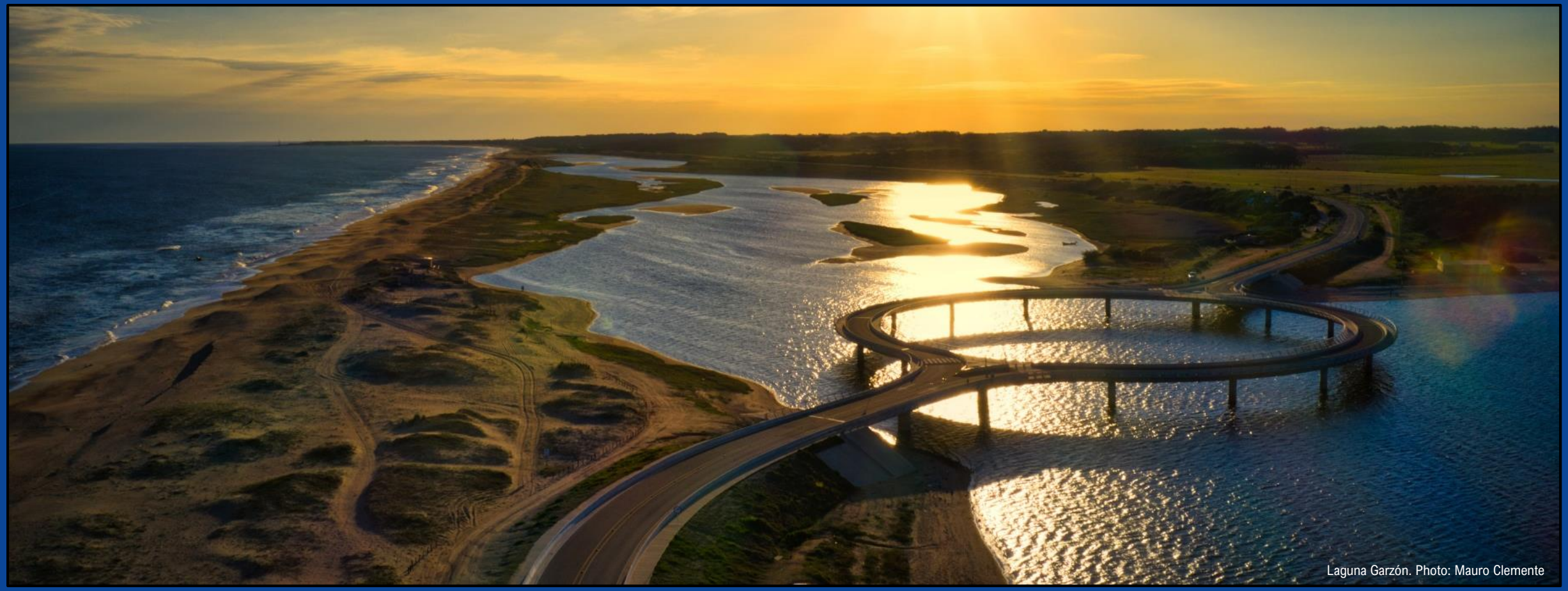

Laguna Garzón. Photo: Mauro Clemente

Delft-FEWS
FEWS-Uruguay

DINAGUA
Dirección Nacional
de Aguas

DEPARTAMENTO
DEL AGUA

CENUR
Litoral Norte

UNIVERSIDAD
DE LA REPÚBLICA
URUGUAY

Implementation of a operational forecast system for decision making in Uruguay (FEWS-Uruguay)

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University of the Republic

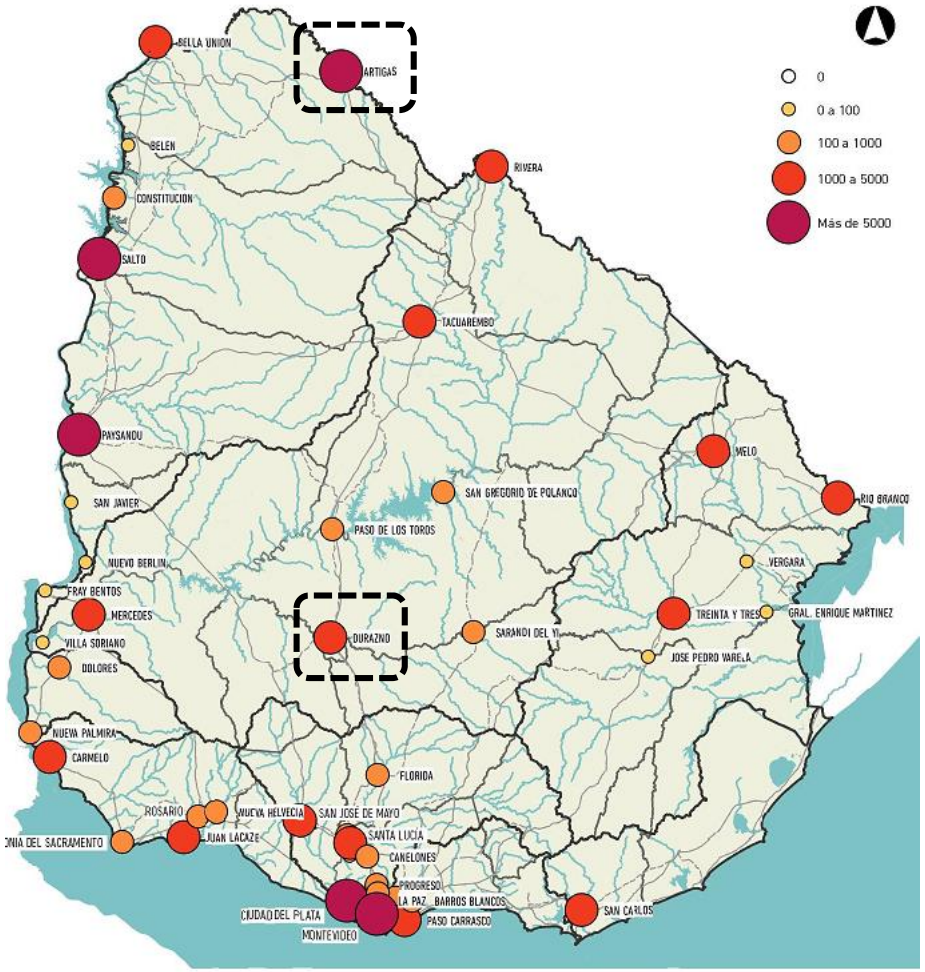
Background

- National Directorate of Water (DINAGUA) is part of the newly created Ministry of Environment of Uruguay
- Contribute to the development of knowledge on water resources in Uruguay.
  - Hydrological monitoring
  - Tools for water resource evaluation, planning and management.
- DINAGUA Situation and Forecast Room
  - Monitor the current hydrological conditions (droughts and floods)
  - Hydrological forecasting
  - Provide the relevant hydrological information (floods, drought) to the **National Emergency System (SINAE)** of Uruguay.

sinae
SISTEMA NACIONAL DE EMERGENCIAS

Coordinates public institutions for the comprehensive management of disaster risk in Uruguay

Floods



Number of inhabitants who lives in flood area (under the 100-year return period). Source: IDU – DINAGUA

City of Artigas after the 2018 flood event. Source: SINAE 2018

City of Durazno after de 2019 flood event. Source: SINAE 2019

What has been done so far at Durazno and Artigas

2002

Preliminary Alert System (SAP) at Yí river basin.

