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Hosted by
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28 JUNE - 2 JULY 2027

DRIVING CHANGE MANAGEMENT IN THE ERA
OF DIGITAL WATER AND GLOBAL TRANSITION

Digital Transformation for River Basins

INBO World Basin Summit
16 June 2026
Rio de Janeiro, Brazil

16-19 JUNE 2026 . RIO DE JANEIRO - BRAZIL



INBO

International Network
of Basin Organizations

World Basin Summit

COOPERATIVE BASIN GOVERNANCE FOR WATER SECURITY

Support:  

Organization:   

Realization:   

The Key Technologies of the "Three Yellow Rivers" Linkage and Their Application in Flood Control (Digital-Model-Prototype Yellow Rivers)

Wu Chengjun

Yellow River Institute of Hydraulic Research, YRCC

Jun, 2026

Digital Transformation for River Basins – Road to Bari_42nd IAHR World Congress





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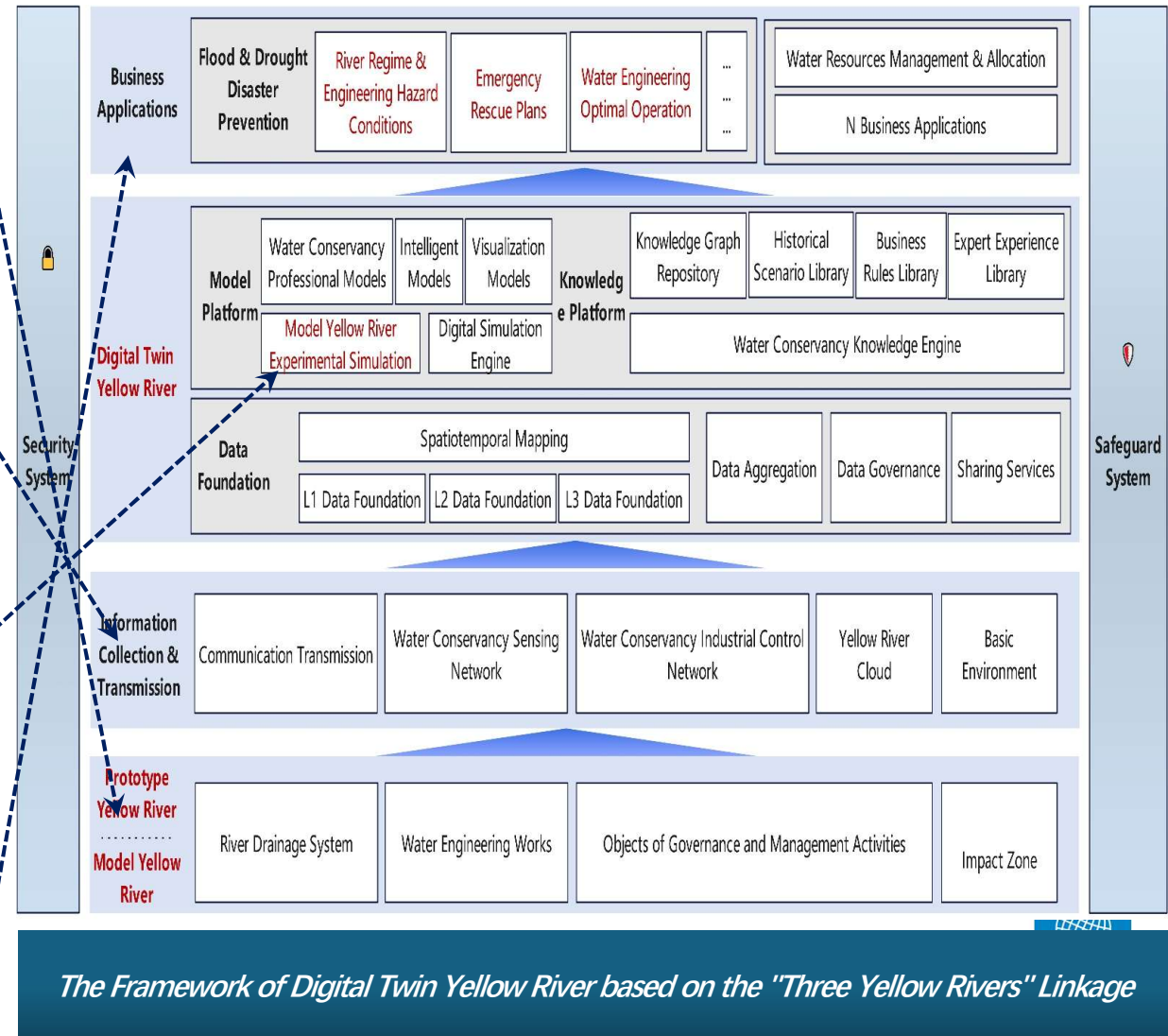
CONTENTS

CONTENTS

-  **The Framework of the "Three Yellow Rivers" Linkage**
-  **Major Progress of the "Three Yellow Rivers" Linkage**
-  **Flood Control Support and Case Studies**

1.1 Framework

- Construct a Multi-dimensional Spatiotemporal Data Framework for the Lower Yellow River
- Real-time Synchronization of Key Data from the Real Yellow River to the Digital Twin Platform
- Integrate the Hydraulic Engineering Models into the Digital Twin Yellow River Platform
- Digital Twin Yellow River achieves parameter self-optimization, real-time calibration, model control, and full-process forecasting, providing feedback for operational applications in the Real Yellow River



1.2 Platform

“三条黄河” 联动平台 “Three Yellow River” Linkage Platform

数字孪生模型黄河 系统管理 2024/04/13 23:02:52 星期日

原型黄河 Real Yellow River

实时动态监测 | 多过程情景回放 | 智能预警预报

工程险情预警 5次

- 根石坍塌 2次
- 坝垛漫顶 3次

Real Yellow River Monitoring Data

测量数据 | 流场数据

时间	断面	含沙量	流速	地形变化
04.12	H5	1.78mg/L	6.4m/s	-
04.13	H7	1.05mg/L	6.5m/s	-
04.14	H12	1.02mg/L	6.7m/s	-

