A METHOD FOR ANALYZING CHANGES IN THE URBAN FRINGE:
ALBANY, OREGON, 1936-1975

by

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A METHOD FOR ANALYZING CHANGES IN THE URBAN FRINGE:
ALBANY, OREGON, 1936-1975

ABSTRACT: A method for analyzing growth of an urban area is developed. Albany, Oregon, from 1936 to 1975 was used as a test case. The method employs the use of remotely sensed imagery combined with an analysis of selected physical characteristics of the land being urbanized. The study consists of an urbanizing boundaries map, a map showing land capability classes, and an analysis of changes observed in the urbanizing pattern. The amount of areal expansion is measured, the trend of urbanization noted, and limitations to future growth discussed.

STATEMENT OF PURPOSE
The purpose of this study is to develop a method for analyzing historical changes in the urbanizing area of a place. The method provides a tool for assessing spatial change and for quantifying that change. The intent of the study is to provide assistance in predicting future spatial changes, given similar conditions. A city for which aerial photography was available over a period of several decades was chosen as a test case.

THE METHOD OF ANALYSIS
Sequent changes in urban fringes can be determined by inspection of remotely sensed imagery taken at intervals. By mapping, comparing, and measuring the boundary changes between urban and non-urban land
used the extent of spatial alteration can be quantified. Further
analysis of the land characteristics, specifically, land capability
classes, limitations for dwellings without basements and septic tank
performance, and floodplain constraints, over which the urbanization
is moving, using soils and floodplain data yields valuable information
for use by the land use planner.

Remotely Sensed Imagery

All available imagery for an area under study should be considered.
Early coverage will probably consist of aerial photographs while more
recent coverage will include high flight and satellite images. Imagery
can be obtained from local government offices, state and federal agencies
located in the area, or from the national repository for both air- and
spacecraft imagery.

In choosing the imagery to use, cost, accessibility in terms of
available time, and equipment required for use of the imagery should
be considered.

Soils and Flood Plain Data

The U. S. Soil Conservation Service (SCS) and the Army Corps of
Engineers both readily supply detailed information regarding soils and
floodplains for use in analyzing the characteristics of the affected
landscape. Other local agencies can supply data of varying detail and
should not be overlooked in the search for useful data.

STUDY AREA

Choosing the Test Case

Albany, Oregon, a nearby city of approximately 30,000 people, was
chosen as the test case. Its size indicated a limited area for analysis
that was appropriate to the time frame. Its nearness enabled frequent trips for use of imagery and facilities at the local agencies and for developing ground truth. But the most important consideration in the selection was the existence of aerial photographs for a thirty-nine year period from 1936 to 1975. Other flights in 1948 and 1967 provided data at fairly regular intervals.

Study Area Described

The urbanizing area of Albany, Oregon, straddles a meander of the Willamette River which separates two counties. It is located between mile 116 and mile 120 (between 186 km and 193 km) from the mouth of the Willamette River which flows north into the Columbia River. The core area of the city, in Linn County, lies at an elevation of 200 feet (61 m) mean sea level on the right bank, approximately 35 feet (10.7 m) above river level. The land slopes upward to 235 feet (71.6 m) elevation at the southern edges of the city as it existed in 1975. On the left bank of the river North Albany, a suburb in Benton County, rises from 180 feet (55 m) elevation at the river to more than 400 feet (122 m) just north of Thornton Lake. Most of the North Albany portion of the study area is relatively low-lying, 200 feet (61 m) elevation or less. The land surrounding the study area is relatively flat and supports farming and some grazing. Boundaries of the study area were determined by the extent of urbanization in 1975.

METHODOLOGY OF BOUNDARY DETERMINATION

A map showing urbanizing boundaries was compiled from aerial photographs taken in 1936, 1948, 1967, and 1975 using the similar squares method of transfer from the photos to a clear mylar surface
overlaying a base map. The actual boundaries were drawn on the mylar overlay with colored pencil, resulting in easily differentiated data by year. The final map shows changing boundaries with various types of broken lines (Fig. 1).

