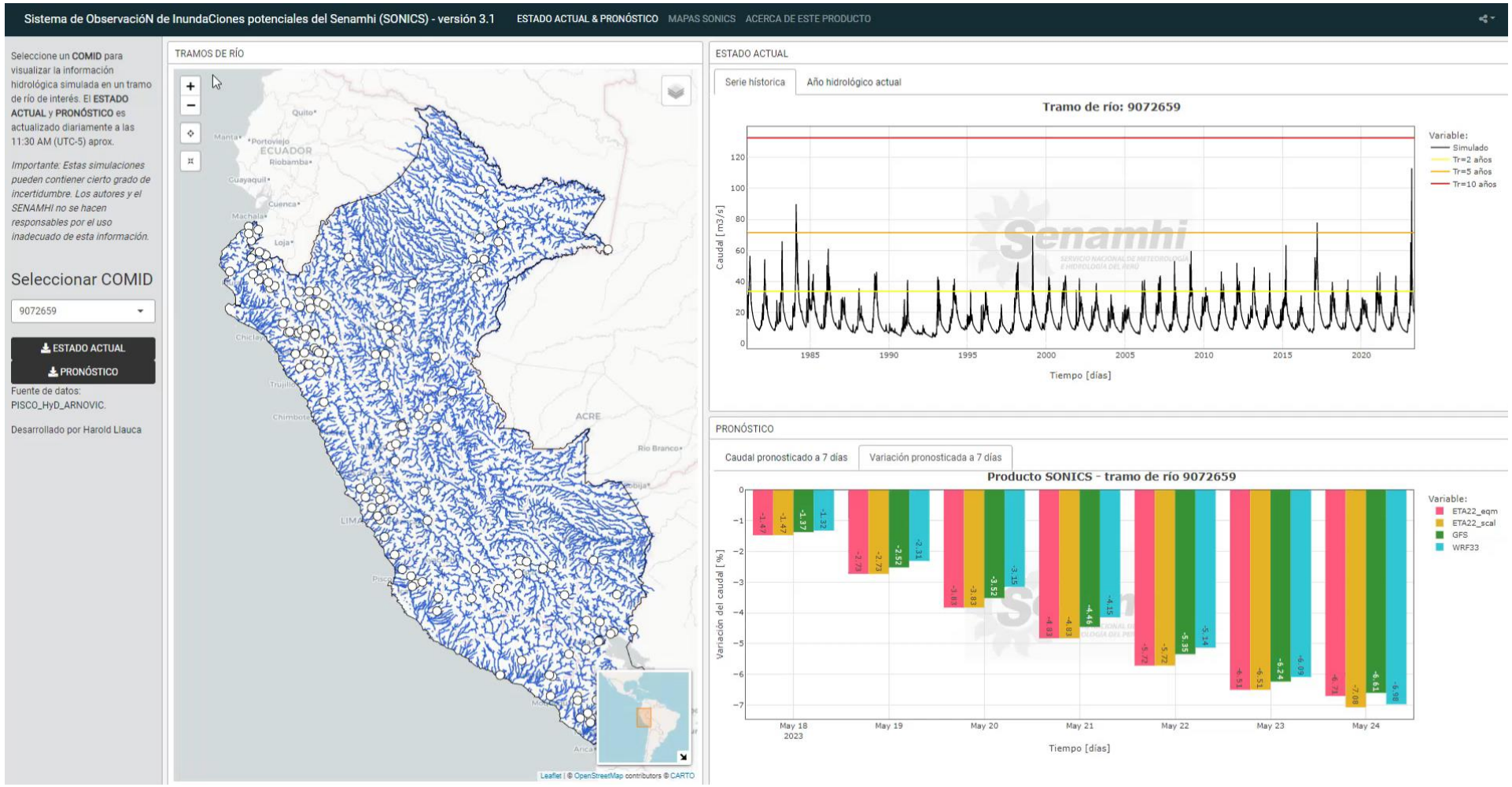
Open-source software

Future developments

Automatic reports

Interactive service

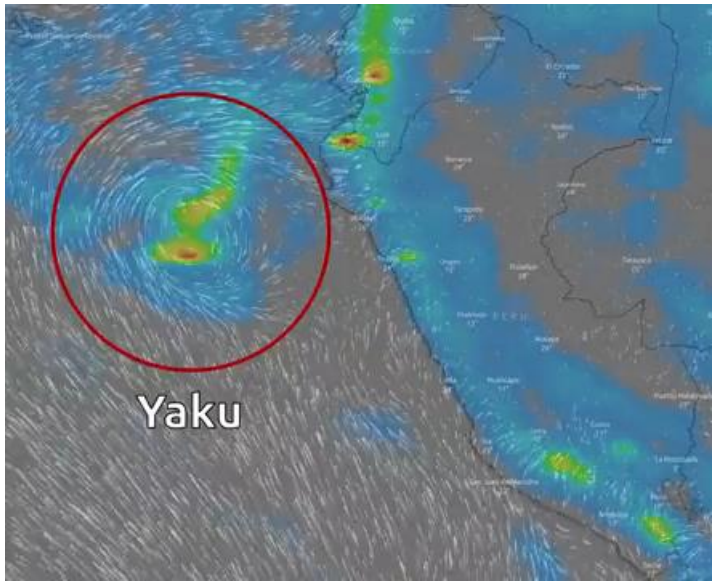
