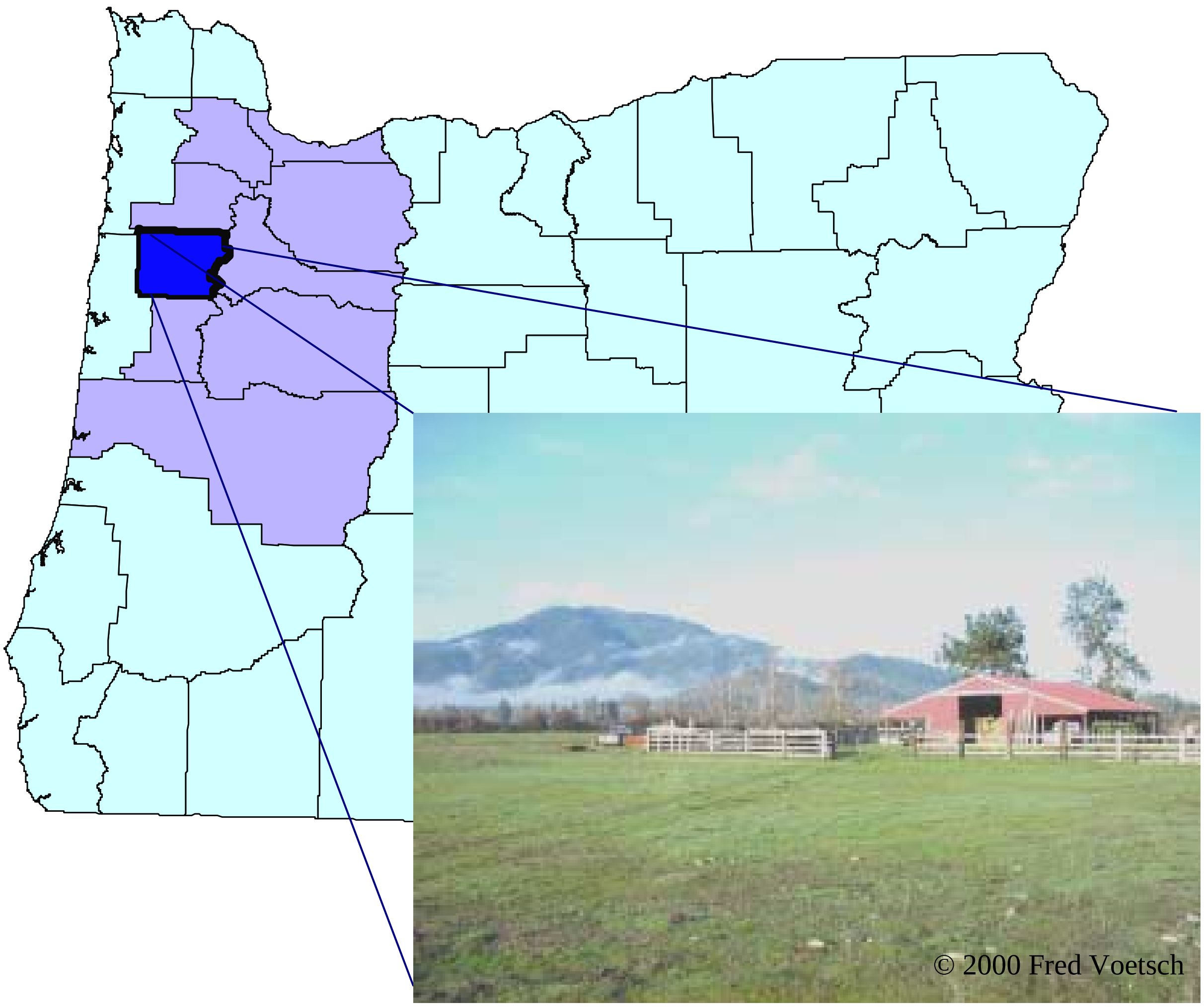
Farm Neighbors, Land Use Policy and Farmland Conversion:

A Dynamic Simulation of Land Use Change in Polk County, Oregon



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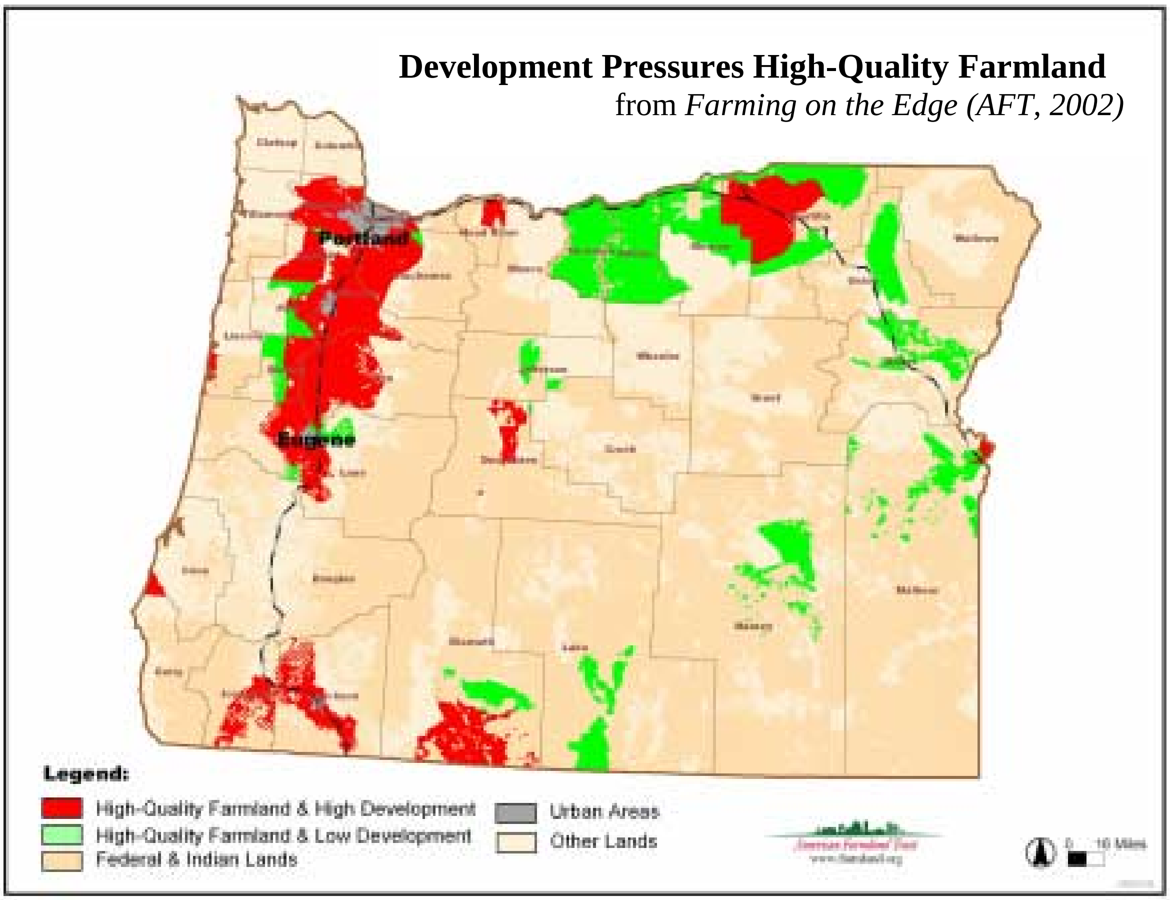
Introduction

Productive farmland provides a wide array of benefits for both rural communities and the Nation. In addition to providing abundant provisions of food, farmland supplies a stream of environmental amenities such as wildlife shelter and scenic open spaces. Yet, under heavy development pressure, farmland is rapidly being converted to non-farm uses.

