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EO for Paddy Flooding Detection & Predictions

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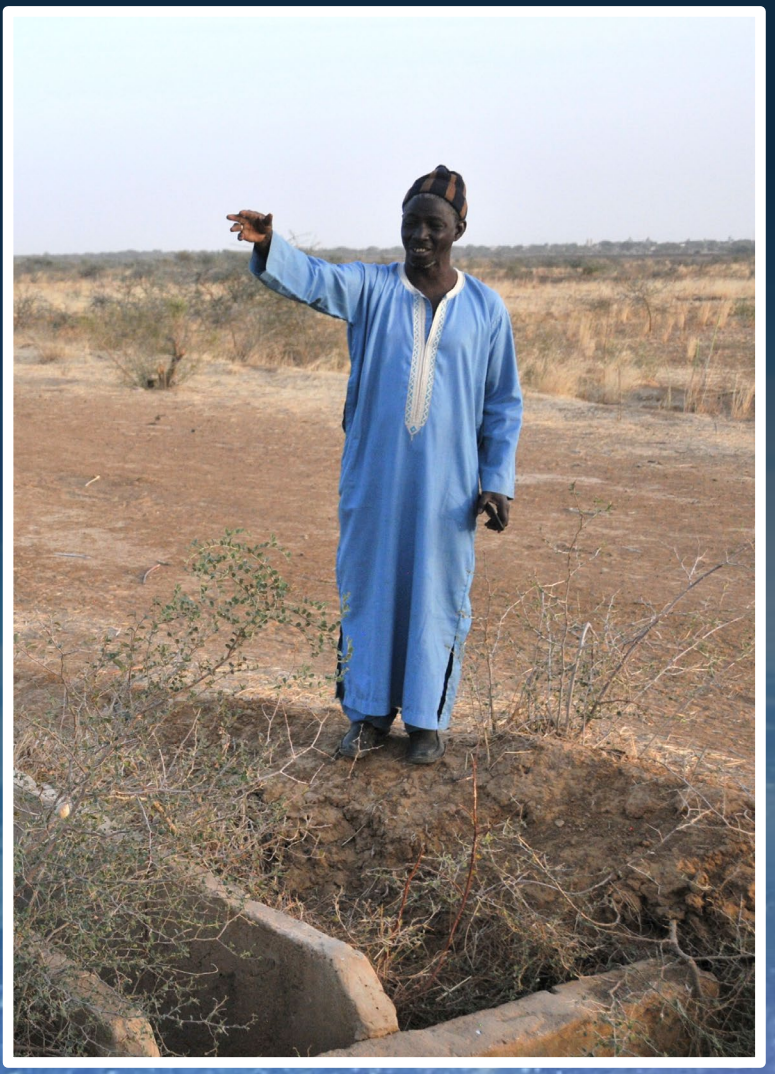


USAID FROM THE AMERICAN PEOPLE | NASA | SERVIR | ALLIANCE Bioversity International CIAT | ICRISAT Transforming Dryland Agriculture | ICIMOD | adpc

The context

- Rice: main staple for the growing urban population of Senegal (consumption: 1.6Mt, total population: 17.2M)*
- Senegal River Valley produces 77% of Senegal's rice*
- BUT national production only covers 25% of national consumption. Rice imports: 500M$/yr and rising*

