

OGS 2022

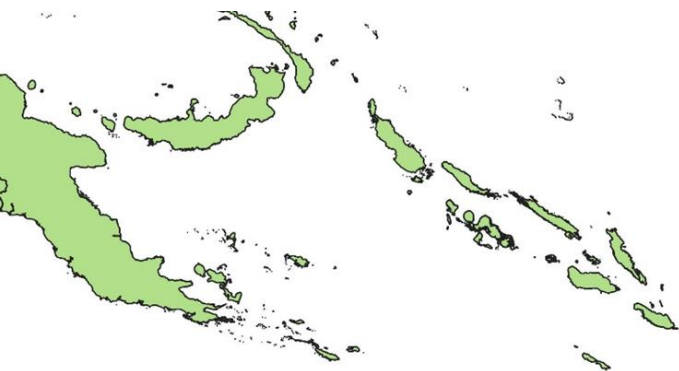


30th November 2022 – New Caledonia
Global Changes Adaptation session

Drought monitoring in the Pacific from satellite and in-situ meteorological data

M. Neuhauser*, A. Peltier, C. Point-Dumont, T. Tilak, N. Sfaksi, S. Lagarde,
G. De Coudenhove, H. Roussaffa, J. Massenet, M. Despinoy

Drought in the Pacific Islands



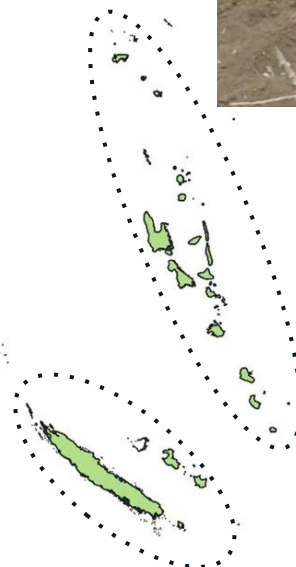
New Caledonia, 2019 : "Second warmest year since 1850"

Météo-France NC, 2020



Vanuatu, 2015 : "Tanna Island particularly affected by drought"

NC 1ère, 2015



French Polynesia, 2021 :
"Polynesia undergoes an extreme drought, warns Météo-France"



Wallis-et-Futuna, 2016 :
"Warmest and driest January in both Wallis and Futuna since the first weather records in 1971."



Fiji, 2010 : "Meteorological drought affected Fiji"*



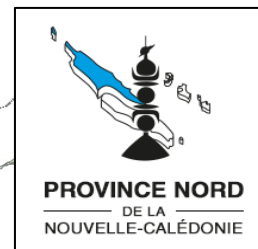
* Extreme Weather and Climate Events and Their Impacts on Island Countries in the Western Pacific: Cyclones, Floods and Droughts (Kuleshov, 2014)

Drought and Resilience in NC

Increase local agricultural production



Reduce the risk of shortages and conflicts of use



The Rural Agency facing the drought hazard :

- purchase of drought food for farmers
- compensation for producers of perennial crops

The drought plan of **the Northern Province** :

simulation tool for the need-resource balance



Increased vulnerability :

since 2010, institutions have come to the aid of farmers five times (2010, 2014, 2015, 2017, 2019)



- Rainfall information
- Medium and long-term forecasts

Existing & Needs

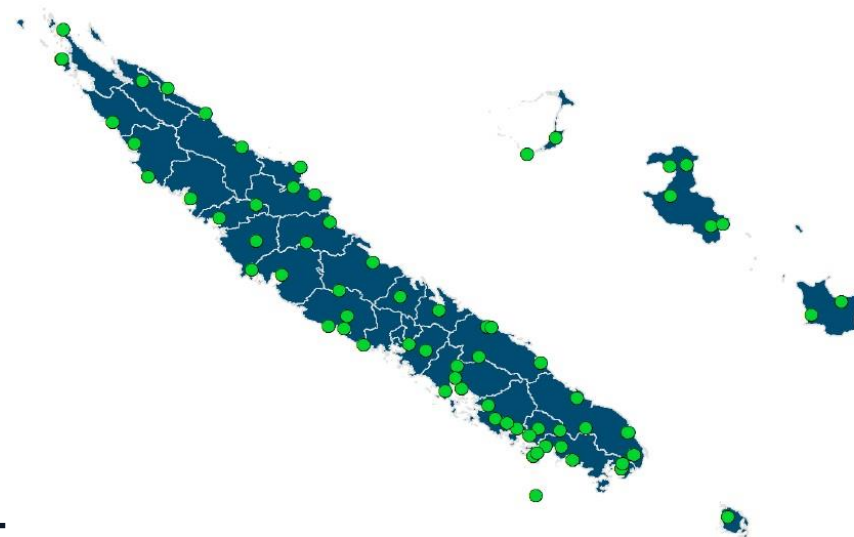
SPI : *Standardized Precipitation Index*