Between 1987 and 1997 the land designated in farms in the U.S. decreased by over 32 million acres (Census of Agriculture, 1997).



Development Pressures High-Quality Farmland
from *Farming on the Edge (AFT, 2002)*

The State of Oregon has been a national leader in protecting farmland through its farmland protection public policies. On May 29, 1973 the State passed Senate Bill 100, thereby creating the most comprehensive land use plan in the country (Liberty, 1992). Bill 100 provides a framework for Oregon to develop a statewide comprehensive land use strategy. It requires every community to develop a comprehensive plan that will guide future growth and land use in a manner consistent with statewide planning goals.

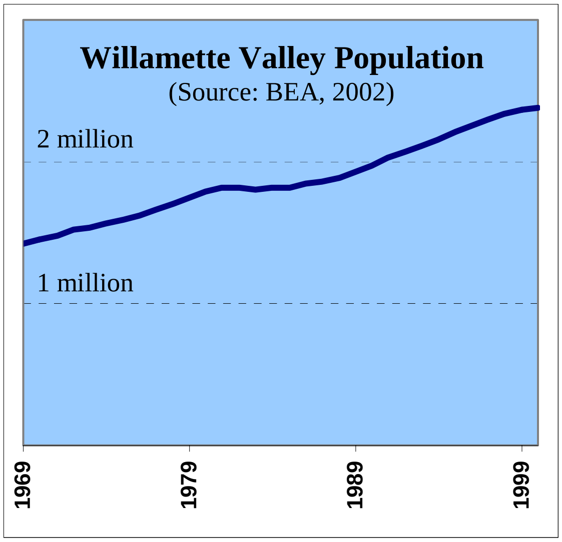
Through these planning goals the State established a strategy to protect farmland from development pressures.

"Planning Goal 3," outlines statutes and administrative rules designed explicitly to preserve farmland. It establishes land to be protected by Exclusive Farm Use (EFU) zones. Land that meets the "agricultural land" definition is mandated to be zoned EFU, and is therefore subject to property tax benefits as well as strict partitioning guidelines. Exclusive Farm Use zones restrict land use to farming and closely related activities.

In addition to Goal 3, Senate Bill 100 also established an "urban containment" policy under "Planning Goal 14." Goal 14 requires that every city and incorporated community establish an Urban Growth Boundary (UGB) that is capable of accommodating growth during the planning period, which is generally 20 years.

Urban growth boundaries place limits on urban development, with most development being restricted to within the UGB. Land outside the UGB is available for farm, forest, or other open space uses.

Despite strict land use policy, Oregon's farmland still faces enormous development pressures. Rapid population growth, especially in the Willamette Valley, requires land for development, which forces land use planners to make difficult decisions.



In order for land use planners to wisely accommodate future development, a better understanding of the rural agricultural economy is needed. Agricultural economies involve complicated interrelationships between individual farmers and between farmers and the related agricultural services industries.

If future development needs are to be met at a minimum cost to agricultural, land use planners and public policy makers will require a better understanding of the interrelationships in rural communities.

In the summer of 2002 the Agricultural Infrastructure Project undertook an investigation of these interrelationships in rural communities. A cooperative effort of the American Farmland Trust, Oregon Farm Bureau and Oregon State University, the project represents the first step towards a comprehensive understanding of farmland loss and its effects on rural communities. This paper presents some of the primary findings of the project.

Interrelationships, Agricultural Infrastructure and Critical Mass

The agricultural infrastructure is the web of personal, economic, social and legal relationships that supports the production of agricultural commodities. It includes, most visibly, agricultural input suppliers and output processors. Additionally, it also includes the formal and informal business relationships between individual farms.

Infrastructure provides access to input and output markets, access to agricultural services ranging from continuing education to consulting, as well as including institutional arrangements, such as the legal and monetary systems.

The degree of interdependence within an agricultural community can have a significant impact on the performance of farm preservation policies. Farmers can depend on neighboring farms within their community for many services, including equipment sharing, land renting, custom work, joint irrigation and drainage projects and assistance in times of need. Additionally, this interdependence may also include farmers' joint need for input suppliers and output processors, transportation systems, agricultural consulting and other infrastructure components.

Concentrations of producers with these joint needs often generate economies of scale, allowing producers access to services more economically than isolated producers would be able to achieve. As an agricultural community shrinks, it is possible that there will not exist sufficient production to support these related services and economies of scale benefits may be lost.

Without a supportive infrastructure the agricultural industry may not be able to continue its role as a significant contributor to regional and national economies. If the agricultural service industries find it difficult to remain in a region, the farmers left producing may also find it increasingly challenging to remain in production. This circle of interdependence raises the issue of a critical mass in agriculture.

The critical mass question is inherently two-fold in nature: 1) dependence between farms; and 2) reliance on local agricultural input suppliers and output processors. Both components are interrelated and must be fully understood in order to prescribe appropriate farm preservation policy. The combination of growing urbanization pressures and unique, highly valuable farmland makes Oregon's Willamette Valley[1] a perfect case study area to examine the critical mass question.

The Willamette Valley

Oregon's Willamette Valley can be captured in one word: *diversity*. Encompassing nine counties, the Valley includes large population centers

[1] For the purposes of this study, the Willamette Valley includes all land in the following counties: Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill.

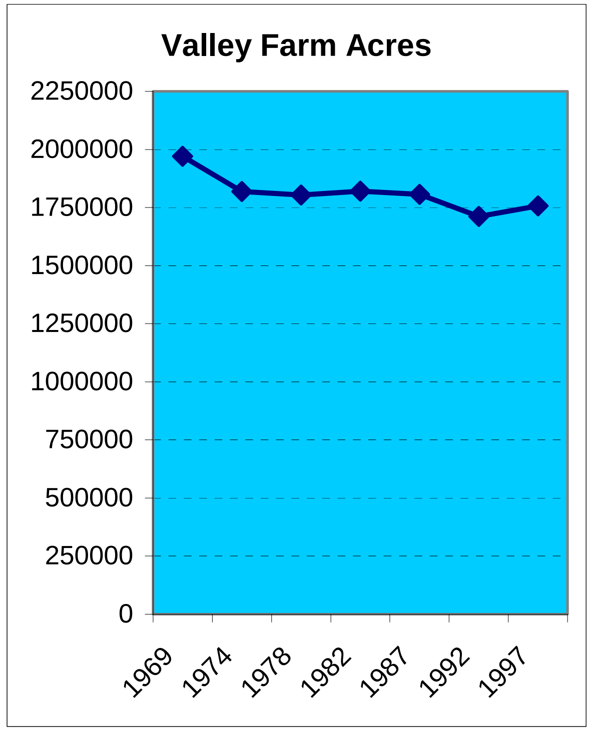
(Portland and Salem), as well as the rugged terrain of the Cascades and coastal mountain ranges with abundant agriculture lying between.

