Memorandum

To: SEMCOG (Southeast Michigan Council of Governments)

From: Emmy Park, City Planner and Nata Kovalova, City Planner

Date: May 2023

Subject: Planning for Sustainable Growth in the Detroit MSA

Introduction

Planning for urban growth is key to a financially and environmentally sustainable future. After a challenging period of deindustrialization, the Detroit MSA is making new attempts at revitalization and is projecting population growth for the first time since 2000.[1] Looking ahead, SEMCOG has an opportunity to promote more compact growth that supports economic development while protecting the area's natural habitats. Understanding where development is most likely to occur in the future can help better prioritize public infrastructure investments and land conservation efforts. In support of this goal, we have developed an urban growth model that identifies key drivers of historical development to predict future development.

Methodology

Gathering Data

To understand historical development patterns, we first looked at where development occurred between 2008 and 2019.[2] We divided the study area into 2500 ft x 2500 ft cells (~0.25 square miles) and used data developed by the USGS to determine the land cover of each cell in 2008 and 2019. This process enabled us to understand land cover at two points in time across the MSA at a granular scale. We observed that roughly 1% of the Detroit MSA converted from undeveloped (farmland, forest, wetland, or other undeveloped) to developed between 2008 and 2019. This development was concentrated outside of Wayne County in suburban and rural counties (Figure 1).

[1] macrotrends. "Detroit Metro Area Population 1950-2023," n.d. https://www.macrotrends.net/cities/22974/detroit/population#:~:text=The%20current%20metro%20area%20population,a%200.51%25%20decline%20from%202020.

[2] We hoped to use a ten-year timeframe, however, land type data was only available for 2008 and 2011, so we opted for a slightly longer lookback period for our model.

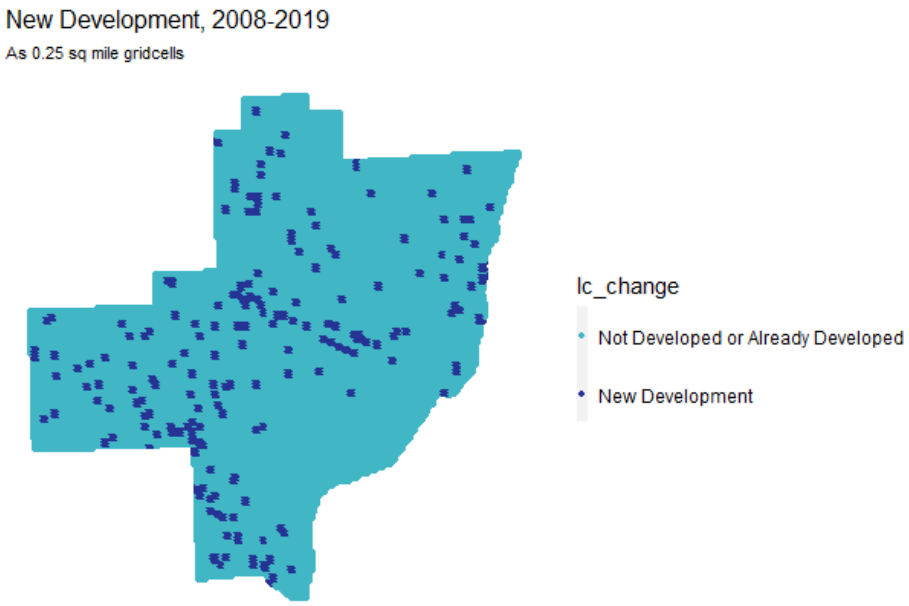

Figure 1: *Map of cells that developed in the Detroit MSA between 2008 and 2019*

Next, we gathered data on variables that might drive land to undergo development and calculated the values of these variables for each cell in the MSA. An initial comparison of cells that underwent development versus all other land areas revealed several trends. Cells that underwent development between 2008 and 2019 were, on average, closer to highways, universities, and nearby development (Figure 2). Cells that underwent development were also on average less populated and had higher incomes than the rest of the MSA (Figure 3). Lastly, farmland and forest developed at a higher rate than other land types.

