



Sentinel-based applications for the automated detection and monitoring of Cultural Heritage

Examples from South Asian archaeology

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What's on today

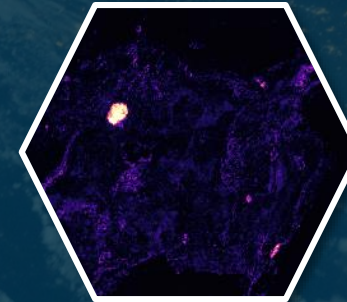
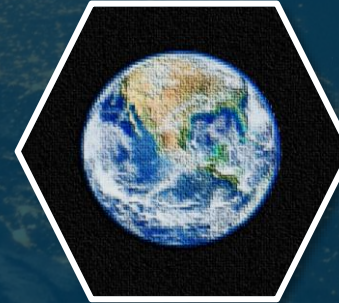
 Endangered archaeology

 Towards Big Earth Data

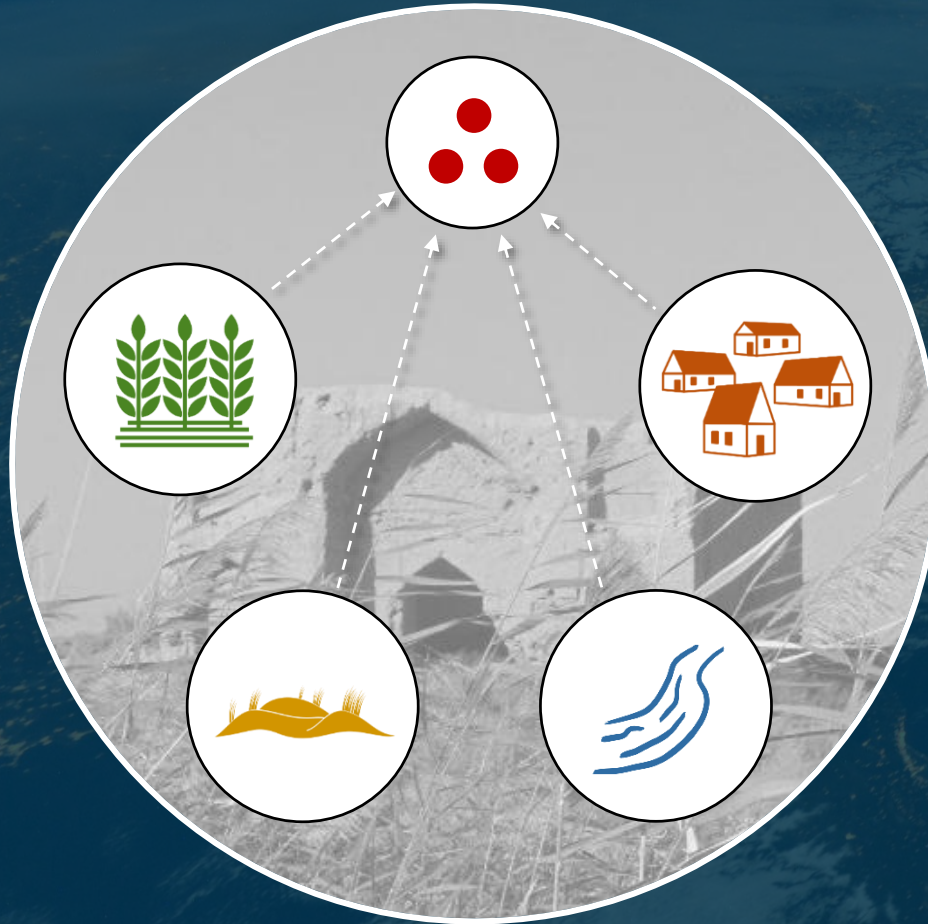
 Site detection in drylands

 Site monitoring and agricultural expansion

 Food for thought



Endangered archaeology



Natural erosion

Agriculture & irrigation

Urban development

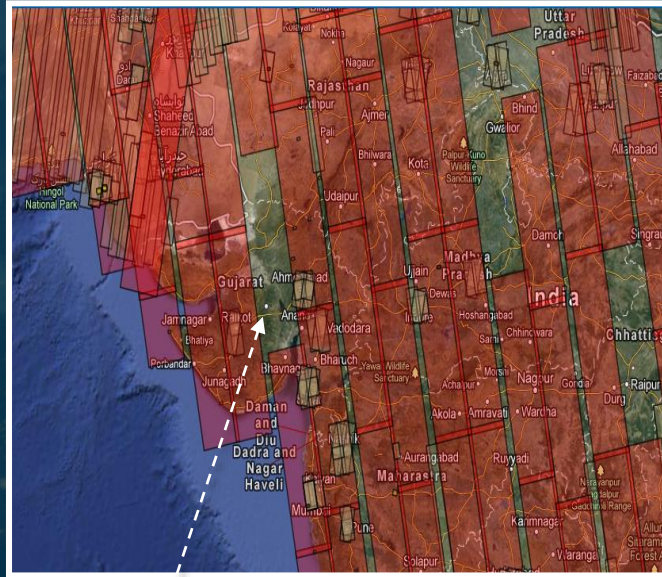
Infrastructure

Conflict

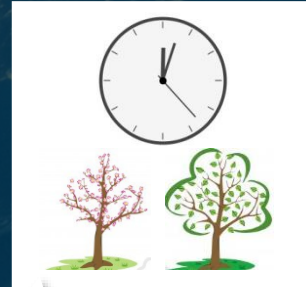
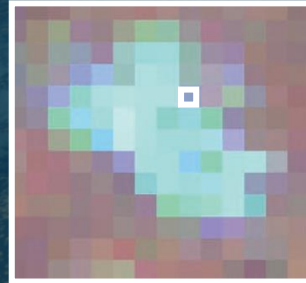
Large-scale looting

Winds of change

*Limited (or costly)
spatial resolution*



Poor coverage



*Limited temporal
resolution*

Global collections



Mid- to high-res



Cloud-computing platforms



Towards Big Earth Data

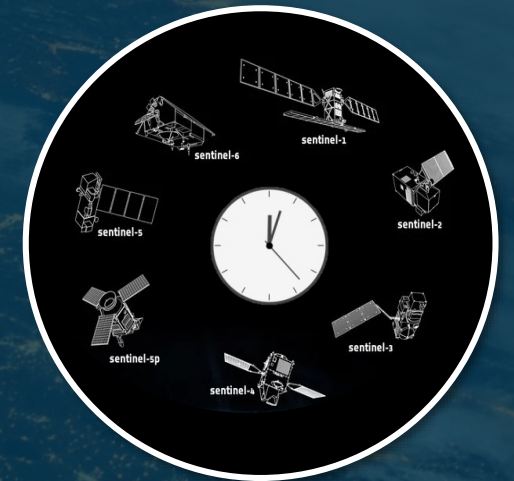
Code-sharing



Earth Engine



Multi-source and multi-temporal



Virtual constellations

“A set of space and ground segment capabilities that operate in a coordinated manner to meet a combined and common set of Earth Observation requirements” ceos.org



