

Table 5. Evaluation metrics for detection accuracy, spatial precision, system performance, user acceptance, and alerting efficacy.

Metric Category	Metric	Formula
Detection Performance	Accuracy, Precision, Recall, F ₁ -Score	$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$
		$Precision = \frac{TP}{TP + FP}$
		$Recall = \frac{TP}{TP + FN}$
		$F_1 - score = 1 \times \frac{Precision \times Recall}{Precision + Recall}$
	False-Positive Rate (FPR)	$FPR = \frac{FP}{FP + TN}$
	Intersection over Union (IoU)	$IoU = \frac{area(B_{pred} \cap B_{true})}{area(B_{pred} \cup B_{true})}$
	mAP@0.5	$mAP = \frac{1}{N} \sum_{i=1}^N AP_i$
Spatial Accuracy	RMSE (Hotspot vs Surveys)	$\sqrt{\frac{1}{N} \sum_{i=1}^N (y_i - \hat{y}_1)^2}$
System Performance	Inference Latency	$\frac{\sum_{i=1}^N t_i}{N}$
	Map Render Time	$\frac{\sum_{i=1}^N render_i}{N}$
	Throughput	$\frac{processed-items}{total-time}$
Usability & Acceptance	System Usability Scale (SUS)	$SUS = 2.5 \times [20 + \Sigma (odd - item\ scores) - \Sigma (even - item\ scores)]$
	TAM Constructs	$\frac{\sum_{i=1}^6 s_i}{6}$
Alerting Efficacy	Notification Latency	$\frac{\sum_{i=1}^N (t_{deliv,i} - t_{det,i})}{N}$
	Response Time	$\frac{\sum_{i=1}^N response_i}{N}$