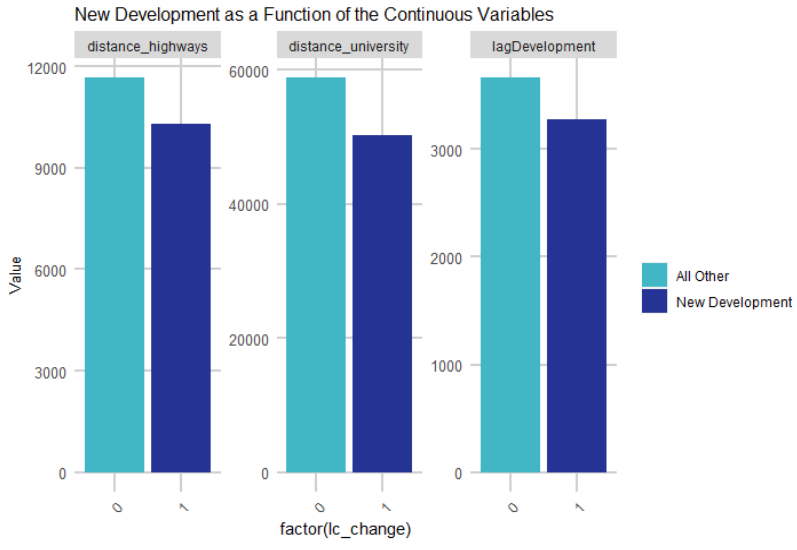

Figure 2: *Average distance in feet from a highway, university, or other development for cells that did not develop vs. cells that did develop, 2008-2019.*

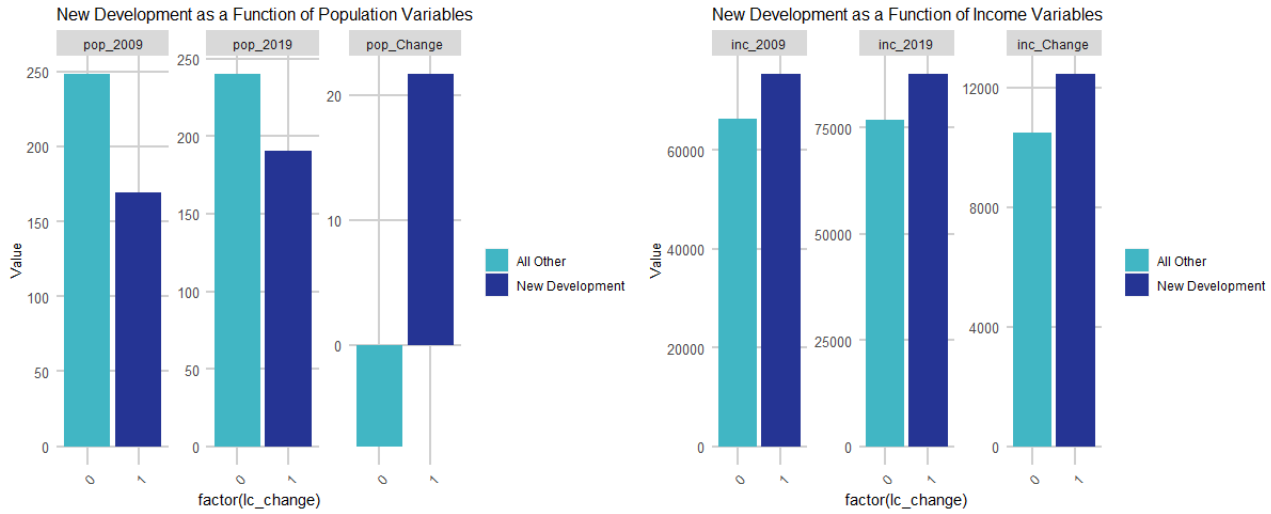

Figure 3: *Average population, population change, income, and income change for cells that did not develop vs. cells that did develop, 2008-2019.*

Developing the Model

Our urban growth model uses binomial logistic regression to predict the likelihood a given cell of land in the Detroit MSA will undergo development. We tested a series of models with different combinations of 2008 land cover and Census data to see which set of variables best predicted land cover change between 2008 and 2019. Our strongest model included variables for whether a cell was wetland, forest, farm, or another undeveloped land type, the distance from existing development, the median household income in 2009, the estimated population in 2009, and the distance from the nearest highway.[3] The model results in Table 1 suggest areas with higher incomes and populations in 2009 were more likely to have developed by 2019. Additionally, areas farther from highways and from existing development were less likely to develop. Lastly, farmland and other undeveloped land types were more likely to undergo development than forest and wetland areas between 2008 and 2019.

