

# Crop performance estimation using the Sentinel-2 multispectral satellite data: case study of River Neretva Delta

MoST | University of Split | Ivan Racetin

Scientific Meeting | IDROVORA Ca' Bianca, Chioggia, Italy | 11 October 2021

# MOTIVATION

- Estimate crop performance variation at the scale of amelioration area as a function of climatic and edaphic changes and agricultural practices

# STUDY AREA: The River Neretva Delta



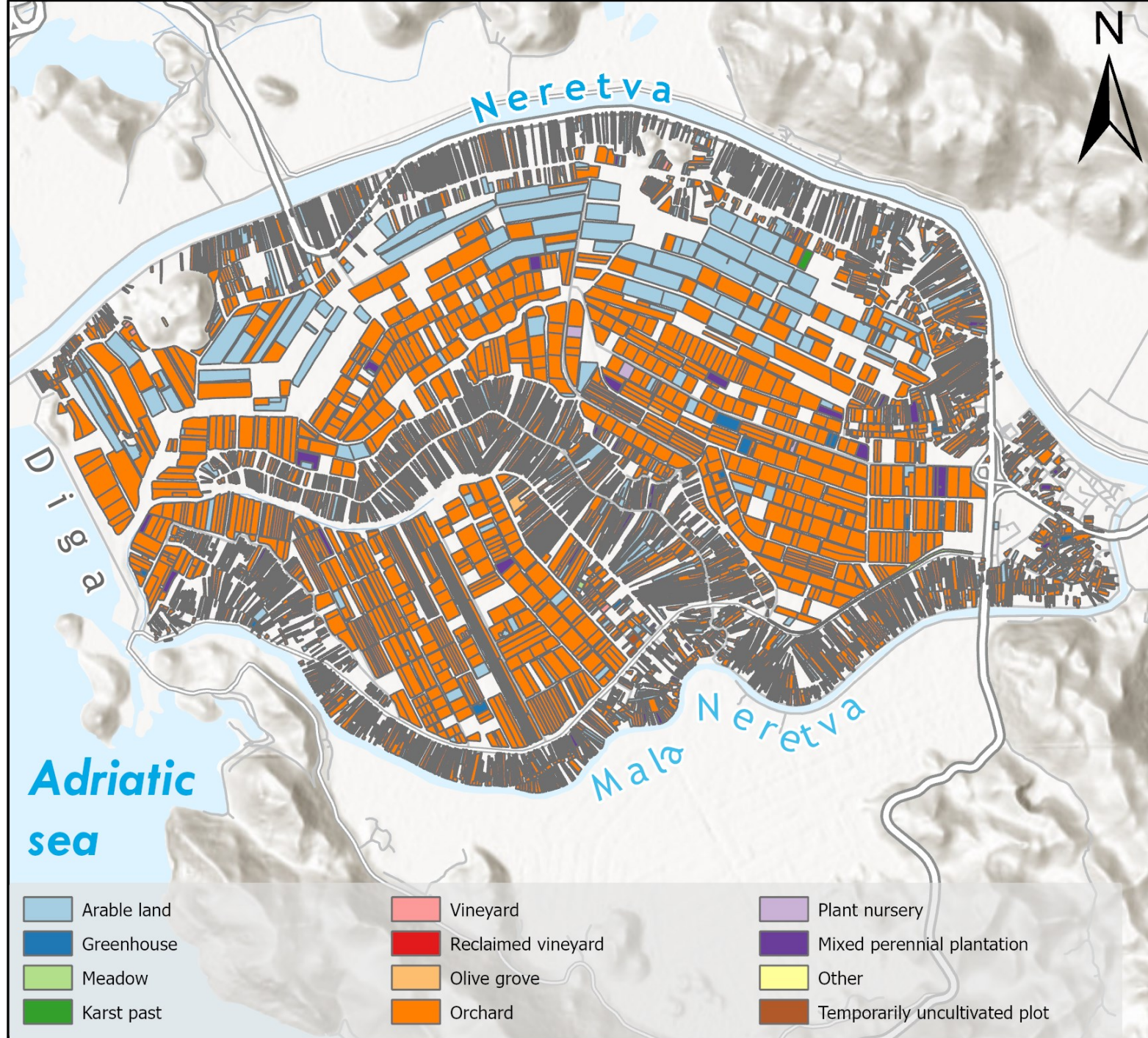
# CLIMATE OVERVIEW

- A semi-arid area characterised by Mediterranean climate with hot, dry summers and mild, wet winters
- The mean annual rainfall (1980-2000) is 1 230 mm, mostly in the period from October to April
- The average annual air temperature is 15.7 °C and the annual Penman-Monteith reference evapotranspiration is 1196 mm