河道工程
River Engineering

模型黄河 Model Yellow River

实时动态监测 | 多过程情景回放 | 智能预警预报

时间	工况名称	操作
2023.07.20	小浪底防洪调度方案	查看详情
2023.07.20	小浪底防洪调度方案	查看详情

模型黄河监测数据

■ 水位	120
■ 含沙量	70
■ 河势流场	8
■ 水下地形	4

监控设备

● 在线 ● 离线 ● 停用 ● 异常

36 24 0 10

安全设备

● 在线 ● 离线 ● 停用 ● 异常

36 24 0 10

三条黄河联动成果 Solution outcomes of “Three Yellow River” Linkage

方案成果展示平台 历史方案成果查询

水位

流场

含沙量

地形

模型黄河综合管理平台

模型展示 数字孪生 实时监控 04/13 23:02:52 星期日

实时监控

实时监控 | 模型展示 | 数字孪生 | 实时监控

实时监控

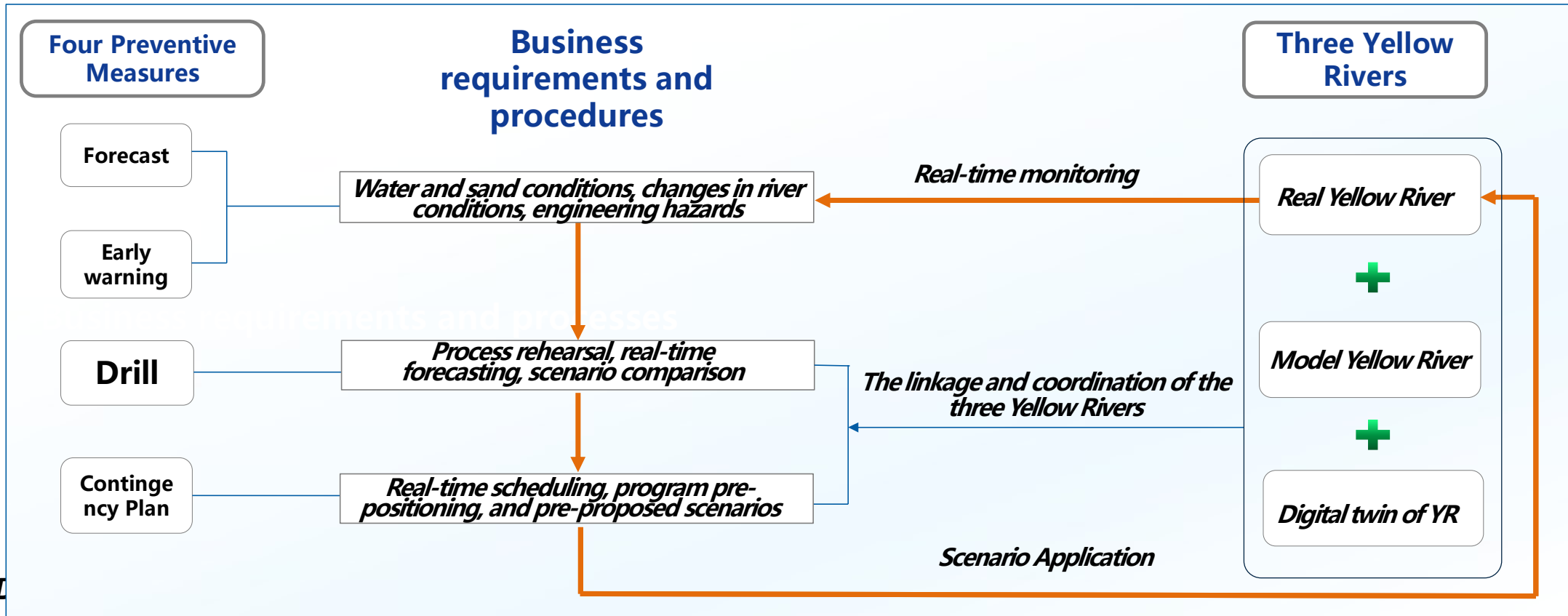
实时监控 | 模型展示 | 数字孪生 | 实时监控

实时监控

实时监控 | 模型展示 | 数字孪生 | 实时监控

1.3 Application

Strengthen the flood control and disaster reduction work system with “Forecast, Early warning, Drill, Contingency Plan” (Four Preventive Measures) as the core.



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2.1 Real YR-Data Platform



黄河科学数据平台界面

Interface of the scientific Data Platform for the Yellow River

- Establish a Yellow River Scientific Data Platform

19 Major Categories | 3.5M Entries | 10.02 TB

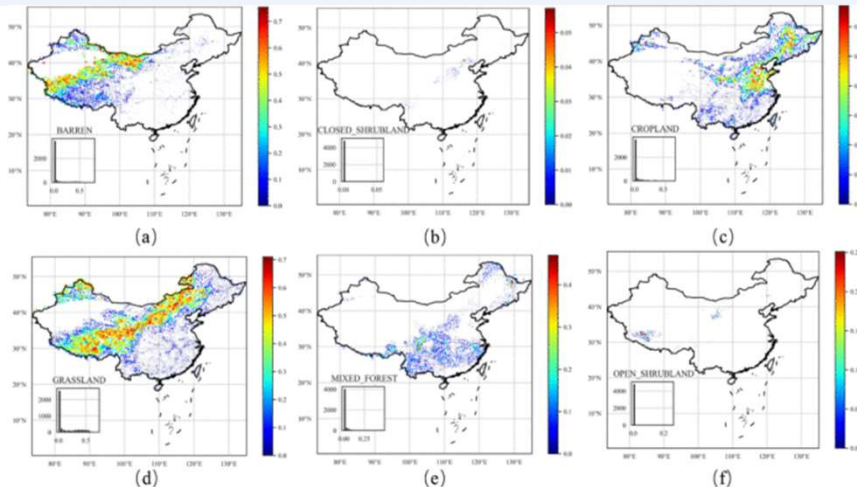
Integrating multi-source monitoring & expedition data, spanning meteorology, glaciers, runoff, and remote sensing

- Enable data retrieval, visualization, dynamic display, and interactive querying

- National-Scale Hydro-Meteorological Database

4,911 Catchments | 5–30 Years | 125 Static Parameters

Daily meteorological time series covering the entire nation



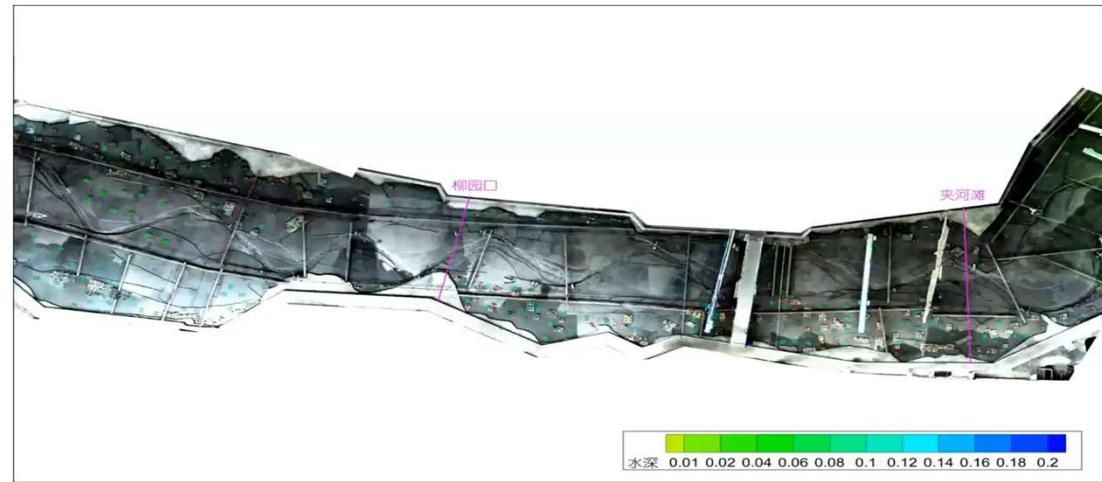
Digital Transformation for River Basins – Road to Bari_42nd IAHR World Congress

2.2 Model YR-Digital Twin

- Construct a Digital Twin of the "Model Yellow River".
- Develop methods for error analysis and control of physical models, autonomous iterative optimization algorithms for key model parameters, and data assimilation and real-time correction methods.



Numerical simulation based on data foundation of the "Model Yellow River"



Numerical simulation based on data foundation of the "Model Yellow River"

2.3 DT-YR— "1314" Models



13 Major Tributaries

Huangshui River, Taohe River, Dali River, Qingshui River, Dahei River, Huangfuchuan River, Kuye River, Wuding River, Fenhe River, et c.

1 Mainstream Ecological Corridor

From the Source Region to the Bohai Sea, 5464km

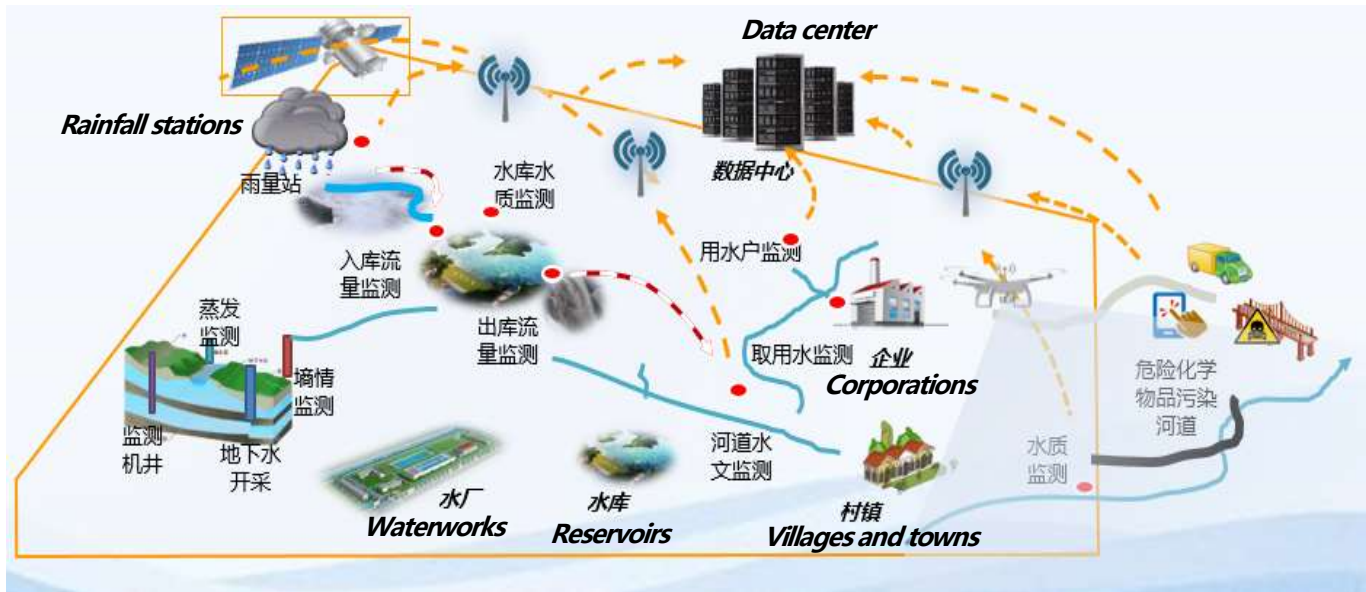
4 Key Areas

Source Region, Loess Plateau, Delta, Irrigated Area

■ Development of the '1314' Mathematical Models: 13 Major Tributaries, 1 mainstream ecological corridor and 4 key areas.