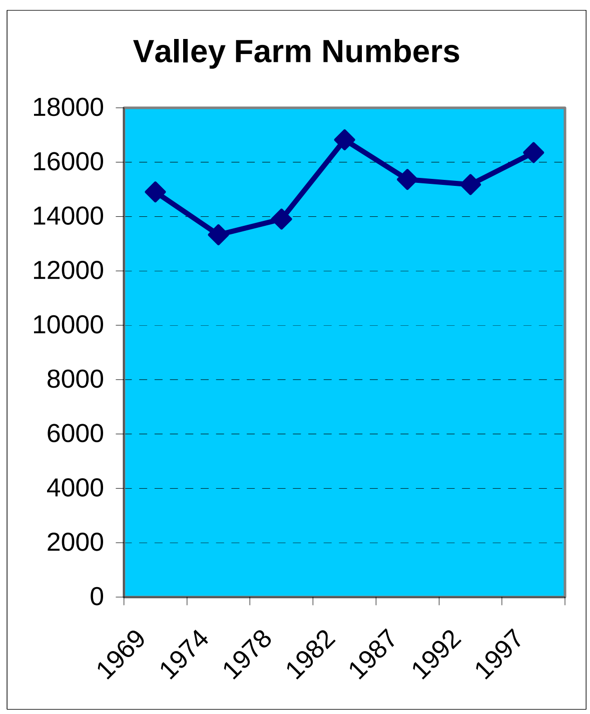
In 1997, agriculture accounted for 21% (1,756,000 acres) of the Valley land area (Census, 1997). Despite the large proportion, agricultural land has declined 11% since 1969.

During this decline, Valley agriculture has seen a dramatic shift in the structure of the industry. The number of farms has increased nearly 10%, which when combined with the declining land area implies a shift in farm size: 147 acres in 1969 to 116 acres in 1997 (Census, 1997).

The shift in structure highlights the adaptive ability of Valley agriculture. The mild climate and diversity of soil types has allowed farmers to adapt to changing economic conditions.

There has been a general shift away from traditional commodities toward products that require more inputs on less land. In 2001 nursery and greenhouse crops, as well as Christmas trees accounted for over 40% of agricultural sales in the Valley compared to only 11% in 1982 (OAIN, 2001).





Modeling Farmland Conversion

The Willamette Valley's strict land use laws, growing population and fertile climate and soils have combined to form a very complicated interrelated agricultural economy. Modeling such an economy is an immense task.

The Agricultural Infrastructure Project employed a Dynamic Simulation Model (DSM) due to its ability to provide an understanding of complicated dynamic systems with multiple interrelationships.

The model can be used as an educational or policy tool. It allows users to isolate key components of interest, such as neighbor interactions and infrastructure effects.

The dynamic modeling process begins with a set of assumptions and functional relationships between key elements in the agricultural economy; from there it simulates land conversion.

Polk County, Oregon was used as the pilot County for the initial simulation exercise.

Understanding the Land Conversion Model

Land in Polk County is divided into three categories:

1. Forested land
2. Developed land
3. Agricultural land.

Forested land is assumed fixed over the near future and is therefore not subject to any land use decision. Developed land includes all land not specified as agricultural or forest land and therefore includes residential, commercial, and industrial lands. Development is assumed irreversible such that developed land can never be converted into farmland.

Agricultural land is divided further into two categories: Restricted Agricultural Land (RAG) and Developable Agricultural Land (DAG). RAG incorporates all agricultural land operating outside UGBs, while DAG includes all agricultural land operating within UGBs.

Within such a land categorization, the relevant land use decisions related to farmland conversion are those made by landowners holding DAG lands. These landowners can choose to continue agricultural production or permanently release their land for development purposes.

If they continue agricultural production they receive a return on their land investment, the size of which depends on their profits[2] and the market value of their land. If they choose to release their land for development purposes they receive a payment for their land, which they can then put into an alternative investment.

Thus, in every time period, landowners choose how much land to release by comparing the return on their investment for staying in production to the return on an alternative investment.

The alternative return is assumed to be the constant risk free rate of four percent. Therefore, agricultural returns and their determinants are the primary variables of interest in the model. Agricultural returns are determined by the profits to agriculture and the market value of agricultural land. In this preliminary model the market value is assumed constant, while the level of agricultural sales and expenses determine profits. In order to simplify the model and isolate the endogenous variables of interest, sales are assumed to follow their historical growth trend. Consequently, the primary variables determining conversion from agriculture to development uses are agricultural expenses and its determinants.

Agricultural expenses are specified to follow a constant historical growth rate with three interaction shift parameters: 1) neighbor interaction factor; 2) output processor factor; and 3) input supplier factor.

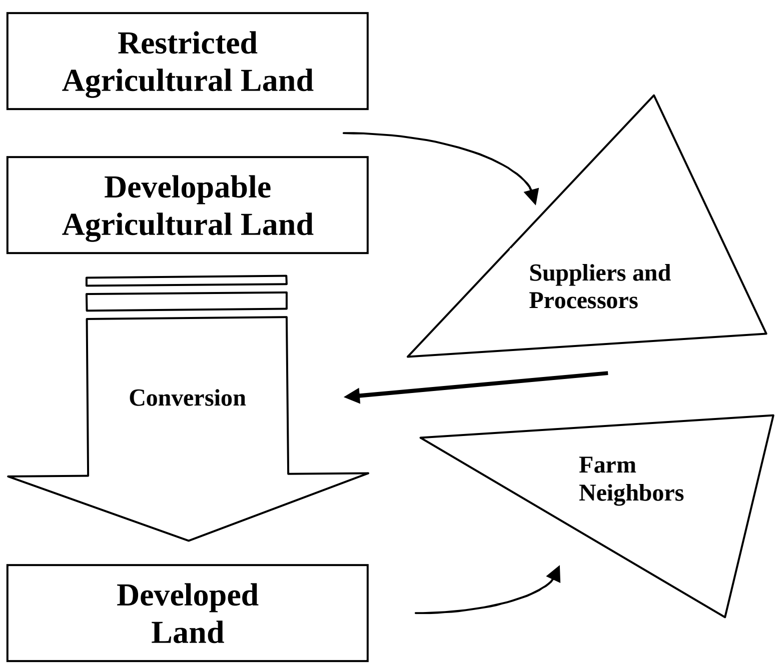
The neighbor interaction factor is meant to capture the added costs of losing neighboring farms due to the interdependence and economies of scale that might exist. It is specified as a constant dollar amount per acre-converted times the total number of acres converted to development. Hence, as acres are converted to development the remaining agriculturist will face higher costs.

[2] Profits are defined following the Bureau of Economic Analysis line code 290: "Realized net income."

Additionally, the number of agricultural input suppliers and output processors can potentially affect agricultural production expenses by affecting access to production services. The numbers of processors and suppliers are assumed to be a function of the amount of land in agricultural production. So as land is converted to development, fewer suppliers and processors will remain to provide services and purchase commodities and therefore expenses may rise. The crop mix and thus degree of dependence on services will determine the size of the infrastructure effects.

The neighbor interaction effect and infrastructure effects outline the feedback effects that drive the simulation model. If agricultural returns are low, thereby leading some agriculturists to release their land for development purposes, the remaining agriculturists will face higher expenses and thus lower profits. In turn, this increases the probability that they also will cease agricultural production.

