BOOK REPORT

A GIS DECISION MODEL FOR DETECTING SUBSTANDARD HOUSING IN ALACHUA COUNTY, FLORIDA

Prepared for
Alachua County Housing Authority
July 2002 - October 2003

Project Investigators
Paul D. Zwick, PhD, Chair
Juna Papajorgji, PhD Student
GeoPlan Center, Department of Urban and Regional Planning
University of Florida

TABLE OF CONTENTS

G Scope of work from Housing Authority

H Companion CD

LIST OF FIGURES

ACKNOWLEDGMENTS

The work done on this project was presented and published at the 41st Annual Conference of the Urban and Regional Information Systems Association (URISA), held in Atlanta, Georgia, in October 11-15, 2003. In addition, this work won URISA's annual Student Horwood Critique Prize for 2003. The project investigators would like to acknowledge Gail Monahan, Executive Director of Alachua County Housing Authority and the staff at the Alachua County property appraiser's office, working under the direction of the Honorable Ed Crapo.

Juna Goda Papajorgji
PhD Student, University of Florida
GIS Manager, Department of Growth Management
Alachua County, Florida
10 SW 2nd Ave
Gainesville, Fl 32601
Phone: (352) 384-3180
Email: juna@ufl.edu

Paul D. Zwick, PhD
Chair, Department of Urban and Regional Planning
University of Florida
431 ARCH Building
Gainesville, Fl 32601
Phone: (352) 392-0997
Email: paul@geoplan.ufl.edu

A GIS DECISION MODEL FOR DETECTING SUBSTANDARD HOUSING IN ALACHUA COUNTY, FLORIDA

ABSTRACT

To overcome the high cost and inaccuracy potentials associated with manual methods of inventory of substandard housing, we have developed, in conjunction with the Alachua County Housing Authority, a GIS decision model for identifying, inventorying, and transparently deploying substandard residences based on the county's property appraiser's information. Although a computerized method to automate the process of inventorying substandard housing based on property tax records in Alachua County, was developed thirteen years ago (*Zwick, Schneider, 1990*), the current one updates, upgrades, and refines the original under contemporary

appraisers' definitions and data formats; implements the refined method into a GIS decision model; creates an interactive mechanism for the deployment of the results; and provides a transparent solution replicable in other counties. The model identifies the county's deteriorated housing stock classifying it by intensity of deterioration in: Highly Substandard, Average Substandard, Low Substandard, Suspected Substandard. The model also determines a deterioration gradient per one mile section grid of the Public Lands Survey System, based on number of substandard and suspected structures per section. A customized menu provides for custom mapping of the structures at a parcel level and for generation of legal address lists by section grid. The result is a resource decision making package to be used re-currently countywide by all Alachua County local governments, the research community, citizens at large, etc. for identification of areas of increasing property structure deterioration and for detecting annual changes and trends in substandard housing (*Zwick 1993*).

INTRODUCTION

Recognizing that manual methods of inventory and identification of substandard housing, such as windshield/field surveys and commissioned inspections by qualified inspectors, remain costly but also often inaccurate (*Zwick, 1990*), orchestrating and administering them presents a number of technical, administrative and financial problems. Therefore, the University of Florida's GeoPlan Center in collaboration with the Alachua County Housing Authority (ACHA) and the University of Florida's Shimberg Center for Affordable Housing, developed a GIS decision model for generating an inventory of substandard housing stock in Alachua County. The model draws on a previous study on substandard housing, conducted thirteen years ago at the GeoPlan Center in a SAS environment. The methods and results of the current research effort for creating the GIS decision model are reported in this paper.

OBJECTIVES

The primary objective of this research was to create a GIS decision model for identifying, inventorying, and transparently deploying substandard residences based on the county's property master appraiser's information and classified by intensity of deterioration. Specific objectives were as follows:

- re-visit the study conducted in 1990 at the University of Florida in a SAS environment with the aim of updating, upgrading, and refining the original method under contemporary appraisers' definitions and data formats

- implement the refined method into a GIS based decision model easy for replication

- create an interactive, transparent and efficient mechanism for the deployment of the results, accessible by anyone with little or no knowledge of GIS

- design the overall model as a resource decision making package to be used re-currently countywide by all Alachua County local governments, the research community, citizens at large, etc.

BACKGROUND

Alachua County, located in North Central Florida, has a population of 218,795 (*Census 2001*) distributed on 84,500 parcels of property. The use of the land by parcel is estimated as 65% agricultural, 20% residential, 9.8% government, 1.5% commercial, 0.5% industrial, and 3.2% other. Census 2001 estimates 95.000 housing units with a home ownership rate 54.9% in a county with 22.8% of its population below poverty rate and 38.7% with a bachelor's degree or higher.

