

Alberta Wells Dataset: Pinpointing Oil and Gas Wells from Satellite Imagery

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Introduction - The Global Challenge

Millions of abandoned oil & gas wells worldwide:

- **Leak methane (potent greenhouse gas) into the atmosphere:**
 - Methane has a significantly higher global warming potential than CO2 over short timescales.
- **Leach toxic compounds into groundwater:**
 - Health and safety concerns for surrounding communities.
- These emissions are **equivalent of millions of tons of carbon dioxide per year.**

Limitations of Existing Well Detection Datasets:

- **Small-Scale:** Typically very small, ranging from 500 to 10,000 samples.
- **Limited Geography:** Confined to small, specific regions.
- **Active Wells Only:** Most existing datasets are limited to only active wells, which severely restricts their utility .

Our Contributions : Alberta Well Dataset

- **First Large-Scale Benchmark Dataset:**
 - 213,000+ oil and gas wells
 - Includes Wells in Abandoned, Suspended, and Active states
 - Medium-resolution Satellite Imagery
- **Problem Framing:**
 - Object detection
 - Binary segmentation
- **Baseline Evaluation:**
 - Comprehensive evaluation of a wide range of deep learning algorithms.
- **Impact:**
 - Scalable identification of abandoned & suspended well sites.
 - Methane Emission Reduction
 - Environmental Protection

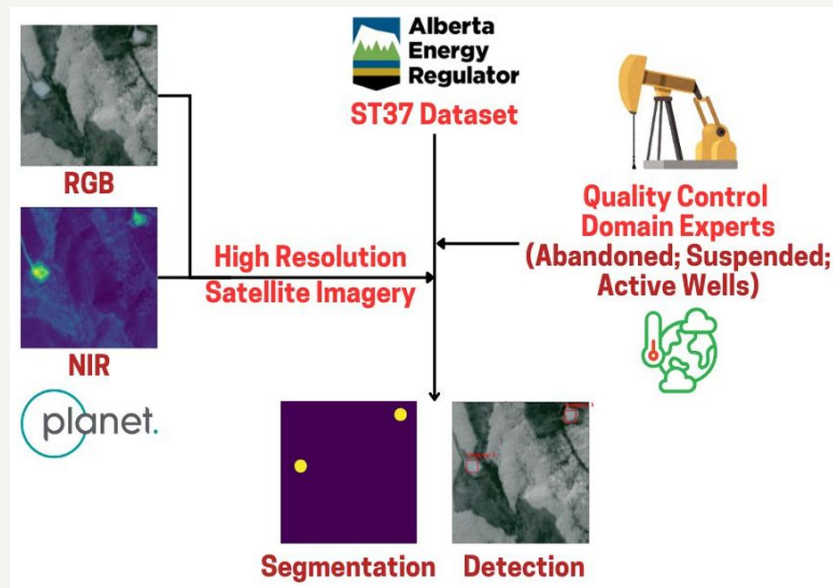


Figure 1 : Alberta Well Dataset Overview

Results : Segmentation & Detection

Architecture	Backbone	Params	GFLOPs	IoU	F1 Score	Precision	Recall
U-Net	ResNet50	32.52M	21.42	58±0.5	61.9±0.8	90.2±2.2	62.3±1.6
	ResNext50	32M	21.81	58.2±0.2	62.1±0.3	88.2±3.5	63.6±1.7
	SE_ResNet50	35.06M	20.83	58.9±0.7	62.9±0.7	88.8±1.6	64.4±1.4
	EfficientNetB6	43.83M	-	60.4±0.3	64.8±0.4	87.8±0.4	66.3±0.3
PAN	ResNet50	24.26M	17.47	57.8±0.8	61.5±0.9	89.3±1.2	61.5±0.9
DeepLabV3+		26.68M	18.44	56.8±0.7	60.6±0.7	89.4±1.3	61.8±1.1
Segformer	mit-b0-ade	3.72M	3.52	57.6±0.5	61.3±0.6	82.6±2.9	69.2±2.1
UperNet	ConvNexT-Small	128.29M	81.76	59.4±0.1	63.5±0.1	81.5±0.5	71.5±0.4
	ConvNexT-Base	146.27M	121.99	59.7±0.3	63.8±0.2	81.1±0.7	72.2±0.2
	swin small	81.15M	134.2	59.9±0.7	64.2±0.7	80.6±0.5	73.1±0.1

Table 1 : Results for the binary segmentation task for a variety of models evaluated over the test set. We report the Intersection over Union (IoU), F1 Score, Precision and Recall.