- ❖ **Tool** for monitoring drought hazard
- ❖ **Universal index** to characterize meteorological drought
- ❖ **Precise quantification** of recurrence of accumulated precipitation over 50 years



SPI values	Precipitation regime	Return Period
2,00 and more	Extremely wet	RP > 43 years
1,50 to 1,99	Very wet	15 years < RP < 43 years
1,00 to 1,49	Moderately wet	6 years < RP < 15 years
-0,99 to 0,99	Normal precipitation	0 years < RP < 6 years
-1,00 to -1,49	Moderately dry	6 years < RP < 15 years
-1,50 to -1,99	Very dry	15 years < RP < 43 years
-2,00 and less	Extremely dry	RP > 43 years

SPI 3-months



*50 weather stations
over the territory*

- **Rainfall deficit \neq plant water stress**
- **Incomplete spatial coverage**

The system

Complementary Earth Observation data

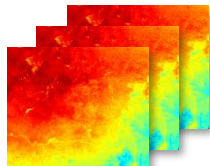


SPATIALIZED = localization

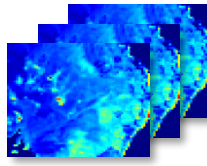


Vegetation

(Optical)



Surface Temperature
(Thermal)



Soil Moisture
(Microwaves)



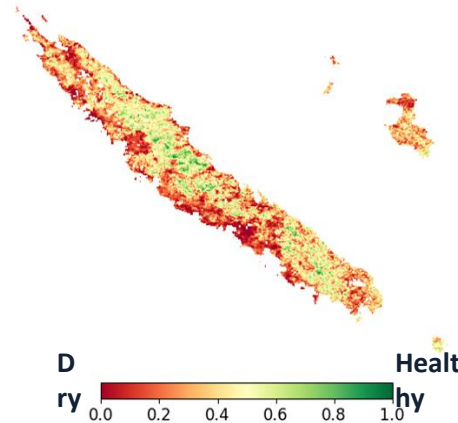
HISTORICAL = quantification



Expert meteorological data:
precipitations, evapotranspiration

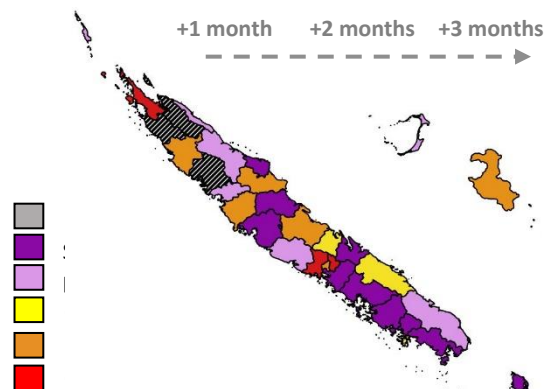
Current Indicator

Anomalies of surface indices



Forecast Indicator

Long-range probabilistic forecast system



User
platform



Agence
rurale

Data collected

METEOROLOGICAL PRODUCTS

SATELLITE PRODUCTS

Scale	Product	Observed variable	Resolution	Repeatability	Period	Storage
1) GLOBAL SCALE	SPI, SPEI	Precipitation, Evapotranspiration	Stations	1 month	1960 - today	100 GB
	MODIS	Vegetation, Temperature	250 m - 1 km	8 days	2000 - today	
	ASCAT	Soil moisture	12.5 km	1 day	2007 - today	
2) LOCAL SCALE	S2-THEIA	Vegetation	10 m	5 days	2016 - today	5 TB
	L7	Vegetation	30 m	15 days	1999 - 2013	
	L8	Vegetation	30 m	15 days	2013 - today	



Installation of a computing server for storage and processing

Methodology

1) GLOBAL DROUGHT INDICATOR :

- Global scale
- Combined drought products (*SPI*, *SPEI*, *MAI*, *VHI*)
- Agricultural drought cause-effect relationship (*Sepulcre-Canto et al., 2012*)

Precipitation deficit



Soil moisture deficit



Vegetation stress



In-situ precipitation

SPI 3-months
40 stations
1981 - today



Precip/Evapotranspiration deficit



SPEI 3-months (*Thornthwaite, 1948*)

