Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 227 (2016) 3 – 10

Procedia
Social and Behavioral Sciences

CITIES 2015 International Conference, Intelligent Planning Towards Smart Cities, CITIES 2015, 3-4 November 2015, Surabaya, Indonesia

Prediction of urban growth using the bucket model

I Made IM Brunner[a*]

[a]Department of Environmental Engineering, Universitas Bakrie, Jl. HR Rasuna Said Kav. C22, Jakarta Selatan 12920, Indonesia

Abstract

A model has been developed to figure out possible population growth pattern in a city. The model suggests that new inhabitants will first saturate the developed urban area, then the overflow fill the partially developed urban area, and lastly move to the adjacent area outside of those two mentioned zones. The last zone is mostly located in an existing agricultural site, which is converted into urban area after the adjacent areas are developed. This model was generated based on spatial and other datasets from the City and County of Honolulu, Hawaii. Those data were analyzed and manipulated mathematically to create the grid map system, a uniform vector grid cell that is filled with demographic, socio-economic, and land use data. This deterministic model is relatively simple yet powerful enough to help planners in decision making process on projecting infrastructures in the future of a city.

Peer-review under responsibility of the organizing committee of CITIES 2015

Keywords: Urban Growth; Spatial Model; GIS; Honolulu.

1. Introduction

This paper attempts to discuss the development of an urban growth model that can be used to assist decision makers, planners, or engineers to look at the possible growth pattern of a city. This "Bucket" model was created

* Corresponding author. Tel.: +62 81317821085; fax: +0-000-000-0000 .
E-mail address: imade.brunner@gmail.com

Peer-review under responsibility of the organizing committee of CITIES 2015
doi:10.1016/j.sbspro.2016.06.036

based on a uniform 0.1 square-miles or around 25.9 hectares grid (approximately 508.6 x 508.6 square-meters) cells. This checker-board pattern cells were populated with number of population who reside in Honolulu, Hawaii. The population data were derived from the 2000 US Census Data and spatially manipulated by overlying the land use, zoning, and tax-map key (TMK) maps. The cells were also filled with number of possible jobs based on the US Economic Census, County Business Pattern, and TMK data. Land use data consisted of information regarding the allocation of land either for urban, rural, agriculture, or conservation purposes.

Although Honolulu is famous for its images of sandy beaches and swaying palm trees, isolated location and extremely centralized government system making it an ideal location for the development of this urban growth model. Honolulu which located on the island of Oahu has an extensive collection of publicly available spatial datasets, as well as other data. Nonetheless, those data come from different sources, which increase level of difficulty in analyzing and comparing them. Creating a grid-based mapping system by spatially converting maps with different size of boundaries into uniform cells could be a possible solution. Data from the original maps were digitally manipulated and stored in vector based cells. The cells hold robust information to assist researchers for various applications.

The Bucket model is based on the assumption that growth first occurs in urban areas already being developed. Once density of an urban area becomes saturated, growth moves to partially developed lands adjacent to the urban district, finally spreads into agricultural and open zone areas. The model could provide a broad picture of where growth could arise based on population increase and how rigidly growth management is applied. The growth pattern is determined by set parameters, which can be related to urban policies stipulated by the government or infrastructure development plans. Decision makers, planners, engineers, or other entities could participate in shaping the model by providing the allowable population increase in an area, among others.

2. Methods

2.1. Grid Map

The checker-board pattern grid map is believed to be more preferable than the original thematic maps. There are several reasons supporting the idea. Firstly, the shapes and sizes of the grid map are equal whereas those of the original thematic maps are not uniform. Secondly, grid map could provide a way in screening out areas that are not suitable for analysis, such as uninhabited areas within an administrative map. Thirdly, grid map is a solution that can be applied in disaggregating a larger size thematic polygon into smaller size cells.

The 25.9 hectares vector type cell is applied because it is within 402.3 meters radius walking distance and about the size of a neighborhood. The distance between centroid of a cell and it adjacent one is between 508.6 to 719.4 meters. This distance is within a comfortable walking distance of 402.3 to 804.7 meters as suggested by the literature (Dittmar & Ohland, 2004; NJTransit, 1994; Regional Plan Association, 1997). The distance between the centroid of a cell and the centroid of second neighbor cells is between 1.1 to 1.5 kilometers. This distance is further than the comfortable walking distance but still within the “walking impact zone” of 1.2 kilometers as revealed in the study of ridership among housing and commercial developments near 4 rail stations in Canada (TCRP, 1995, p.31).

The cell, since it is smaller than the size of a typical census block group, which can provide more detailed information. Another benefit is that the number of population within a cell can be directly compared to other cell to determine their density level. Analysis of population using this grid maps system has been applied in several studies (UH DURP & UHERO, 2015; Brunner, Kim & Yamashita, 2011; Kim, Brunner & Yamashita, 2006). Meanwhile, similar studies using a larger cell of 0.25 square-miles or around 64.75 hectares have been conducted for analysis of transit route in Logan, Utah (Ramirez & Seneviratne, 1996), as well as in south Placer County, California (Milam & Luo, 2008) to find out the correlation between land use development density and intensity with potential Bus Rapid Transit (BRT) stations location.

Figure 1, “Population Distribution on Oahu in 2000,” shows the comparison between population distributions based on the 2000 Census Blockgroups and grid based map. The baseline population grid based map is more realistic than the 2000 Census Blockgroups map. Population on Oahu in reality resides mostly near the main roads, and most of the island interior mountainous areas are unpopulated. The blockgroup map does not have information that could separate populated and uninhabited areas. Hence, populations of a blockgroup are distributed evenly within the