Archaeological signatures and patterns

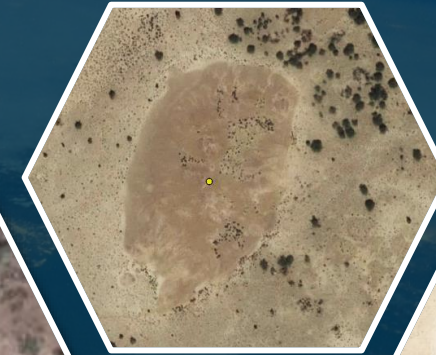
Site detection in drylands



Site detection in drylands



*Only a few
excavated ones*

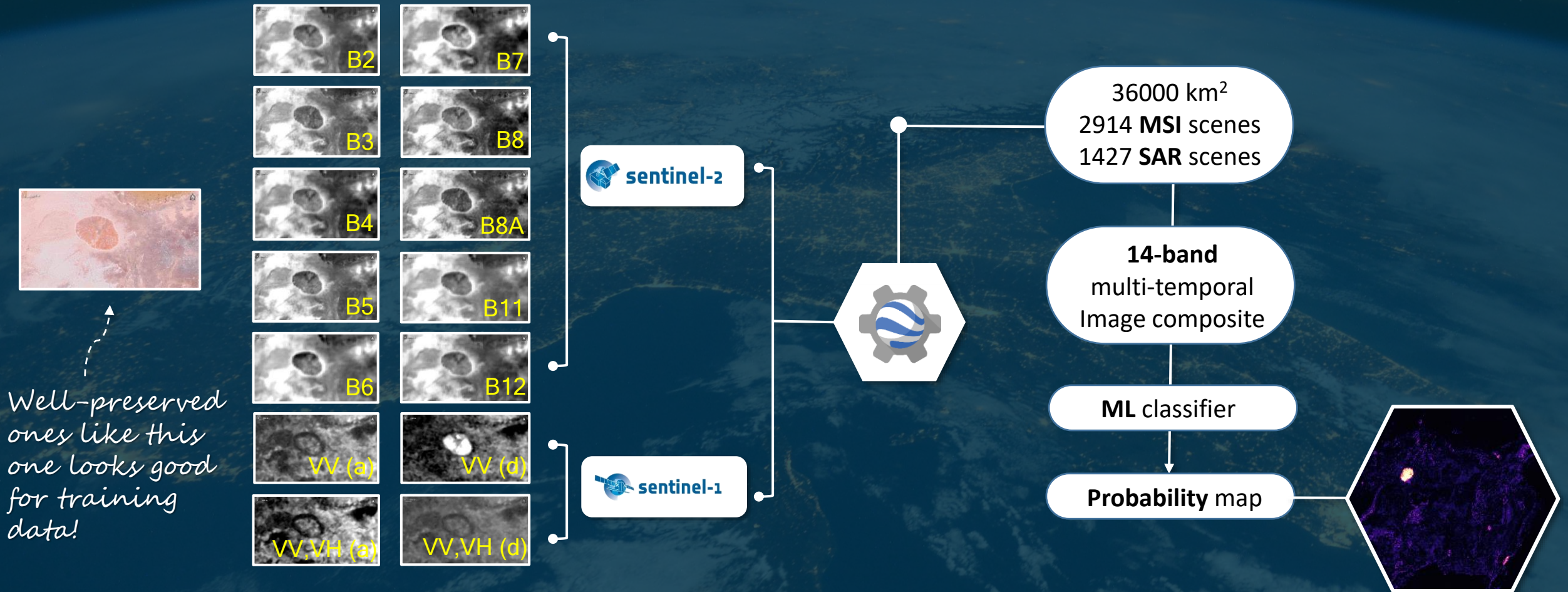


Not excavated

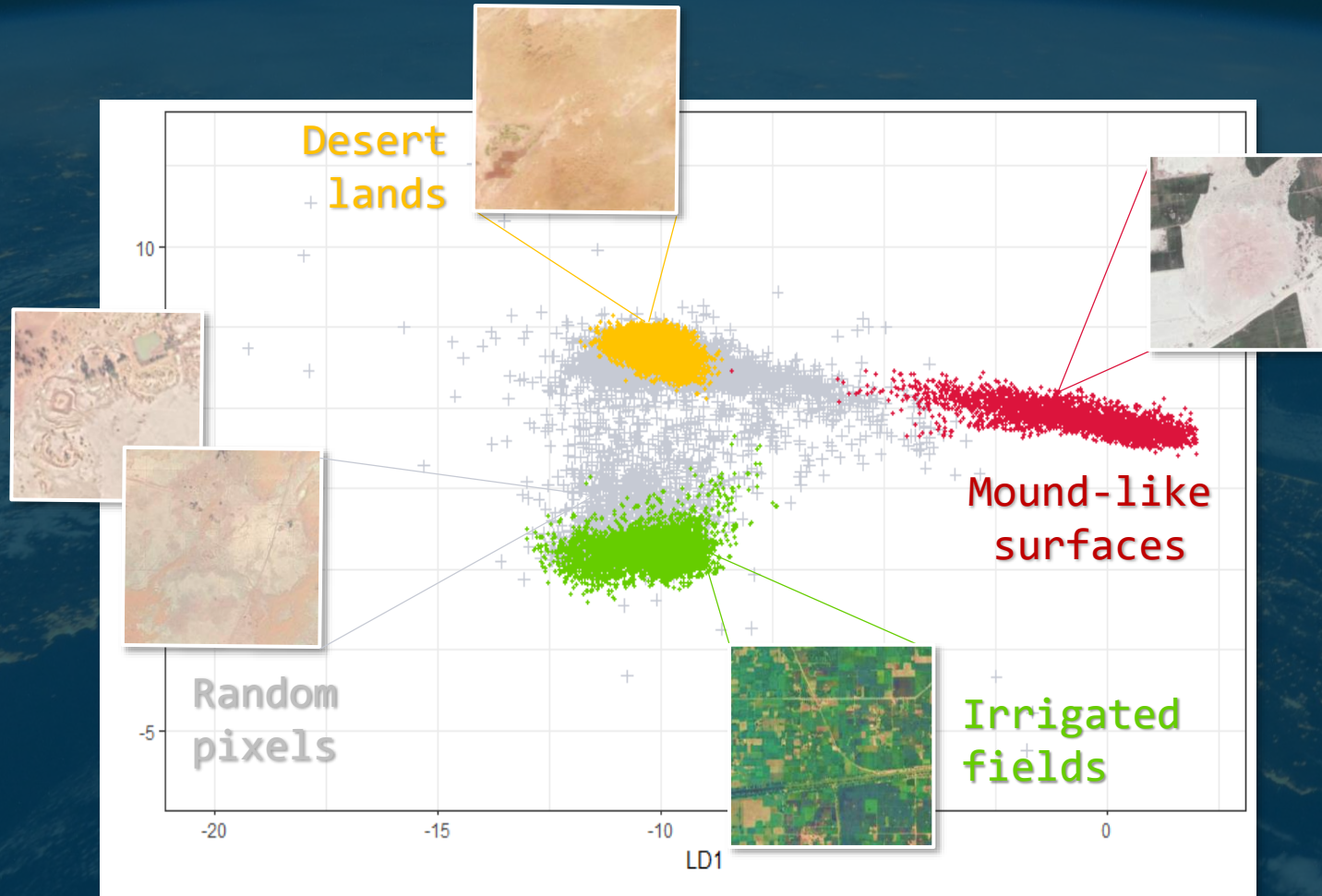


