Research Note

GEOGRAPHIC INFORMATION AND GLOBAL POSITIONING SYSTEMS FOR TREE MANAGEMENT

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Key Words. GIS; GPS; tree survey; hazard assessment; amenity valuation.

Work by Kane and Ryan (1998) previously highlighted the potential of using GIS and GPS for locating hazardous trees in The Notch State Park in Massachusetts. During December 1997, application of this technique was being executed independently by the authors in the United Kingdom using different software packages (IDRISI and MapInfo) and GPS (Magellan ProMark X CP) hardware.

Among the number of GIS software packages available, IDRISI and MapInfo have the most wide-ranging applications to land use. For this project, MapInfo was employed to process and store environmental and map data. Three tasks required attention prior to the analysis of data: 1) accurate cartographic survey and grid referencing of the area's features including tree positions; 2) formatting of map data to construct a GIS map; and 3) in-depth tree survey data collection including hazard assessment and amenity valuation.

METHODS

Landscape features were mapped using Magellan Global Positioning Systems (GPS) handheld receivers. Sufficiently accurate positioning of features such as individual trees was accomplished using 2 receivers: a stationary base station receiver left at a known reference location and a "rover" receiver used in the field to map the various features.

The satellite signals upon which the GPS operates have a degree of error. This is a compositional error partly deliberately induced for United States national security reasons and partly technologically and environmentally induced. Processing of the 2 sets of data from the base station and the rover removes most of the error from the final data coordinates.

Walking along features such as tracks or the boundaries of different land cover areas, carrying the rover receiver, allowed mapping of these features to an accuracy within ± 5 m (16.4 ft). Leaving the rover receiver stationary at the base of a tree for 6 minutes allowed locations of individual trees to be mapped to an accuracy of less than ± 1 m (3.3 ft).

The GPS data were used to construct GIS map layers representing the tree locations and land cover areas (Figure 1, next page).

These map layers could then be spatially overlaid to a computerized base map. The base map in this project was digitally drawn into the computer from an existing British Ordnance Survey (OS) map and provided the spatial context for the other map layers. The GIS database was constructed using MapInfo software, as was the map.

TREE SURVEY DATA

The following detailed site data collected from the tree survey were entered into a GIS database:

- tree number (for initial location during the survey)
- map reference (6-figure OS coordinates)
- species
- dbh (millimeters)
- clear trunk to first branch (meters)
- mean crown diameter (meters)
- height (meters)
- amenity tree values (Helliwell 1994)
- health and structural assessment recommendations

Each record from this database was automatically linked to the appropriate tree location on the GIS map.

The amenity tree valuation system uses size, life expectancy, importance of positioning in the landscape, presence of other trees, form, and special factors (Helliwell 1994). A hazardous tree assessment procedure was employed to evaluate the structural stability with reference to public safety (including a climbing inspection of selected trees).

DISCUSSION

The computer map and accompanying database gave a greater facility for tree managers in this project to

- provide a detailed and accurate map to locate trees and designate land usage
- provide precise locations of trees with their dimensions (e.g., crown spread)
- allow selective display of map information (e.g., positions and numbers of all trees requiring crown reduction)
- facilitate rapid selection and display of selected database information
- determine areas within which construction and development can be accomplished without damage to trees
- carry easily accessed and easily updatable information on tree valuations, health, etc.

