

GIS-Based Spatial Allocation Analysis of Population Growth in Regional Water Resource Planning

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Abstract

Adequate water resource management has become increasingly important in Central Texas because of the rapid population growth and the limited water resources in the region. The Lower Colorado River Authority (LCRA) is involved in water resource management in the region. One task in water resource planning at LCRA is to spatially allocate estimated countywide population growth for a given period in the future to sub-county areas and determine the subsequent water demand change in sub-county areas. Currently LCRA uses a spreadsheet model that cannot take into account major factors affecting the spatial distribution of population growth in a county. The author extended existing models to facilitate the spatial allocation of population growth in regional water resource planning based on current practices at LCRA. This paper presents a GIS-based system consisting of a set of mathematical models and analysis procedures that can be used in spatial allocation analysis of population growth in the context of regional water resource management.

I. INTRODUCTION

Central Texas in the United States of America has been experiencing a steady population growth during the past decade. This growth trend will continue for the next three decades. A problem faced by the Lower Colorado River Authority (LCRA) in Texas is the growing threat of water shortage in the lower Colorado River basin due to the rapid population growth. This situation requires improved water resource planning for the region. A key step in the water planning process at LCRA is to allocate countywide population growth during a given time period to sub-county areas. This spatial allocation process aims to determine how population growth from a historic or current year to a future year in a county would distribute in space within the county, and what the spatial distribution of water demand change would be in the county as a result of the population growth.

The majority of water allocation literature has been dedicated to assessing and projecting residential water demand (Adderley and Maidment 1990; Kabir 1990; Billings and Agthe 1998). It is arguable that several variables including population, annual precipitation, income, and water price may affect water demand across geographic space, but the appropriateness of using these variables to estimate water demand remains questionable (Adderley and Maidment 1990). It has been demonstrated that the most reliable method for estimating water demand in an area is to multiply the number of people in the area by water consumption per capita day (Adderley and Maidment 1990). The key then is to determine the number of people in a sub-county area.

One approach to address this problem is to estimate the population in sub-county areas based on estimated county

level population in a given year using interpolation techniques. But past experience at LCRA indicated that conventional interpolation techniques are not appropriate for estimating population in sub-county areas (Kabir 1990). Instead, a spatial allocation approach was suggested, which focuses on the characteristics of sub-county areas in order to allocate an appropriate amount of population from the county to the sub-county area of interest (Kabir 1990). The question then becomes how one can develop a set of models that can be used to forecast population growth in sub-county areas in a county.

Forecasting how sub-county areas would grow in a county lies in the heart of urban growth modeling. There are two basic approaches of modeling (urban) growth. One approach uses Cellular Automata models and forecasts urban growth using the interactions between spatial area units (see, e.g., Meaille and Wald 1990; White and Engelen 1993; Clarke *et al.* 1997; Clarke and Gaydos 1998; Batty *et al.* 1999). The second approach is based on gravity models and takes consideration of a number of key factors that are considered to influence urban growth (Batty 1992; Batty and Xie 1994a, 1994b; Landis 1995; Bell *et al.* 2000). In order to be consistent with existing practices at LCRA, we chose to stay with the tradition of gravity models. The most recently developed models along this tradition are the ones presented by Bell *et al.* (2000).

Factors considered important for spatial allocation of population growth at LCRA include potential carrying capacity of a piece of land, accessibility of a piece of land to facilities, adjacency of a piece of land to developed land, and transportation convenience of a piece of land (Kabir 1990).

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Potential carrying capacity is defined as the percentage of land for further development in any given area as well as what the land is planned for in the zoning map (single family residential area, multi-family residential area, and areas with no zoning).

Accessibility to facilities is a key factor contributing to the attractiveness of a piece of land for future development. Examples of facilities include schools, libraries, retail centers, and employment centers, to name a few. The adjacency of a piece of land to areas that are already developed is another factor contributing to its attractiveness for future development. Although there are exceptions, new residential development usually starts in locations that are not too far away from existing developed areas. Transportation convenience is another important factor determining how attractive a particular piece of land is.

Current practices at LCRA use a spreadsheet model that cannot fully account for these factors as well as the spatial variations of these factors in geographic space. The author modified and extended the models proposed by Bell *et al.* (2000) and used the models in spatial allocation of population growth in the context of regional water resource planning. Although water demand may include water usage in commercial and industrial operations, agricultural irrigation, and other purposes, the exclusive focus of this discussion is on water demand change related to residential development as a result of population growth.

