SNHM

On the Job-Training in Seasonal Hydrological Forecasting

Introduction to Objective Seasonal Forecasts in West Africa and the Sahel

October 2025

AGRHYMET – Regional Climate Centre for West Africa and the Sahel

Seasonal Hydrological Forecasting

❑ Seasonal forecasts

Seasonal forecasts are **estimates** of the **average state of the climate** (or of meteorological and hydrological variables) over a **period generally ranging from 1 to 6 months**, and sometimes up to 7 months in advance. They do not aim to predict daily weather conditions, but rather to estimate the average trend of a given season — for example, to determine whether the rainy season will be **wetter**, **normal**, or **drier** than the climatological average.

❑ Seasonal forecasts

- Seasonal hydrological forecasting aims to anticipate future hydrological conditions (above normal, normal, or below normal) several months in advance.
- It is generally based on forcing hydrological or statistical models with seasonal climate forecasts.

❑ Motivation for hydrological forecasts

- West Africa is highly vulnerable to hydrological extremes (floods and droughts) due to climate variability and change.
- Communities downstream of dams and rivers are particularly exposed to recurrent floods with severe socio-economic impacts.
- Seasonal hydrological forecasts are strategic services for:
  - Water resources planning
  - Drought and flood risk prevention
  - Hydraulic infrastructure management

❑ Motivation for hydrological forecasts

- AGRHYMET, as a Regional Climate Centre, plays a leading role in producing such forecasts to serve CILSS and ECOWAS member states.
- Traditional Regional Climate Outlook Forums (RCOFs) rely on consensus-based, subjective forecasts.
- Forecasts lacked reproducibility, objectivity, and local relevance.
- In line with **WMO Decision 9 (EC-72)**, AGRHYMET has developed the **WAS-NexGen tool** for operational, objective, and scientifically rigorous forecasts.

❑ Current Approch : Overview of the consensual based hydrological forecasts

- Currently, AGRHYMET and its partenaires provide consensual seasonal hydrological forecasts. These consensual forecasts are based on the analysis (expert judgment) of the flowing elements :
  - Dynamical Climate model forecast from global centers
  - Statistical models forecasts using the relation between predictors and predictands (predictands are usually compute from observation data)
  - Expert knowledge of regional climate and hydrological processes
- At the beginning of each season, AGRHYMET organizes a **regional forum** with national hydrology and meteorology services from 17 countries to coproduce and dissiminate seasonal hydrological forecasts.

❑ Consensus-based forecasting approach

Curent consensual based approch are mainly based on PyCPT :