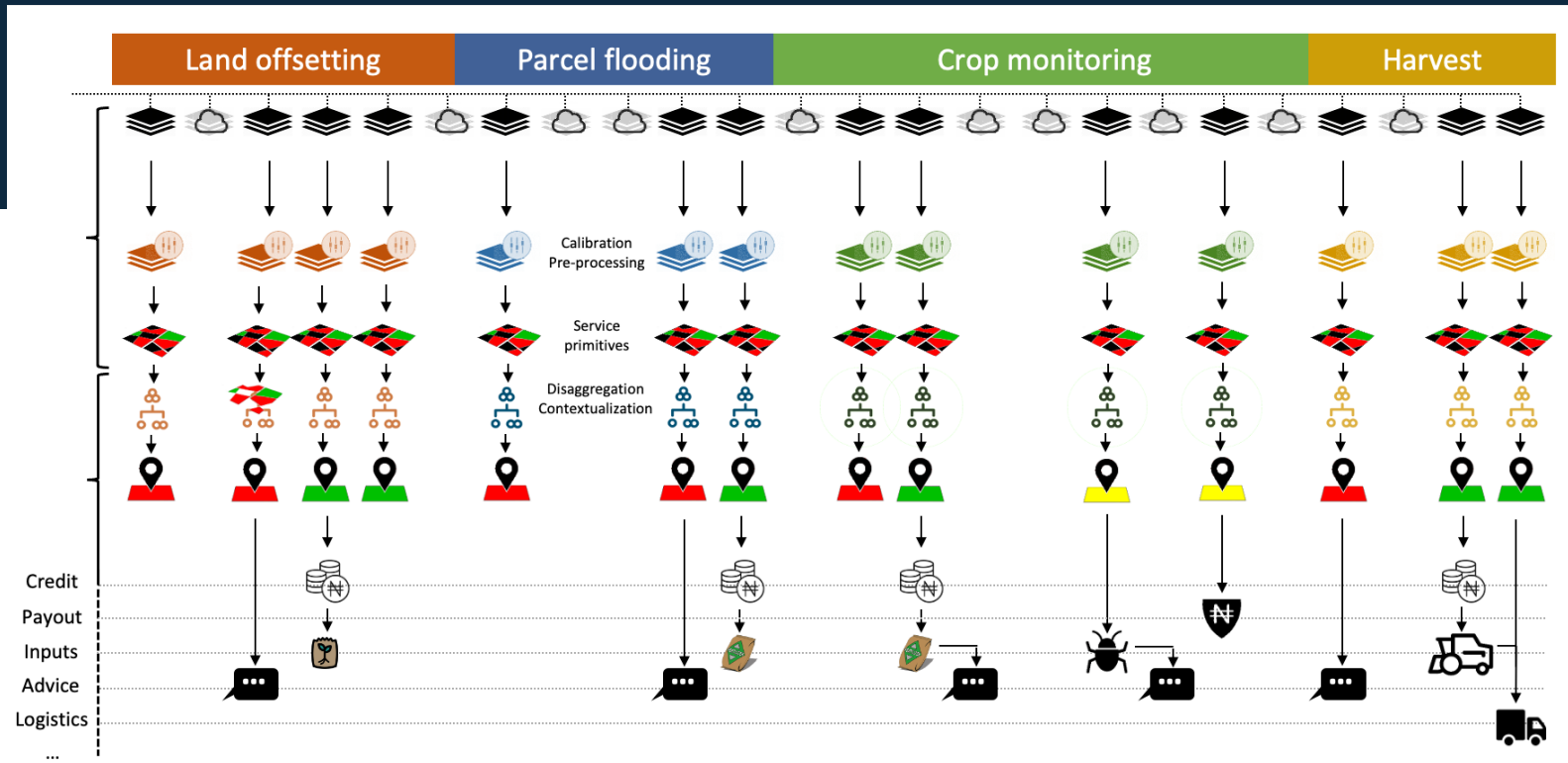
*data source: ANSD, 2021

The opportunity

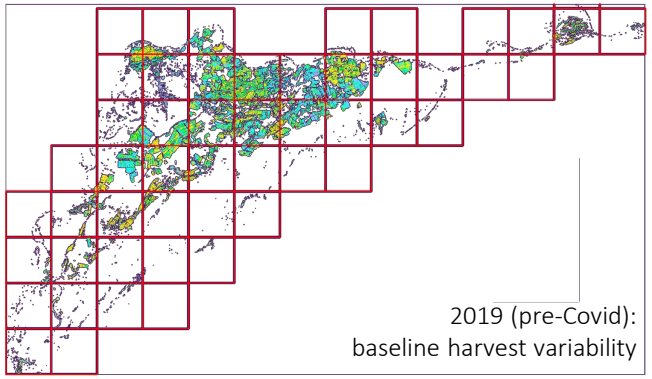
- Increasing national production requires financing for smallholders (inputs, etc.)
- Contract farming is a major opportunity for financial inclusion
- BUT de-risking the provision of credit to smallholders is complex and expensive

The solutions

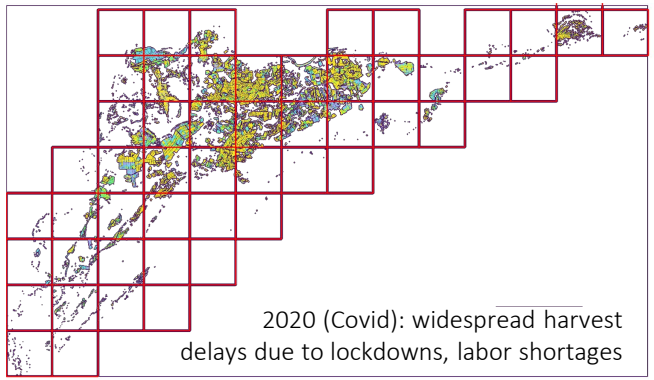
- Good agronomic practices (GAPs) help reduce yield loss and default
- Ag/fintechs want to reduce the cost of monitoring farmer compliance with GAPs
- Satellites increasingly “see” plot-level management practices



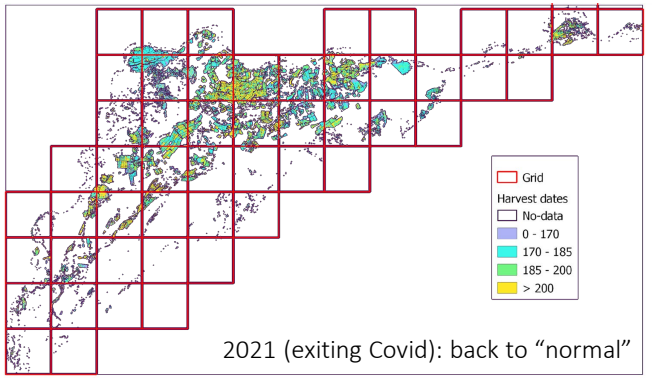
S1 VH harvest date estimates



2019 (pre-Covid): baseline harvest variability



2020 (Covid): widespread harvest delays due to lockdowns, labor shortages



2021 (exiting Covid): back to “normal”

Risk mapping

IFC Africa Agriculture Accelerator Program

agCelerant Risk sharing facility 2023

Risk mitigation framework applied to map risks from production to commercialization

219 unique process-level risks mapped along the rice value chain:

- 76 pre-season (19 critical)
- 143 in-season (34 critical)

An Extract: Risks that FIS can solve using EO

Risk/Solution	Impact	Loan Repayment Capacity	Interest Rates	Credit Terms
Delayed flooding due to insufficient planning and resources	High residual risk of crop loss leading to reduced income	Decreased ability to repay loans	Higher risk premiums, increased interest rates	Stricter credit terms, higher collateral requirements
Soil erosion impacting crop stability	Medium residual risk of decreased crop productivity	Potential reduction in financial stability	Moderate increase in interest rates	Possible adjustments in credit terms
Predicting the Physiological Maturity of Rice	Accurate predictions of rice maturity can help in better scheduling of labor and machinery, reducing the costs associated with idle time or rushed harvests.	Enhanced ability to plan and mitigate delayed flooding and harvesting	Potential reduction in interest rates	More favorable credit terms
Monitoring of the Permanence of Standing Water in Plots	Improved monitoring of water levels and understanding flooding and drainage cycles, farmers can optimize water usage, leading to reduced costs associated with water consumption and management.	Effective water management can prevent crop loss due to improper drainage, saving potential revenue that might have been lost due to crop failure.	Potential reduction in interest rates	More favorable credit terms. Easy monitoring of potential losses by insurance companies
Fusion of Sentinel 1 and 2 for flooding mapping and estimation of flooding dates	Improved monitoring and prediction of flooding events	Enhanced ability to plan and mitigate delayed flooding	Potential reduction in interest rates	More favorable credit terms. Easy monitoring of potential losses by insurance companies
Fusion of Sentinel 1 and 2 for harvest mapping and estimation of harvesting dates	Improved monitoring and prediction of harvesting events	Enhanced ability to plan and mitigate delayed harvesting	Potential reduction in interest rates	More favorable credit terms Easy monitoring of potential losses by insurance companies
GPS for Accurate Parcel Mapping	Accurate parcel mapping and management	Improved loan conditions	Lower interest rates	Reduced collateral requirements, Enhanced creditworthiness

Research questions and resources

- How do EO estimates of flooding patterns compare with ground data?

- Can frugal mathematical models help predict harvestable area?

- Can EO help ‘phenotype’ farmer response to the prospect and availability of credit?

