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WESTERN AGRICULTURAL ECONOMICS ASSOCIATION



# PROCEEDINGS

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# URBANIZATION OF LAND IN THE WESTERN WATER RESOURCE REGIONS

by

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## INTRODUCTION

Interagency surveys of the three westernmost water resource regions<sup>1</sup> provided both the need and opportunity for analysis of the quantity, quality, and location of land being taken for urban use in those areas. The overall purpose was to provide a basis for projecting urban land requirements in the regions. Specifically, the objectives were:

1. To measure the acreage of land converted to urban uses in the most recent period practicable.
2. To identify the prior use of land urbanized.
3. To relate quantities of land urbanized to population increases.

## PROCEDURES

The study attempted to identify and measure virtually all urbanization of land in the three water resource regions. A preliminary examination was made using airphoto index sheets (uncontrolled mosaics of airphoto prints) from the national file of the Agricultural Stabilization and Conservation Service (ASCS).

These index sheets (scale 1:63,360 or 1 inch to the mile), taken at two different points in time, were compared to identify changes in land use. Counties showing conversion of more than 50 acres per year to urban uses were selected for more intensive photo interpretation--49 counties in total. Of these, 15 were in the Columbia-North Pacific, 26 in the California, and 8 in the Colorado Water Resource Regions.

Four categories of rural land use and 7 of urban use were used:

### RURAL LAND

Cropland--row crops, close grown crops, hay orchards

Grassland--managed pasture and rangeland

Idle land--unused cropland

Forest--areas substantially covered by trees

### URBAN LAND USE

Dense residential--houses on small lots, town houses, apartments

Open residential--one house or less per acre

Institutional--schools, hospitals, government buildings

Commercial--mainly shopping centers

Industrial--factories, storage yards, auto graveyards, gravel pits

Recreational--parks, golf courses, drive-in theaters, race tracks

Airports

### TYPE AND AMOUNT OF URBANIZATION

Shifts to urban and associated uses in the Columbia-North Pacific Region were confined to three situations--the major metropolitan complexes of Portland and Seattle, medium-sized cities such as Spokane, and smaller centers such as Missoula and Idaho Falls with the greatest amount of change occurring in the large metropolitan areas. The California Region exhibited the same general pattern with shifts occurring in the metropolitan areas along the coast, around the inland cities, and around several smaller area centers. Again, the greatest amount took place in the metropolitan complexes. The California Region showed a higher proportion of dense residential development than did the other two regions.

Shifts within the Colorado Water Resource Region took place around cities ranging in size from 6,000 to 23,000 in addition to Phoenix and Tucson. (Photos were not available for Las Vegas.)

Overall, in the three water resource regions, about .15 acres of land were developed for commercial, industrial, institutional, recreational, and airport use for each acre going to residential use (table 1).

Table 1. Urbanization of Land by Type of Use

Urban Use	Water Resource Region			
	Columbia-North Pacific	California	Colorado	Total Western Regions
	(Percent)	(Percent)	(Percent)	(Percent)
Dense residential--	61.4	75.8	56.0	71.0
Open residential--	26.7	8.4	23.3	13.1
Industrial-----	7.7	5.7	4.3	5.8
Institutional-----	.3	4.4	3.7	3.7
Commercial-----	.9	3.0	7.7	3.3
Recreational-----	2.4	1.9	4.2	2.3
Airports-----	.6	.8	.8	.8
Total Urban	100.0	100.0	100.0	100.0

## PREVIOUS USE OF LAND

In the Columbia-North Pacific Region, land use prior to urbanization ranged from a high proportion of forest in the Seattle area to predominantly good farmland in the Idaho Falls area. About 53 percent of the shift took place on cropland and 27 percent on forest land (table 2). The remainder was about equally divided between grassland and idle.

In the California Region, over 80 percent of the urbanization took place on cropland, most of which was in intensively cultivated orchard and truck crops. Grassland of the dry-range type accounted for most of the remainder. Less than one percent occurred on idle land. Only Sonoma County showed any forest converted to urban use.

In the Colorado Water Resource Region, 71 percent of urban development occurred on cropland--for the most part irrigated and under intensive cultivation. The remainder occurred on what was categorized as grassland but much of which was near-desert.

For the three regions as a whole, about 76 percent took place on cropland and 18 percent on grassland. Only small percentages came from idle and forest categories.

### RELATIONSHIP TO POPULATION INCREASE

In order to explore relationships between population increases and urbanization of land, the photos were selected to encompass as nearly as possible the same years as the two most recent censuses of population, 1950 and 1960. Coverage was available from the ASCS for most of the counties for the periods 1948-54 and 1959-66. Airphoto coverage was obtained from commercial sources for a few areas where ASCS coverage was not available. Overall, census and airphoto coverage years had a 60 percent coincidence. Typically, the photos bracketed more years than the censuses.

For each additional person added to the population of the study area, an average .06 acres of land was converted to residential use and an additional .01 acres for other related urban uses--a total of .07 acres for all urban uses (table 3).