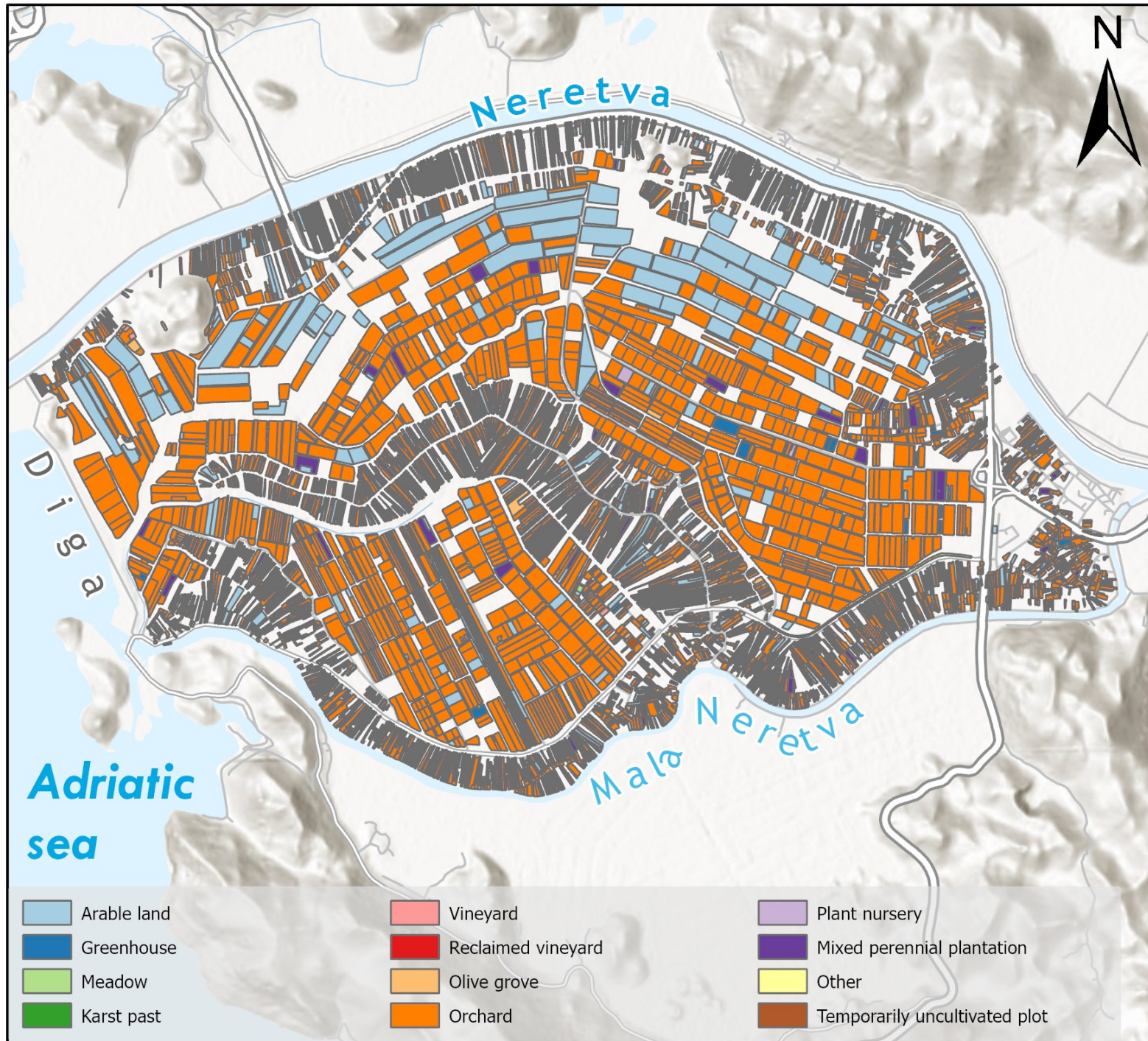
# LAND USE DATA

- Paying Agency for Agriculture, Fisheries and Rural Development (PAAFRD) in Croatia keeps track about the agricultural land use through Farmers Register
- ARKOD – land parcel identification system, and other accompanying registers
- ARKOD data is published yearly, and it serves for determination of agricultural incentives

