TABLE 8-2

LIST OF VARIABLES

Dependent Variables
Land Value - assessed value per thousand square feet in 1985
Likelihood of development: 1976-85 - log of developed: 1 / Vacant: 0 in 1985

Policy Variables
Zoning - 0 (less intensive) to 8 (more intensive)
Floodplain elevation - required elevation above base flood, 1 (0 feet) to 5 (no development allowed)
Floodway elevation - required elevation above base flood, 1 (0 feet) to 3 (no development allowed)
Program implementation - 0 (no lead department or individual) to 2 (both a lead department and oversight individual)
State/regional regulatory program - yes (1) or no (0)

Control Variables
Flood hazard
    Hazard on parcel - composite with range of 1 (little hazard) to 12 (extreme hazard)
    Flood history - recent flooding in city, 0 (none during study period) to 3 (2 floods, one within 5 years)
City growth - percentage population growth, 1975 - 1985
City income - median family income (thousand dollars), 1980
Parcel size - thousand square feet, 1976
Accessibility
    Road frontage - feet in 1976 (estimate)
    Thoroughfare adjacent - yes (1) or no (0), 1976 (estimate)
    Thoroughfare distance - (thousand feet), 1976 (estimate)
    Interchange distance - (thousand feet), 1985
    Central business district distance - (thousand feet), 1985
    Shopping distance - closest regional shopping center (thousand feet), 1985
Open space adjacent - yes (1) or no (0), 1985
Sewer - available, yes (1) or no (0), 1985
Neighborhood characteristics
    Neighborhood income - median family income (ratio of census tract/city, 1980)
    Neighborhood education - percentage with high school education (ratio census tract/city), 1980

Most of the other control variables are self-explanatory, but we should note that we measured accessibility and parcel characteristics directly from maps, rather than in the field. For several of the control variables (parcel size, road frontage, and thoroughfare adjacency) we estimated the conditions we believed to exist on January 1, 1976. For other accessibility variables, we measured current distances to facilities and assumed they were the same throughout the study period. Schools, open space, and shopping centers were included only if they were open in 1980, the mid-point of the study period.

Methods of Statistical Analysis

Different statistical methods and different subsets of the parcel sample were used to evaluate each of the dependent variables listed in Table 8-2. We explored the relationship between the control and policy variables and the assessed land value of floodplain parcels with multiple regression; however, we used a logistic regression model to examine the second dependent variable--the likelihood of development. Logistic regression can be used with a dichotomous variable (whether or not a parcel develops) and is useful for identifying the factors that predict whether a parcel will develop.

The Value of Vacant Land

We examined three hierarchical regression models of land value and the policy and control variables. The first step was to develop a model which explained variation in land values due to the control variables. Next, we added measures of the flood hazard to that model, and finally we added the floodplain management policy variables. The results of the final, full model are shown in Table 8-3.

The Control Variables

We used the first variable listed, city income, to control for the differences in the average land value among the ten communities. The median family income of each of the ten cities had a significant affect on the value of vacant land: a $10,000 increase in median family income produced a $515 increase in land value per thousand square feet. Six parcel characteristics had a statistically significant effect on land value; they are listed below in order of the magnitude of standardized regression coefficients.

1) Parcel size--land value per thousand square feet for a half acre lot is $130 less than for a quarter acre lot.

TABLE 8-3

REGRESSION OF LAND VALUE ON CONTROL AND POLICY VARIABLES FOR VACANT LAND ZONED FOR RESIDENTIAL USE

DEPENDENT VARIABLE: Assessed land value per thousand square feet

Independent Variables	Coef-ficient	Std Error	Std Coeff	Proba-bility
Control Variables				
City income	51.46	6.02	0.471	**
Parcel size[a]	-188.05	19.53	-0.495	**
Road frontage	0.04	0.05	0.032	ns
Frontage on major road	240.72	84.77	0.117	**
Distance to major road	- 7.46	14.13	-0.021	ns
Distance to interchange	- 5.94	3.01	-0.074	*
Distance to CBD	3.48	1.81	0.165	*[b]
Distance to regional shopping	5.42	2.75	0.103	*
Adjacent open space	244.80	88.99	0.094	**
Neighborhood education level	671.06	197.92	0.162	**
Flood history	-162.76	33.32	-0.258	**
Policy Variables				
Zoning	95.01	14.07	0.228	**
Floodplain elevation	- 5.93	5.53	-0.049	ns

TABLE 8-3 - continued

REGRESSION OF LAND VALUE ON CONTROL AND POLICY VARIABLES FOR VACANT LAND ZONED FOR RESIDENTIAL USE

DEPENDENT VARIABLE: Assessed land value per thousand square feet

Independent Variables	Coef-ficient	Std Error	Std Coeff	Proba-bility
Floodway elevation	5.97	9.63	0.022	ns
Program implementation	- 70.46	53.89	-0.083	ns
State/regional program	59.01	82.54	-0.039	ns
Constant	-669.56	284.29	0.000	*

Adjusted R^2 = .527
N = 498

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* = signficant at 95% confidence level.

