

# Urban Simulation Modeling of Aurangabad City is regarding different types of model using OPUS (Open Platform for Urban Simulation)

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**Abstract**— Many countries of the world are currently suffering from problems caused by speedily growing population in urban areas, both governments and human being have a duty to find ways to overcome these problems. We have discussed different domain of urban modeling and case study of the UrbanSim model system for Aurangabad city. Map including elementary areas of ninety nine zones in Aurangabad city and some applications for planning activities in different areas. For this work, we have used the open source software tool OPUS for urban planning and design. We have used four models, (a) Residential development project location choice model (RDPLCM), (b) Non residential development project location choice model (NRDPLCM), (c) Real estate price model (REPM) and (d) Household location choice mode (HLCM). We have done simulation using OPUS on these four models. The base year data set is the year 2012. The simulation has been performed up to the year 2022. The results for different parametric quantities have been predicted for these years. The result shows variation in population for given data set and map.

**Keywords**— Aurangabad City Map, GIS, Urbansim, OPUS.

## I. INTRODUCTION

Urbansim is a tool used by urban contrivers, stakeholders to help formulate and policy or insurance makers and evaluate combinations of land use, environmental policies and transportation [1]. It is intended to support deliberation and debate on such issues as building new transit systems or espousing alternative growth management regulations as well as broader issues such as livable cities, economic vitality, environmental preservation and social equity. Stakeholders should be able to consider different scenarios UrbanSim to model the resulting patterns of urban growth and redevelopment, packages of possible policies and investments and based on these alternatives of resource consumption, of transportation usage and other environmental impacts [2].

The Residential Development Project Location Choice Model (RDPLCM) predicts the location choices of real estate developers to build new real estate development projects. The Nonresidential Development Project Location Choice Model (NRDPLCM) predicts the location choices of real estate developers to build new non-residential real estate development projects. The Real Estate Price Model (REPM) predicts the price per unit of each building. The Household Location Choice Model (HLCM) predicts the location choices of new or relocating households. In this case study, we use the variable `zone_tot_pop` to predict the zone total population up to 2022 year.

The base year contains the number of dataset table such as

household, job building and zone. All these data set tables are related to each other and we can change the dataset value according correct information of any city. We have created an imaginary dataset in the base year 2012 for the imaginary Aurangabad city. We have tested the simulation results for two illustrates. First, we have applied estimation, simulation on base year 2012 dataset and second, the result is taken in the form of animation, map and table. After this, we have changed the dataset value and then estimation and simulation is performed. It shows the variation in the output. For proper input dataset we get a most appropriate prediction of the population. We can get the variation in the map as well as in a table which shows year-wise variation in a population and Growth rate.

## II. LITERATURE SURVEY

The literature that has been done focuses on the efforts required to be fully developed, operational model. In literature, there is little direction on how to evaluate UrbanSim for a prospective application.

The literature review considers only research that has involved the use of UrbanSim instantly, has been a spin-off of work on UrbanSim or that has reported on UrbanSim. The literature circumference UrbanSim can be classified into four categories: Various different descriptions of UrbanSim as it has evolved. These include: (I) Waddell and Borning (2004) (II) Davis (2006) and Waddell (1998) (III) Waddell (2001) and Waddell (2000). (IV) Hunt (2005)

contains a description and analysis of UrbanSim in comparison with other models [3].

Articles in the computer science literature distinguish UrbanSim and various aspects of the UrbanSim system in the context of software and user interface development: Noth (2003); Freeman-Benson and Borning (2003); Schwartzman and Borning (2007) and Waddell (2003) [4].

A literature on methodological developments has used data referring to, or resulting from, UrbanSim to look into betterments in two broad areas. The biggest number of these articles has looked at distinct selection, introductions concerning to household location choice [5,6,7] and joint household location choice and mode or workplace choice [8,9]. The other articles have looked at sensibility analysis of variance in UrbanSim results [10] and methods to quantify the amount of doubtfulness in UrbanSim results [11,12].

A Number of UrbanSim diligence has been reported. One-half of these have been written by the developers of UrbanSim. They show that UrbanSim can be used successfully [13] and that the desegregation of land-use can have an important impact on transportation system performance results [14] Waddell (2002) shows that in the case of Eugene, Oregon, UrbanSim produced good results for predicting land-use development (e.g. Where households and jobs will locate in the future). This is proved using correlations of UrbanSim predictions against the real development in 1995. Waddell, Wang and Charlton (2007) provide an elaborated description of an application in the region of Salt Lake City, Utah. Among other things, it shows that likened to a systematic analysis using a traditional transportation modeling coming that total vehicle miles traveled (VMT) are 5% higher and that total congestion delays are 16% higher. A more recent, although not a final model [15] of San Francisco shows how a recent version of UrbanSim has been used with an activity based model. This paper reports that it took 1 year to develop this model [16].

