Land use change and livelihood responses to large investments for high-value agriculture: managing risks in the era of the Green Morocco Plan

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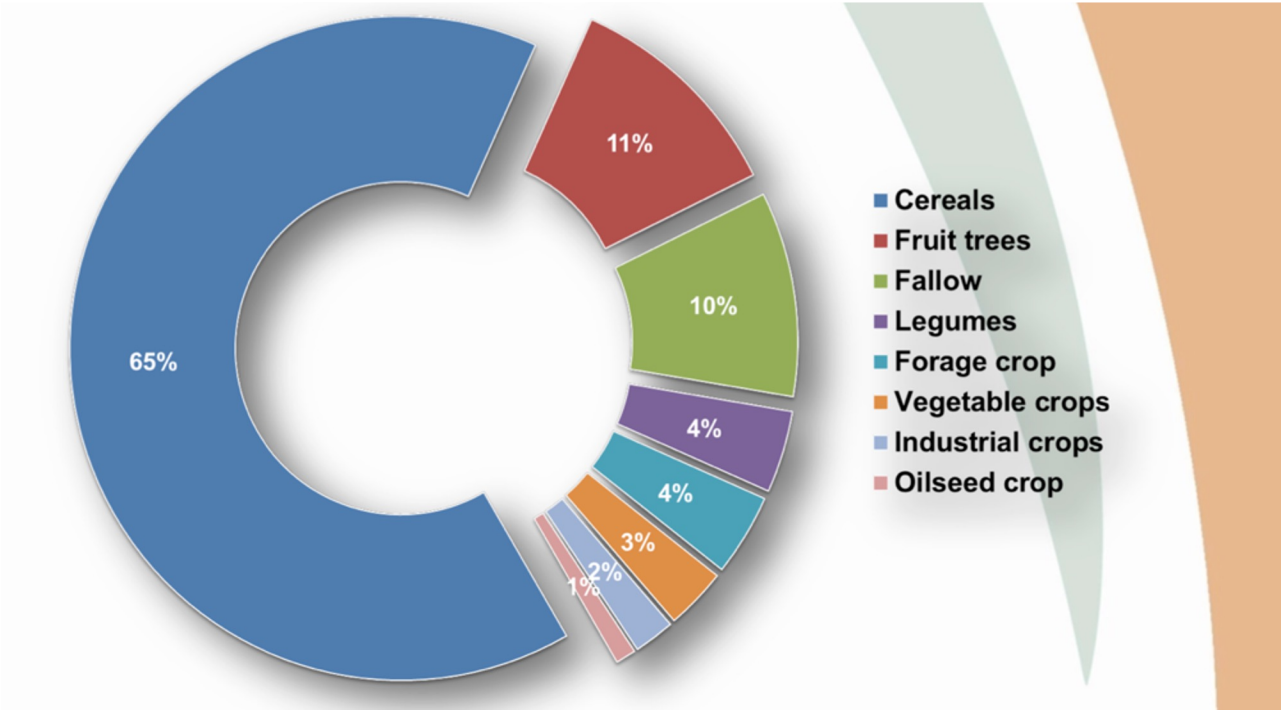
Background

How can large-scale agricultural investments (often with substantial land use change) contribute to sustained, inclusive economic growth?

Transforming a landscape from one crop-type to another can either enhance a region's capacity to withstand unanticipated adverse conditions or further deplete the resources needed to sustain it.

Facts About Green Morocco Plan

- In Morocco, agriculture contributes to 15-20% of the GDP
- First sector provider of employment (38% nationally and 75% in rural areas)
- The Green Morocco Plan (Phase I: $10 billion from 2008-2020; Phase II: 2020-2026) aims at increasing growth, reducing poverty, ensuring sustainability of the agricultural sector and enhancing export to international markets
- Converting substantial swathes of lower-value cereal crops to higher-value, drought-resistant perennials, mostly olives (1.2 million ha)



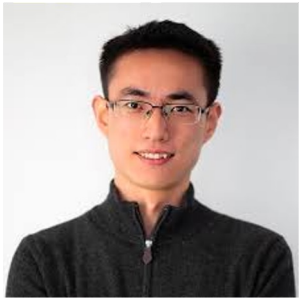
Problem Statement

Official statistics report that olive production and export volumes have increased by 65% and 540% since then, respectively, largely because of a 35% increase in the cultivated area.