On the ground

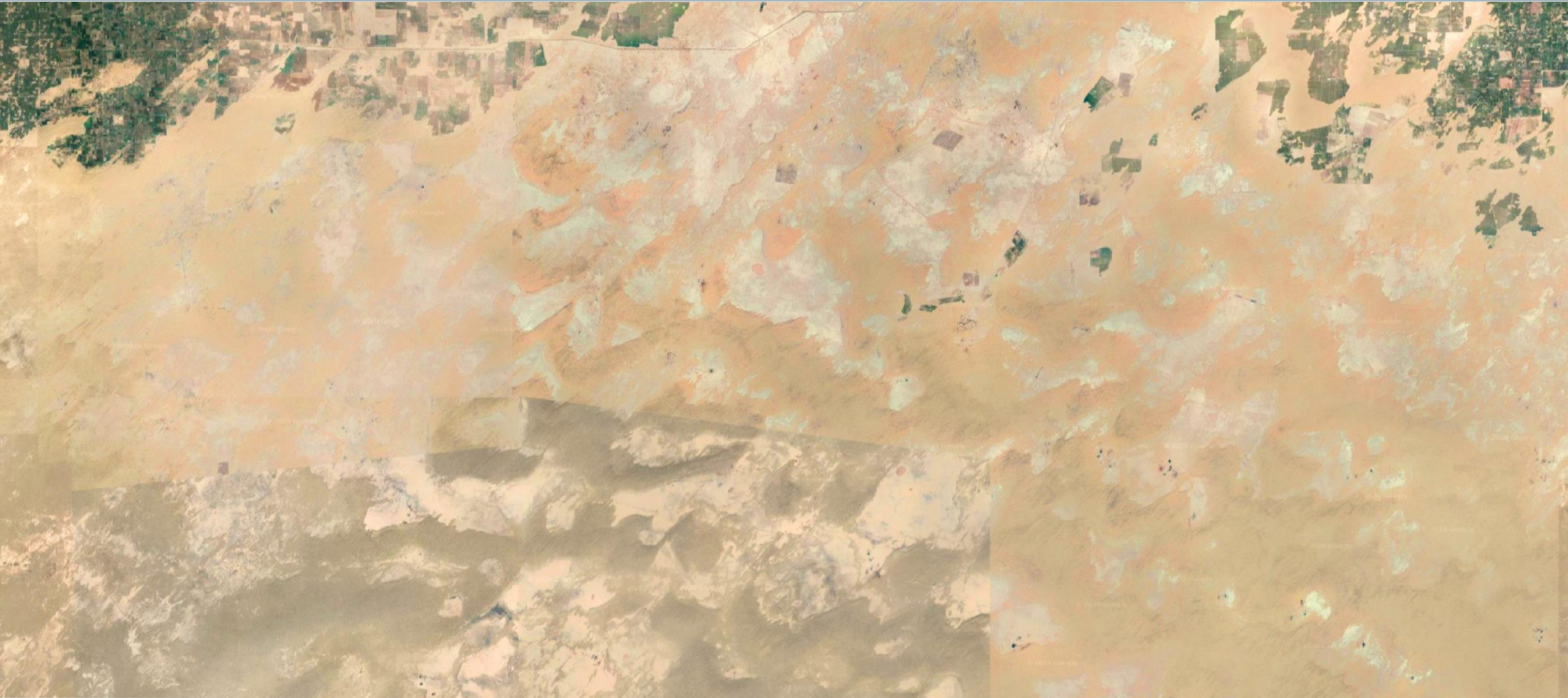
Machine-learning approach