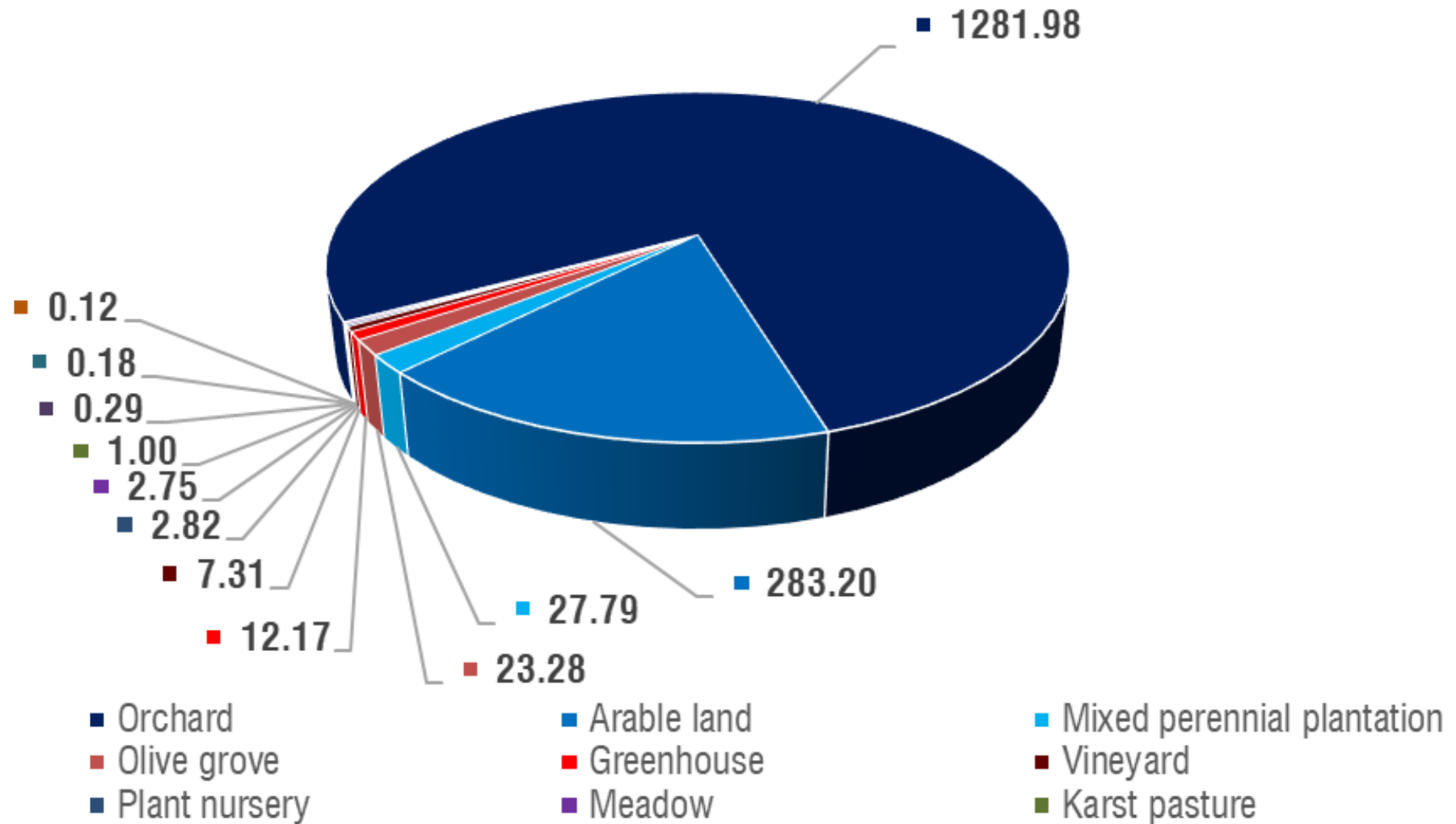
# PAAFRD data for 2019



# PAAFRD data for 2020



# AREA IN HECTARES OF LAND USE IN 2019





# SATELLITE DATA

- Sentinel-2 Multi-Spectral Instrument (MSI)
- twin polar-orbiting satellites (Sentinel-2A and 2B) in the same orbit
- Level-2A products:
  - bottom-of-atmosphere (BoA) reflectance
  - data projected in the Universal Transverse Mercator (UTM) map projection and WGS84 datum

Band number	Sentinel-2A		Sentinel-2B		Spatial resolution (m)
	Central wavelength (nm)	Bandwidth (nm)	Central wavelength (nm)	Bandwidth (nm)	
$B_1$	442.7	21	442.3	21	60
$B_2$	492.4	66	492.1	66	10
$B_3$	559.8	36	559	36	10
$B_4$	664.6	31	665	31	10
$B_5$	704.1	15	703.8	16	20
$B_6$	740.5	15	739.1	15	20
$B_7$	782.8	20	779.7	20	20
$B_8$	832.8	106	833	106	10
$B_{8a}$	864.7	21	864	22	20
$B_9$	945.1	20	943.2	21	60
$B_{10}$	1373.5	31	1376.9	30	60
$B_{11}$	1613.7	91	1610.4	94	20
$B_{12}$	2202.4	175	2185.7	185	20

# SATELLITE DATA

- Study utilized 40 cloudless Sentinel2 MSI satellite images, dating from 15 January 2019 to 15 December 2020

2019	2020
15 January	15 January
7 February	9 February
27 February	21 February
4 March	5 March
21 March	20 March
20 April	9 April
8 May	24 April
9 June	9 May
27 June	22 May
7 July	13 June
19 July	28 June
11 August	8 July
28 August	21 July
5 September	10 August
20 September	22 August
12 October	10 September
22 October	21 September
26 December	21 October
	31 October
	10 November
	25 November
	15 December

# SPECTRAL INDICES

	Satellite index	Equation	Reference
1	Enhanced Vegetation Index (EVI)	$EVI = 2.5 \frac{B_8 - B_4}{B_8 + 6B_4 - 7.5B_2 + 1}$	(Huete, Didan et al. 2002)
2	Green Normalized Difference Vegetation Index (GNDVI)	$GNDVI = \frac{B_8 - B_3}{B_8 + B_3}$	(Gitelson and Merzlyak 1998)
3	Global Vegetation Moisture Index (GVMI)	$GVMI = \frac{(B_8 + 0.1) - (B_{12} + 0.02)}{(B_8 + 0.1) + (B_{12} + 0.02)}$	(Ceccato, Gobron et al. 2002)
4	Normalized Difference Vegetation Index (NDVI)	$NDVI = \frac{B_8 - B_4}{B_8 + B_4}$	(Rouse, Haas et al. 1974)
5	Red Edge 1 NDVI (NDVI <sub>RE1</sub> )	$NDVI_{RE1} = \frac{B_8 - B_5}{B_8 + B_5}$	(Forkuor, Dimobe et al. 2018)
6	Red Edge 2 NDVI (NDVI <sub>RE2</sub> )	$NDVI_{RE2} = \frac{B_6 - B_4}{B_6 + B_4}$	(Forkuor, Dimobe et al. 2018)