USAID, NASA | ICRISAT-led (West Africa) |2022-2027 (phase 2)
9 institutions, 6 countries (BF, GH, ML, NE, NG, SN)
“Building the regional EO marketplace”

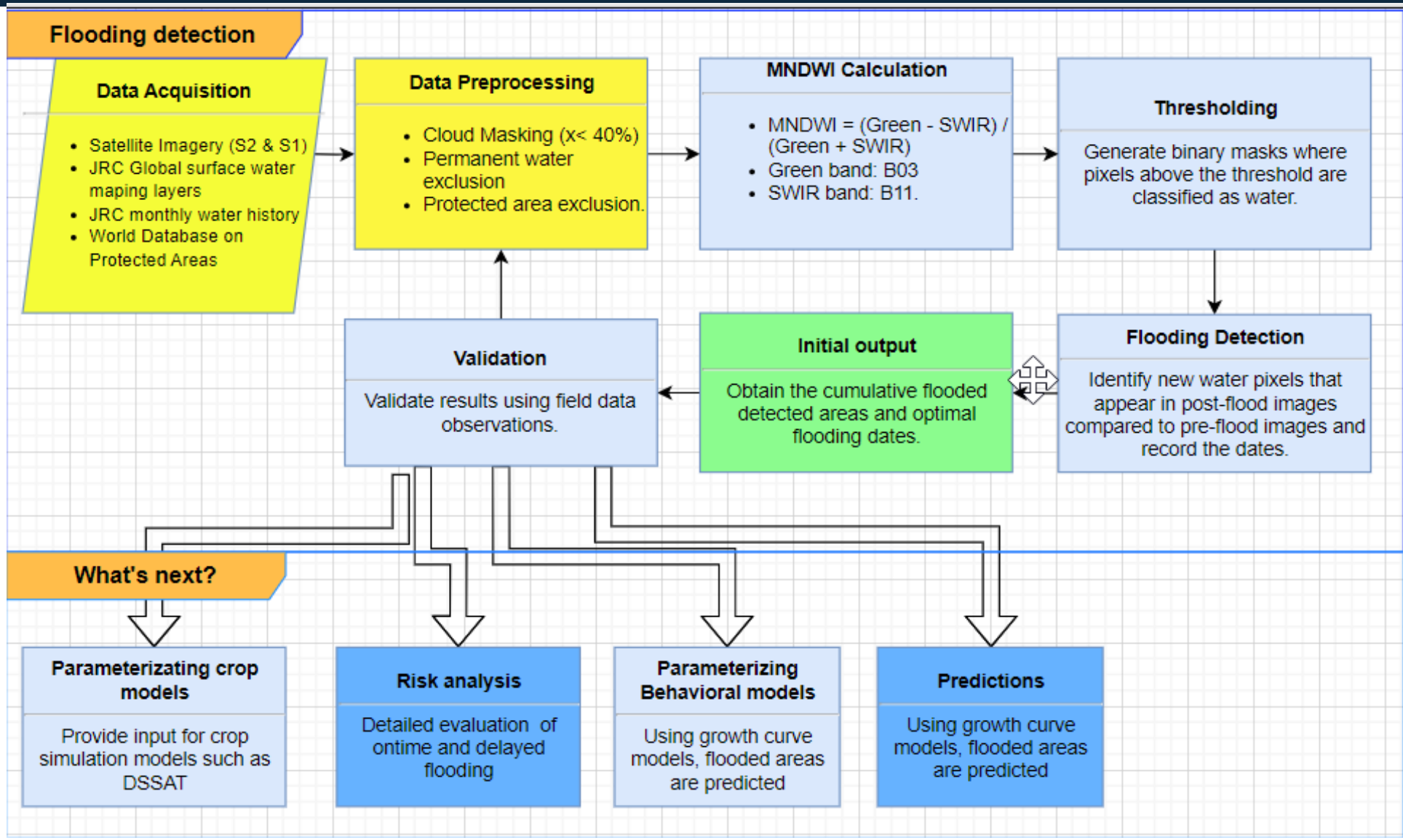
NEW Financial instruments

BMBF-FONA | DLR-led | 2022-2026
13 institutions, 2 countries (GH, SN)

Methods

Ground data:

- agCelerant / IFC (2023 dry hot season) - 599 plots financed (~8,000 ha)
- SAED (2022-24 weekly bulletins)

