

# Automatization of an Early Cereal Classification Model using Random Forest and Remote Sensing Data in a Semi-Arid Region

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# PLAN

**01** Introduction

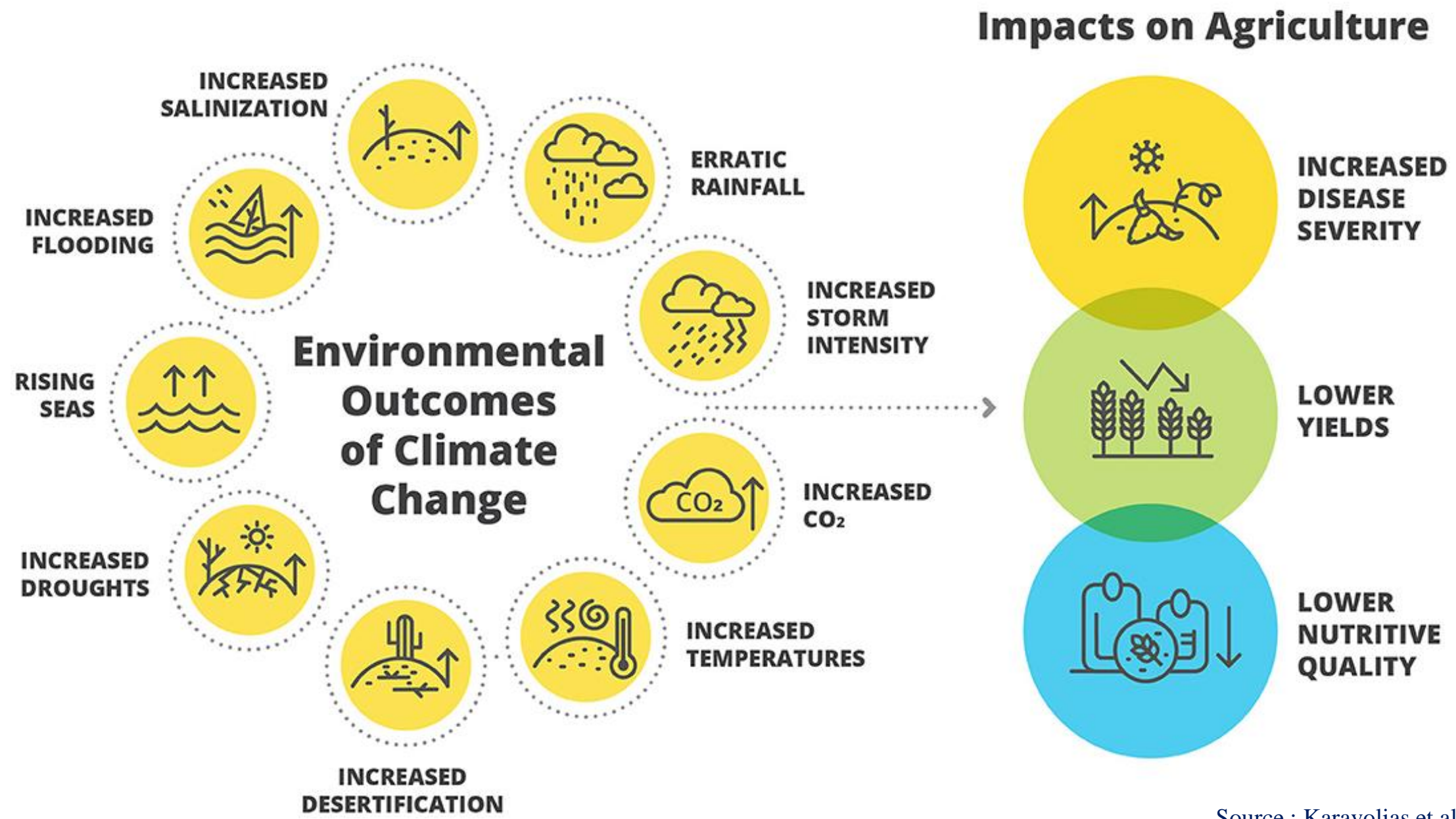
**02** Study Area

**03** Methodology

**04** Results

**05** Conclusions







# Introduction

## Context

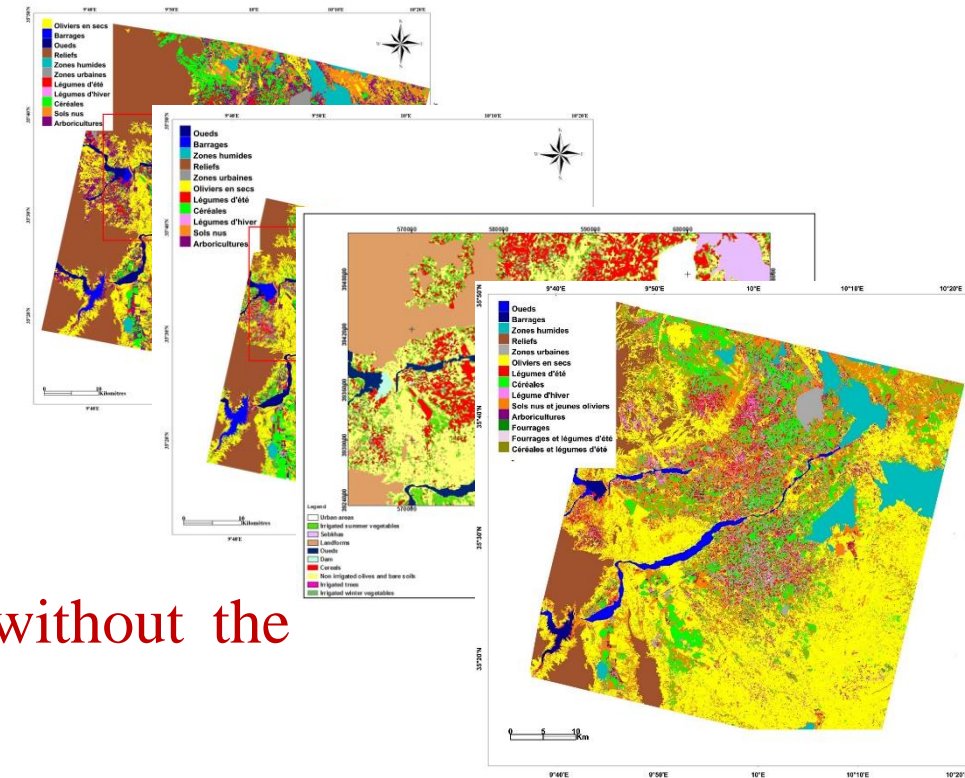
For Lleida (Catalonia), yearly land cover maps are published by the Department of Climate Action, Agriculture and Rural Agenda since 2009/2010.

