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ASIAN DEVELOPMENT BANK

Remote Mapping of Rice Paddy Boundaries in Cambodia

2021 October 13

Point of Contact: Dr. William Wu (QED) <w@qed.ai>

Climate Resilient Rice Commercialization Sector Development Program, RICESDP
Asian Development Bank (ADB)

<https://qed.ai>

Introduction to QED

Introduction to QED

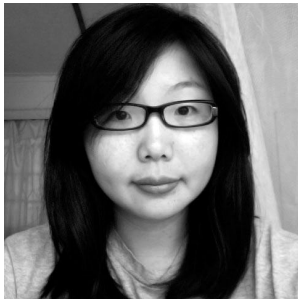
Quantitative Engineering Design | <https://qed.ai>

WHY

Build data systems and AI to empower organizations pursuing the health and agricultural SDGs (2,3,6,15)

WHO

~25 software engineers
+ analysts and domain experts in health and agronomy



Jiehua Chen ("J.C.")

Ph.D. Stat (Stanford)
M.S. Econ (Stanford)
B.S. Math+Phys. (Tsinghua)
Ex-Columbia Earth Inst.

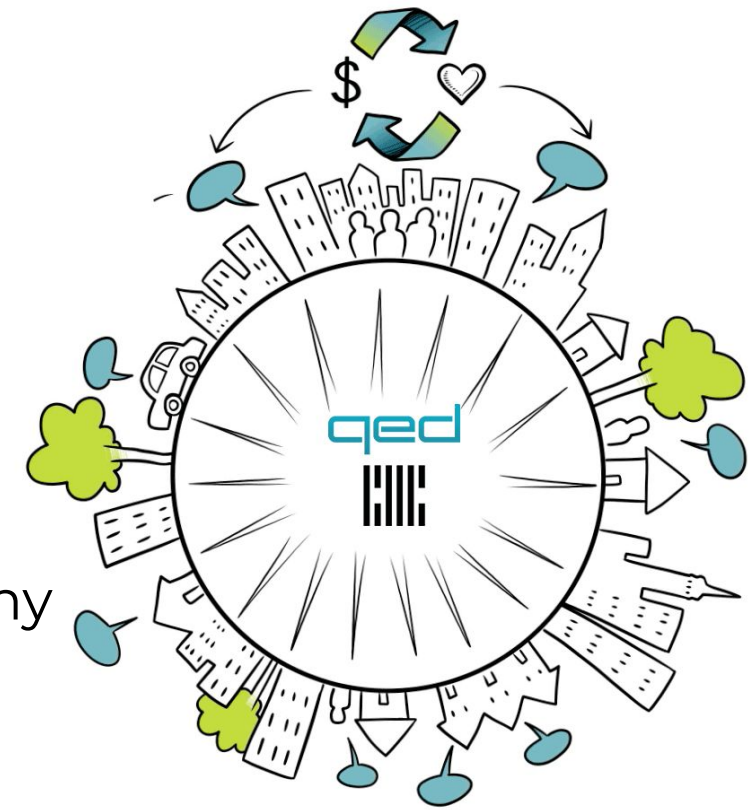


William Wu

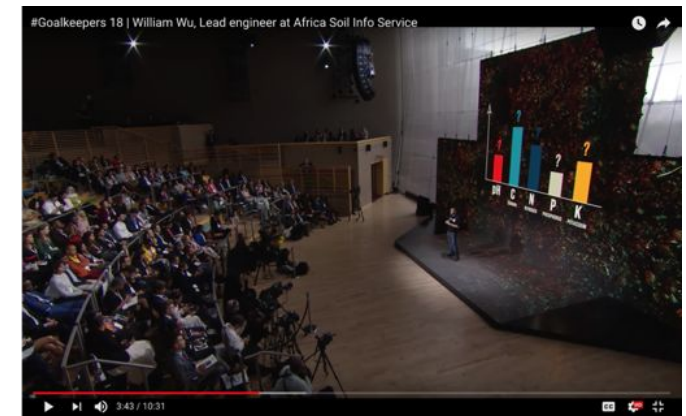
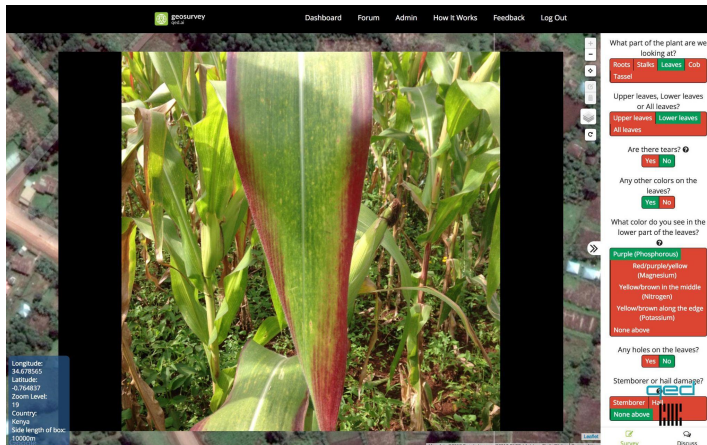
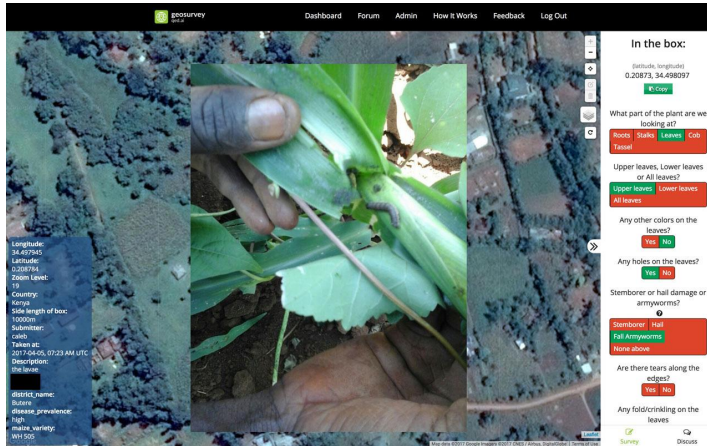
Ph.D. EE (Stanford)
M.S. Math (Stanford)
B.S. EECS (Berkeley)
Ex-NASA JPL

HOW

- forte: technologies for challenging environments
- enabling partners to scale using software and AI
- since 2012, has supported projects in 13 countries



Technologies To Overcome Data Scarcity

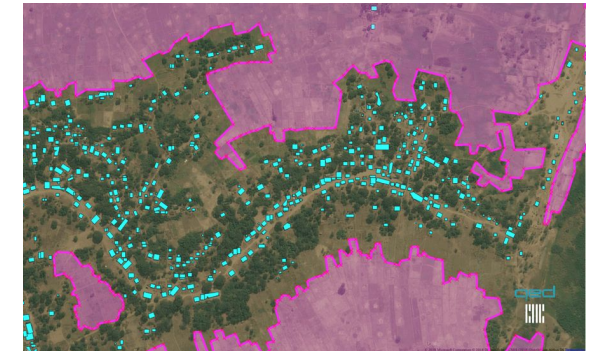
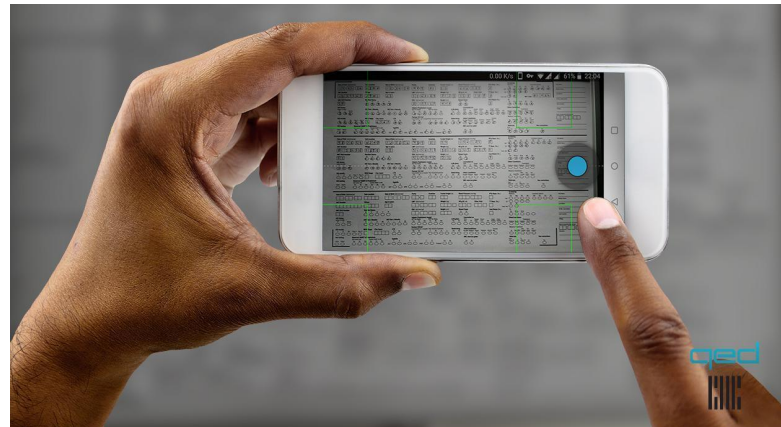
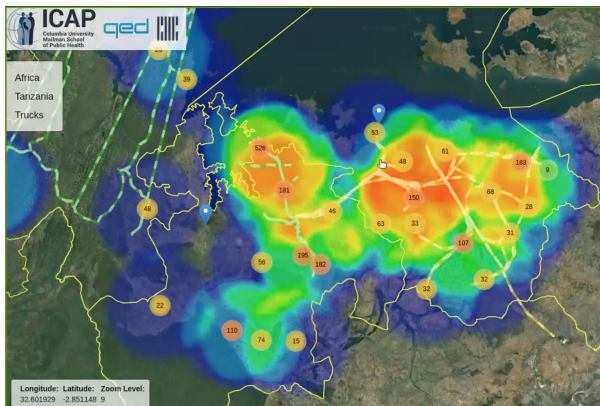
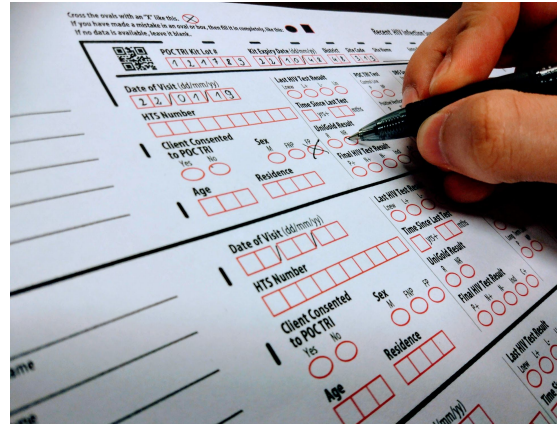