Always check your training data, then predict



Results

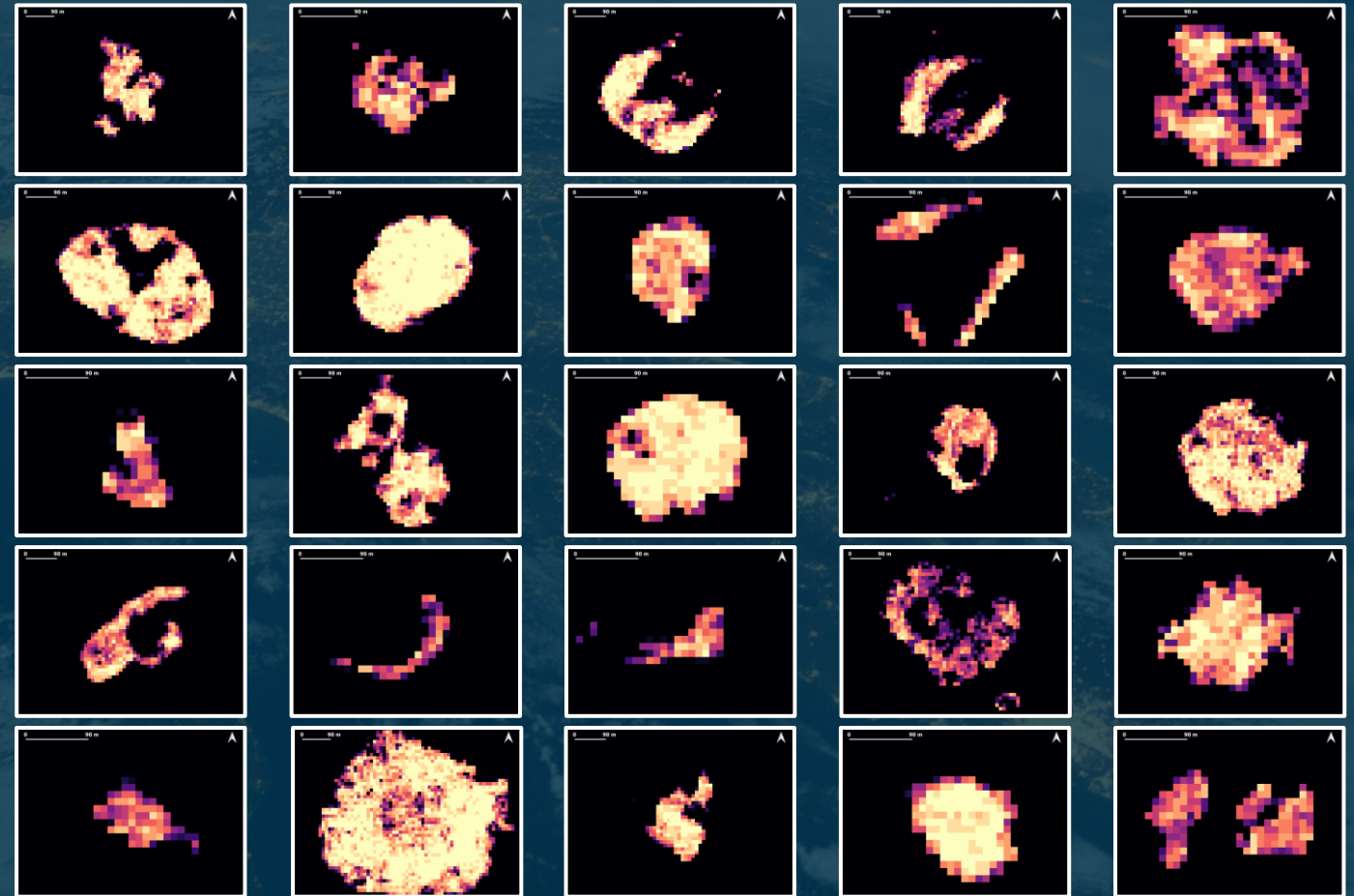
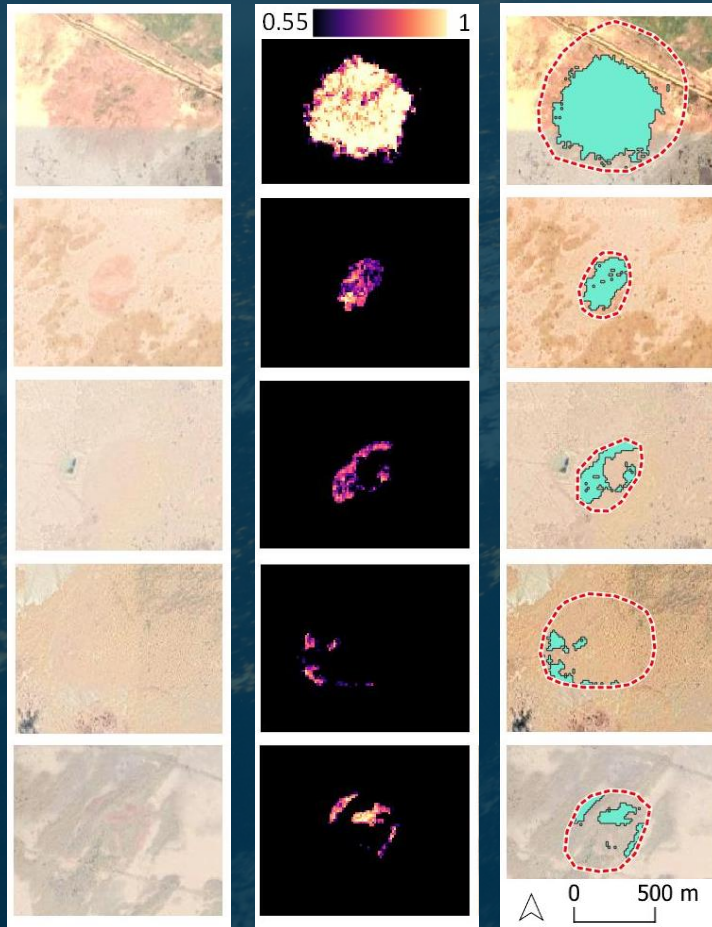


