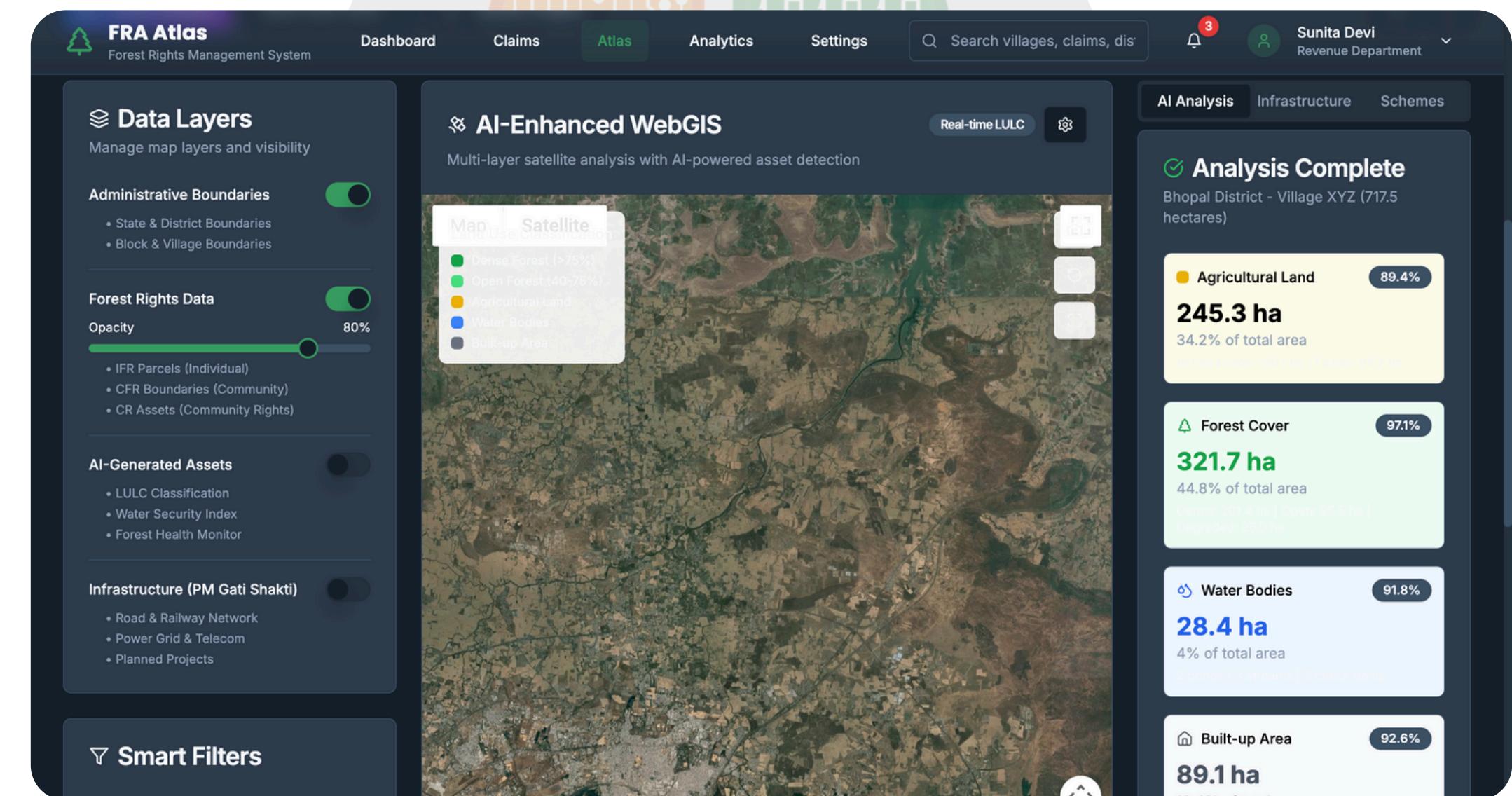


SMART INDIA HACKATHON 2025

- **Problem Statement ID** – SIH12508
- **Problem Statement Title** – Development of AI-powered FRA Atlas and WebGIS-based Decision Support System (DSS) for Integrated Monitoring of Forest Rights Act (FRA) Implementation. (States to be concentrated: Madhya Pradesh, Tripura, Odisha, Telangana)
- **Theme** – Miscellaneous
- **PS Category** - Software
- **Team ID** – 98050
- **Team Name** – \$ARAIZONA\$



Our Solution

AI and WebGIS-enabled FRA Atlas that digitizes scattered records, integrates satellite-based asset mapping, and provides a DSS to recommend FRA patta holders with CSS schemes.