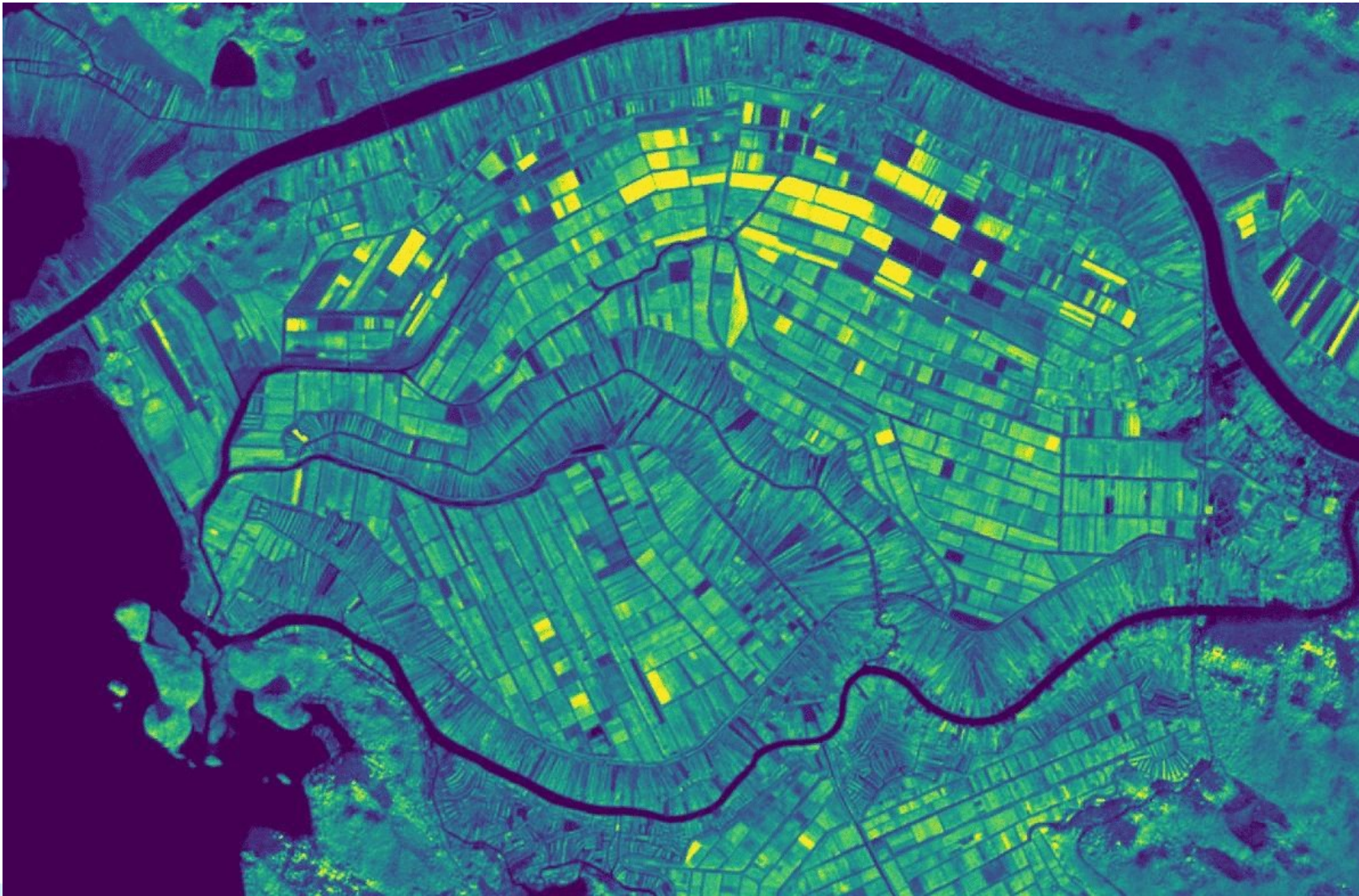
# RESULTS

- Results are categorized by the two most frequent land used: orchards and arable land
- for specific land use, a crop health and productivity is assessed by satellite indices