Results



Results

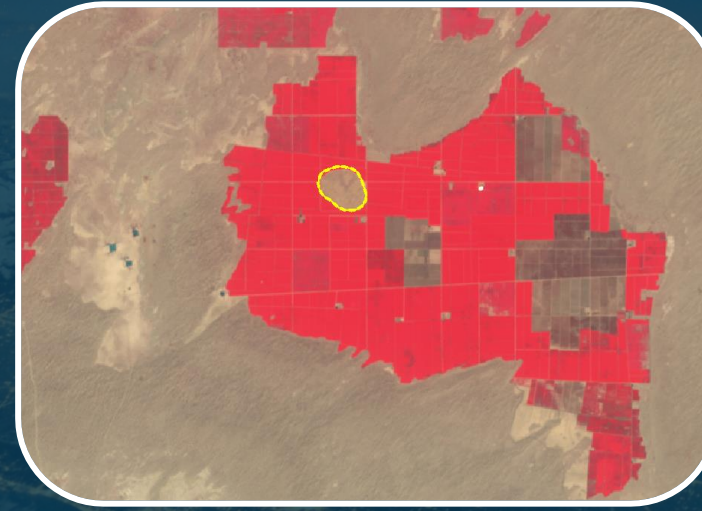
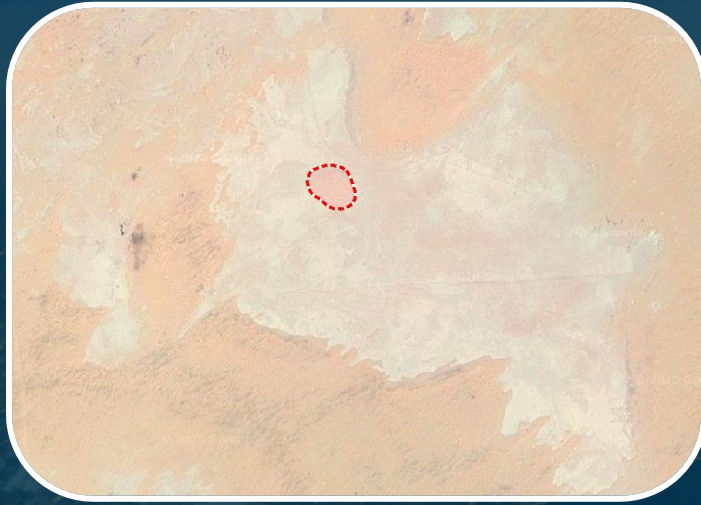
In basemaps
RF probability
RF vectorised