Problems & our Solutions

Scattered, Non-digitized FRA Records

Description: Legacy records of FRA are paper-based, inconsistent, and difficult to verify.

Solution:

- AI-based **digitization** using **OCR & NER** to extract scattered paper data.
- **Standardized** database integrated into the FRA Atlas.

No Centralized, Real-Time Mapped Repository

Description: FRA claims are not available on a digital platform.

Solution:

- **FRA Atlas** with **WebGIS** integration.
- **Interactive layers** for claims, land use, socio-economic data, and **progress tracking**.

No Satellite Asset Mapping

Description: No integration of FRA data with satellite data.

Solution:

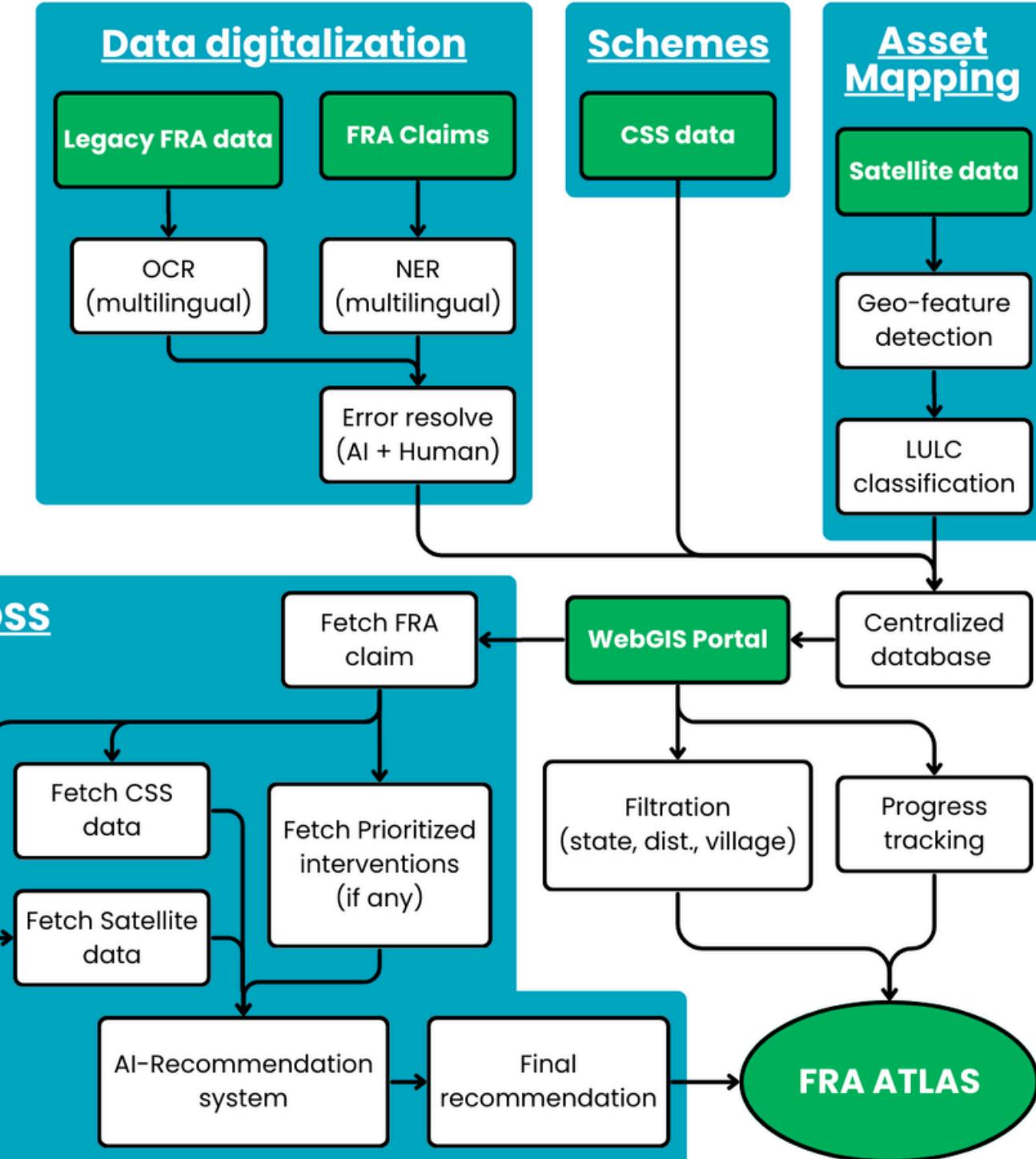
- AI/ML + Remote Sensing to map **real time** geography.
- Integrated forest, groundwater, and infrastructure layers.

