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SENTINELKILNDB

A Large-Scale Dataset and Benchmark for OBB Brick Kiln Detection in South Asia

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Air Pollution: A global crisis

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Brick Kiln Technologies

Circular Fixed Chimney Bull’s Trench Kiln

Fixed Chimney Bull’s Trench Kiln

Zig-Zag Kiln

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Unorganized sector, hard to regulate

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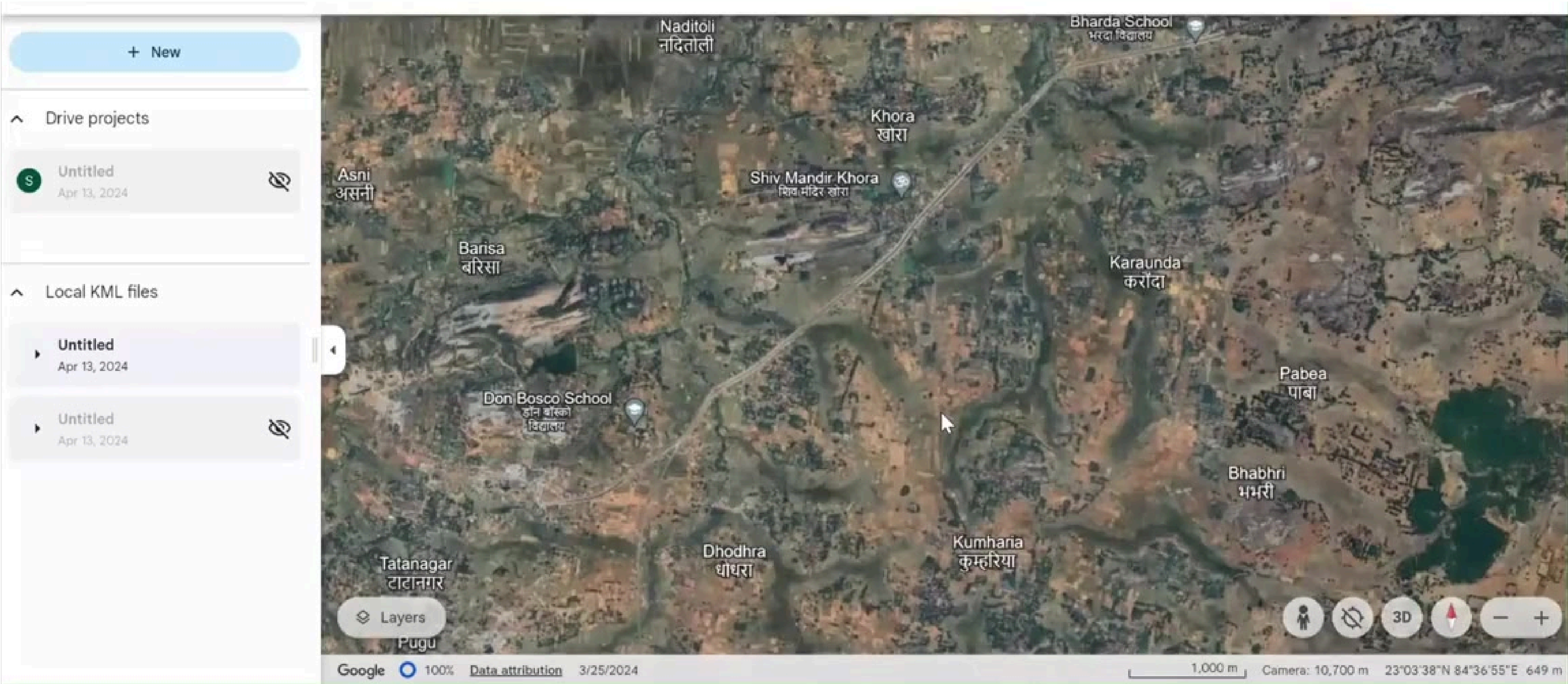
Manual Annotation: Accurate but Labour Intensive



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SentinelKilnDB Dataset

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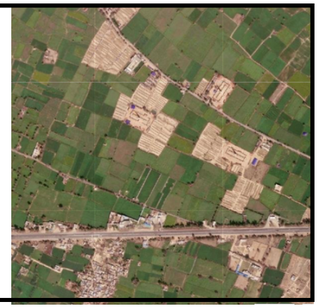
Dataset Sources

sentinel-2

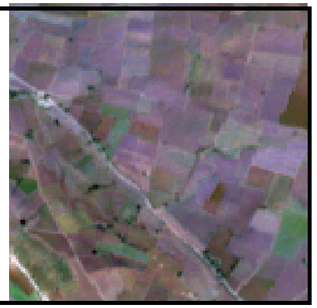
planet.