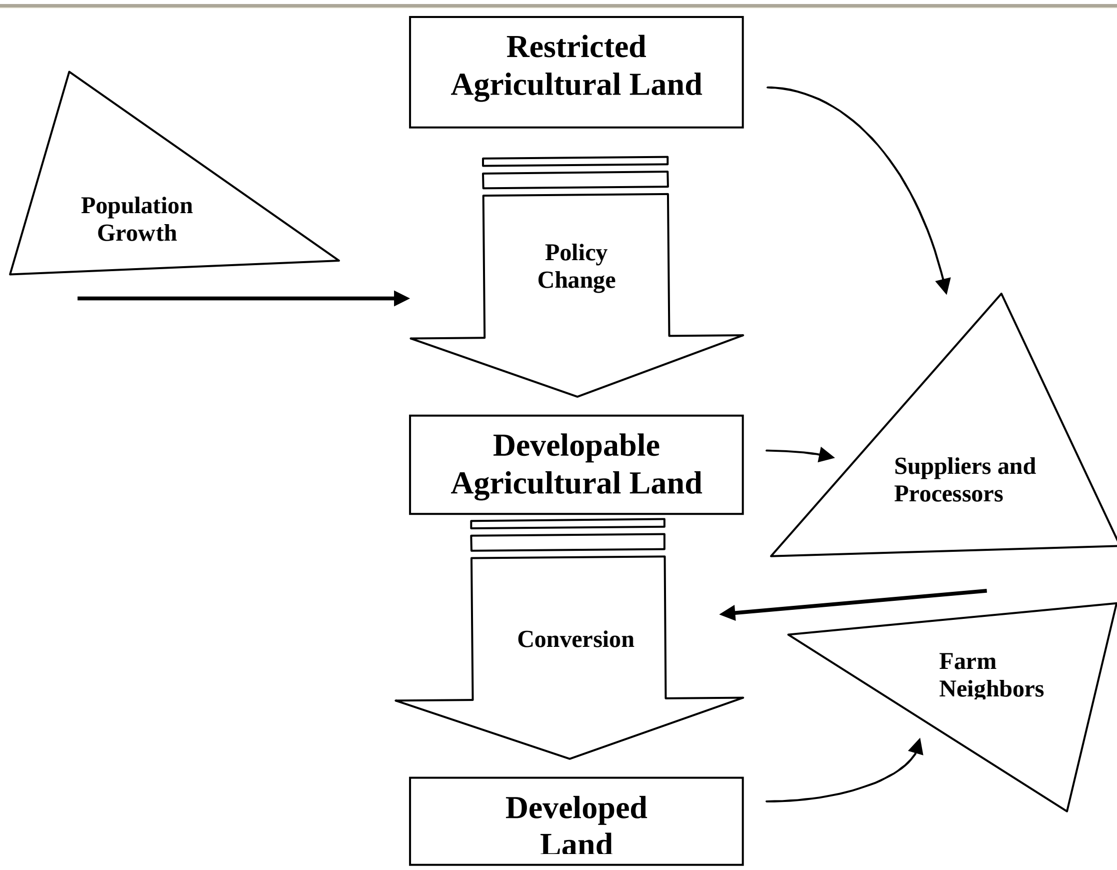
Conceptual Determinants of Land Conversion



Since the conversion from an agricultural use to development can only occur on agricultural land inside an urban growth boundary (e.g. DAG), the model must incorporate land use policy changes. Here, the distinction between restricted agricultural land and developable agricultural land becomes critical.

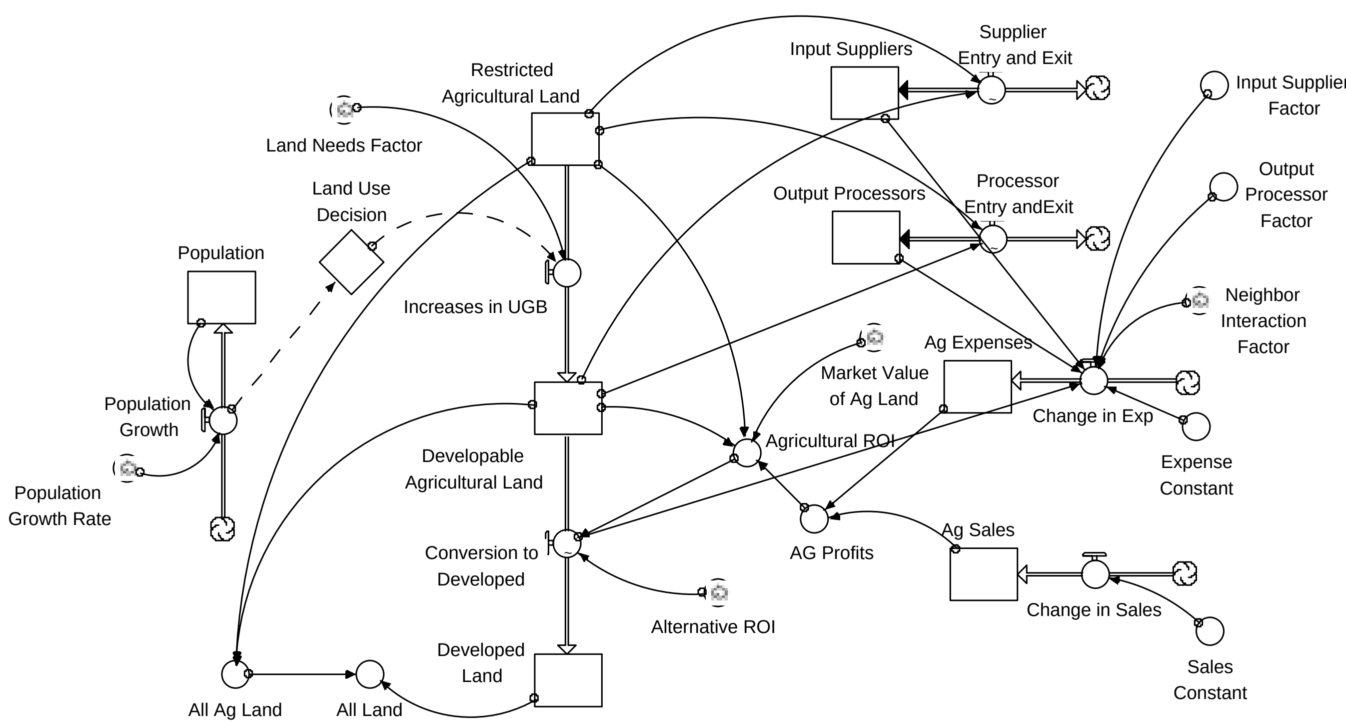
Restricted agricultural land is protected from development pressures as long as it is outside the UGB. Oregon land use policy provides for adjustments in the UGB in order to accommodate 20 years of population growth. With exponential population growth and a constant proportion of acres needed per new person, adjustments in land use policy allow land to be transferred from restricted to developable by expanding the UGB. The conceptual land conversion model thus integrates an understanding of the forces affecting land use policy with a model of agricultural land conversion.

Conceptual Land Conversion Model



Using the conceptual model outlined above land conversion is simulated using the STELLA 7.0.3 software package. Functional relationships were specified using historical data and results from an agricultural producer survey administered to 30 farmers in Polk County.

Dynamic Simulation Model



Simulating Land Conversion in Polk County, Oregon

Polk County zoning data is used to determine the starting values for the three land categories. The remaining data necessary for the model is derived from the Bureau of Economic Analysis and U.S. Census Bureau.

The functional relationships that drive the model are derived from the various data sources, and the agricultural producer survey administered for the Agricultural Infrastructure Project.