[3] Census data was only available for 2009 and later.

Table 1: Model Regression Results

	Estimate	**Std. Error**	**Z Value**	**Pr(>|z|)**
(Intercept)	-7.962e+00	8.453e-01	-9.420	< 2e-16 ***
wetlands_2008	5.311e+00	7.464e-01	7.116	1.11e-12 ***
forest_2008	5.479e+00	7.197e-01	7.613	2.68e-14 ***
farm_2008	6.499e+00	7.310e-01	8.890	< 2e-16 ***
otherUndeveloped_2008	7.259e+00	7.834e-01	9.266	< 2e-16 ***
lagDevelopment	-8.721e-04	1.315e-04	-6.633	3.30e-11 ***
inc_2009	1.748e-05	4.658e-06	3.752	0.000175 ***
pop_2009	1.227e-03	4.914e-04	2.497	0.012515 *
distance_highways	-1.067e-05	1.118e-05	-0.954	0.340093

*Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 1107.5 on 8985 degrees of freedom
Residual deviance: 852.1 on 8977 degrees of freedom
(86 observations deleted due to missingness)
AIC: 870.1

Number of Fisher Scoring iterations: 9

Our model assigns a probability of development to each cell in the MSA, but it is up to us to select the cutoff above which we predict development will occur. At a lower threshold, our model is better at predicting precisely where development occurred but also overpredicts overall new development (Table 2). For this reason, we proceeded with a higher threshold of 10% since we are more concerned with where development generally occurs.

Table 2: Confusion Matrix for Model 10

Variable	Sensitivity	Specificity	Accuracy
predClass_05	0.31	0.95	0.94
predClass_10	0.16	0.99	0.98

Future Scenarios

Using the urban growth model, we are able to predict where demand is most likely to occur in 2029 under various scenarios. In this section, we analyze how population growth and a new highway might shape the pattern of future demand for development.

Impact of Population Growth

Our model predicts that areas with higher populations are more likely to experience development demand in the future. To predict development demand in 2020, we adjusted our starting period and ran our model using population data from 2019 instead of 2008. The results suggest we can expect higher development demand in the urban and suburban areas of the MSA relative to the rural fringes, which is consistent with how we understand the relationship between population and future development demand (Figure 5).