esri™



WorldCover

esa



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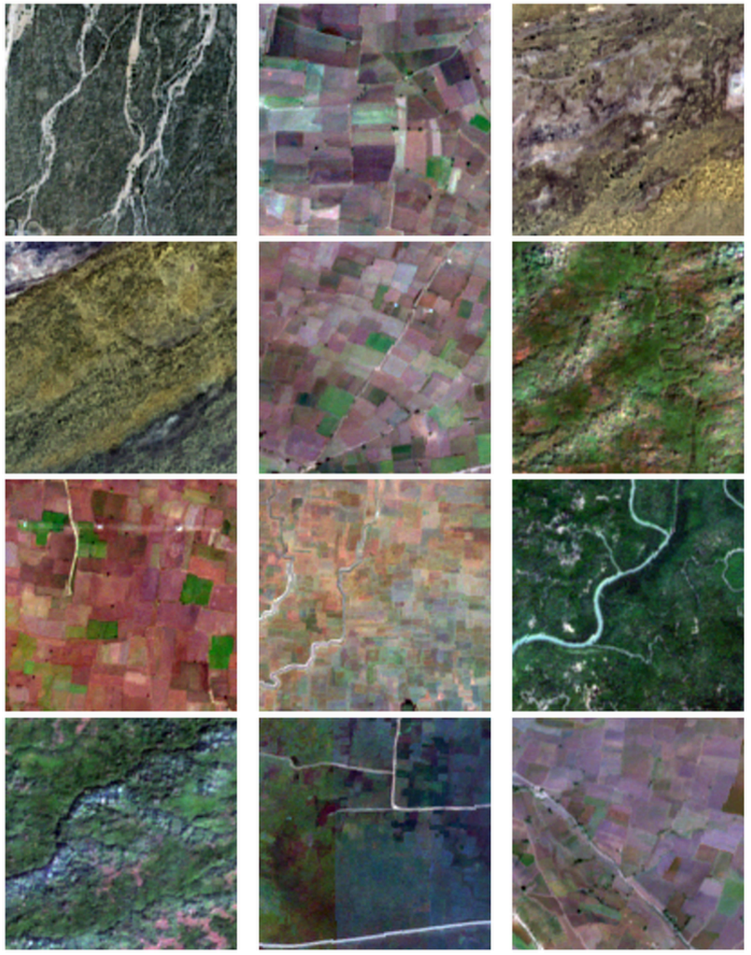
Curating Negative Samples



Helps the model learn when not to predict a kiln, reducing false positives and improving overall reliability.

1. **Clean Non-Kiln Data:** We curated over 41,000 Sentinel-2 tiles from ESA WorldCover v200, representing regions without brick kilns.
2. **High Confidence Selection:** Used areas with ≥99.9% class confidence across major land-cover types.
3. **Manual Verification:** Every candidate tile was cross-checked with Esri basemaps and any tile with visible kiln was removed.

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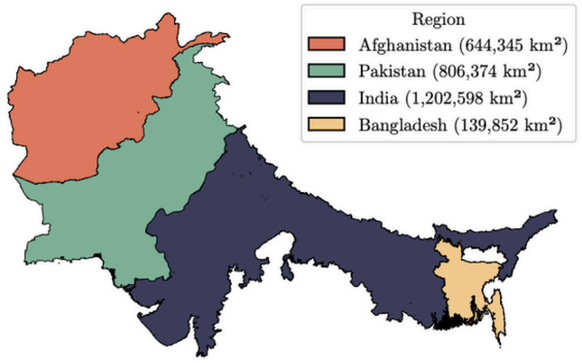
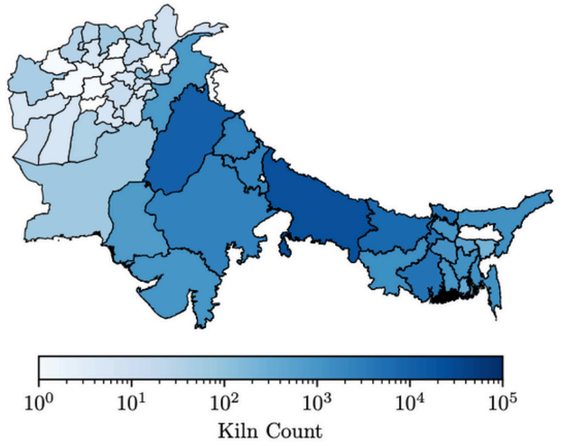
Dataset Overview

- 62,671 kilns across India, Bangladesh, Pakistan, Afghanistan
- Coverage: ~2.8 million km²
- OBB annotations on Sentinel-2 (10 m/pixel) imagery



(a) Coverage of our dataset over various countries



(b) Brick kiln count per state

(c) CFCBK

(d) FCBK

(e) Zigzag

Figure 2: Spatial distribution of brick kilns and their counts across various regions. (a) Geographic extent of our dataset, covering Afghanistan, Pakistan, India, and Bangladesh. (b) Kiln count per state on a log scale. (c–e) Spatial distribution of kilns by type: CFCBK, FCBK, and Zigzag. CFCBKs are predominantly found in Uttar Pradesh, Bihar and West Bengal regions, FCBKs are present in all regions, and Zigzags are present in all regions except Afghanistan.