Existing land cover maps for the Kairouan plain (Tunisia) have been produced yearly since 2008 using various image sources such as SPOT, ENVISAT ASAR radar and Landsat images.

However, the applicability of these approaches to larger regions and/or different periods/years and their validation have been limited to their study period.

1- Can a land cover classification model be automated without the need for field data collection?

2- Is it possible to have an early land cover classification model?

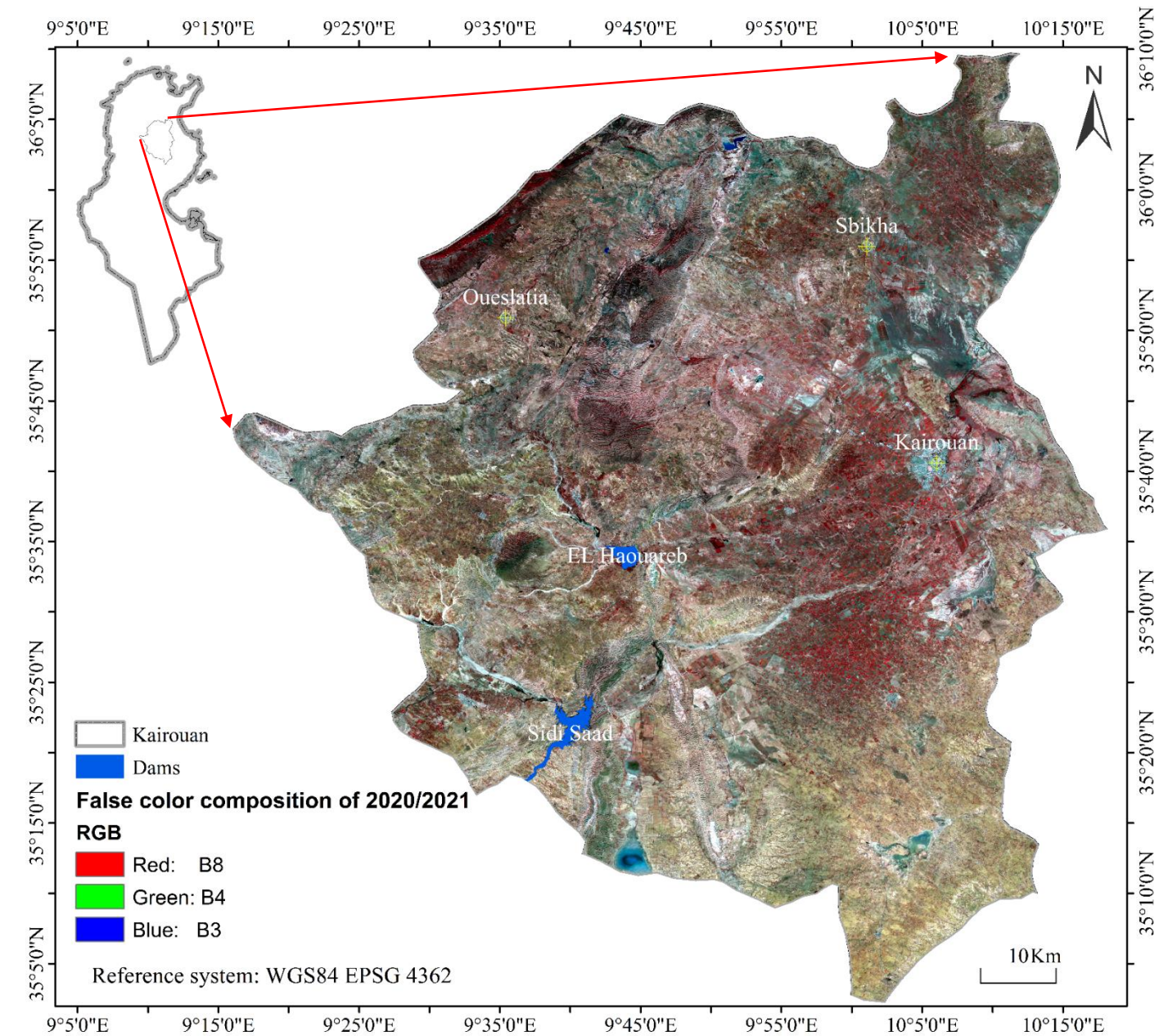


Source: LR GREEN TEAM

## Objectives

1. Development and calibration of a land cover classification model for a **reference year 2020/2021**.
2. Development of a multi-year classification model for mapping winter cereal and validated **over the years 2011/2012 through 2021/2022**.
3. Development of an early classification model to obtain a cereal map **as early as possible** (since January, February, March, April, and May).