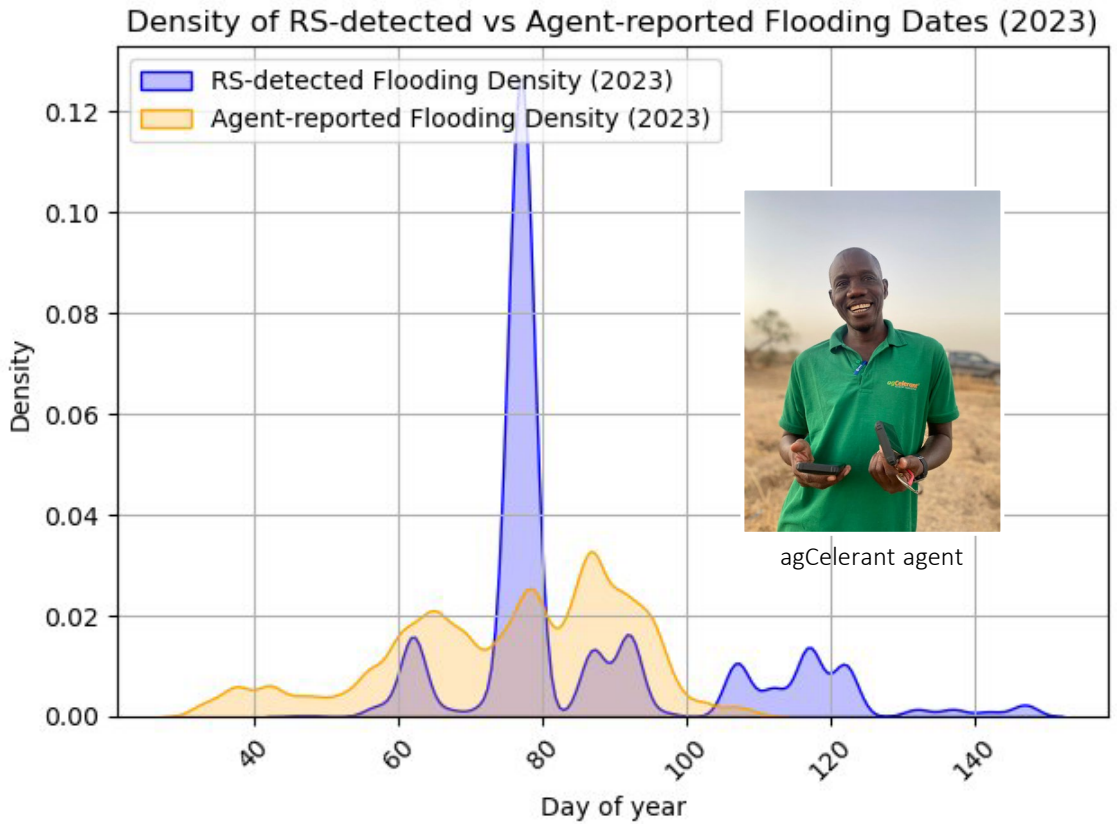


Flooding patterns, EO vs ground

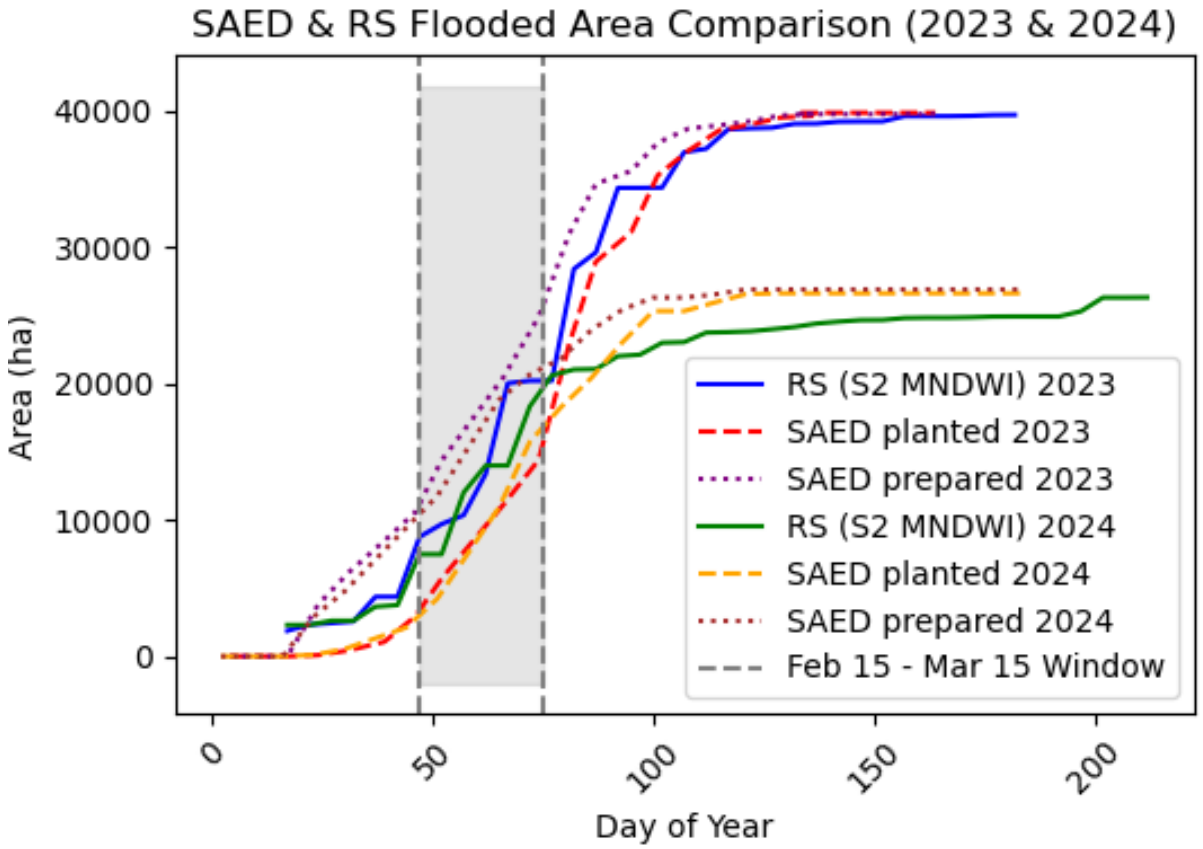
- agCelerant field agents cover 100-200 farms per 15 days ~ mostly declarative or ex-post estimations of the starting flooding date
- Reporting unit are large contractual fields (with multiple elementary plots)

- SAED agent network is sparse, often relying on farmer organizations' declarations gather by phone

