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Simulation of Urban Area through Opus : Open Platform for Urban Simulation

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***Abstract*— Many countries of the world are currently suffering problems caused by speedily growing populations in urban areas, and both governments and human being has a duty to find ways to overcome these problems. Over population of urban areas has an increasing frequent population problem. Overpopulation can lead to overcrowding and poor quality housing in many grows cities. So upcoming problems like land use, transportation, and other environment problem will be faced by urban planner in future. UrbanSim is more general software platform to support integrated modelling, and has been launched with international imposition to use it and also for further development under the Open Platform for Urban Simulation (Opus). Researchers can use it at starting level modelling system support for transportation, land, and environmental planning in metropolitan areas. In recent year some application has been developed over the system in U.S. cities and abroad, including City Salt Lake, Detroit City, Honolulu City, Zürich City, Houston, Paris, Phoenix City, Seattle City, and, Eugene-Springfield. Simulation result obtained for the Aurangabad City is also presented in the paper.**

***Keywords*— UrbanSimulation, Open Source Framework, Land -use, Environmental, Transportation modelling and Opus.**

I. INTRODUCTION

Urbansim is open source software, which is continuously used by many countries for urban planning application over 15 years. The project was developed by Paul Waddell and his research team at university of Washington since 1990's.The Urbansim was motivated from planning and predicting urban areas for future year. The first prototype model was developed in 1991 for Oregon. It was operate on parcel, zone, and gridcell geographically. Urbansim is freely available on www.urbansim.org and it was further developed in OPUS (Open Platform for Urban Simulation). Opus was inspired from some different simulation project like as ILUTE, Urbansim and MATsim project [1]. The Opus was also motivated from similar project R-project. The main objective to develop Opus project is to support transportation, land-use, and other environment planning.

This paper has objective to understand Urbansim working for who would like to use urbanism project. This paper is useful for researcher and will planner for planning urban areas through opus. This paper gives the overview, architecture and model structure of urbanism. At the last paper is based on prototype model for Aurangabad city.

II. OVERVIEW OF URBANSIM

Urbansim is simulation system used over past years to inform deliberation on public choices with long term[2].Significant effect of urban areas have come under to pressure to link planning of transportation , environment quality and land use and from citizen side effect of growth such as housing, sprawl, congestion, affordability and loss of open space. For example, consider highway expansion project. Due to excess demand of vehicle the congestion problem is lead force to slow down. Thus urban planner work on balance capacity. This is challenging task for urban planner to control bottleneck congestion. Before doing the expansion of highway the civil engineer known about the changing scenario with rescpect to time. They can predict about new capacity and increasing vehicle. This is depending upon n the population growth and household income. In short, the planner had done simulation before doing that expansion project [3]. For this purpose they can use OPUS. The Urbansim or OPUS has some task as follows:

- It is predicting the land information up to 10to 40 years for travel model.
- It is predicting land use pattern from investment in transits infrastructure or road way or transit pricing.
- Predicting growth of land use or economical changes with respect to time
- Predicting employment job with respect to population density and household.
- Predicting land use development in large capacity transits corridors.

The urbanism model is unique in that prior operational land use model based on cross sectional, equilibrium key features of urbanism model and software implementation, aggregate approaches to get on approach that model individuals jobs, households and parcels their changes from one year to next year [4]. The basic key feature of urbanism model and software implementation.

A. Key Features of the UrbanSim Model System

Some Important features may be listed as follows:

- The model simulates different choices and the key decision maker's impact on urban development; e.g. the location and mobility choices of households.

- The model explicitly accounts for land, structures (houses and commercial buildings), and occupants (households and businesses).
- The model simulates urban development with respect to time and space, as opposed to an equilibrium approach.
- The model simulates the land price over land market, government policy
- The model is required high level of spatial data like zonal data to travel model zones.
- The model indicates newly developed and redeveloped area.

B. Key Features of the UrbanSim Software Implementation

- A. The software supporting Apple OS X, Windows, Linux and other platforms supporting Python.
- The software is implemented in the Open Platform for Urban Simulation (Opus). The software is Open Source, using the GPL license and freely available at www.urbansim.org
- The user interface focuses on configuring the model system, managing data, running and evaluating scenarios.
- The Opus is implemented using python to maximize software flexibility.
- The Opus inputs and output can be viewed using GIS software like as ArcGIS or Post GIS.
- The Opus can support various database.