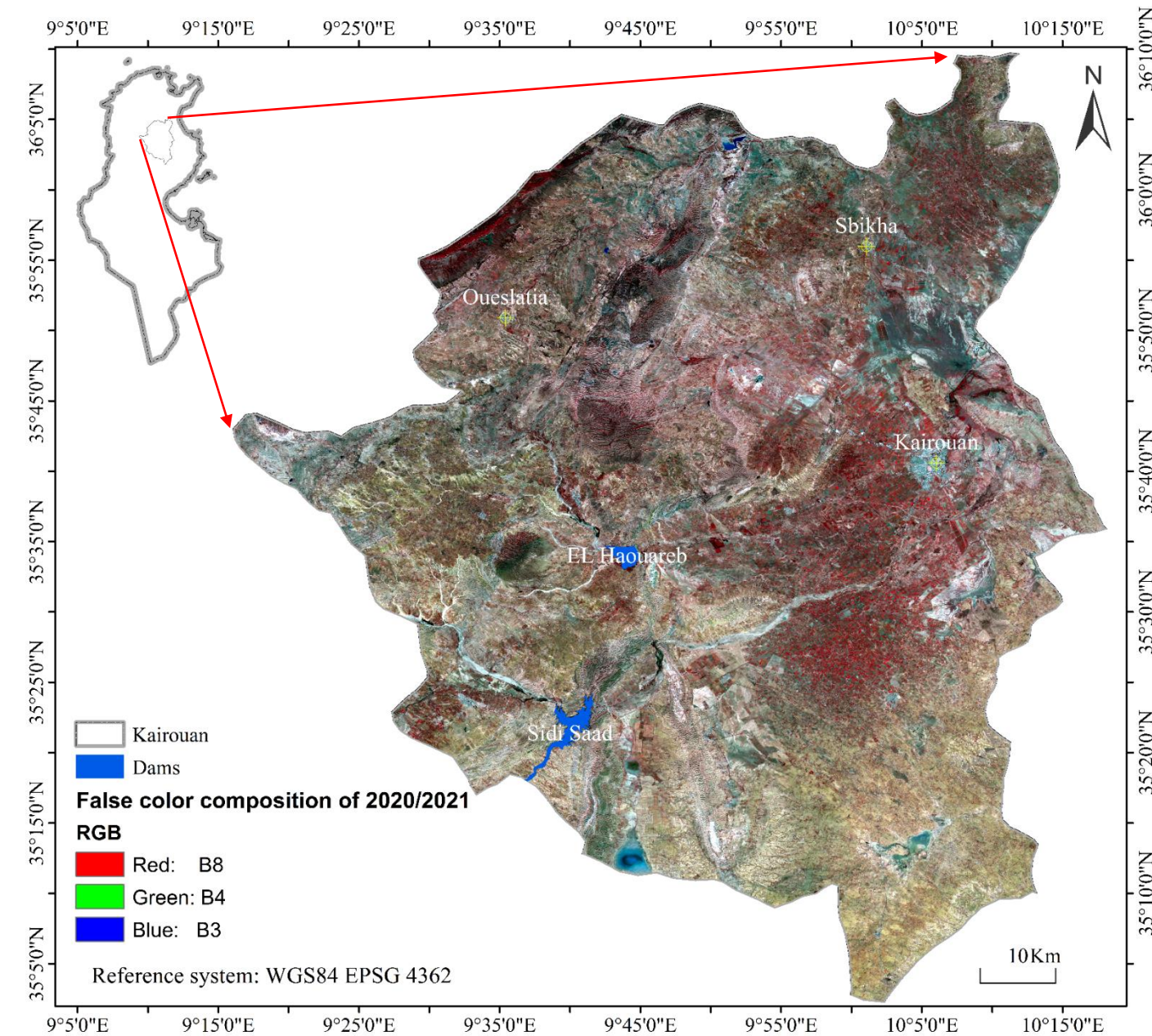
# Study Area





# Study Area

# Data base



## Ground Truth data

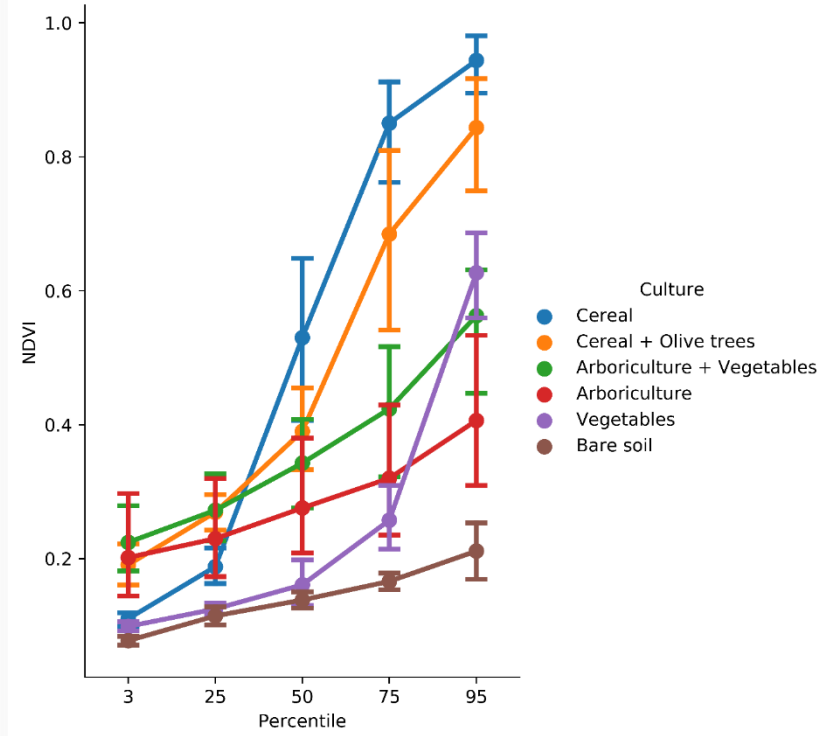
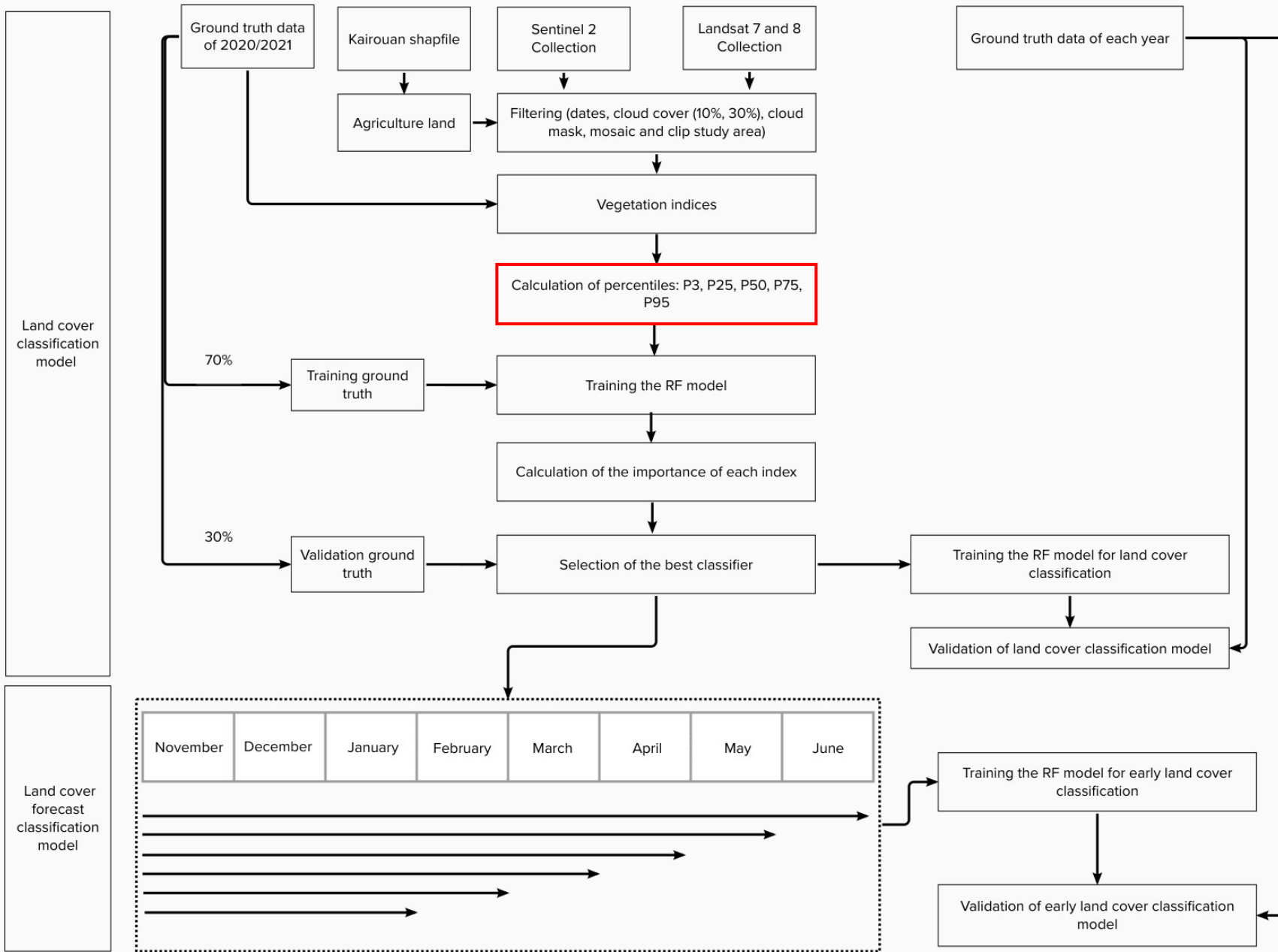
Class	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022
Cereal	57	76	76	26	99	188	171	117	261	419
Cereal with olive trees	-	1	2	-	41	43	40	30	109	69
Fodder crop	-	28	-	4	-	-	-	-	32	35
Vegetable	69	96	96	93	23	21	22	17	71	12
Arboriculture	11	3	3	54	11	10	18	45	215	164
Arboriculture with vegetable	42	33	33	32	25	35	35	49	35	44
Bare soil	14	15	3	60	35	6	11	26	53	129
<b>Total</b>	<b>193</b>	<b>252</b>	<b>213</b>	<b>269</b>	<b>234</b>	<b>303</b>	<b>297</b>	<b>284</b>	<b>776</b>	<b>868</b>

