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Title

Unit 53 - Urban Planning and Management Applications

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UNIT 53 - URBAN PLANNING AND MANAGEMENT APPLICATIONS

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Compiled with assistance from Robert McMaster, Syracuse University

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The slide set contains eight slides (#53 to 60) to illustrate this unit.

UNIT 53 - URBAN PLANNING AND MANAGEMENT APPLICATIONS

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[A. INTRODUCTION](#)

- involve the use of computers to carry out functions of urban government
- history of use extends back to first introduction of computers in cities in early 1960s
- major involvement of US Bureau of the Census as provider of data
 - development of DIME files (locations of street centerlines, address ranges for each block, hooks to census reporting zones) for 1970 census
- series of city case studies in late 1960s/early 1970s in US
 - comparable studies in many countries
 - case studies designed to demonstrate simple GIS capabilities for urban government:
 - planning using social statistics for small areas, e.g. crime data
 - simple record-keeping
 - problems associated with primitive state of hardware and software at that time

Characteristics of applications

- scale:
 - scale of DIME and TIGER (derived from USGS mapping at 1:24,000, 1:50,000, 1:100,000) sufficient to show street center lines but not parcels
 - adequate for transportation planning, vehicle routing, general development strategies
 - at this scale GIS can interface with existing records from census
 - increasing interest in parcel level data for land records, zoning, services, subdivision plans
 - at this scale can interface with assessor's tax records
- functionality:
 - many installed systems used for mapping, e.g. updating subdivision plans
 - limited use for inventory, e.g. identifying parcels impacted by proposal
 - little use for modeling - modeling applications more likely supported by specific software not linked to GIS - e.g. school bus routing packages

Adoption

- early adoption by federally funded case study cities, others with adequate budgets
- now almost all local governments have some level of involvement
- in many states the state government plays a coordinating role

Organizations

- Urban and Regional Information Systems Association (URISA) organized in late 1960s
 - similar organizations in many countries
 - membership drawn from local, state and federal government, consultants, academics
 - sustained interest in GIS, particularly in recent years
- Spatially Oriented Referencing Systems Association (SORSA) provides an international

forum

B. EXAMPLE - ASSESSING COMMUNITY HAZARDS

- this example describes modeling of community vulnerability to hazardous materials
- there is an increasing concern with the manufacture, storage, transportation, disposal of hazardous materials
 - recent EPA study revealed an average of 5 incidents per day over past 5 years where hazardous materials were released into the environment from small and large production facilities

Anticipatory hazard management

- crucial component in mitigating potential impacts
- determines exact hazard distribution in an area
 - exact locations of sources and zones of potential impact
- determines what can be done to prevent or reduce serious accident
 - identify population distribution, social and economic characteristics
 - needs daytime locations of population as well as residential (night-time) locations
 - identify communication resources and transportation plan for evacuating area
- this example deals with airborne toxic releases
 - occur rapidly, disperse over large area with immediate health effects
 - evacuation more likely needed than for spills into soil or water
 - population at risk may depend on specific substance released
 - needs detailed socioeconomic information - e.g. age of population is a factor in evacuation planning, assessing potential impact because of possible mobility impairment

Hazard zone geometries

- regions defined by level of risk to population, based on proximity to hazards
 - combination of hazard zones produces a potential "contoured risk surface"
- overhead - Hazard zone geometries
- specific geometries include:
 - areas of risk due to production of hazardous materials
 - lines of risk due to hazards of transportation and transmission
 - points of risk produced by consumption

US Superfund Amendments and Reauthorization Act

- US Superfund Amendments and Reauthorization Act (SARA), 1986

Title III - The Emergency Planning and Community Right-to-know Act, covers four aspects of hazards mitigation:

- emergency planning
 - emergency notification
 - community right-to-know and reporting requirements
 - reporting of chemical releases
- third component (community right-to-know) requires companies, organizations to submit emergency and hazardous chemical inventory information - including quantities and general locations