Table 2. Prior Use of Urbanized Land

Prior Use	Water Resource Region			
	Columbia-North Pacific	California	Colorado	Total West Coast
	(Percent)	(Percent)	(Percent)	(Percent)
Cropland	53.4	82.0	71.0	76.4
Grassland	9.3	17.1	28.5	17.6
Forest	26.8	.2	-	3.9
Idle	10.5	.7	.0	2.1
Total	100.0	100.0	100.0	100.0

Table 3. Land Use Shifts Per Capita Increase in Population

Water resource region	Acres residential use per capita	Acres all urban acres per capita
Columbia-North Pacific -----	.09	.10
California -----	.05	.06
Colorado -----	.10	.12
Total Western Regions	.06	.07

Commercial, industrial, institutional, and recreational uses of land are less likely to be directly related to population within a given county than is residential use. However, in the aggregate one would expect a fairly close relationship. Business and industry either go where clientele and labor are found or attract people to the area after they have been established.

The types of recreational uses identified in this study--golf courses, drive-in movies, etc.--are oriented to resident population. Some institutional uses such as colleges and mental hospitals may have a State or regional orientation. However, there are offsetting factors. One county may have a penitentiary while another hosts a university.

Individual counties showed substantial variation in relationship between urbanization of land and population increase. The Columbia-North Pacific varied from .04 acres per person in Snohomish County, Washington, to .28 acres in Marion County, Oregon. The Colorado Region varied from .05 acres in Pima County, Arizona, to .35 acres in Montrose County, Colorado. California showed a range from .02 acres in Monterey County to .18 acres in Ventura County. The California Region also had the extreme case of San Bernardino County with .43 acres per capita. This was considered to be atypical because many developments had been laid out but only partially built upon and was excluded from calculation of the tables and equations presented here. Generally the more populous counties evidenced lower rates.

Many factors have an influence on variation among counties in land taken for residential use. Zoning laws and subdivision regulations affect lot sizes. Topography may confine development to certain areas. Some counties have a higher proportion of their population living in apartment and row houses.

Also, there is some error inherent in using airphoto interpretation to measure urbanization. As an area becomes more highly urbanized, previously unused lots and other small tracts of land are built upon. Houses and garden apartments are sometimes razed and replaced by high-rise apartments. This can add to residential capacity but not be identifiable by airphoto interpretation. Individual houses built at scattered intervals along rural roads were not measured. The houses can be identified but the amount of land associated with each is nearly impossible to determine from airphotos.

Despite fairly wide deviations from the average relationship, simple correlations between land urbanized and population increases were quite high--.89 for both residential use and all urban uses.

Several other variables were explored as possibly explaining more of the variation among counties. In using multiple regression, the amount of land taken for residential use was best explained by two variables--absolute increase in population and percentage increase in population. Percentage increase was used as a proxy for stage of urbanization. As counties become more densely populated, annual percentage increase in population begins to decrease even while absolute annual increases are still large.

Using these two explanatory variables the following equation was established:

$$Y = 123.64 + 0.035 X_1 + 4.122 X_2 \quad (1)$$

(0.003)      (2.251)

where: Y = acres converted to residential use (average annual)

X<sub>1</sub> = number increase in population (average annual 1950 to 1960)

X<sub>2</sub> = percentage increase in population 1950 to 1960

Standard error of each coefficient shown in parentheses.

The R<sup>2</sup> was 0.80. T-values for the X<sub>1</sub> and X<sub>2</sub> variables indicate significance at the 1 percent and 10 percent levels respectively.

A regression was also run substituting land for all urban uses as the dependent variable. The resulting equation follows:

$$Y = 152.39 + 0.038 X_1 + 5.566 X_2 \quad (2)$$

(0.004)      (2.974)

where: Y = acres converted to all urban uses (average annual)

X<sub>1</sub> = number increase in population 1950 to 1960

X<sub>2</sub> = percentage increase in population 1950 to 1960

Standard error of each coefficient shown in parentheses.

The R<sup>2</sup> was 0.74. T-values for the two variables indicate significance at the 1 percent and 10 percent levels respectively.

### CONCLUSIONS

Significant quantities of land were converted to urban uses in the study areas during the period encompassed by the analysis. Of the land urbanized, about 60 percent went to dense residential use, 20 percent to open residential use, and smaller percentages to commercial, industrial, institutional, recreational, and airport uses.

Overall, some 70 percent of the land urbanized came from active cropland. Very little came from idle cropland. Highly productive irrigated land apparently is kept in production virtually up to the time of construction of houses, shopping centers, and factories.

The coefficients developed in the study appear to provide a general basis for projecting urban land uses. The average relationship of .07 acres per person could be useful as a general guide to planning in multi-county areas. More detailed analysis considering additional variables would be needed for precise planning, and to take account of such factors as local regulations, topography, and stage of urbanization. The model and coefficients have limitations for use at the county level, the large constant factors (123.64 and 152.39) making the equations unrealistic for treating expected population increases deviating greatly from the mean of 12,000 for the study counties. This might necessitate grouping or subdividing counties in some cases.

### FOOTNOTES

1. Columbia-North Pacific, California and Colorado Water Resource Regions. These include the States of Washington, Oregon, California, and Arizona, plus parts of Idaho, Montana, Colorado, New Mexico, Utah, Nevada and Wyoming.