plant health surveillance

proximal sensors (carbon, NIR)

digital soil mapping

Technologies To Overcome Data Scarcity



mobile hospitals
in Tanzania

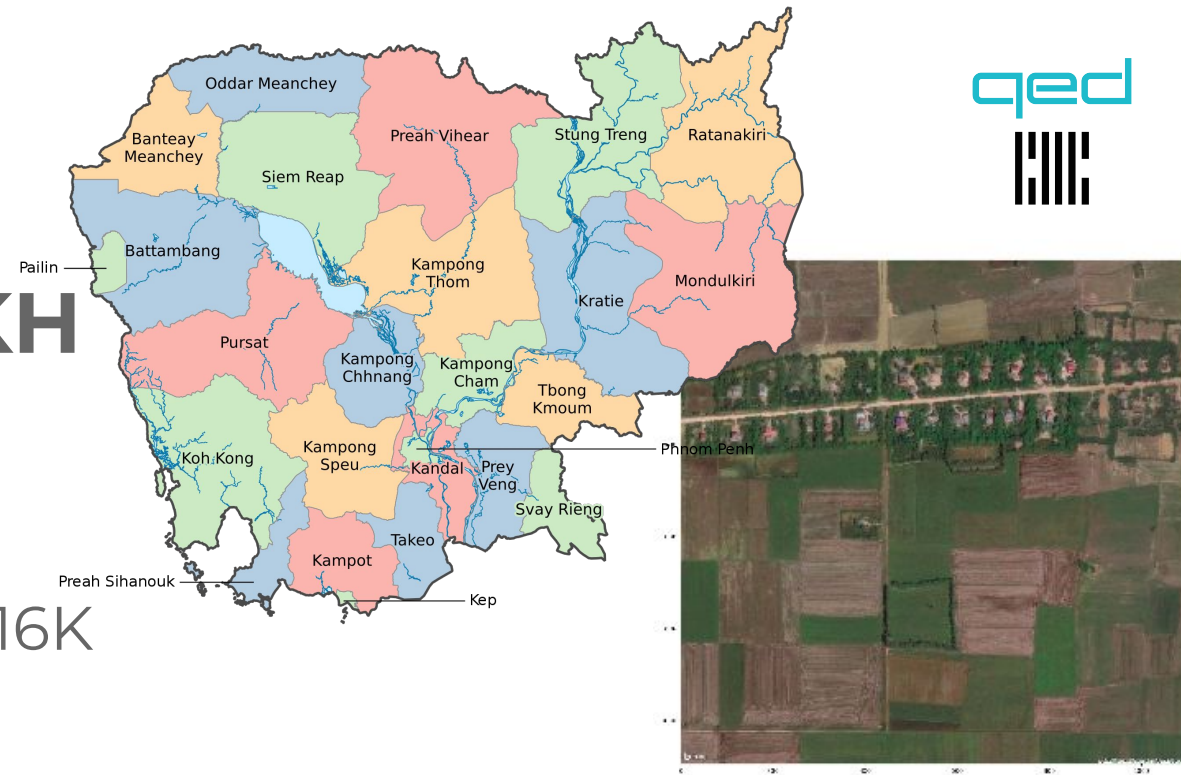
ScanForm: write on paper and digitize
the data with a smartphone!

land cover mapping for
sustainable development

Objectives in Cambodia

Objectives

- **Mapping Rice Paddies in KH**
 - Generate polygonal boundaries (remotely) for rice paddies in nine selected areas (16K ha, spanning ~16K farming families)



region #	1	2	3	4	5	6	7	8	9
name	Prey Sangha	Anglong Run	Ta Mao	Chhuk Ksach	Ta Soong	Chamkar Kouy	Ansong	Rumlech	Anlong Char
district	Bavel	Thma Koul	Thma Koul	Baray	Baray	Svay Antor	Kampong Trabaek	Sithor Kandal	Preah Sdach
province	Battambang	Battambang	Battambang	Kampong Thom	Kampong Thom	Prey Veng	Prey Veng	Prey Veng	Prey Veng
area (ha)	1150	1435	1038	1650	2070	2100	1510	2380	3000

Methods: Geosurvey



Geosurvey

Left: Screenshot from Geosurvey, in Oyo State, NG. A surveyor has highlighted the croplands in orange.

- Scalably annotate imagery (satellites/drones/phones)
- Rapidly train artificial intelligence



Outline each rice field separately. If the field is intersecting with blue rectangle outline also its parts outside of rectangle.