32 stations
1991 - today

ASIRT (MetOp)
Anomalies of Soil Water Index



MODIS (Aqua, Terra)
Vegetation Health Index
Combined anomalies of NDWI, LST
1 km
2000 - today

Wet
Precipitation deficit

Wet
Soil moisture deficit

Healthy
Stress

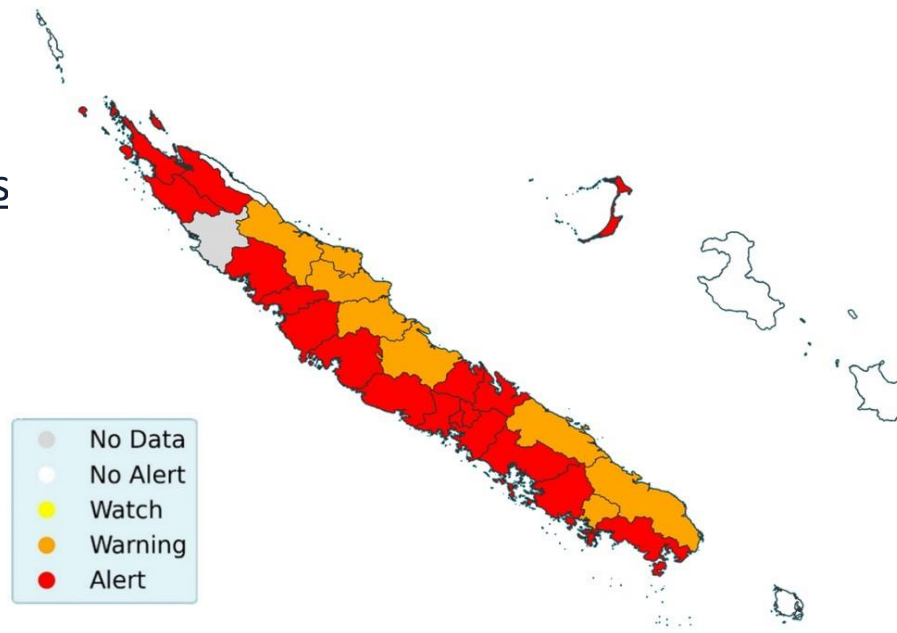
Methodology

1) GLOBAL DROUGHT INDICATOR :

- Global scale
- Combined drought products (*SPI*, *SPEI*, *MAI*, *VHI*)
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Drought Alerts



Methodology

- 2) **LOCAL INDICATOR:**
- Local scale (10 m)
 - Updated every 10 days
 - Focus on vegetation stress



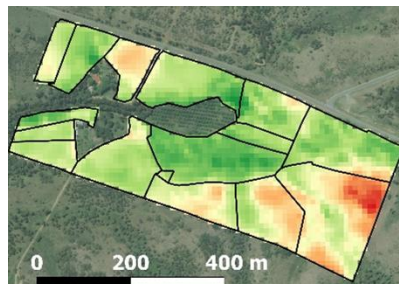
Landsat (L7, L8)
USGS Level 2 reflectances
30 m
2000 - today