2005

Preliminary Alert System (SAP) at Cuareim river basin

2011

Developing of a event-based rainfall-runoff model of the Yí and Cuareim river

2017

Incorporate the event-based rainfall-runoff models into a model centric forecast system (SATI-UY)

2019

Implementation of Delft-FEWS in Uruguay

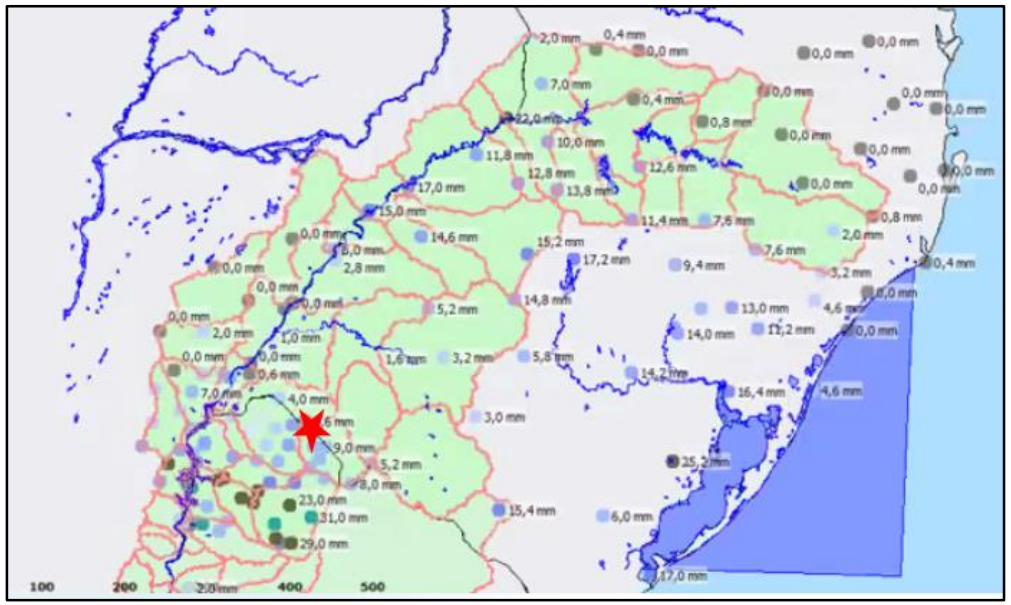
Main problems associated with Uruguay flood forecast system in 2019

- Difficulties in keeping the system operating autonomously
- Implemented models based on events that did not represent well some events
- Automation was not robust: modelers intervention was necessary in certain events
- Difficulties in transferring models to public administration: problems associated with ownership of developments

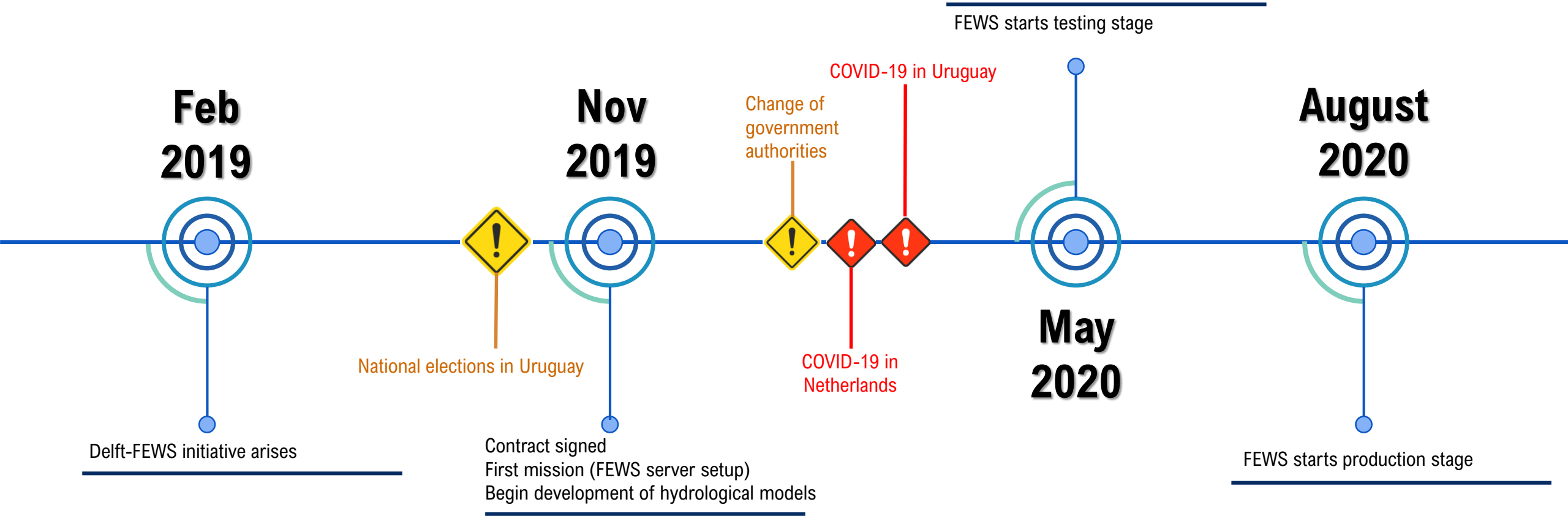
Salto Grande, Uruguay's largest hydroelectric plant (which is shared with Argentina) started using FEWS in 2014.