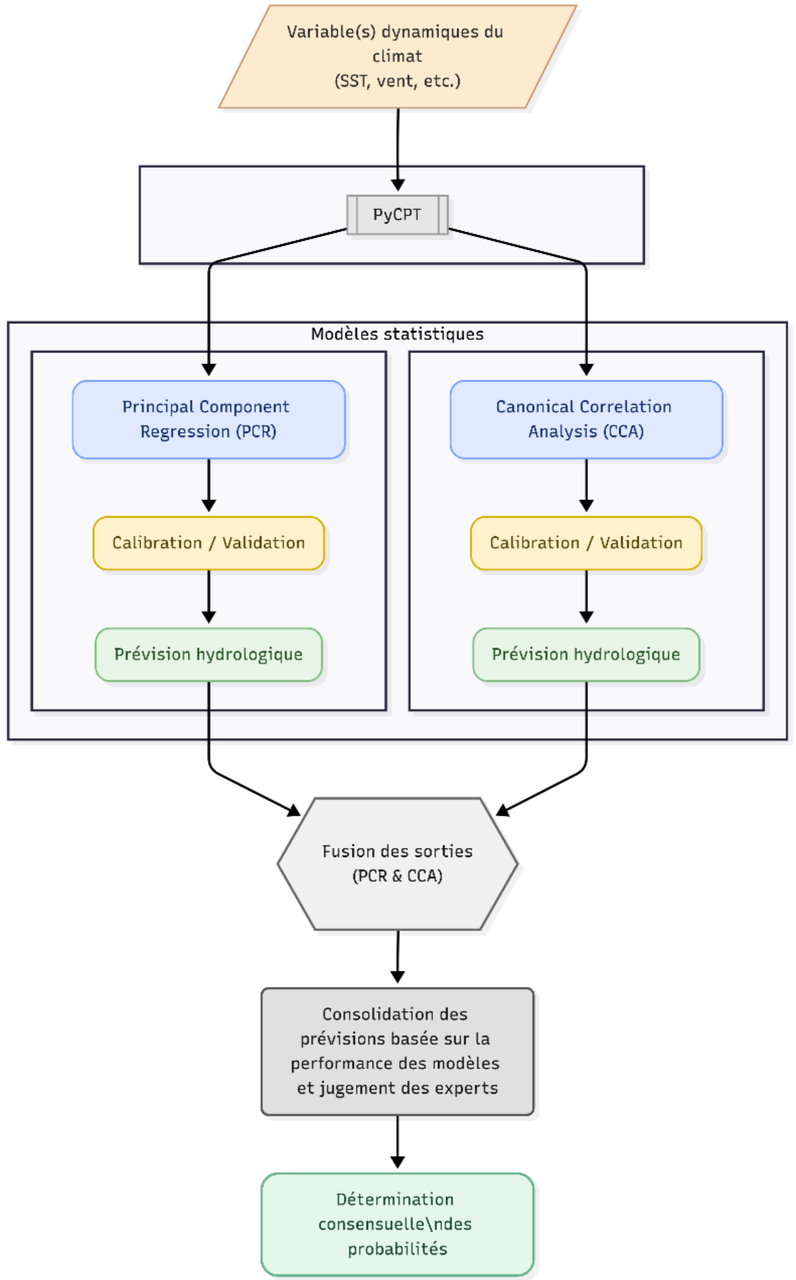
a) 📥 Data downloading

b) ⚙️ Data processing

c) 📊 Data modeling

d) 🔗 Forecast consolidation based on model performance and expert judgment

e) 🌊 Hydrological forecasting



Seasonal Hydrological Forecasting

Un autre Sahel est possible !