## Satellite data



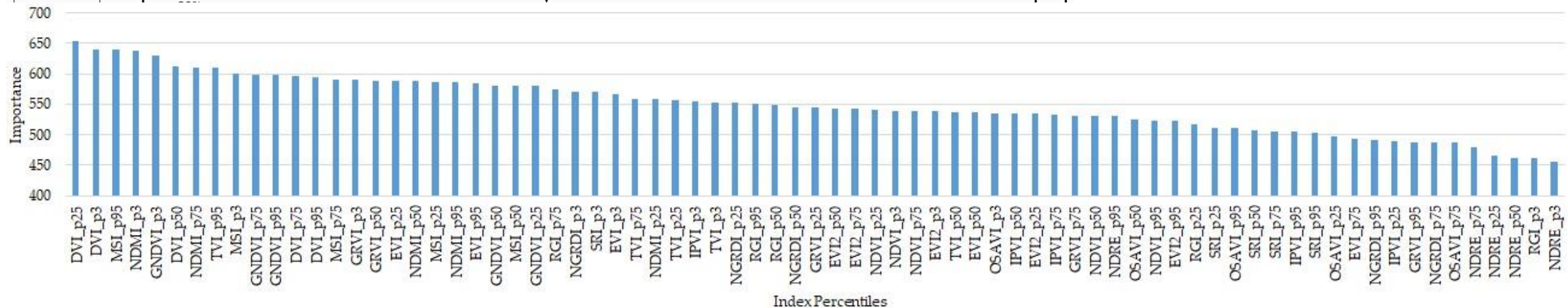
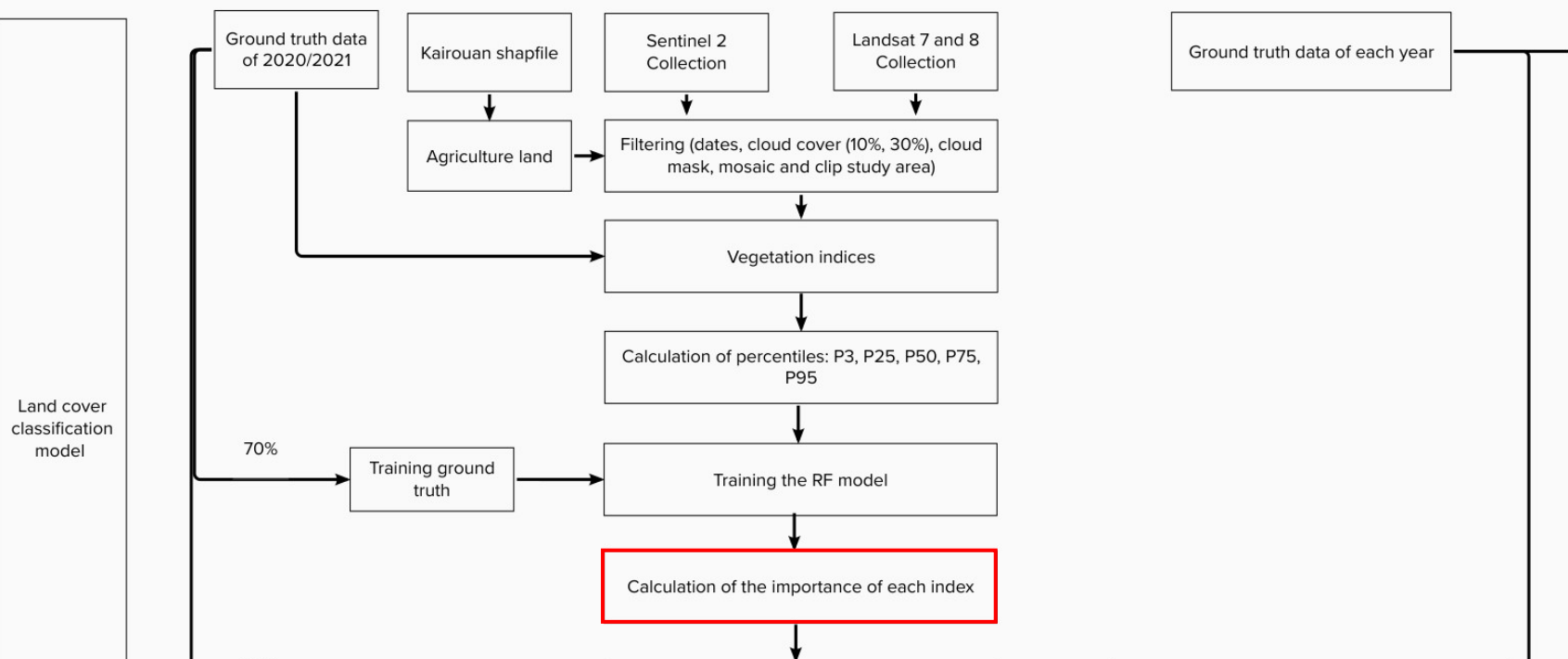
Google Earth Engine