II. MATHEMATICAL MODELS

In order to conduct the spatial allocation analysis, it is necessary to divide the county in question into a grid of a given resolution (e.g., specified by a user of the system). During the modeling process, the system calculates a score for each of the factors discussed in the last section. The system then allocates county level population growth over the study period proportionally to each grid cell in a sub-county area of interest based on the overall score of each cell. This overall score is a weighted combination of all factors. Before we discuss mathematical models for determining these scores, it is necessary to present the formula for computing water demand in sub-county areas.

Determining water demand in sub-county areas

For an area of interest in a county, one can divide the area into grid cells of a given resolution. The key here is to determine the water demand in each grid cell. In order to do that, the number of people in a grid cell has to be determined. For a year in which the exact population in census tracts or census block groups is known (e.g., censal years 1990 and 2000), the number of people in each grid cell can be estimated using the Polygon-in-Cell procedure (Appendix A). This type of years are called base years. This grid is called a base year population

grid. Once the number of people in each grid cell in a given year is determined, the subsequent water demand associated with each grid cell in that year can be obtained using the expression given below.

$$WD_c = NP_c \times GPCD \times N_t \quad (1)$$

where:

WD_c = water demand in cell c in the year in question

NP_c = the number of people in cell c in the year

$GPCD$ = gallons of water consumption per capita day

N_t = number of days in question

Modeling potential carrying capacity

A score measuring the potential carrying capacity of a piece of land for further development can be determined using Expression (2) given below. The availability of land in any grid cell is obtained by overlaying the grid cell with a map layer of the 100-year floodplain, a map layer of zoning if applicable, a map layer of census tracts containing the population density, and a map layer of preserved lands in the county in question. Once the population density of the study area exceeds a given number (e.g., 2000 people per square mile), this area is considered as a built area. This overlay process produces a map layer containing only land available for further development. The proposed zoning categories in a county include industrial, commercial, residential (single family vs. multi-family), and open space (no zoning yet). Because this discussion is focused on residential development, we will only consider three zoning categories, single-family residential, multi-family residential, and open space in the expression given below.

$$L_{ac} = \sum_{i=1}^n (K_i \times P_i \times A_g) \quad (2)$$

where:

L_{ac} = a score measuring potential carrying capacity of cell c

K_i = a scaling factor representing the importance of land use (zoning) category i

P_i = percentage of land available for further development in cell c for land use category i

A_g = the area of a grid cell (known once the resolution of the grid is given)

Modeling accessibility of a grid cell to facilities

A score for measuring accessibility of each grid cell to facilities is calculated based on the proximity of a grid cell to different facilities as well as the attractiveness of a facility. The model is a modified version of the model proposed by Bell *et al.* (2000). The formula used for calculating the accessibility score associated with each cell is given below.

$$A_{ac} = \sum_{i=1}^k (W_i \times \frac{F_{ic}}{F_{i\max}}) \quad (3)$$

where:

$$F_{ic} = \sum_{j=1}^l F_{ijc}$$

$$F_{ijc} = \frac{M_{ij}}{(d_{ijc})^b}$$

A_{ac} = accessibility score for grid cell c

k = the number of facility types

l = the number of instances within a facility type; it varies from one facility type to another

W_i = user provided or automatically calibrated weight for facility type i

F_{ic} = measure of accessibility of cell c to all instance (j) of facility type i

F_{imax} = maximum value of F_{ic} in all cells for facility type i

M_{ij} = a quantitative value reflecting the attractiveness of any instance j of facility type i

d_{ijc} = is the distance between cell c and any instance j of facility type i

b = distance decay parameter

Expression (3) has its roots in the traditional literature of accessibility modeling in transportation (Hanson 1995, p.5). First, the expression calculates the accessibility of a grid cell to a particular type of facilities (e.g., schools, shopping centers, and employment centers)—denoted as F_{ic} . Second, the expression normalizes the accessibility scores of the grid cell associated with all facility types through the computation of F_{ic}/F_{imax} . Third, the expression measures the accessibility of each grid cell to all facility types using a weighted combination of the normalized accessibility scores.

