School Site Selection Using Spatial Analysis

Project: Spatial Data Analysis - Homework 1
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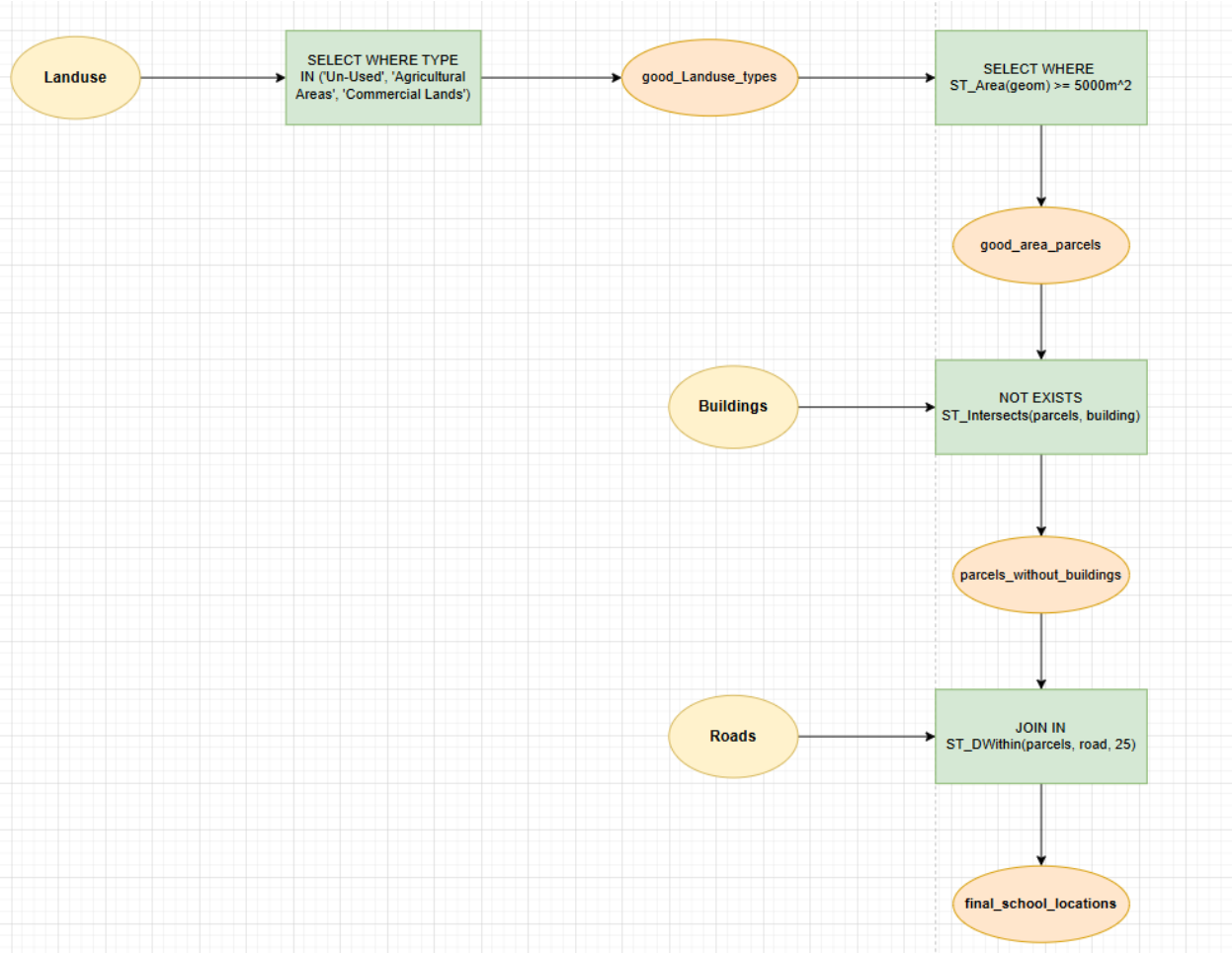

Executive Summary

This project identifies suitable locations for new school construction using PostGIS spatial analysis and QGIS visualization. From 140 initial land parcels, **7 suitable sites** were identified totaling **52,779.20 m²** through systematic application of four selection criteria.