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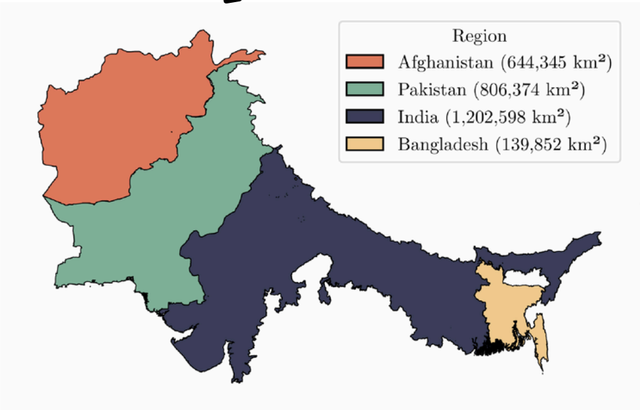
Data Creation Pipeline

YOLO11m-OBB
30K - Data (ACM JCSS)

predict

ultralytics YOLO11



2.8M km²

Planet Imagery

Hand Validation

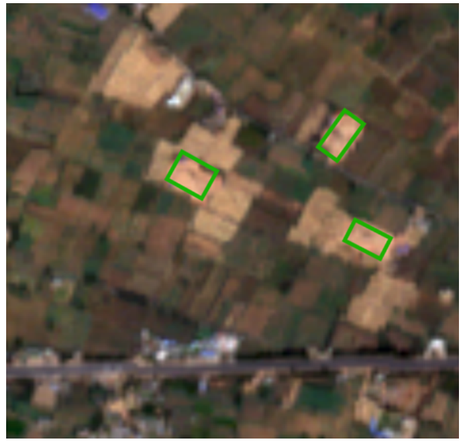
ESRI Imagery

Iterative Expansion Strategy:
3 Times

Expand Dataset :
63K Data

Label Transfer

Sentinel-2 Imagery



SentinelKilnDB

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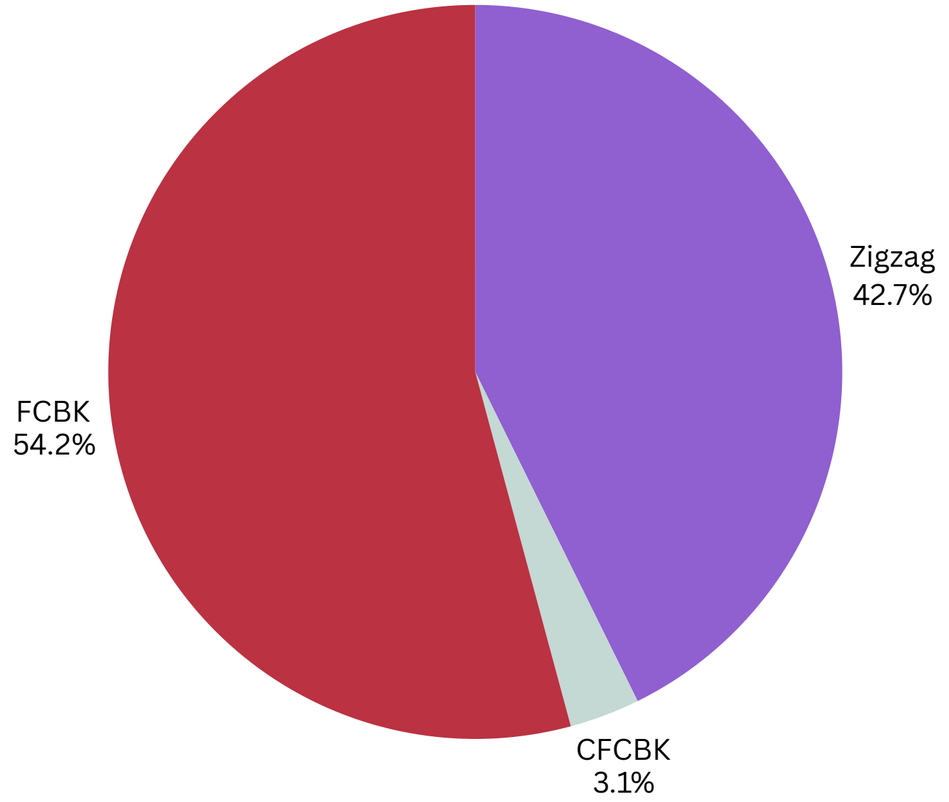
Overall Brick Kiln Distribution

Country	State/Region	CFCBK	FCBK	Zigzag	Total	Negative Samples
India	9 states	1,939	21,451	19,592	42,982	30,650
Bangladesh	8 divisions	2	1,461	5,440	6,903	5,548
Pakistan	4 provinces	3	10,443	1,731	12,177	3,970
Afghanistan	34 provinces	0	608	1	609	900
Total	-	1944	33,963	26,764	**62,671**	41,068