Modeling adjacency of a grid cell to developed land

A score measuring the adjacency of a grid cell to developed land is determined by the expression given below.

$$A_{dc} = \frac{k}{D_{cj}} \text{ (if } D_{cj} \geq k \text{ miles) or } 1.0 \text{ (if } D_{cj} < k \text{ miles)} \quad (4)$$

where:

A_{dc} = adjacency score for grid cell c

D_{cj} = is the distance between grid cell c to the nearest developed cell j

k = a constant specified by the user

Constant k is a threshold distance. In Expression (4), grid cells within this threshold distance from developed areas are assigned a full score of 1.0. Grid cells that are more than k miles from developed land are assigned a score that decreases from 1.0 to 0.0 when the distance from a grid cell from developed land increases from k miles to infinite.

Modeling transportation convenience of a grid cell

Based on the same logic as described in Section 2.4, a score (A_{tc}) measuring the transportation convenience of a grid cell is determined by an expression similar to Expression (4). This

score reflects the closeness from a grid cell to the nearest roads (e.g., highways) considered in the modeling process. The distance can either be network based distance or straight distance. This score can be obtained by replacing A_{dc} with A_{tc} in Expression (4).

Determining overall score of a cell

Once the scores for measuring potential carrying capacity of a grid cell, the accessibility of a grid cell to facilities, the importance of adjacency of a grid cell to developed land, and the transportation convenience of a grid cell are determined, a combined score measuring the population growth/decline for each grid cell can be determined by the formula given below.

$$S_c = \frac{L_{ac}}{L_{amax}} \times (W_a \times \frac{A_{ac}}{A_{amax}} + W_a \times \frac{A_{dc}}{A_{dmax}} + W_t \times \frac{A_{tc}}{A_{tmax}}) \quad (5)$$

where:

S_c = the combined score of grid cell c

L_{ac} = score measuring the potential carrying capacity of cell c

A_{ac} = score measuring the accessibility of cell c to facilities

A_{dc} = score measuring the adjacency of cell c to developed land

A_{tc} = score measuring the transportation convenience of grid cell c to highways

W_a = user provided weight reflecting the relative importance of accessibility to facilities

W_d = user provided weight reflecting the relative importance of adjacency

W_t = user provided weight reflecting the relative importance of transportation convenience

L_{amax} = maximum L_{ac} for all grid cells, used to normalize the values of L_{ac} associated with all grid cells in the study area

A_{amax} = maximum A_{ac} for all grid cells, used to normalize the values of A_{ac} associated with all grid cells in the study area

A_{dmax} = maximum A_{dc} for all grid cells, used to normalize the values of A_{dc} associated with all grid cells in the study area

A_{tmax} = maximum A_{tc} for all grid cells, used to normalize the values of A_{tc} associated with all grid cells in the study area

Determining spatial allocation of population growth

Based on the final scores of the grid cells in the study area and the estimated population change in a given time period from the base year to a future year in question, population change of each cell for that given period of time can be determined as follows using expression (6).

$$POP_{change-cell} = \frac{S_c}{\sum_{c=1}^n S_c} \times POP_{change-county} \quad (6)$$

where:

$POP_{change-cell}$ = population change in cell c in the given time period

S_c = combined overall score of cell c
 n = the number of grid cells in the entire county in question
 $POP_{change-county}$ = population change in the county during the given time period

Once the spatial allocation of population growth in the sub-county area in question is determined, the number of people in each grid cell in that sub-county area in the future year in question can be obtained by adding the number of people in each cell as determined by Expression (6) and the number of people in each cell in the population grid corresponding to the base year. The total water demand in each grid cell in that future year then can be determined by Expression (1). We thus have the spatial allocation of the population in the sub-county area and the subsequent spatial distribution of water demand in the area.

III. GIS PROCEDURES AND THEIR IMPLEMENTATIONS

A GIS-based system, called WaterPlanTools, was designed and implemented in ArcGIS using a combination of Visual Basic programming and Visual C++ programming. A GIS functional module consisting of a set of procedures was designed for each of the seven expressions discussed in the last section. Due to space limitations, only GIS procedures related to two functional modules, the module related to modeling potential carrying capacity and the module related to accessibility modeling, are presented in this section (Tables 1 and 2). Descriptions related to the other modules can be found in Zhan (2001).