**Aerial Photograph Sources**

The photographs used in this study were obtained from the following agencies:

Agricultural Stabilization and Conservation Service (ASCS), Albany, Oregon, 1936 series at a scale of 1:4,800;

ASCS, Corvallis, Oregon 1948 series for the Benton County portion of the study area at a scale of 1:4,800;

Linn County Surveyors Office, Albany, Oregon, 1948 series for the Linn County portion, scale of 1:4,800;

Linn County Surveyors Office, Albany, Oregon, 1967 series, scale of 1:12,000; and

Linn County Surveyors Office, 1975 series, scale of 1:48,000.

Other sets of imagery were available from the above agencies, from the Linn County Engineers Office, and from the Environmental Remote Sensing Applications Laboratory located on the Oregon State University campus. After analysis of coverage extent, and year and scale of imagery, the above flights were determined to be the most comprehensive, at somewhat similar scales, included the earliest and latest imagery available, with a minimum number of different scales. The last factor was important both in reducing the amount of work necessary and in attaining maximum accuracy during data transfer.

**Base Map**

A base map was constructed of portions of four United States
Fig. 1 The Urbanizing Fringes, Albany, Oregon, 1936-1975
Geological Survey (USGS) 7 1/2 minute quadrangles (scale of 1:24,000): Albany (1970), Lewisburg (1970), Riverside (1969), and Tangent (1969). These were carefully cut, fitted, and taped together to form a sheet large enough to work with comfortably. The scale allowed considerable detail but reduction of the finished product was later required. The trade-off between ease of working and reproduction expenses should be carefully assessed at the beginning of the project.

Quarter-Mile Mylar Grids

A quarter mile (0.4 km) grid was carefully constructed with ink on clear mylar at a scale of 1:24,000, resulting in a pattern covering 30 square miles (77.7 square km), each divided into 16 squares. The grid was centered over the courthouse and taped, inked-side to the back, to the working base map. This resulted in a completely cleanable surface for the original work. The importance of this should not be underestimated for ease in making corrections while at the same time retaining the grid lines.

Quarter mile (0.4 km) grids at the scales of the different photograph series were constructed on clear acetate using the courthouse in the photographs as the central reference point. Hwy 20 and Hwy 99E served as additional reference points. Centering on the courthouse proved to be a problem for the 1936 photographs as the courthouse had not yet been built. However, a park occupied the future site and its center was used.

Boundary location transfer was done by eyeball estimation of the lines on the photograph grid and on the base map overlay grid. Although unsophisticated, this procedure worked out satisfactorily with only occasional difficulty in line placement.
Two types of tracing paper were tried as substitutes for the mylar and acetate and were found to be very easily torn during the data transfer process and subject to distortion from heat and/or humidity changes. Further, because of their opaqueness a light table was required for ease of picking out structures on the photos. However, the heaviness of the paper on which the photos were printed prevented light from being an effective aid. Thus, the use of tracing paper was abandoned.

Determination of Urban Fringe

The urbanizing boundaries were determined using the U. S. Census definition of urbanized which is 1,000 inhabitants per square mile (2.6 km$^2$) or by urban usage of land. For ease in working with the definition, houses were counted using the 1970 Census figure of 3.25 persons per household in the urban fringe. Calculated out, this resulted in 307.69 houses, rounded off to 308, per square mile required for urbanization to have taken place. To further facilitate the process the number of houses per square (16 squares per square mile) on the quarter mile grid was calculated to be 19.25. The question of boundary line location then became one of counting dwellings and drawing the boundary line to include only those areas meeting the above criterion. On the east side of the city where the airport and a regional park exist and north along the right bank of the Willamette River where industrial development precludes dense residential area, the boundaries were determined by those urban functions. Bryant Park, west of the Calapooia River, was included as part of the urban area because of its proximity and service to the urban area.
Measuring Area Changes

A grid measuring one inch square (6.5 cm²) and divided into tenths of an inch was used to measure areal changes in urbanizing boundaries. The grid, on standard-sized paper (8 1/2 x 11 inches or 21.6 cm x 27.9 cm) was taped to the underside of the mylar overlay showing the boundary lines and areal extent determined by counting the number of squares involved for each succeeding boundary. The number of squares (in square tenths of an inch) were converted to square inches, then multiplied by a factor of .1435 square miles. This is the amount of surface area of land represented by 1 square inch at a scale of 1:24,000 of the base map/mylar overlay. The resulting number was then multiplied by 640 acres per square mile (Table 1). The city of Albany and the suburb of North Albany were calculated separately because of the differential in their growth rates.