There have also been three self-governing reports of UrbanSim applications. Joshi (2006) report on the application of UrbanSim to analyze the effects of a planned light rail system in Phoenix, concentrating primarily on land-use implications. Nothing is mentioned about the exploit required for model implementation. The number of authors in the paper suggests the resources required were significant. Zhao and Chung (2006) is the most detailed independent analysis of an application of UrbanSim in Volusia County, Florida. They report success in implementing UrbanSim and that it is executable, although there is not much detail about the resources required. They report that the main challenges were related to data

aggregation, preparation and parameter estimation. They also conclude that the expertise required to develop the model is outside of the scope of what some MPOs may have and therefore that they would require external consultant services, and that the user manual is insufficient [17].

Loechl (2007) describes the results of modeling efforts for the region of Zürich. The model was not fully implemented (there was no interaction with a transport model) and the paper describes problems encountered in data collection and how these were overcome. It also reports on the simulation results obtained in this effort [18].

Some other report has just been released by IAURIF in Paris that itemizes ten lessons learned after four years of modeling efforts for the Paris region [19]. They report that theirs is the first full execution of UrbanSim outside of the United States and it provides practical lessons that they were able to derive from their efforts over the past four years. Among other things it reports that an interdisciplinary team of 4 people was required for four years! They also provide interesting insights into the factors that are needed to develop a well-functioning, UrbanSim model [20].

### III. DESIGN AND DEVELOPMENT OF DATABASE

UrbanSim can be configured to run at a Grid Cell Level, Zone Level or Parcel Level. The zone level configuration means any irregular polygons from Traffic Analysis Zones used in travel models for large administrative units such as cities or small Census Blocks or regions. It is up to the user to determine what level of geography fits their needs and data restraints best [21].

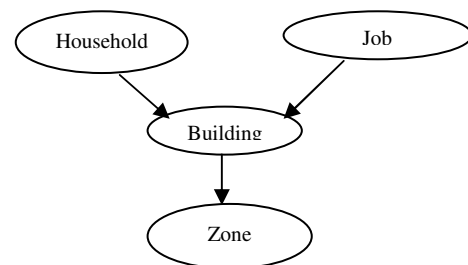


Fig. 1 zone

Households and jobs are still located in buildings and buildings can be linked spatially to zones. But this approach would give up considerable detail for analyzing development locations and capacity constraints due to zoning or land use plans.

| Sr. No. | Table Name                                | Required |
|---------|---|----------|
| 1       | annual_employment_control_totals          | Y        |
| 2       | annual_household_control_totals           | Y        |
| 3       | annual_household_relocation_rates         | Y        |
| 4       | annual_job_relocation_rates               | Y        |
| 5       | buildings                                 | Y        |
| 6       | building_sqft_per_job                     | Y        |
| 7       | building_types                            | Y        |
| 8       | cities                                    | N        |
| 9       | counties                                  | N        |
| 10      | development_event_history                 | Y        |
| 11      | employment_adhoc_sector_groups            | N        |
| 12      | employment_adhoc_sector_group_definitions | N        |
| 13      | employment_sectors                        | Y        |
| 14      | fazes                                     | N        |
| 15      | home_based_status                         | Y        |
| 16      | household_characteristics_for_ht          | N        |
| 17      | households                                | Y        |
| 18      | households_for_estimation                 | N        |
| 19      | jobs                                      | Y        |
| 20      | jobs_for_estimation                       | N        |
| 21      | large_areas                               | N        |
| 22      | race_names                                | N        |
| 23      | target_vacancies                          | Y        |
| 24      | travel_data                               | Y        |
| 25      | zones                                     | Y        |

Table 1: Database table name

#### A. Shapefiles of Imaginary Aurangabad City

We have created the shapefile of the Aurangabad city using ArcMap tools, available with the Arc GIS 10 software. We have created base year data and shapefiles directory in the database for aurangabad\_city\_zone project. We have divided the Aurangabad region into 99 zones. The shapefile for Aurangabad city is shown in below figure 2.