Table 1 shows the eight steps for computing the score measuring the potential carrying capacity of each grid cell in the sub-county area in question. The first step constructs a

Table 1. Functions related to modeling potential carrying capacity

Step	Description of Procedures	Related Data
1	Construct a countywide grid. Construct a grid covering the entire county containing the study area specified by the user.	Layer of county boundary
2	Specify weights for each landuse category. Let the user choose the categories of landuse and input a scaling factor K_{is} for each category of landuse (single-family, multiple-family, and open space)	
3	Obtain land suitable for further development. Overlay the layer of 100-year floodplain and the layer of preserved land to produce a layer containing polygons showing land suitable for further development.	Layer of 100-year floodplain; layer of preserved land
4	Produce a layer showing the percentage of land available for further development in each census tract based on population density. First, use the census tracts in the base year as the base layer. Second, compute the percentage of land available for further development in each census tract based on the population density of each census tract. Third, find the census tract with the highest population density in the entire county (e.g., 2000 people per square mile). The percentage of land available for further development in census tract i can be obtained by the expression: $P_{land(i)} = 100 \times (1 - PD_i/PD_{highest})$, where, $P_{land(i)}$ is the percentage of land in census tract i for further development, PD_i is the population density in census tract i , and $PD_{highest}$ is the highest population density in census tracts in the study area.	Census block groups or census tracts and the resulting layer obtained in Step 3 in this table
5	Produce a layer containing polygons with developable land AND percentage of land available for further development in each polygon. This layer can be obtained by overlaying the resulting layers of Steps 3 and 4.	
6	Produce a new layer consisting of polygons showing developable land, the percentage of land available for further development in each polygon, AND the proposed category of land use (single-family, multiple-family, and open space). This layer can be obtained by overlaying the resulting (outcome) layer of Step 5 in this table and the layer of zoning map.	Layer of zoning map
7	Obtain the percentage of land for further development for each category of land use in each cell in the entire county. This task can be accomplished by summing all parts of all polygons (outcome layer of Step 6 in this table) covered by the cell in question in relation to a specific category of landuse using the polygons-in-cell procedure (Appendix A).	Layer of polygons from the outcome layer of step 6 in this table
8	Use Expression (2) to obtain the potential carrying capacity score L_{ac} associated with each cell in the entire county.	Results of Step 7 in this table

Table 2. Functions related to modeling accessibility to facilities

Step	Description of procedures	Related data
1	Decide the number of facility types k based on a user's choice from a list of facility types provided by the system (e.g., schools, shopping centers, employment centers, etc.)	Layers of facilities of interest
2	Set the distance decay parameter and obtain the weights for each facility type	
3	For each facility type i	
3.1	For each grid cell c in the entire county	
3.1.1	For each instance j of facility type i (e.g., School No.8 in all schools)	
3.1.1.1	Compute the distance between instance j and grid cell c	Layers of facilities of interest
3.1.1.2	Compute F_{ijc} based on Expression (3)	Layers of facilities of interest
3.2	Compute F_{ic} based on Expression (3)	Layers of facilities of interest
3.3	Find the maximum value (F_{imax}) of all F_{ics} for all grid cells for facility type i	
4	Compute A_{ac} for all facility types ($i = 1, 2, \dots, k$) based on Expression (3)	

grid of given resolution covering the entire county. This is important because only county level population data are available for the analysis. The population growth has to be proportionally distributed to the entire county. The spatial distribution of population growth in a sub-county area specified by the user then can be determined. After obtaining a scaling factor for each of the three categories of land use in Step 2, Steps 3 to 7 overlay four map layers, the 100-year floodplain, the preserved lands, census tracts, and zoning map to obtain the score for measuring potential carrying capacity in each grid cell. The final step, Step 8, completes the process and computes a score for each grid cell using Expression (2).

Key procedures in the module related to accessibility modeling are the three nested loops (Table 2). These three nested loops compute the values of F_{ic} and F_{imax} . Once these values are obtained and the weights are given, the value of A_{ac} can be determined using Expression (3).

IV. EVALUATION OF THE SYSTEM

The system was tested using data from Travis County in Texas. A total of nine different map layers were collected for testing the system (Table 3). Travis County, where the state capital Austin is located, had a total of 812,280 residents in 2000. Most of the population in the county lives in the Austin city limits. Areas surrounding the city have been experiencing fast growth during the past decade. Figure 1 depicts the spatial distribution of population density in Travis County. It shows that population are mostly concentrated in the Austin city limits in Travis County in 2000.