FINDINGS: BOUNDARY CHANGES

1936

Albany's urban area (Fig. 1) in 1936 consisted of 892 acres (368 ha) bounded on the north by the right bank of the Willamette River and on the west, except for Bryant Park, on the right bank of the Calapooia River. The southern boundary was uneven, showing growth along new streets southward and evidence of leapfrogging in one area, although in 1936 this urbanized parcel was connected for a short distance to the main part of the city. The eastern edge was a generally north-south line approximately 2 blocks east of Greary Street. North Albany contained only a small area, 18 acres (7 ha), of residential buildings.

1948

In 1948 growth continued southward along the right bank of the
Table 1. Changes in Urbanized Area, Albany, Oregon, 1936-1975

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Area</th>
<th>Acres</th>
<th>Hectares</th>
<th>% of Urbanized Area</th>
<th>Increase in Area</th>
<th>Average Growth in Acres per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1936</td>
<td>910</td>
<td>368</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Albany</td>
<td>18</td>
<td>7</td>
<td></td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albany</td>
<td>892</td>
<td>361</td>
<td></td>
<td>98.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1948</td>
<td>1,458</td>
<td>590</td>
<td></td>
<td></td>
<td>160.1</td>
<td>45.6</td>
</tr>
<tr>
<td>North Albany</td>
<td>18</td>
<td>7</td>
<td></td>
<td>1.3</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Albany</td>
<td>1,439</td>
<td>582</td>
<td></td>
<td>98.7</td>
<td>161.4</td>
<td>45.6</td>
</tr>
<tr>
<td>1967</td>
<td>4,205</td>
<td>1,702</td>
<td></td>
<td></td>
<td>288.5</td>
<td>144.6</td>
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<tr>
<td>North Albany</td>
<td>313</td>
<td>127</td>
<td></td>
<td>7.4</td>
<td>1,702.2</td>
<td>15.5</td>
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<tr>
<td>Albany</td>
<td>3,891</td>
<td>1,575</td>
<td></td>
<td>92.6</td>
<td>270.4</td>
<td>129.1</td>
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<tr>
<td>1975</td>
<td>5,730</td>
<td>2,319</td>
<td></td>
<td></td>
<td>136.3</td>
<td>190.7</td>
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<tr>
<td>North Albany</td>
<td>684</td>
<td>277</td>
<td></td>
<td>11.9</td>
<td>218.4</td>
<td>46.4</td>
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<tr>
<td>Albany</td>
<td>5,046</td>
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<td></td>
<td>88.1</td>
<td>129.7</td>
<td>144.7</td>
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Increases During Study Period

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Area</th>
<th>Acres</th>
<th>Hectares</th>
<th>% of Urbanized Area</th>
<th>Increase in Area</th>
<th>Average Growth in Acres per Year</th>
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<tbody>
<tr>
<td>Total Area</td>
<td>4,820</td>
<td>1,951</td>
<td></td>
<td></td>
<td>629.5</td>
<td>123.6</td>
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<tr>
<td>North Albany</td>
<td>666</td>
<td>270</td>
<td></td>
<td></td>
<td>3,718.4</td>
<td>17.1</td>
</tr>
<tr>
<td>Albany</td>
<td>4,154</td>
<td>1,681</td>
<td></td>
<td></td>
<td>565.8</td>
<td>106.5</td>
</tr>
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</table>

1 Figures are for the intervals between data years, except for the summary data in the last section which cover the entire period.
Calapooia, the southern boundary extended unevenly but smoothed the irregular line of the earlier outlier parcel. New detached development occurred on the southeast side and to the east while the core area expanded eastward. North Albany development remained static. The gain in urban area was 547 acres (221 ha), making a total of 1,458 acres (590 ha) of urbanized land.