The interactive dashboard and the near future SONICS service



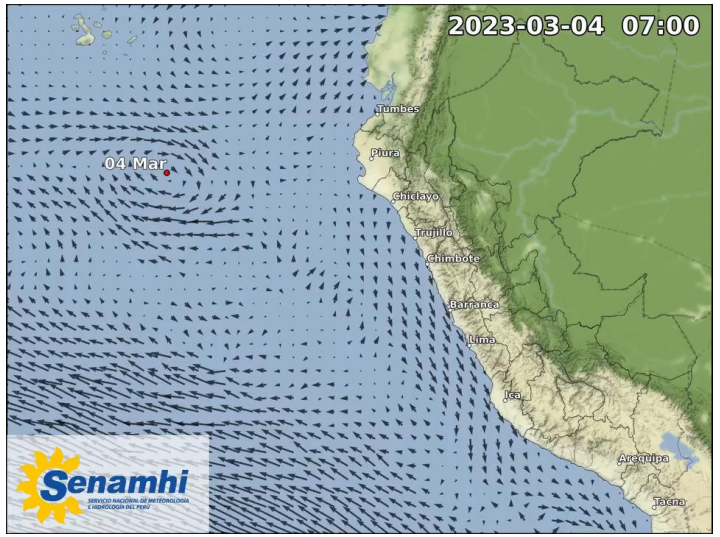
Llauca et al. (in prep)