Architecture	Backbone	Params	GFLOPs	IoU_0.1	IoU_0.3	IoU_0.5	mAP_50	mAP_50:95
RetinaNet	ResNet50	18.87M	0.93	24.58±0.11	43.07±0.8	59.79±0.36	0.18±0.28	0.63±1.12
FasterRCNN		41.09M	24.7	36.79±1.07	46.95±0.66	61.29±0.35	5.20±1.00	19.12±3.41
FCOS		31.85M	25.81	34.79±0.99	48.51±0.59	62.66±0.43	9.67±1.47	30.46±3.11
SSD Lite	MobileNet	3.71M	0.64	33.91±0.18	50.30±0.08	65.07±0.03	9.76±0.39	25.14±0.66
DETR	ResNet-50	41.47M	6.86	41.78±0.11	51.15±0.14	63.17±0.11	15.22±0.28	38.45±0.32

Table 2: Results for the object detection task for a variety of models evaluated over the test set. We report the intersection over union (IoU) over thresholds (0.1,0.3,0.5) and the mean average precision (mAP) for both IoU = 0.5 and IoU ∈ [0.5,0.95] thresholds.

AWD : Model Prediction Illustration

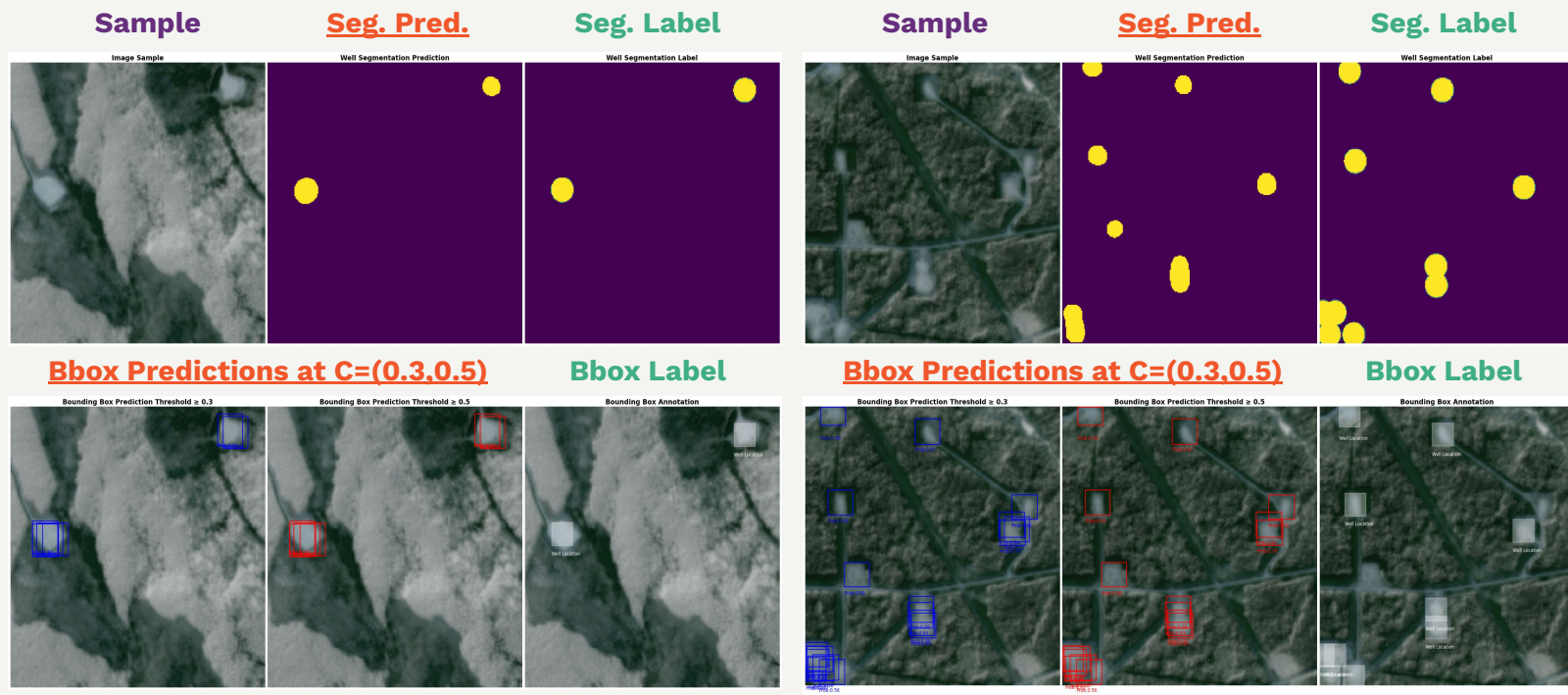


Figure 2 : Sample image patches from our dataset includes examples with two wells, and multiple wells. Additionally, we present qualitative results with predictions generated by our Segmentation U-Net (ResNet50) and DETR ResNet50 model.

Conclusion

In this work we present:

- **Alberta Wells Dataset (AWD)**
 - First large-scale benchmark dataset for identifying oil and gas wells
 - Focus on abandoned and suspended wells.
- **Framed well identification as :**
 - **Object detection** and **Binary segmentation** tasks
 - Evaluated a wide range of popular deep learning methods.
- **Our experiments highlighted the critical importance of:**
 - Incorporating **Near-Infrared (NIR) imagery**
 - Including **all well types (active, suspended, abandoned)** for robust detection.

Ultimately, our work aims to:

- Improve **estimation of methane emissions** and groundwater contamination.
- Prioritize **oil and gas wells for plugging and decontamination** using **scalable remote sensing for global environmental impact mitigation**.

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Paper & Dataset