In Alachua County an inventory of substandard housing had not been done since 1990, when a computer based model conducted by Richard H. Schneider and Paul D. Zwick based on SAS programming was carried out at the University of Florida's Department of Urban and

Regional Planning, GeoPlan Center (*Computers, Environment and Urban Systems, Vol.14, pp. 273-28).*

ACHA in its mission to assist low income and disadvantaged people in the county, was the primary agency in need of a new study on substandard housing. The local community of builders and many other local planning agencies in the county were also in need of this study (*there are ten local governments in Alachua County, the two major ones Gainesville and Alachua County*). Alachua County in its recent update of the comprehensive plan, in the housing element, policy 1.1.3.4, requires the county to '*maintain an inventory of substandard housing*'. The Housing division of Alachua County is also interested in this substandard inventory for its Community Development Block Grant (CDBG) program which targets areas for rehabilitation of severely distressed homes.

With a mandate from these various local planning agencies that were in need for a countywide inventory of substandard housing stock, indiscriminately of jurisdictional boundaries, ACHA decided to re-visit the computer based study on substandard housing, conducted more than a decade ago at the University of Florida. This study created an inventory of substandard housing. ACHA contacted Dr. Zwick at the University of Florida because it desired an efficient method for determining the quality of the housing stock within the county. The housing authority was convinced that conducting housing surveys or studies to determine the condition of its nonstandard housing in the same manner that many other communities have been using for many years by windshield surveys or staff memory, was not cost justifiable. The

Housing Authority also realized that manual methods of data collection are much too time consuming and are often subject to inconsistencies of subjective interpretation. Therefore they directed the University of Florida for the new study as explained in the following section.

DIRECTIVE

The University of Florida's GeoPlan Center, was directed to develop a GIS based decision model for identifying county-wide deteriorated housing stock by the Alachua County Housing Authority (ACHA) and the University of Florida's Shimberg Center for Affordable Housing. The model would produce a reliable inventory of substandard housing units from the pool of single family, mobile homes, multi family, and condominiums, categorized by intensity of deterioration in a grading scale. GeoPlan would collaborate with ACHA and the Shimberg Center to incorporate the results of their windshield surveys (~265 single family residences) into testing the model. Upon testing the model with the field collected data, refinements and adjustments would be implemented by GeoPlan to reach the final model. GeoPlan would than create a detailed documentation of the model, to insure easy update and rerun in future years. It would then run the model and generate the inventory of substandard housing stock. GeoPlan would also write a customized application that would provide for user interactive generation of maps and owners' address lists of parcels, by one mile section grid of the Public Lands Survey System (PLSS). The user would have the freedom to create maps and address lists based on her choice of category of intensity of deterioration and location of section grid.

This directive turned out to be an ambitious task under the funding reality of $18,000, when most special housing condition surveys cost many times that amount - often hundreds of thousands of dollars while often failing to give a comprehensive picture of the housing conditions (*Schneider, 1989*).

METHOD

The work for this research underwent five stages:

- *Exploration and definitions*
- *Data collection*
- *Model development*
- *Model testing*
- *Deployment of results*

The *exploration and definition* stage was employed to understand the variables and the methods that the property appraisers use to evaluate housing and their interpretation of the existing data. *Data collection* was a stage in which we gathered, explored, judged and manipulated the necessary data. In the *Model development* stage we designed and developed the model and ran it to generate the results. We tested the accuracy of the model with field collected data, during the stage *Model testing,* with the results of the first run. At last, during the *Deployment of results* stage, we developed a customized interface that provides for an interactive

way to obtain maps of substandard structures by category and to obtain maps and addresses for one mile section grid of the Public Lands Survey System (PLSS).

Exploration and definitions

We started out by exploring the available information from the property appraiser tax master file. We then interviewed the director of Residential and Agricultural appraisers and the Oracle database programmer at the property appraiser's office, to find out what data was available, which was the system that the appraiser's used to define the quality of housing, which were the various variables, classifications and indexes that are currently in use in Alachua County and what were their precise definitions. Based on these explorations, upon being convinced of the relevance of the information for what we set out to accomplish, such as availability of GIS data, sufficiency of GIS documentation, data dictionary of the appraiser's definitions currently stored in a IS400 system, we determined our unit of analysis and the variables to be used in the evaluation of deteriorated housing as follows:

unit of analysis

- single family residential
- mobile homes
- multi family with 10 or more units
- condominiums

variables

- structural condition
- heating or heating fuel condition
- bathroom condition
- living space condition
- actual or effective year built
- post effective year built structural improvements
- quality rating index
- market value
- replacement value or (property adjusted value)