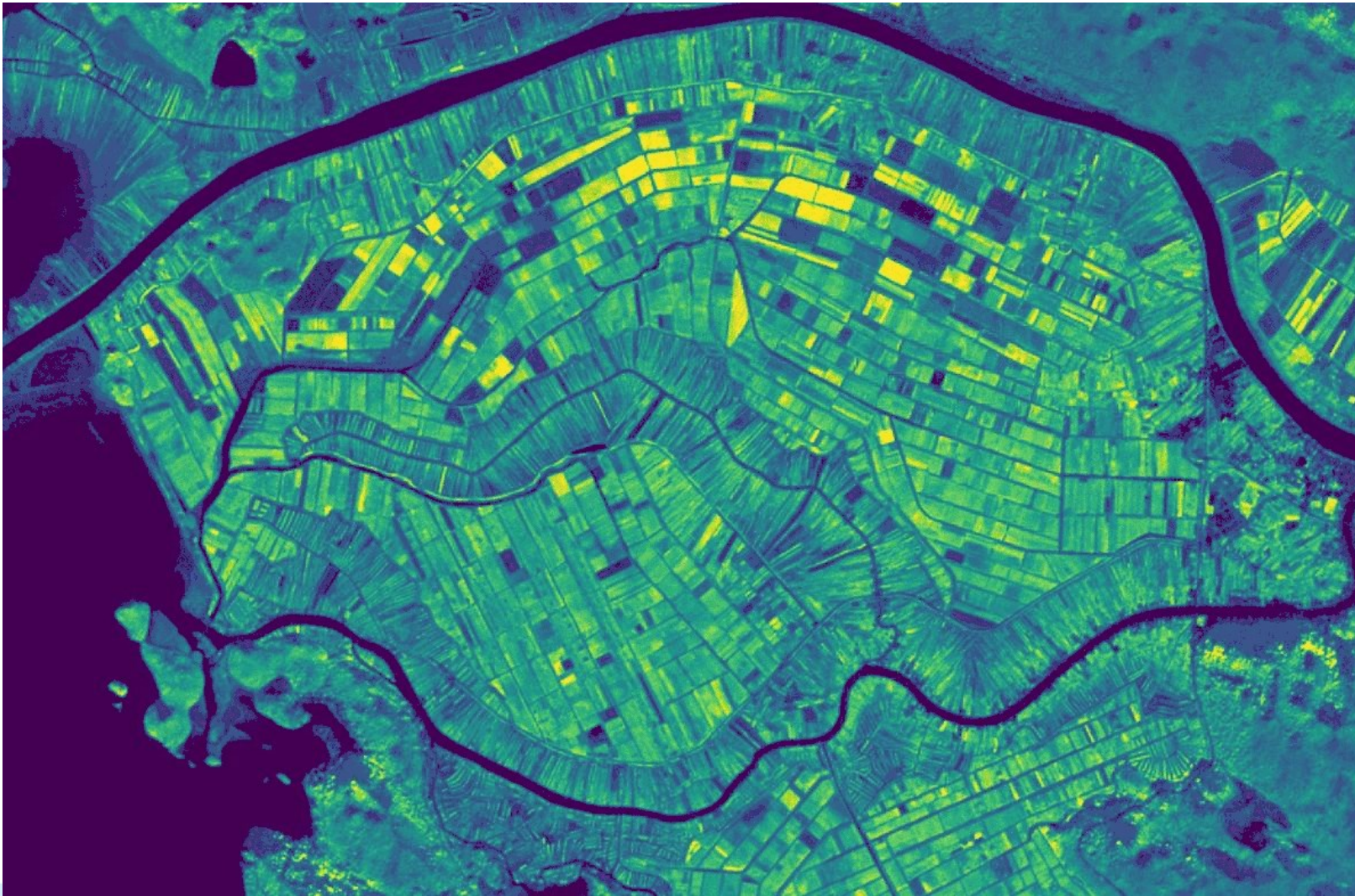
# EVI 2019

2019

- 15 January
- 7 February
- 27 February
- 4 March
- 21 March
- 20 April
- 8 May
- 9 June
- 27 June
- 7 July
- 19 July
- 11 August
- 28 August
- 5 September
- 20 September
- 12 October
- 22 October
- 26 December