We want to evaluates social and environmental consequences of large-scale agricultural investments, focused on:

(1) the transition from cereals to perennial crops in the drought-prone Mediterranean country of Morocco
(2) the possibility to use remotely-sensed indicators of environmental stress at the basis of responsible, adaptive relief financing

Research Team



Zhenong Jin (PI)

Stanford □ AtlasAI □ UMN

Crop mapping & yield prediction, especially for smallholders in Africa

Elinor benami (Co-I)

Stanford □ UC Davis □ VT

Socioeconomic consequence of oil crops in the tropics

Agricultural insurance

Collaborators

David Mulla (UMN)

Pioneer in precision agriculture

Consultant to MCC projects that planted 8 million olive trees on 80,000 ha in Morocco

David Mulla (UC Davis)

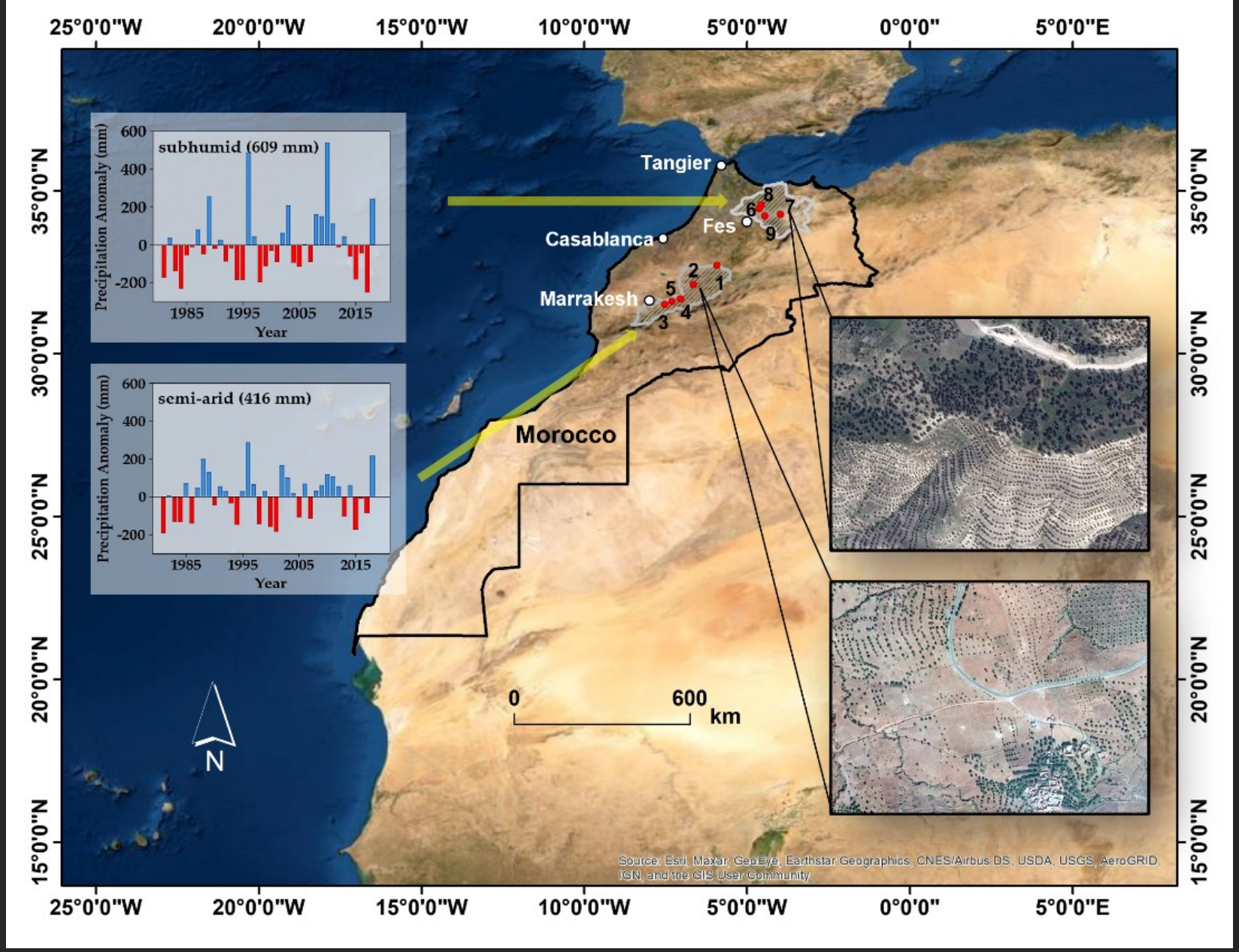
Economist working on poverty dynamics

20+ years project experience in Morocco

Rachid Bouabid (NSAM)

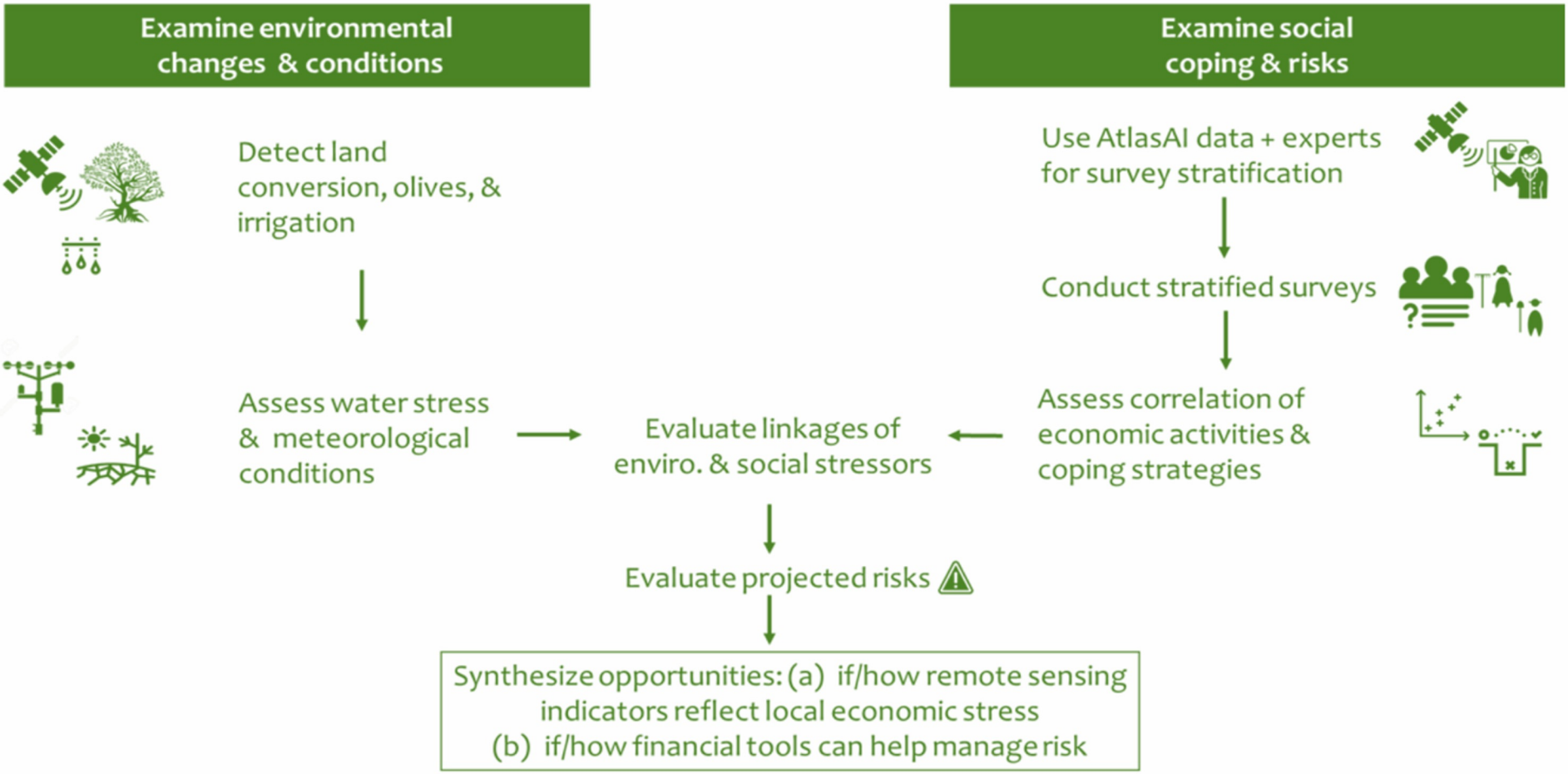
Local expert in soil fertility and crop management