Data collection

The collection of data started with identifying the multiple Oracle tables of the property appraiser's tax master files. These tables had been standardized from the Florida Geographic Data Library (FGDL), a statewide mechanism for GIS data distribution hosted at the GeoPlan Center, University of Florida. They were fully integratable with the main tax parcels database for Alachua County stored in a GIS format, submitted to the FGDL by the property appraiser's office. A total of 54,870 parcels were identified representing a census of the county's housing stock to be analyzed. The majority of them 46,922 (86%) were single family residential, 5,396 (10%) were mobile homes, 390 multi-family with 10 or more units, and 2,162 (4%) were condominiums. A number of steps followed to explore, manipulate, question the main GIS

database and associate it with the Oracle tables. This operation resulted in the loss of 112 records, to finally yield 58,612 structures to be considered for the 54,870 parcels. Other GIS data pertinent to this project such as the customized Public Lands Survey System (PLSS) for Alachua County, Census 2000, Future Land Use, etc., were obtained by both FGDL and the Growth Management department in Alachua County (*http://www.fgdl.org and http://growth-management.alachua.fl.us*).

Model development

Once the unit of analysis and the variables had been identified and the data was ready to be processed, we defined the criteria that would be used in the model as follows:

- incomplete structure when missing interior or exterior walls, floors and roofs
- having no heating type or identified heating fuel
- lacking a full bathroom
- containing less than 250 square feet of living space
- with an actual or effective year of construction prior to 1940
- with an actual or effective year of construction prior to 1940 but with structural improvements
- quality rating below average or minimum
- having a market value less than half the property adjusted value (replacement value)

The overall design of the model's logical structure followed. It was finalized as shown in the flow chart in Figure 1, where each box indicates the criteria posed on each variable and the lines indicate the processing.

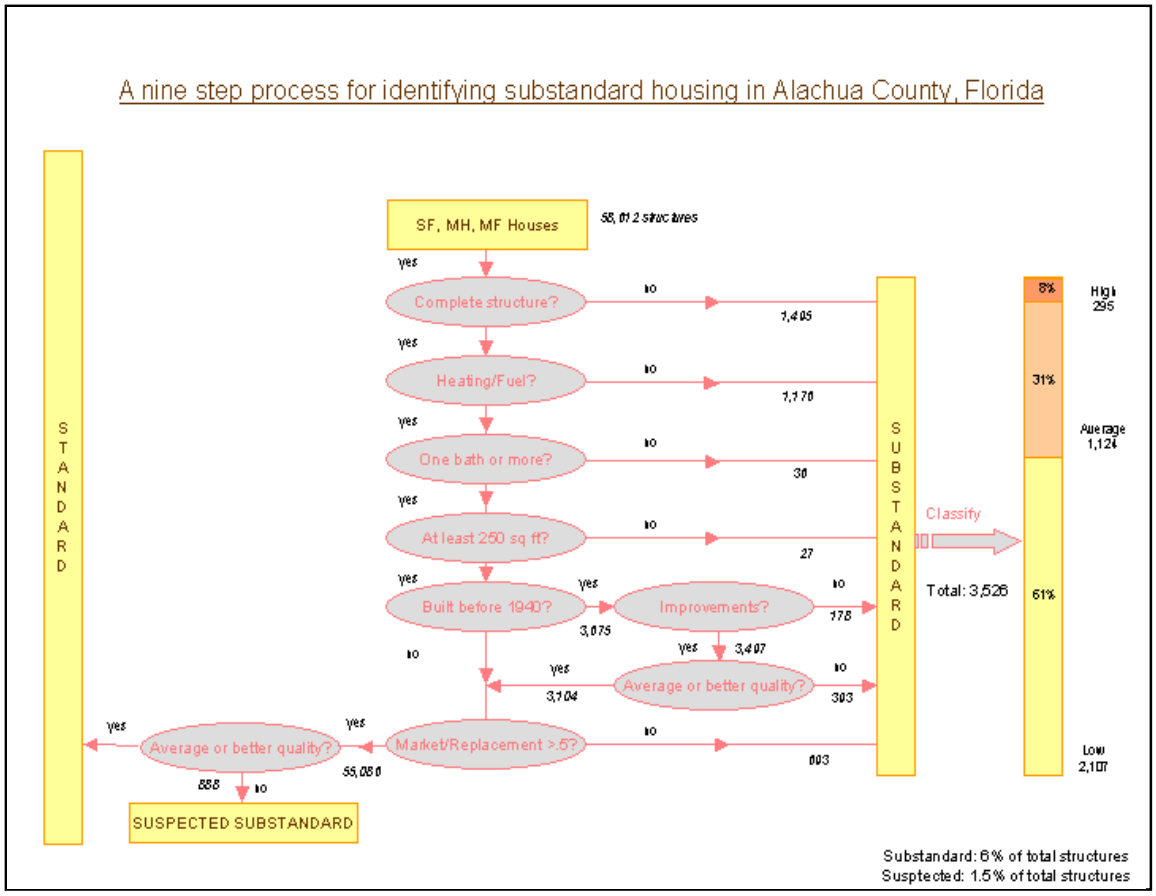

Figure 1: Model flow chart for selection of sub-standard housing.