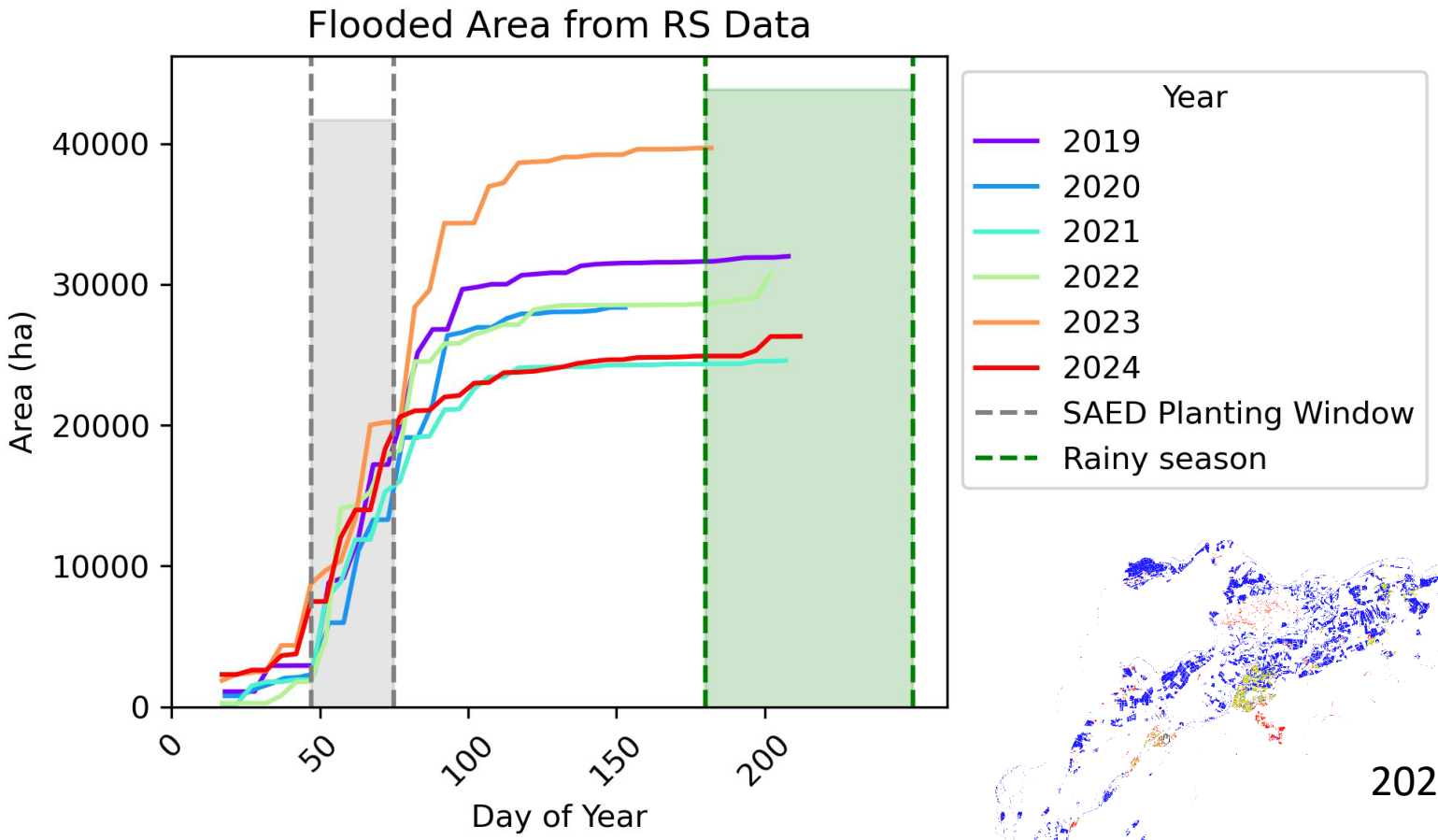
SAED bulletin

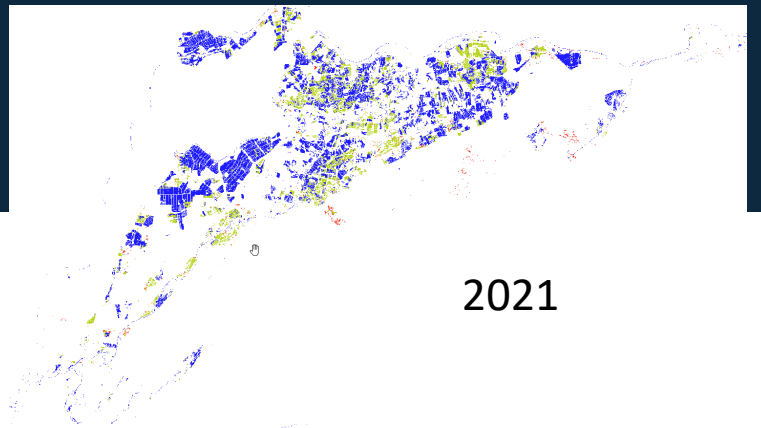


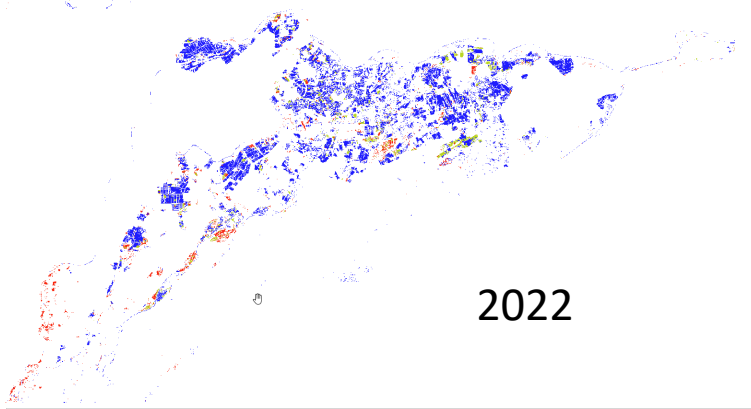
agCelerant agent

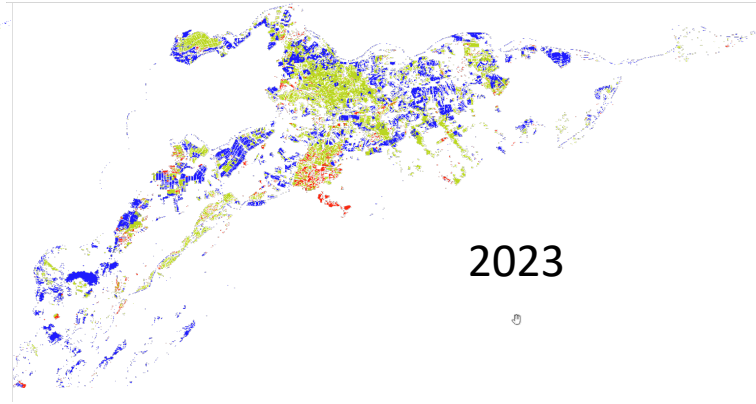


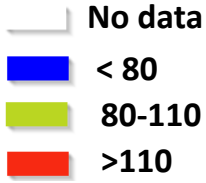
Flooding patterns, EO across years









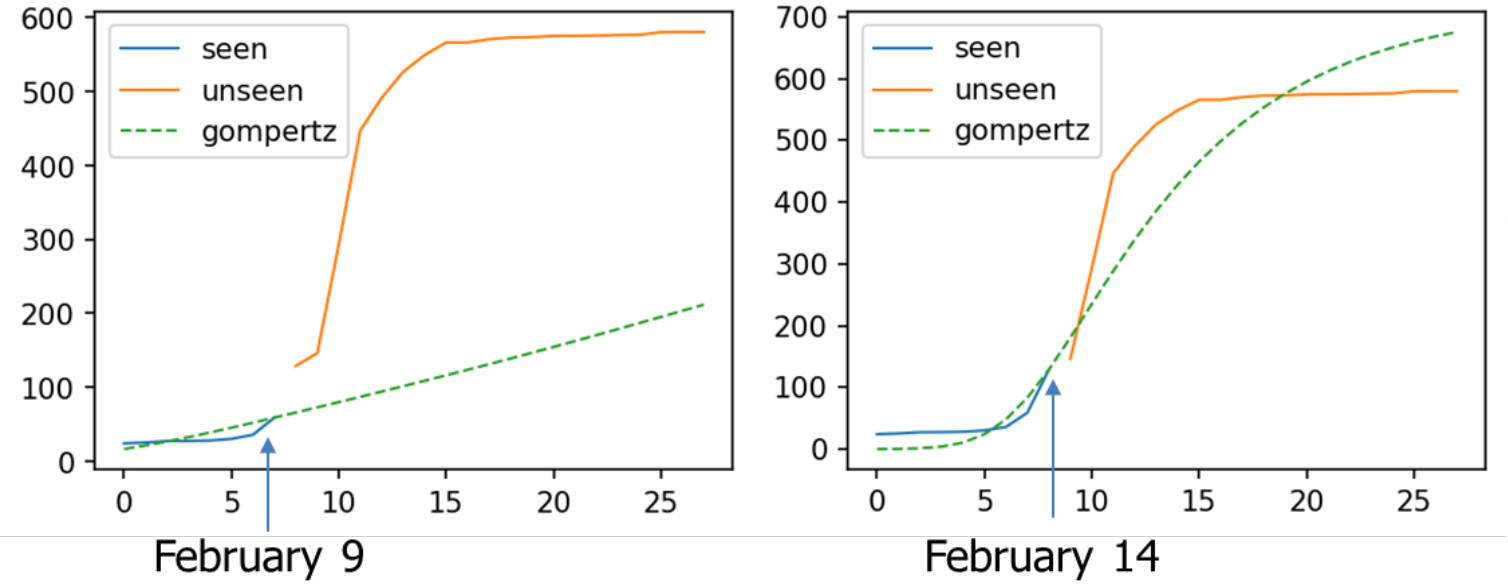


- Total flooded area varies significantly across years
- Large flooded areas don't necessarily translate into large production levels due to delays in flooding