Work very closely with olive growers


25°0'0"W
20°0'0"W
15°0'0"W
10°0'0"W
5°0'0"W
0°0'0"
5°0'0"E
35°0'0"N
30°0'0"N
25°0'0"N
20°0'0"N
15°0'0"N
subhumid (609 mm)
Precipitation Anomaly (mm)
600
400
200
0
-200
1985
1995
2005
2015
Year
semi-arid (416 mm)
Tangier
Casablanca
Fes
Marrakesh
Morocco
1
2
3
4
5
6
7
8
9
N
0
600
km
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

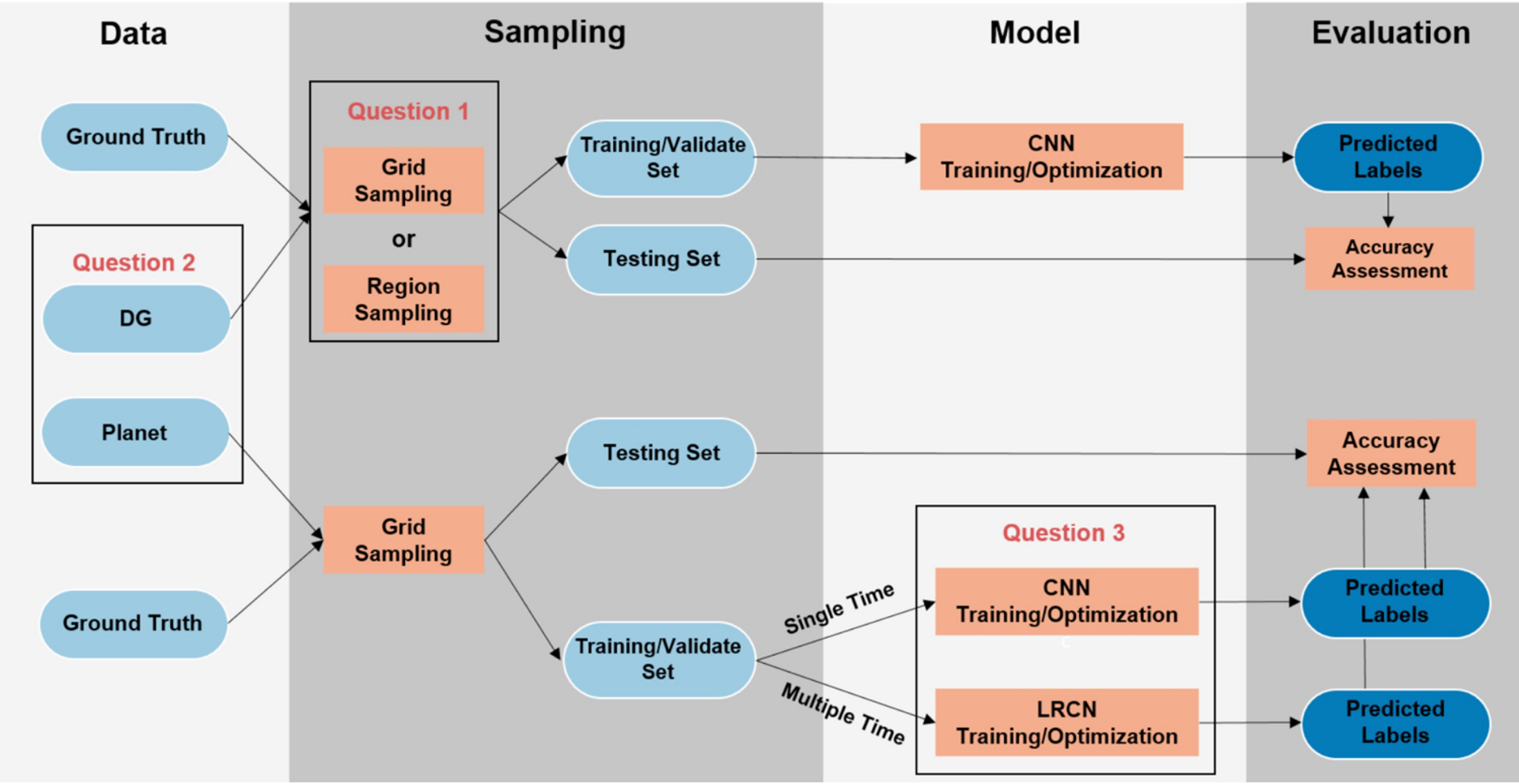
Study Area

Overview of The Project



Preliminary Results

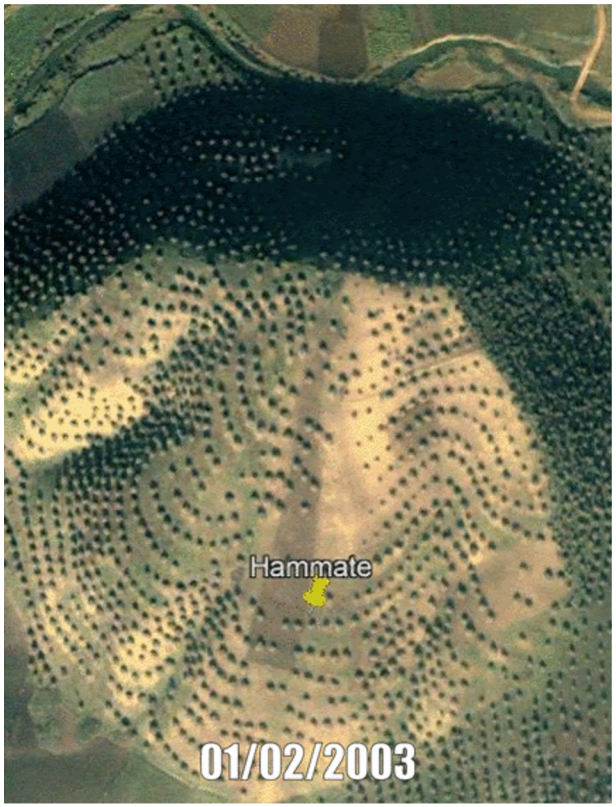
- Mapping tree crops is an understudied topic
- For an algorithm to be applied at national scale or beyond, a few fundamental questions remain to be answered



Spatial Features

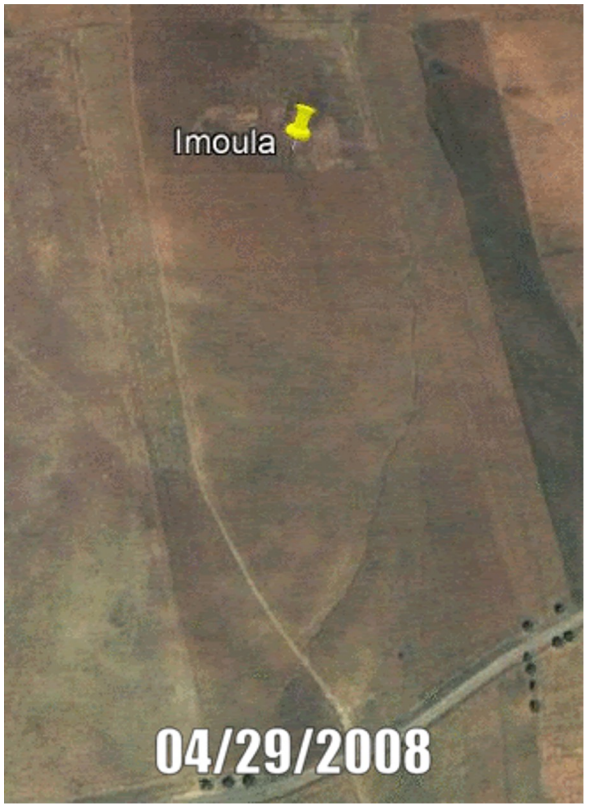
Legacy olives:

- Planted along contours
- Mostly in sub-humid region
- Large crown size

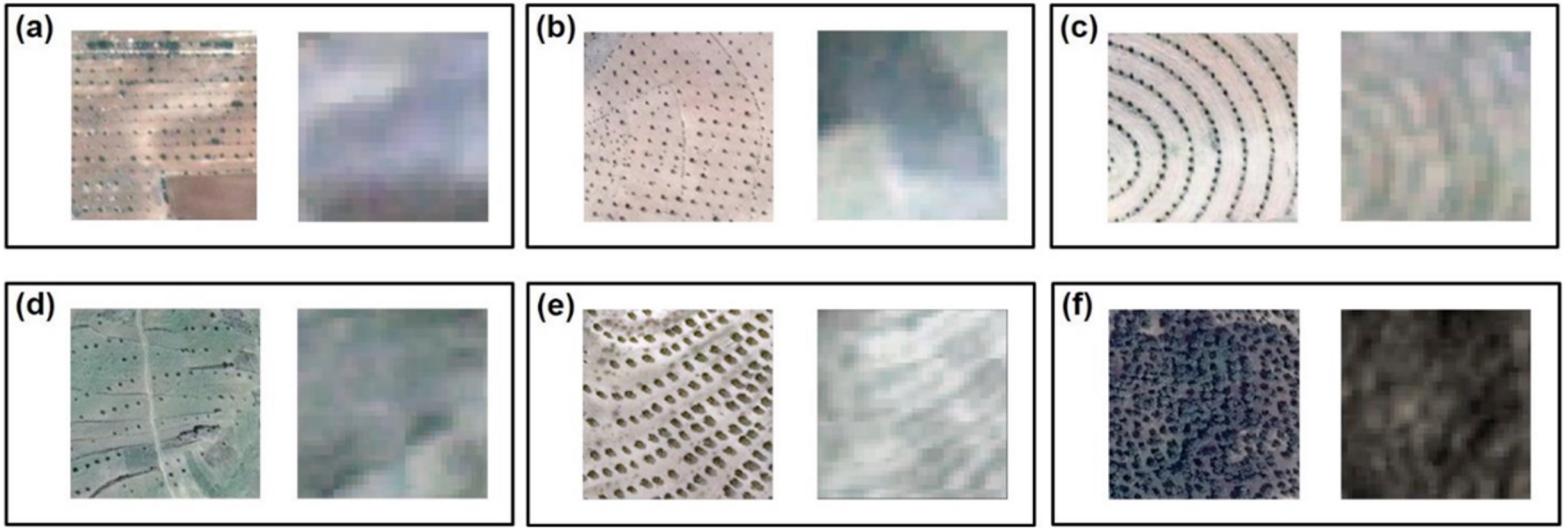


Newly planted by GMP:

- Planted after 2008
- Grow slowly
- Small crown size, hardly visible from PlanetScope