III. OPUS ARCHITECTURE

Opus was firstly implemented in java then later it was redeveloped in the Python programming language. The python high-level programming language and which is widely popular in the modelling and GIS communities. Python is easy languages to interfaces the software in other languages such as c, C++. The Opus leverages python libraries [10]. The Opus work flow is dynamic simulation system, iteratively between data analysis, model system, scenario simulation and indication and visualization illustrated in fig. 1.

The Opus can be structured in following classes which is corresponds to workflow : Data classes for developing and analysing data, Model classes for configuration , developing, estimation, specifying models and miscellaneous group that support python packages as shown in fig 2.

A. Developing and analysing data

Data at both ends at start and end modelling. A database is collection of attributes such as a set of countries, a set of person. A data is encapsulated in python called dataset. Opus allows user read data in different format [5]. There are predefined subclasses of class storage; user can from following types.

- ASCII or CSV files
- SQL storage (MySQL, PostGrass)
- Database formatted files
- ESRI formatted files
- Numpy(Python) arrays

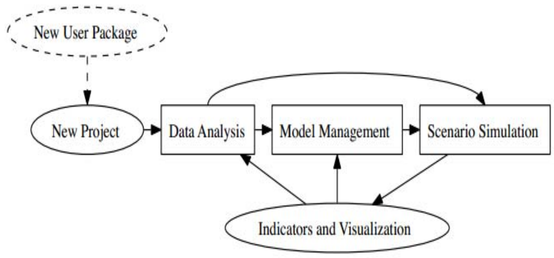

Fig. 1 Opus work flow. Model management includes creating, configuring and estimating models; Scenario simulation includes configuring and running a system of models [10].

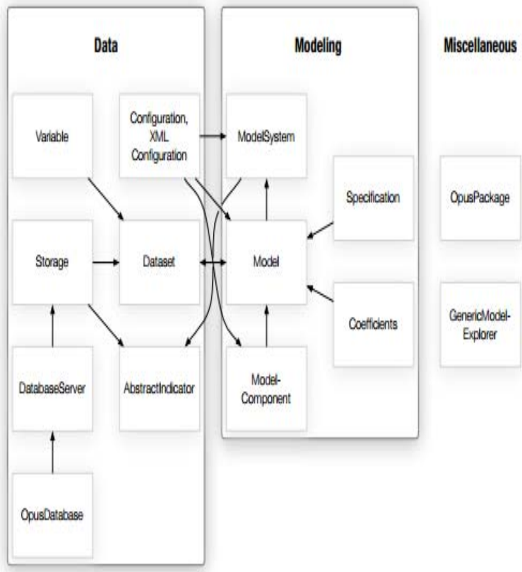

Fig. 2 Opus Architecture [10].

B. Implementation and configuration model

Opus managing a group of models combine into group of model system that can be used for simulating over period of time [7], for repeatedly it called method ‘run’. And for implementation a method called ‘estimate’. To make easy use of Opus offers few commonly used component. The regression, allocation, hierarchical choice, simple, choice, allocation models have an estimation and simulation component. We discussed it in section IV.

C. Indicator framework

Indicator framework is useful for analysing data in Opus environment. It is also helpful for analyse result of simulation from running model system. It operates on cache directory.

IV. MODEL STRUCTURE

A. *Geographic Units of Analysis in Urbanism Models*

We begin with an overview of the three different data structures that UrbanSim now supports: gridcells, parcels, and zones.

1) Gridcells :

The gridcell-based approach to developing the data for UrbanSim, as the name proposes, begins with the decision of resolution to use for a grid to overlay the study area. There is no absolutely correct grid cell resolution, and a rational choice of 150 meters by 150 meters was chosen in early UrbanSim applications shown in fig.3, mainly as a compromise between the high level of resolution desired, and the increased computational necessities made by higher resolution data.