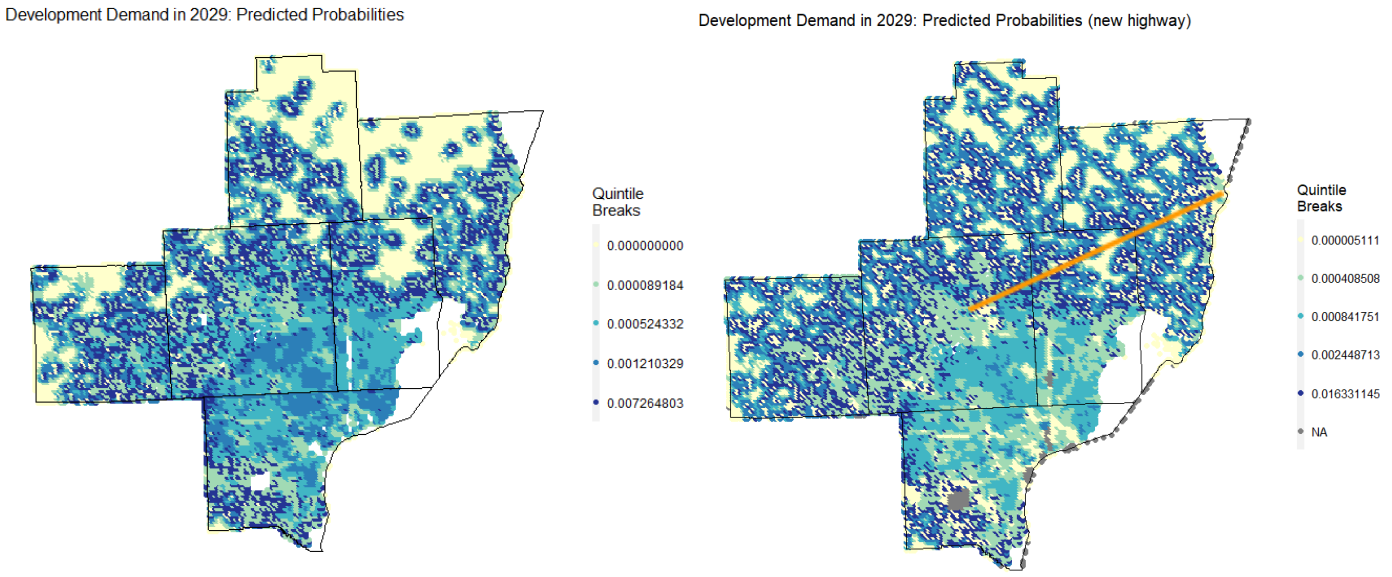

Figure 5: *The probability of development in 2029 with and without a new highway (shown in orange). The darker the blue, the higher the likelihood of development.*

Impact of New Infrastructure Construction

To model how future infrastructure investments might change development, we imagined a new highway that would allow for easier access to job centers running from Port Huron in the northeast to Auburn Hills in Oakland County. Since our model predicts the closer an area is to a highway, the higher the probability of development, we expect this new highway will spur new development in the surrounding areas. After re-running our model with the new highway, we do observe a higher likelihood of development around the newly constructed highway in 2029 (Figure 5). The increased accessibility to jobs may draw people to towns surrounding the new highway, so we might also expect population growth to outperform forecasts in this part of the MSA.

Conclusion

Our urban growth model predicts that development will continue to sprawl to the outskirts of the Detroit MSA but that it will be most concentrated in the suburban areas and near major highways. With this understanding of future development demand in mind, we recommend SEMCOG prohibit development in existing wetlands and protect at least half of existing forest land from future development (Figure 6). Although this limits suitable land for development, it would allow for more concentrated development near existing residential and employment centers. Future iterations of the model that predict development at the land parcel level could allow for greater visibility into additional opportunities for infill development.

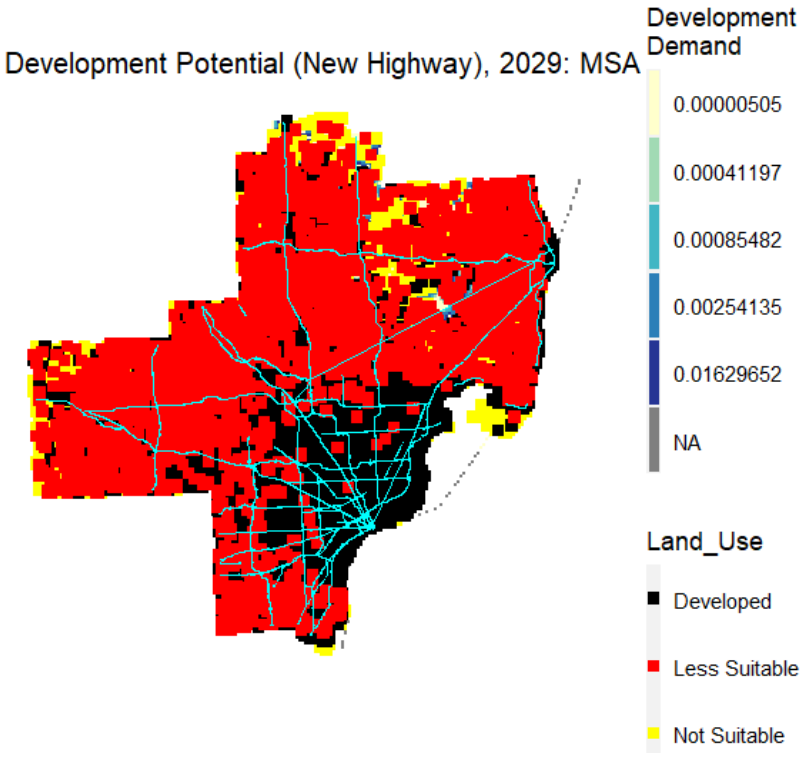

Figure 6: *The probability of development demand overlaid with already developed land (black), land that should not be considered suitable for development (wetland), and land that is semi-suitable for development (forest).*