Split: Train 71,856 | Val 23,952 | Test 18,492

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SentinelKilnDB Benchmark

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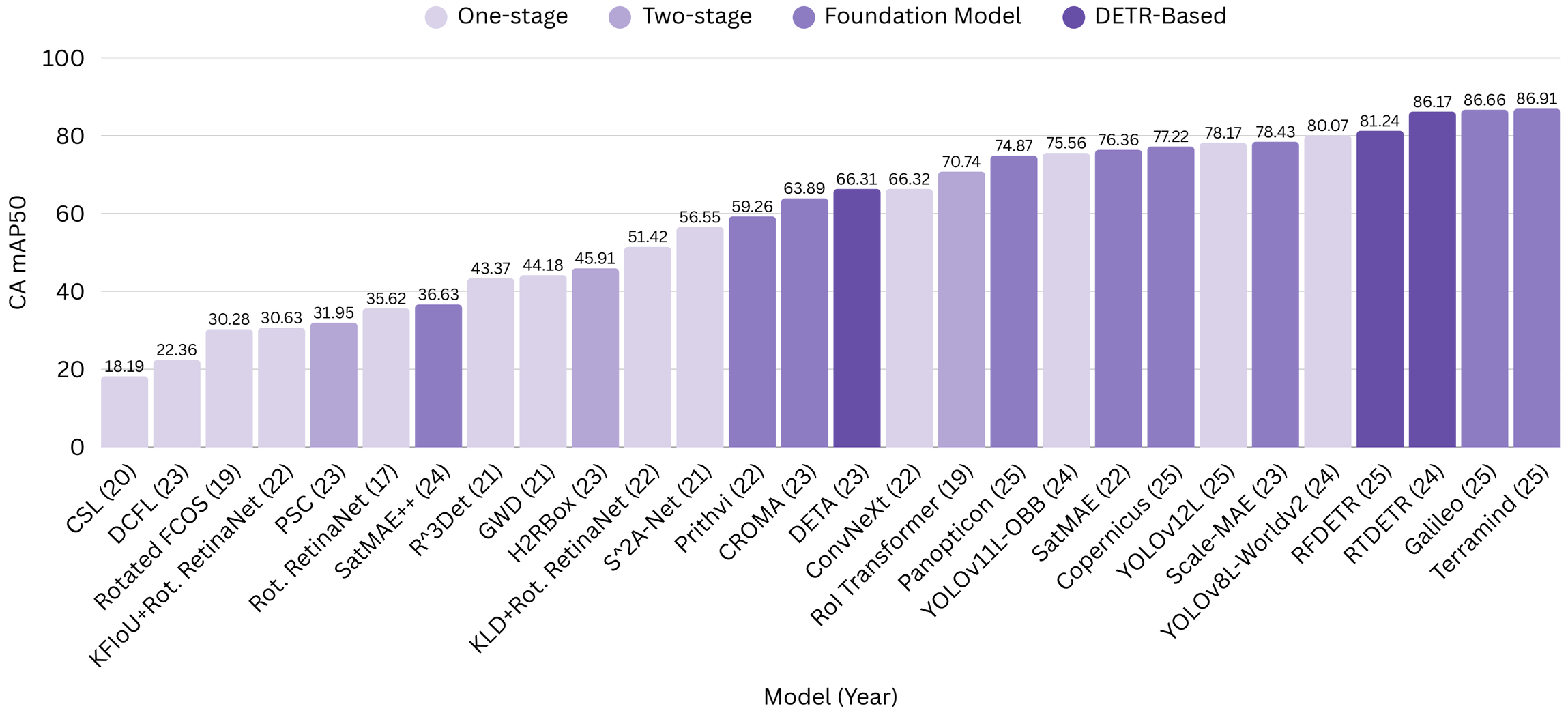
T1 In-region Detection: Train and test within same region