Sentinel-2 (2A, 2B)
THEIA Level 2 reflectances
10 m
2016 - today

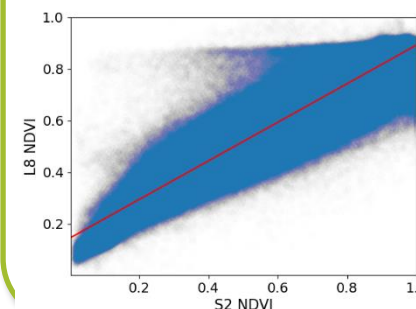
PREPROCESSING

- Computing NDWI, NDVI
- Clouds filtering and reprojection



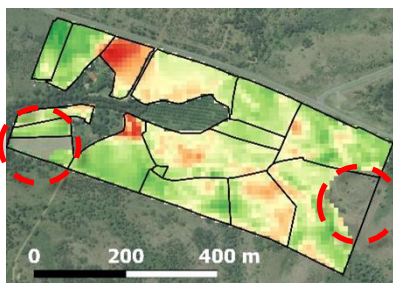
COMPOSITING

- Radiometric calibration



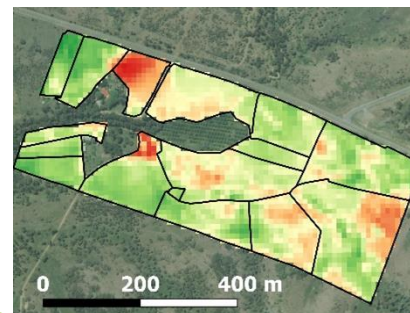
POSTPROCESSING

- Filtering bare soil, dense vegetation
- From NDVI 10-day composites



ANOMALIES

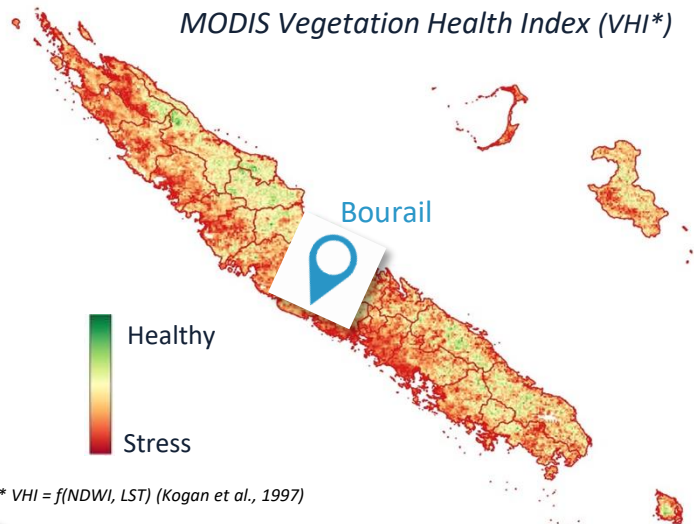
- NDWI Anomalies (Amri et al., 2011)



Some results : November 2019

Global Indicator

MODIS Vegetation Health Index (VHI*)



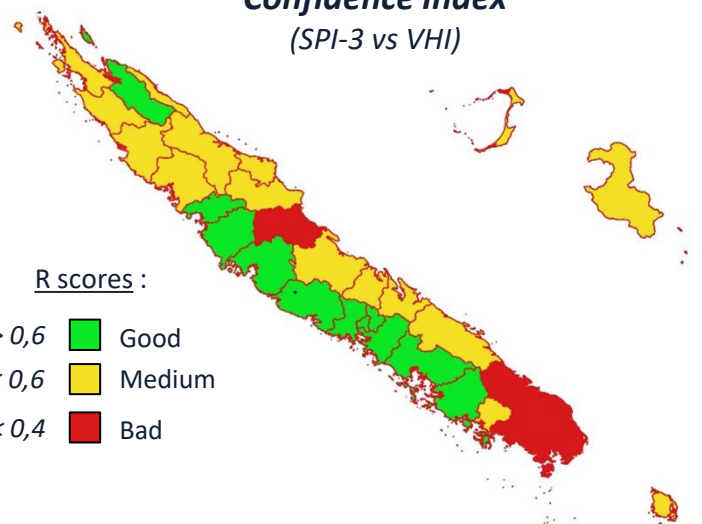
* $VHI = f(NDWI, LST)$ (Kogan et al., 1997)

Confidence Index

(SPI-3 vs VHI)

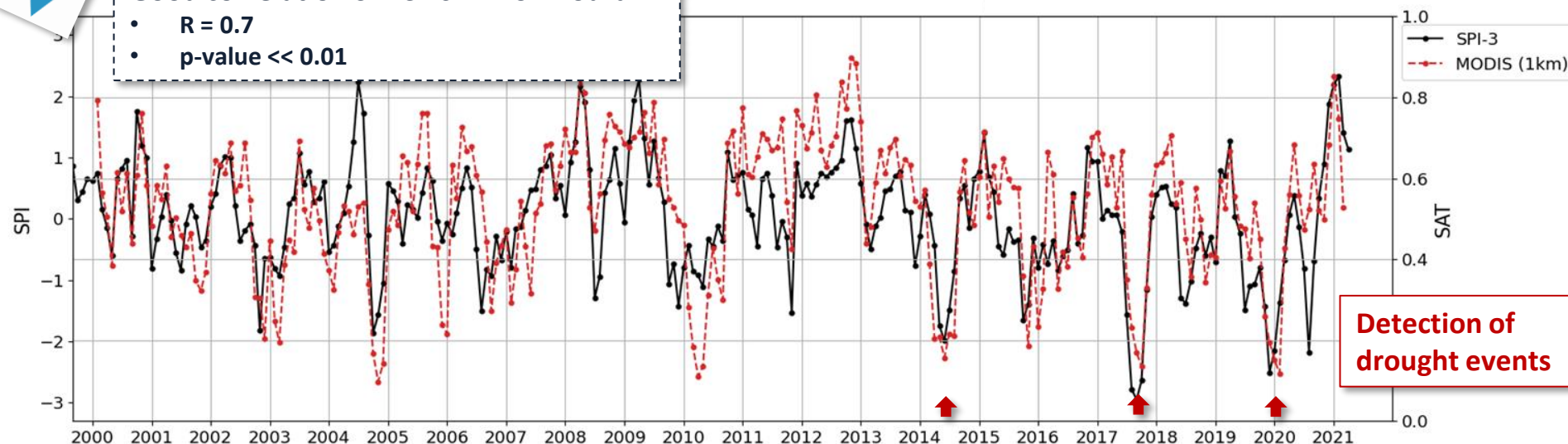
R scores :