13 Key Tributaries	1 Ecological Corridor	4 Key Regions	Core Science
Taohe, Fenhe, Weihe...	Mainstem Connectivity	Source, Loess, Delta, Irrigation	Basin Systems Science
Targeted Intervention	Ecological Baseline	Spatial Priorities	Evolution Laws, Groundwater Mechanisms etc.

2.3 DT-YR— "1314" Models



■ Comprehensive Basin, Whole Process, and All-Material Simulation Forecasting: Rainfall, runoff and sediment processes in major tributaries, multiphase flux of pollutants from ice and sediment, river regime changes, engineering hazard early warning and forecasting, multi-channel utilization and habitat change simulation in the Yellow River estuary, irrigation water demand forecasting.

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2.3 DT-YR—Developed Models

	Mechanistic Model 机理模型	Machine Learning Model 机器学习模型	Intelligent Recognition Model 智能识别模型
流域面水土流失模型 <i>Watershed Surface Erosion Model</i>	多空间尺度水土流失数学模型系统 <i>Modeling system for soil erosion at multiple spatial scales</i>	基于机器学习的黄河典型区产水产沙预测模型	
水库联合调度数学模型 <i>Mathematical Model of Reservoir Joint Operation</i>	水库群水沙调度动力学模型	基于机器学习的水库调度方案推荐模型 <i>A machine learning-based model for recommending reservoir scheduling plans</i>	
河道演进水沙数学模型 <i>Mathematical Model of River Channel Evolution Water and Sand</i>	河道一维/二维水环境生态模型 河道平面二维水沙动力学模型 河道一维非恒定水沙动力学模型	黄河下游滩区洪灾损失评估模型 <i>Flood Damage Assessment Model for the Lower Yellow River Beach Area</i>	河道非法行为视频识别模型 <i>Video Recognition Model for Illegal Behavior in River</i>
河口演变数学模型	河口二维径流-潮流-波流泥沙模型		水边线视频识别模型 <i>Video Recognition Models for Waterfront Lines</i>
冰凌数学模型 <i>Mathematical Model of Ice cream</i>	河道一维/二维河冰动力学模型	基于数据挖掘的内蒙古河段开河日期预测模型 <i>Data mining-based prediction model for river opening date of Inner Mongolia river section</i>	流凌密度视频识别模型 <i>Video Recognition Model for Ice Cream Flow Density</i>
污染物输移扩散数学模型 <i>Mathematical Model of Pollutant Transport and Dispersion</i>	水库(湖泊)水环境生态模型 三维紊流泥沙水质动力学模型		水污染物/漂浮物视频识别模型 <i>Video Recognition Model for Water Pollutants or Floating Objects</i>
农业与灌区数学模型 <i>Mathematical Model of Agriculture and Irrigation Districts</i>	河道水沙输移与灌区引水循环双过程耦合数学模型 引黄灌区渠系闸群优化调控模型	农业非点源污染负荷估算模型 <i>Model for estimating agricultural nonpoint source pollution loads</i>	

- We independently developed more than 20 professional models in 3 categories (Mechanistic Models, Statistical and Machine Learning Model, and Intelligent Recognition Models). The River Ice Dynamics and Water-sand Dynamics Models have been embedded in the National Flood Control Conference System, which has filled the gap of ice-cream forecasting of the MWR.

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C O N T E N T S

- I The Framework of the "Three Yellow Rivers" Linkage
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3.1 Flood Defense Support

- Based on the Real Yellow River, integrate the Model and the Digital Twin to conduct major flood defense drills before the flood season, which provide technical support for determining key areas for engineering measures, and levee defense during major flood events.
- Achieve forward simulation of flood progression and disaster risks, and perform backward simulation to develop joint reservoir dispatch plans.



Experiments in the Model Yellow River

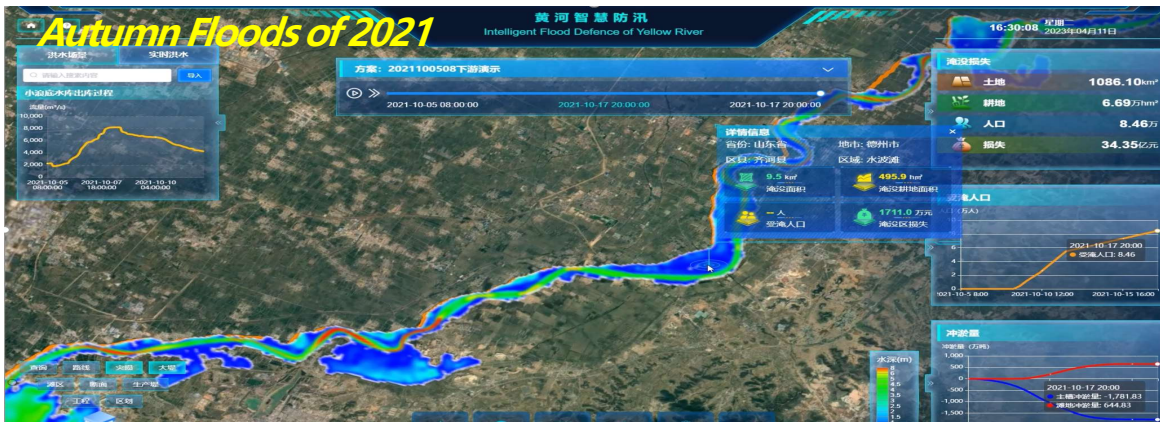


Forecast using Digital Twin Yellow River

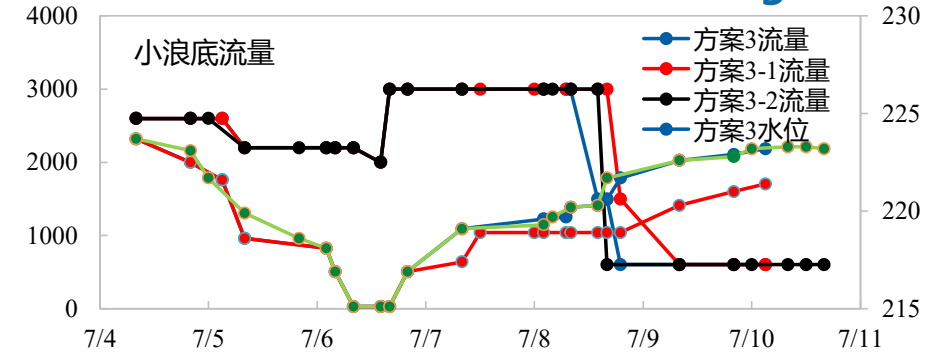
3.2 Flood Control Application Cases

Model Applications in the Yellow River Flood Defense in 2023

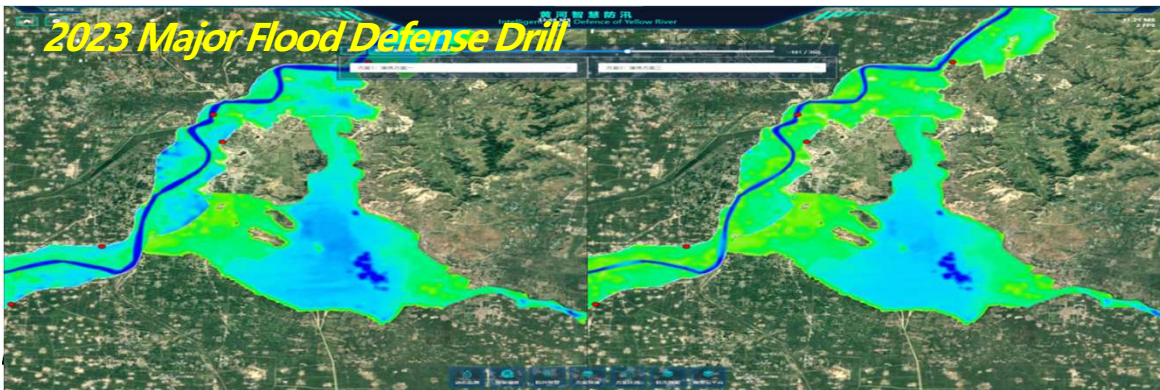
◆ Reservoir group operation schemes for 2021 Autumn Flood