Initial Values for Model Variables

Variable	Initial Value	Data Source	Notes
Developed Land	29,295	Dept. of Land Conservation and Development (DLCD)	acres
Developable Land	1,440	Our estimate based upon discussion with Polk County Planning Office	acres
Restricted Agricultural Land	185,000	DLCD	acres
Population	45,231	BEA	Polk County
Agricultural Expenses ($1,000)	$87,751	BEA	$1999
Agricultural Sales ($1,000)	$101,417	BEA	$1999
Input Suppliers	584	Census	Regional[3]
Output Processors	242	Census	Regional

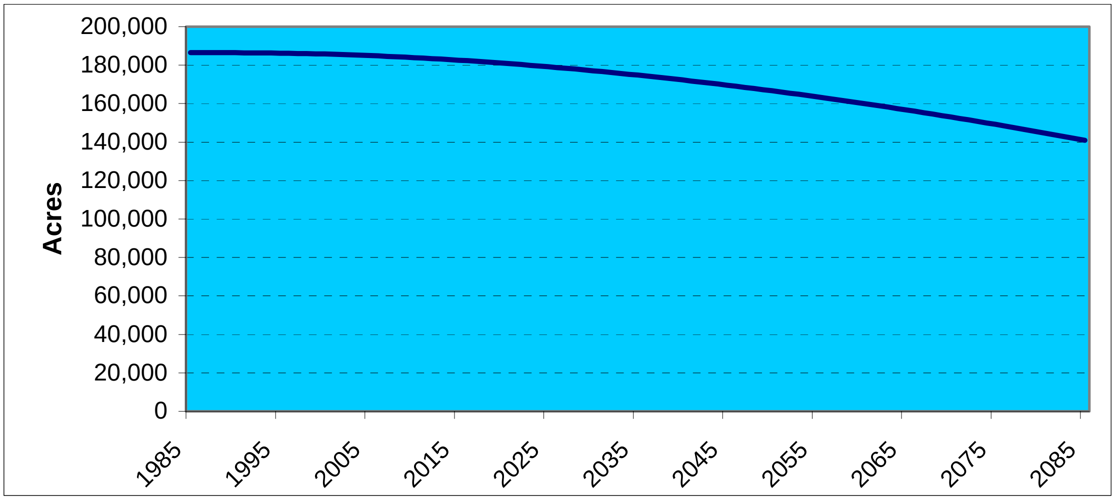
[3] The relevant number of input suppliers and output processors is measured at the regional level. The appropriate region is defined as the Willamette Valley (see footnote 1).

Initial Model Assumptions

Parameter	**Value**	**Units**
Population Growth Rate	0.022	% / year
Land Needs Factor	0.30	acre / person
Alternative Return On Investment (ROI)	0.04	% return / year
Market Value of Ag Land	3.00	$1,000
Input Supplier Factor	0.00	$1,000 / firm
Output Processor Factor	0.00	$1,000 / firm
Neighbor Interaction Factor	0.015	$1,000 / acre
Expense Constant	1,188.60	$1,000 / year
Sales Constant	1,132.90	$1,000 / year

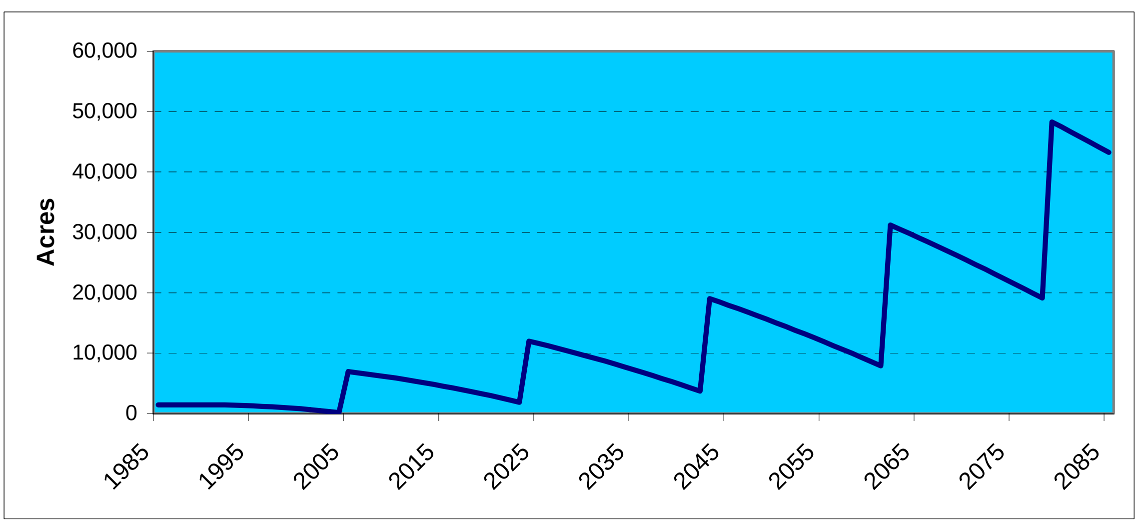
Using the initial values and assumptions the model simulates land conversion over the next 100 years. Simulation depicts agricultural land being lost at a slowly increasing rate.

Simulating the Conversion of Agricultural Land



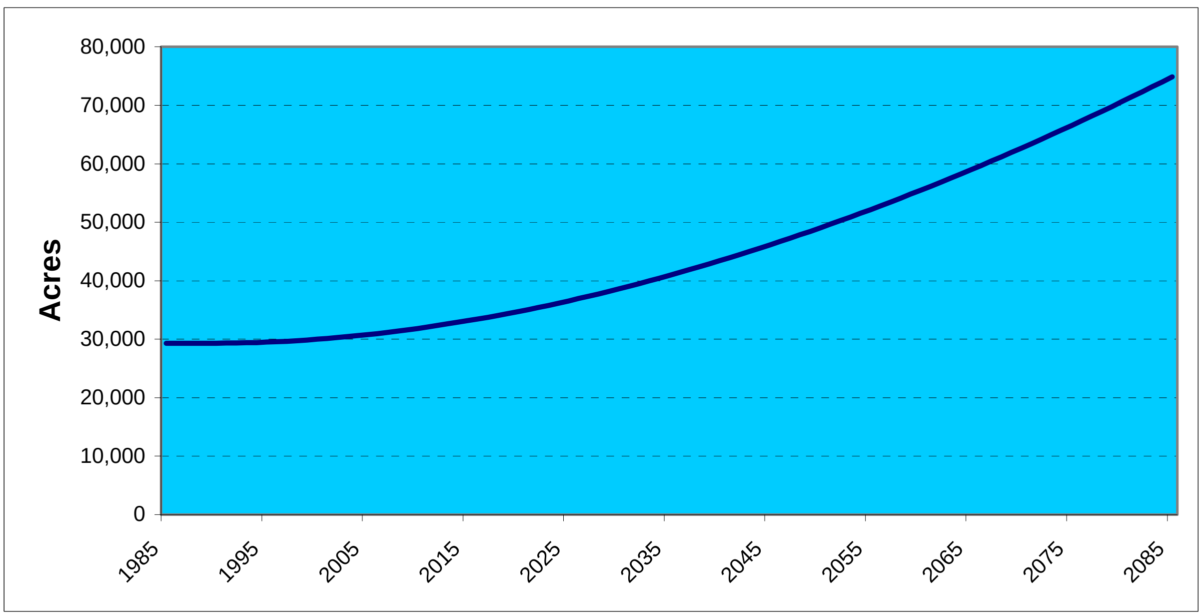
The increasing rate is driven by two factors: population growth and neighbor interactions. Population grows exponentially such that in every year more new people are added to the population than in the previous year. This implies that restricted land will be converted to developable land at an increasing rate in order to accommodate the necessary increases in the UGB.