- $R > 0,6$ Good
- $0,4 < R < 0,6$ Medium
- $R < 0,4$ Bad

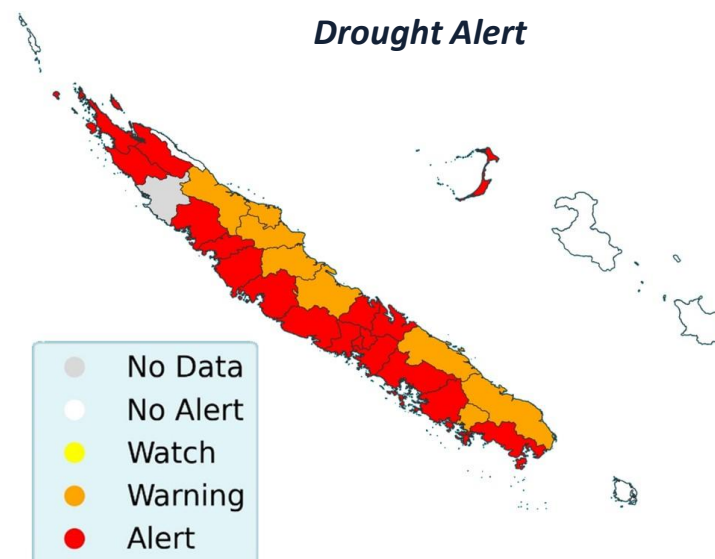
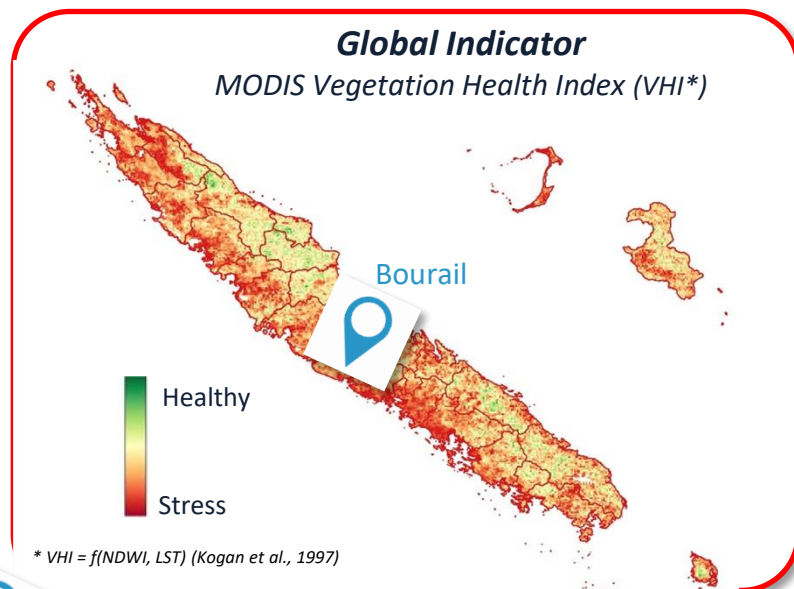


Good correlation SPI-3 vs VHI on Bourail :