As shown in the chart, we designed the model as a nine step process implemented in an exclusive prioritization sequence. Our first variable is the structural condition and we start by querying if structural problems are present. If yes the unit is declared substandard. We then continue the query with the remaining structures and in step two we query for heating unit. Those that do not have one we identify as substandard and we continue our query in step three and ask for structures with less than one full bath. After identifying those with less than full bath as substandard, we continue the query asking if the unit has adequate living space (less than 250 sft = inadequate). Next, we investigate if the structure was constructed before 1940, if yes, we then check if any improvements have been made to the structure since 1940. If improvements have not been made, then we declare the structure substandard and if improvements have been made we then check its quality rating. If the quality rating is below average then the structure is declared substandard. The quality rating is a subjective indicator, determined by the field appraiser based upon experience, education, judgment etc. It rates the subject property structure in relation to other property structures in the county using a 6 scale system which ranges from minimum to superior. If the quality rating is average or better and improvements have been made then the structure continues through the process and undergoes the last check for substandard detection. We determine if the structures marked value as compared to the property structure's adjusted value is more than 50%. If this is the case, the structure goes to substandard and if it is not the structure gets screened one more time for quality rating. If not of average or better quality the structure is then declared suspected substandard, otherwise it remains standard.

The determination of structural market value versus structural adjusted value is based upon the structure's age and building materials (*Zwick, 1990*). In Alachua County, property structures are rated based upon the types of construction materials employed. Developers from the county determine on a point scale the quality of building materials used in construction of housing units, for example, ratings are given for materials used in flooring, roofing, interior wall construction, and so on. The points are then added to give a combined 'quality index' for construction materials in the structure. The quality index is combined with the age of the structure and then utilized to determine the amount of appreciation or depreciation from the adjusted structural value (replacement value) to produce a market value for the structure. A 'quality index' of 100 causes no market value appreciation or depreciation from the replacement/adjusted value. If the market value is less than half the adjusted value the structure is declared substandard.

Upon segregation of the stock of substandard housing, the model goes back and evaluates the intensity of deterioration for each of them. Since our model was based on an exclusive prioritization sequence, as long as a structure met one criterion we declared it substandard. But so far, we have not checked to see if a structure meets more than one criterion. Therefore the model goes back to evaluate how many criteria of substandard-ness are being met simultaneously in one structure. After it does that evaluation, based on the results that we obtained, we decided to classify as follows: when only one criterion is met, the structure is classified low substandard, when two criteria are met, the structure is classified as average

substandard, and when three criteria are met at once the structure is classified as highly substandard. We did not encounter any case when more than three criteria were met at once.

The next step in the model is to determine the intensity of deterioration per one mile section grid of the Public Lands Survey Systems. (*See Figure 3 under Results section*). This intensity was determined by number of substandard structures per section grid. The number of structures per section would allow for a deterioration intensity grading of the entire county that would provide for identification/mapping of areas with high levels of substandard structures. The final step is to summarize the substandard structures by Section Township Range grid, in a way that for each one mile Section a list of addresses by parcel will automatically be generated, along with the substandard parcels map.

Model testing

Testing of the model's accuracy was essential to the successful completion of the study. To accomplish this task two verifications stages were decided upon. At the time this paper is being written, the second verification is yet to occur. The first one was completed using a small sample of housing stock, field inspected by the Housing Authority and the Shimberg Center. A total of 265 structures had been surveyed by them and had been tied to tract and block group number. After a sequence of data conversion steps, we were finally able to create a GIS file that indicated by tract and block group the location of these surveyed houses. This GIS file enabled us to compare the survey results with the results of our model. Under the reality of the field data not tied to a parcel ID, we could only test the accuracy of our model at the scale of one mile

Section Township Range grid. At this scale our results turned out 100% accurate. As shown in Figure 2 below, all of the substandard structures that were field surveyed cover an area of nine STR mile grids. The results of our model for each of these nine grids yield the following in the pattern substandard/suspected: 205/20, 137/16, 59/3, 51/7, 45/7, 43, 40/5, 22/19, 11/2. Therefore at worst our model has tested that in ½ mile radius, estimated as a 10 minutes walk, there are at worst 13 structures and at best 225, around a location pinpointed by the field surveyors. At this point we are contemplating a reverse testing, where we will give our results to the field people who will double check them on a parcel basis.

