# Sand Mining Watch

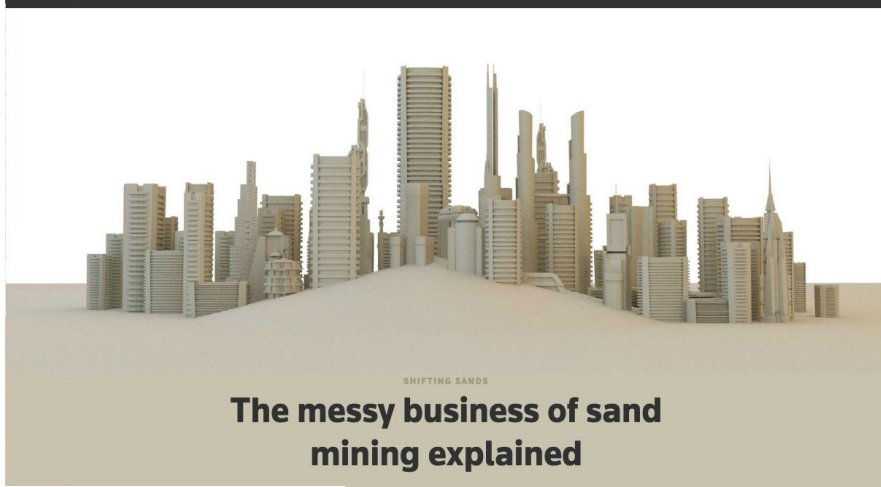## Leveraging Earth Observation Foundation Models to Inform Sustainable Development

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# Sand mining: the global environmental crisis you've probably never heard of

REUTERS GRAPHICS

SHIFTING SANDS

## The messy business of sand mining explained

...y construction boom is driving unregulated sand
...ound the world - eroding rivers and coastlines,
...pting ecosystems and hurting livelihoods.

WORLD ECONOMIC FORUM

FUTURE OF THE ENVIRONMENT

## Sand mining: the environmental challenge you've probably never heard of

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## Why the world is running out of sand

(Image credit: Getty Images)

...ates suggest that between 32 and 50 billion tonnes of sand and gravel are extracted from the Earth each year

Image: REUTERS/Andres Martinez Casares

**This article was first published in April 2019 and updated in June 2022.**

...Forum Agenda

Yale Environment 360    Published at the Yale School of the Environment    Explore | Search | About E360

A worker collects sand at a mine near Port au Prince, Haiti in April 2014. HECTOR RETAMAL/AFP/GETTY IMAGES

DEVELOPMENT

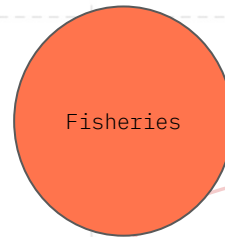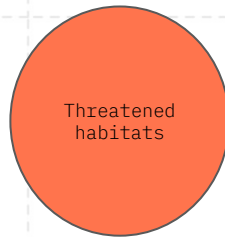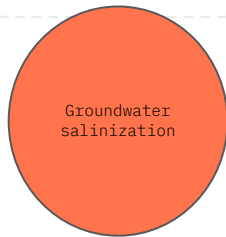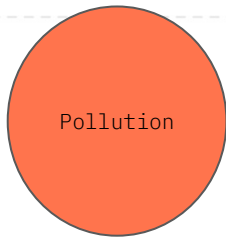## The Hidden Environmental Toll of Mining the World's Sand

# drivers



Reclamation

Asphalt

Concrete

Impacts Associated with Sand Mining

No. of studies

| Channel | Sediment | Morphological | Flow | Water Quality |

Incision — Channel instability — Channel erosion — Widening — Channel narrowing — Change in channel character — Bed coarsening — Increase in bed and sediment load — Sediment reduction — Creation of deep pools — Consolidation of islands — Destruction of aquatic/riparian habitat — Afforestation — Flow reduction — Increased flow velocity — Improved flood control — Decrease in flood control — Increased turbidity — Increased intrusion — Increase in metals