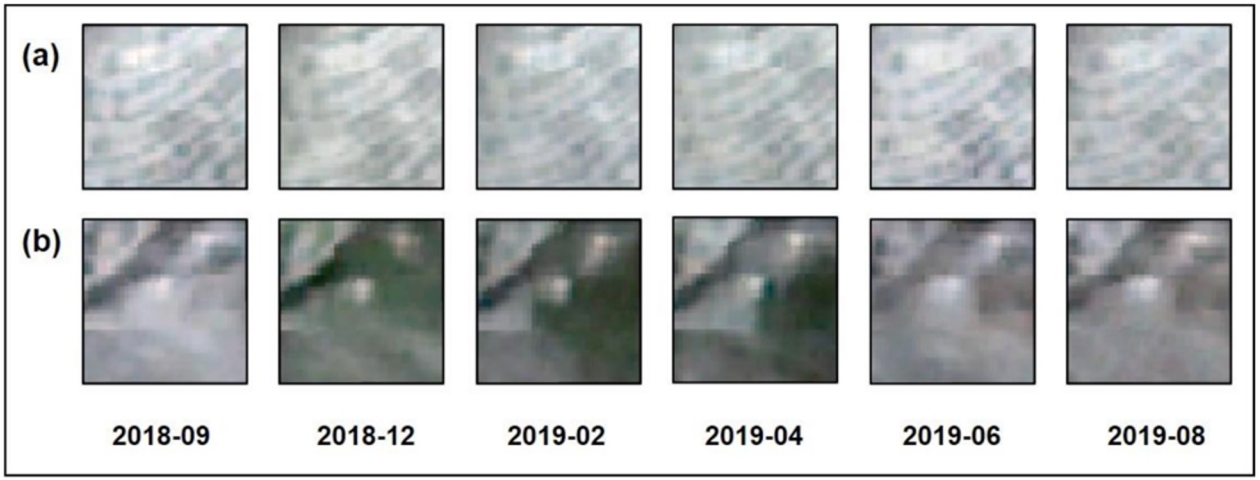


DG vs Planet



	Site	DG Basemap (0.5m) Precision	Recall	F1	OA	PlanetScope (3m) Precision	Recall	F1	OA
Semi-arid	1	0.883	0.838	0.860	0.938	0.212	0.332	0.299	0.643
	2	0.931	0.819	0.872	0.945	0.252	0.302	0.275	0.637
	3	0.876	0.934	0.904	0.950	0.320	0.580	0.413	0.579
	4	0.839	0.913	0.874	0.937	0.228	0.437	0.3	0.509
	5	0.825	0.920	0.870	0.948	0.194	0.389	0.259	0.576
Overall		0.868	0.887	0.877	0.943	0.259	0.420	0.320	0.588
Sub-humid	6	0.881	0.940	0.910	0.941	0.443	0.699	0.542	0.629
	7	0.899	0.881	0.89	0.917	0.570	0.465	0.512	0.664
	8	0.827	0.878	0.851	0.875	0.534	0.585	0.558	0.622
	9	0.892	0.976	0.932	0.942	0.670	0.522	0.587	0.702
Overall		0.879	0.924	0.901	0.924	0.545	0.557	0.551	0.659

Multi-temporal Planet

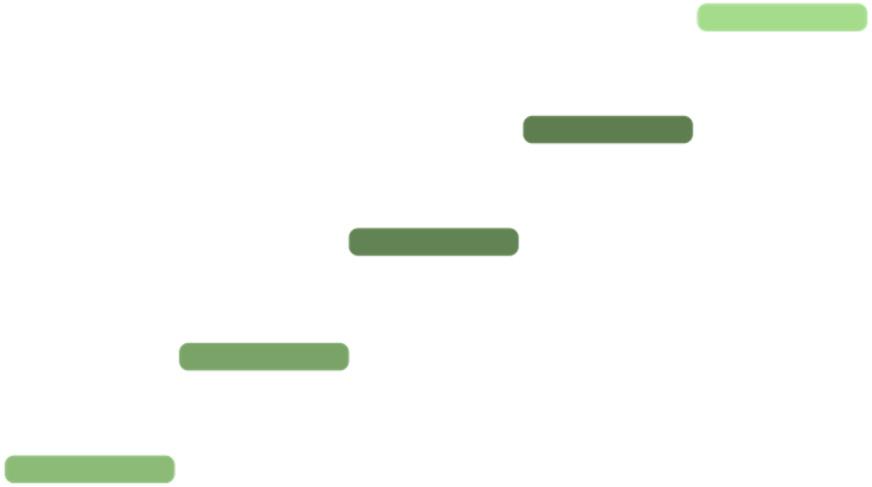


- Olives are evergreen thus have more stable features over time
- Non-olives show some phenological changes