One of the cities with flood problems is in the basin of the Salto Grande reservoir

SINAE obtained funding to implement in DINAGUA FEWS and generate flood forecasts based on models developed by the University of the Republic



Development timeline (from scratch to operational system)



FEWS-Uruguay: Main features

IMPORT AND PREPROCESS

- Different data source and type
- Import Numerical Weather Prediction
- Transform daily data from 00:00 to 07:00
- Convert water level into discharge
- Automatic interpolation of water level measurement
- Aggregate rainfall and discharge data
- Data manual and automatic validation

IMPORT OBSERVED AND FORECAST DATA

PREPROCESS DATA

VALIDATION OF DATA

HYDROLOGICAL MODELLING

- Two river basin: Cuareim and Yí
- Lumped and semi-distributed Sacramento Rainfall - Runoff conceptual model
- Unit Hydrograph
- Muskingum routing model
- Hydrological model forcing: GFS and GEFS (30 members + control run)
- Forecast post-processing (percentile)

RUN HYDROLOGICAL MODEL UPDATE

RUN HYDROLOGICAL FORECAST

ERROR CORRECTOR

- Autoregressive Moving Average (ARMA) model

ERROR CORRECTOR

FLOOD MAPS

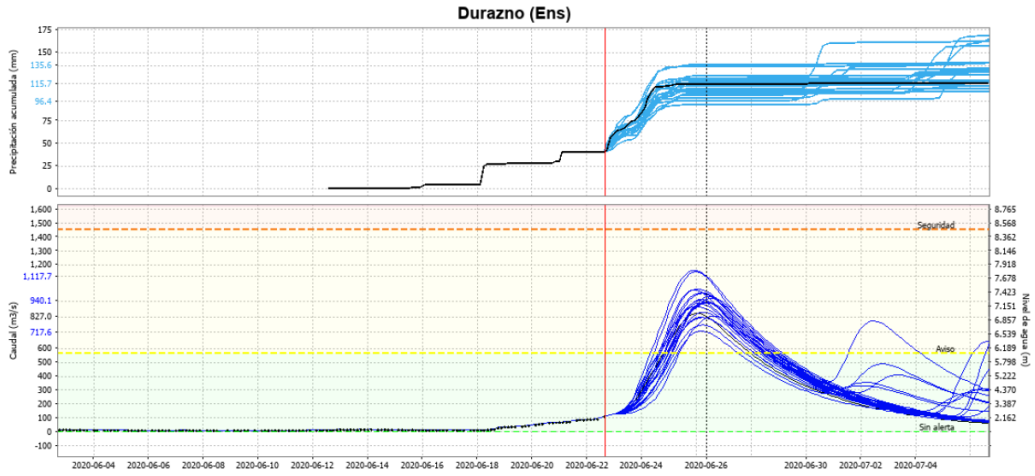
- Non conservative model method
- Predicted flood maps for Durazno and Artigas city

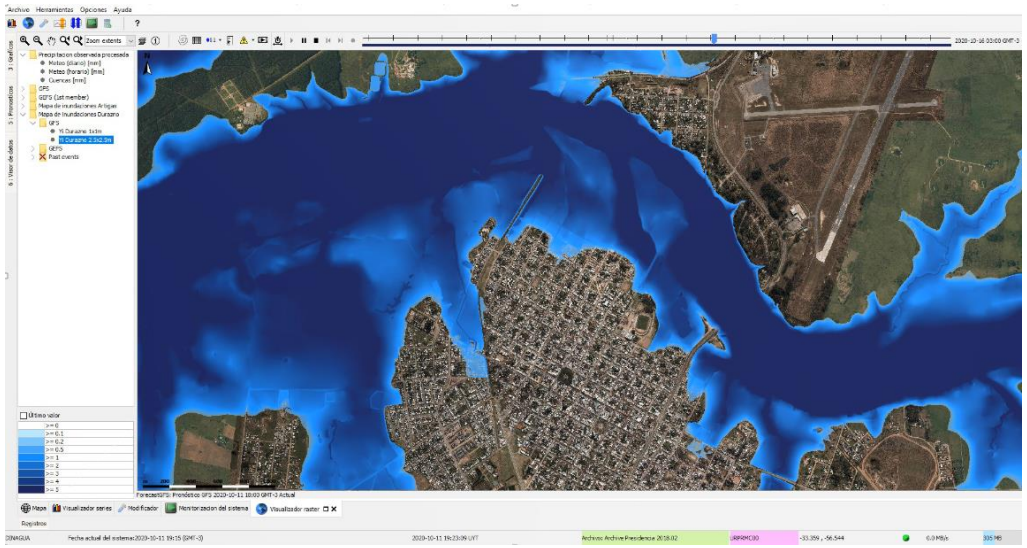
RUN FLOOD MAPS

OPEN ARCHIVE

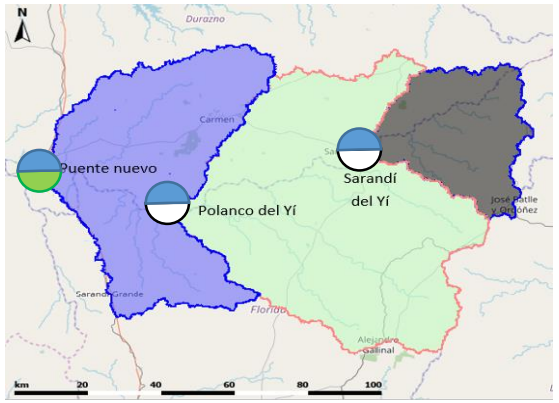
- Save observed and simulated data for forecast verification