Orengo, Conesa *et al.*, PNAS 2020

Site monitoring and agricultural expansion

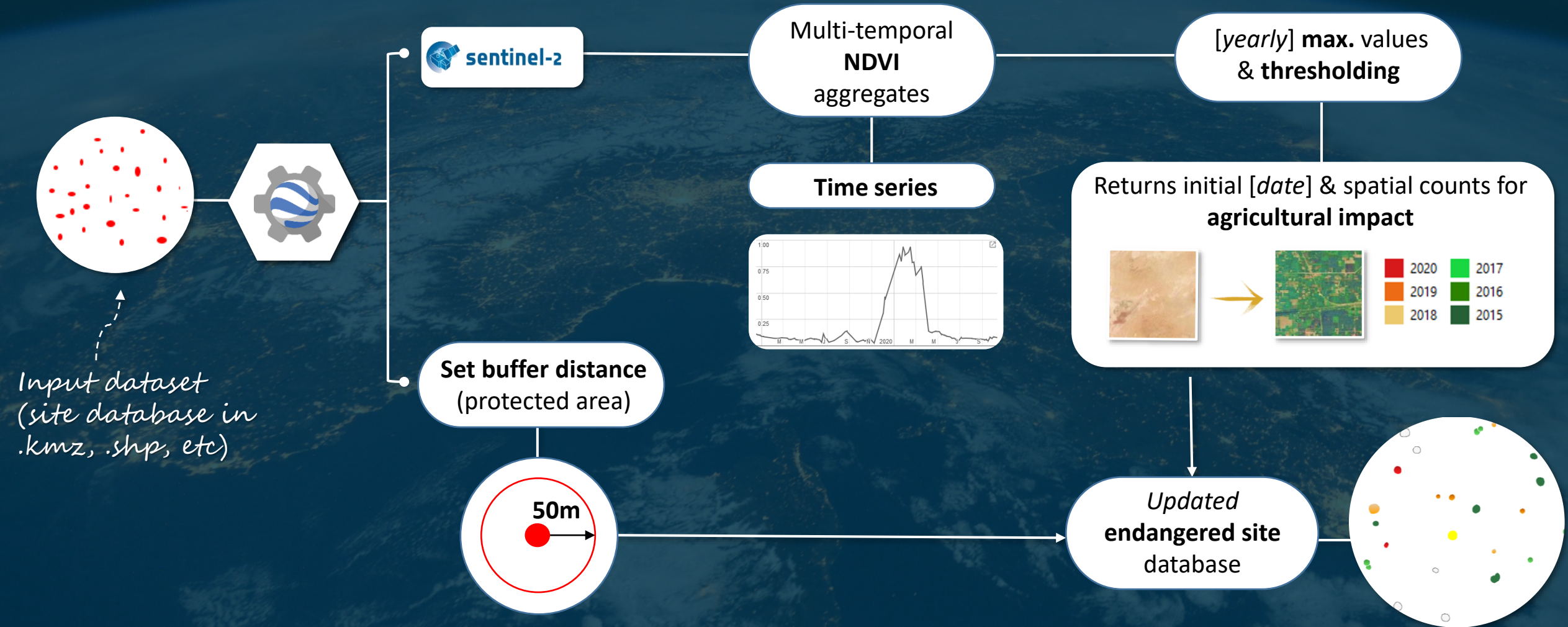
Many mounds
are located in
silty desert
playas