Erosion, flooding

Pollution

Groundwater salinization

Threatened habitats

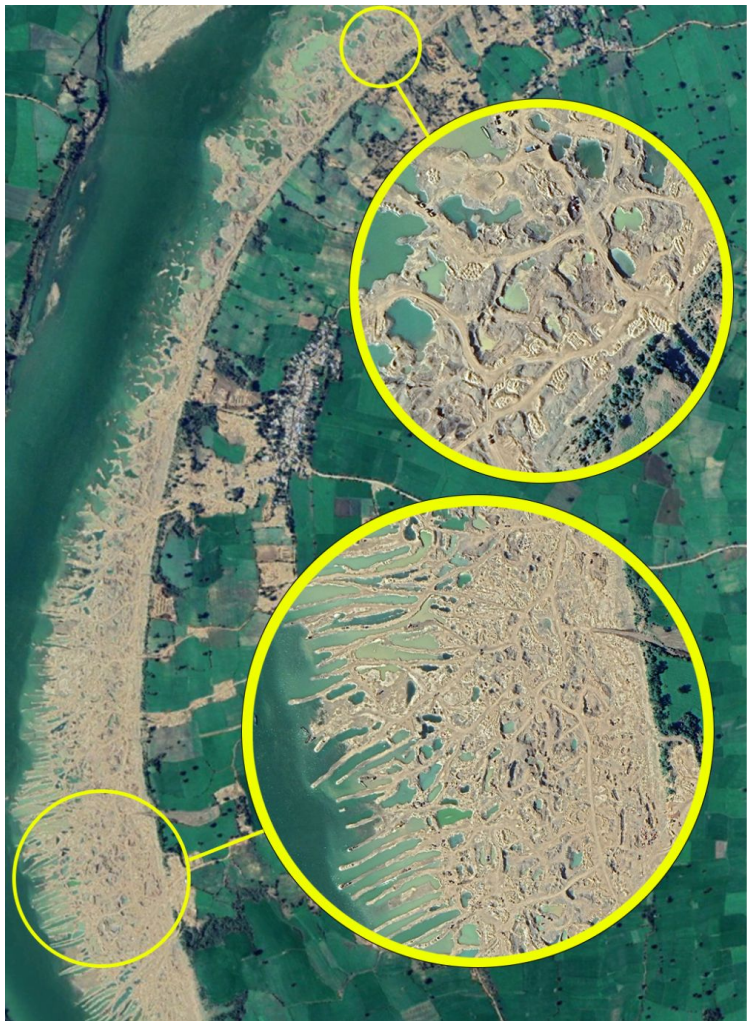Fisheries

ENVIRONMENT | OUT OF EDEN WALK

# Inside the deadly world of India's sand mining mafia

India ranks second after China in its use of construction sand, a dwindling and increasingly valuable resource.

Is it possible to detect sand mining activity from freely available satellite data?