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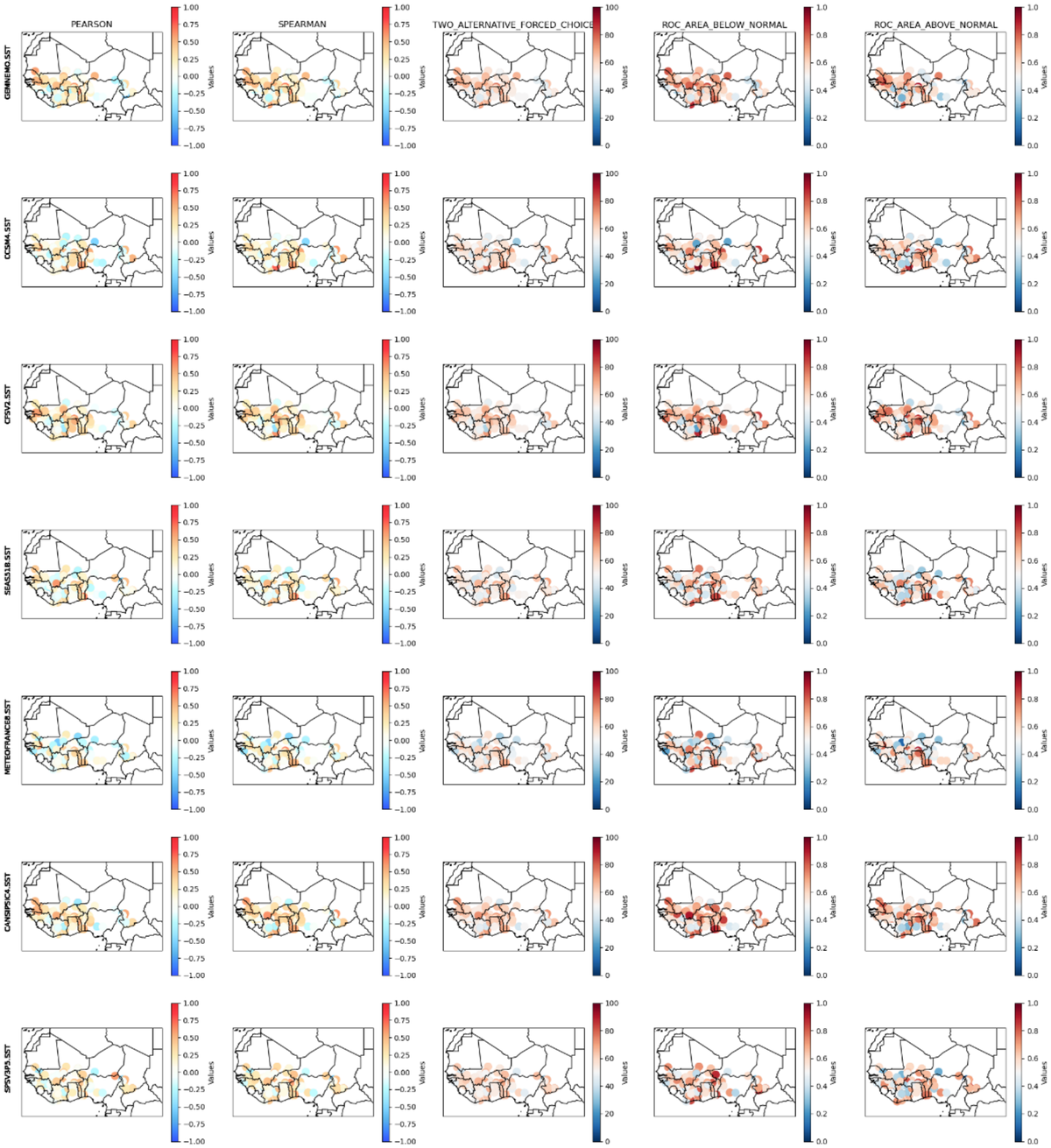
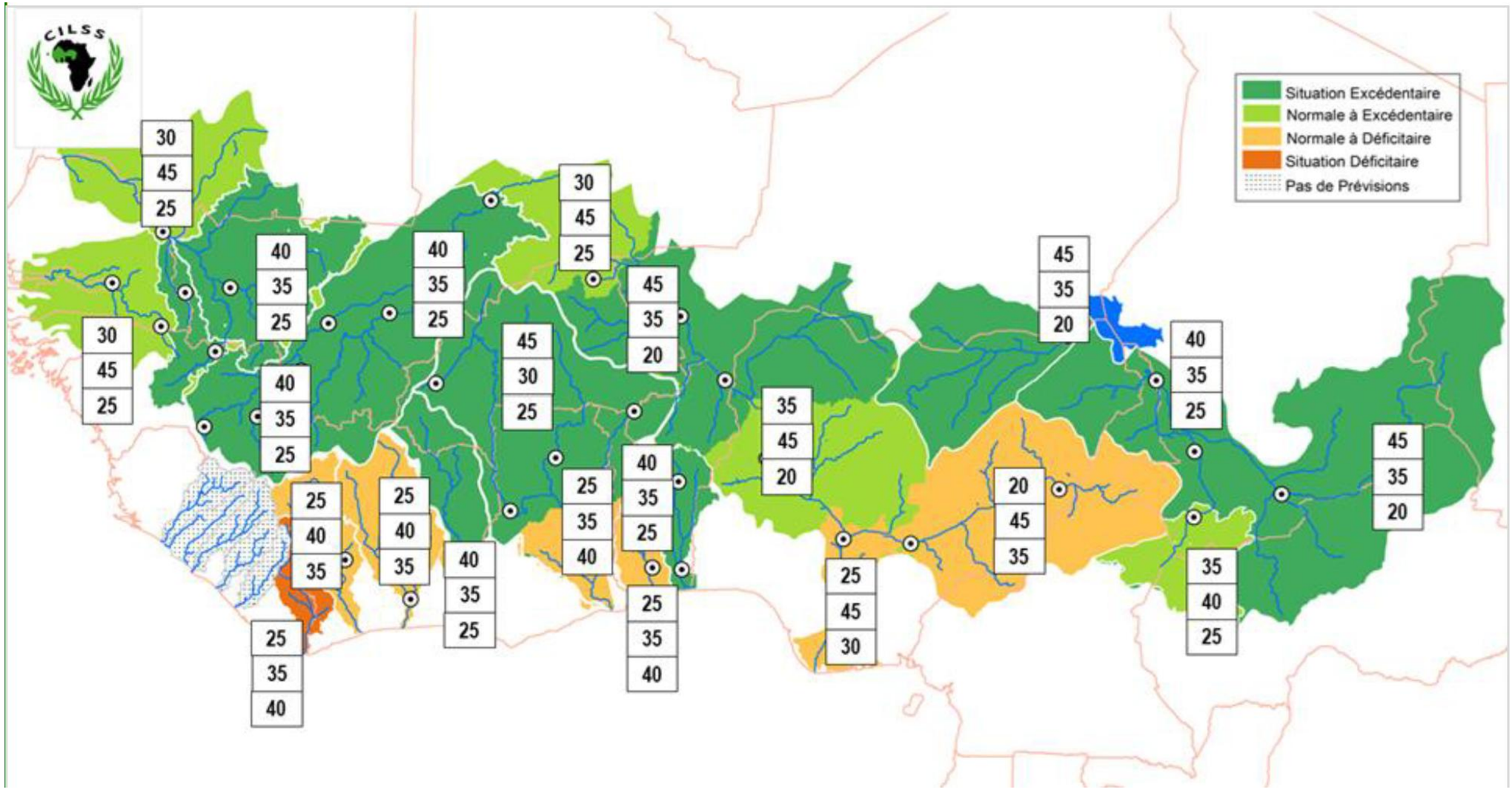
Examples of statistical's models performance used in the consensual approach