# Methodology





# Methodology



Index Percentiles

model

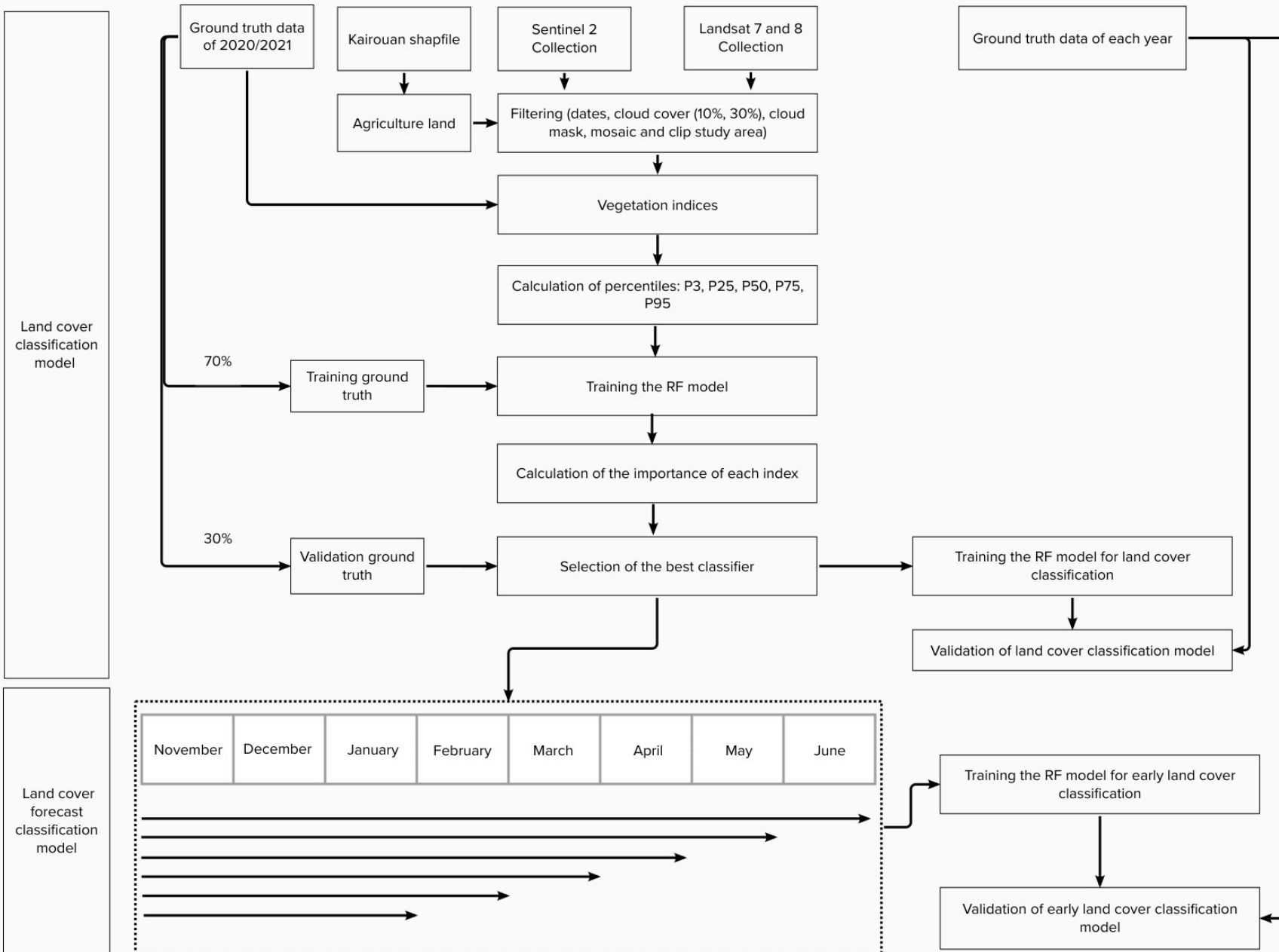
## Metrics:

### Overall classification

- Overall Accuracy (OA)
- Kappa index (Kappa)