Because total population in Travis County increased 40% from 1990 to 2000, it is reasonable to assume that the total population would grow at about half of that rate over the next decade from 2000 to 2010. Therefore, we assumed that total population in Travis County would increase 20% from 2000 to 2010 and reach 974,736 for the test. We then used this estimated

population growth to conduct the spatial allocation analysis. The results are given in Figures 2 and 3. Figure 2 shows the spatial distribution of estimated population in 2010 in a chosen area of the county. The resulting spatial allocation of water demand change from 1990 to 2010 is given in Figure 3. As can be seen in Figure 3, areas that will experience the most population growth are the areas in the east and west sides of the chosen area. This situation is expected because the central portion of the chosen sub-county area is the center of the city of Austin. The center of Austin is already a built up area. Future urban growth in the county is expected to be outside of the center of the city.

This GIS-based system has several advantages compared to the spreadsheet-based models currently used at LCRA. First, the GIS-based system takes into account major factors that are considered important by the LCRA in affecting the spatial distribution of population growth. This is a significant improvement in the practice of spatial allocation of population

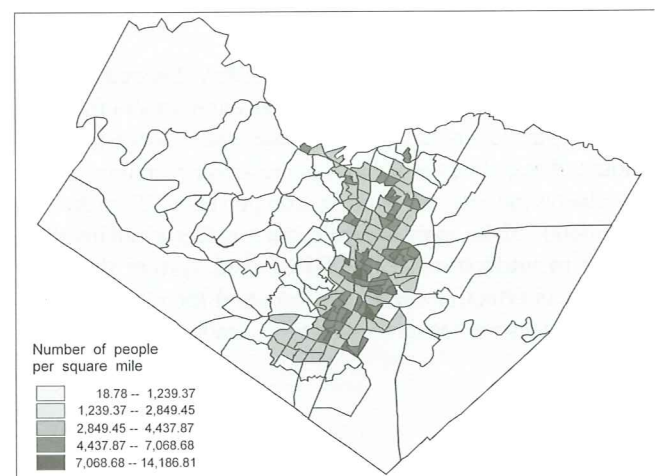


Figure 1. Census tract population density in Travis County, Texas, in 2000

Table 3. Data used for the case study

Name (shapefile)	Source	Attribute Needed	Description
Data used to determine potential carrying capacity			
County Polygon(lcra_counties.shp)	ESRI	e.g., Pop1990, Pop 2010	Use the county boundary to generate grid covering the county
Flood Plains(flood.shp)	LCRA	Zone (A)	FEMA floodplain data delineating the polygons of 100-year flood plain
Preserved Land(pres_land.shp)	TNRIS	Preserve (preserve)	This layer contains polygons showing federal, state, local parks, and any preserved lands.
Census Tracts(lcra_tracts.shp)	Census	e.g., Pop 1990; Pop2000	Census tracts from the 1990 or 2000 census
Zoning Map(Austin_lu.shp)	County/MPO Government	Landuse (single family, etc)	This layer contains polygons delineating the boundaries of different zones designated for different land uses (single-family residential, multi-family residential, open space).
Data used for modeling accessibility to service facilities			
Employment Centers	County government	Size	This layer contains point data showing the location of employment centers. The number of employees (size) in each center is the attribute used for the analysis.
Retail Centers (retailcenters.shp)	County Government	Size	This layer contains point data showing the location of retail centers. The size of each center is the attribute used for the analysis.
Schools (travisschools.shp)	TEA	Rating	This layer contains point data showing the location of schools. The rating of each school is the attribute used for the analysis.
Data used for modeling adjacency to developed land			
Census Tracts (lcra_tracts.shp)	Census	e.g., Pop1990, Pop2000	Census tracts from the 1990 or 2000 census
Data used for modeling transportation convenience			
Highways (lcra_highways.shp)	ESRI	NA	Highway data edited from ESRI data sets

Note: ESRI - Environmental Systems Research Institute; LCRA - Lower Colorado River Authority; TNRIS - Texas Natural Resources Information Service; TEA - Texas Education Agency; MPO - Metropolitan Planning Organization

growth in water resource planning at LCRA. Second, the GIS geodatabases provide a very convenient environment for water resource planners to store, manipulate, and manage the large amount of map data needed in water resource planning. Third, as is always the case, the visualization power of GIS makes the presentation of the analysis results much easier for all involved parties to understand. The GIS-based system therefore provides an effective communication tool for water resource planners, decision makers, community leaders and citizens.

