Problem Statement

"To analyze the role of El Niño in influencing groundwater level changes in Chennai, identify areas prone to water loss, and propose solutions for sustainable water management using satellite imagery and data analytics."

Plan to Build the Project

1. Understand the Scope

- **Objective** : Investigate El Niño's impact on Chennai's groundwater levels and locate regions with high water retention potential.
- **Key Deliverables** :
- Correlation between El Niño patterns and groundwater fluctuations.
- Identification of water-saving potential zones using satellite data.

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2. Where to Find Datasets

- **Groundwater Data** :
- Central Groundwater Board of India (CGWB).
- Open Government Data (OGD) platform of India.
- Tamil Nadu Water Supply and Drainage (TWAD) Board.

- **Climatic and Oceanic Data** :
- National Oceanic and Atmospheric Administration (NOAA) El Niño datasets.
- India Meteorological Department (IMD).
- **Satellite Imagery** :
- Sentinel-2 from Copernicus Open Access Hub.
- Landsat 8/9 from the USGS Earth Explorer
- **Hydrological Maps** :
- Bhuvan (ISRO's Geoportal).
- OpenStreetMap for regional mapping.
- **Supplementary Data** :
- Urban layout from Chennai Corporation.

Methodology

A. Data Collection

- Fetch historical climatic and groundwater data for Chennai (5–10 years).
- Download satellite imagery of Chennai for dry and wet seasons.
- Collect El Niño indices (e.g., ONI - Oceanic Niño Index).

B. Data Preprocessing

- Clean and normalize the data (removal of missing values, handling outliers).
- Align temporal data from different datasets to ensure consistency.
- Perform georeferencing on satellite imagery.

C. Analysis Modules

1. **Correlation Analysis** :

- Use statistical techniques (e.g., Pearson correlation) to find links between El Niño events and groundwater levels.

1. **Satellite Image Processing** :

- Employ Google Earth Engine (GEE) or QGIS for image analysis.
- Calculate NDWI (Normalized Difference Water Index) to identify water bodies.

- Use supervised/unsupervised classification algorithms to map water-retention areas.

1. **Groundwater Modeling** :

- Train machine learning models (e.g., Random Forest, XGBoost) to predict groundwater level variations based on climatic parameters.

D. Optimization and Insights

- Use geospatial data analysis to identify vulnerable areas prone to water loss.
- Generate heatmaps of water scarcity and retention zones.

E. Visualization and Reporting

- Develop an interactive dashboard using tools like Power BI, Tableau, or Plotly to:
  - Display changes in groundwater levels over time.
  - Highlight water-saving potential zones.
  - Show El Niño patterns in an accessible format.

Modules/Algorithms/Functionalities/Protocols

1. **Modules** :

- Data Collection: APIs and databases for climatic and satellite data.
- Data Processing: Scripts for cleaning and normalization.
- Analysis: Geospatial and statistical analysis tools.
- Visualization: Dashboards with interactive maps.

1. **Algorithms** :

- NDWI for water body detection from satellite images.
- Correlation algorithms (Pearson, Spearman).
- Machine Learning algorithms (Random Forest, XGBoost).

1. **Functionalities** :

- Fetch real-time data updates from meteorological APIs.
- Generate groundwater level prediction models.
- Display dynamic maps for water retention analysis.

1. **Protocols** :

- Follow Open Geospatial Consortium (OGC) standards for spatial data.
- Adhere to FAIR data principles (Findable, Accessible, Interoperable, Reusable).

Proposed System

1. **Input** :

- Groundwater level data.
- El Niño indices.
- Satellite images (Sentinel, Landsat).

1. **Processing** :

- Data cleaning, transformation, and geospatial alignment.
- Correlation and statistical analysis for patterns.
- Satellite image classification for water zones.

1. **Output** :

- Interactive maps of water retention zones.
- Statistical reports correlating El Niño with groundwater changes.
- Recommendations for water-saving strategies.