Lack of Decision Support System for CSS

Description: No tool to recommend CSS schemes to FRA patta holders.

Solution:

- AI-rule based **Decision Support System (DSS)**.
- **Prioritizing interventions** like borewells in water-scarce villages.



Programming Languages & Frameworks

- Backend:** Python (FastAPI/Django) for API development, PostgreSQL-based Celery task queues, GraphQL via Ariadne, gRPC microservices
- Frontend:** React.js with MapLibre GL JS for WebGIS interface, Next.js for SSR, Redux Toolkit for state management, React Query for data caching
- Database:** PostgreSQL with PostGIS extension for spatial data, TimescaleDB for time-series metrics, PgVector for similarity search, PostgREST for auto-generated REST APIs
- AI/ML:** Python (scikit-learn, spaCy, doctr/surya OCR libraries), PyTorch for deep learning, Hugging Face Transformers, MLflow for experiment tracking
- GIS Processing:** QGIS, GeoServer for map services, GDAL/OGR for format translation, GeoPandas/Shapely for in-code geometry ops, Rasterio/rio-tiler for raster tiling

Data Processing Workflow

Document Digitization

- Scan (300 DPI) → Preprocess → OCR → NER → Validation → Database Storage

Satellite Analysis

- Sentinel-2 Data → Feature Engineering → ML Classification → Village Assets → DSS Integration

Decision Support Logic

- Rule Engine + AI Scoring → Priority Rankings → Actionable Outputs → Scheme Convergence

AI & ML Components

- OCR Engine:** Tesseract (MVP) → doctr/surya (Production)
- NER Pipeline:** spaCy with custom fine-tuned models
- LULC Classification:** Random Forest (MVP) → U-Net/SegFormer (Production)
- Remote Sensing:** Sentinel-2 imagery processing with NDVI/NDWI indices

FRONTEND LAYER

WebGIS Atlas Interface

Stack : ReactJS, Angular

Mobile Responsive UI,

Multi Language Support

Decision Support System (DSS)

Atlas, Settings, Profile, Claims, Help centre, Notification, AI analysis

API LAYER

For DSS Implementation

- 1.DILRMP API
- 2.Bhuvan API (ISRO)
- 3.Bhoonidhi API (NRSC)
- 4.PM KISAN API
- 5.MGNREGA API
- 6.JalJeevan API

API's For Document Verification

- 1.Aadhaar Authentication
- 2.Digilocker API

API's For Financial Management

- 1.DFMS API

MISCELLANEOUS API'S

- 1.Translations API
- 2.Notifications API
- 3.Messaging API
- 4.AI Chatbot (OpenAI)

DATA AND INFRA API

- 1.data.gov.in APIs
- 2.Water Data Portal

AI PROCESSING LAYER

OCR(Optical Character Recognition)

MVP- Tesseract
Production – Surya OCR / docTR

NameEntityRecognition

1.Sapcy+Custom Models
2.opennnyaiorg/en_legal-ner-trf
3.AI4 Bharat Indic NLP(NER)