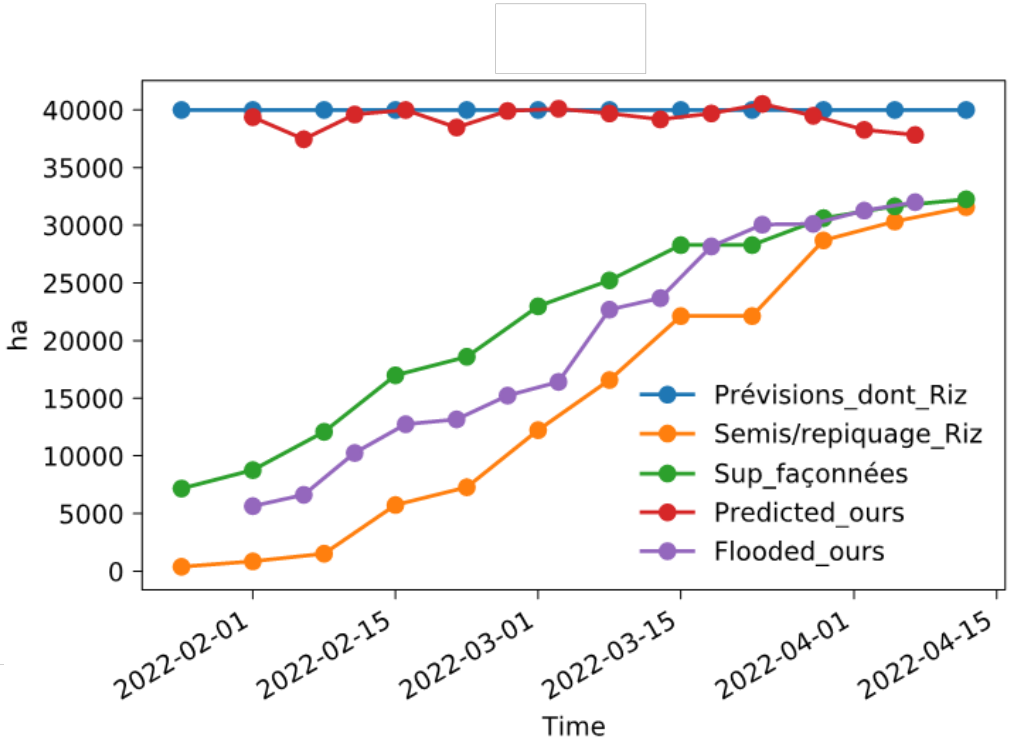
Predicting harvestable area, Gompertz

$$y(t) = a \cdot \exp(-b \cdot \exp(-c \cdot t))$$

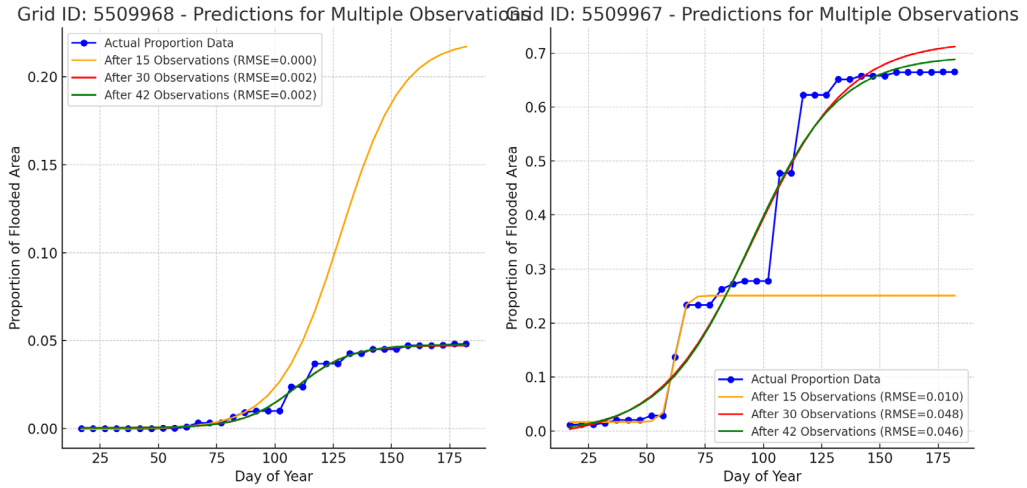
Predictions: trimmed mean from 5 best fits of Gompertz ensemble