V. CONCLUSION

The spatial allocation of countywide population growth to sub-county areas and the computation of the subsequent water demand change in sub-county areas are very important

tasks in water resource planning at the Lower Colorado River Authority (LCRA) in Texas in the United States due to rapid population growth and limited water resources in the region. Current spreadsheet models at LCRA cannot be used to fully account for factors affecting the spatial distribution of population growth in regional water resource planning. In order to help improve existing methods for regional water allocation analyses at LCRA, this discussion has presented a set of mathematical models for spatial allocation of population growth in the context of water resource planning. This set of models is a modified and extended version of the most recently developed models (Bell *et al.* 2000). Factors considered in the models include potential carrying capacity of a piece of land, accessibility of a piece of land to existing facilities/services, adjacency of a piece of land to existing developed land, and transportation convenience of a piece of land. These models

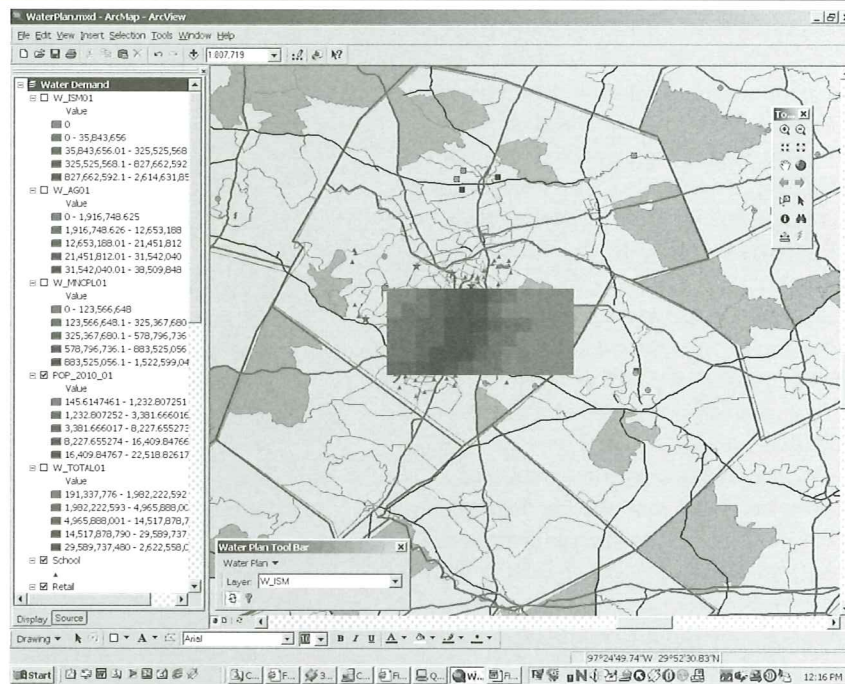


Figure 2. Spatial allocation of estimated population in 2010 in a chosen area in Travis County, Texas. Darker pixels in the grid indicate a higher population count.

and the GIS-based system reported in this article significantly improve the practices of regional water resource planning at LCRA.

Future work along this line of the research is to test the robustness of the system and fine-tune the mathematical

models. In addition, a set of mathematical procedures for automatically calibrating the models is under development and in the process of being tested. Automatic calibration of these models will further enhance the usefulness of the GIS-based system and help LCRA in its daily operations in regional water resource planning.