LULC Classification

- 1.DDPN-Segformer
- 2.Swin Transformer with U-Net

DSS AI

Explainable_ml_ensemble

Geopatial AI Features - 1.Sentinel-2, temporal transformer

DATA LAYER

PostGIS Database Spatial Data, Claims, Titles etc

Document Storage S3/minIO, PDF/Images

Vector Optimized Map Data

WebGIS Service Vector Tiles, map services



Operational Feasibility

- Data Availability:** Maintained FRA claims, structured CSS schemes, and easily accessible **satellite imagery**.
- Pilot State Strategy:** Primary focus on only 4 states for rapid testing, fast error handling. (Madhya Pradesh, Odisha, Telangana, Tripura)
- Prebuilt Ecosystem:** Active involvement of MoTA, State Tribal Departments & NGOs ensures quick and easy adoption of the system.

Social Feasibility

- Ecosystem:** Government organizations, NGO's already working on FRA.
- Cultural:** **Multilingual support**, respect for tribal land rights.
- Policy alignment:** Transparency & compliance with FRA Act & CSS schemes.

Challenges & Strategies

Data-Related Challenges : Legacy, incomplete data reduce accuracy.
Strategy: Field verification, official record cross-checks, AI-assisted error detection.

Technical Challenges : Low digital literacy among govt. officials.
Strategy: Multilingual user-friendly interface, chatbots.

Infrastructure Challenges : Poor internet and unreliable power in tribal regions.
Strategy: Offline functionality, hybrid deployments, low-bandwidth optimization.

Operational Challenges : Stakeholder coordination & timely data updates.
Strategy: Clear role definition, streamlined workflows and architecture.

Technical Feasibility

- Data Digitalization:** **OCR & NER** models already used in e-governance.
- AI/ML for Asset Mapping:** **Satellite Image Process, Computer Visionary**, Change Detection are already validated in Agricultural, Forestry and Environmental Monitoring Systems.
- WebGIS Platform:** Widely adopted in Smart Cities and Land Record digitilization.
- Decision Support System (DSS):** Rule based, AI enabled DSS, and APIs are mature and proven in health & agriculture industry.
- Cloud Infrastructure:** Govt.-approved scalable platforms like **AWS, Docker, Kubernetes**.

Economic Feasibility

- MVP:** ₹44.9L – ₹63.4L (Proof-of-concept validation).
- Year-1 Production:** ₹1.85Cr – ₹2.21Cr (Comparable to GIS industry standards).

Deployment Options:

- Cloud-Managed** – ₹2.21Cr
- Hybrid** – ₹2.03Cr

INNOVATION AND UNIQUENESS

- AI analyzes deforestation, forest health, crop trends, and water bodies.** ★★
- Centralized WebGIS** for live claim tracking.
- Inbuilt training module for new users.
- Mobile app** enables easy adaptability.
- APIs like PM-Kisan, GatiShakti power precise **data integration**.
- OCR & NER** digitizes legacy documents automatically.
- Rule-based DSS** suggest eligible areas for CSS.
- AI suggests infrastructure gaps for targeted action.** ★★
- Monthly claim trends, export tools, and statewise **tracking**.
- Satellite imagery visualizes** forest type and density changes graphically.
- PDF/JSON reports** for claim status (total, approved, rejected, pending).
- Role-based portal** for secure departmental access.

Social Impact

- FRA Atlas implementation will benefit around 90M+ tribal people.
- With better monitoring, and transparency, the overall claim processing rate is expected to **rise by 60%-80%**.
- DSS ensures patta holders get all eligible CSS benefits, they could see an **annual income boost** of ₹40,000–60,000 per household.
- **Access** to all **government schemes** (MGNREGA, PM-KISAN, DAJGUA, Jal Jeevan Mission)
- Quick and **easy implementation** of schemes.

Environmental Impact

- Asset mapping helps in **conservation of forest** cover, water bodies, soil and agricultural land.
- FRA monitoring can potentially **reduce deforestation** by 25–30%.
- **DSS** prioritizes necessary interventions, prioritize government resources.
- Real-time alerts to **stop encroachments** in reserved areas.