Comparison of Class-Agnostic mAP50 across Models

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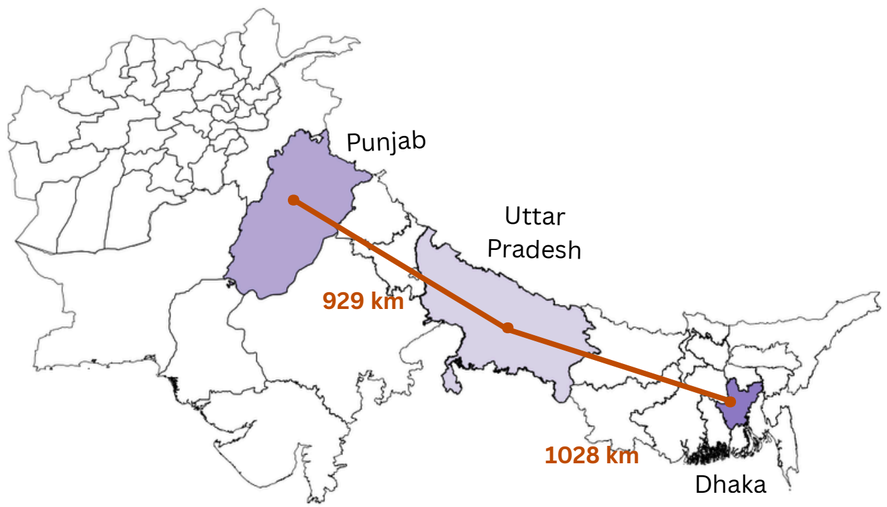
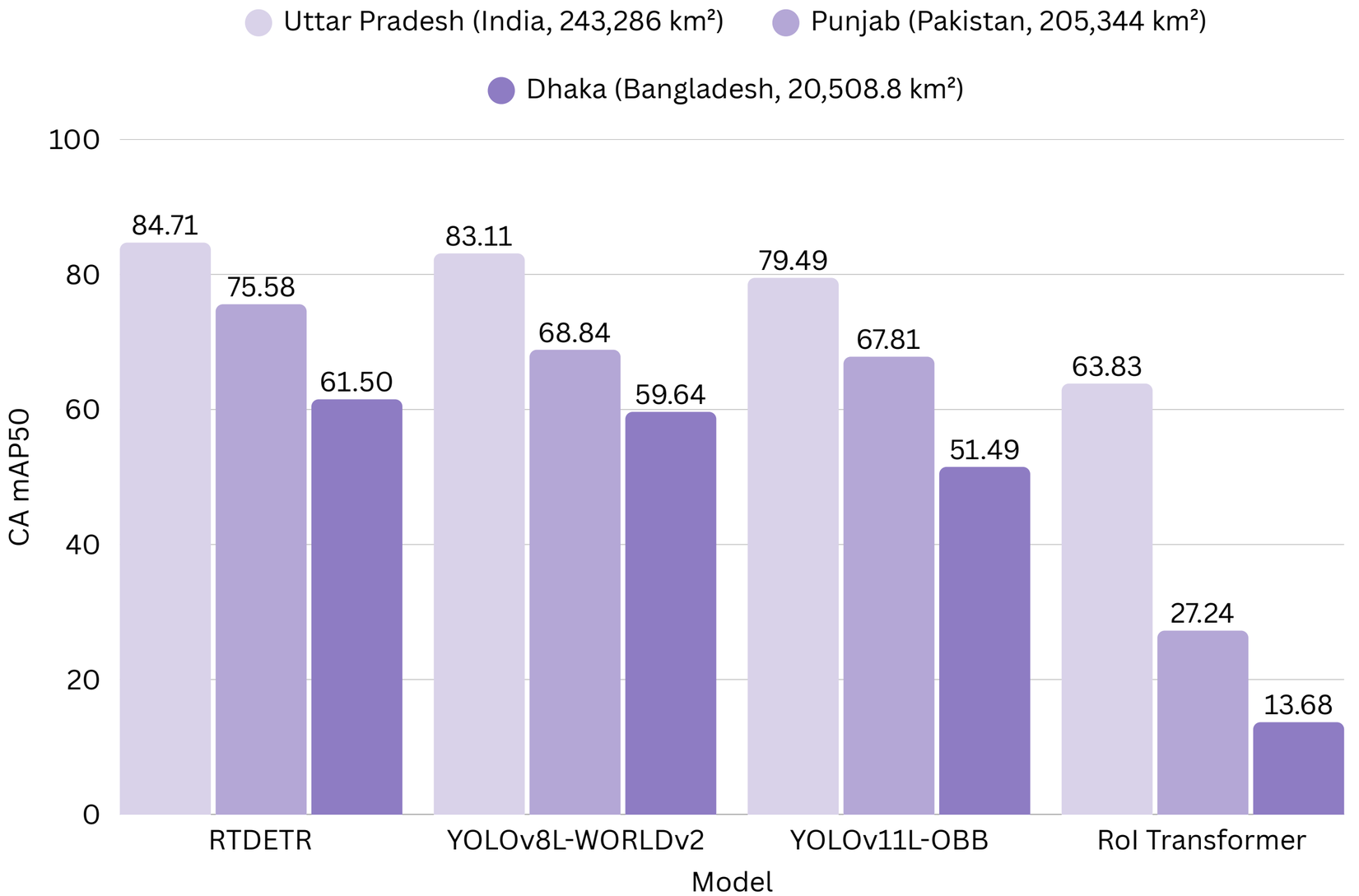
T2 Out-of-the-region Generalization: Evaluate transfer to unseen regions