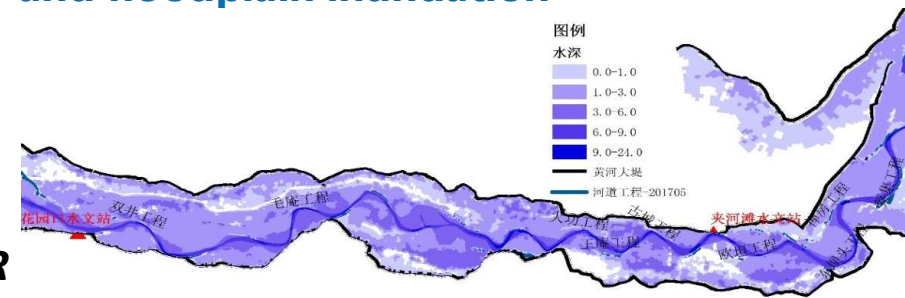
◆ Calculated 5 groups of flood operation schemes for 2023 Water-Sediment Regulation



◆ Provide two distinct reservoir operation schemes



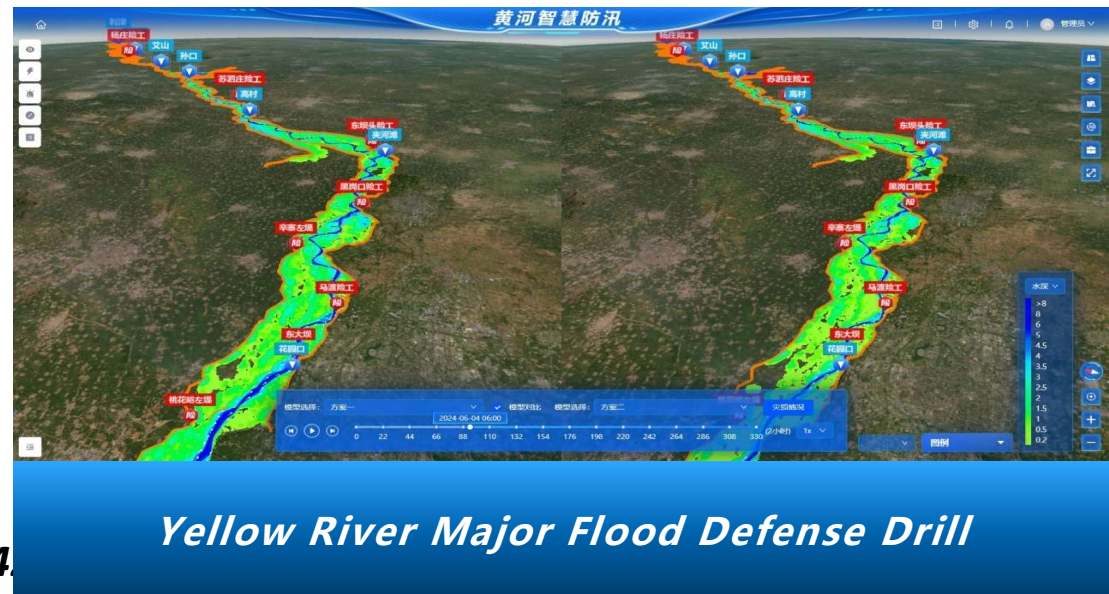
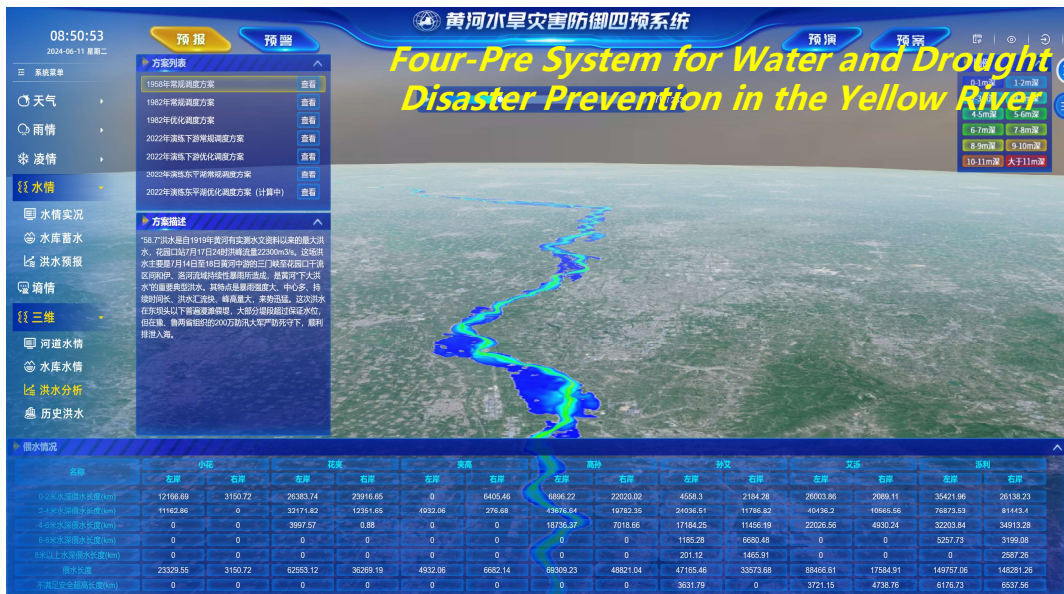
◆ Transplanted "7.20" Storm to simulate beyond-design-standard flood propagation and floodplain inundation

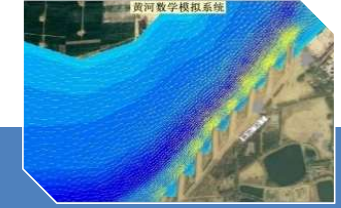


3.2 Flood Control Application Cases

Model Applications in the Yellow River major flood defense drill in 2024

Two sets of operational dispatch scenarios were utilized to simulate the flood progression, assess inundation risks, analyze riverbed erosion and sediment deposition, and evaluate the flood diversion process at Dongping Lake. These simulations supported the development of the recommended dispatch strategies.





Thanks for your attention!

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COOPERATIVE BASIN GOVERNANCE FOR WATER SECURITY



From Paper Records to AI-Supported Risk Management of Cyanobacterial Blooms

A decade of learning in the San Roque Basin



Dra. Biol. Ariana Rossen on behalf of
Dra. Bioch. Ana L. Ruibal Conti, MSc Biol Maria Ines Rodriguez and MSc Bioch. Marcia Ruiz

Instituto Nacional del Agua-Argentina

WHO WE ARE: INA – CIRSA / LAyCA



National Water Institute (INA)

Argentina's national scientific-technological institute for water resources research, studies and specialised services, under the Secretariat of Infrastructure and Water Policy.



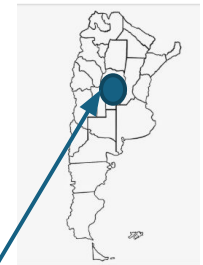
CIRSA – Center of the Semi-Arid Region

One of INA's regional centres, with two sites in Córdoba province: Córdoba Capital and Villa Carlos Paz, on the shore of the San Roque Reservoir.



LAyCA – Area of Applied Limnology and Water Quality

The team behind this work: focuses on surface waters - rivers, lakes and reservoirs - and their ecological and water-quality dynamics.