Figure 3: Gridcells in Pragati Housing society Area of Aurangabad City

2) Parcels

To address some of the limitations of the gridcell-based data structure, recent development of UrbanSim has adopted a data structure based on parcels. The parcel-based Urbanism application uses a data model that reflects parcels, buildings, households and jobs as the primary objects and units of analysis. Households and jobs choose locations by selecting a particular building, which is associated with a specific parcel. Real estate development is based on development projects occurring on specific parcels. In the most recent extensions of the Puget Sound model, persons have been added to the data model, and workers are associated with specific jobs. These data relationships are showman Figure 4, and make clear that only the link of buildings to a geographic unit is changed.

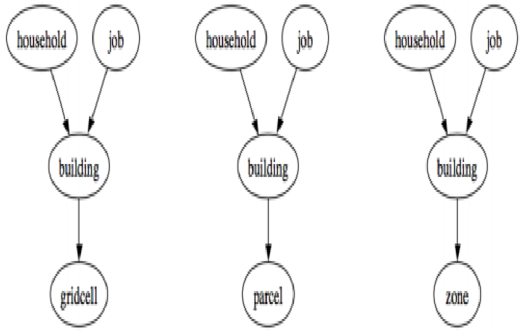

Figure 4: Flexible Geographic Units for UrbanSim

3) Zones

Given the available flexibility in configuring models in OPUS, an alternative data structure can be readily substituted for parcel or gridcell based data. For example, locations could be defined by zones used in the travel model, to make them consistent with current-generation zone-based travel models. This approach can also be used to create a rather simple model system using less geographic detail. For example, an application in Paris used Communes or administrative areas roughly equivalent to traffic analysis zones in number (approximately 1300)

B. *Comparison of Operational Model Characteristics*

To clarify differences between UrbanSim and other operational urban models that have been reviewed elsewhere [1,2,3] , Table 1 compares the key features of four model approaches.

C. *Description of Opus models and model components*

1) Demographic and Economic Transition Models

The Demographic Transition Model simulates births and deaths in the population of households. Externally inflicted population control totals determine overall target population values, and can be specified in more detail of income presence or absence of children and groups, age, size, by distribution[7]. This enables the modeling of a shifting population distribution over time. Iterative proportional fitting (is used to determine how many households of each type are to be created or deleted. Newly created households are added to the household list but without an assignment to a specific housing unit (placed in limbo), to be placed in housing later by the Household Location Choice Model. Households to be deleted to meet the control totals are drawn preferentially from households in midpoint, selected at random. The Economic Transition Model is responsible for modeling job creation and loss. Employment control totals are determine employment targets, and can be specified by distribution of business sector.

TABLE I
COMPARISON OF OPERATIONAL MODEL CHARACTERISTICS [1]

Characteristic	**DRAM/EMPAL**	**MEPLAN and TRANUS**	**CUF-2**	**UrbanSim**
Model Structure	Spatial Interaction	Spatial Input Output	Discrete Choice	Discrete Choice
Household Location Choice	Modeled	Modeled	Not Modeled	Modeled
Household Classification	Aggregate, 8 categories	Aggregate User-Defined	Not Represented	Disaggregate, Income, Persons, Workers, Child
Employment Location Choice	Modeled	Modeled	Not Modeled	Modeled
Employment Classification	Aggregate, 8 categories	Aggregate User-Defined	Not Represented	Disaggregate,10-20 Sectors
Real Estate Development	Not Modeled	Modeled	Modeled	Modeled
Real Estate Classification	4 Land Uses	Aggregate, User-Defined	7 Land Uses	24 Development Types
Real Estate Measures	Acres	AcresUnitsFloorspace	Acres	AcresUnitsFloorspace
Real Estate Prices	Not Modeled	Modeled	Not Modeled	Modeled
Geographic Basis	Census Tracts or Aggregates	User-Defined Zones (2 - 300)	Grid Cells	Grid Cells
Temporal Basis	Quasi-dynamic, Equilibrium(5-10 year steps)	Cross-Sectional, Equilibrium	Annual, Dynamic	Annual, Dynamic
Interaction with Travel Models	Yes	Yes	No	Yes
Modular Model Structure	Partial	No	No	Yes
Software Access	Proprietary	Proprietary	NA	Open Source

2) Household and Employment Mobility Models

Model simulates households deciding whether to move the Household Mobility. Measure probabilities are based on ancient data. Once a household has chosen to move, it is placed in midpoint to indicate it has no current site, and the space it earlier occupied is made available. The Employment Mobility Model determines which jobs will move from their current locations during a particular year using a similar approach to the Household Mobility Model [9].