# EVI 2020



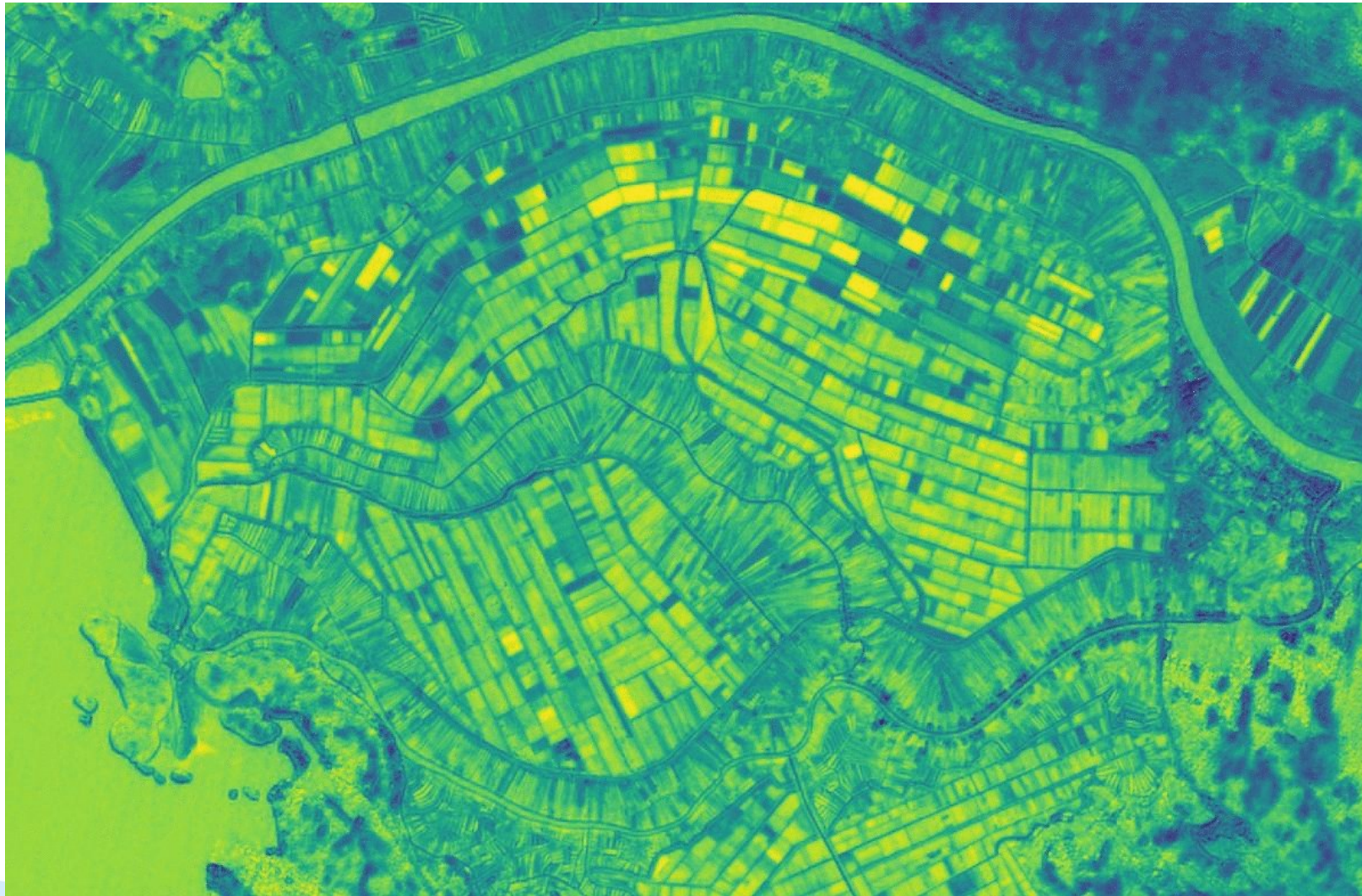
2020

- 15 January
- 9 February
- 21 February
- 5 March
- 20 March
- 9 April
- 24 April
- 9 May
- 22 May
- 13 June
- 28 June
- 8 July
- 21 July
- 10 August
- 22 August
- 10 September
- 21 September
- 21 October
- 31 October
- 10 November
- 25 November
- 15 December

# GVMI 2019

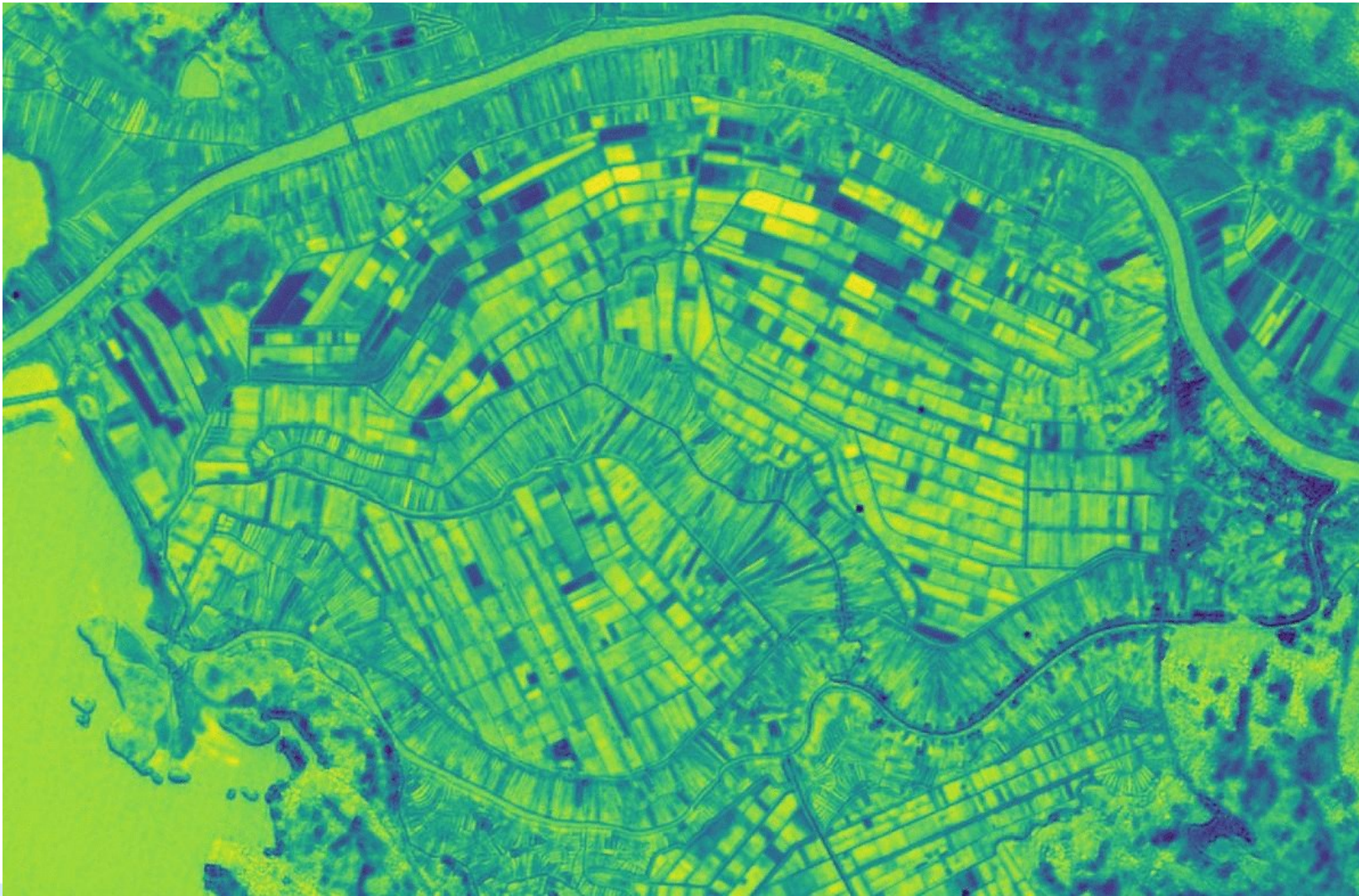
2019

- 15 January
- 7 February
- 27 February
- 4 March
- 21 March
- 20 April
- 8 May
- 9 June
- 27 June
- 7 July
- 19 July
- 11 August
- 28 August
- 5 September
- 20 September
- 12 October
- 22 October
- 26 December