** = significant at 99% confidence level.

[a]Log (parcel size).

[b]Direction of effect as hypothesized so 1 tail test applied.

2) CBD distance--land value increased $19 for each mile of distance ($3.48/1000 feet).

3) Location adjacent to a thoroughfare--parcels were valued $241 per thousand square feet higher than parcels not adjacent to a thoroughfare, but for parcels that were not adjacent the distance to the thoroughfare did not affect land value.

4) Proximity to a regional shopping center--land value increased $29 for each mile of distance.

5) Location adjacent to open space--land value increased by $245 per thousand square feet over properties not adjacent to open space.

6) Proximity to a highway interchange--land value decreased by $31 per mile from an interchange.

Access factors which did not significantly affect land value include road frontage and thoroughfare distance. Sewer availability did not vary much for the sample and was not included in the model.

The measure of the socioeconomic status of the neighborhood (the ratio of the proportion of high school-educated people in the census tract to the proportion in the city as a whole) was significant. Land values were $273 higher per thousand square feet in neighborhoods with a rate of high school graduation 20% above the city average versus a neighborhood with a rate 20% below the city average. The growth rate in the census tract was not significant and was not included in this model.

The development attractiveness factors, when modeled alone, explained over 46% of the variation in floodplain land value across the ten cities. Flood hazard characteristics, when added to the development attractiveness variables, provided a significantly better-fitting model (probability = .05). Flood history is statistically significant; cities which experienced a flood between 1981 and 1985 lost $325 per thousand square feet in land value when compared with cities that did not experience flooding. The flood hazard actually existing on the individual parcels, however, did not affect land value. Since that measure was statistically insignificant, and collinear with other variables added to the regression equation, it was not used in the final model summarized in Table 8-3.

Where the results differed from those of past research, we believe, the differences can be explained. Proximity to the central business district, for example, lowered rather than raised the value of land in our sample. That result is probably due to the suburban cities and urban fringe development in the sample; also an increase in satellite commercial areas and dispersion of employment have decreased or even reversed the traditional reign of old central cities as the dominant business district. Thoroughfare adjacency increased residential land values, indicating that improved access outweighed the loss of value due to traffic and noise. Another factor we expected to be an amenity--proximity to regional shopping--reduced land value. Land value may have increased with distance from these shopping areas because urban congestion associated with them is a disamenity; also, smaller more frequently used grocery-oriented neighborhood centers (which we did not measure) may be a greater attraction than major malls. The minor deviations from the results of past research seem reasonable, and we are confident that development attractiveness factors have been adequately measured and that the model controlled for their effect.

Floodplain Land Use Management Program

Zoning regulations had a statistically significant effect on land values, and the five program measures together produced a significantly better-fitting model than the control variables (development attractiveness and hazard) alone (prob = .001).

Zoning was highly significant and had a substantial effect on land value. Parcels zoned for medium intensity uses (single-family residences on quarter acre lots) were valued at $379 per thousand square feet lower than parcels zoned for multi-family apartments. None of the other floodplain land use management policies, however, affected land value by themselves. The cities' requirements regarding elevation above the base flood, which are the major component of local regulations required by the National Flood Insurance Program, were not statistically significant in our model.

There are two explanations for why various program measures were not statistically significant. First, the market for vacant land may not account for the extra development costs likely to be caused by elevation regulations until land development and construction begin. Second, the builder survey reported in Chapter 6 provides some evidence that developers pass the additional cost of building in the floodplain forward to consumers, rather than backward to landowners, so they do not pay less for land because it is located in a floodplain.

Variation in floodplain elevation regulations, a state/regional regulatory program, and the clarity of program implementation did not affect the value of raw land in the floodplains of the ten cities. That would imply that those program components were also not reducing development expectations of landowners.

Development

By using logistic regression, we could measure the shift in the probability of an outcome (the log odds of a parcel developing) with a unit change in a predictor variable. The coefficients reported in Table 8-4 are the effects of the explanatory variables on the odds of development; thus, a coefficient greater than one (1) indicates that a variable is associated with an increase in the odds of a parcel developing, and a coefficient less than one (1) indicates a decrease. For more information on logistic regression, consult one of the listed references (Aldrich and Nelson, 1984; Petersen, 1984; Steinberg, 1987; Winship and Mare, 1984).

We used the population growth rate from 1975-1985 for each of the ten cities to control for variation in floodplain development due to overall city growth; in fact, city growth was highly associated with floodplain development. At the mean growth rate for the sample of 9.22%, the likelihood of a floodplain parcel being developed between 1976 and 1975 was 12.3%; with a growth rate of 20%, however, the likelihood of development increased to 26.4%. The odds of parcels vacant in 1976 being developed between 1976 and 1985 decreased with parcel size and increased with road frontage, proximity to regional shopping centers, and location in a higher income area. The availability of sewer service had a very substantial positive effect on the likelihood of development. Adjacent open space, adjacent thoroughfares, and proximity to a thoroughfare, highway interchange, and the central business district had no significant effect on the likelihood of development (see Table 8-4). Neither flooding in a community between 1976 and 1985 nor the degree of flood hazard on a parcel had a significant effect on the likelihood of development.