Key Results:

- 7 suitable parcels identified (5% success rate)
- Average parcel size: 7,539.89 m²
- 85.7% of sites directly adjacent to roads

- Mix of un-used (71.4%) and agricultural lands (28.6%)

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1. Introduction

1.1 Objectives

Identify suitable land parcels for school construction using multi-criteria spatial analysis in PostGIS with the following requirements:

1. Land use types: Un-Used, Agricultural, or Commercial
2. Minimum area: 5,000 m²
3. No existing buildings on parcels
4. Within 25m of nearest road

1.2 Tools and Technologies

- **PostgreSQL + PostGIS** - Spatial database and analysis
- **QGIS 3.16+** - Geographic visualization
- **SQL** - Query development

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2. Data and Study Area

2.1 Database Schema

Landuse Table (Primary dataset)

- `idd` - Primary key
- `type` - Land use classification
- `area` - Parcel area (m²)
- `geom` - Polygon geometry

Buildings Table

- `idd` - Primary key
- `geom` - Building footprints

Roads Table

- `idd` - Primary key
- `name` - Road name
- `geom` - Road centerlines

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3. Methodology

3.1 Analysis Workflow

```
Initial Landuse (140 parcels)
        ↓
① Land Use Type Filter → 140 parcels
        ↓
② Area ≥ 5000 m² → 23 parcels
        ↓
③ No Buildings → 17 parcels
        ↓
④ Road Proximity ≤ 25m → 7 parcels (FINAL)
```

3.2 Sequential Filtering Approach

Each criterion progressively narrows the candidate set, ensuring all requirements are met while optimizing query performance.

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4. Selection Criteria

Criterion 1: Land Use Type

Requirement: Un-Used, Agricultural Areas, or Commercial Lands

```
WHERE type IN ('Un-Used', 'Agricultural Areas', 'Commercial Lands')
```

Result: 140 parcels retained

Criterion 2: Minimum Area

Requirement: Area ≥ 5,000 m²

```
AND ST_Area(geom) >= 5000
```

Result: 23 parcels (83.6% eliminated)

Criterion 3: No Buildings

Requirement: No building footprints intersecting parcels

```
AND NOT EXISTS (
```

```
    SELECT 1 FROM buildings b
    WHERE ST_Intersects(l.geom, b.geom)
)
```

Result: 17 parcels (26.1% eliminated)

Criterion 4: Road Proximity

Requirement: Within 25m of nearest road

```
AND EXISTS (
    SELECT 1 FROM roads r
    WHERE ST_DWithin(l.geom, r.geom, 25)
)
```

Result: 7 parcels (58.8% eliminated)

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5. Technical Implementation

5.1 Complete SQL Query

```
-- Final query applying all criteria
CREATE TABLE final_school_locations AS
SELECT
    l.idd,
    l.type,
    l.owner,
    l.area,
    l.geom,
    ST_Area(l.geom) as calculated_area,
    (SELECT MIN(ST_Distance(l.geom, r.geom))
     FROM roads r) as distance_to_nearest_road
FROM
    landuse l
WHERE
    -- Criterion 1: Land use type
    l.type IN ('Un-Used', 'Agricultural Areas', 'Commercial Lands')

    -- Criterion 2: Minimum area
    AND ST_Area(l.geom) >= 5000

    -- Criterion 3: No buildings
    AND NOT EXISTS (
        SELECT 1
        FROM buildings b
        WHERE ST_Intersects(l.geom, b.geom)
    )

    -- Criterion 4: Road proximity
```

```
    AND EXISTS (
        SELECT 1
        FROM roads r
        WHERE ST_DWithin(l.geom, r.geom, 25)
    )
ORDER BY
    ST_Area(l.geom) DESC;

-- Add primary key and spatial index
ALTER TABLE final_school_locations ADD PRIMARY KEY (idd);
CREATE INDEX idx_final_sites_geom ON final_school_locations USING
GIST(geom);
```