Comparison of Class-Agnostic mAP50 for Out-of-Region Performance

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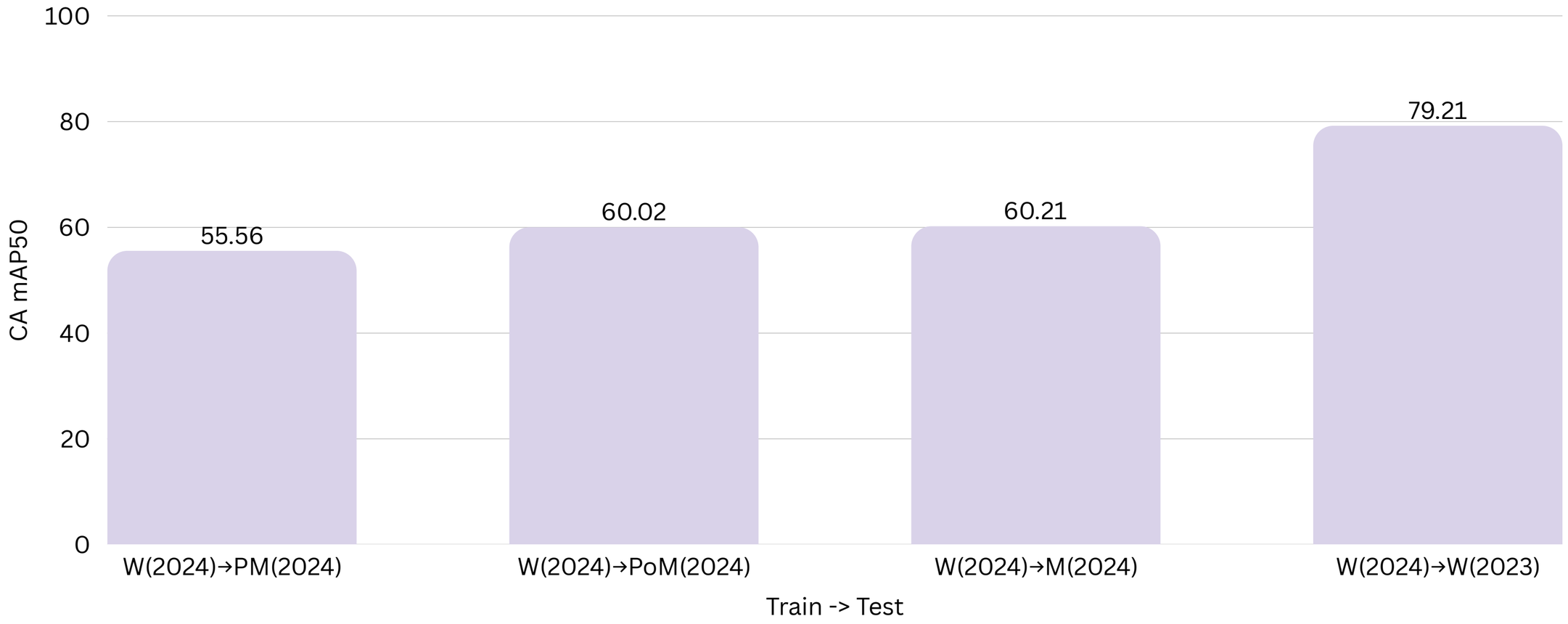
T3 Temporal Generalization: Adapting to seasonal variation

Single-season splits: Train/test in the same season (baseline)

(PM: Pre-Monsoon, M: Monsoon, PoM: Post-Monsoon, W:Winter)



Comparison across single-season train-test splits

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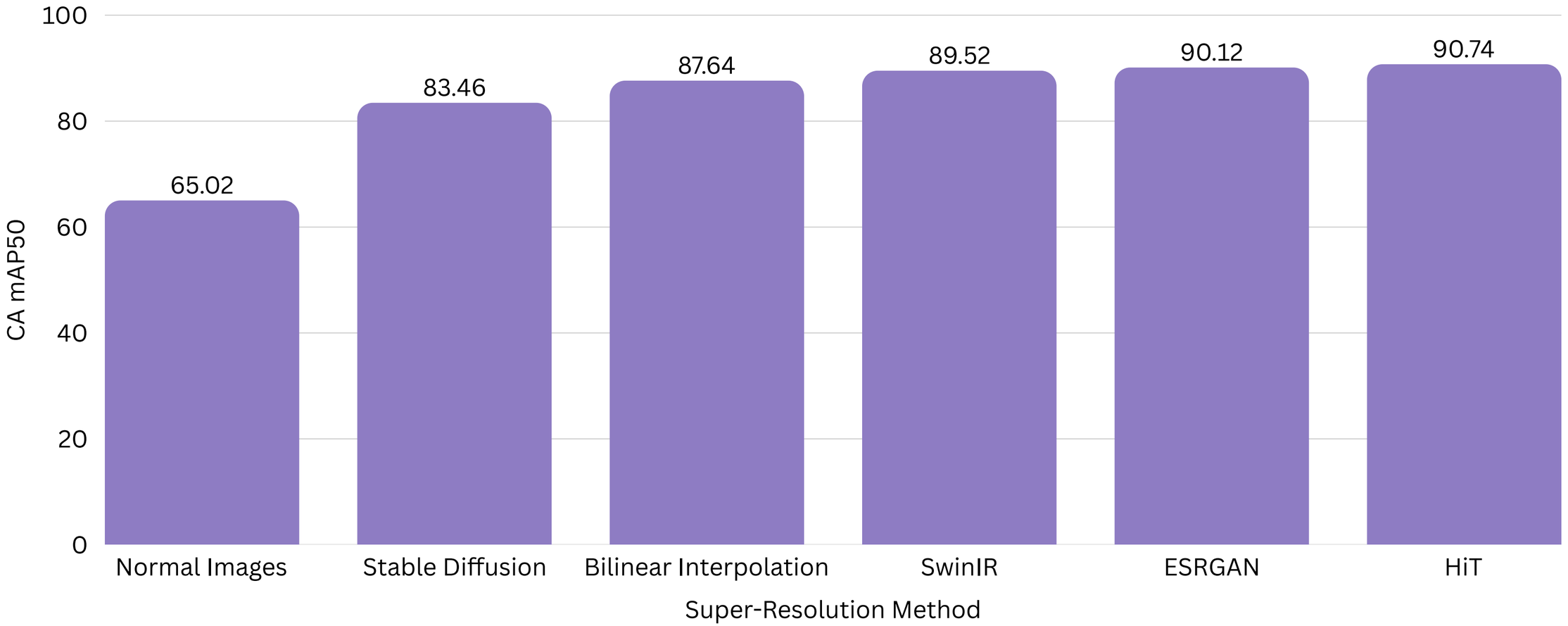
T4 Super-Resolution: Gains on YOLOv11L-OBB from upscaling the Sentinel-2 imagery