	Site	Single Time CNN				Multi-temporal LRCN			
		Precision	Recall	F1	OA	Precision	Recall	F1	OA
Semi-arid	1	0.212	0.332	0.299	0.643	0.455	0.260	0.331	0.759
	2	0.252	0.302	0.275	0.637	0.313	0.172	0.222	0.726
	3	0.320	0.580	0.413	0.579	0.389	0.274	0.321	0.706
	4	0.228	0.437	0.3	0.509	0.444	0.212	0.337	0.743
	5	0.194	0.389	0.259	0.576	0.341	0.389	0.364	0.741
Overall		0.259	0.420	0.320	0.588	0.397	0.271	0.322	0.736
Sub-humid	6	0.443	0.699	0.542	0.629	0.715	0.711	0.713	0.820
	7	0.570	0.465	0.512	0.664	0.575	0.451	0.513	0.675
	8	0.534	0.585	0.558	0.622	0.595	0.653	0.612	0.661
	9	0.670	0.522	0.587	0.702	0.689	0.727	0.708	0.756
Overall		0.545	0.557	0.551	0.659	0.650	0.637	0.643	0.735

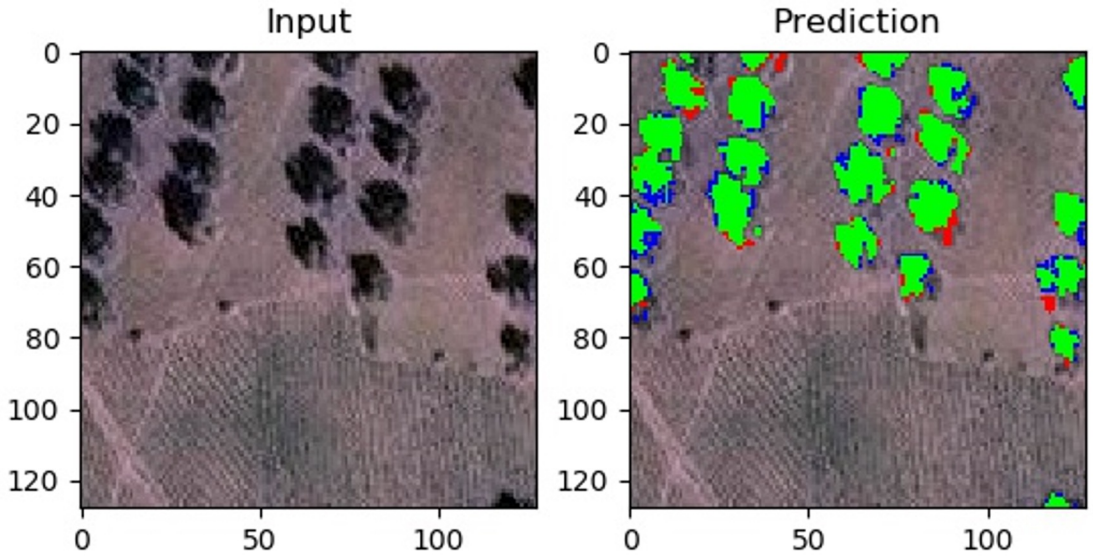
Next Steps

- Collecting ground truth at 20 sites from the two regions
  e.g. almonds, argan, in addition to olives
- Less labels: exploring self-supervised clustering to reduce the demand for labels
- Spatio-temporal information: developing more advanced CNN-LSTM model, possibly with attentions, to distinguish key phenological stages
- Limited travel plan, designing survey questions



Thank you!
Questions?

If we have unlimited access to DG…



A simple UNet classifier achieved an overall accuracy of 97% for 200 images from the sub-humid region in Morocco

Article | Published: 14 October 2020

An unexpectedly large count of trees in the West African Sahara and Sahel

Martin Brandt ✉, Compton J. Tucker ✉, Ankit Kariryaa, Kjeld Rasmussen, Christin Abel, Jennifer Small, Jerome Chave, Laura Vang Rasmussen, Pierre Hiernaux, Abdoul Aziz Diouf, Laurent Kergoat, Ole Mertz, Christian Igel, Fabian Gieseke, Johannes Schöning, Sizhuo Li, Katherine Melocik, Jesse Meyer, Scott Sinno, Eric Romero, Erin Glennie, Amandine Montagu, Morgane Dendoncker & Rasmus Fensholt

Nature (2020) | Cite this article