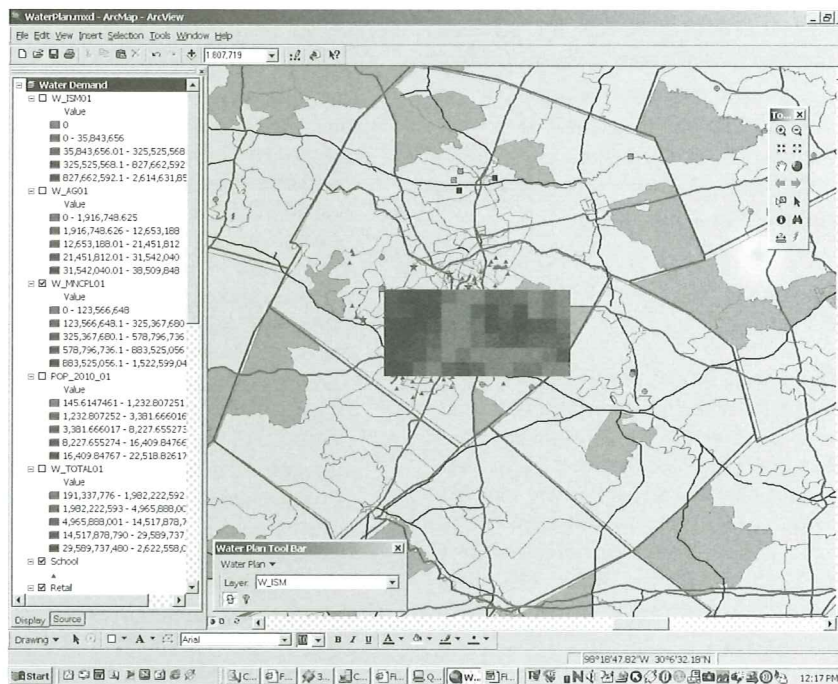


Figure 3. Spatial allocation of water demand change from 1990 to 2010 in a chosen area in Travis County, Texas. Darker pixels in the grid indicate a bigger increase in water demand.

APPENDIX A. THE POLYGONS-IN-CELL PROCEDURE

In several occasions, we need to compute the number of people in a grid cell. The number of people within a grid cell is the sum of the people from the part of each census tract that falls within the grid cell. This operation is called 'The Polygon-in-Cell Procedure.' This procedure is used to approximately estimate the number of people in a grid cell.

If we assume that population density in each census tract is uniform, then population density in each census tract can be determined by dividing the number of people in each tract by the area of that tract. The procedure consists of three steps: (1) for each census tract that is partly covered by a grid cell, determine the area of the part of that census tract covered by the cell; this operation can be easily achieved by a standard function in a commercial GIS; (2) based on the area determined in the first step and the population density of each census tract, compute the number of people in the part of each census tract covered by the grid cell; (3) sum the results obtained in the second step to get the total number of people in the grid cell. A special case is that a grid cell only covers part of one census tract. In this case, we only need to deal with one census tract, but the procedure remains the same. The limitation of this procedure is, of course, in the assumption of uniform population density in a census tract. Fortunately, this problem can partly be solved when population data at the census block group, a finer area resolution than the census tract, are used. Therefore, it is recommended to use census block group population data whenever it is possible.

In the example given below (Figure. A-1), there are five census tracts. All five census tracts are covered by the grid cell shown in the figure. The procedure first determined the area covered by the grid for each of the five census tracts. The procedure then estimate the number of people within the covered portion of each census tract by multiplying the population density of each census tract and the covered area of that census tract. The number of people in this grid cell is the sum of the people in all five covered parts of the five census tracts.

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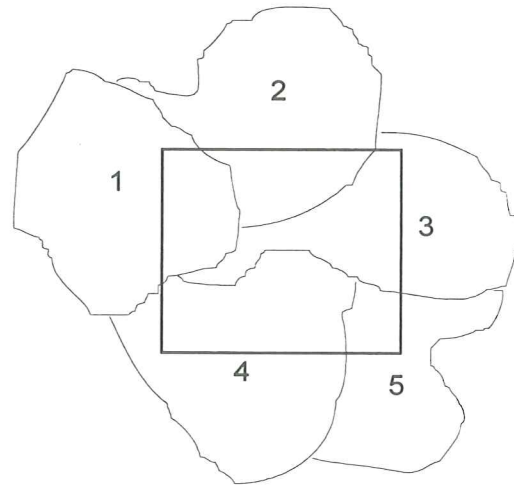


Fig. A-1. An example related to the Polygon-in-Cell procedure

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CPGIS News

CPGIS GEOINFORMATICS, 2002 NANJING, CHINA

CPGIS 2002 Conference was held in Nanjing on June 1-3, 2002. Due to the increasing number of participants, the conference was relocated from the New Era Hotel to the Nanjing International Conference Hotel, located in the historical and scenic Zhongshan District, a leafy and quiet hilly area. At 9 am on June 1, a documentary movie entitled "A Decade of CPGIS" (director: Hui Lin) opened the conference, followed by Prof. Peng Gong's introduction of all distinguished guests. President of Nanjing University, Prof. Shusheng Jiang, welcomed CPGIS 2002 Conference participants to Nanjing. CPGIS President, Dr. Fahui Wang, delivered a short speech and invited everybody to the CPGIS 2003 Annual Conference to be held in Toronto, Canada, followed by speeches of presidents of sister organizations (CAGIS, CGIS, HKAGIS and CPGPS). At the opening ceremony, Prof. Shupeng Chen read his emotional letter to congratulate the CPGIS and the conference organizers. About 200 conference participants then posed for a group picture (Photo 1). Three keynote speeches were delivered by Prof. Michael Goodchild, Prof. John Townshend and Prof. Michael Batty. Twenty-four sessions were held in three separate conference rooms during the three-day conference.