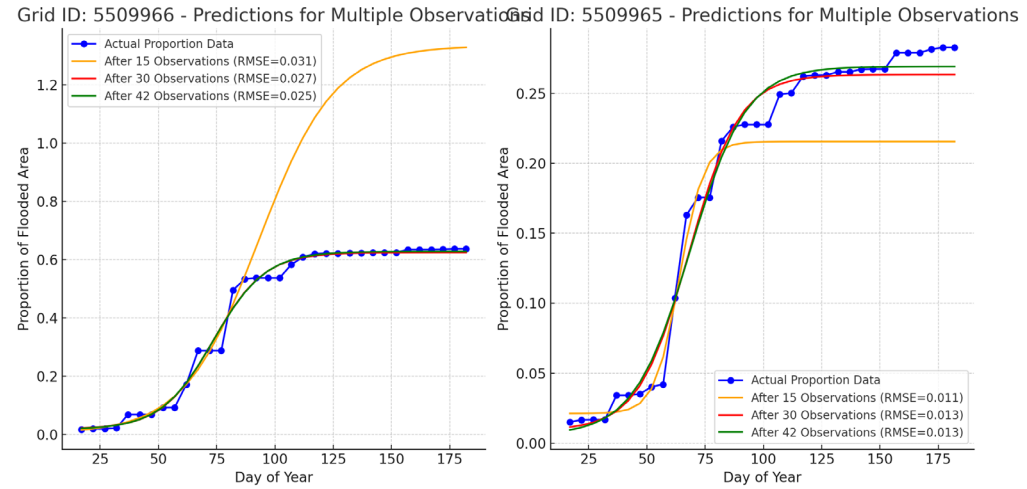


Prediction using cumulative areas in 2022



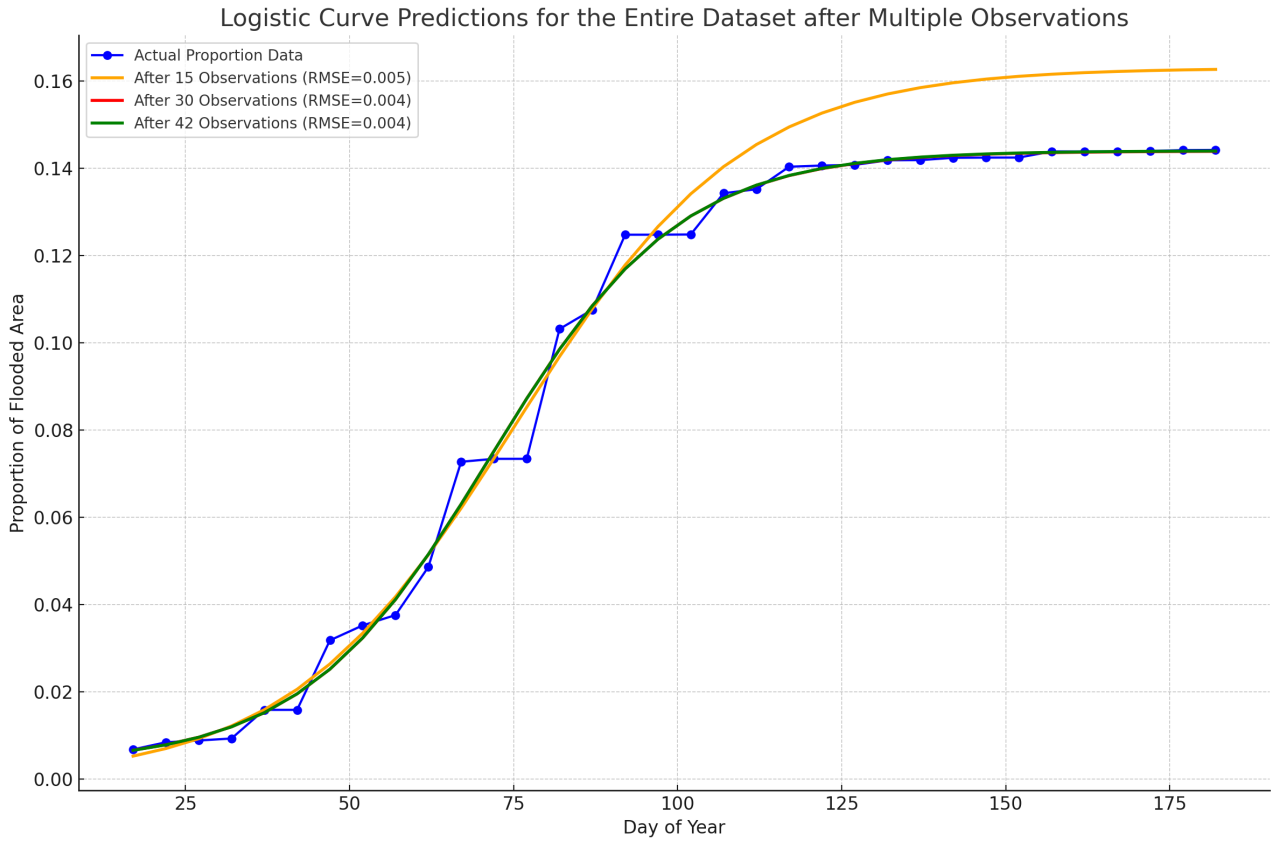
Predicting harvestable area, Logistic



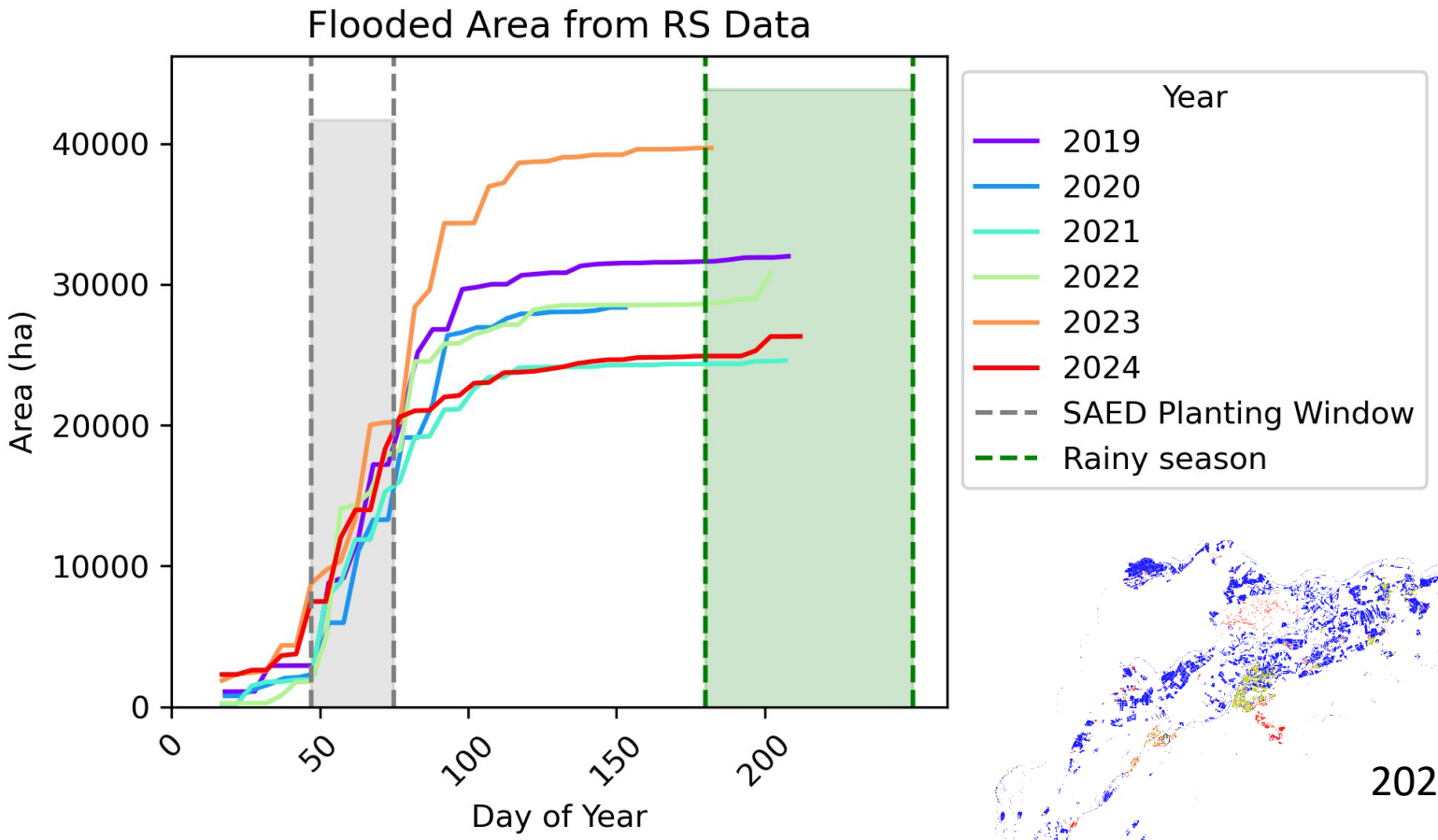


$$y(x) = \frac{a}{1 + e^{-c(x-d)}} + b$$

Prediction using cumulative proportion areas in 2023



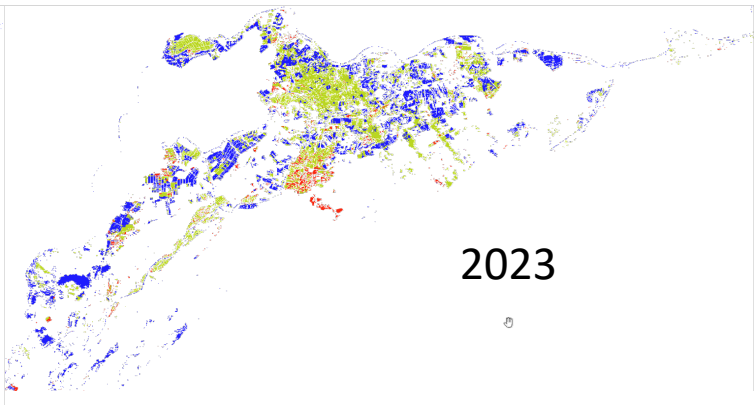
Credit and flooding, interannual



LBA credit information (source: SAED)

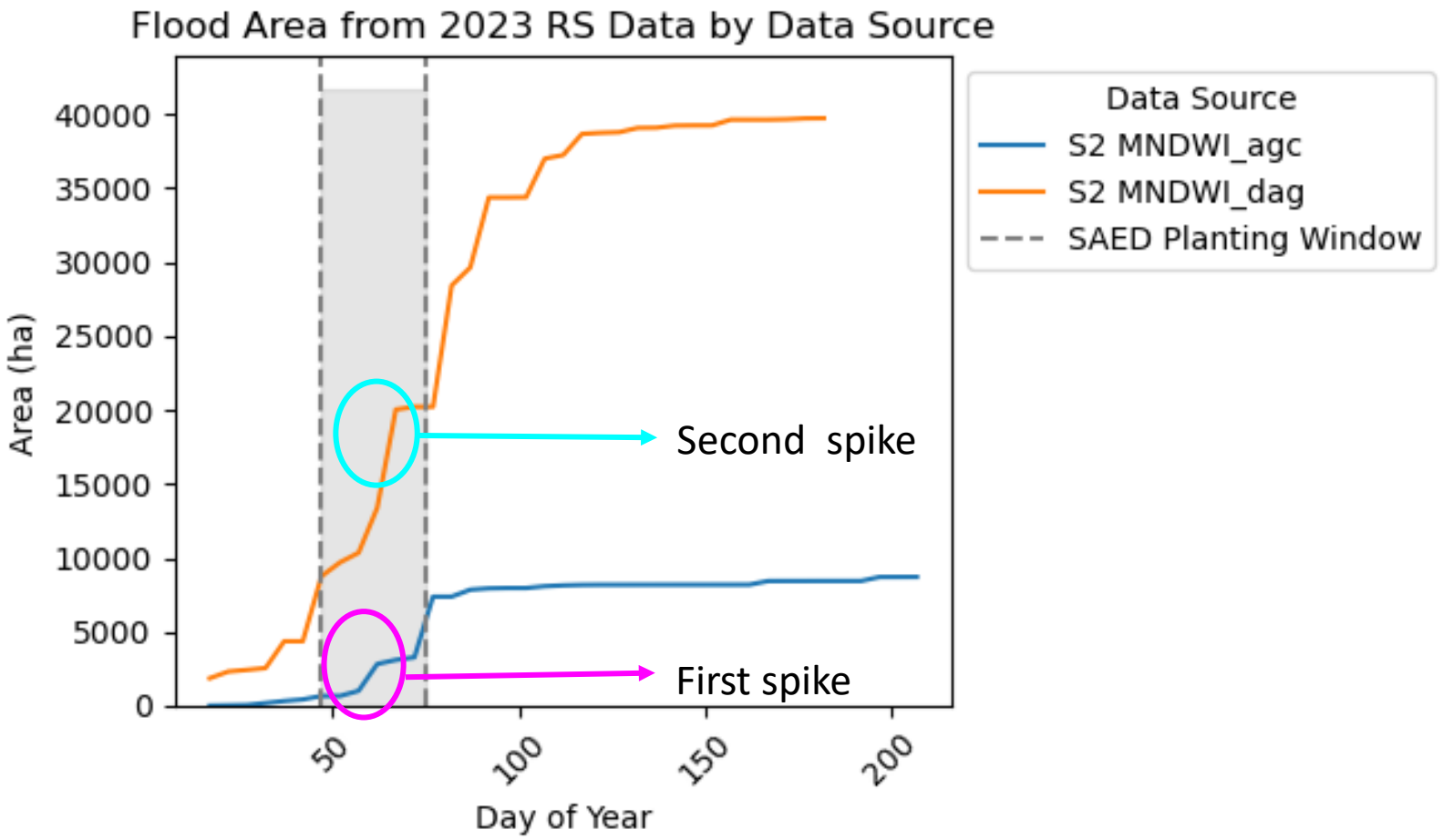
Date	Committee	Amount financed	Hectares
3/15/2022	1st & 2nd	7,482,000,000,000	19246
3/7/2023	1st & 2nd	8,384,000,000,000	18153
2/13/2024	1st	4,952,000,000,000	11243

- LBA – lead agricultural bank, sets the funding trend
- 2023: large financing volume + poor timing = yield losses + default
- 2024: low financing volume linked to 2023 default rates



No data
< 80
80-110
>110

Credit and flooding, intraseasonal



- **First Spike Hypothesis** – independent of presence of credit.
- **Second Spike Hypothesis:** Reaction by the second category of farmers (those who lack internal reserves and thin file GIEs) to the promise of credit.

Perspectives

- EO satisfactorily estimates flooded areas from smallholder farm to region
- EO shows promise to increase the lead time to skillfull estimates of harvestable area
- More granular financial data being analyzed to test farmer's response to intra-seasonal patterns in credit approval and disbursement
- Sentinel1-Sentinel2 data fusion workflow in development to extend this capability to rainy season
- Next EO products to target land preparation (stubble burning and offsetting) and harvesting rate
- Once validated, workflows to be pushed to operations on *agCelerant* platform