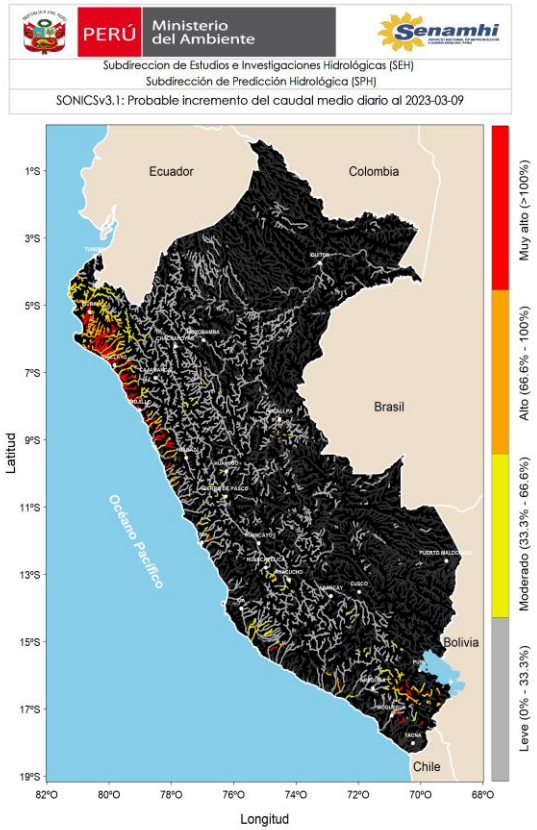
SONICS application during March 2023

River flood forecasting during the unusual “Yaku” event

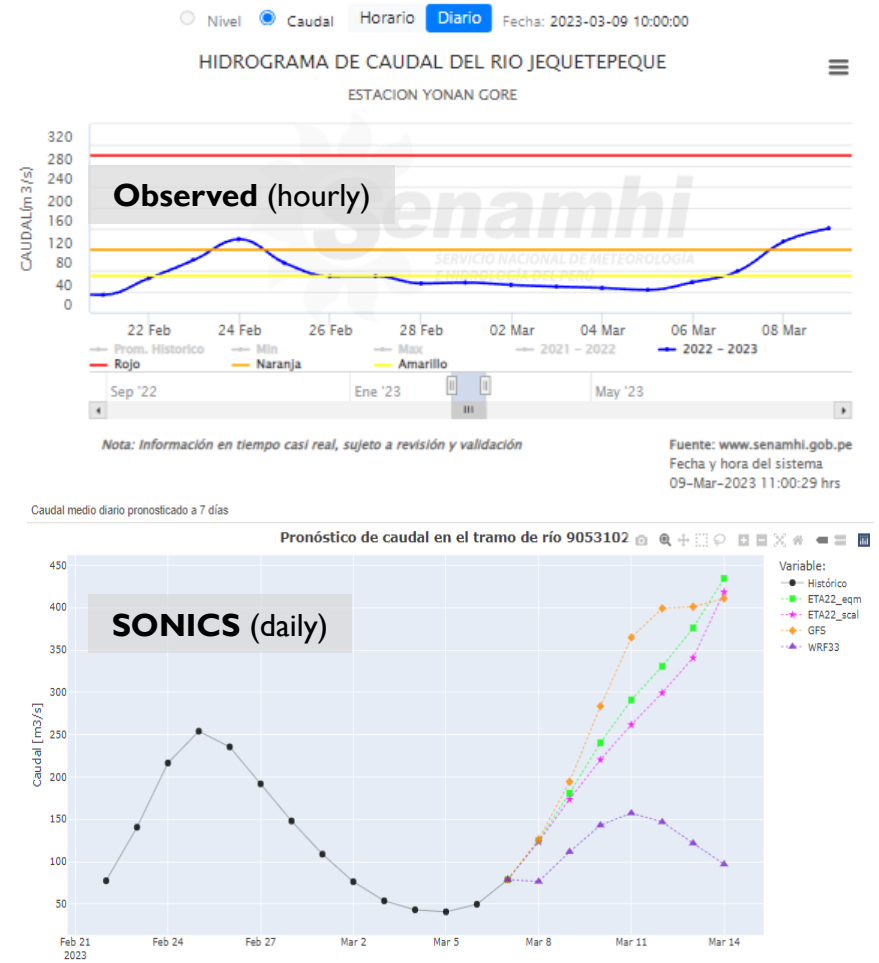


Yaku tracking





YONAN GORE STATION



Summary…

- Peru is an Andean country located in South America that have high climate diversity and vulnerability to river flooding.
- The Peruvian data-scarcity context prompted the development of new hydrometeorological gridded data, such as **PISCO**, to support national studies.
- The **PISCO_HyD_ARNOVIC** dataset contain simulated daily flow series outputs from a national hydrological model in approximately 12 thousand river reaches across the country (from 1981 to the present day).
- **SONICS** is a Peruvian framework develop using the national hydrological model driven by PISCO and the WRF, ETA and GFS rainfall forecast models.
- Future works will incorporate a new river network (MERIT-Hydro) and develop the **SONICS climate service to support river flood detection and forecasting in Peru**.

Many thanks!

¡Muchas gracias!

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