Update

View sample

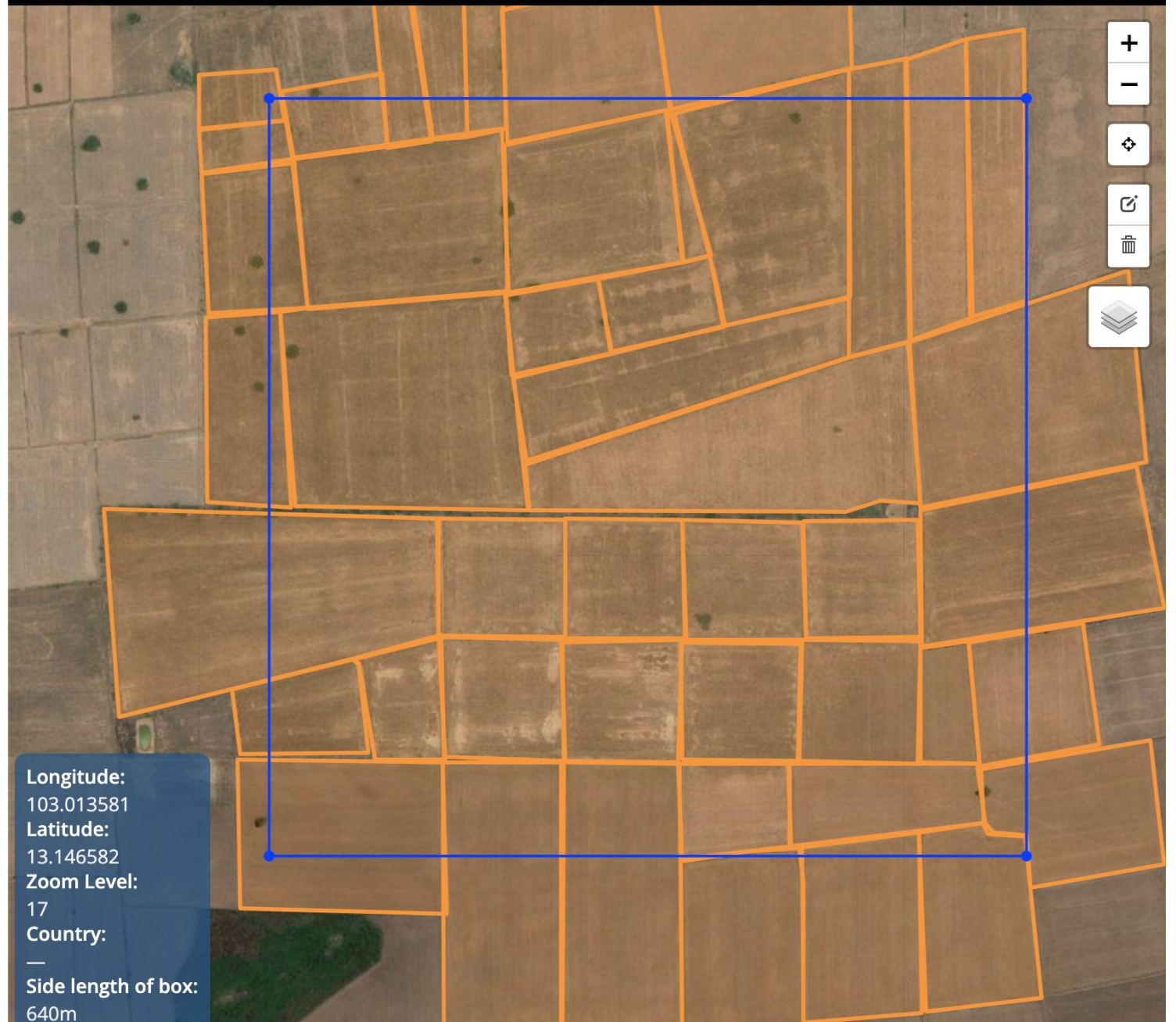
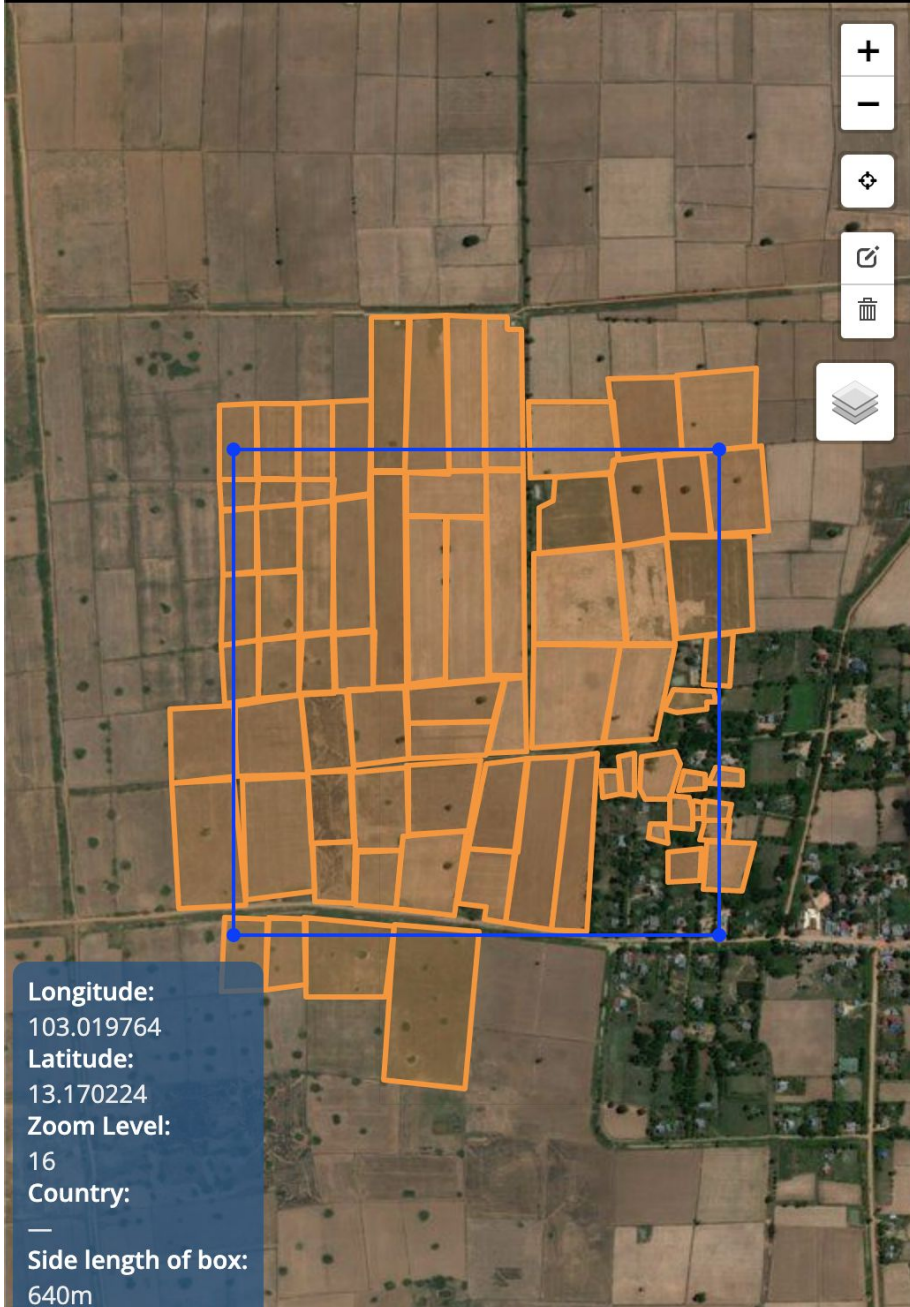
Grid

Color: Blue ▼

☐ Show markers

Markers in a row: 4

Longitude:
102.966024
Latitude:
13.305199
Zoom Level:
16
Country:
—
Side length of box:
640m



Cambodia Southern Plots

Status

Edit

Samples

Results

Teams

Discussions

Diagnoses

Username contains:

Latitude greater or equal to:

Latitude less than or equal to:

Longitude greater than or equal to:

Longitude less than or equal to:

Created after or on

Select Date..

×

Created before or on

Select Date..

×

Submission count greater than or equal to:

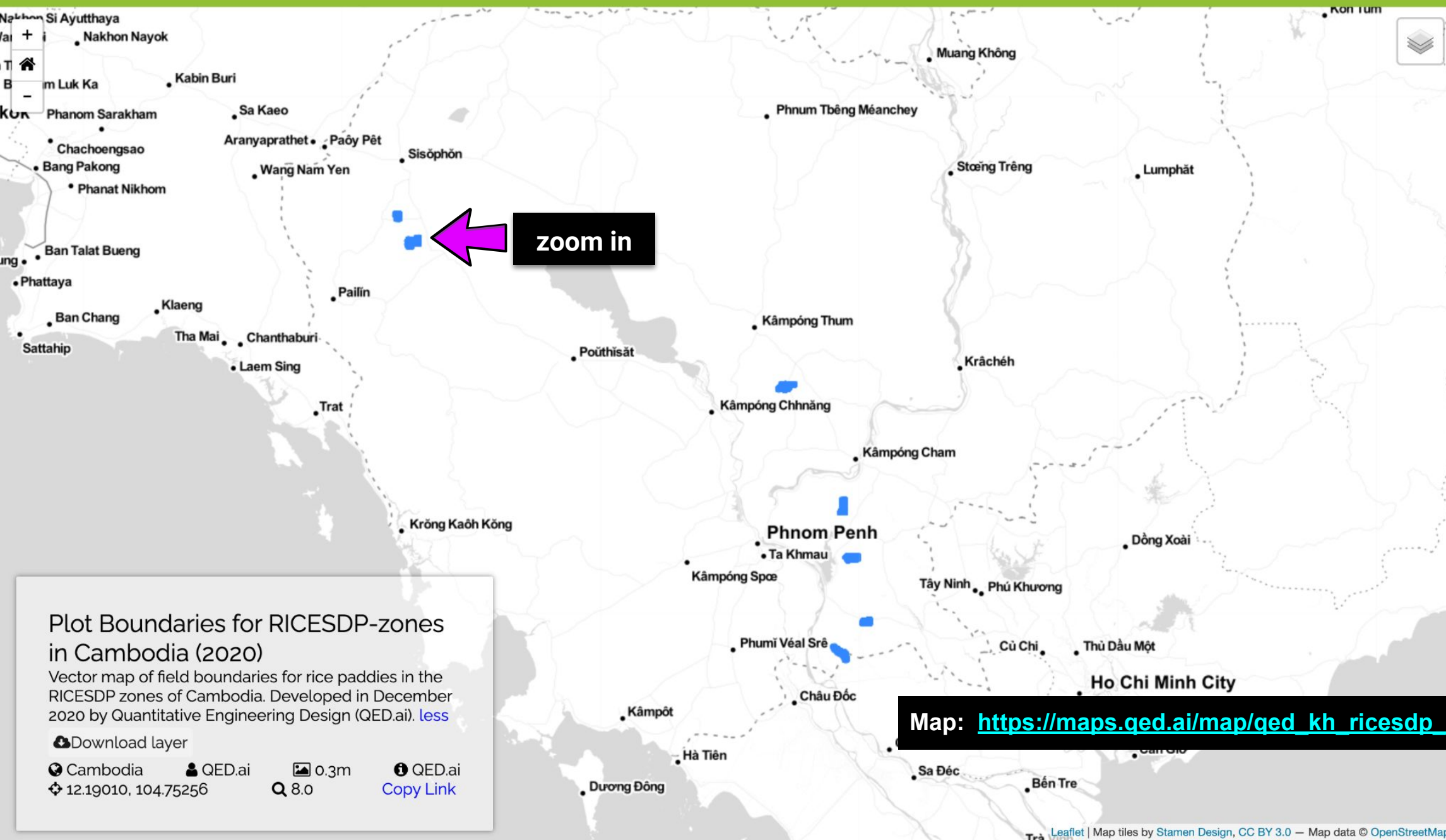
Submission count less than or equal to:

Filter

Order by:

Uploaded at descending

▼



Plot Boundaries for RICESDP-zones in Cambodia (2020)

Vector map of field boundaries for rice paddies in the RICESDP zones of Cambodia. Developed in December 2020 by Quantitative Engineering Design (QED.ai). [less](#)

Download layer

Cambodia QED.ai 0.3m QED.ai
12.19010, 104.75256 8.0 [Copy Link](#)

Map: https://maps.qed.ai/map/qed_kh_ricesdp_boundaries



Plot Boundaries for RICESDP-zones in Cambodia (2020)