Floodplain land use management program measures had a significant effect on the likelihood of development; the model including program measures fit significantly better than those which included only the control (development attractiveness) variables at probability = .001.

Floodplain elevation regulation had a statistically significant and important effect on development. For a parcel approximately 80% in the floodplain, the likelihood of development was 22% where no elevation above the base flood was required, but that likelihood fell to 9% where two feet of elevation above the base flood was required. (The effect was not significant, however, for commercial development alone.) Floodway elevation regulations were not statistically significant, nor was the measure of program implementation.

A state or regional floodplain regulatory program increased the likelihood of development, from 7% where no program existed to 21% where one did. That effect is the opposite of what we predicted. The reasons that we expected a higher score on the program implementation measure to increase the likelihood of development may also apply to the state/ regional regulation measure. If state or regional regulations resulted in a clearer, better organized program and consistent standards throughout a state or region-- rather than a second, time-consuming level of bureaucracy for developers to deal with--then it could make development easier (relative to a poorly organized or complex program) and lead to increased development.

Policy Implications

Higher density zoning led to higher land values but less likelihood of residential development. Floodplain elevation requirements (multiplied by the percentage of the parcel in the floodplain for each of the models) had a substantial negative effect on the likelihood of development, but had no effect on land values. Floodway elevation, possibly due to the low number of parcels actually located in a defined floodway (approximately 20% of the sample parcels), had no affect on land value or the likelihood of development.

Floodplain elevation, which is a key component of floodplain land use management programs, does seem to deter development. Requirements for greater elevation reduced the development of floodplains, but they did not affect raw land values. That lack of effect on land values indicates that elevation regulations do not affect the predevelopment landowners' or developers' perceptions of the value of their property.

State/regional regulatory programs affected the likelihood of development; however, the effect was opposite from that hypothesized. State participation in floodplain management increased the likelihood of development, perhaps due to a state's role in encouraging more efficient and better organized programs.

The apparent failure of the floodplain land use management programs (other than zoning) to reduce the value and hence the development expectations for vacant floodplain land, before land enters the development process, could mean that much of the currently vacant floodplain property in the ten cities is already, in fact, in the early stages of development. Perhaps floodplain elevation regulations (and the uncertainty that typically comes with new regulations) have delayed development only temporarily and the reduction in likelihood of development will be reversed in the future. Another possibility is that we did not detect an effect because all of the parcels we studied were at least partially within the floodplain. Flood hazard and floodplain regulations may reduce land value and development potential equally for all floodplain parcels, regardless of the magnitude of the risk and strength of the regulations. Since our sample consisted only of floodplain parcels, we could detect only effects caused by a variation from low to high hazard and low to high program strength.

TABLE 8-4

LOGISTIC REGRESSION OF DEVELOPMENT STATUS ON CONTROL AND POLICY VARIABLES FOR ALL PARCELS

DEPENDENT VARIABLE: Log likelihood of development -- > Ln (developed parcel/ vacant parcel)

Independent Variables	EXP (Coef- ficient	Std Error	Proba- bility
Control Variables			
City growth	1.0907	0.0136	**
Parcel size	0.9993	0.0002	**
Road frontage	1.0004	0.0002	*
Distance to major road	0.9440	0.0620	ns
Distance to CBD	1.0201	0.0051	ns
Distance to regional shopping	0.9803	0.0906	ns
Adjacent open space	1.1238	0.2739	ns
Sewer available	16.0238	0.5856	**
Neighborhood income level	2.9282	0.2552	**
Flood history	0.9641	0.1038	ns
Policy Variables			
Zoning	1.0511	0.0396	ns
Floodplain elevation[a]	0.8955	0.0249	**
Floodway elevation[b]	0.9573	0.0405	ns
Program organization	1.1239	0.1835	ns

TABLE 8-4 - continued

LOGISTIC REGRESSION OF DEVELOPMENT STATUS ON CONTROL AND POLICY VARIABLES FOR ALL PARCELS

DEPENDENT VARIABLE: Log likelihood of development -- > Ln (developed parcel/ vacant parcel)

Independent Variables	EXP (Coef-ficient	Std Error	Proba-bility
State/regional program	3.0062	0.2597	**
Constant	0.0018	0.8745	**

Proportional Reduction in Error = .301[c]
N = 988

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* = significant at 95% confidence level.

** = significant at 99% confidence level.

[a]This is an interaction term (required floodplain elevation for the community multiplied by the percentage of the parcel in the floodplain.

[b]This is an interaction term (required floodway elevation for the community multiplied by the percentage of the parcel in the floodway).

[c]There is no R^2 statistic in logit regression. The proportional reduction in error indicates the improvement in explanation of the variance in development status compared to a model that includes only the constant.