Baseline Simulation of Developable Land



The trend in developable land highlights the relationship between land use policy and land conversion. The spikes represent increases in the UGB, which is assumed to be updated every 20 years to accommodate population growth. These policy induced incremental increases in the amount of developable land grow subsequently larger over time in order to accommodate the exponentially growing population. The periods of decline in between policy adjustments depict the conversion of developable land to development. Conversion occurs at an increasing rate as time elapses due to the increasing effect of neighbor interactions.

Baseline Simulation of Developed Land



The baseline simulation highlights the model's ability to explore land conversion over time. Although its precision is highly dependent on data quality and availability, and the validity of underlying parameters, the model has great potential as a learning tool and policy mechanism.

In the subsequent section, the model's potential is explored further by simulating land conversion under alternative assumption and policy adjustments.

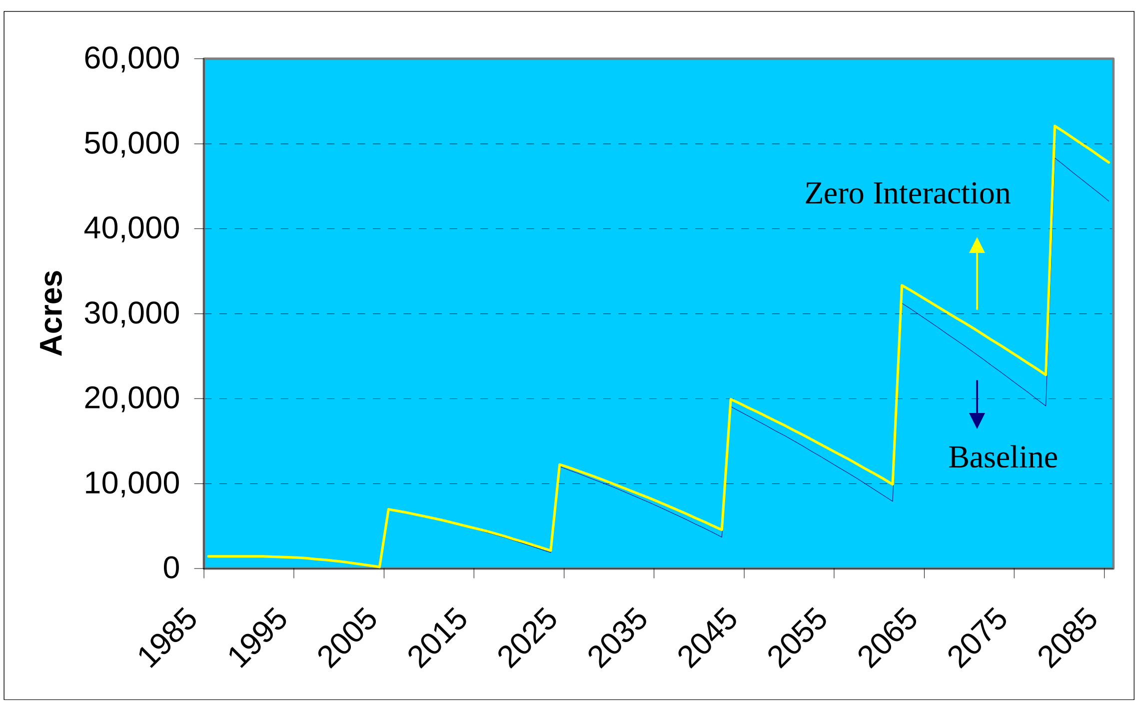
Simulating Alternative Assumptions and Policy Adjustments

Dynamic simulation models are well suited to exploring hypothetical changes to the underlying assumptions. The land conversion model allows users to readily alter assumptions or simulate potential policy changes and quickly observe the implications of the changes. This section will present two changes, which emphasize the model's capability.

One of the key assumptions in the model is the degree of neighbor interaction. The baseline neighbor interaction factor of 0.015 implies that for every acre lost to development, the total expenses of the remaining agriculturists in the County will increase by $15.00. Next, consider two hypothetical scenarios, the first where there are no neighbor interactions and the latter where there are extensive interactions.

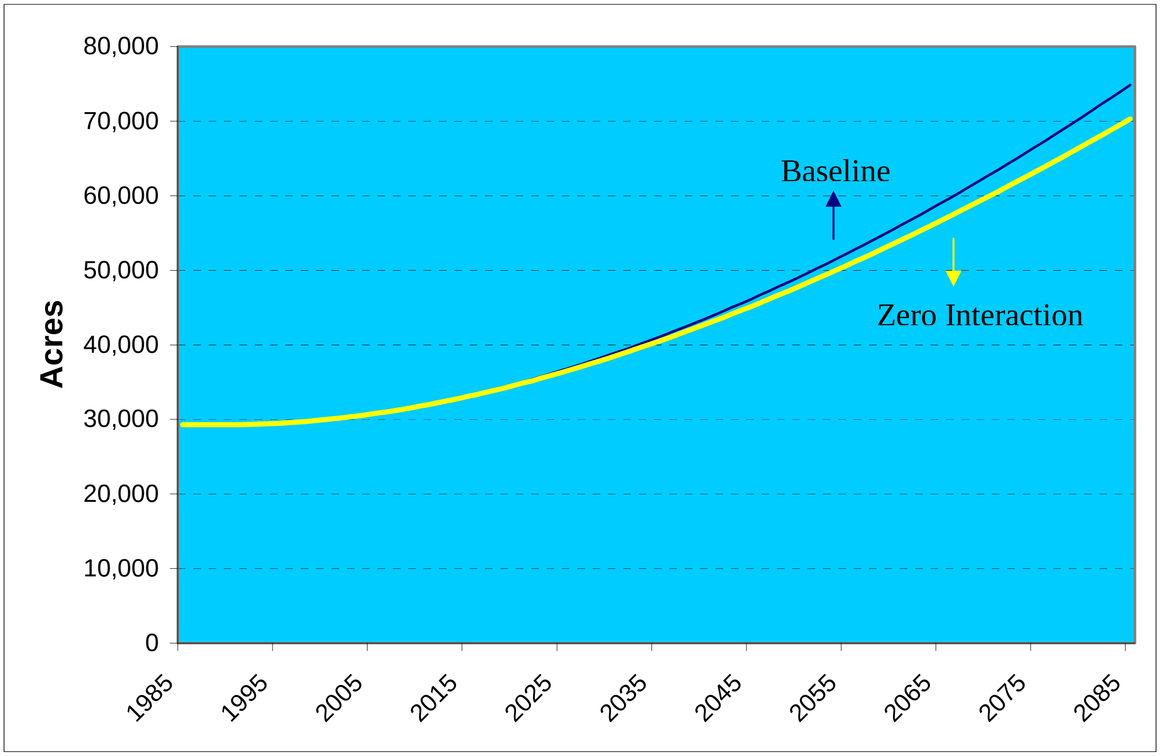
If it were believed that producers had little or no dependence on neighbors (neighbor interaction factor of zero), then the conversion of land to development would have no impact on expenses and agricultural profitability would not be impacted by the conversion of neighboring lands. As a result, developable land would be converted at a slower rate.