Vector map of field boundaries for rice paddies in the RICESDP zones of Cambodia. Developed in December 2020 by Quantitative Engineering Design (QED.ai). [less](#)

Download layer

Cambodia

QED.ai

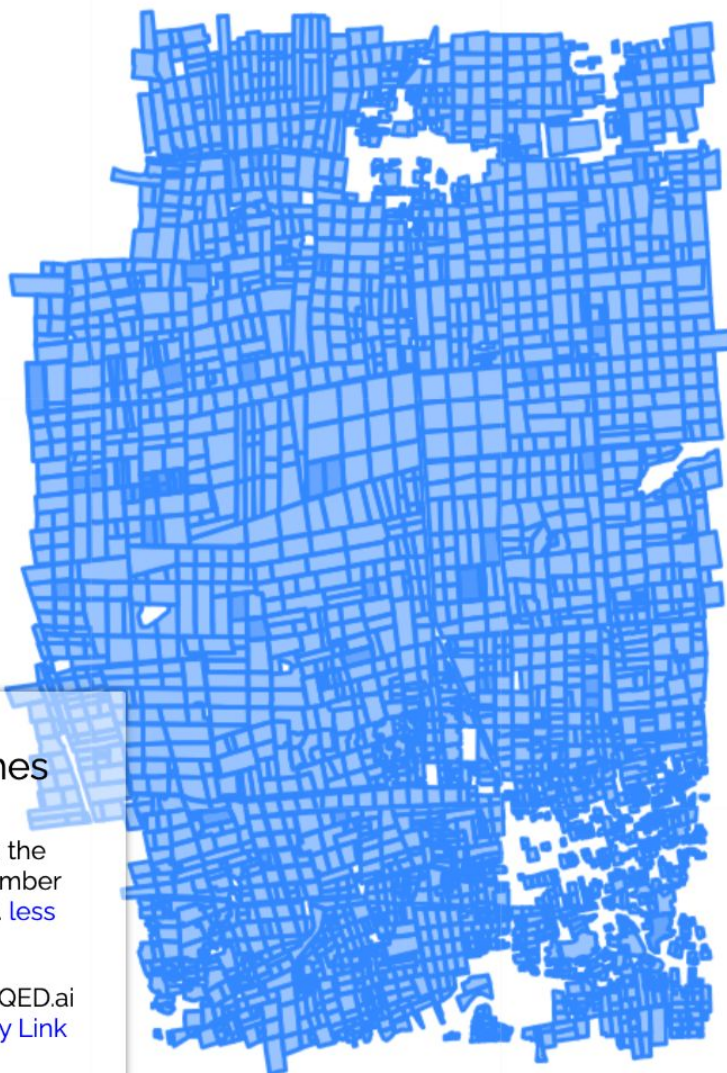
0.3m

QED.ai

13.15178, 103.02959

14.0

[Copy Link](#)



Map: https://maps.qed.ai/map/qed_kh_ricesdp_boundaries



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Cambodia

QED.ai

0.3m

QED.ai

13.14985, 103.01740

17.0

[Copy Link](#)

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Plot Boundaries for RICESDP-zones in Cambodia (2020)

Vector map of field boundaries for rice paddies in the RICESDP zones of Cambodia. Developed in December 2020 by Quantitative Engineering Design (QED.ai). [less](#)

Download layer

Cambodia

QED.ai

0.3m

QED.ai

13.14985, 103.01740

17.0

[Copy Link](#)

Map: https://maps.qed.ai/map/qed_kh_ricesdp_boundaries

Scaling Up: Artificial Intelligence

- **Question: Why not map *all* rice in KH like this?**
- **Answer:**
 - Approximately 3M hectares of rice in KH
 - Time required for one person to trace all of it:
23.1 years on a 40 hour workweek
 - Once humans are done, the map is outdated!

Bottom-line: A.I. and compromises are essential to national scale-up and long-term sustainability.

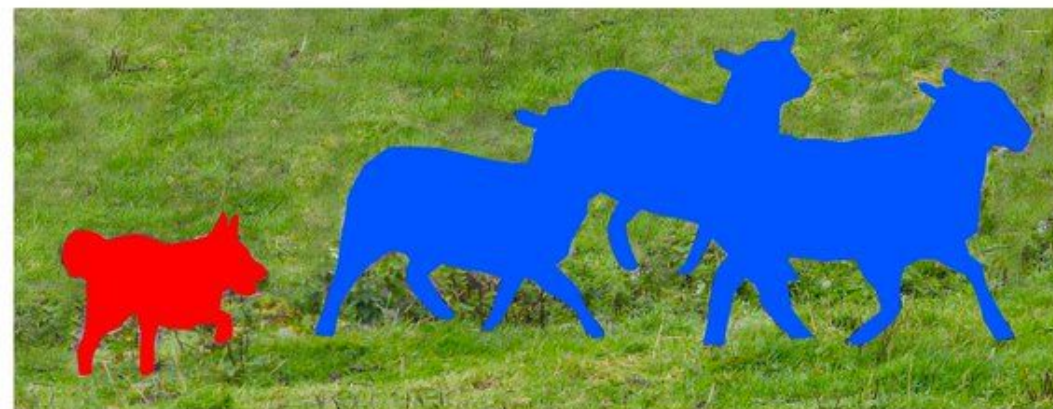
Proposal from QED.ai: Map all rice in KH at national scale!

Evolution of some ideas in computer vision

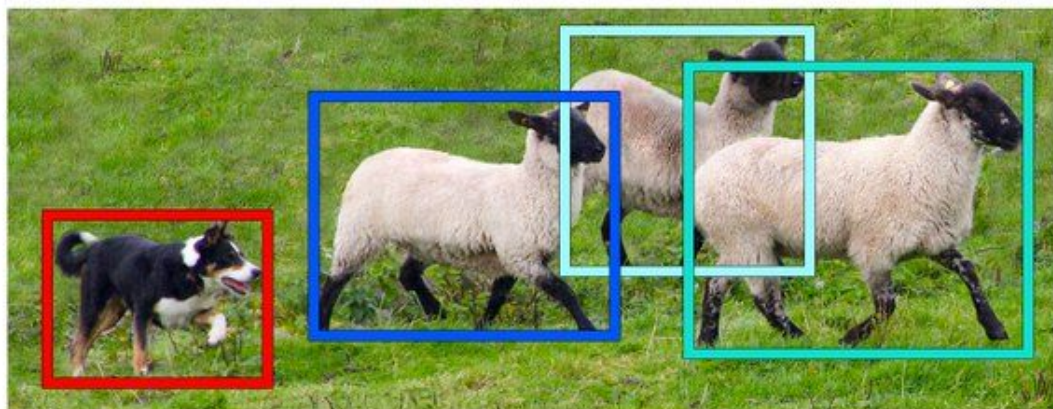
...