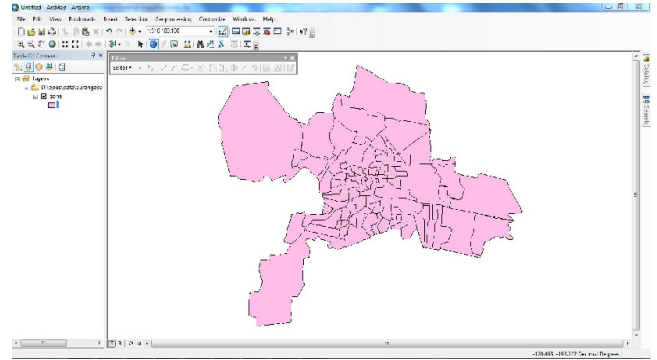


Fig. 2 Shapefile of imaginary Aurangabad City

#### B. Data flow Diagram

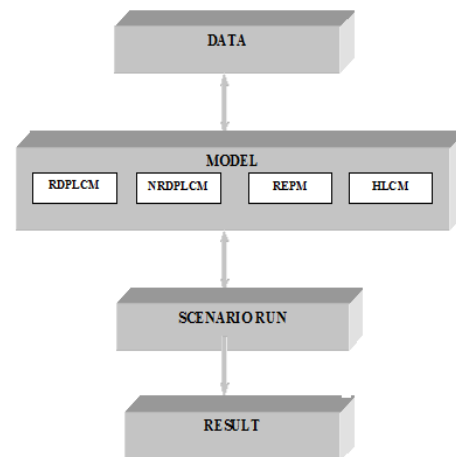


Fig. 3 Data flow diagram

##### (a) Data

We are using the base year database 2012 for Aurangabad\_city\_zone project. We are creating shapefiles which based on the imaginary Aurangabad city. Shapefiles directory is a special one for creating a modified in the ArcMap GIS software.

##### (b) Model

We are estimating on the given dataset using following four models. They are RDPLCM, NRDLPCM, HLPCM and REPM.

##### (c) Scenarios Run

Here, we are performing simulation operations on an Aurangabad city zone. Above mentioned model and dataset in use for predicting variation in population of Aurangabad city. Results of estimation has been provided in this phase.

##### (d) Result

The final results are in animation, map and table format. These clearly show the change in population of Aurangabad city up to the year 2022.

### C. Model Specification

Future land use patterns depend on household and job location choices, which in turn depend on the supply, quality, and price of built space, access to jobs and other destinations, household income, industry sector, and so forth.

#### (a) Development Project Transition Model (DPTM)

##### Objective

To predict new development projects those need to be built to satisfy market demand.

##### Algorithm

1. It compares the current (simulated) vacancy rate for each building type to the target vacancy rate.
2. When the current vacancy rates fall below that time new building can be generated.
3. If the structural vacancy rate as the threshold or trigger that provides a market signal to developers that conditions are profitable to begin new projects.
4. The sampling previously built buildings and placing them in the queue to be located in the Residential and Nonresidential Development Location Choice Models.

#### (b) Residential Development Project Location Choice Model (RDPLCM)

##### Objective

Predicting the location choices of real estate developers to build new real estate development projects.

##### Algorithm

Development projects to be located by this model are generated by the Development Project Transition Model. These two models are working parallel and virtually identical except for their focus on residential or nonresidential buildings.

#### (c) Non-residential Development Project Location Choice Model (NRDPLCM)

##### Objective

Predicting the location choices of real estate developers to build new non-residential real estate development projects.

##### Algorithm

Development projects to be located by this model are generated by the Development Project Transition Model. The Residential and Nonresidential projects are handled by parallel models that are virtually identical except for their focus on residential/non-residential buildings.

#### (d) Real Estate Price Model (REPM)

##### Objective

To predict the price per unit of each building.

##### Algorithm

A hedonic regression this model used in Real estate price model. It uses for the hedonic regression structure, which is a multiple regression, estimated using Ordinary Least Squares (OLS), normally with the price specified as a log of price.

#### (e) Household Relocation Model (HRM)

##### Objective

To predict the relocation of households within the region each simulation year.

##### Algorithm

1. This model is implemented as a cross-classification rate-based model, there we have studied the household situation moving the age of the member, income category applied to each household in the synthetic population, each simulation year.
2. The model uses Monte Carlo Sampling to determine the outcome. It works by drawing a random number (from the uniform distribution, between 0 and 1), and comparing that random draw to the probability of moving for each household. There for they will move from one location to another.
3. The household is moved from the current location, It means that in practical where then were located there have the building id ,but when it has a null value. They remain on household table, but do not have a location.