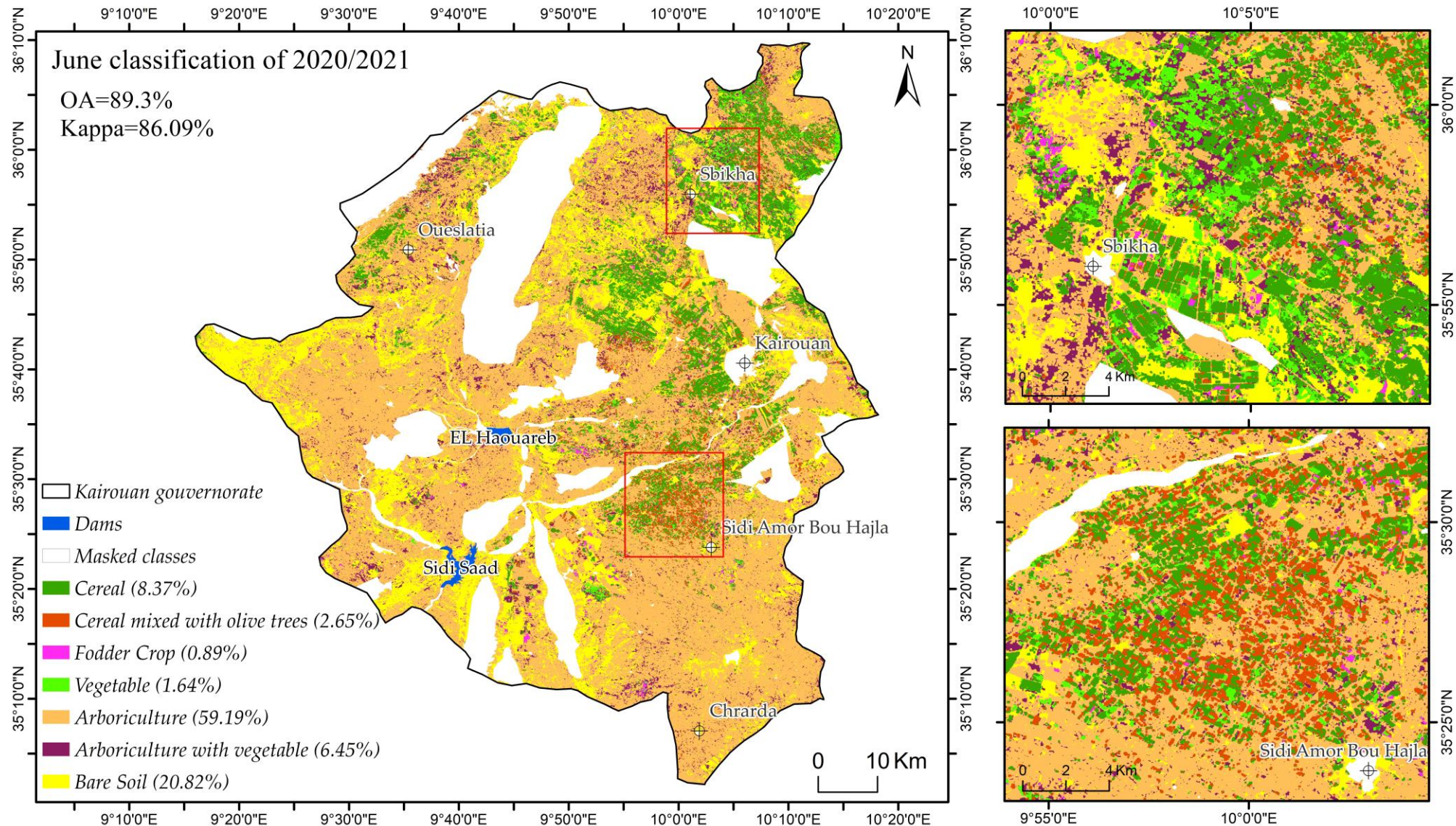
### Classes

- Precision (P)
- Recall (R)
- F1 score (F1)





## 1. Reference land cover classification model



Land cover classification of the 2020/2021 agricultural season by using RF classification algorithm with multi-temporal S2 data from November 1, 2020, to June 30, 2021

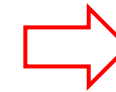


# Results

## 1. Reference land cover classification model

Confusion matrix for the 2020/2021 classification using the most important indices for land cover classification in our study area: DVI, MSI, NDMI and GNDVI

	Cereal	Arboriculture + Cereal	Fodder crops	Vegetable	Arboriculture	Arboriculture + Vegetable	Bare Soil	Row total
Cereal	12680	385	0	140	112	9	3	13329
Arboriculture + Cereal	347	3984	1	1	419	122	0	4874
Fodder crops	443	28	696	19	3	4	0	1193
Vegetable	46	1	0	1286	2	178	0	1513
Arboriculture	24	232	16	0	7298	53	45	7668
Arboriculture + Vegetable	41	45	171	74	346	820	16	1513
Bare Soil	6	0	5	19	819	8	8133	8990
Column total	13587	4675	889	1539	8999	1194	8197	39080
CA (%)	95.1	81.7	58.3	85	95.2	54.2	90.5	
PA (%)	93.3	85.2	78.3	83.6	81.1	68.7	99.2	
F1 (%)	94.2	83.4	66.9	84.3	87.6	60.6	94.6	



This classification model correctly classified the different classes, in particular two classes of cereals.

# Results

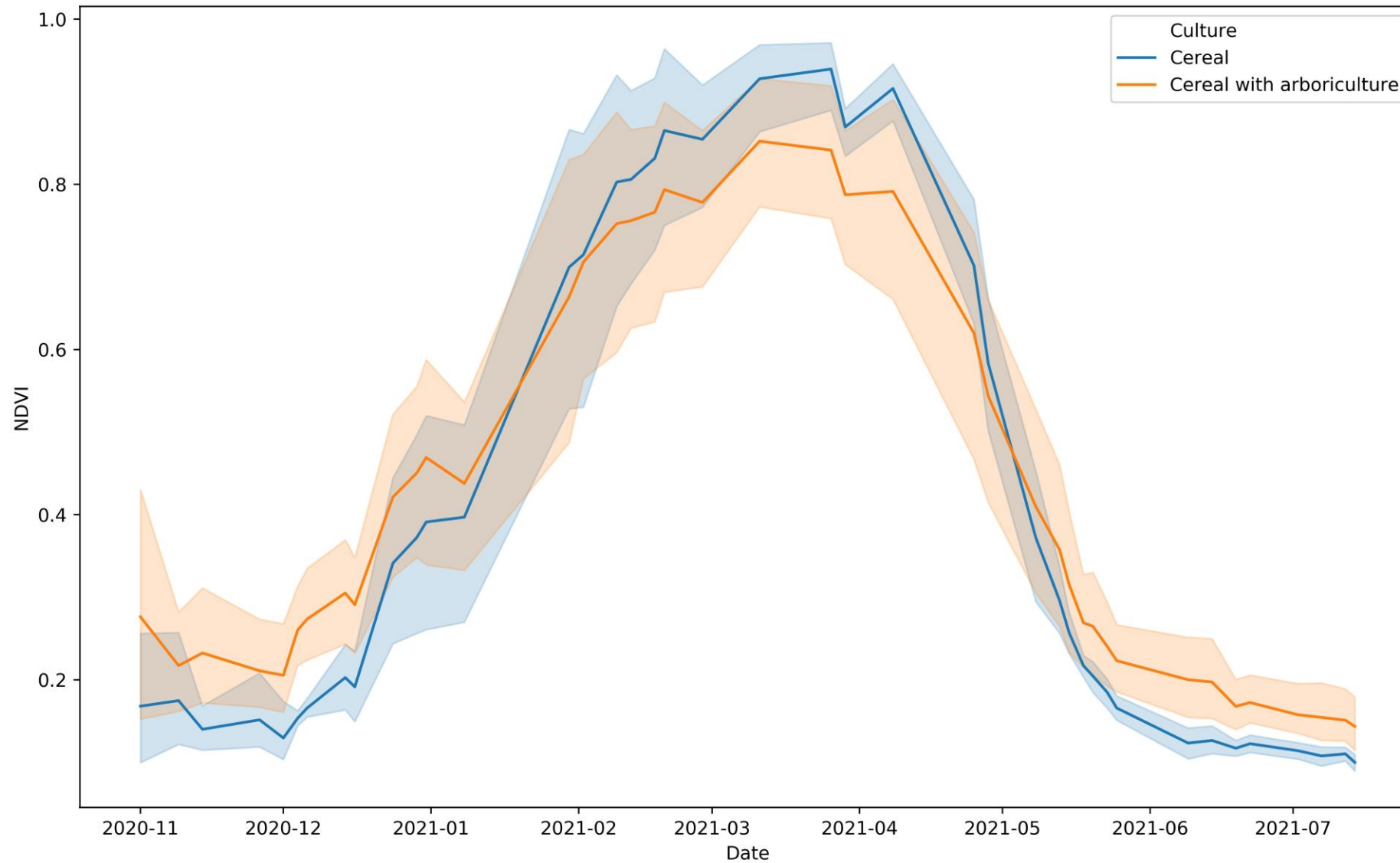
## 2. Multi-year cereal classification model

Validation of cereal and cereal with olive trees June classification results by setting P, R and F1 for cereal and cereal mixed with olive trees and OA and Kappa for overall classification accuracy.