1967

By 1967 the urban area had increased considerably. On the south side residential area built up east of the Calapooia River and west of the Southern Pacific Railroad. A significantly large area also developed beginning approximately 1 mile (1.6 km) east of the railroad and to the south of the core area of the city. Two areas of leapfrogging occurred to the southeast of the city. Between 1948 and 1967 the airport and adjacent Timber Linn Memorial Park were established on the east side of town. In addition, a heavy industrial complex developed to the north along the Willamette River. An area known as Draperville appeared about a mile to the east along Knox Butte Road. Total gain in area was 2,452 acres (992 ha).

The original urbanized area in North Albany increased approximately 100 percent in 1967. Further increases occurred in three island areas one of which includes a golf course. The gain in area was 295 acres (119 ha) or an increase of 1,702 percent.

1975

By July 1975 the southern margins of the urbanizing area were smoothed out by industrial development. Housing filled in a large area southeast of the core, overtaking the closer of the two 1967 growth
islands. The further island increased in size about 50 percent. No noticable expansion occurred on the east or north sides. The North Albany area increased considerably, amalgamating the three 1967 islands into one unit while leaving the original area isolated. Albany and North Albany gained 1,154 acres (467 ha) and 371 acres (150 ha), respectively. Total urbanized area amounted to 5,730 acres (2,319 ha) in 1975.

PATTERN OF INCREASES IN URBANIZATION

In 1936 the urban area consisted of 892 acres (368 ha) adjacent to the Willamette River. From there the city grew steadily southward and eastward with expansion northward along the right bank of the Willamette River after 1948. Initially, the city grew outward in all directions although eventually the Calapooia River began functioning as a barrier to westward expansion. North Albany developed slowly until after 1948, when the area began to undergo rapid urbanization; by 1975 it had increased in area by 3,718 percent. Albany and North Albany developed at distinctly different rates throughout the thirty-nine year period of the study (Fig. 2).

Three trends of future increase in residential or urbanizing area can be identified: 1) southward from the present urbanized area along Hwy 99E; 2) southeastward along Grand Prairie Road, following in the path of existing isolated development; and 3) in North Albany.

The area east of the Willamette and north of the city, designated for heavy industry in the current Albany Comprehensive Plan will exert considerable pressure against further residential fill-in in that area, although expansion of industry into that area will move the actual
Fig. 2. Increases in Urbanization, Albany, Oregon, 1936-1975
urbanized boundary northward. Eastward expansion will be thwarted by the low elevation of the territory and its propensity to sheet flooding during times of high water.

Pressure on the urbanizing fringes will be relieved to a certain extent by build-up of residential area along the county roads west of the Calapooia. However, this agricultural area should remain essentially rural in character. Its separation from the city by the Calapooia floodplain will tend to keep the area from joining the present urbanized area.

SELECTED CHARACTERISTICS OF AFFECTED LAND

Several land characteristics, of the many described by others, seemed significant as determinants of land use, past and future. Considered here are land capability by class, ratings for dwellings without basements and for septic tank limitations, and flooding constraints.

Land Capability Classes

The capability classes of soils as defined by the Soil Conservation Service (SCS) refer to the suitability of the soil for agricultural uses. However, in many instances, soils well-suited for agriculture are also well-suited for urban purposes. The SCS identifies eight capability classes of successively greater limitations. Of the eight classes the first four have the greatest capability for cropping. Classes V through VIII are usually limited to pasture, range, woodland, or recreation uses. Of the eight classes all but V and VII exist in the study area.

A land capability map was compiled for the study area from information obtained from the Tangent, Oregon, Field Office of the SCS (Fig. 3). The map showed the study area to be almost entirely made up of class I, II, III, and IV land. Only small areas along the rivers were of classes
Fig. 3 Land Capability Classes, Albany, Oregon Metropolitan Area
VI and VIII. Inspection of the Land Capability Class map reveals that large portions of the land either already urbanized or in the path of expansion is of a very mixed character. These areas, shown with screen overlaying the basic pattern, consisted of II, III, or IV class land with dense island patterns of another member of the same three classes. In practical terms, this means those areas are quite difficult to categorize except at a scale larger than the scope of this study.