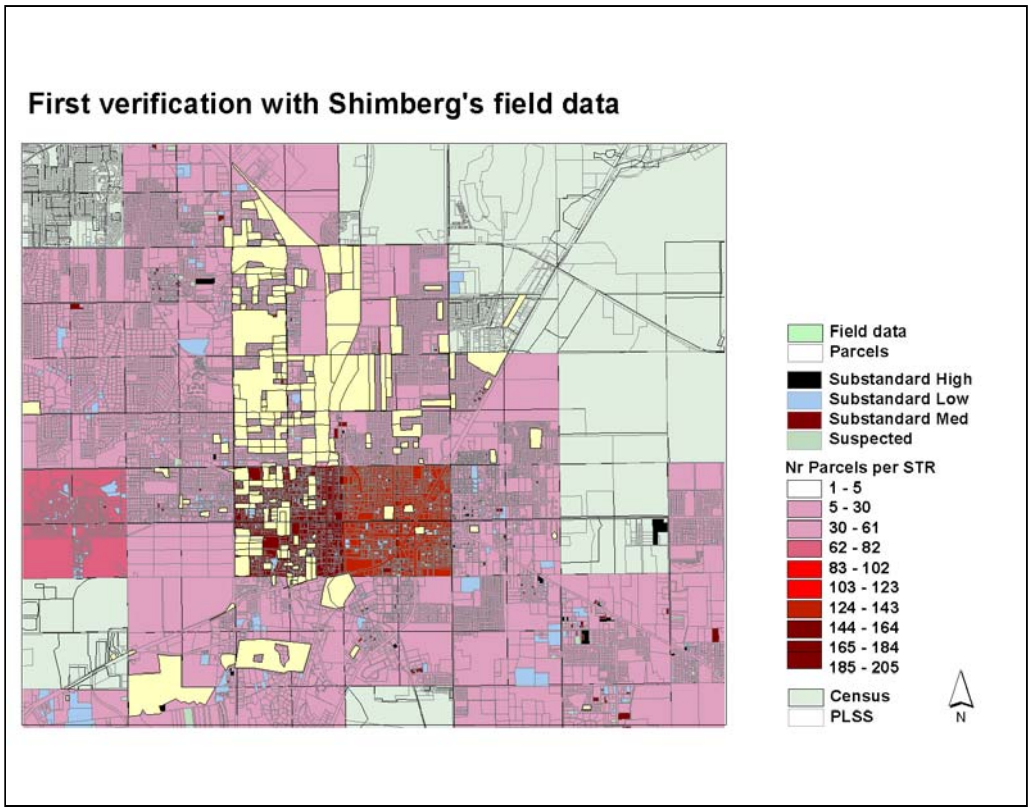

Figure 2: Data from the field overlaid with model results.

Deployment of results

To achieve the objective of creating an information resource package for decision making we developed a customized interface using the Avenue programming language. Our decision to use the ArcView 3.2 environment for the implementation of this project, was not only to accommodate the existing GIS environment of the Housing Authority, but it was also driven by our conviction that ArcView3.2 would be a better package for reaching a broader base of GIS users.

Thus, the results of the model are made easily accessible on a variety of pre-defined choices, with a good amount of interactivity. As shown in Figure 3 we provide a customized menu with several menu options, that allows for various display of the results of the model, such as for county wide mapping by intensity of deterioration per one mile STR grid, for comprehensive or separate display of each of the substandard categories, etc. The full technical documentation on the model and a customized help system are also provided through this menu.