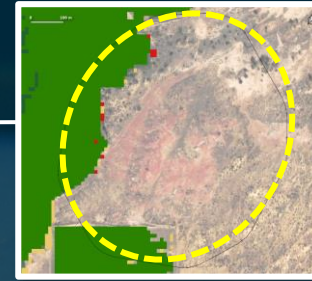
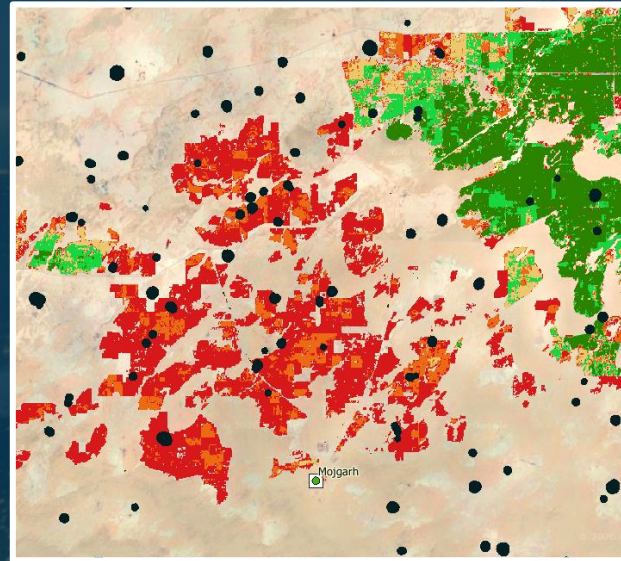
After heavy rains
in Feb 2020,
many desert lands
were transformed
into irrigated
fields

How many sites are potentially endangered by agricultural encroaching?

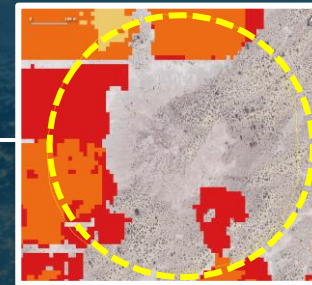
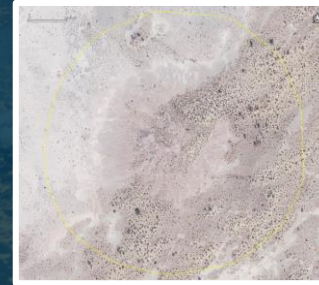
Index-based change detection



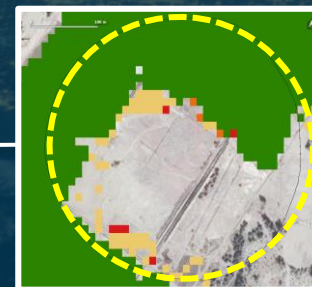
Results



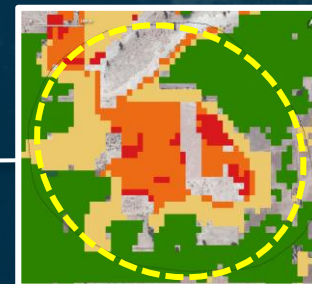
Low impact
 31.78 ha
 20 % endangered
 First 2016
 Last 2016
 Most 2016



Moderate impact
 27.76 ha
 33 % endangered
 First 2018
 Last 2020
 Most 2020



High impact
 8.67 ha
 60 % endangered
 First 2016
 Last 2020
 Most 2016



Total impact
 14.82 ha
 84 % endangered
 First 2015
 Last 2020
 Most 2015

Systematic monitoring for task priority

To sum up

Automatized workflows for *remote* archaeological research:

- ✓ Save time and computational resources
- ✓ Assures complete inspection in large areas
- ✓ Pixel-based information
- ✓ Consistency

Set of data & tools ready to share to heritage policy-makers

Moving from ML to DL approaches

Coding is fun!



Food for thought

➤ Towards a fully enabled *space archaeology*

➤ Third-party high-resolution datasets & data providers

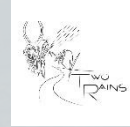
➤ Gaps between field archeologists, computational archaeologists and space experts

➤ Integration of workflows into DIAS & web-based apps

➤ Mobile applications for on-site observations



Acknowledgements



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UNIVERSITY OF
CAMBRIDGE



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Thank you!



@fc_conesa

| @hector_orengo

| @ArnauMaps



giap.icac.cat