Case study

- Santa Monica, CA selected as case study location
 - is a separate administrative entity within Los Angeles basin
 - city population of 88,300 suited the scale of the prototype study
- community had initiated a community right-to-know law
 - fire department must be informed of any production or storage of over 50 gallons or 500 pounds or 2,000 sq ft of any hazardous material
 - records stored by Police Department
- explores use of GIS for assessing community vulnerability
 - three levels - simple spatial analysis, cartographic modeling and risk assessment modeling

C. DATABASE

- constructed for MAP (Map Analysis Package)
- uses 100 m resolution pixels
 - difficulty of estimating population data for finer resolution because of confidentiality restrictions
 - adequate for airborne toxics
 - soil or water-borne would require finer resolution, different data models (3D and linear objects respectively)
- database includes:
 - hazardous materials locations and descriptions
 - demographic data
 - infrastructure - transportation, sewer lines, landuse
 - physical geography - geologic faults, topography

Hazardous materials

- records maintained by Police Department's Toxic Chemical Coordinator
- hundreds of different types of chemicals reported

overhead - On-site hazardous materials

- some sites had only one chemical - e.g. solvent
- chemical company has many toxic chemicals on site
- genetic engineering company with assorted radioactive materials
- study used UN Classification of Hazardous Materials

overhead - UN Classification of hazardous materials

- categories added to UN classification by the city include:
 - PCBs
 - gunshops

slide 53 - composite map showing presence of hazardous materials by class in 100 m cells

Demographic information

- from 1980 census, includes:
 - age structure - includes classes under 5, 5-15, 15- 65, over 65
 - ethnicity includes classes percent black, white, asian
 - percent non-English speaking
 - population density
- assigned from census tracts to cells assuming uniform density

Urban infrastructure

- includes:
 - locations of all public institutions
 - schools, colleges, hospitals, theaters, shopping centers
 - major street network
 - traffic flow densities
 - storm sewer network
 - includes numbers of catchbasins per 100 m cell
 - major oil pipeline
 - detailed land use map

Physiography

- terrain model at 100 m resolution from 1:24,000 topographic sheet
- allows:
 - tracing of chemicals flushed into storm sewer network
 - use of wind dispersion model

D. ANALYSIS

Simple spatial analysis

slide 54 - create composite map of all hazardous materials, construct 500 m buffer zones (MAP command SPREAD)

slide 55 - composite map of services

slide 56 - overlay of 500 m buffers on services to identify those services in close proximity to hazardous materials

- could identify specific services and specific classes of hazardous materials, e.g. schools and radioactive materials

Cartographic modeling

- cartographic modeling was used to model effects of hazardous materials incidents
- for example, consider the event of a liquid spill:
 - control measures by the fire department would likely include washing the effluent into the storm sewer network
 - during similar previous incidents, vapors within the storm sewer network have risen into buildings
- modeling strategy for assessing impact on schools
 - model flow through storm sewer network using terrain data
 - buffer around network
 - identify impacted schools falling in the buffer

slide 57 - topography of Santa Monica

slide 58 - sewers "draped" over topography (MAP command COVER)

slide 59 - flow forced downhill (under gravity) through storm sewers from assumed origin (beginning of red line in slide) to Santa Monica Bay

- uses the MAP command STREAM with the constraint DOWNHILL

slide 60 - buffer zone of 300 m on either side of path

Risk assessment model

- this represents a first step in developing a comprehensive spatial method for evaluating community vulnerability

overhead - Conceptual risk-assessment model

- note: GIS functions named in this overhead refer to OSU MAP commands
- risk zones were identified:
 - within 500 m of hazardous material site (HAZZONE)