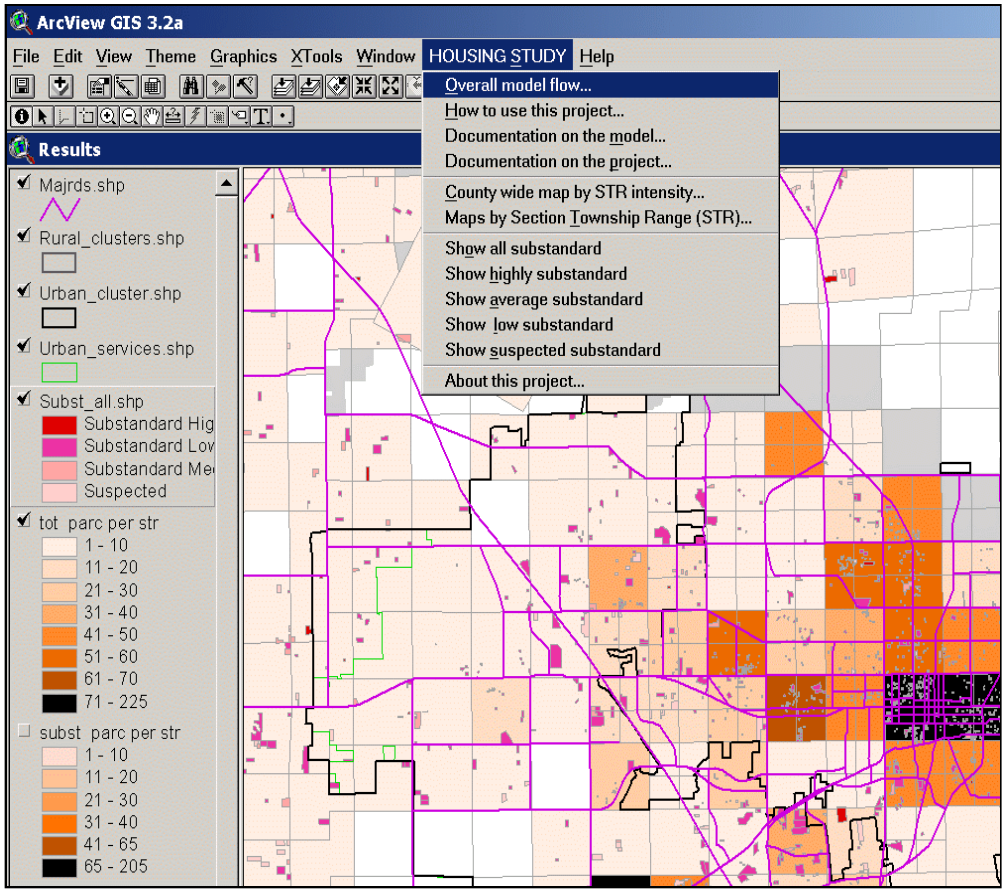

Figure 3: The customized menu with several display choices.

As can be seen in Figure 4, one of the menu options provides for mapping by one mile Section grid of any the substandard categories and for generation of corresponding legal addresses, by interactively entering Section and Township Range numbers.

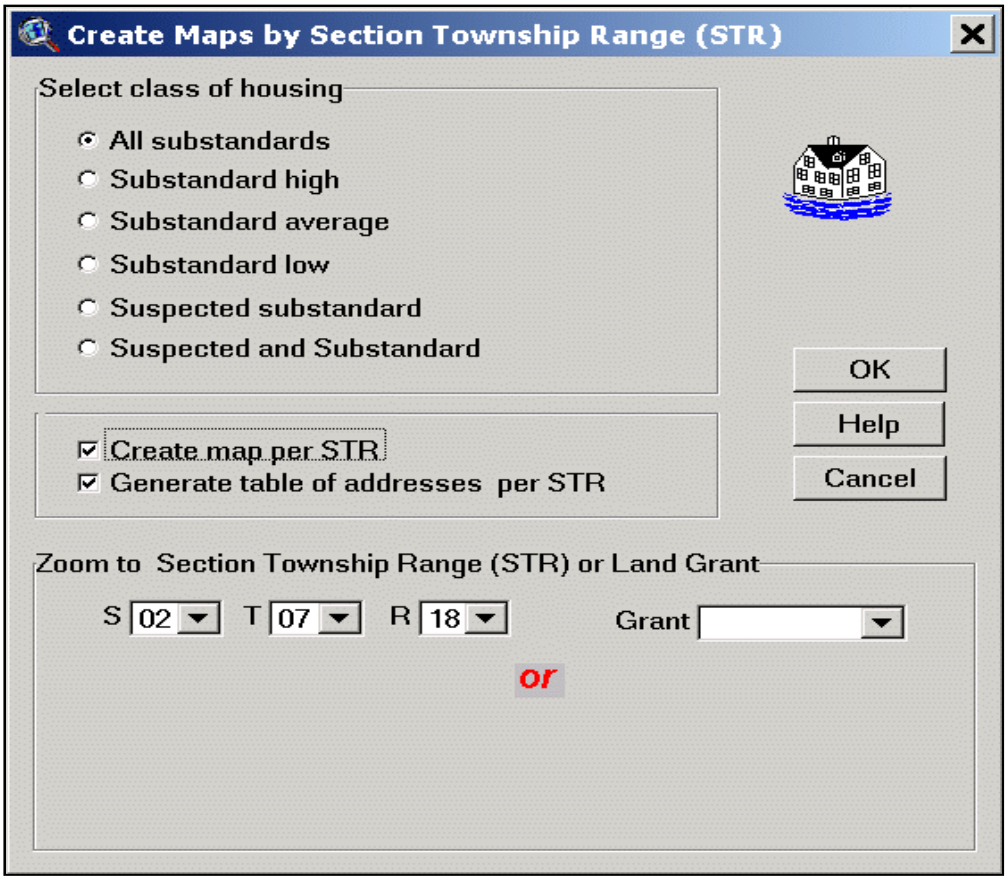

Figure 4: Maps by Section Township Range.