Data	Year	Cereal			Cereal with olive trees			Land Cover	
		P	R	F1	P	R	F1	OA	Kappa
<b>Reference year S2</b>	2020/2021	<b>95.1</b>	93.3	94.2	<b>81.7</b>	85.2	83.4	89.3	86.1
S2	2021/2022	<b>95.1</b>	75.3	84	27.4	84.7	41.3	73.5	61.9
	2019/2020	<b>86.9</b>	83.1	85	60.4	76.9	67.6	73.2	62.4
	2018/2019	<b>90.8</b>	69.6	78.8	36.1	74.4	48.6	67.3	44.1
	2017/2018	<b>85.8</b>	87.8	86.8	40.9	52.2	45.9	75	45.2
L8	2021/2022	<b>91.8</b>	30.8	46.1	9.1	42.1	14.9	47.6	34.3
	2019/2020	<b>69.1</b>	58.5	63.3	33	66.7	44.2	49.9	32.1
	2018/2019	<b>82.8</b>	43.5	57	20.7	86.7	33.4	42.2	16.2
	2017/2018	<b>89.3</b>	71.7	79.6	21.9	60.2	32.1	59.5	27.7
	2016/2017	<b>70.5</b>	27.8	39.8	17.8	56.6	27.1	44.3	33.1
	2014/2015	41	80.2	54.2	-	-	-	38.3	22.9
	2013/2014	50.1	65.5	56.8	-	-	-	30.7	7
L7	2012/2013	57.4	48.2	52.4	-	-	-	25.3	6.3
	2011/2012	48.8	62.8	62.8	-	-	-	36.7	7.1

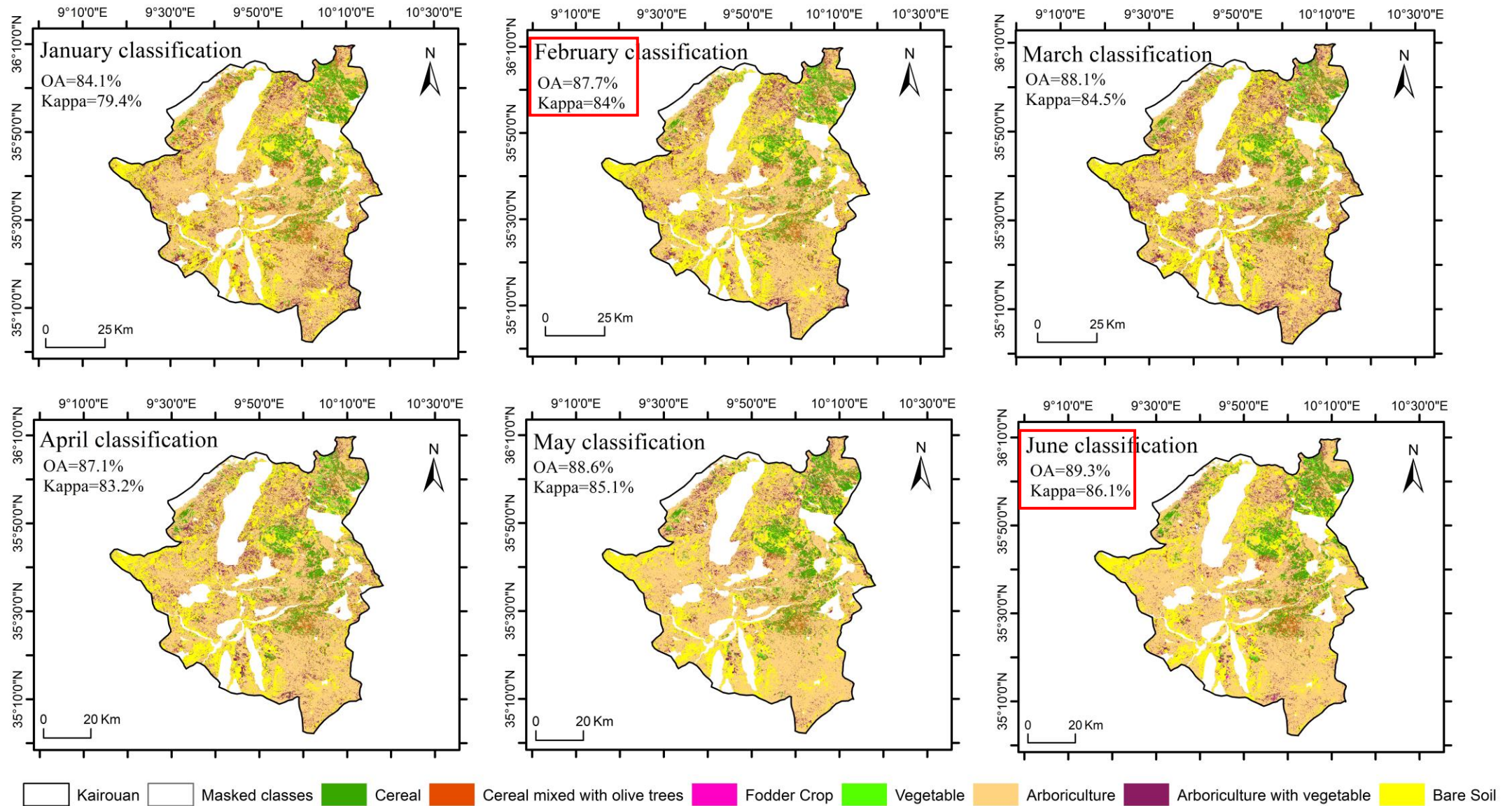
## 2. Multi-year cereal classification model

➔ Strong similarity between cereal and cereal cultivated with olive trees classes





## 3. Early multi-year cereal classification model



Land cover classification for the 2020/2021 agricultural season by using multi-temporal S2 data for the different classification periods.