- $R = 0.7$
- $p\text{-value} < 0.01$



Some results : November 2019

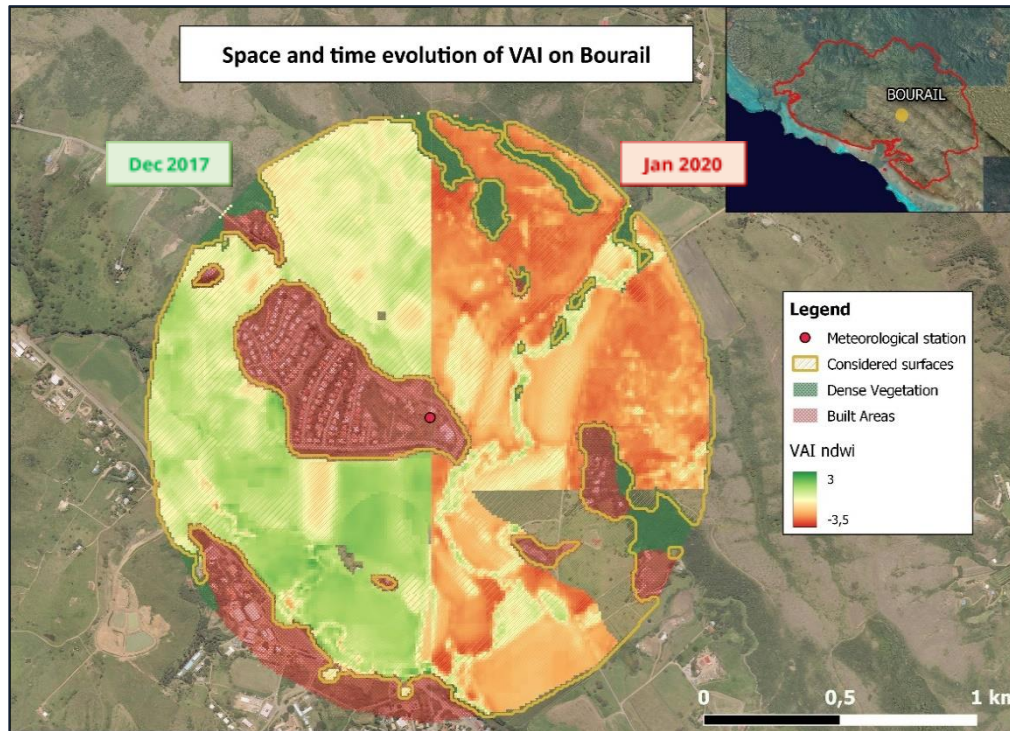


Good correlation SPI-3 vs VHI on Bourail :

- $R = 0.7$
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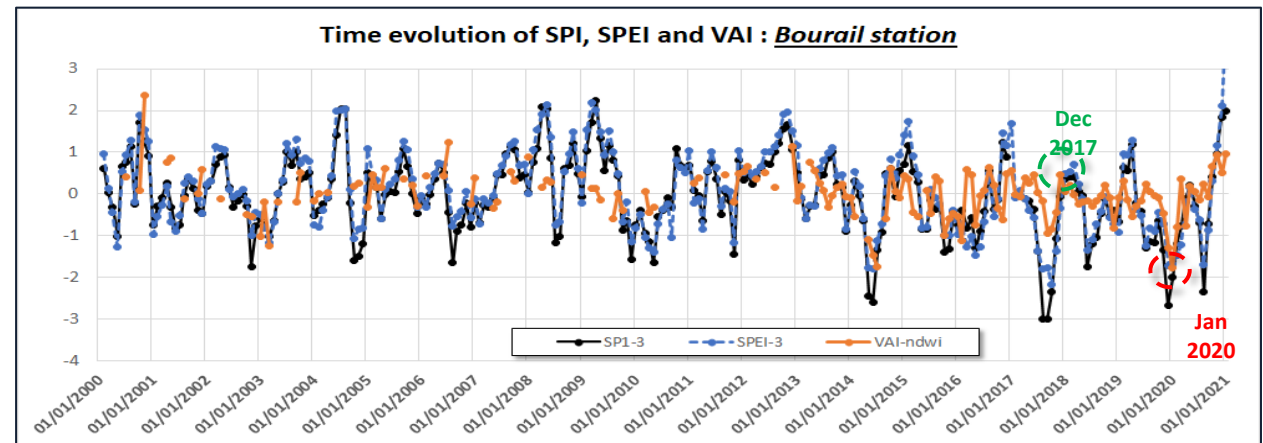


Some results : Local scale



Local Indicator
S2/Landsat Vegetation Anomaly Index (VAI*)

$$*VAI = (NDWI - NDWI_{mean}) / NDWI_{dev}$$



Externalities for valorization

EO4DM Project :

- Global drought in NC
- First local indicator
- Plateform prototype



Industrialization & Pacific :

- "Fonds Pacific" project
- Operational production on NC
- Adaptation to other Pacific islands



Valorization in agriculture :

- Decision-making tool for water management
- Projects in preparation with partners
- Field instrumentalization



?