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THE CASE STUDY: SAN ROQUE RESERVOIR BASIN

A reservoir under chronic pressure

Importance of the Reservoir

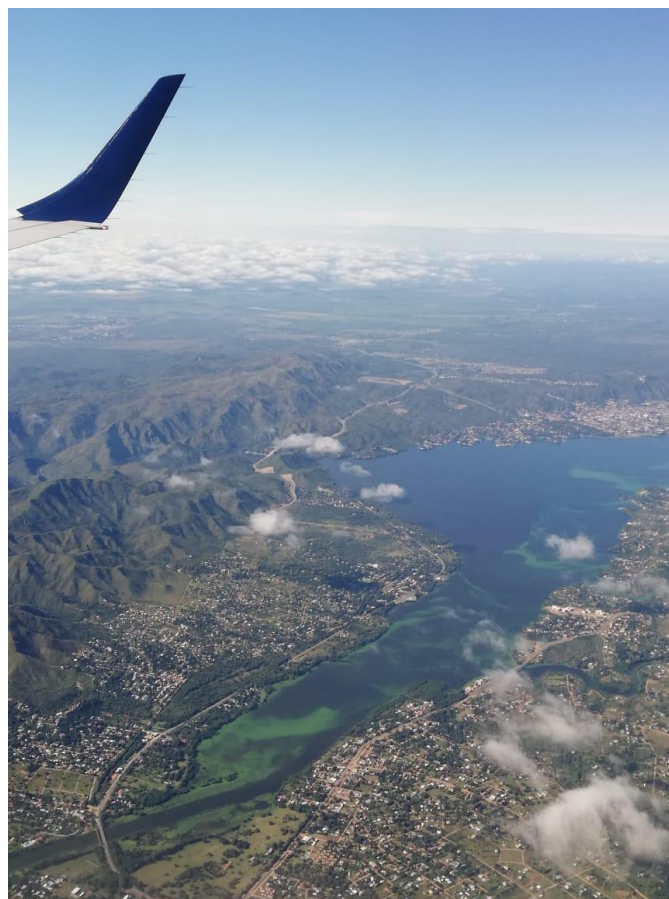


- Drinking water supply
- Recreational & Touristic Center
- Regulation of floods
- Energy production

Challenge



- 20+ years of recurrent cyanobacterial blooms linked to advanced eutrophication



San Roque Reservoir and Watershed
Photo: Nathali Pussetto

Aerial Views of San Roque Reservoir



Algal Bloom at the San Roque dam. Photo: APHRI

THE CASE STUDY: SAN ROQUE RESERVOIR BASIN

Data collection



Over 20 years of continuous monitoring



~1,750 km²

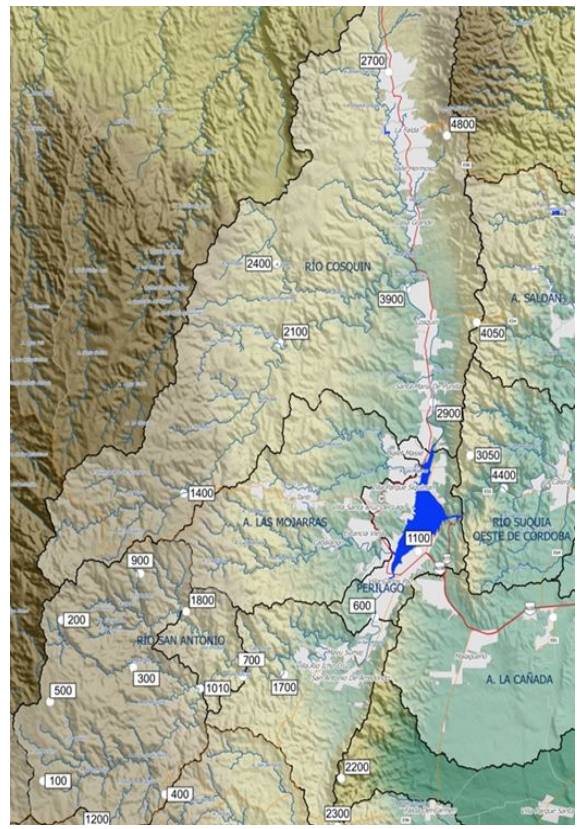
Catchment area, Punilla Valley, Córdoba province



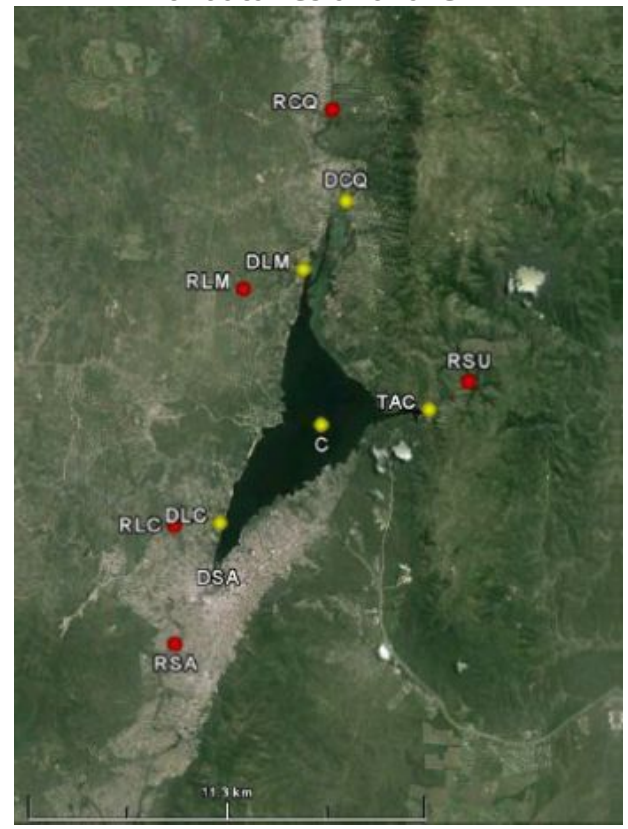
4 tributaries

Main tributaries: San Antonio & Cosquin rivers, Las Mojarras & Los Chorrillos streams

Meteorological stations in the basin



Water quality sampling sites in tributaries and lake



DATA COLLECTION: HISTORICAL

Water quality & flow data



Tributaries



Lake

1999-Present (in transition)

MS Excel® FILES
+1600 records
Monthly



Meteorological stations in the basin



1986-Present (in transition)

Hydrological Data
Meteorological



Estación automática
de monitoreo dotada
de sensores



Transmisión de
datos en VHF



Processing
Center
CIRSA



(1)



Archivo de texto
plano

+106 records
Daily or less

Data transmission and storage process. (1) Expert review. (Image: Pablo Andreoni)

THE SYSTEM: PROBLEMS AND CHALLENGES

PROBLEMS



Paper records & disconnected spreadsheets

Water quality, hydrology and meteorology stored separately, with no shared structure.



High manual workload

Large volumes of data analysed without automated tools.



Risk of human error

Manual handling increases the chance of inaccuracies.



Slow, retrospective decisions

Event detection too slow for effective prevention; no automated alerts.



CHALLENGES



Building a centralized Database

Water quality, Meteorological and Hydrological Data



Automating Data Extraction, Transformation, and Loading (ETL)



Moving from retrospective analysis to predictive analysis



Visualization

A dashboard translates model outputs into clear, actionable alerts for decision-makers.



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THE COST BARRIER, AND HOW WE ADDRESSED IT

Digital transformation requires systems engineering profiles that public water institutes rarely have the budget to hire full-time



The barrier

Digital transformation is not just a technical challenge — it is an economic one.

Building and maintaining ETL pipelines, databases and predictive models requires systems engineering profiles.

Hiring full-time systems engineers is costly, and public water institutes such as INA rarely have a budget line for this kind of permanent technical staff.

Without this capacity, valuable monitoring data risks remaining underused — “data-rich but insight-poor”.