DELFT-FEWS OPEN ARCHIVE

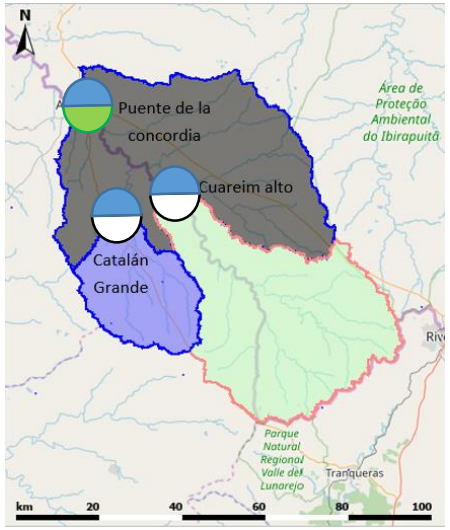




FEWS-Uruguay: Hydrological modelling

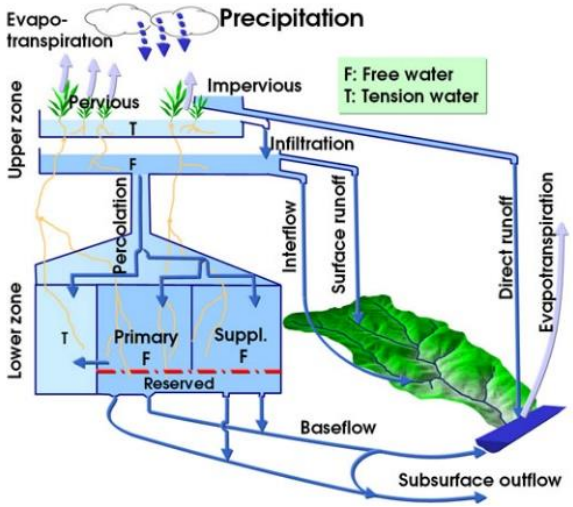


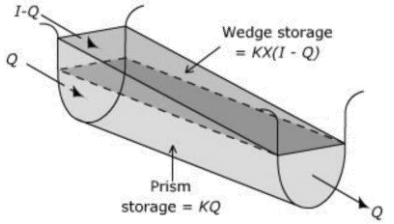
- Aggregated models (Sacramento): like the one from Salto Grande that showed good results in Artigas City
- Semi distributed models (Sacramento + Muskingum): using synthetic rating curves for ungauged stations



Head observations available
Trustable rating curve

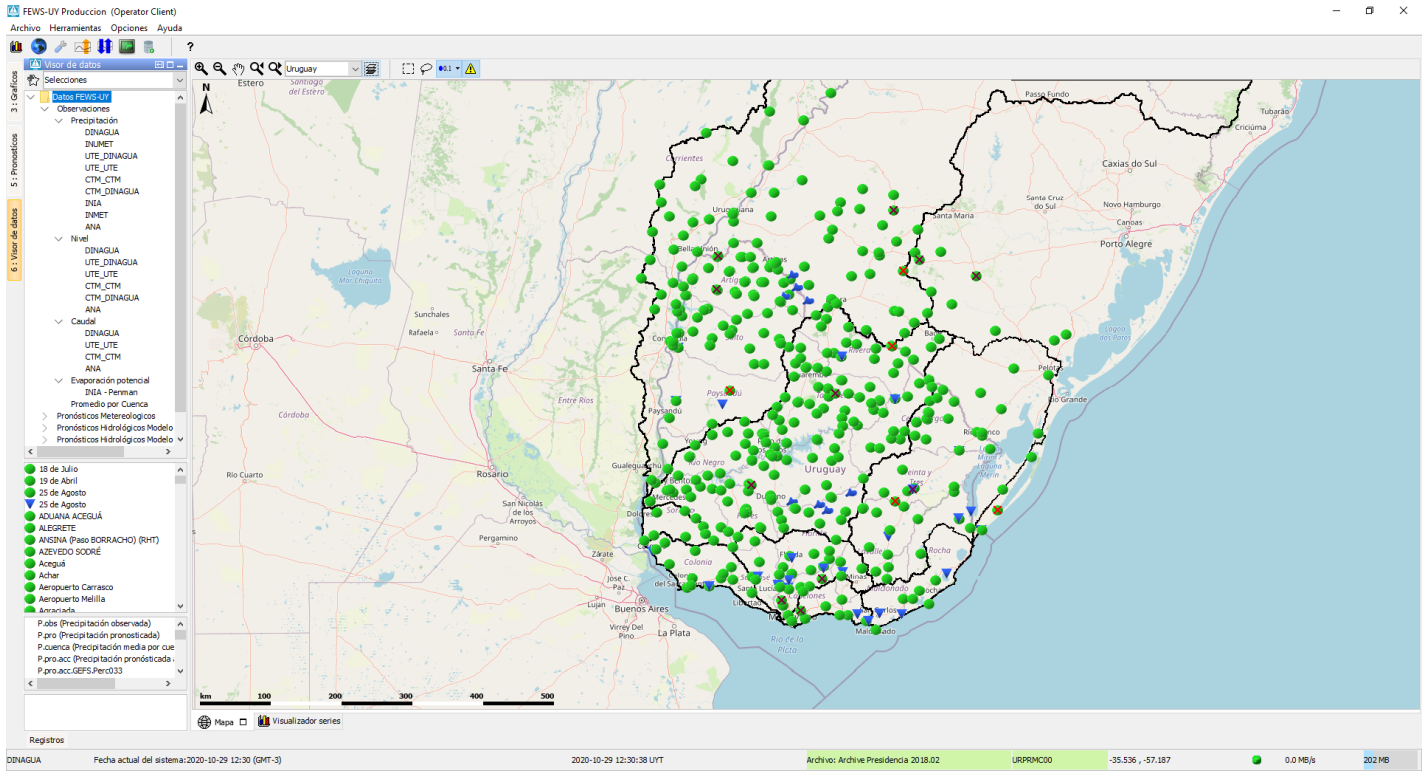
Head observations available
Non trustable or not existing rating curve





There are 2 models for each basin in FEWS Uruguay
It's like a “mini ensemble” of hydrological models