# GVMi 2020

2020



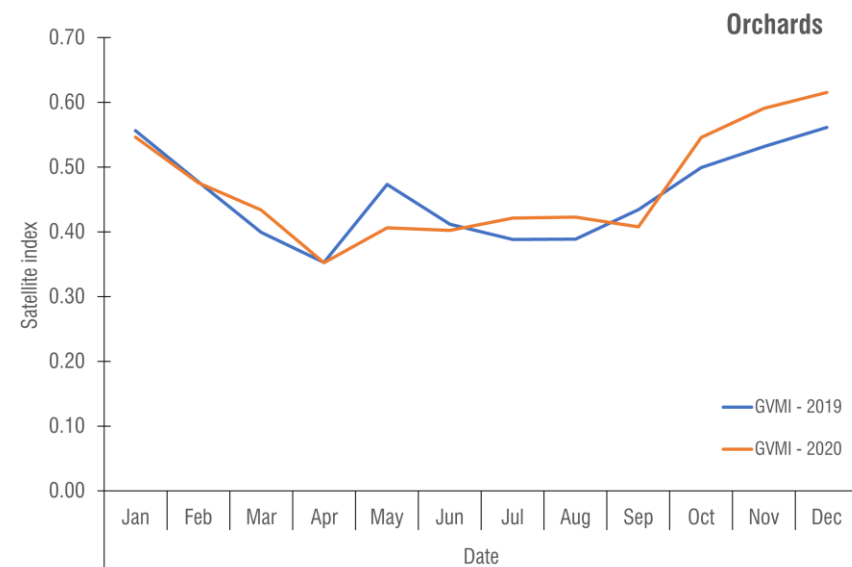
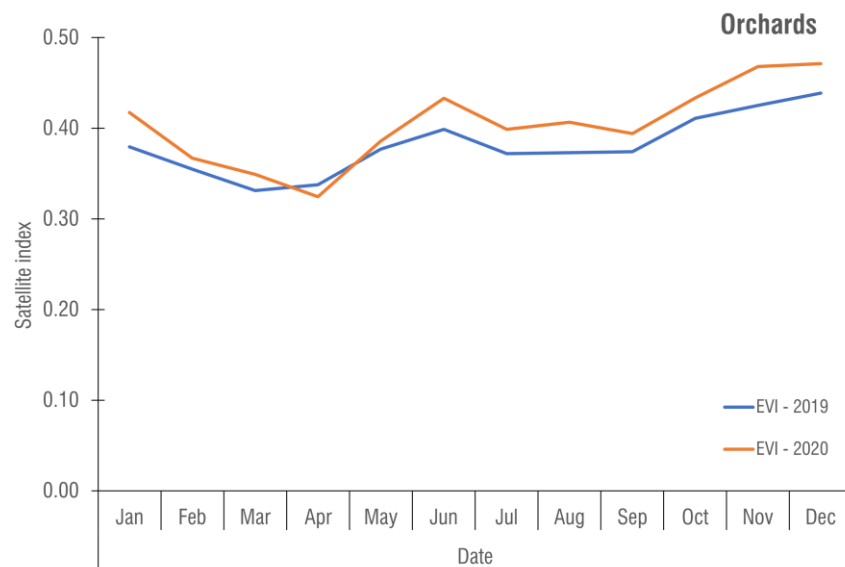
- 15 January
- 9 February
- 21 February
- 5 March
- 20 March
- 9 April
- 24 April
- 9 May
- 22 May
- 13 June
- 28 June
- 8 July
- 21 July
- 10 August
- 22 August
- 10 September
- 21 September
- 21 October
- 31 October
- 10 November
- 25 November
- 15 December



# ORCHARDS

- the most frequent land use, with more than 1280 hectares
- In 2019 there were 3460 land parcels cultivated with orchards having average area of 3756 m<sup>2</sup> and median area of 1906 m<sup>2</sup>
- In 2020 there were 3393 land parcels with median area of 1924 m<sup>2</sup> and average area of 3783 m<sup>2</sup>

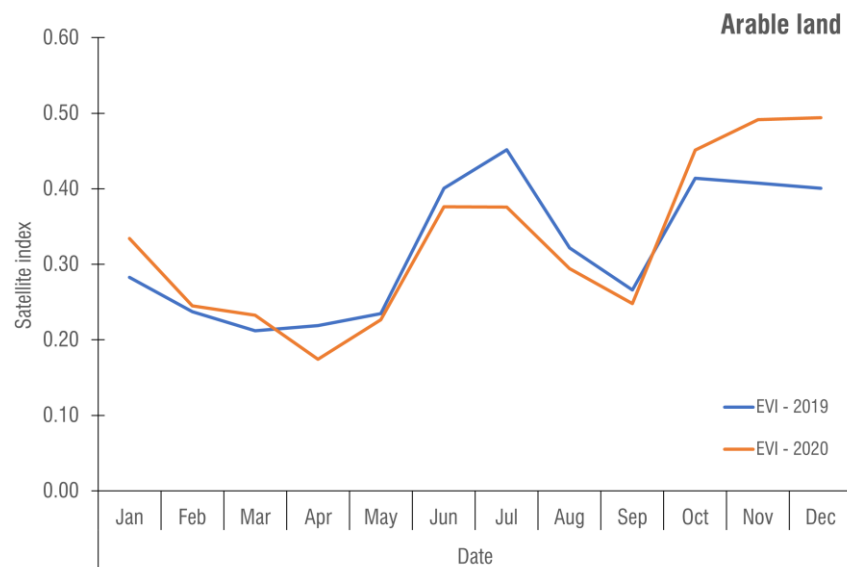
# STATISTICS – MEDIAN OF SATELLITE INDICES FOR ORCHARDS