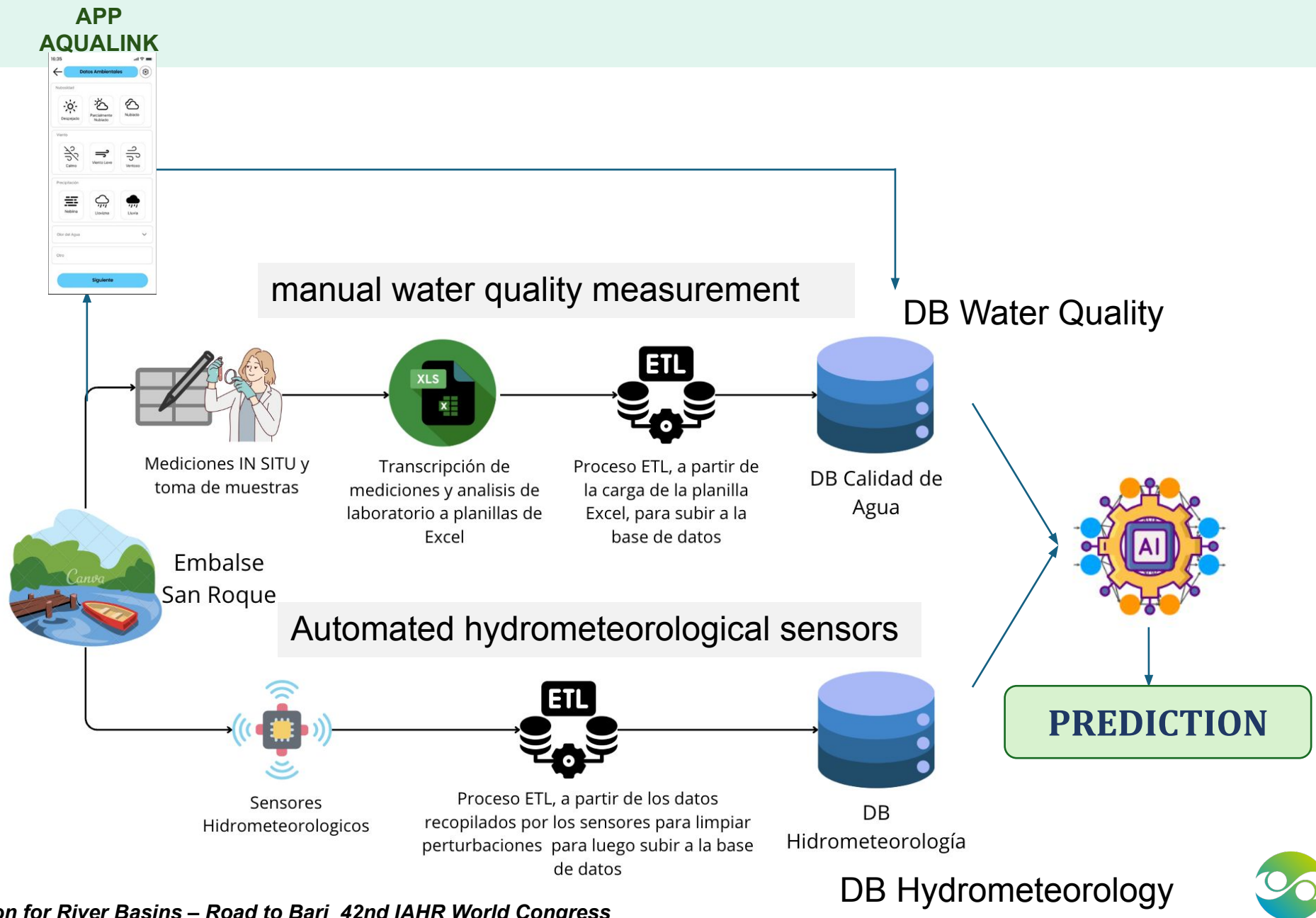
Our solution: a university partnership (A win-win approach)

A collaboration agreement with the School of Engineering (Universidad Católica de Córdoba) channels this need into student final-year projects.

Systems Engineering students complete their mandatory thesis or capstone project by building real components of INA-CIRSA's data infrastructure: ETL pipelines, databases, mobile apps and ML models.

The institute gains the technical work it could not otherwise afford; students gain a real-world problem, supervision, and a completed thesis.

THE PRESENT SYSTEM



FIVE BUILDING BLOCKS OF THE PROCESS

Each block represents a type of progress made over the decade, sustained by successive scholarships and internships



Data structuring

Water quality & hydro-met records organized into a SQL database

Practices: Barafani, Gonzalo, Francisco

2016-2023

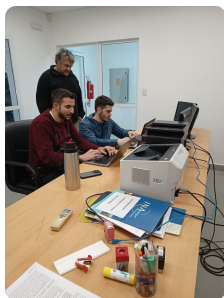


ETL automation

Automated data loading pipeline (Apache Hop, Kafka, PostgreSQL)

Scholarship: J. C. Dubowez

2023-2024

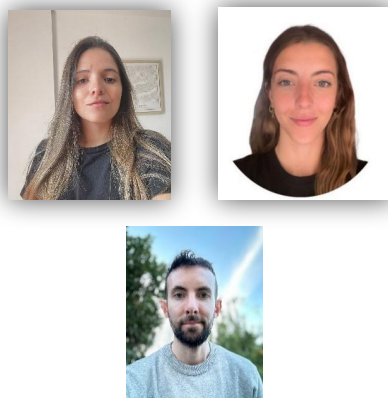


Models

Statistical models and first Machine Learning risk model

Theses: P. Andreoni; Cersofíos & Morellato

2024-2025

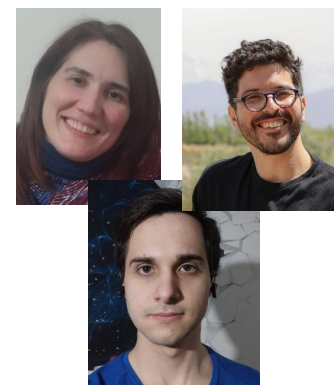


Field data capture (App)

Mobile apps to digitize field sampling and probe readings

Practices: Ignacio, Silvia, Agustín

2024-PRESENTE



Real time

Real-time ETL feeding the predictive model in production

Ongoing scholarship: Agustín

2025...



FIVE BUILDING BLOCKS OF THE PROCESS

Each block represents a type of progress made over the decade, sustained by successive scholarships and internships



Visualization & color-coded alerts

MANAGEMENT OF CYANOBACTERIAL RISK



Approach and key learnings — a decade at a glance



6

Publications & research theses



10

Students engaged through internships & scholarships



1

Mobile apps for field data capture



1

Centralized ETL data platform

People and projects, 2016 - present

- 2016-19 Pablo Andreoni — temporal progression of cyanobacteria drivers
- 2023 Facundo Barafani — LAyCA data management system
- 2023 Juan Cruz Dubowez — data system development
- 2023 Gonzalo — data processing, reservoir & tributaries
- 2023 Francisco — process automation for data pre-processing
- 2024 Agostina Morellato — data conditioning for AI models
- 2024 Sofía Cersoffos — DB validation for cyanobacteria model
- 2024 Ignacio — mobile app, hydrometric data
- 2024 Silvia — mobile app, environmental data
- 2024 Agustín — mobile app, water-quality probe data
- 2024 Juan Cruz Dubowez — ETL deployment & DB validation
- 2024-present Agustín — real-time ETL for predictive model



Barriers and needs



Two structural gaps in the data pipeline

Identified in the 2026 call for new student projects: upstream, further automation of field data acquisition and quality control; downstream, a public-facing platform for open data access (inspiration: Australia's Bureau of Meteorology).



Continuity beyond student cycles

The process currently relies on successive thesis and internship projects. Sustained institutional resources and permanent staff are needed to consolidate and scale the system long term.



From descriptive to real-time predictive

Moving from retrospective, descriptive models towards real-time predictive alerts integrated into operational decisions — work already underway through an ongoing scholarship on real-time ETL.



Data quality and model robustness

Historical data gaps and sensor reliability issues constrain model robustness, reinforcing the continued need for hybrid expert-and-algorithm validation.

THANK YOU FOR YOUR ATTENTION

THE REST OF THE TEAM



Ana Laura

alrc71@gmail.com



María Inés

minesrodrig@gmail.com



Marcia

mruiz@ina.gob.ar

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Territorial Intelligence for Water Governance **Advancing Watershed: Sustainability through Monitoring, Data Analytics, and Modeling**

Carlos Emilio Gutiérrez Ulloa, Ph.D.