FEWS-Uruguay: Importing observed data

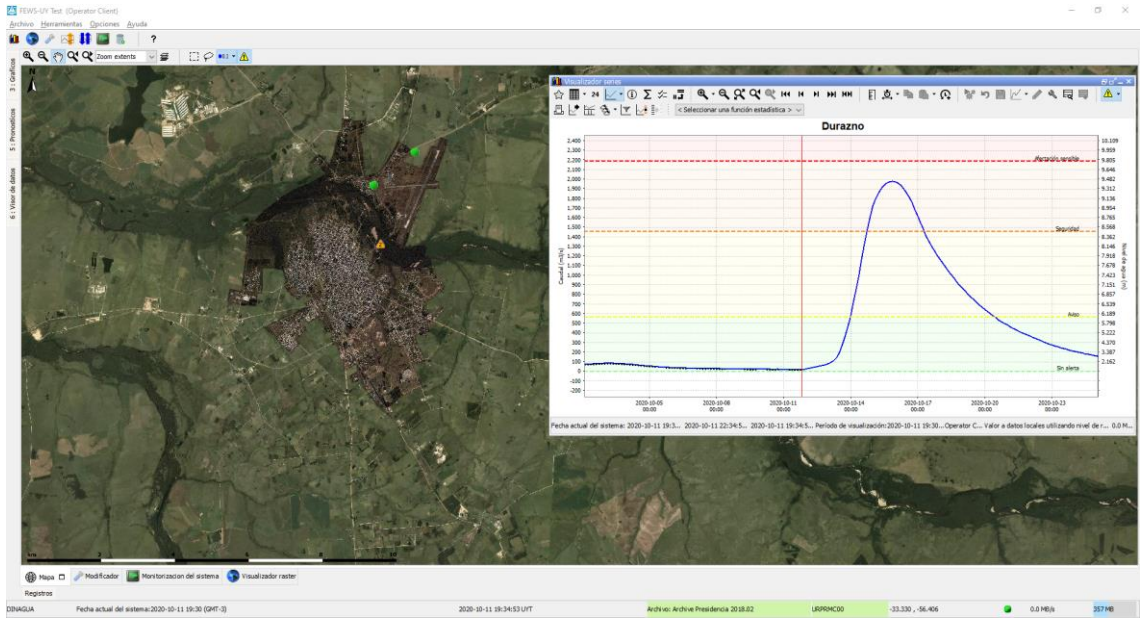


Available data sources in FEWS-Uruguay

Number of gauges imported in FEWS-Uruguay

437	Rainfall Gauges	52	Discharge gauges	106	Water level gauges	6	Pot. Evapotranspiration

FEWS-Uruguay: Flood forecast

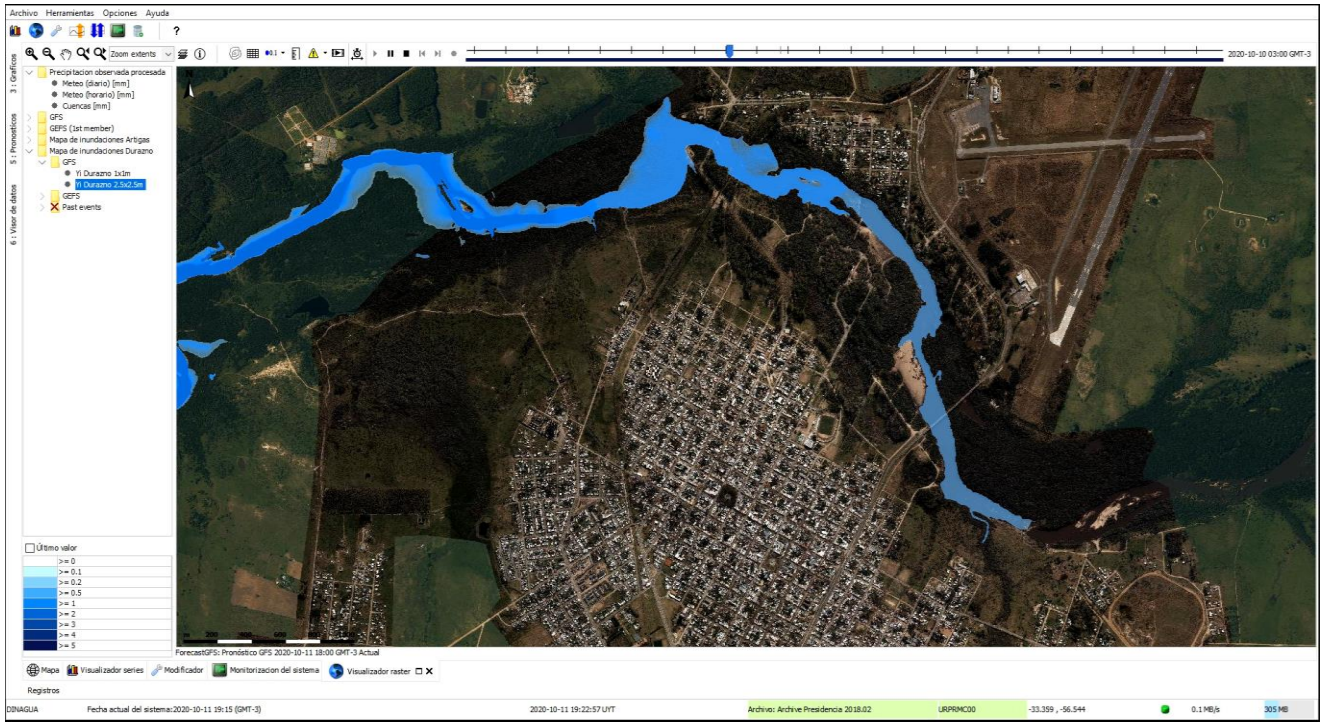


Deterministic forecast at Durazno city in Uruguay

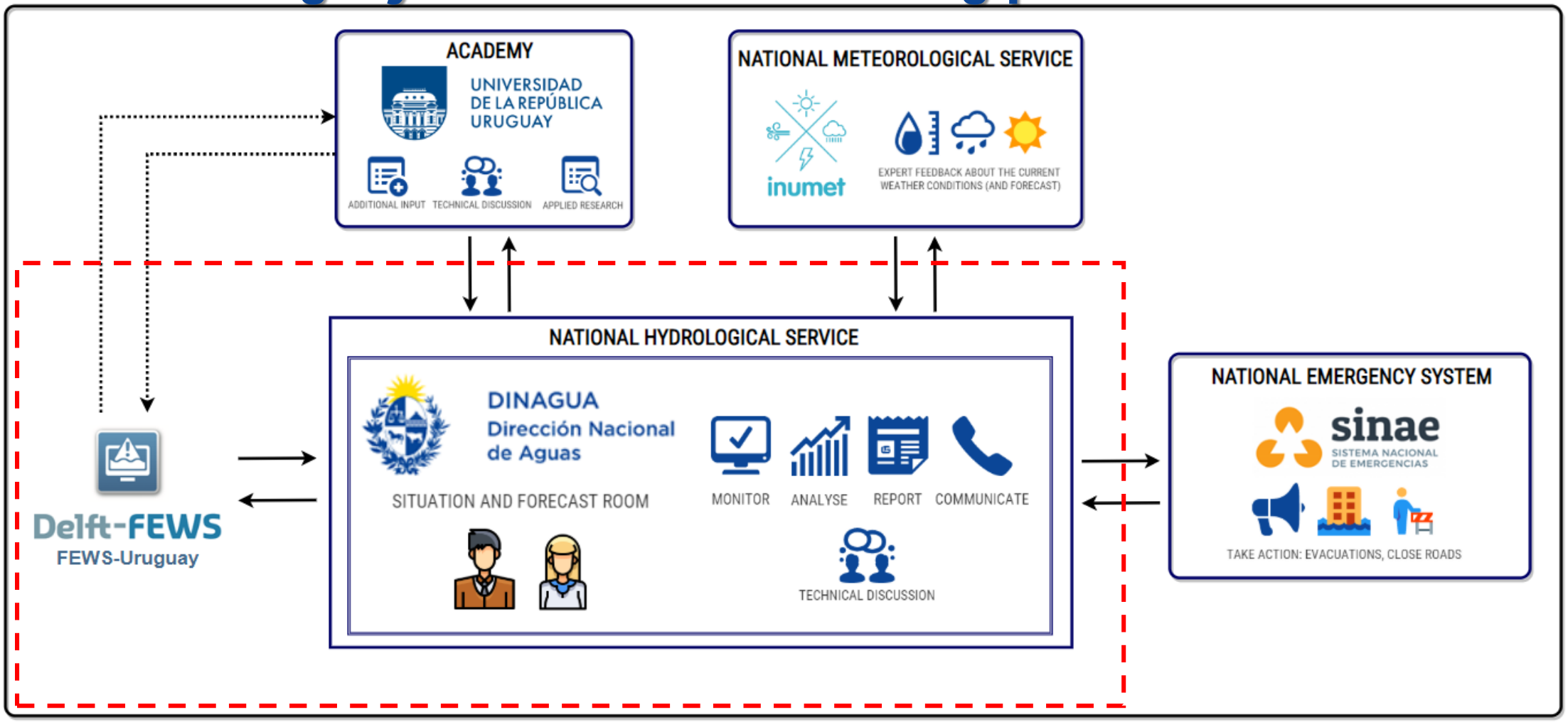
- Deterministic forecast using the GFS
- There is an ensemble forecast using the GEFS (30 members + unperturbed run)