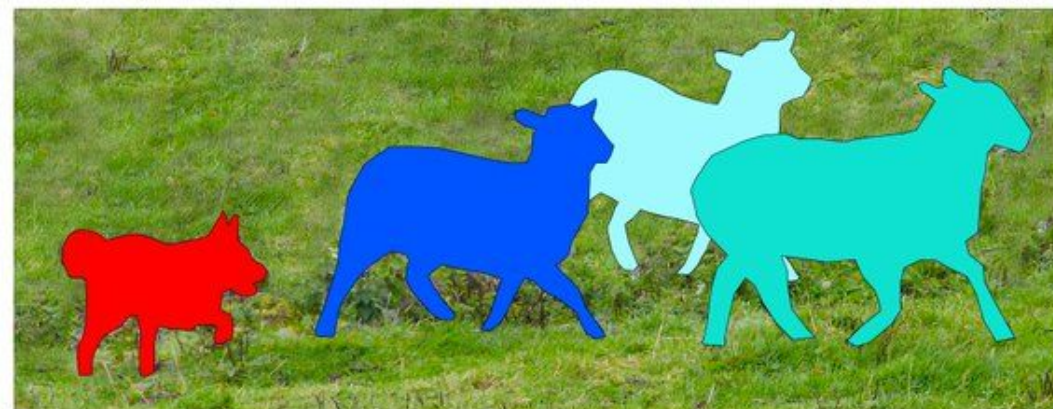
Image Recognition



Semantic Segmentation

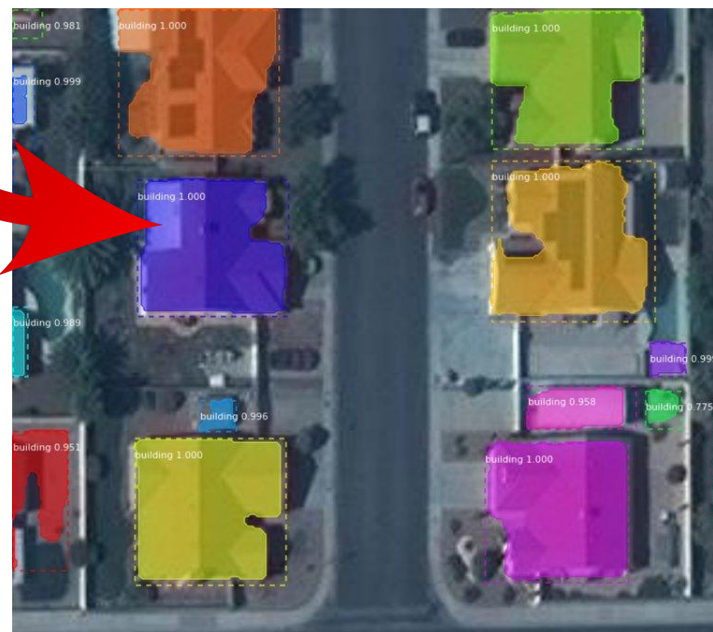
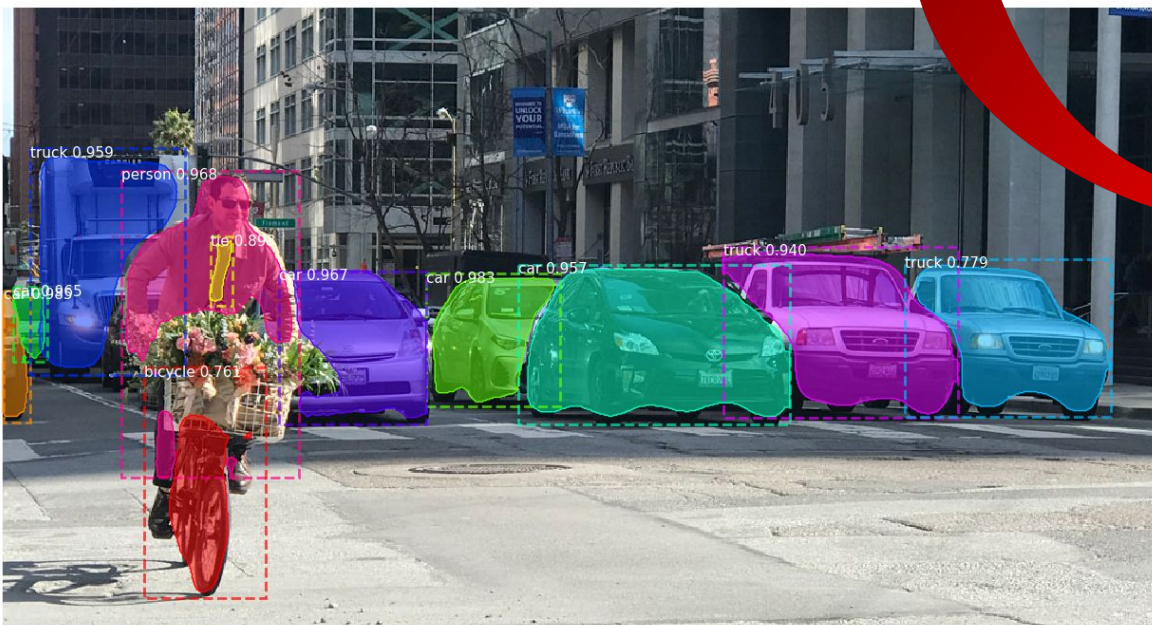
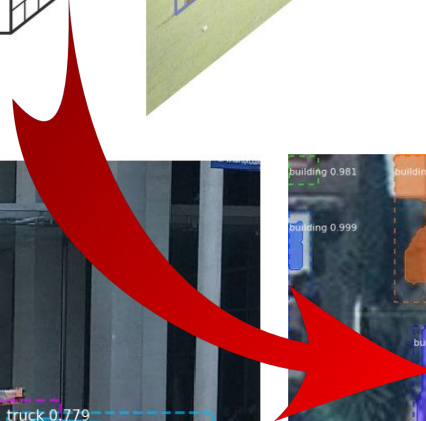
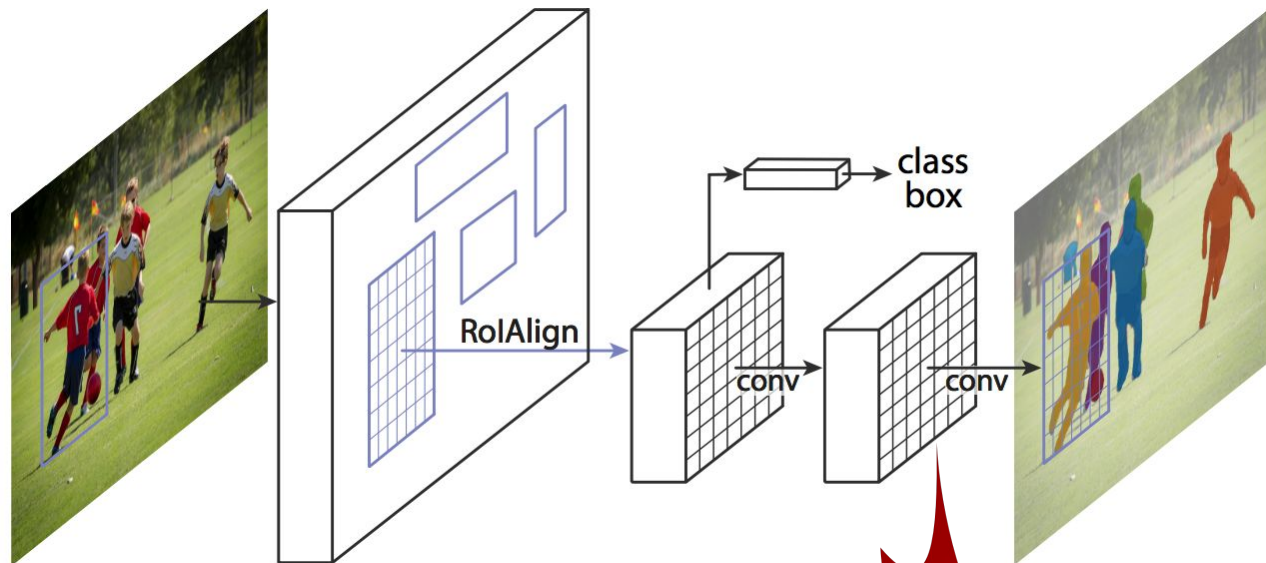


Object Detection



Instance Segmentation

Applying the state-of-the-art to Ag Dev



Preliminary Performance for A.I.

Map	Res	Accuracy	Precision	Recall	F1-Score	IoU	mAP
QED Rice Boundaries, KH	0.3m	83.8%	96.7%	80.3%	87.8%	78.2%	64.5%

cheatsheet for nerds:

		Actual	
		Positive	Negative
Predicted	Positive	True Positive	False Positive
	Negative	False Negative	True Negative

$$\text{acc} = (\text{tp} + \text{tn}) / (\text{tp} + \text{tn} + \text{fp} + \text{fn})$$

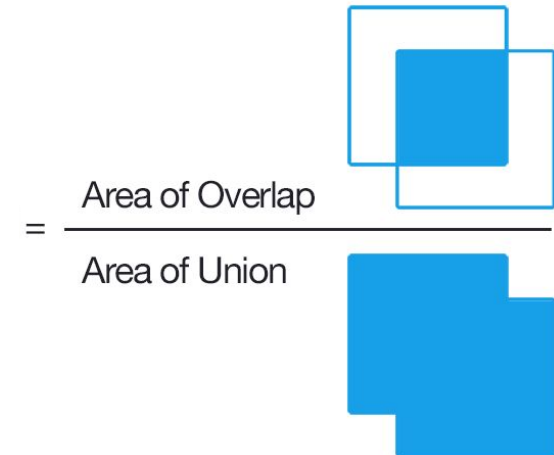
$$\text{prec} = \text{tp} / (\text{tp} + \text{fp})$$

$$\text{recall} = \text{tp} / (\text{tp} + \text{fn})$$

$$\text{f1} = 2 \times \text{prec} \times \text{recall} / (\text{prec} + \text{recall})$$