# Results

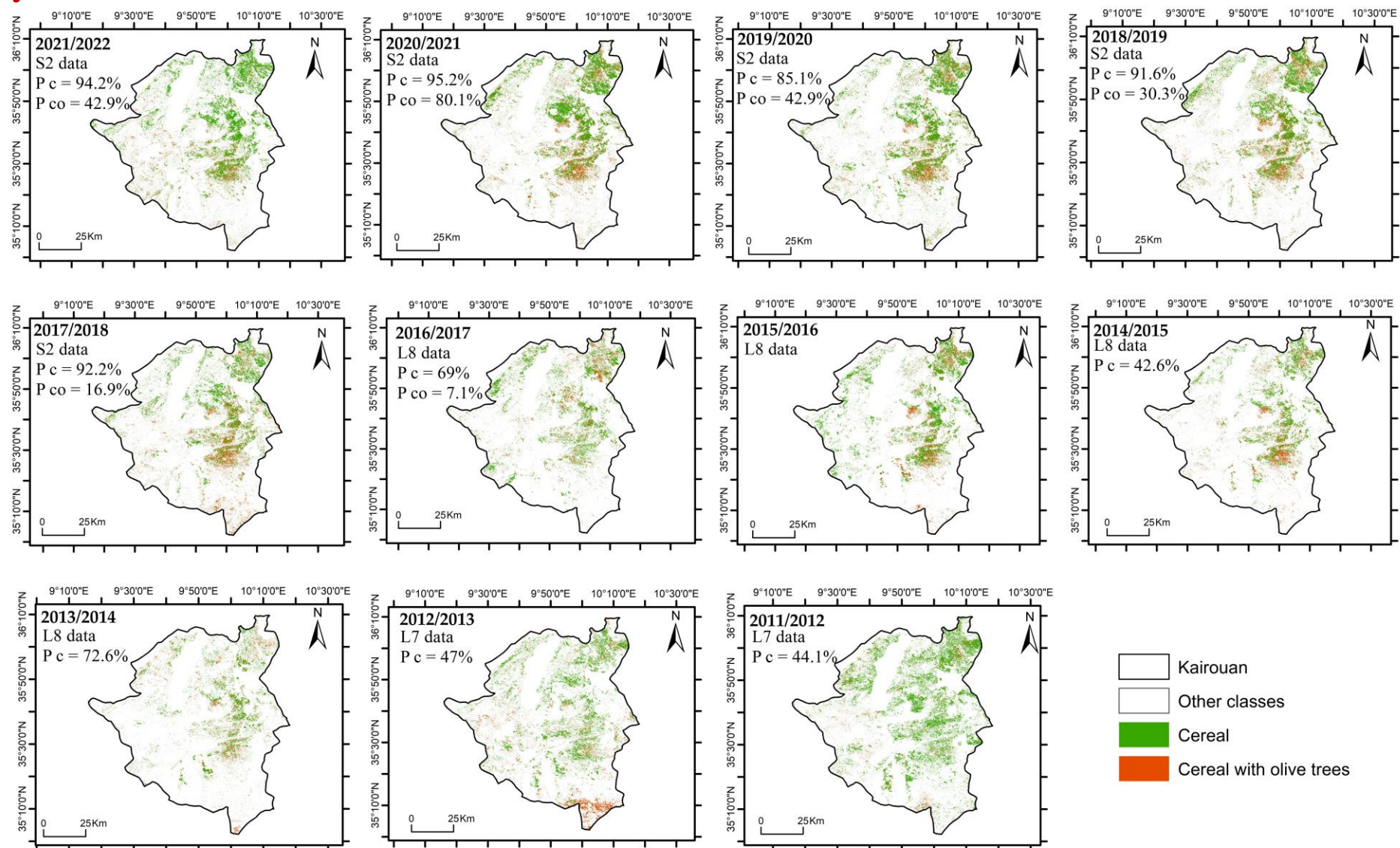
## 3. Early multi-year cereal classification model

Validation of cereal and cereal with olive trees February classification results by setting P, R and F1 for cereal and cereal mixed with olive trees and OA and Kappa for overall classification accuracy.

Data	Year	Cereal			Cereal with olive trees			Land Cover	
		P	R	F1	P	R	F1	OA	Kappa
Reference year S2	2020/2021	<b>95.2</b>	91.8	93.5	<b>80.1</b>	88.2	83.9	87.7	84
	2021/2022	<b>94.2</b>	78.1	85.4	42.9	55.8	48.5	75.2	63.8
	2019/2020	<b>85.1</b>	78.1	81.5	42.9	61.9	50.7	60.6	45.8
	2018/2019	<b>91.6</b>	64.6	75.8	30.3	48.4	37.3	57	30.9
	2017/2018	<b>92.2</b>	57.9	71.1	16.9	47.3	24.9	51.3	24.9
L8	2021/2022	<b>95.4</b>	54.2	69.1	23.7	50.4	32.3	67.9	55.3
	2019/2020	<b>84.6</b>	52.2	64.6	40.7	72.3	52.1	49.1	35.2
	2018/2019	<b>83.5</b>	27	40.8	10.1	17.8	12.9	22.9	4.6
	2017/2018	<b>93.7</b>	34.8	50.7	12.9	34.5	18.8	32.5	12.4
	2016/2017	69	36	47	7.1	7	7	43.6	30.2
	2014/2015	42.6	69.4	52.8	-	-	-	43.2	27.8
	2013/2014	<b>72.6</b>	38.1	49.9	-	-	-	20.9	10.4
L7	2012/2013	47	25.8	33.4	-	-	-	14.7	0.6
	2011/2012	44.1	23.2	30.4	-	-	-	22.1	3.2



## 3. Early multi-year cereal classification model



Early cereal identification maps (**4 months before harvest**) were obtained by using multi-temporal satellite data from November 1,  $yi-1$  to February 28,  $yi$ .



# Conclusion

- The calibrated classification model allow for **early** land cover mapping, up to **three or four months before the cereal harvest**, with a precision for cereal crops that is comparable to a map produced at the end of the cycle.
- The obtained results are very encouraging, especially for the future. The proposed methodology responds to the problems of field displacement, storage capacity and computing power.
- With other ground truth data covering all of Tunisia, this model can be applied on a national scale and can be a decision support tool for food security.

Khlif, M.; Escorihuela, M.J.; Chahbi Bellakanji, A.; Paolini, G.; Kassouk, Z.; Lili Chabaane, Z. Multi-Year Cereal Crop Classification Model in a Semi-Arid Region Using Sentinel-2 and Landsat 7–8 Data. *Agriculture* 2023, 13, 1633. <https://doi.org/10.3390/agriculture13081633>

Thank you for your attention!

Kairouan, 14 mai 2022