Economic Impact

- 90M+ FRA-recognized households results in potential **GDP boost**.
- **Reduced leakages** of resources, **higher ROI** for government.
- Higher agricultural productivity that results in increased household income.
- **70% cost savings** compared to manual claim process.

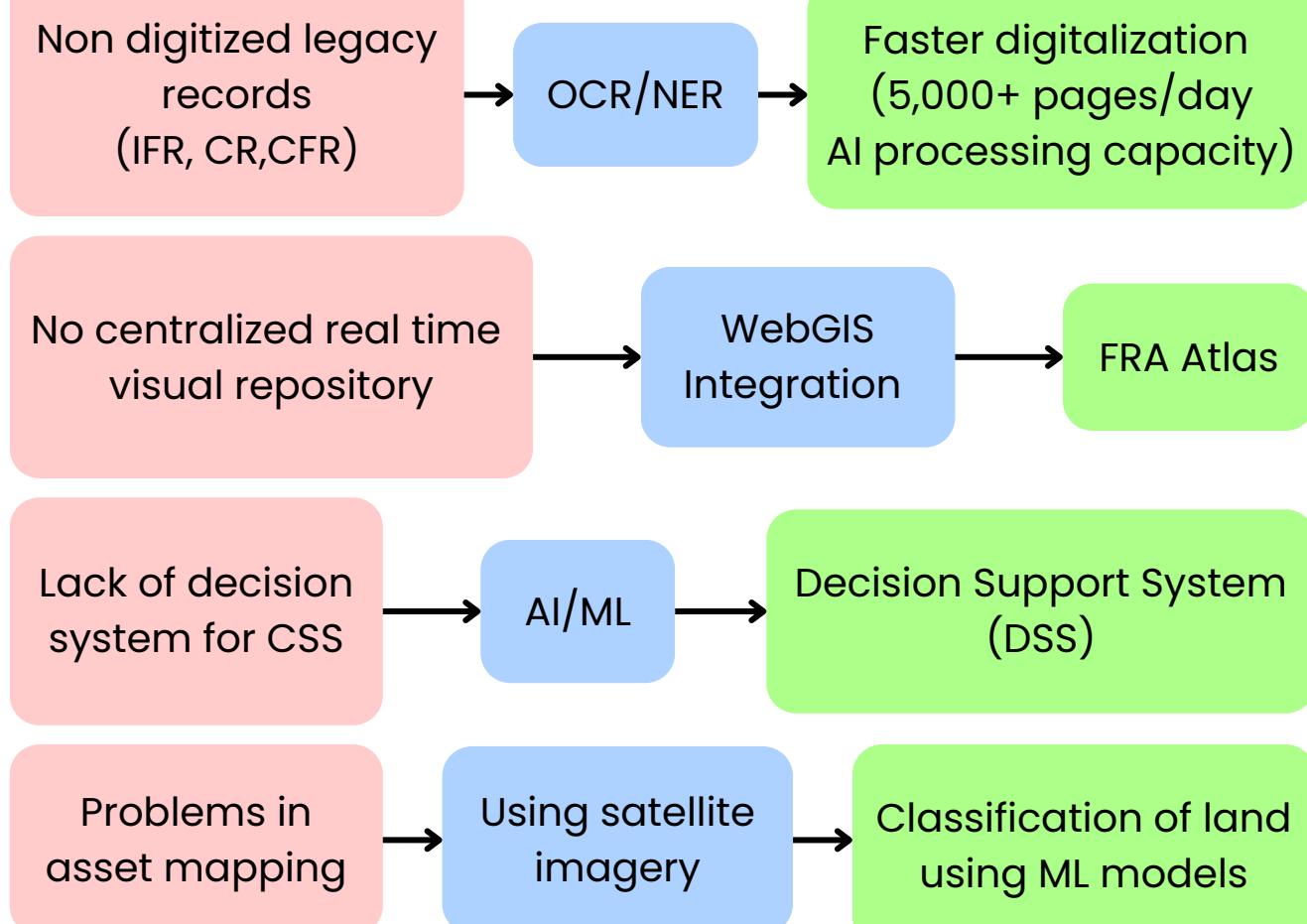
SUSTAINABLE DEVELOPMENT GOALS (SDG)

- **SDG 1 – No Poverty** - Boosts tribal income via welfare access.
- **SDG 2 – Zero Hunger** - Improves food security through land rights.
- **SDG 8 – Decent Work & Growth** - Enhances livelihoods & GDP.