# ARABLE LAND

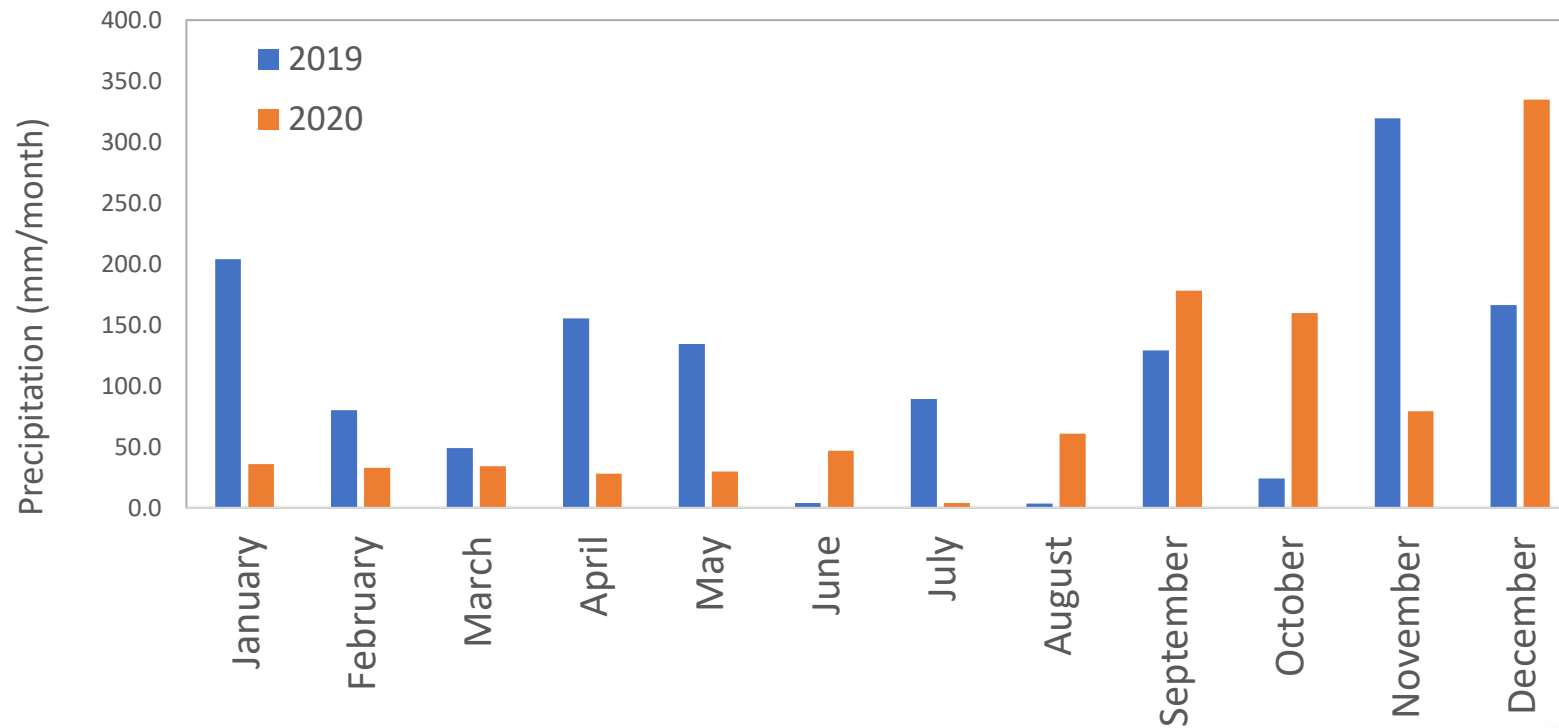
- the second most represented agricultural land use with more than 290 hectares.
- In 2019 there were 593 land parcels cultivated with arable land having average area of 4915 m<sup>2</sup> and median area of 1608 m<sup>2</sup>
- In 2020 there were 581 land parcels with median area of 1635 m<sup>2</sup> and average area of 5059 m<sup>2</sup>

# STATISTICS – MEDIAN OF SATELLITE INDICES FOR ARABLE LAND



# Meteo-climatic data

Monthly precipitation (mm/month)



# CHALLENGES


- A variety of crops are present in the Delta
  - Annual and perennial crops
- Relatively small parcel sizes
- Great number of producers → different irrigation, fertilization and agrotechnical practices


# THANKS!

University of Split  
Faculty of Civil Engineering, Architecture and Geodesy  
Ivan Racetin, PhD

 Matice hrvatske 15,  
21 000 Split, Croatia

 ivan.racetin@gradst.hr

 +38521303392  
+385959066048

 [www.italy-croatia.eu/MoST](http://www.italy-croatia.eu/MoST)