❑ Final product of the consensual based forecast



Objective Seasonal Forecasting

❑ AGRHYMET efforts towards reproducibility seasonal forecasts

Phase I of AICCRA project has played a central role in this transition:

Key Outcomes:

Development and deployment of **PyCPT (IRI)** which automates the traditional statistical methods used for seasonal forecasts

Beyond automation, AGRHYMET also explored new technological opportunities to further improve forecasting capabilities.

The use of artificial intelligence (AI) and machine learning (ML) is being explored as a way to enhance the accuracy and speed of seasonal and sub-seasonal forecasts.

AI complements, not replaces, traditional forecasting.

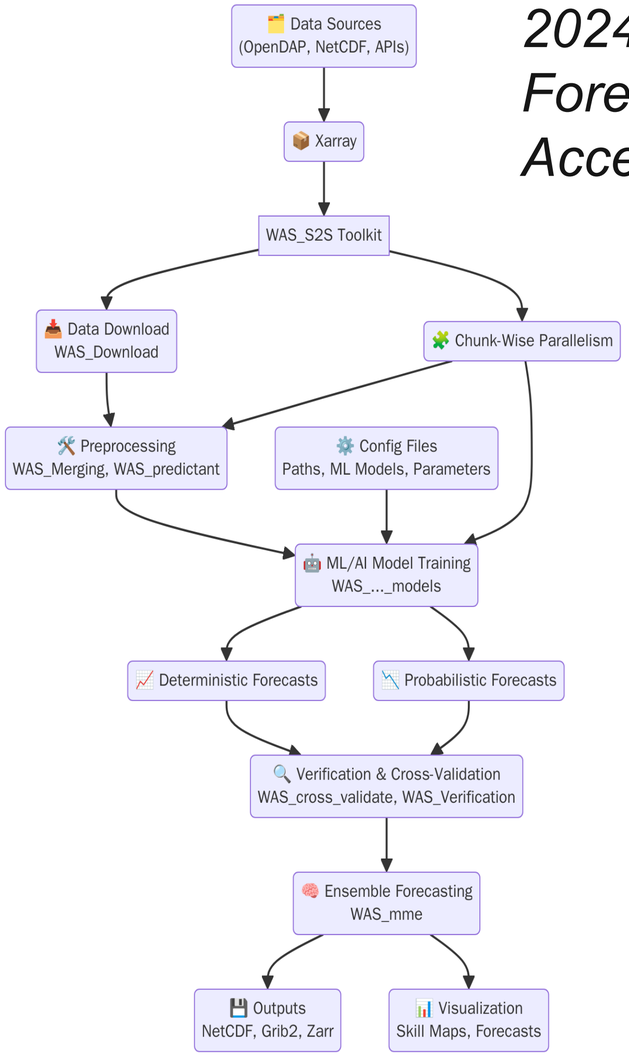
❑ AGRHYMET's Strategic Vision

Ali A. Zougmore R. Segnon A. 2024. Quelle approche stratégique pour une nouvelle génération des prévisions saisonnières en Afrique de l'Ouest et du Sahel : analyses et propositions. AICCRA Reports. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

- AI complements, not replaces, traditional forecasting.
- a more streamlined organizational format for the RCOF, making it more sustainable;
- easier monthly updates of forecasts.
- Output Format defined.