As it can be seen in both Figure 3 and Figure 4, the user has a wide range of semi-prepared choices for accessing the results of this model with no more than basic familiarity with ArcView.

RESULTS

As shown in the flow chart in Figure 1, the final results reveal that 6% of the county's residential buildings fall under the substandard category and 1.5% under the suspected substandard category. The substandard category was classified in three groups: highly substandard, average substandard,and low substandard. Out of the 58,612 residential structures considered, 3,526 were found substandard and were broken down based on intensity of deterioration into: 295 (*8%*) structures highly substandard, 1,124 (*31%*) structures average substandard, and 2,107 (*61%*) structures low substandard. The category of suspected substandard 888, was identified with the aim of rehabilitating them with minimum expenditure at present to prevent spending more in the future. So, for each Section Township Range we have identified a total number of substandard structures broken down into three categories and a total number of suspected substandard structures.

In Figure 5 we show a map of the deterioration intensity distribution of the county's substandard residential structures by Township, Range, Section grid. The map indicates that most areas with a high gradient of intensity of deterioration of substandard structures are located primarily in South East Gainesville, the county's major city. There are some in High Springs, Waldo, Newberry and other small old rural communities. This map indicates that while the majority of the substandard structures are located in the central largest city, sections with high concentration of substandard housing per mile grid, are located in the surrounding rural areas of the county which coincide with designated rural clusters in the county's Future Land Use.

There are two sections in South East Gainesville that contain a minimum of 137 up to 205 substandard structures per section and respectively 16 up to 20 suspected substandard. In each of these sections there are at least 20 highly substandard. There are five sections in Gainesville and one in High Springs that contain anywhere from 51 to 63 structures in substandard alone, and from 53 to 79 if we included the suspected, with anywhere from 1 to 10 of highly substandard. It is interesting to note that the geographic distribution of the 295 highly substandard structures tends to follow the pattern of high intensity of deterioration by section grid, but not necessarily too close. Quite often the highly substandard residences are found in nearby surrounding grids, with a lower intensity of deterioration gradient per grid.

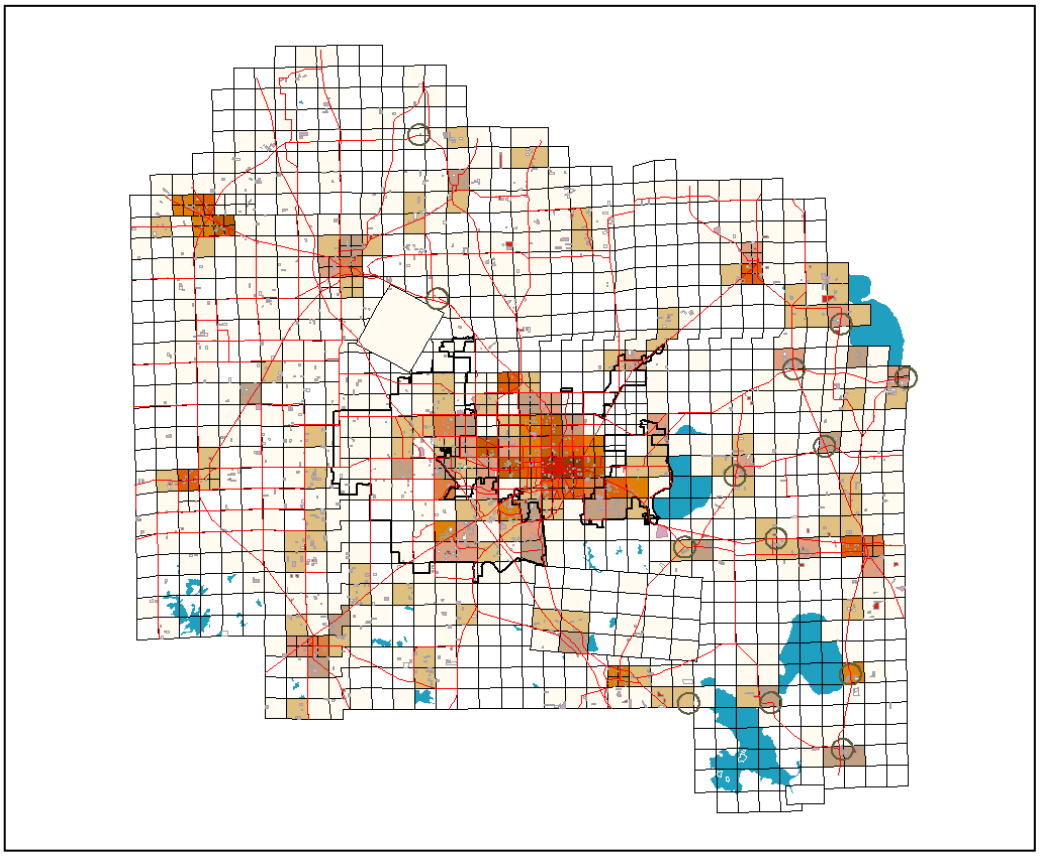

Figure 5: Concentration of substandard structures by one mile section grid.