Soil Ratings for Development

From data obtained from the SCS Field Office in Tangent, Oregon, working maps showing ratings of soils for suitability for dwellings without basements and for septic tank limitations were compiled.

SCS rates conditions as slight, moderate, or severe. A rating of slight means that little or no adjustments are needed for the designated use and that no limitations are indicated. A moderate rating means that soil limitations can be overcome by engineering technology. A severe rating means that there are serious limitations for the intended use.

Dwellings without basements. Estimation from the working map indicated soils in the study area were rated as severe for approximately 60 percent of the area. Only very small, widely scattered areas were rated as having slight limitations, perhaps only 5 percent.

The core area of the present urbanized zone and southward are particularly unsuited for dwellings due to the predominately severe rating. North Albany, in most of the growth areas, is rated as having moderate limitations.

Septic tank limitations. Septic tank limitations are even more restrictive with very large portions of the study area, 75 to 80 percent,
rated severely. Again, only a few widely scattered islands of slightly rated soils appear.

The city is sited almost entirely upon severely rated soils which indicates the importance of the sewage treatment plant. The plant came into use in 1952 and was remodeled in 1968 to attain tertiary treatment capability. From 1885 to 1952 a primitive system consisting of an underground network of pipes funneled the wastes directly into the Willamette River.

Flooding Constraints

Rainfall over the study area is approximately 40 inches (101 cm) annually, occurring mostly during the late fall, winter, and spring seasons. The soils, except in bottom lands are often clayey and heavy. The combination of precipitation and soil characteristics results in a tendency toward poor drainage and waterlogging. Overland flow results, particularly in those areas where tributaries flow almost parallel to the Willamette River.

Large portions of the built up area in North Albany are subject to 100 year flooding (Intermediate Regional Flood), that is, flooding that has a 1 percent chance of occurring in any given year. The right bank of the Willamette River and portions of the tributaries near the river are also subject to 100 year floods. Much larger areas, particularly in North Albany, are subject to the Standard Project Flood, one resulting from the worst possible combination of meteorological and hydrological conditions.

IMPACT OF SELECTED LAND CHARACTERISTICS ON DEVELOPMENT

The Albany urbanized area developed on land suited for agriculture
and at the same time easily developable because the slope is slight. All three potential growth areas, south and southwest of the present city and North Albany, are suitable for agriculture according to SCS capability classification. Thus conflict between preservation of a limited resource, agricultural land, and the needs of a growing population will emerge.

Limitations for dwellings without basements can be modified through engineering technology but the potential for property loss from wetness and other associated constraints definitely exists for occupants of affected areas.

Septic tank limitations in most of the expansion paths are rated as severe. Hookups to sewage treatment facilities should be required before new residences are allowed.

Floodplain constraints and potential losses from flooding appear to be greatest in the North Albany area.

CONCLUSIONS

The use of remotely sensed imagery in the analysis of changing urban boundaries seems, from this study, to meet the criteria of being fairly simple yet effective. The method can incorporate much more sophisticated procedures, equipment, and materials if available. The use of SCS data and floodplain information for formal analysis of limitations to urbanization is also effective, as was expected.

The use of this method for analysis of the Albany, Oregon, urbanizing situation showed that severe limitations occur in all the areas of probable future expansion.

What all this means is that care must be taken in the selection of
development sites if potential property loss is to be held to a minimum. The reality of the situation decrees that agricultural land will be developed into urbanized area but this can be tempered by careful planning and a commitment to the plan instead of random development moving roughshod over the landscape, as it appears to have done in the past.

FUTURE RESEARCH

It is suggested that more work be done in the area of mapping the various SCS-developed limitations for comparative purposes. It would seem that a capability class system, similar to that used by SCS for agricultural land could be developed for the same land but emphasizing characteristics important to urbanizing development.
FOOTNOTES


6 Personal communication from Mike Corso, Albany Engineering office, 1976.

7 The Linn County Planning Department, Linn County Physical Characteristics and Optimum Land Utilization (Albany, Oregon: Linn County Planning Department, 1970), pp. 7-10.

8 The Linn County Planning Department, op. cit., footnote 7, pp. 38-42.