Seasonal Hydrological Forecasting

WASS2S tool for climate forecasting



Houngnibo M. Ali A. Assoumana B. Minoungou B. Segnon A. Zougmore R. 2024. Integration of Artificial Intelligence in Seasonal to Sub-Seasonal Forecasting Systems in West Africa and the Sahel. AICCRA InfoNote. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

Distributed as package on pypi: https://pypi.org/project/wass2s/

Documentation link: https://wass2s-readthedocs.readthedocs.io/en/latest/

A continuous development and improvement:
write to mandela.houngnibo@cilss.int if you want to contribute

The WASS2S tool currently used for seasonal climate forecasting will be extended to include seasonal hydrological forecasting.

Towards Objective Seasonal Hydrological Forecasting

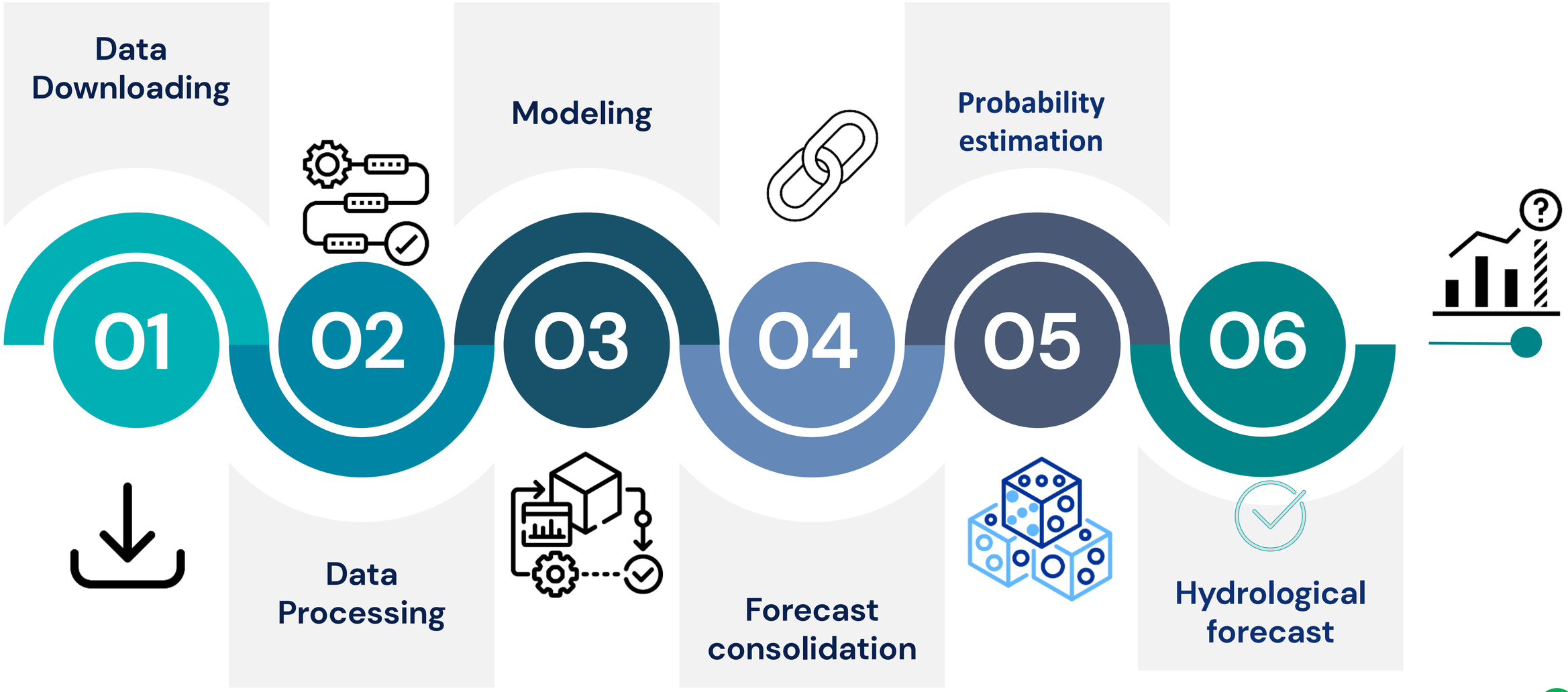
❑ New Approach is under development to advance Seasonal hydrological Forecasting

To respond to the call for **objective seasonal forecasts**, AGRHYMET has initiated the development of a **new generation of seasonal hydrological forecasting** based on:

- Statistical methods
- Physically-based hydrological models
- Artificial intelligence algorithms

This new approach, currently under testing, could be operationalized in the upcoming season.