2021

2022

Now

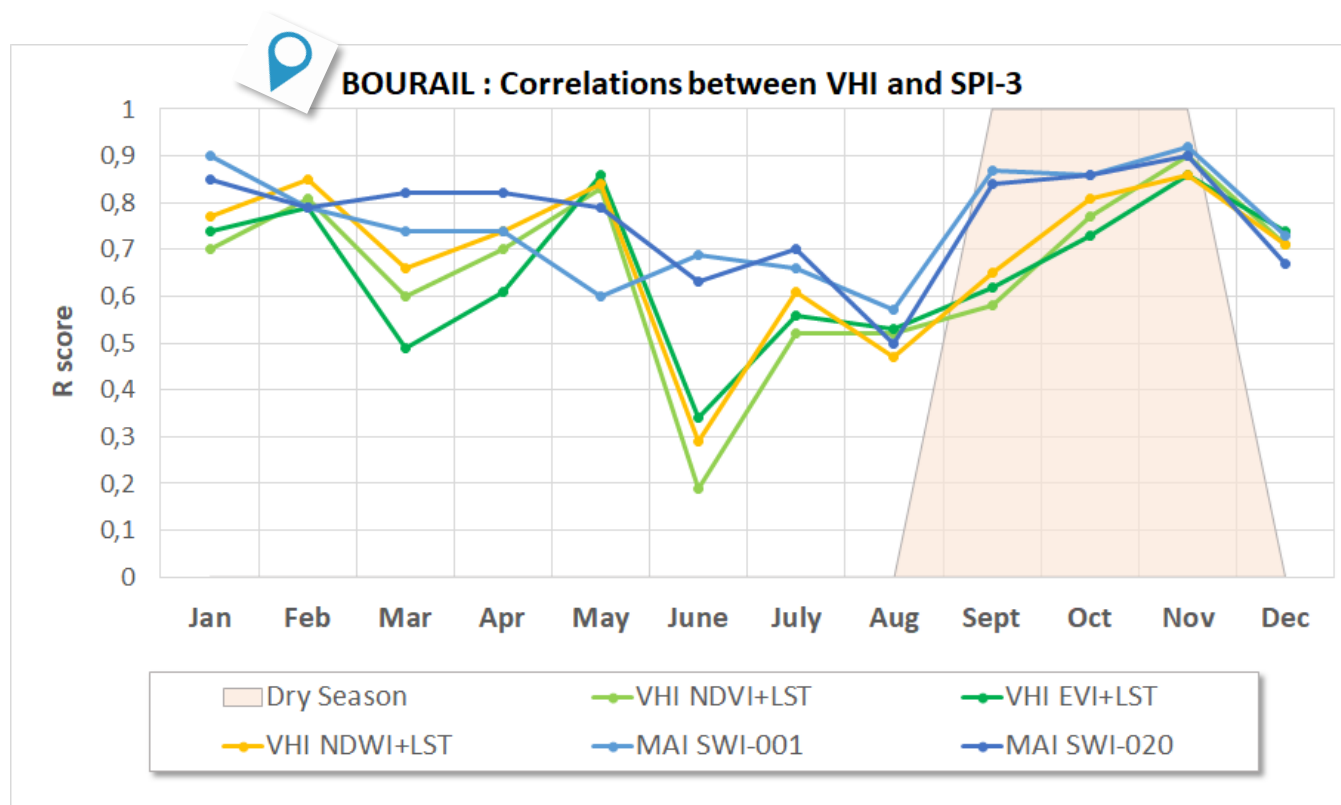


**Thank you for
your attention**

Any questions ?