Comparison of Class-Agnostic mAP50 across Super-Resolution Methods

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Impact

Largest public dataset for brick kiln detection in South Asia.

Dataset	Imagery	Classes	Quantity	Instances	GSD
DOTA-V1.0	Google Earth	15	2,806	188,282	0.1 4.5m
FGSD	Google Earth	43	5,634	2,612	0.12 1.93m
DIOR-R	Google Earth	20	23,463	192,518	0.5 1m
SentinelKilnDB	**Sentinel-2**	**3**	**114,300**	**97,648**	**10m**

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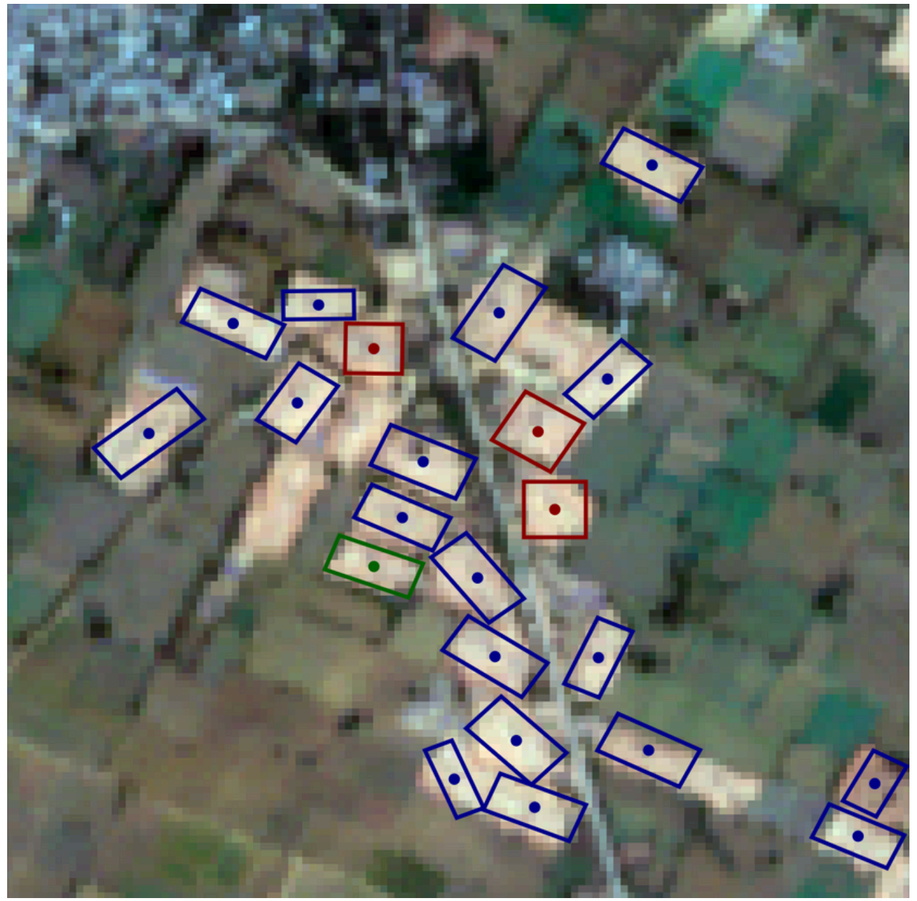
Applications

- Provides a benchmark for OBB detection in low-resolution satellite imagery and geospatial generalization
- Enables accurate kiln-level emission estimates for air quality modeling
- Assists policymakers in monitoring technology transitions and compliance
- Facilitates research on cross-region model robustness and transferability