- FEWS-Uruguay forecast the water level and projects it through a Digital Elevation Model (DEM)
- Do not represent a hydrodynamic behaviour
- However, the method provide good results

flood forecast map at Durazno city in Uruguay

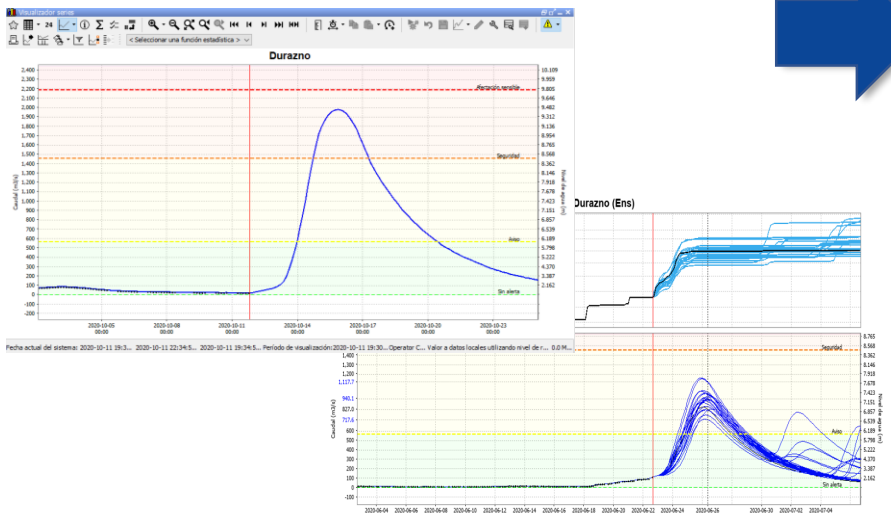


FEWS-Uruguay in the decision making process



FEWS-Uruguay in the decision making process at DINAGUA

Delft-FEWS
FEWS-Uruguay



MONITORING	WATCH	ADVISORY	WARNING	EMERGENCY
Normal situation	Some possibility of a flood event in the next 72-144 hours	There is a possibility of a minor flood event in the next 48-72 hours	There is a high probability of a moderate flood event in the next 24-72 hours	This level of alert activate when there is a confirmed flood impact
Not internal or external communication required	Observed water level is >75% of the moderate flood threshold	Observed water level is >90% of the moderate flood threshold	Observed water level is <90% of the moderate flood threshold	Internal notification via email (e-mail) about the change in the level of alert
Daily review of the forecasts	Internal notification via email (e-mail) about the change in the level of alert	Internal notification via email (e-mail) about the change in the level of alert	Internal notification via email (e-mail) about the change in the level of alert	Waiting time to address the issue kept increasing
	No external communication required	Send a daily Flood report to the local and National Emergency System (SINAE, CECOED)	Send a daily Flood report to the local and National Emergency System (SINAE, CECOED)	Send a daily Flood report to the local and National Emergency System (SINAE, CECOED)
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FEWS-Uruguay in the decision making process

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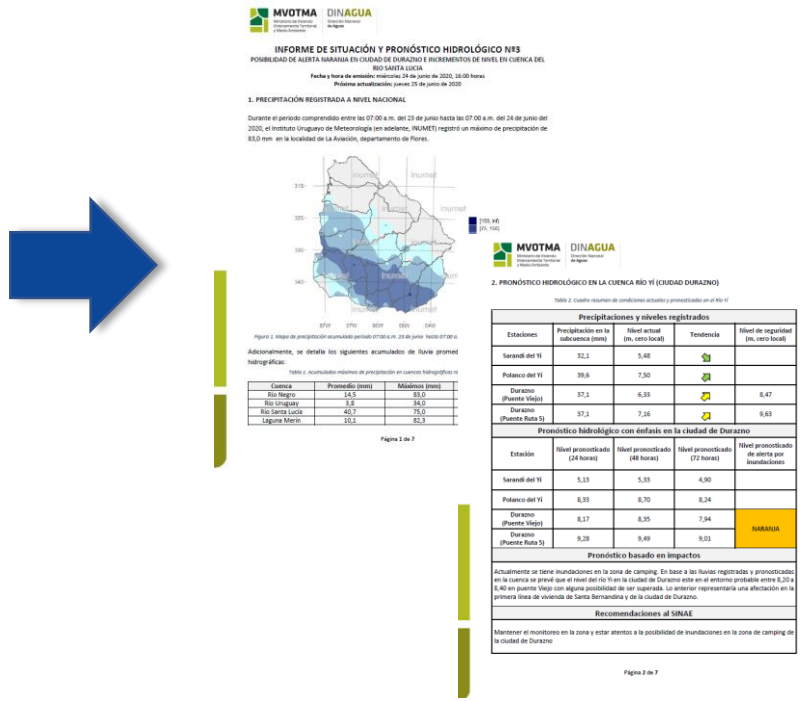

MVOTMA DINAGUA

INFORME DE SITUACIÓN Y PRONÓSTICO HIDROLÓGICO Nº3

POSIBILIDAD DE ALERTA NARANJA EN CIUDAD DE DURAZNO E INCREMENTOS DE NIVEL EN CUENCA DEL RÍO SANTA LUCÍA

Fecha y hora de emisión: miércoles 24 de junio de 2020, 16:00 horas

Próxima actualización: jueves 25 de junio de 2020

1. PRECIPITACIÓN REGISTRADA A NIVEL NACIONAL

Durante el período comprendido entre las 07:00 a.m. del 23 de junio hasta las 07:00 a.m. del 24 de junio del 2020, el Instituto Uruguayo de Meteorología (en adelante, INUMET) registró un máximo de precipitación de 83,0 mm en la localidad de La Aviación, departamento de Flores.