#### (f) Household Location Choice Model (HLCM)

##### Objective

To predict the location choices of new or relocating households.

##### Algorithm

1. Households to be located by this model are those that were added by the Household Transition Model or predicted to move by the Household Relocation Model.
2. The model selects all those households with no location, and identifies all available, vacant housing units within the simulation year.
3. In this model, there is the choice sets are generally too large, normally random sampling of alternatives is used to construct plausible sized choice sets.
4. This model uses a Multinomial Logit Model structure to generate location choice probabilities across the choice set for each household.
5. The location probabilities are used by Monte Carlo Sampling to make a determination for each household regarding which of the available locations they will choose.

6. Once a household has chosen a location, then that located is nominated to the household after the residential unit becomes unavailable for any other household.

**D. Result table**

We have applied 4 models on above mentioned dataset. These models are Residential development project location choice model (RDPLCM), Non-residential development project Location Choice model (NRPLCM), Real estate price model (REPM) and Household location choice model (HLCM). We have estimated data set on these 4 models and simulation is performed. After this we got results in table and map format. They are shown in figure 4 and 5.

| zone_id | zone_tot_pop_2019 | zone_tot_pop_2018 | zone_tot_pop_2013 | zone_tot_pop_2012 | zone_tot_pop_2011 |
|---------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 46      | 3605.0            | 3619.0            | 3597.0            | 3583.0            | 3601.0            |
| 47      | 1930.0            | 1919.0            | 1932.0            | 1997.0            | 1907.0            |
| 48      | 1915.0            | 1915.0            | 1918.0            | 1955.0            | 1915.0            |
| 49      | 1054.0            | 1054.0            | 1054.0            | 1073.0            | 1054.0            |
| 50      | 2184.0            | 2200.0            | 2208.0            | 2228.0            | 2212.0            |
| 51      | 1966.0            | 1964.0            | 1964.0            | 2015.0            | 1973.0            |
| 52      | 2290.0            | 2295.0            | 2292.0            | 2360.0            | 2287.0            |
| 53      | 1330.0            | 1335.0            | 1330.0            | 1345.0            | 1330.0            |
| 54      | 3013.0            | 2995.0            | 3003.0            | 3123.0            | 3010.0            |
| 55      | 365.0             | 365.0             | 365.0             | 372.0             | 365.0             |
| 56      | 742.0             | 761.0             | 757.0             | 705.0             | 746.0             |
| 57      | 687.0             | 687.0             | 687.0             | 713.0             | 687.0             |
| 58      | 1412.0            | 1417.0            | 1408.0            | 1437.0            | 1409.0            |
| 59      | 1717.0            | 1708.0            | 1687.0            | 1677.0            | 1703.0            |
| 60      | 851.0             | 851.0             | 856.0             | 856.0             | 852.0             |
| 61      | 1151.0            | 1151.0            | 1152.0            | 1174.0            | 1162.0            |
| 62      | 2099.0            | 2077.0            | 2082.0            | 2227.0            | 2082.0            |
| 63      | 2276.0            | 2282.0            | 2276.0            | 2416.0            | 2276.0            |

Fig.4 Result table

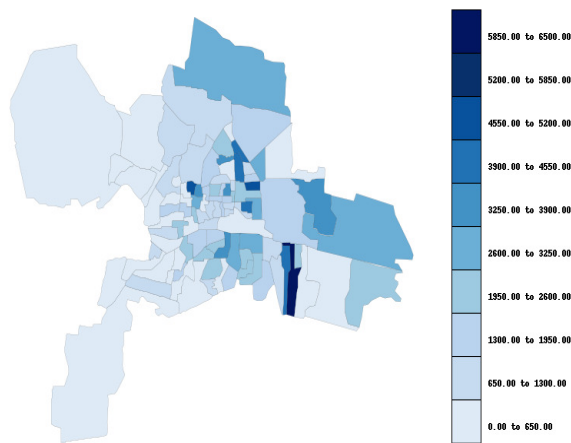


Fig.5 Result Map

Following bar chart displays the variation in population with respect to the dataset. X –axis represents the year and the Y-axis represents the population.