Deputy director of planning and environmental management
Regional Autonomous Corporation of Cundinamarca (CAR) - Colombia
cgutierrezu@car.gov.co



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Functions

Environmental Authorities of the National Environmental System -SINA

- **Ministry of Environmental and Sustainable Development**
National- level environmental authority
- **Regional Autonomus Corporations and Development Corporations (33)**
Regional-level environmental authorities



- **Regional Autonomus Corporation of Cundinamarca – CAR**

Is the largest of the corporations, our territory covering **104 municipalities and 2 departments** with more than 12 million inhabitants

- **Issues environmental permits, regulates emissions and water use,** and enforces environmental compliance. Manages protected areas and watersheds while promoting conservation, stakeholder engagement, and sustainable resource management.



Information flow



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Sources of information



01 Hydrometeorological monitoring network | 442 stations



02 Video surveillance systems
(14 in the Middle Basin of the Bogotá River)



03 Field activities carried out by the Entity's professionals
(More than 25,600 SAE registered files)



04 Entity Information Systems
(More than 64 applications)




05 Satellite imagery
(Historical and recent high resolution imagery)



06 Automatic Water Quality Network
(32 Water Quality Stations, generating 7 million data for year)



07 Environmental monitoring, operation and analysis center - PESCAR
10 modules: Air, water, soil, mining, fauna, flora, waste, climate, car resources and environmental complaints



08 General Water Quality Sampling Programs
10 programs, generating 66 thousand data per year



09 Drones
Flying over 65,000 hectares per year

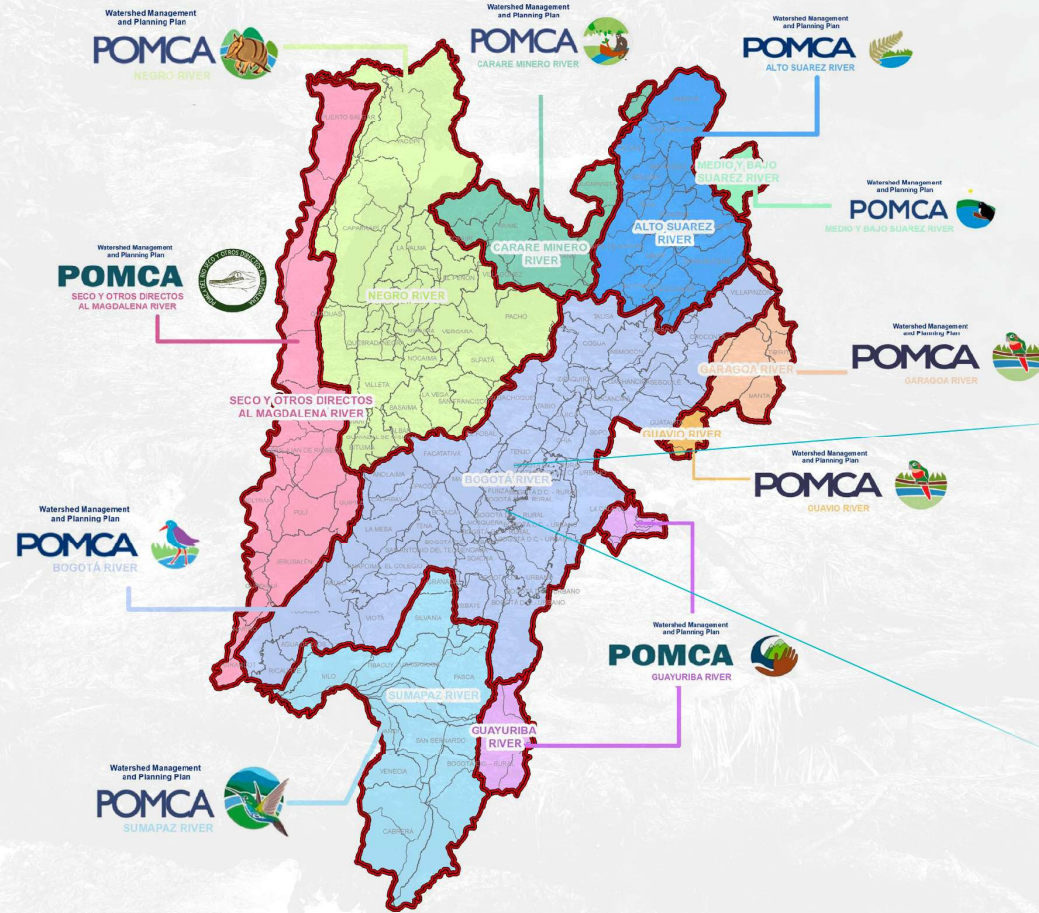
CAR

A stylized butterfly logo with blue and green wings, positioned to the right of the large 'CAR' text.

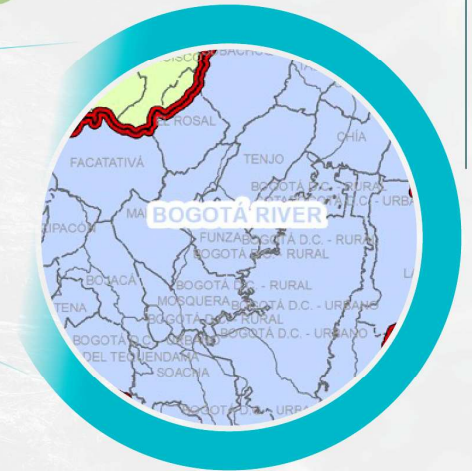
Environmental Evaluation, Monitoring and Control Platform -PESCAR.



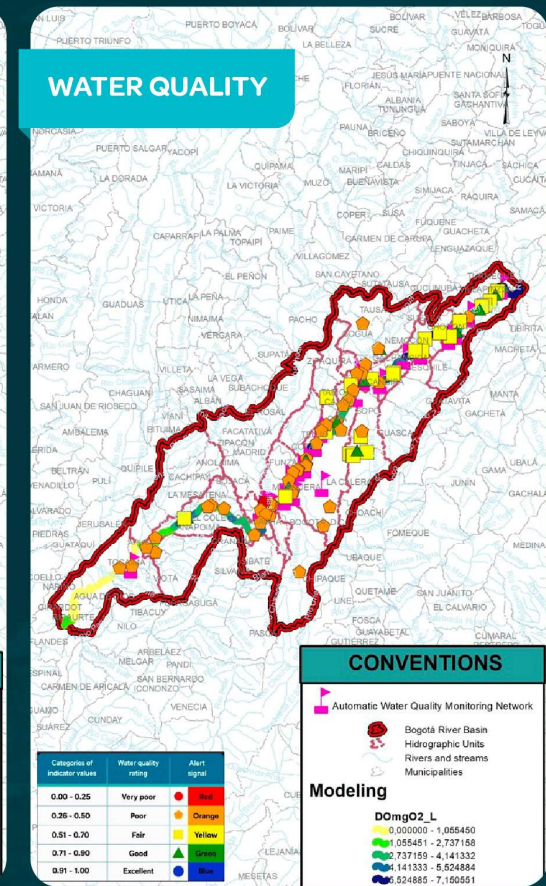
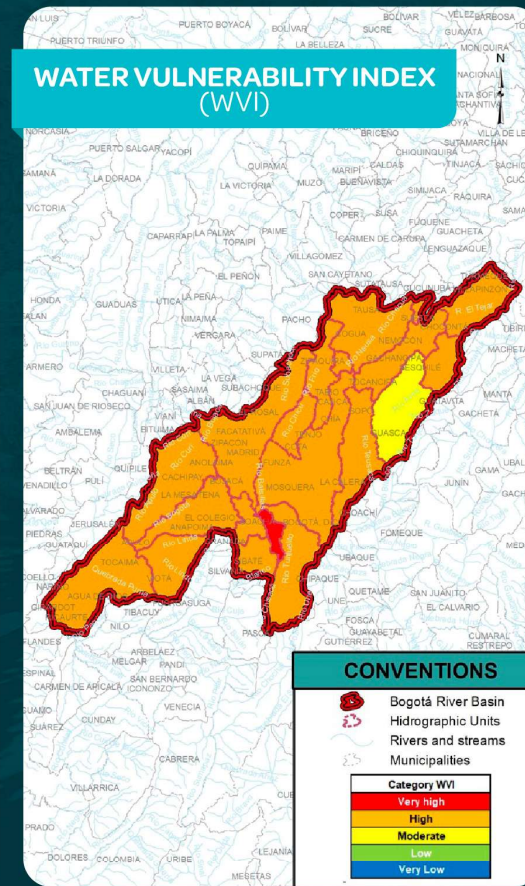
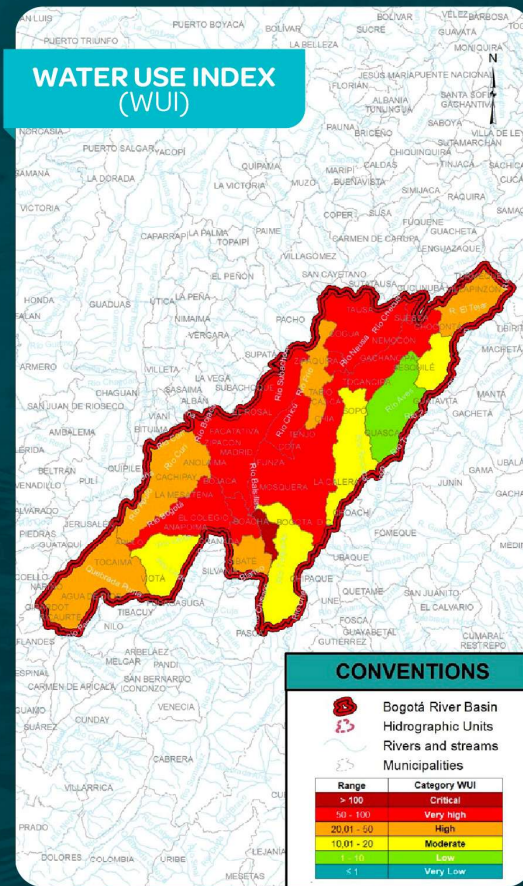
10 Hydrographic Basins CAR Jurisdiction