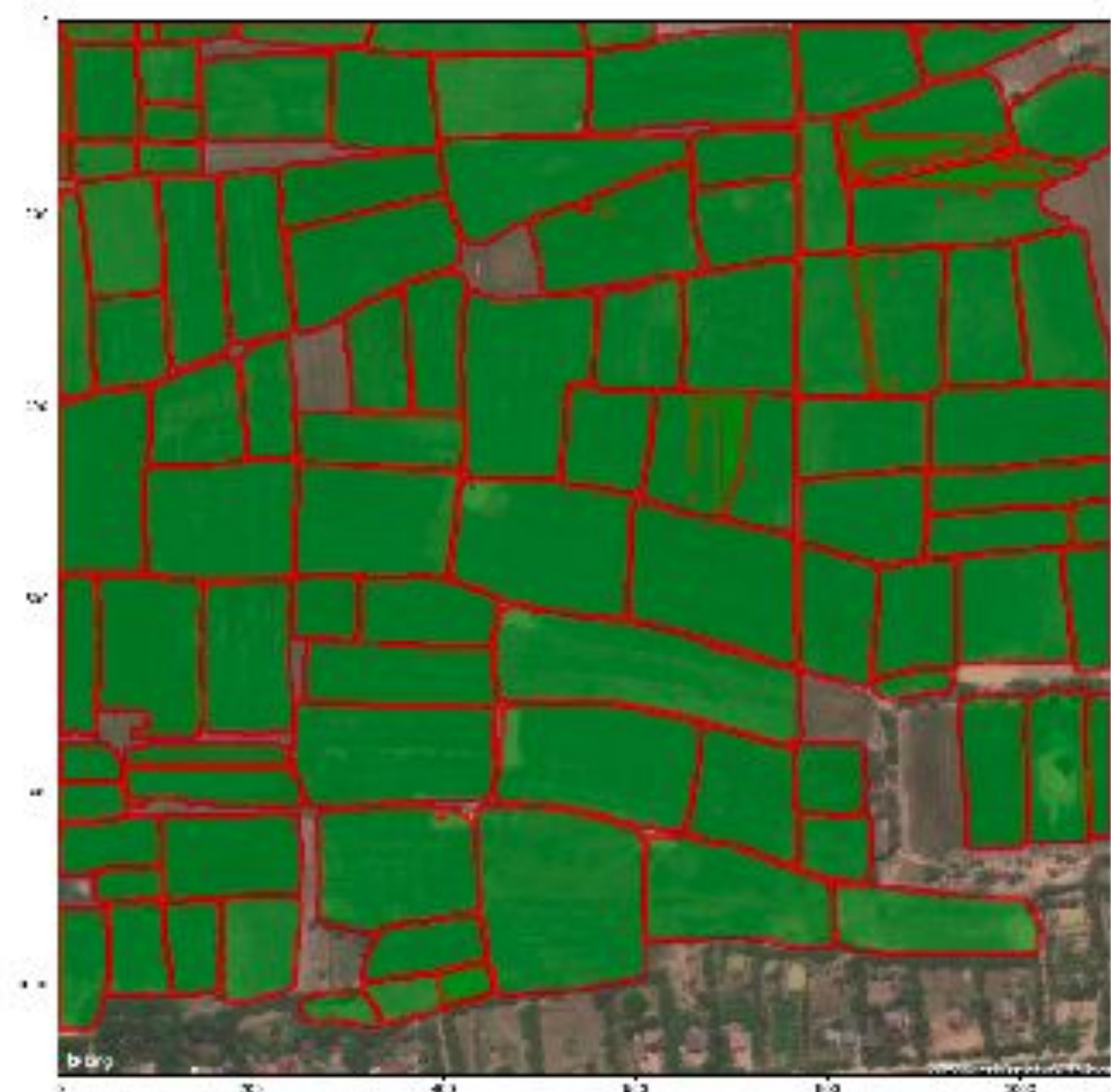
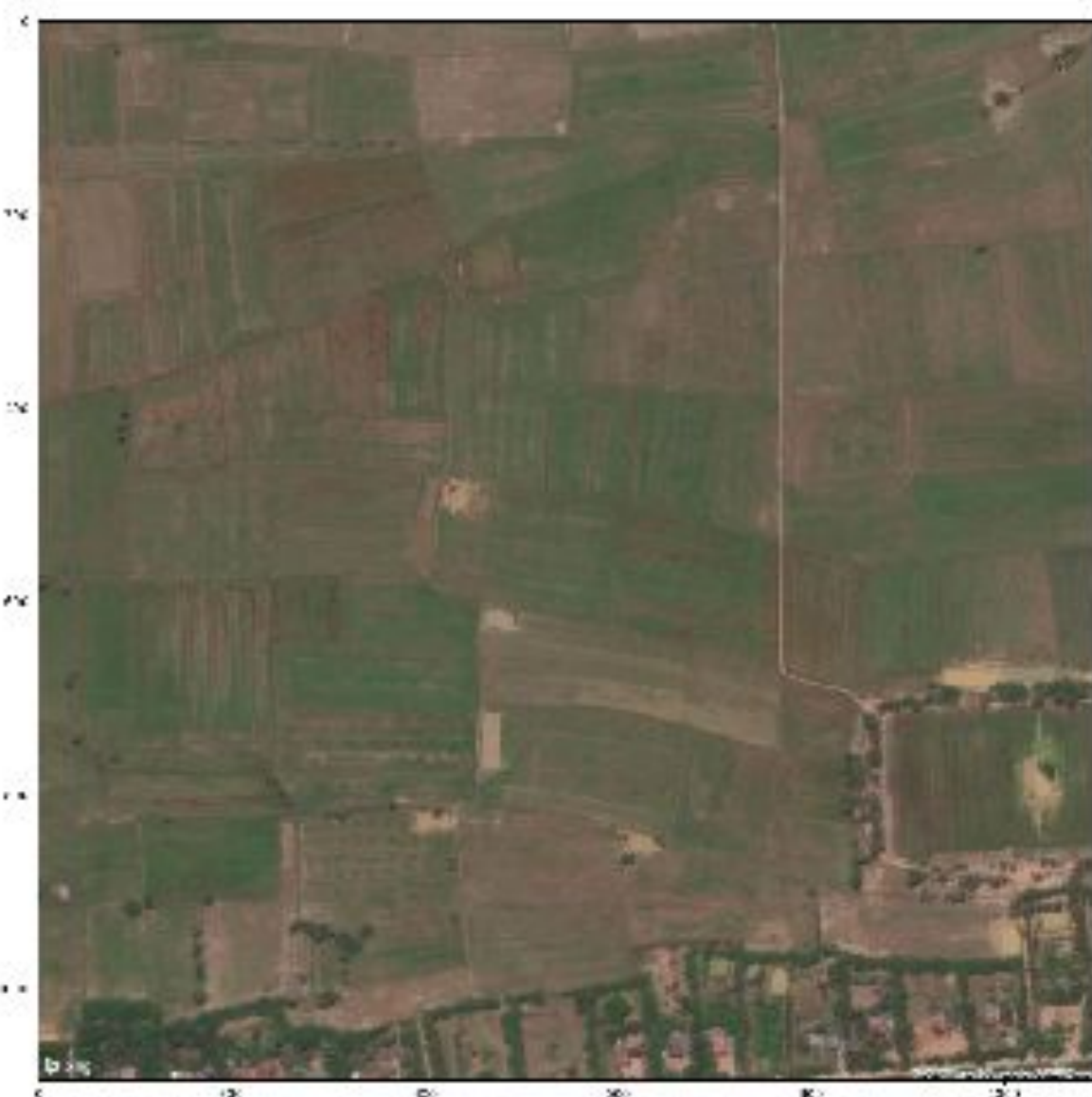
$$\text{iou} = \text{tp} / (\text{tp} + \text{fn} + \text{fp})$$

$$\text{iou} = \text{tp} / (\text{tp} + \text{fn} + \text{fp})$$



mAP = over-complicated!
... seeing is believing ...

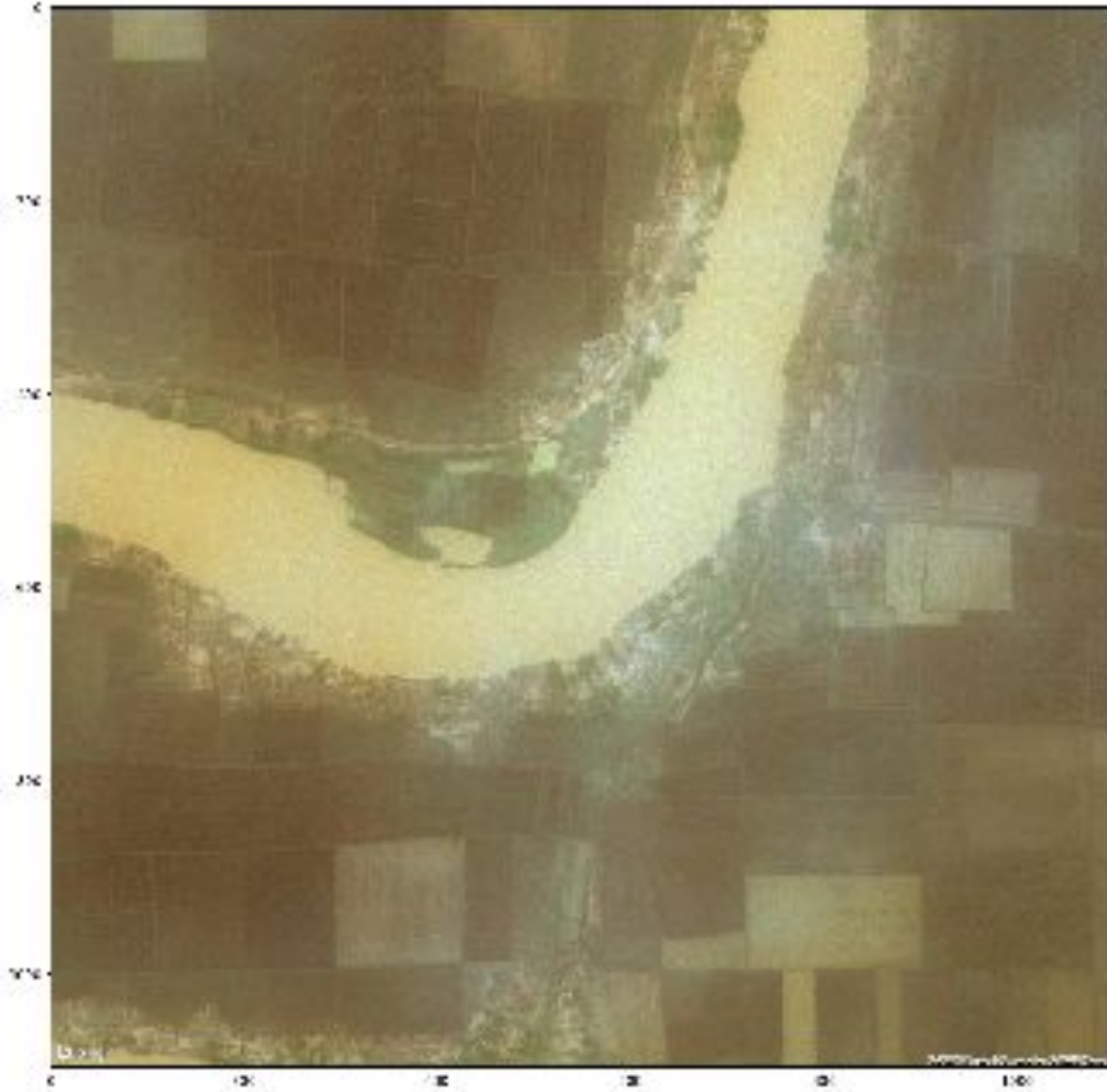
Visuals (satellite on left, AI on right)