a) May 2023

1) Seasonal variation in mining footprint

2) High resolution imagery shows the typical signatures of sand mining, including scarring, pitting, mounds, deep grooves in the sand, heavy vehicles and their tracks.
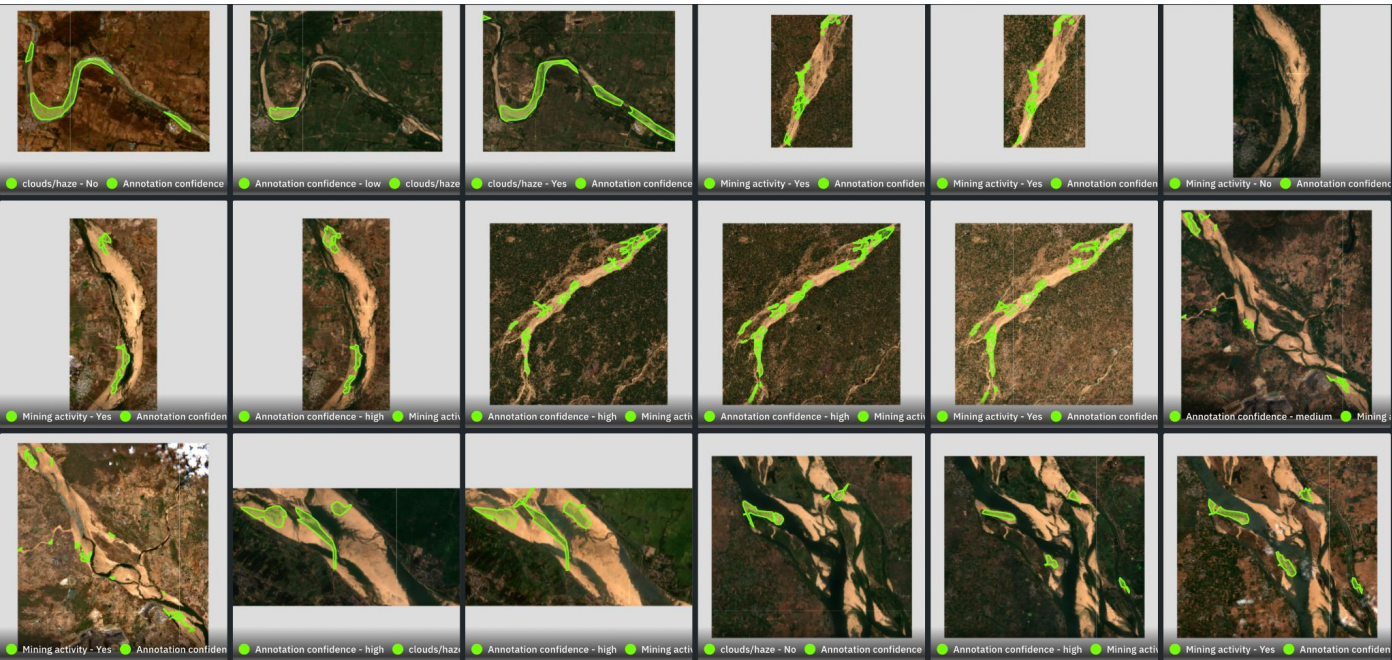
3) Likely to be the remnant of a mine washed out by the previous monsoon flood

b) Sept. 2022

challenges & intuition

RGB

SWIR1-SWIR2-NIR

"Mapping Construction Grade Sand: Stepping Stones Towards Sustainable Development". Shah and Nair 2023

SAR

challenges & intuition

dataset

⚠️ low data regime!

# approach: semi-supervised learning



Dense sampling of river basins

Target pre-training path
*self-supervised*

Segmentation Head

Model Gym

sandmine

non-mine

Fine-tuning path
*fully-supervised*
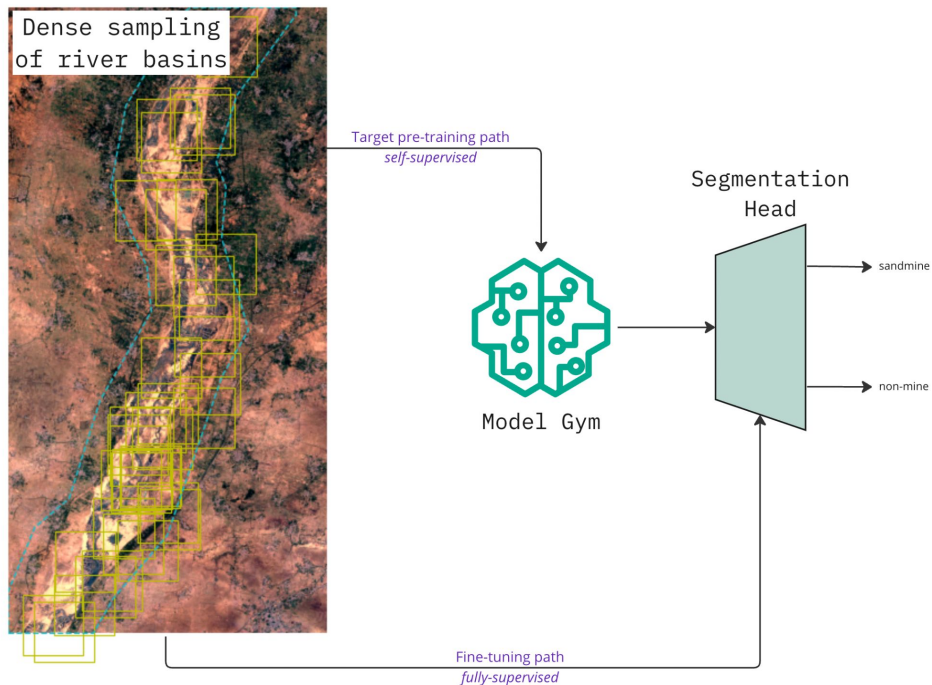
Full Supervised:

- UNet + ResNet blocks
- ResNet 18/50

Semi-supervised use pre-trained models:
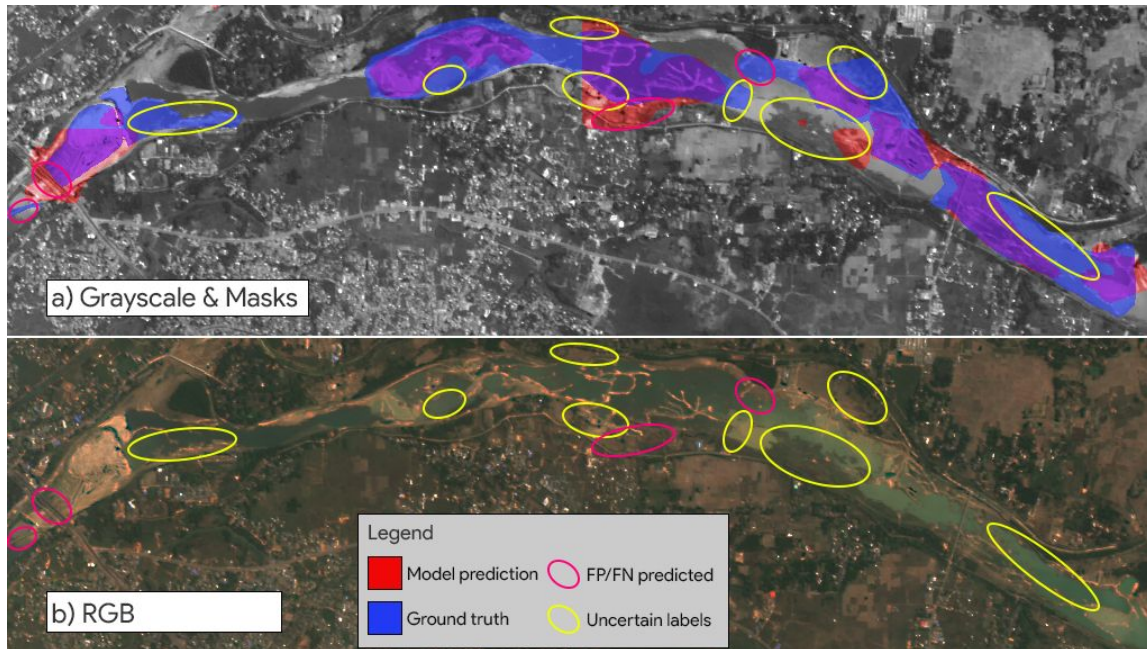
- SatMAE
- SSL4EO

# preliminary results

| Model | F1 | Average Precision |
|---|---|---|
| U-Net | 0.4884 | 0.5075 |
| SegFormer-B0 | 0.4180 | 0.3160 |
| SSL4EO-ResNet18* | 0.4786 | 0.4793 |
| SSL4EO-ResNet50* | 0.4926 | **0.5711** |
| SATMAE-Large* | **0.5327** | 0.5582 |

*pre-trained models



Using a spatially held-out validation set to assess performance

# preliminary results



a) Grayscale & Masks

b) RGB

Legend
Model prediction
FP/FN predicted
Ground truth
Uncertain labels

## next steps

- Encoding uncertainty in labels
- Expanding the dataset
- Test-time training and other distribution shift invariances
- Iterative fine-tuning