OBB Detection in Low-Resolution Imagery

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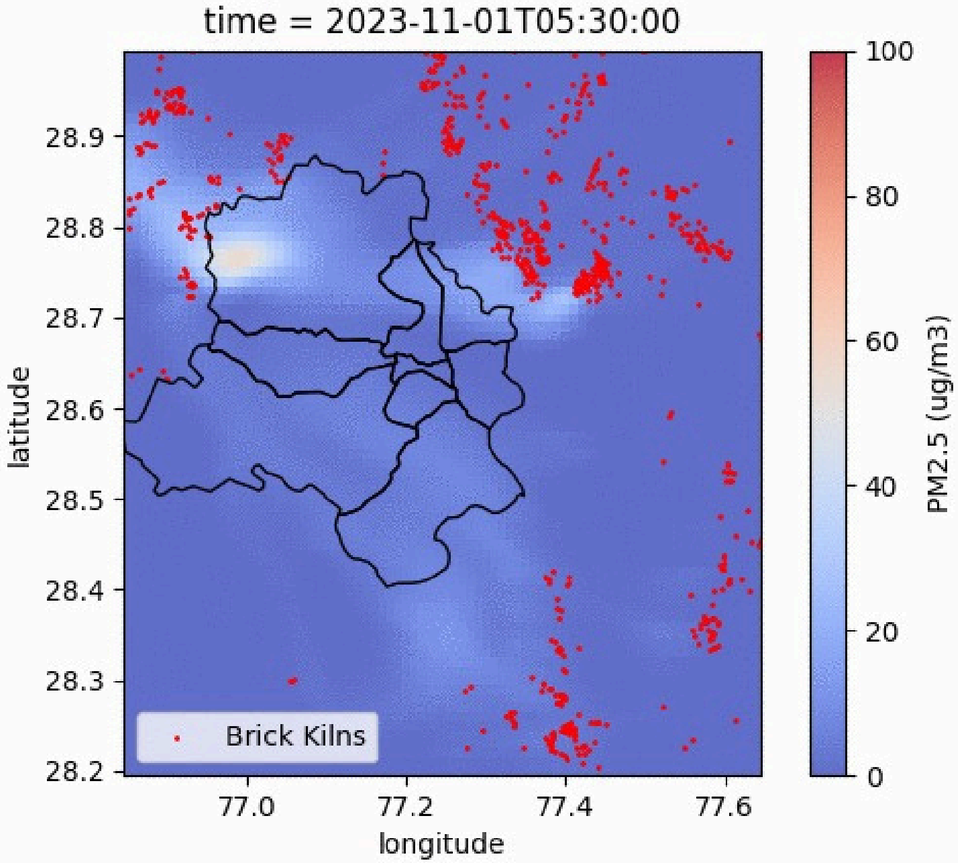

Air Pollution simulations for What-if scenarios

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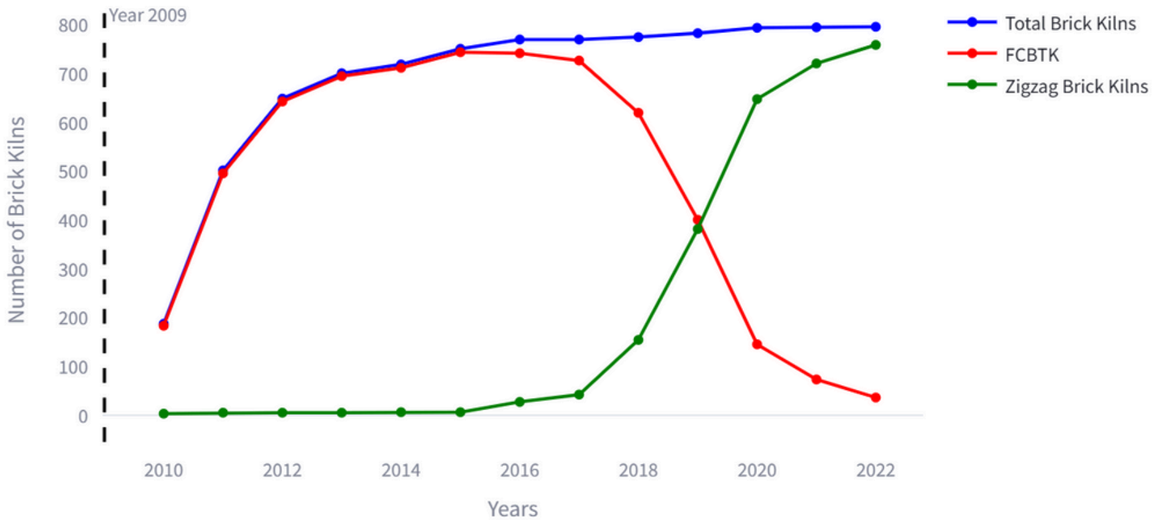

Number of Brick Kilns over years in Delhi

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Conclusion

62671
Kilns

2.8M
Km^2 Coverage

4
Countries

3
Kiln Types

114300
Sentinel-2 Images

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Models