Prof. Guanhua Xu (Minister of the Ministry of Science & Technology of China) joined the evening banquet on June 1. In the subsequent CPGIS party, six long-time supporters of

CPGIS (Prof. Zhizhuo Wang, Prof. Shupeng Chen, Prof. Guanhua Xu, Prof. Deren Li, Prof. Michael Goodchild and Prof. Michael Batty) received the honorary membership plaques. Drs. Fahui Wang and Axing Zhu presented the 2002 Excellent Service Awards to Prof. Peng Gong and Dr. Chaowei Yang. Three students received the 2002 Student Travel Awards: Jianwu Tang for his paper "Modeling ecosystem respiration in a ponderosa pine plantation in the Sierra Nevada Mountains, California: integrating high resolution remote sensing, chamber measurement of flux, and forest inventory", Pai-Hui Hsu for his paper on "Dimension Reduction of Hyperspectral Images for Classification Application", and Yu Meng for her paper on "A Simplified Map-Matching Algorithm for In-Vehicle Navigation Unit". The 2002 Best Student Paper Award went to Pai-Hui Hsu. The crowd was also entertained by high-quality artistic performances by the students from the Department of Urban and Resource Sciences of Nanjing University. In addition, during the conference, CPGIS members from Nanjing University held a party to celebrate Professor Bingxian Chen's 70 years old birthday (Photo 2).

(Fahui Wang)

CPGIS 2002 GO-WEST TOUR

CPGIS 2002 Go-west Tour has been successfully conducted from 4 June to 14 June 2002 (see Photos 4, 5, and 6). With the support from Ministry of Education of China and our local



Photo 1. A group picture of CPGIS Geoinformatics'02, June 1 - 3, 2002, Nanjing, China



Photo 2. CPGIS members from Nanjing University held a party to celebrate Professor Bingxian Chen's 70 years old birthday.

hosts, the CPGIS go-west team has visited 3 major cities in western China, namely Xi'an, Lanzhou and Urumqi. Three one-day lecture series have been delivered by five team members to full-house audience of over 200 people in each of the venues. During the tour, we have great opportunities to discuss issues and collaboration opportunities with the leaders of local universities, research institutes and government departments. A number of communication channels have been established so that future collaboration can be followed up between CPGIS and our western China collaborators. Below are some facts and details about the go-west tour activities.

Team Members:

Qiming Zhou (team leader), Hui Lin, Bin Li, Bin Jiang, Winnie Tang.

Lecture topics:

Qiming Zhou: Remote Sensing for Rangeland Vegetation Studies

Hui Lin: Virtual Geographical Environment

Bin Li: Geographical Information Service in Western China Development

Bin Jiang: Information Technology for Urban Planning and



Photo 3. The CPGIS go-west team members and host leaders at Northwest University.

Photo 4. Visiting “zhong guo mei hang” and discussing with leaders.



Design

Winnie Tang: GIS and Geo-business: Challenge and Opportunity in Western China.

Official Activities:

- 5 June: The first CPGIS go-west open lecture series. Venue: Northwest University.
- 5 June: Discussion with postgraduate students at Northwest University.
- 6 June: Visiting “zhong guo mei hang” and Shaanxi Provincial Bureau of Surveying and Mapping.
- 7 June: Discussion with scholars of Lanzhou University led

by Prof Yang Shu, vice-president of Lanzhou University.

- 8 June: The second CPGIS go-west open lecture series. Venue: Lanzhou University and the Institute of Cold and Arid Region Studies, Chinese Academy of Sciences
- 9 June: Discussion with officials of Gansu Provincial Bureau Surveying and Mapping.
- 12 June: The third CPGIS go-west open lecture series. Venue: Xinjiang University.
- 12 June: Discussion with scholars and postgraduate students (Qiming Zhou)



Photo 5. Presenting CPGIS flag to Prof. Yang Shu, vice president of Lanzhou University.