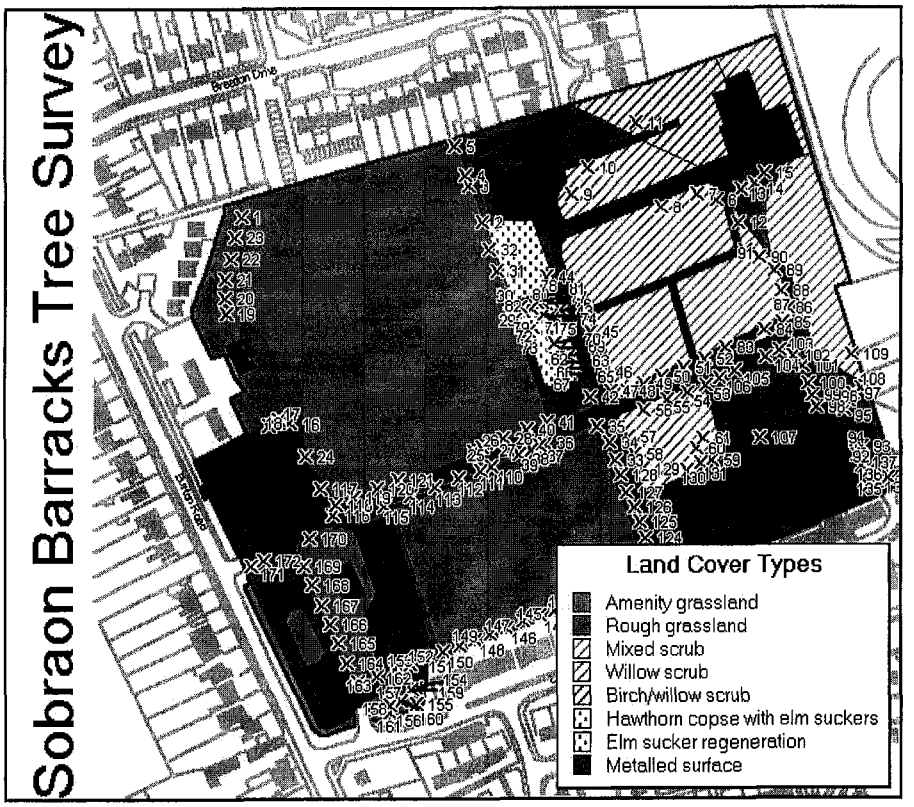

Figure 1. Tree locations and land cover types.

Figure 2 (next page) shows how GIS allows map and database information to be integrated. Trees displayed require removal.

CONCLUSION

Global positioning systems allow rapid and accurate mapping of landscape features while the use of geographic information systems technology allows rapid access, processing, and updating of tree survey data. The use of this data in the field using a laptop computer should aid the professional tree surgeon in determining that he or she is dealing not just with the correct trees, but that the arboricultural information is up to date and accurate.

This system is of special value in refining recording systems for tree inventories, thus making the procedure simpler, more efficient, and able to be used in the field. Indeed, barring financial expense, there is no technical reason why such an electronic system should not be vehicle based with additional database and map information being transmitted from a central office location.

LITERATURE CITED

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Kane, B., and D.P. Ryan III. 1998. Geographic information systems and the global positioning system. J. Arboric. 24(3):135–143.

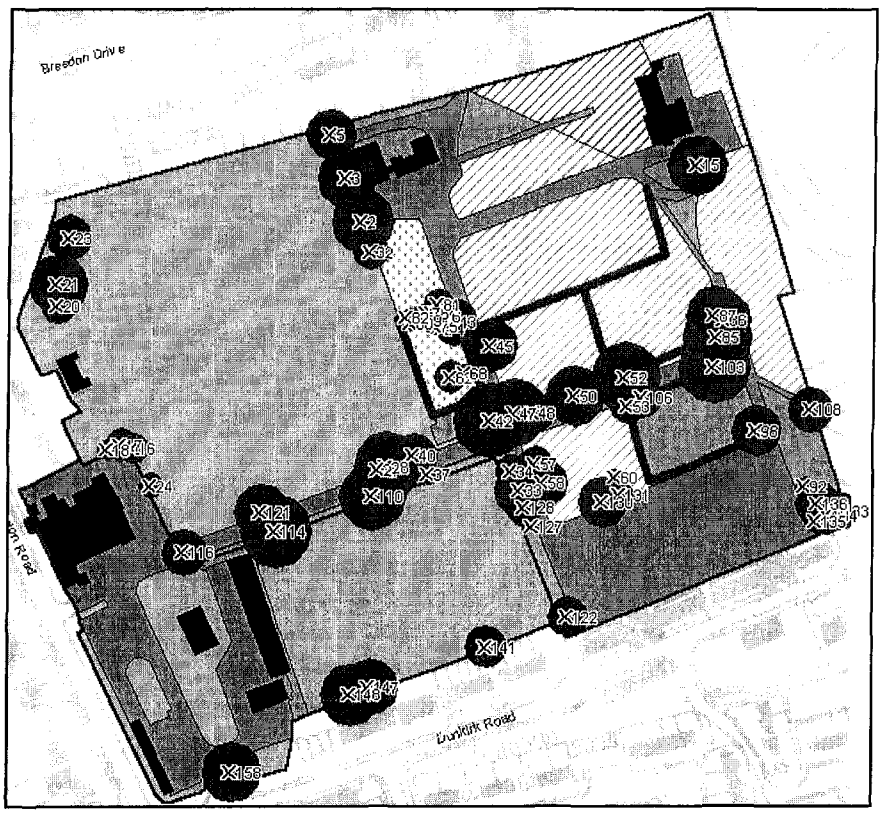

Figure 2. Integrated map and GPS information showing all condemned trees requiring removal.