3) Household and Employment Location Models

The Household Location Choice Model chooses a location for each household that has no current location. A sample of locations with unused housing units is randomly selected from the set of all vacant housing for each such household. Each alternative in the sample is evaluated for its desirability to the household, through a multinomial logit model calibrated to observed data[6]. The household is assigned to its most desired location among those available. Responsible for determining a location for each job that has no location is the Employment Location Choice Model. For each such job, a sample of locations with empty square feet, or space in housing units for home -based jobs, is randomly selected from the set of all possible alternatives. The variables used in the household location model include attributes of the housing in the grid cell (age, price, density), neighbourhood characteristics (land use mix, local accessibility to retail, density, average property values,), and regional accessibility to jobs. Variables in the employment location model include real estate characteristics in the grid cell (type of space, price, type of space, density, age), neighbourhood characteristics (land use mix, employment in each other sector, average land values), and regional accessibility to population.

4) Real Estate Development Model

The Real Estate Development Model simulates developer choices about what kind of construction to undertake and where, including both new development and regeneration of existing structures. Each year, the model iterates over all grid cells on which development is allowed and creates a list of possible transition replacements (representing different development types), including the being chosen is calculated in a multinomial log it model. Variables included in the developer model include characteristics of the grid cell (current development, policy constraints, land and improvement value), characteristics of the site location (proximity to highways, arterials, existing development, and recent development), and regional accessibility to population.

5) Land Price Model

The Land Price Model simulates land prices of each grid cell as the characteristics of site modification over time. It is based on urban economic theory, which states that the value of site is capitalized into the price of land[8]. The model is calibrated from ancient data using a relating regression to include the effect of site, neighbourhood, accessibility, and policy effects on land prices. It also allows incorporating the effects of short-term fluctuations in local and regional vacancy rates on overall land prices. Similar variables are used as in the Development Model.

V. Case Study On Aurangabad City

The UrbanSim is applied to Aurangabad regions. In this case, UrbanSim models were developed with readily-available data and limited human resources. In a new region the purpose was to understand how difficult it was to develop an UrbanSim model that could be used to evaluate its use. The case-study differs considerably. In the case of Aurangabad, very limited data and no transport model were readily available. For Aurangabad, relatively abundant and easy-to-use data were available. A well-developed transportation model was also at our disposition.

The study region includes ward-wise data; the following figure shows the 99 ward in Aurangabad city. We plan to integrate all available data and simulations results will be generated in future.

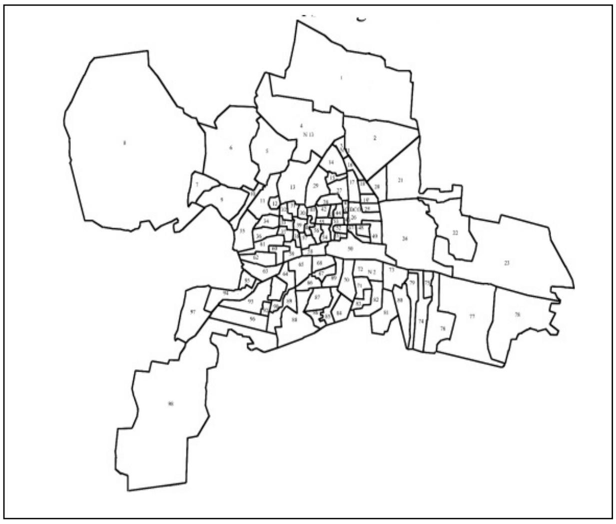

Fig.5 Aurangabad city ward wise map

VI. Conclusions

The UrbanSim tool has made significant progress toward developing models to support land use and transportation planning and growth management. While much has been accomplished, many challenges remain. Like as, adding micro simulation of demographic processes (household change). Metropolitan land use, transportation and environmental planning must be more effectively integrated than has traditionally been the case. The challenge of balancing multiple objectives and agendas within urban areas in the India and abroad have grown increasingly intractable politically and this work represents a small effort to contribute to more deliberative and informed metropolitan governance. It is, in closing, only one step forward. Some important websites are listed for convenience. A preliminary study of Aurangabad region is also reported.

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