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6. Results and Analysis

6.1 Filtering Progression

Step	View Name	Count	Criteria Applied
1	`suitable_landuse_types`	140	TYPE IN (Un-Used, Agricultural, Commercial)
2	`suitable_area_parcels`	23	ST_Area(geom) ≥ 5,000 m²
3	`parcels_without_buildings`	17	NOT ST_Intersects with buildings
4	`final_school_locations`	7	ST_DWithin roads 25m

Overall Reduction: 95.0% (140 → 7 parcels)

6.2 Final School Sites

ID	Land Use Type	Area (m²)	Distance to Road (m)
20	Agricultural Areas	9,935.86	0.00
131	Un-Used	8,247.02	0.00
215	Un-Used	7,981.13	0.00
8	Un-Used	7,283.46	0.00
145	Un-Used	7,214.55	0.00
11	Un-Used	6,255.88	14.22
17	Agricultural Areas	5,861.30	0.00

6.3 Summary Statistics

Area Analysis:

- Total Area: 52,779.20 m²
- Mean: 7,539.89 m²
- Minimum: 5,861.30 m²
- Maximum: 9,935.86 m²

Distance to Roads:

- Mean: 2.03 m
- Sites adjacent to roads: 6 (85.7%)
- Maximum distance: 14.22 m

Land Use Distribution:

Land Use Type	Count	Total Area (m²)	Percentage
Un-Used	5	36,982.04	71.4%
Agricultural Areas	2	15,797.16	28.6%
Total	**7**	**52,779.20**	**100%**

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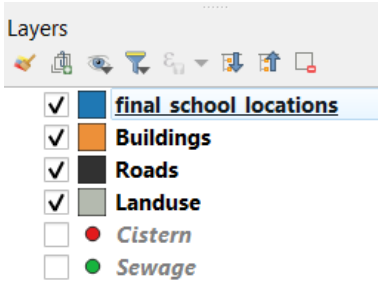
7. QGIS Visualization



7.1 Loading Data in QGIS

Method 1: Direct PostGIS Connection

1. Layer → Add Layer → Add PostGIS Layers
2. Create connection to database
3. Select `final_school_locations` table
4. Add to map

Method 2: DB Manager

1. Database → DB Manager → PostGIS
2. SQL Window → Execute query
3. Check "Load as new layer"

7.2 Map Styling

Final School Sites:

- Fill: Green (#4CAF50), 60% opacity
- Outline: Dark Green (#2E7D32), 1.5pt
- Labels: Site ID and area

Supporting Layers:

- Roads: Gray lines (1.5pt)
- Buildings: Red outlines (0.5pt)
- 25m Road Buffer: Blue dashed (40% opacity)

7.3 Map Layout Elements

- Title: "Suitable School Sites Analysis"
- Legend with all layers
- Scale bar and north arrow
- Data sources and projection info
- Results summary table

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8. Conclusions and Recommendations

8.1 Summary

Successfully identified **7 suitable parcels** totaling **52,779 m²** through rigorous spatial analysis. All sites meet the four selection criteria and are development-ready with excellent road access.

8.2 Immediate Next Steps

1. **Site Verification** - Field visits to all 7 sites

2. **Environmental Assessment** - Phase I environmental studies
3. **Cost Analysis** - Land appraisals and development estimates
4. **Stakeholder Engagement** - Community consultation and owner contact

8.3 Future Enhancements

Additional Analysis:

- Multi-criteria decision analysis (MCDA) with weighted criteria
- Cost-benefit analysis integration
- Student population density mapping
- Environmental constraints (slopes, flood zones)
- Traffic and accessibility modeling

Data Improvements:

- Property values and ownership details
- Existing school locations and capacity
- Demographic and enrollment projections
- Utility infrastructure availability

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END OF REPORT