Governance & Administration Impact

- Single-source, **centralized** database for FRA claims, asset mapping, and CSS application status.
- **Transparent workflow** across Ministry of Tribal Affairs, DAJGUA ministries Forest Department and NGOs.
- Approx. **58.65 M+ hectares** of land across 4 states can be **monitored**.

- **SDG 10 – Reduced Inequalities** - Empowers marginalized tribal communities.
- **SDG 13 – Climate Action** - Cuts deforestation & monitors encroachment.
- **SDG 15 – Life on Land** - Conserves forests & biodiversity.
- **SDG 16 – Strong Institutions** - Ensures transparent, accountable governance.



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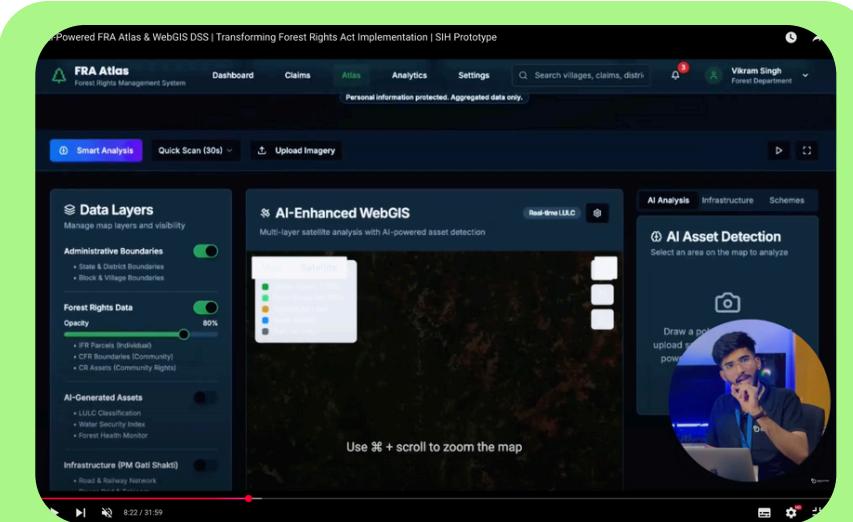
PROTOTYPE

RESEARCH AND REFERENCES

- [1. Critical assessment of implementation of the Forest Rights Act \(FRA\)](#)
- [2. Geo-informatics for Forest Rights in Maharashtra](#)
- [3. Status of Implementation of Scheduled Tribes and Other Traditional Forest Dwellers Rights, Odisha](#)
- [4. Implementation of Forest Rights Act, 2006 – Ministry of Tribal Affairs \(Government of India\)](#)
- [5. Securing Rights, Enabling Futures: Policy Lessons from FRA and Future Pathways](#)
- [6. Supreme Court Impacts on Forest Rights Act Implementation](#)
- [7. Forest Rights Act \(FRA\) Explainer](#)
- [8. Challenges in Forest Rights Implementation](#)
- [9. Forest Rights Act After Ten Years](#)
- [10. Launch of Dharti Aaba Janjatiya Gram Utkarsh Abhiyan \(DAJGUA\)](#)

BUSINESS MODEL CANVAS (LINK)

- [1. Geo-informatics and Remote Sensing for Forest Rights Implementation](#)
- [2. OCR and Named Entity Recognition Pipelines for Document Digitization in Multilingual Contexts](#)
- [3. Vector Tile Generation and WebGIS Optimization using MapLibre and PostGIS](#)
- [4. Deep Learning techniques for Land Use Land Cover \(LULC\) Classification Using Sentinel-2 Imagery](#)
- [5. PostGIS for Spatial Data Management and Analytics in Environmental Applications](#)
- [6. Design Patterns for Rule-Based and AI-Enhanced Decision Support Systems \(DSS\) in Social Sector Applications](#)
- [7. Open Source GIS for Forest and Tribal Resource Management](#)
- [8. Data Governance and Provenance Models for Geospatial AI Systems](#)



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