Acknowledgements. The authors thank the Lincoln City Council Planning Department for their permission to publicize contractual information, their enlightened approach to tree preservation, and their willingness to test a previously untried approach to arboricultural management. Thanks particularly to Jill Wilson, LCC Department of Planning. Thanks also to Dr. Melanie Smith, whose consultations resulted in the project being implemented.

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Résumé. La flexibilité et la puissance de traitement de l'information des logiciels de systèmes d'informations géographiques (SIG) crée une application potentiellement importante en arboriculture. La collaboration entre l'unité des SIG de l'Université De Montfort et le Conseil municipal de Lincoln en Angleterre a permis de démontrer les possibilités excitantes de cette approche à la gestion des arbres. Dans une proposition innovatrices du Conseil municipal de Lincoln, une équipe spécialisée de l'Université a été embauchée pour inventorier un secteur d'un terrain aménagé (partiellement abandonné et autrefois des campements militaires) et les arbres qu'il contient avant de le développer. Les données de cet inventaire ont été fournies dans ce contrat sous la forme d'une base de données et d'une carte électronique pour analyse sur un logiciel de SIG (et aussi sous la forme d'un fichier CAD ou DAO compatible de type .dxf). Ceci a donné à l'utilisateur final un moyen efficient et rapide de gestion de l'information arboricole et a permis aux gestionnaires d'arbres et aux constructeurs de prendre des décisions précises et claires. L'information arboricole a donné au gestionnaire d'arbres les critères nécessaires pour désigner les arbres à préserver et à protéger. Ceci a permis également d'établir un système pour évaluer les paiements compensatoires lors de dommages à n'importe quelle composante du site.

Zusammenfassung. Die Flexibilität und die Kraft, die in Informationen der geographischen Informationssysteme (GIS) steckt, macht die Computer software und ihren Einsatz in der Baumpflege zu einer wichtigen Entwicklung. Eine Kollaboration zwischen der GISverantwortlichen Abteilung der DeMontfort Universität und der Stadtverwaltung von Lincoln in England zeigte kürzlich die aufregenden Möglichkeiten dieser Entwicklung im Baum-management. In einem innovativen Antrag der

Stadtverwaltung in Lincoln, wurden Spezialisten von der Universität unter Vertrag genommen, einen Landstreifen aus dem Naherholungsbereich (teilweise aufgelassen und früher mit Militärbarracken bestanden) und seine Bäume vor einer Weiterentwicklung zu untersuchen. Die Daten aus dieser Erhebung wurden für diese Zusammenarbeit in Form einer Datenbank und einer elektronischen Karte für die Analyse in der GIS software (und als eine CAD-kompatible .dxf file) aufbereitet. Dies liefert dem Endnutzer einen effizienten und schnellen Eindruck über die Nutzung der Informationen und gestattet den Auftragnehmern und Baumpflegern, akkurate und klare Entscheidungen zu treffen. Die Informationen aus der Baumpflege gaben den Baumpflegern die Kriterien, die Bewertung von Bäumen mit Pflegebedarf, vorzunehmen. Es wurde ebenfalls ein System eingeführt, um Ausgleichszahlungen für jeden Entwicklungsschaden am Standort festzulegen.

Resumen. La flexibilidad y el poder para procesar información en un sistema de información geográfica (GIS) como software computacional hace de su aplicación a la arboricultura un importante desarrollo en potencia. La colaboración entre la unidad GIS de la Universidad De Montfort y el Lincoln City Council, Inglaterra, demostraron recientemente interesantes características de este acercamiento al manejo de árboles. En una propuesta innovadora dada por el Lincoln City Council, un grupo de especialistas de la universidad fueron contratados para estudiar un área de tierra de amenidad (parcialmente abandonada y formalmente en barracas del ejército) y sus árboles anteriores al desarrollo. Los datos de la investigación fueron empacados en forma de una base de datos y un mapa electrónico para análisis en software GIS (y como un archivo compatible CAD). Éste da al usuario final medios eficientes y rápidos para manejar información referente a la arboricultura y facilita a los manejadores de árboles/contratistas el tomar decisiones precisas y claras. La información arboricultural da a los manejadores de árboles el criterio necesario para designar árboles a la preservación/protección. También establece un sistema para evaluar pagos compensatorios por cualquier daño en el sitio de desarrollo.