- within 500 m of Santa Monica Freeway (FREEZONE)
- within 300 m of underground storage tank (TANKZONE)
- appropriate distances were determined by consulting toxic chemical information and emergency planning personnel
- uniform distances assumed
- the remainder of the city not in risk zones was eliminated from further consideration (leaves RISKZONES)
- next, examined two components of risk assessment:
 - human component
 - hazardous materials component
- human component has four variables:
 - average population density within 500 m (HAZDEN)
 - need to give greatest weight to areas of highest density
 - number of residents under 5 or over 65 within 500 m (HAZMOBIL)
 - these age groups will need special attention if evacuation is required
 - percent not speaking English as primary language within 500 m (HAZLANG)
 - difficulty of managing evacuation of non- English-speaking minorities
 - adjacency to school site (HAZSCHOL)
- the first three human component variable were weighted based on the original classed data
 - e.g. census classification for percent Hispanic ("non-English speaking" group for this analysis) assigns classes of: 0 - outside database 1 - 1-4% 2 - 5-8% etc
 - these class values were used as the weights for each human component
- these four human component variables then added to create a human hazard potential map (HAZHUMAN)
 - problem with lack of adequate basis for weighting
 - e.g. little research on relative difficulty of evacuating schools, elderly and non-English- speaking populations
- hazardous materials component has four variables, for each cell it is determined:
 - number of hazardous materials within 500 m
 - diversity of materials within 500 m
 - number of underground storage tanks within 500 m
 - maximum traffic flow within 500 m
 - used as a surrogate for transportation hazard of hazardous materials
- variables weighted and added to create composite (HAZSCORE)
 - first three variables weighted directly by value
 - e.g. if a cell had 16 occurrences of hazardous materials within 500 m it had a weight of 16 on the first variable
 - traffic flow weighted by class
- finally, human and hazardous materials components added to create composite risk map

(SCOREMAP), reclassified from an original range of 1-75 into five categories

- highest risks along major traffic arteries due to concentration of industrial sites as well as transportation risk
- note: this analysis was not intended for use in evacuation planning, it was designed only as a planning tool

E. POTENTIAL IMPROVEMENTS TO MODEL

- relative weighting of components in human risk score should be based on research into relative difficulty of evacuating different groups, also relative susceptibility to materials
- relative weighting of components in hazardous materials score should be based on history of previous incidents involving each material, also toxicity of material
- needs plume dispersion model
 - score assumes impact within 500 m in all directions
 - actual impact will depend on wind dispersion of plume
 - need for model to assess likely dispersion based on atmospheric conditions, nature of incident
 - materials have different dispersion characteristics based on e.g. density of vapor
- socio-economic data was based on census tract level
 - errors introduced by assuming uniform density within tract
 - needs finer resolution data for human component
- needs evacuation model which incorporates actual road network, assigns traffic to it and estimates congestion
 - areas should be prioritized based on difficulty of evacuation, size of population and level of risk
- many of these capabilities are available in CAMEO, developed by NOAA for the Macintosh and now widely implemented in US emergency response organizations

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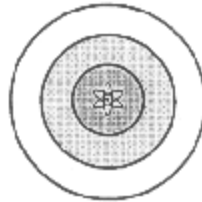
EXAM AND DISCUSSION QUESTIONS

1. Discuss the possible roles of GIS in hazard management, including long-term planning, detailed evacuation planning and management of an actual incident. What GIS functions and data models are most relevant to each role, and what problems can you foresee?
2. Discuss the role of the time dimension in the Santa Monica study. How frequently should the study be updated? What arrangements would be needed to ensure that the database remains valid in the future?
3. The Santa Monica study integrates decision-making and data collection at the city level. Discuss the advantages and disadvantages of organizing hazard management at each level of administrative organization - city, county, state and national. What would you recommend as an optimum level?
4. Discuss the relative advantages of raster and vector models for anticipatory hazard management, using the Santa Monica study as an example.

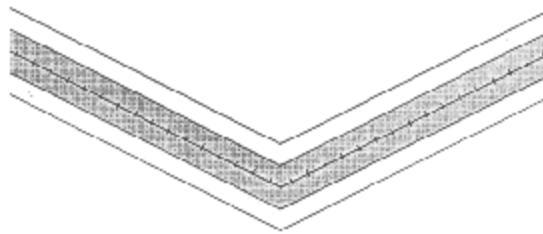
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UNIT 53 IMAGES

Areas Production Hazard
- e.g. nuclear power plant accident



Lines Transportation Hazard
- e.g. toxic chemical transport



Points Consumption Hazard
- e.g. consumption of toxic chemical in food



Hazard Zone Geometries