Visuals (satellite on left, AI on right)



Visuals (satellite on left, AI on right)





- ☐ Mapviz
 - ☐ None
 - ☐ Stamen TonerLite
 - ☒ Bing
 - ☐ Google Hybrid
 - ☐ Google Satellite
-
- ☒ Plot Boundaries for RICESDP zones in Cambodia, A.I.-generated (2021)
 - ☒ Plot Boundaries for RICESDP-zones in Cambodia (2020)

Comparison of Cambodia Rice Paddy Boundaries

Delineation of rice paddies in selected regions of Cambodia, generated by QED.ai. Human-traced and A.I.-based (fully-automated) plot boundaries are overlaid; A.I. F1-score is 87.8%. Sponsor: Asian Development Bank (ADB) [less](#)

Download layer

Cambodia

QED.ai

0.3

QED.ai

12.12589, 104.09555

8.0

[Copy Link](#)



zoom in

Map: https://maps.qed.ai/map/qed_plot_boundaries_cambodia_composite



- ☐ Mapviz
 - ☐ None
 - ☐ Stamen TonerLite
 - ☒ Bing
 - ☐ Google Hybrid
 - ☐ Google Satellite
-
- ☐ Plot Boundaries for RICESDP zones in Cambodia, A.I.-generated (2021)
 - ☒ Plot Boundaries for RICESDP-zones in Cambodia (2020)

ground truth

Comparison of Cambodia Rice Paddy Boundaries

Delineation of rice paddies in selected regions of Cambodia, generated by QED.ai. Human-traced... [more](#)

Download layer

Cambodia

QED.ai

0.3

QED.ai

11.13087, 105.50798

15.0

[Copy Link](#)

Map: https://maps.qed.ai/map/qed_plot_boundaries_cambodia_composite



- ☐ Mapviz
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A.I.

Comparison of Cambodia Rice Paddy Boundaries

Delineation of rice paddies in selected regions of Cambodia, generated by QED.ai. Human-traced... [more](#)

Download layer

Cambodia

QED.ai

0.3

QED.ai

11.13087, 105.50798

15.0

[Copy Link](#)

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ground truth + A.I. :
close match

Comparison of Cambodia Rice Paddy Boundaries

Delineation of rice paddies in selected regions of Cambodia, generated by QED.ai. Human-traced... [more](#)

Download layer

Cambodia

QED.ai

0.3

QED.ai

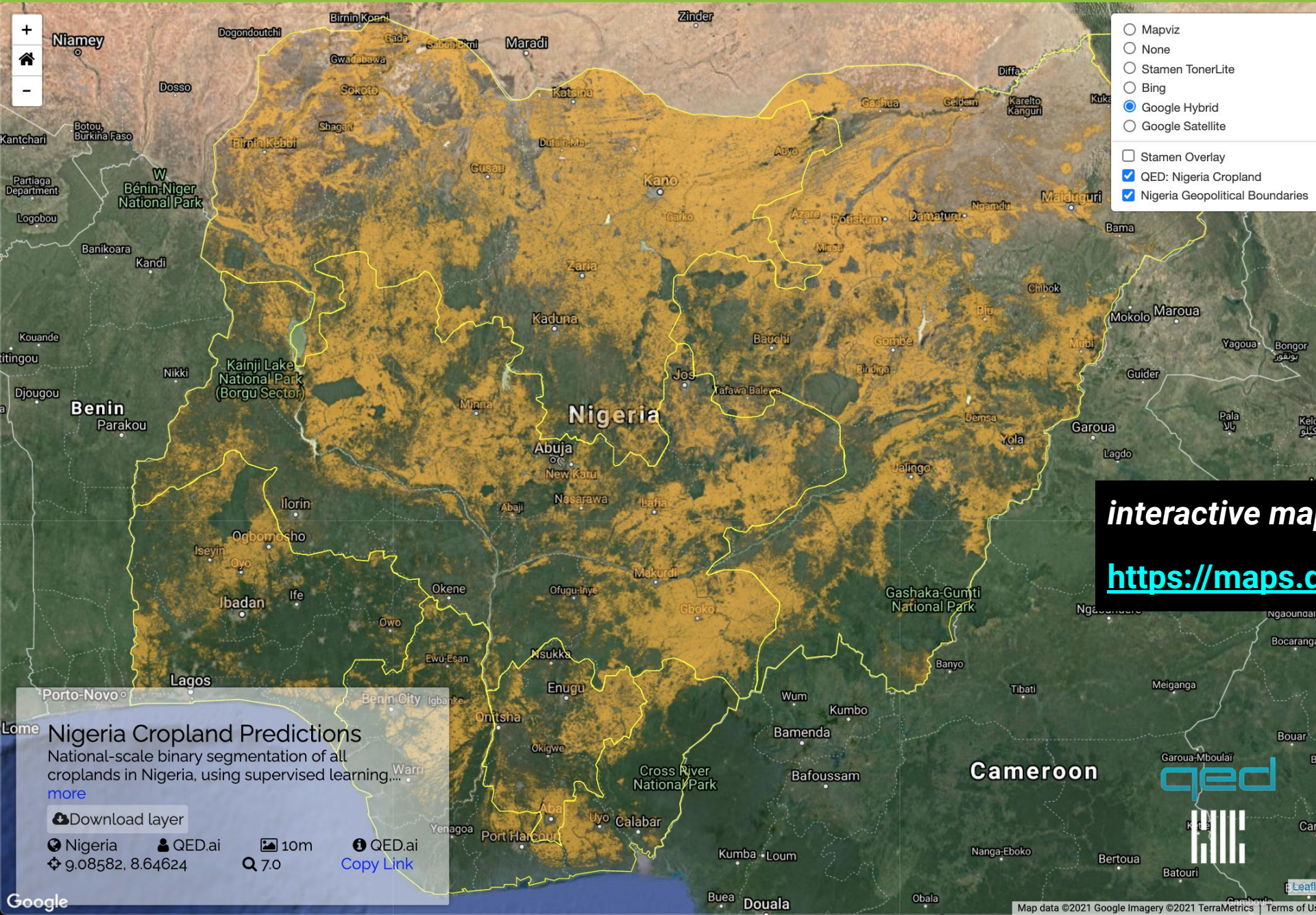
11.13087, 105.50798

15.0

[Copy Link](#)