Developable Land without Neighbor Interaction Effects



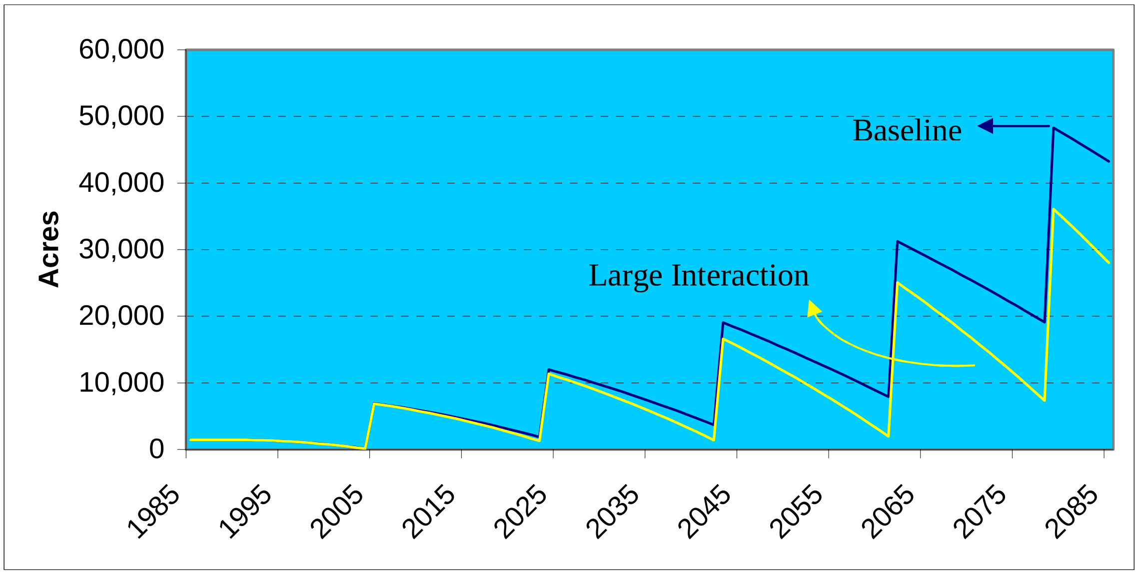
As expected, more land remains in an agricultural use without the impact of neighbor interactions. With no neighbor interaction effect, farmers are more likely to remain producing as neighboring farms are converted to developed land. Similarly, the quantity of land developed increases at a slower rate.

Developed Land without Neighbor Interaction Effects

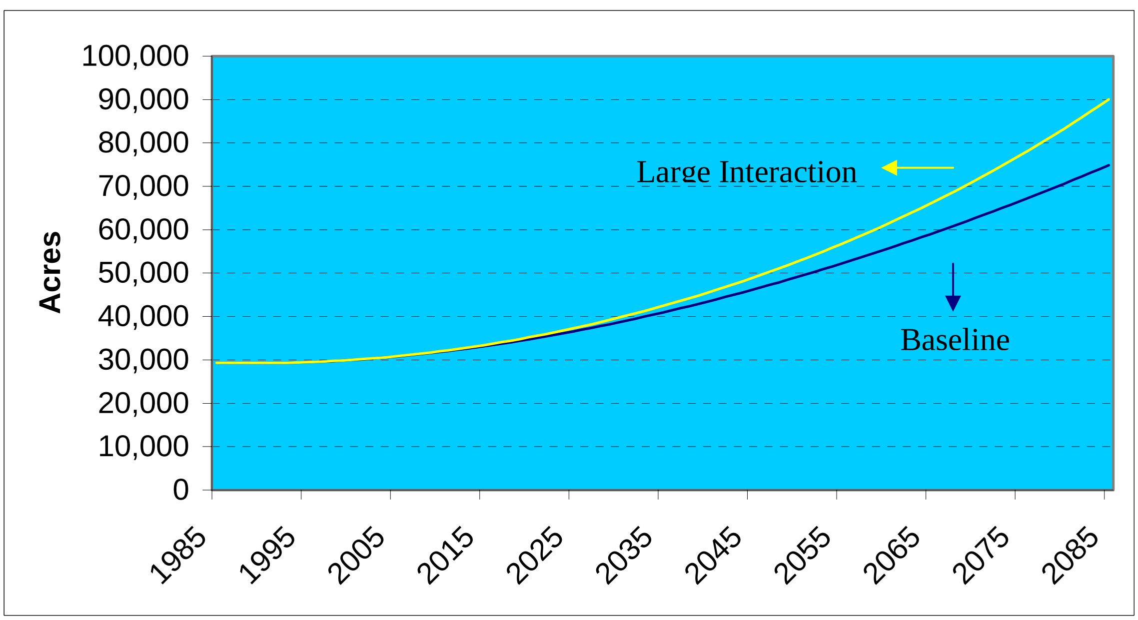


Alternatively, neighbor interactions might constitute a large cost savings for producers. If expenses were highly affected by the loss of neighbors, i.e. the conversion of developable land to developed land, then agricultural land would be converted more rapidly.

Developable Land with Large Neighbor Interaction Effects



Developed Land with Large Neighbor Interaction Effects

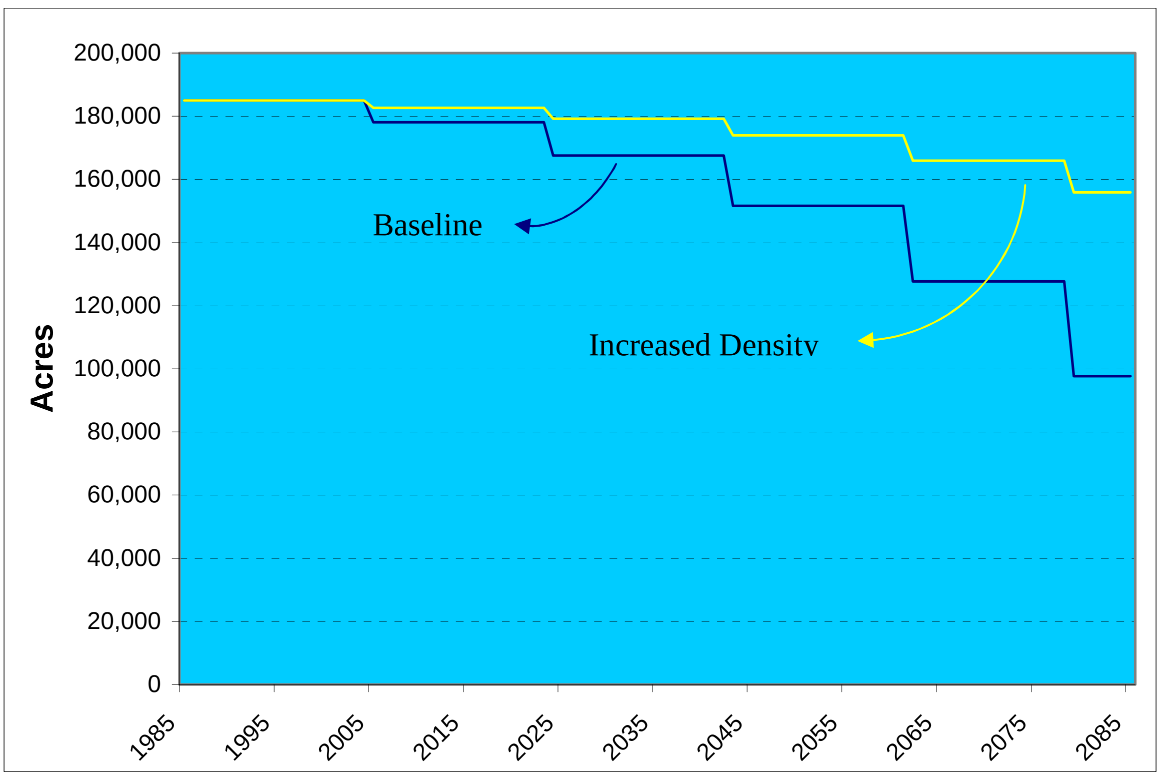


In addition to allowing users to become intimately familiar with the implications of altering underlying assumptions, the model is well suited for considering the affects of proposed policy.