DISCUSSION

We believe that we have successfully met the objectives that we set out to accomplish. The methodology developed for the Housing Authority based on the present definitions and data formats of the property appraisers', has proven to work well in a GIS environment. This methodology can successfully identify and inventory the vast majority of residential housing structures within the county, and it can determine the quality of them with accuracy and efficiency. This methodology also provides for the classification of the structures by intensity of deterioration of the structure and for a listing of legal addresses to be used for notification and inspection. The model has in addition proven successful in determining a deterioration gradient per one mile Section grid of the Public Lands Survey System. This gradient can be useful to indicate the county's areas that should be prioritized for surveys, based on the intensity of the deterioration.

The step by step flow of the logical structure of the model has been documented in technical details and it can be accessed from the customized menu. Its transparency encourages further fine-tuning and future re-runs. An easy replication of this model in other settings (*counties*) can be done. Modifications in weighting and calibration can be incorporated easily in its existing overall logical structure. One of this model's strengths remains the use of data that crosses local government jurisdictional boundaries, which commonly lack standardization and therefore hinder the success of models such as this.

We want to emphasize that this model is not intended to generate absolute results with absolute accuracy, but to rather give a fair representation of the reality, reducing costs of overall windshield surveys dramatically. As it is the case with every other model, this one too, is as good as the data fed into it. From our interviews with the property appraisers' staff, we have become aware that each structure in Alachua County gets inspected approximately once in three years.

Although we have automated the process of accessing the results and made them efficiently transparent to anyone with basic to no knowledge of ArcView, and although we have created a fully integrated resource decision making package, we believe that the next step for this project should be a web application. This application will enable all local governments in Alachua County to savor the results of this public investment. Such an application will also help to bring local public information closer to its community's citizenry and therefore contribute to a better public participation in the decision making process. Although it is beyond the scope of this report to speculate on the design and implementation features of the web application, we believe that no matter how simple the application, its return will multiple times justify the funding investment.

REFERENCES

Berry, J. K. “Beyond Mapping: Concepts, Algorithms, and Issues in GIS”, 1993. GIS World, Inc., Fort Collins, Colorado, USA.

BOCC Alachua County, “Adopted Amendments to Update the Comprehensive Plan”. http://growth-management.alachua.fl.us/compplanning/amendments.php

BOCC Alachua County, “Alachua County Affordable Housing Study”, 2003. http://growth-management.alachua.fl.us/housing/housing_study.php

Property Appraiser Office Alachua County [Honorable Edward A. Crapo], “Master Appraisal Files”, 2002.

Schneider, R. H., Zwick, P. D., Feller Jeff. “University of Florida - City of Largo, Florida, Housing Research Project”. Research Report. May 1995.

Zwick, P. D., Schneider, R. H., “Searching for substandard housing in Alachua County: A case study”, Computers, Environment and Urban Systems, Vol. 14, pp. 273-282, 1990. USA

Note: web pages functional as of August 19, 2003, 6:47 am.

FINAL MAP PRODUCTS

APPENDIX A

DETAILED TECHNICAL DOCUMENTATION ON THE GIS METHOD

APPENDIX B

AVENUE SOURCE CODE

List of scripts

acha_dlg.maps.but.ok
acha_dlg.maps.open
acha_dlg.maps.select
acha_menu.map
acha_dlg.but.help
acha_dlg.but.cancel
acha_menu.display
acha_menu.BaseLayers
acha_display
acha_menu.plss
acha_menu.doc
acha_callPDF
acha_layout
acha_menu.banner
Table.Append

APPENDIX C

INSTRUCTIONS FOR INSTALLATION AND USE OF PROJECT

APPENDIX D

DEFINITIONS FOR APPRAISER'S VARIABLES

APPENDIX E

DEFINITIONS FOR APPRAISER'S GIS DATA

APPENDIX F

TEST FILES SUBMITTED BY SHIMBERG CENTER

APPENDIX G

SCOPE OF WORK GIVEN FROM ALACHUA COUNTY HOUSING AUTHORITY