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MVOTMA DINAGUA

2. PRONÓSTICO HIDROLÓGICO EN LA CUENCA RÍO YÍ (CIUDAD DURAZNO)

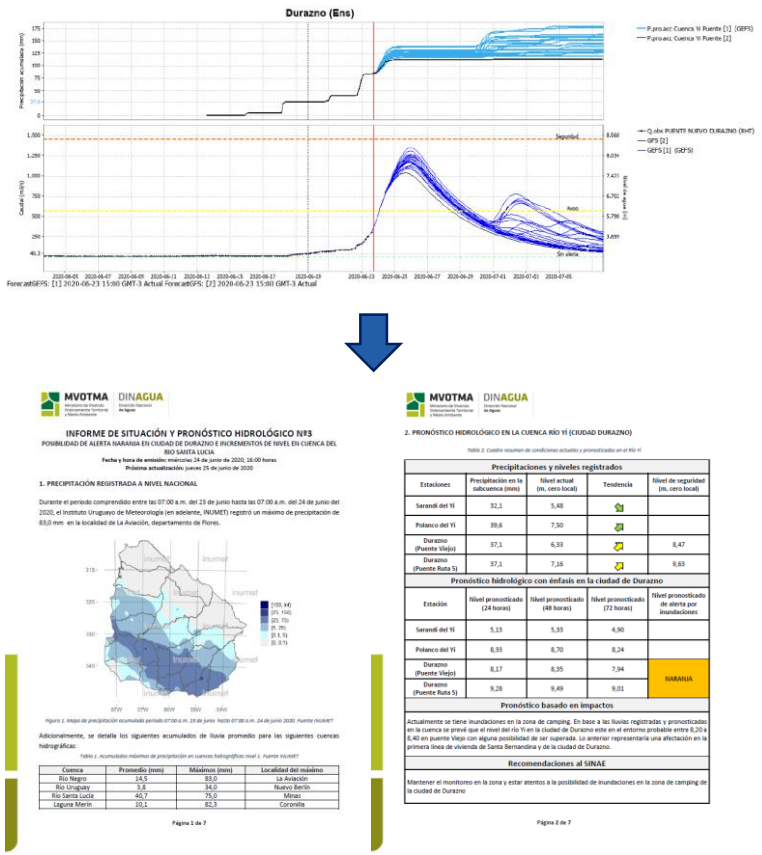
Precipitaciones y niveles registrados				
Estaciones	Precipitación en la subcuenca (mm)	Nivel actual (m, cero local)	Tendencia	Nivel de seguridad (m, cero local)
Sarandí del Yí	32,1	5,48		
Polanco del Yí	39,6	7,50		
Durazno (Puente Viejo)	37,1	6,33		8,47
Durazno (Puente Ruta 5)	37,1	7,16		9,63
Pronóstico hidrológico con énfasis en la ciudad de Durazno				
Estación	Nivel pronosticado (24 horas)	Nivel pronosticado (48 horas)	Nivel pronosticado (72 horas)	Nivel pronosticado de alerta por inundaciones
Sarandí del Yí	5,13	5,33	4,90	
Polanco del Yí	8,33	8,70	8,24	
Durazno (Puente Viejo)	8,17	8,35	7,94	NARANJA
Durazno (Puente Ruta 5)	9,28	9,49	9,01	
Pronóstico basado en impactos				
Actualmente se tiene inundaciones en la zona de camping. En base a las lluvias registradas y pronosticadas en la cuenca se prevé que el nivel del río Yí en la ciudad de Durazno este en el entorno probable entre 8,20 a 8,40 en puente Viejo con alguna posibilidad de ser superada. Lo anterior representaría una afectación en la primera línea de vivienda de Santa Bernardina y de la ciudad de Durazno.				
Recomendaciones al SINAE				
Mantener el monitoreo en la zona y estar atentos a la posibilidad de inundaciones en la zona de camping de la ciudad de Durazno				

Página 2 de 7

Example of flood report provided by DINAGUA

Early (unexpected) employment of FEWS-Uruguay results

- Minor flood event at Durazno between Jun 26 and 28, 2020
- FEWS-Uruguay was on test mode at DINAGUA Situation and Forecast Room. However, it was a great opportunity to evaluate the forecast system.
- DINAGUA analysed the FEWS-Uruguay outputs and submitted a daily flood report.
- Civil Protection in Uruguay (CECOED and SINAE) took decision based on DINAGUA flood report
- Local journal reported that “the new forecast system has provided accurate results”
- Although the forecast model was unable to predict the time of the peak, the maximum water level was very good (obs = 8.16 m, sim = 8.17 m)



Flood report provided by DINAGUA on Jun 24, 2020

Tras informe del CECOED aumentó número de autoevacuados en Durazno

duraznodigital junio 28, 2020

En virtud de que el pico de creciente se producirá durante la madrugada del domingo 28 de junio, funcionarios del Centro Coordinador de Emergencia (CECOED) pidieron a dos personas que viven a pocos metros del río Yí su rápida autoevacuación.

A las mismas el CIB Santa Bernardina las auxilió y dio alimentos, amén de la opción de ir a su gimnasio o a la casa de algún familiar. A estar por datos recogidos por **DURAZNO DIGITAL** los mismos optaron por casa de familia, en tanto sus muebles y pertenencias fueron llevados al Club Sportivo Yí, por así haberse dispuesto en los protocolos de actuación del Comité de Emergencia para esta inundación del río Yí.

En lo que tiene relación con el río, durante la noche sabatina las aguas habían pasado los 8,33 metros sobre su nivel normal y crecían a razón de 1 centímetro por hora, lo que indica que el Nuevo Sistema de Predicción que está utilizando el **CECOED** -a instancias del SINAE- se ha anticipado con exactitud a los hechos.

Local journal reporting about “the new forecast system” during the flood emergency at Durazno. Source: Durazno Digital

Lesson learned and comments

COMMUNICATION

Highly important to deliver the proper information to the person who takes action on the field

FLOOD IMPACTS

Better decision are taken if you include an analysis of the possible impacts.

UNCERTAINTY

DINAGUA assumed the risk of uncertainty in the hydrological forecast. However, it should be communicated in the flood report.