For example, consider a policy intended to slow the conversion of agricultural land by increasing the density of development. This type of policy would allow influxes of new people to reside on less land. In the simulation model this policy implies a reduction in the land needs factor.

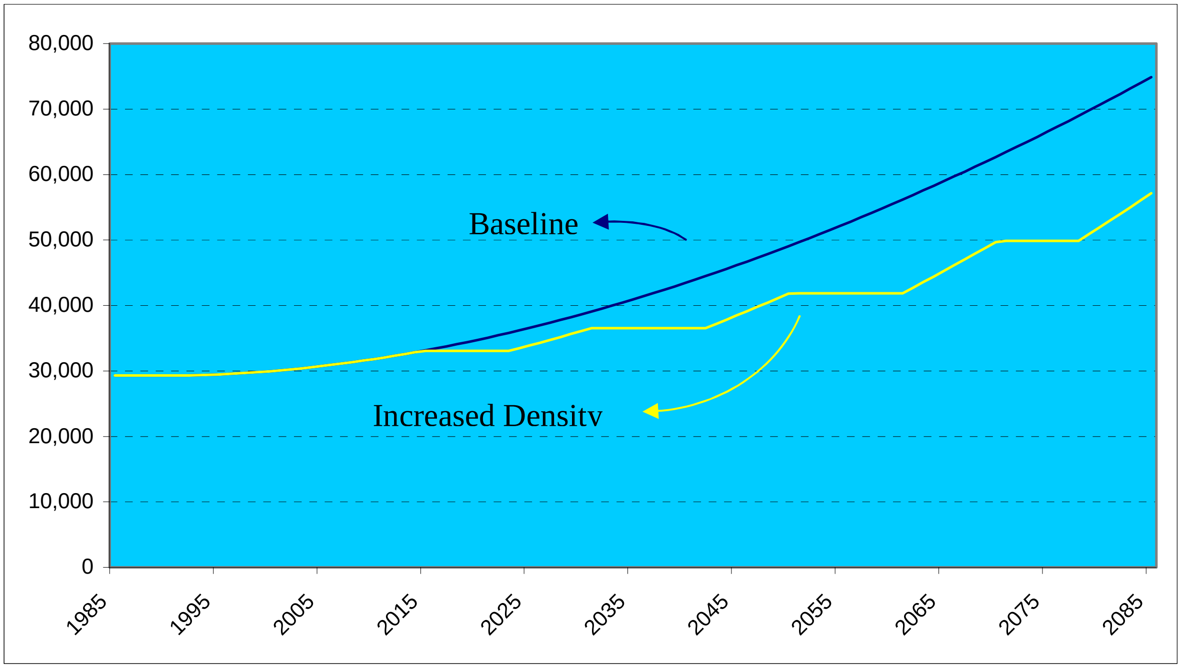
If the land needs factor is reduced from the baseline of 0.30 to 0.10, implying that each new person only requires one tenth of an acre, then restricted agricultural land will be converted to developable land at a slower rate.

Restricted Agricultural Land with Increased Density



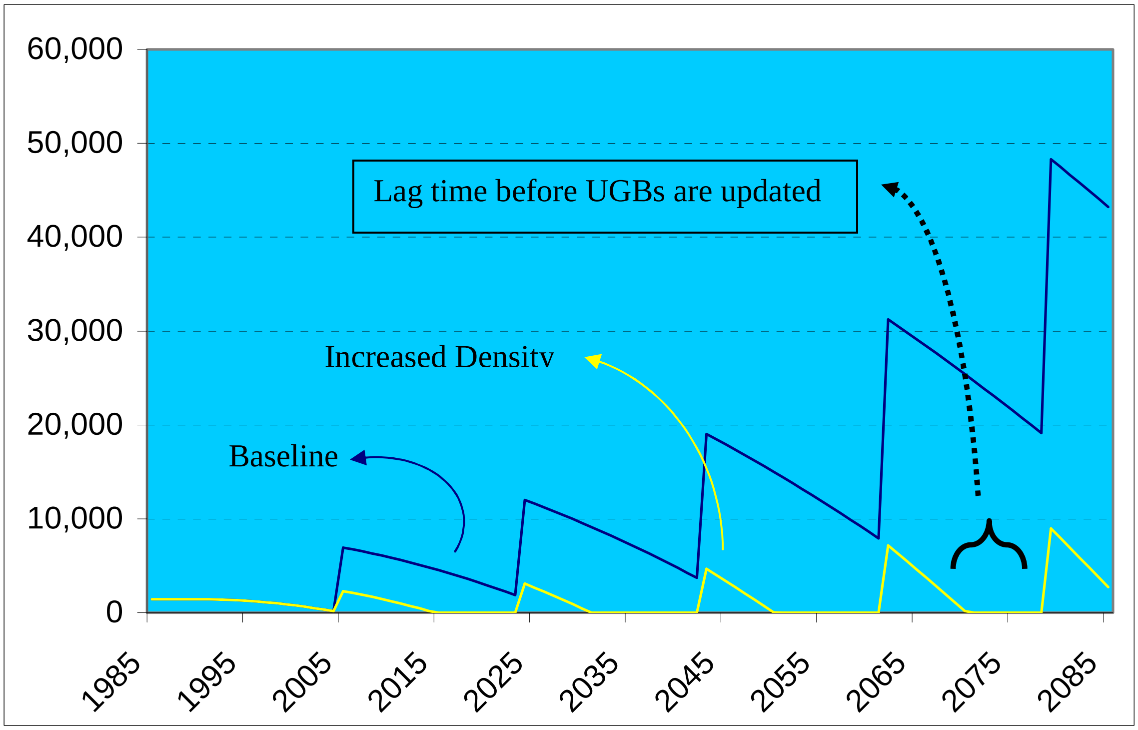
The decreased land needs factor allows restricted agricultural land to be preserved for an extended duration since population growth places less pressure on policy makers to increase the UGB. With less land available for development, developed land increases at a slower rate.

Developed Land with Increased Development Density



The lag periods in conversion to developed land correspond to periods where there is not enough developable agricultural land available to satisfy the demand for development. Once UGBs are updated and there is an inflow of developable land, then development resumes.

Developable Land with Increased Development Density



Conclusion

The pilot project in Polk County, Oregon has resulted in a land conversion simulation model with great potential as a learning tool and policy instrument. The result is a user-friendly model, that allows all users to easily consider the implications of the interrelationships in small agricultural communities on the conversion of agricultural land.

As W. Edward Demming said, "All models are wrong. Some models are useful." The use of the simulation model lies in its ability to increase understanding of a highly complex dynamic system. As data availability and quality increase, the model can be updated and adjusted in order to enhance its ability to further knowledge about the nature and consequences of farmland conversion.

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