Map: https://maps.qed.ai/map/qed_plot_boundaries_cambodia_composite

Related Work and Use Cases



NIGERIA

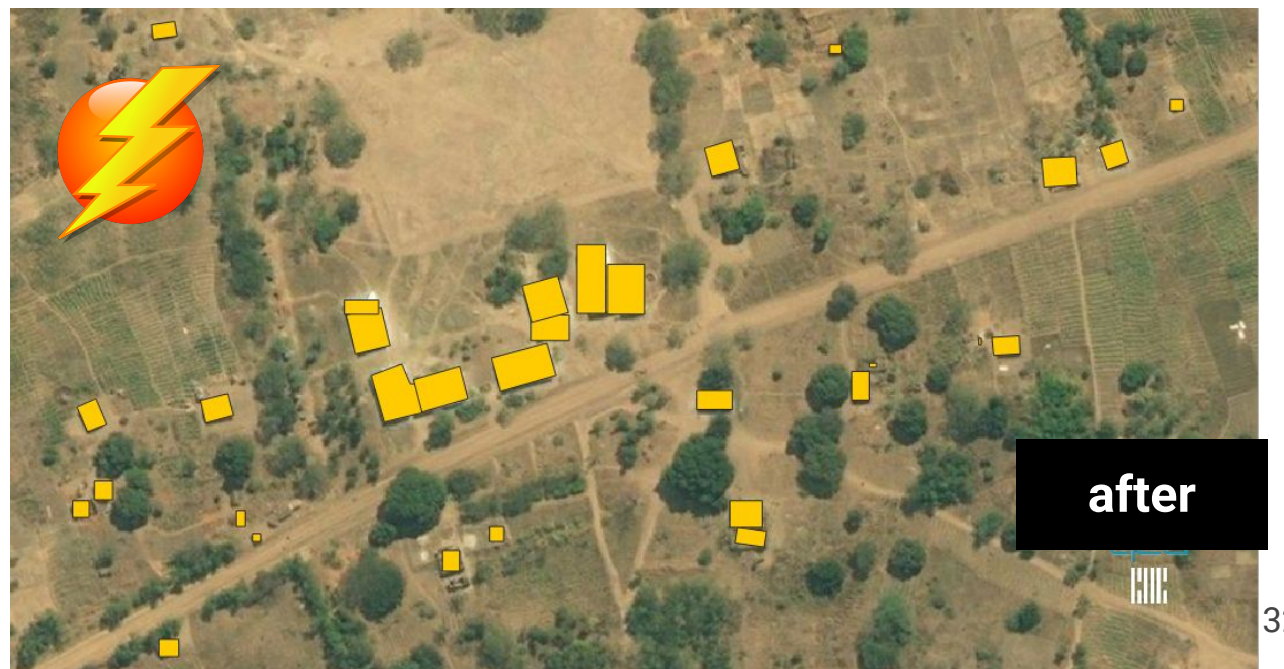
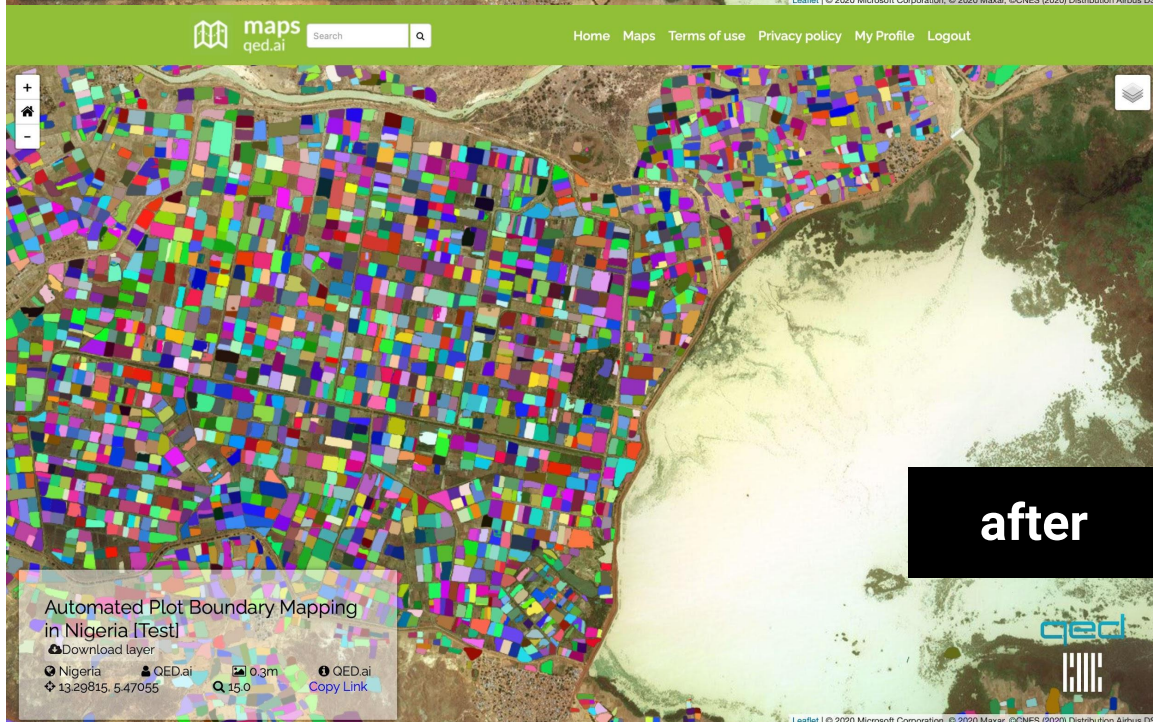
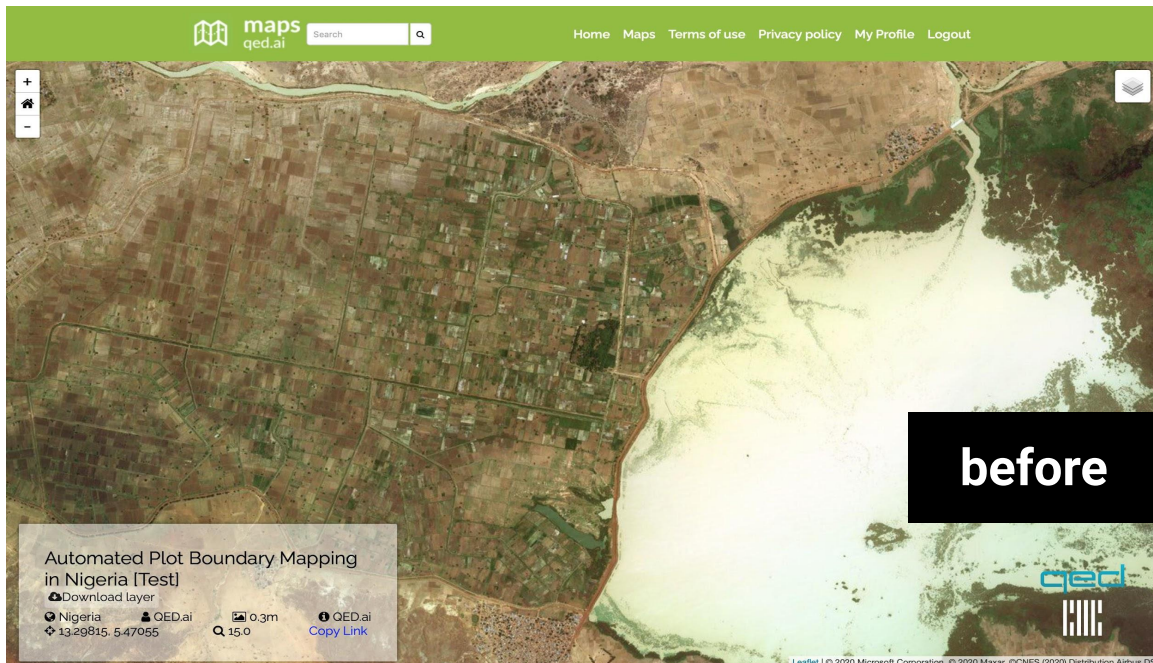
National Cropland Map

- *Acc. and precision: ~85%*
- *Spatial resolution: 10 m*
- *Scale: National*
- *Derived from 2020 imagery.*
- *Can be annually updated on a semi-automated basis.*

interactive map:

https://maps.qed.ai/map/ng_cp_preds

BILL &
MELINDA
GATES
foundation





ag ecosystems (NSAF): nsaf-geospatial.qed.ai

interactive maps of all crops, buildings, soils, roads, agro-dealers, food processors, financial facilities, etc. throughout Nepal, to advance geospatial agricultural intelligence for public & private sectors

Nepali

Sudur Pashchimanchal

Madhya Pashchimanchal

Pashchimanchal

Madhyamanchal

Purwanchal

Longitude: Latitude: Zoom Level:
81.479030 29.011509 9

- ☒ Google Hybrid
- ☐ Offline Google Hybrid
- ☒ Development Regions
- ☒ Zones
- ☒ FAW Report
- ☒ Infrastructure
- ☐ Roads
- ☒ Croplands
- ☒ Buildings

- States Borders
- Roads
- Croplands
- Buildings
- Stock available
- Fall Armyworm affected zone
- Agrovet
- Agriculture cooperative
- Collection center
- Multipurpose Cooperative
- Miller
- Financial Institutions (SACCOs)
- Machinery Supplier
- Financial institutions (Banks)
- Insurance Company
- Farms (Livestock / Agriculture)
- Feed Processor
- Vegetable Retailer
- Grain or Goat Aggregator
- Agri Market center
- Seed Company
- Vegetable Wholesaler
- Agri Input Manufacturer
- Other Service Provider
- Extension Services Provider
- Haat Bazaar

- Many exciting use cases for mapping ...

- grid electrification
- crop-type classification
- agro-dealer placement
- fertilizer optimization
- yield estimation
- ... and government policy!

Below: QED maps integrated by Prime Minister into agricultural statistics used by NP's national fertilizer subsidy program. what can also be done for KH?

email: maps@qed.ai
web: <https://maps.qed.ai>