OPERATOR

The forecast operator was able to run different rainfall scenarios in the hydrological model using the modifier tool

MODEL ERROR

Although the forecast model was unable to predict the time of the peak, the maximum water level was very good (obs = 8.16 m, sim = 8,17 m)

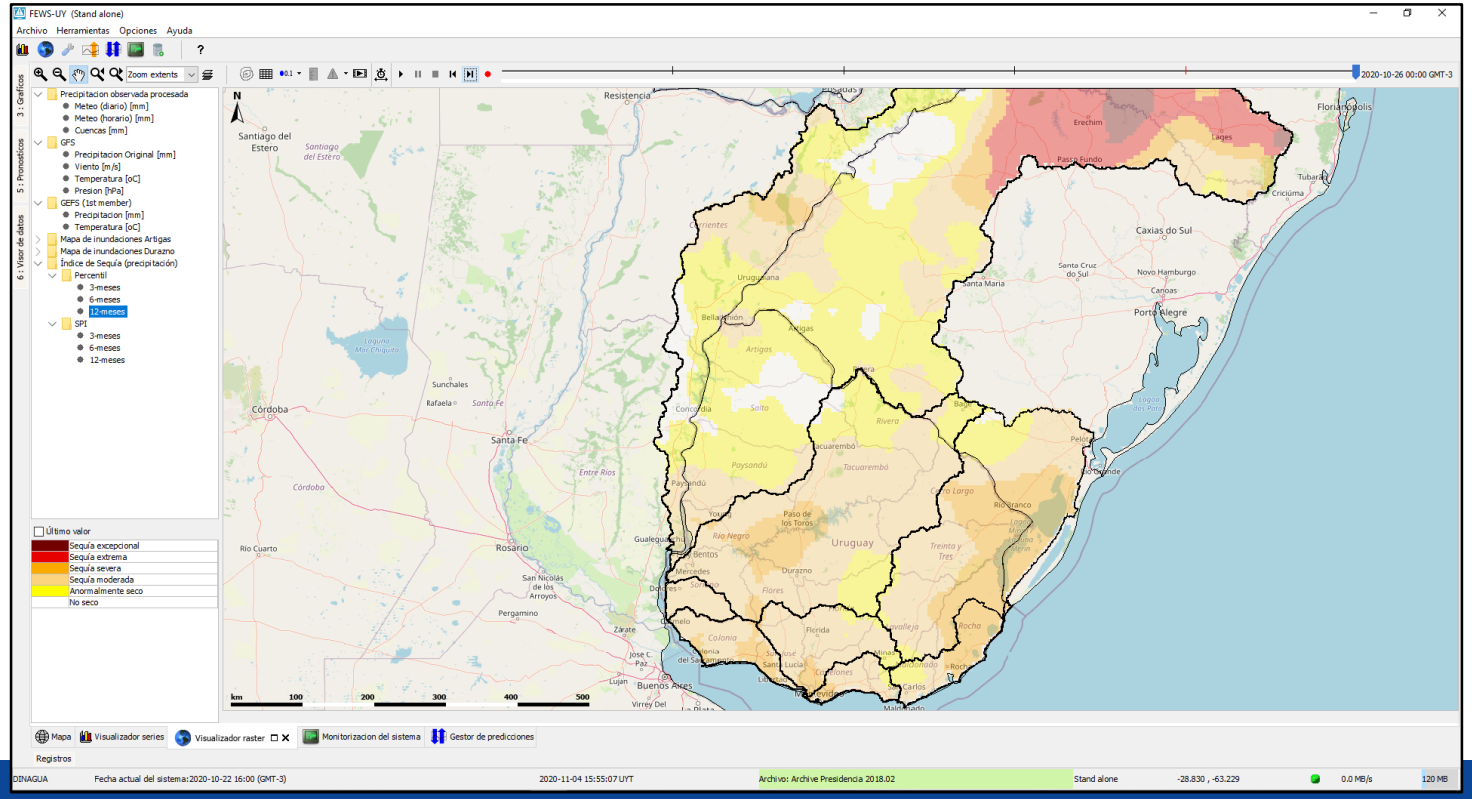
ARMA MODULE

The ARMA error corrector is a great tool to improve the reliability of the forecast. However, it should be calibrated with a set of observation and model runs.

FEWS-Uruguay: Hydrological Drought Monitor

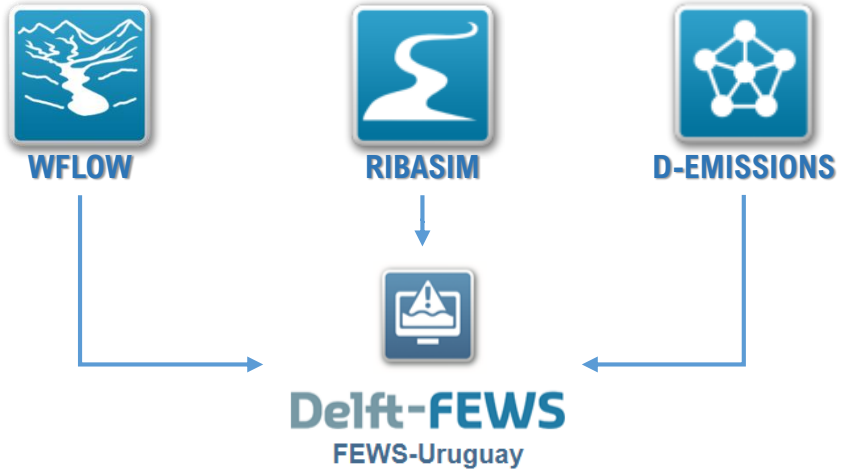
- FEWS-Uruguay was configured to import data from the Drought Information System of the South of South America (SISSA)
- SISSA s a virtual institution that operates within the framework of the Regional Climate Center for the South of South America (CRC-SAS).

- Drought Index imported in FEWS-Uruguay
  - Rainfall percentile
  - Standardized Precipitation Index SPI
  - Discharge percentile (ongoing)
  - Discharge index SDI (ongoing)



FEWS-Uruguay: Santa Lucia River Basin (2021 – 2023)

- Why Santa Lucia river basin?
  - ❑ 79% of the water is used as drinking water
  - ❑ 13% is used for agricultural purposes
  - ❑ Water quality and quantity issues
- Improve the flood early warning system by implementing an operational hydrological forecasting in the catchment
- Implement a water allocation model (RIBASIM) in the basin to be used at DINAGUA for water management and planning
- First steps in solving many water quality problems by getting a quantitative overview of the emissions of substances in Santa Lucia River basin.
- Runs of different scenarios for water planning in the catchment



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