The Bogotá River Basin includes **45 municipalities** and Bogotá D.C., supporting a population of more than **10 million people**. This makes it one of Colombia's most strategic and densely populated watersheds.



Hydrographic Basins CAR Jurisdiction





Groundwater quality information generated

Recharge Zones:

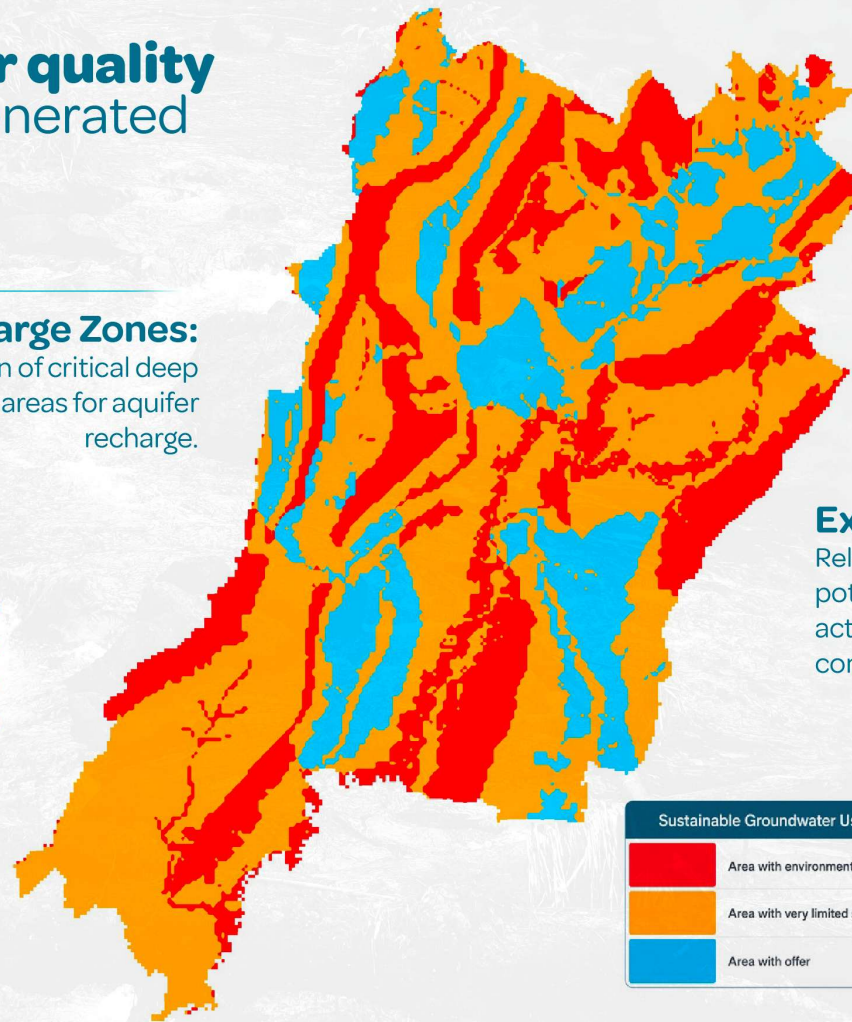
Identification of critical deep infiltration areas for aquifer recharge.

Lithological Potential:

Calculation and modeling of the permeability of geological units within the basin.

Extraction Index:

Relationship between potential recharge and actual demand from water concessions.



Sustainable Groundwater Use Potential	
Red	Area with environmental restriction
Orange	Area with very limited supply
Blue	Area with offer



What is for...



PRODUCTS AND OUTCOMES

- Territory Knowledge
- Water Quality Status
- Water Vulnerability Assessment
- Risk Alerts and Management
- Sustainable Water Resources Planning and Management



Integrated water resource management

PROJECT 1



Water resource assessment for environmental management

PROJECT 2



Water resource management and planning

PROJECT 3



Environmental infrastructure for water resources

PROJECT 4



Sustainable environments for water resource governance



Governance around water

Transformation pillars



Technology Platform

Interactive web platform with monitoring stations, traffic-light alert dashboards, dynamic reporting, and a mobile app delivering targeted push notifications.



Data Governance

Metadata catalog, interoperable real-time APIs, data traceability, and institutional information reuse.



Community Engagement

Knowledge ownership fostered through participatory information generation and accessible data exchange tools.





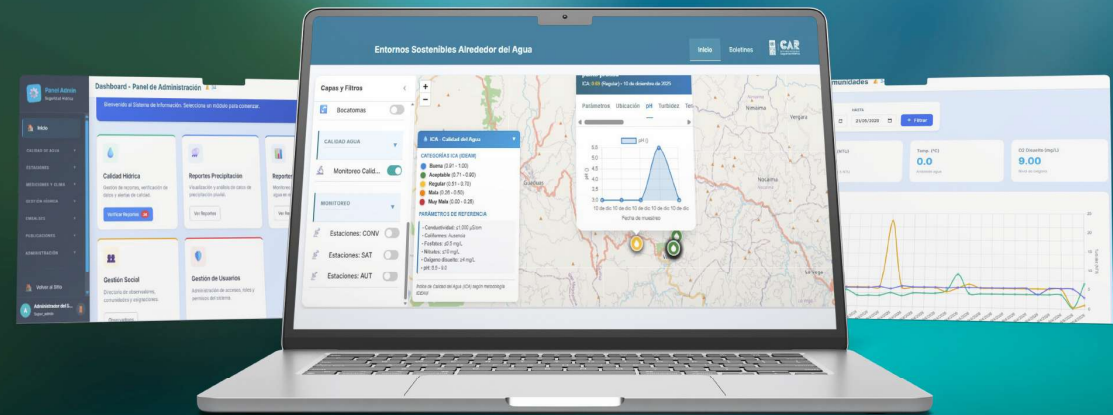
Web Viewer

Public Access:

Provides direct access to key environmental information, including citizen-reported hydrometeorological events, precipitation and hydrological data, water quality monitoring results, real-time radar imagery, and other relevant datasets.

Administrative Access (CAR):

Enables the management of communities, water bodies, monitoring sites, and observers through dedicated administrative modules. It also supports the review, validation, and approval of water quality reports submitted by observers, ensuring compliance with established quality criteria. Additionally, the platform facilitates the automated publication and updating of hydrometeorological bulletins issued by the Corporation.





Challenges and Opportunities



Water resources face increasing pressure from pollution, overexploitation, climate variability, and competing demands across sectors.



Environmental authorities need greater investment to ensure sustainable water management and the protection of ecosystems.



Climate adaptation, digital monitoring, and integrated watershed management create opportunities to improve water security and sustainability.



Implement actions for restoration, rehabilitation and ecological connectivity in the ecosystems of the micro-basin for risk mitigation and restoration of ecosystem services

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