| Year | Zone 46 | Zone 47 | Zone 48 | Zone 65 |
|------|---------|---------|---------|---------|
| 2012 | 3583    | 1997    | 1955    | 2560    |
| 2013 | 3597    | 1932    | 1918    | 2502    |
| 2014 | 3602    | 1932    | 917     | 2500    |
| 2015 | 3601    | 1907    | 1915    | 2505    |
| 2016 | 3612    | 1940    | 1917    | 2516    |
| 2017 | 3602    | 1924    | 1917    | 2510    |
| 2018 | 3619    | 1919    | 1915    | 2500    |
| 2019 | 3605    | 1930    | 1915    | 2500    |
| 2020 | 3600    | 1968    | 1922    | 2500    |
| 2021 | 3579    | 1900    | 1915    | 2500    |
| 2022 | 3599    | 1941    | 1918    | 2502    |

Table 2: Population of Household Database

Following bar chart fig.6 displays the variation in population with respect to the dataset. X –axis represents the year and the Y-axis represents the population.

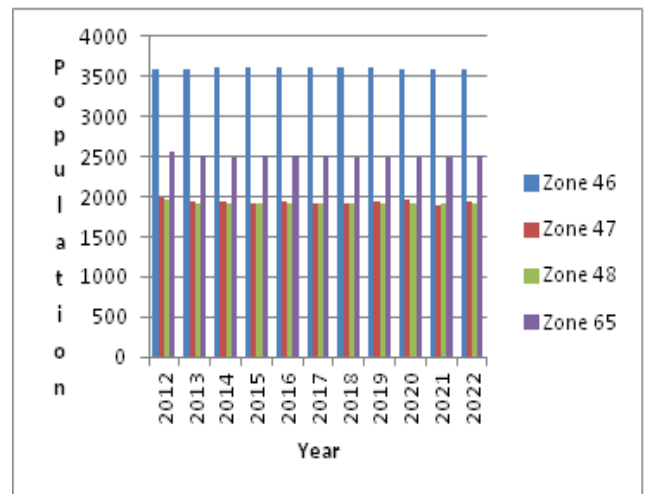


Fig.6 Zone Population

**E. Calculating Percent (Straight-Line) Growth Rates**

**Growth Rate:**

$$\text{Growth Rate} = \frac{V(\text{future Value}) - V(\text{base value})}{V(\text{base value})} * 100 \dots\dots\dots (1)$$

Where,

V (future value) = No. of population in next Year.

V (base value) = No. of population in base Year.



In the above equation, we have to find out the change in the growth rate of population between the future year with respect to the base year.

Following line chart displays the variation in Growth rate with respect to the dataset. X –axis represents the year and the Y-axis represents the rate of change.

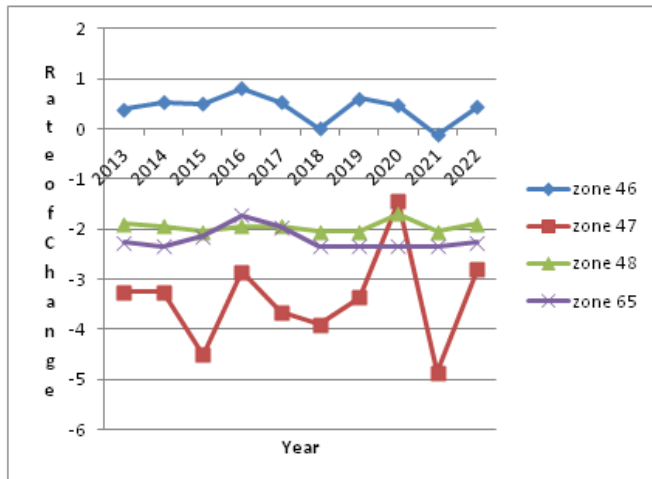


Fig. 7 Growth rate of population

#### IV. CONCLUSION

Urbansim is a modeling system developed to support for analyzing land policies and infrastructure investment we have used four model using OPUS tool are (a) Residential development project location choice model (RDPLCM), (b) Nonresidential development project location choice model (NRDPLCM), (c) Real estate price model (REPM) and (d) Household location choice mode (HLCM). We have done simulation using OPUS on these four models.

We have observed population change for specific input in above bar chart and graph. For the input, we have predicted population from the Year 2012 to Year 2022 and a plot graph for 4 zone named as zone 46, zone 47, zone 48 and zone 65. The graph shown in fig.7. On X – axis population years and on Y-axis change in growth rate. As shown in the bar chart fig. 6, there is a substantial change in population for the year 2013 onwards. There is variation in growth rate for each year as shown in the graph. When the growth rate is positive it shown that population has been increasing for the specific zone and year. But when it is negative, it describes that population has been decreased.

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