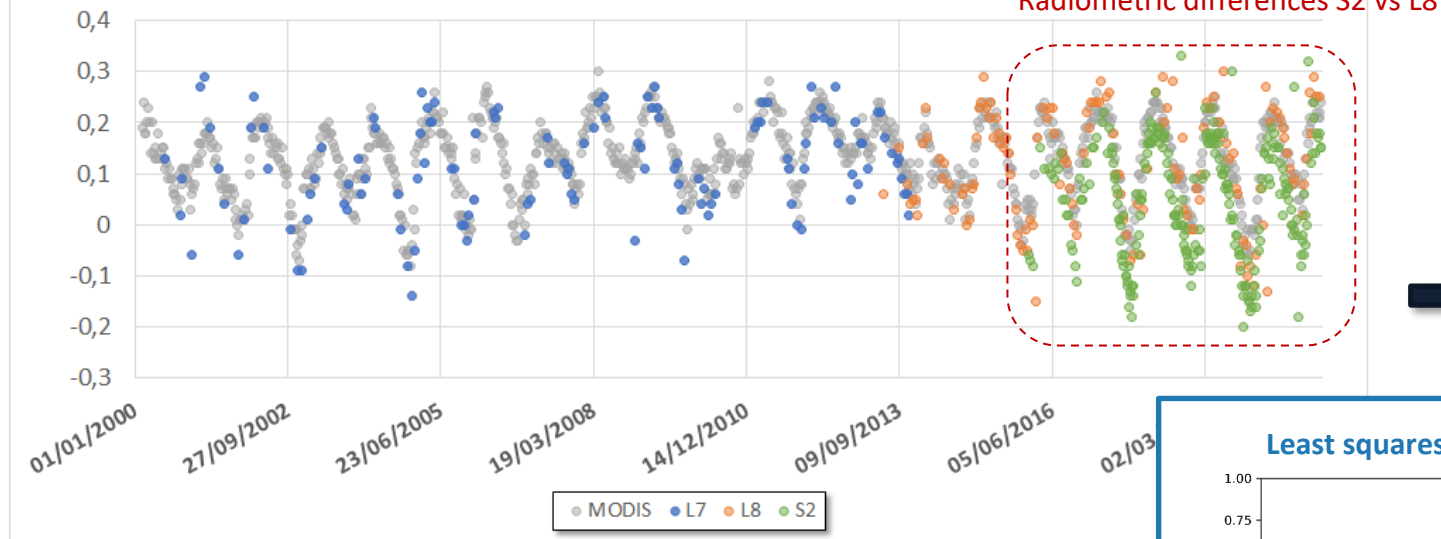
Evaluation of global indicator

Seasonal effects on correlation scores

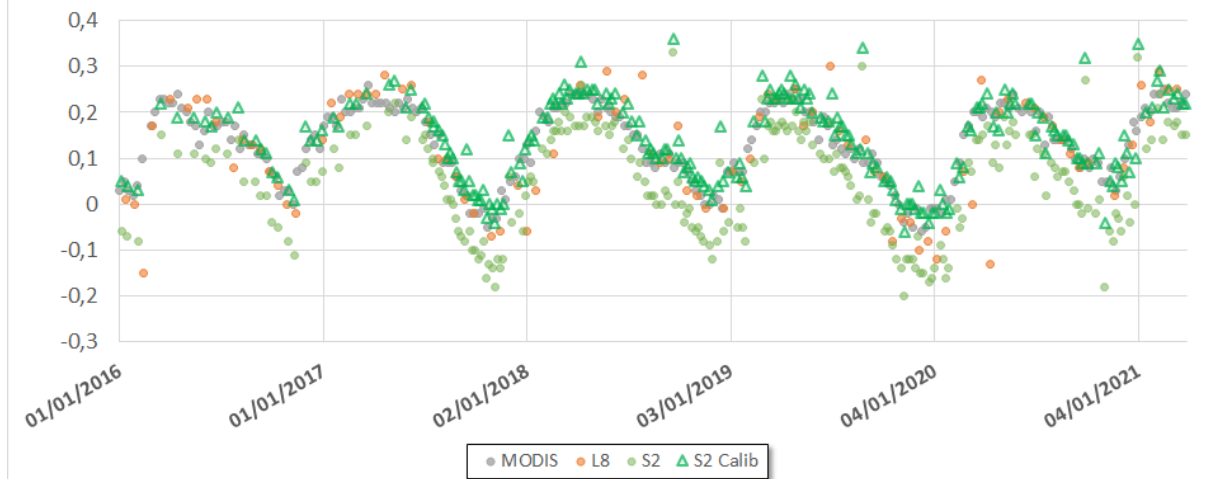


Radiometric calibration

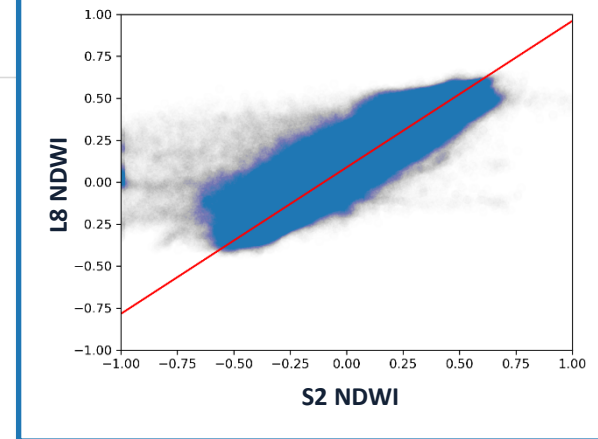
Time evolution of NDWI on Bourail



Calibration of S2 NDWI on Bourail



Least squares linear regression



Evaluation of local indicators