❑ Objective seasonal forecasts rodamap



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❑ WASS2SHydroR Framework for Seasonal Hydrological Forecasting

WASS2SHydroR Framework :

a) **Data downloading**

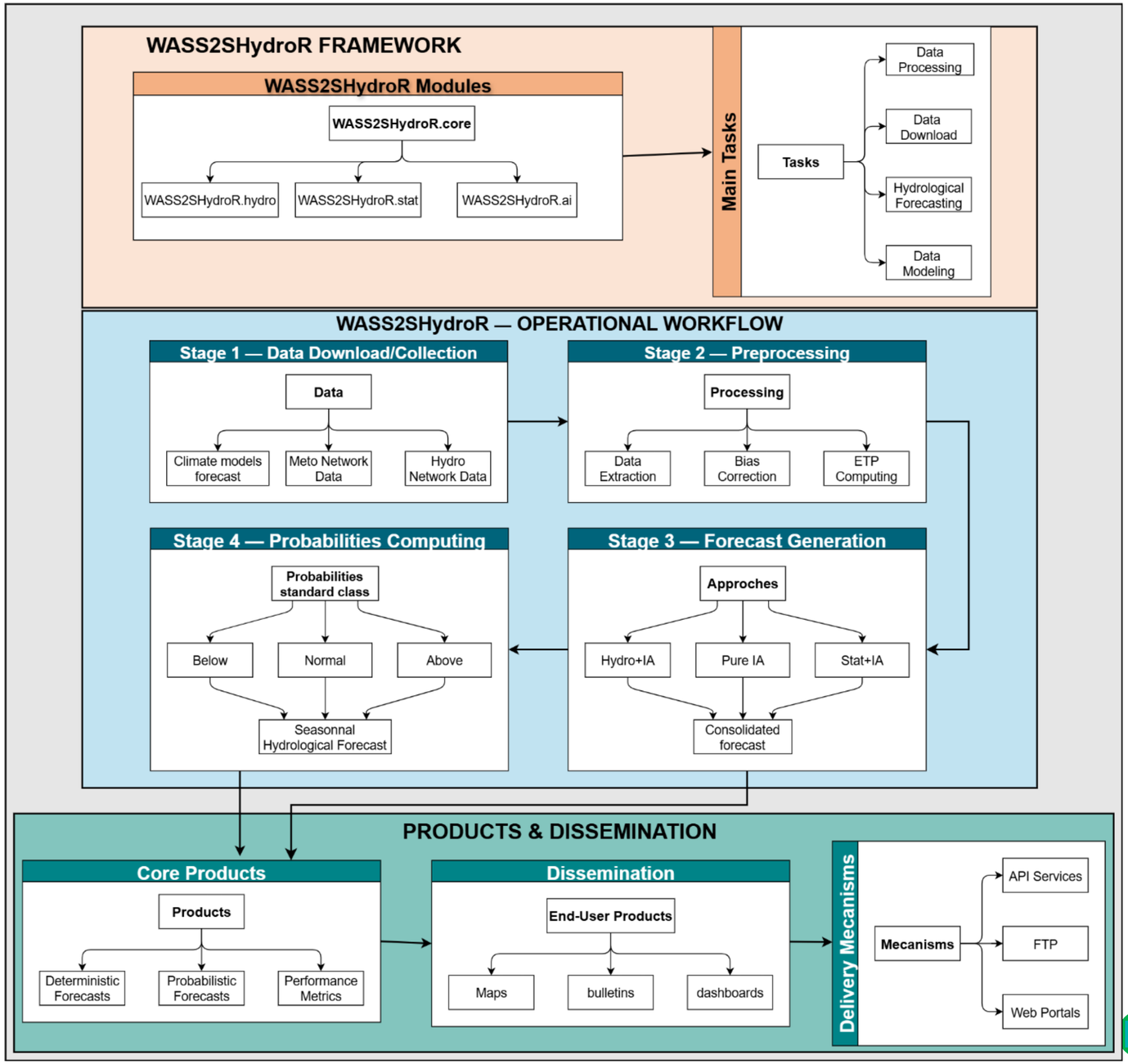
b) **Data Processing**

c) **Data Modeling**

d) **Forecast Consolidation**

e) **Probability Estimation**

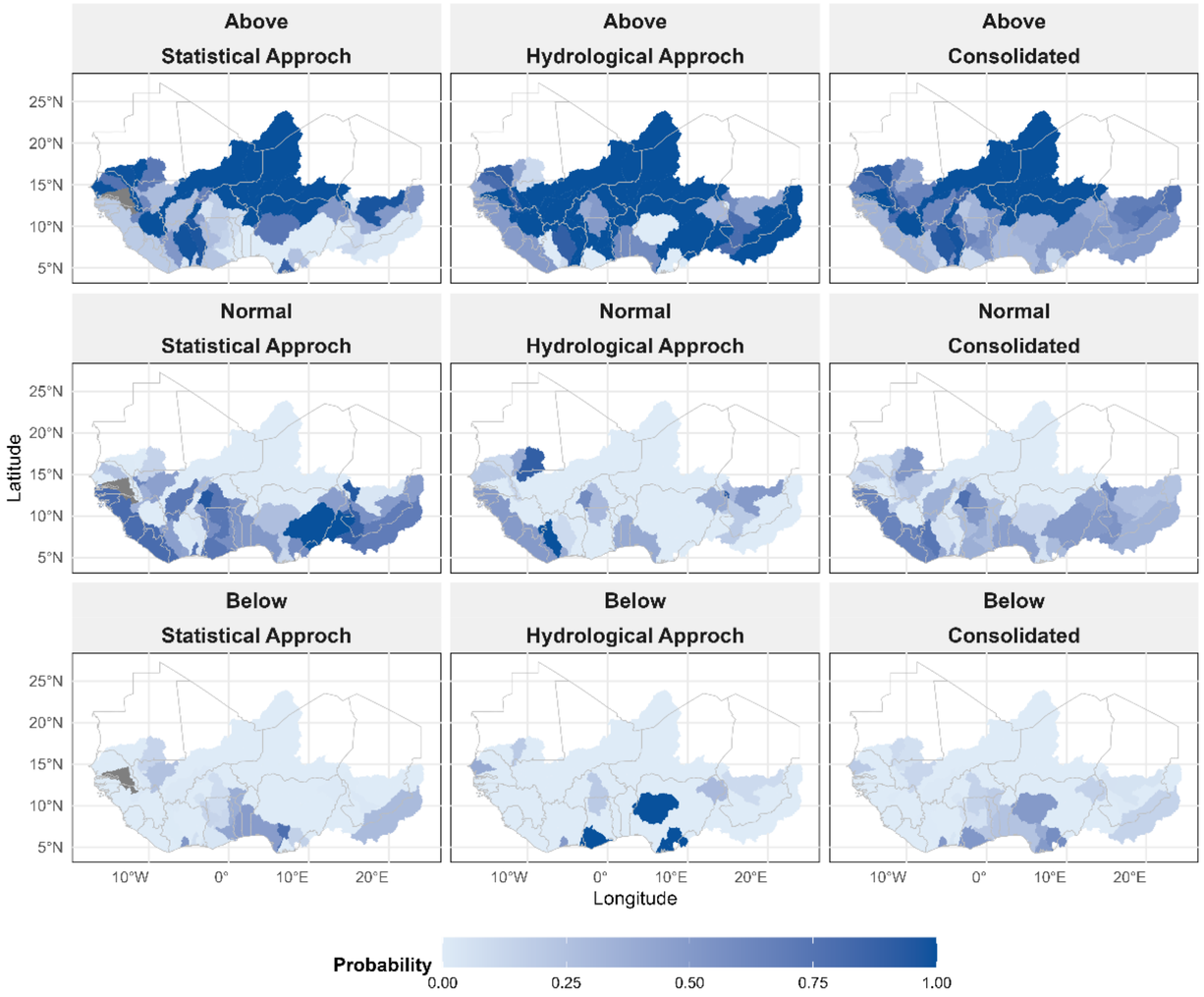
f) **Hydrological Forecast**



❑ *Objective Seasonal Hydrological Forecasting – Preliminary Results*

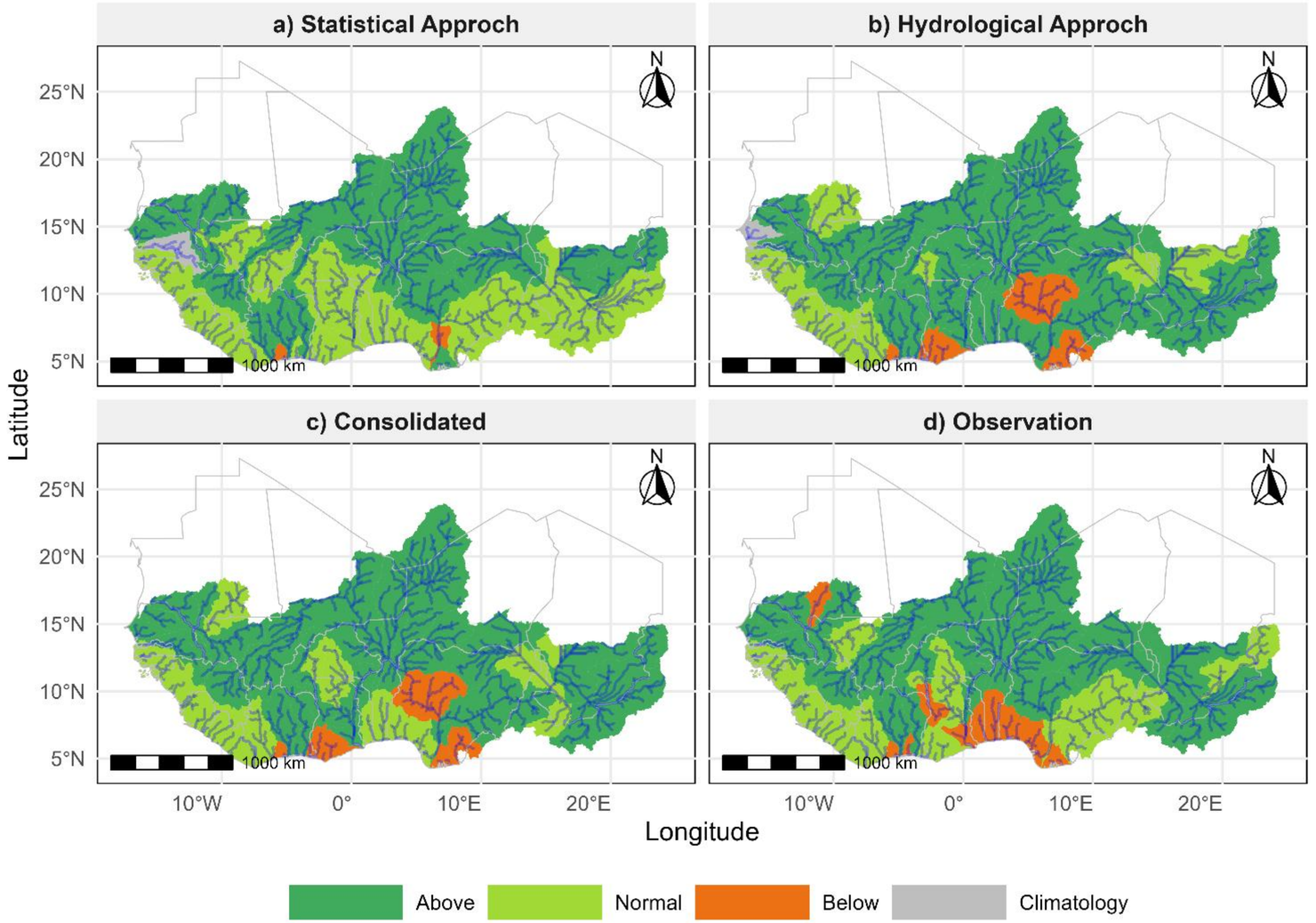
Examples of preliminary results.

The consolidated approach combines the strengths of both statistical and hydrological methods, providing more robust seasonal forecasts.



❑ *Objective Approach to Seasonal Hydrological Forecasting*

The consolidated approach improves consistency compared to statistical and hydrological methods alone, and aligns more closely with observed patterns.



❑ Training and Capacity Building

- AGRHYMET has planned an **intensive capacity-building for NHSs in the upcoming months**.
- This training will target the **17 countries of West Africa and the Sahel national hydrological services under the mission of AGRHYMET.**
- **The training will highly be gender sensitive**
- **The participants will be appointed officialy by the NHSs;**
- **Private participation is also allowed**

❑ Key Messages

- Seasonal hydrological forecasts are criticaal inputs for water resources management, flood and drought risk reduction, and dam operation in West Africa.
- Current approaches rely on climate models, statistics, and expert judgment, with limited transability and reproducibility in the process.
- AGRHYMET is finalizing the developement of new generation of forecasts, combining statistical methods, physically-based hydrological models, and artificial intelligence.
- Capacity building and training are crucial to ensure that national services and stakeholders can adopt and operationalize these new forecasting tools.

Thank you for your kind attention!